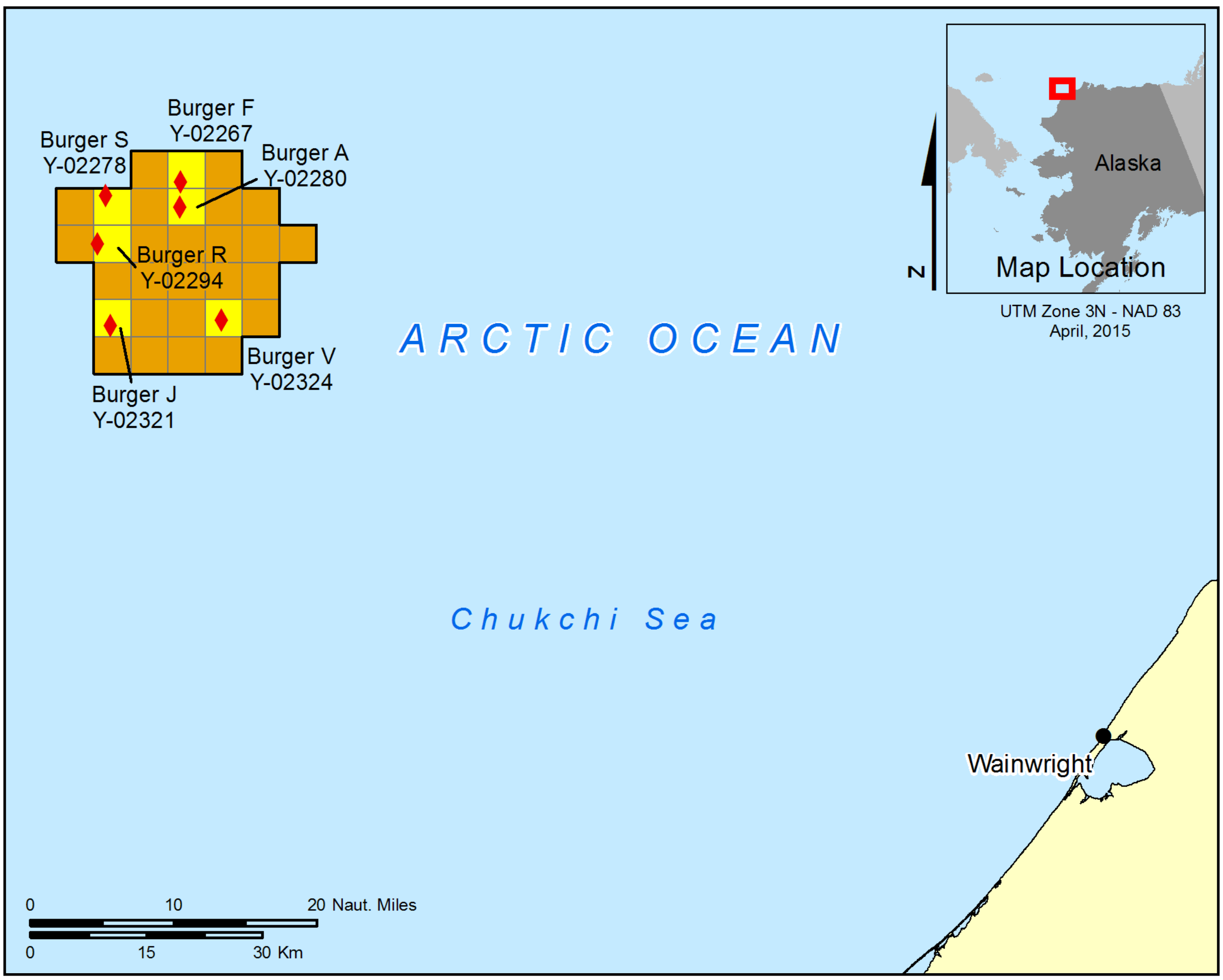
Alaska Outer Continental Shelf

OCS EIS/EA
BOEM 2015-020

Shell Gulf of Mexico, Inc.
Revised Outer Continental Shelf Lease Exploration Plan
Chukchi Sea, Alaska

Burger Prospect: Posey Area Blocks 6714, 6762, 6764, 6812, 6912, 6915
Revision 2 (March 2015)

ENVIRONMENTAL ASSESSMENT



BOEM Bureau of Ocean Energy Management
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Alaska OCS Region

May 2015

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ENVIRONMENTAL ASSESSMENT

Prepared By:
Bureau of Ocean Energy Management
Alaska OCS Region
Office of Environment

Cooperating Agencies:
U.S. Department of this Interior
Bureau of Safety and Environmental Enforcement
Bureau of Land Management

State of Alaska

North Slope Borough

BOEM Bureau of Ocean Energy Management
U.S. Department of the Interior
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Alaska OCS Region

May 2015

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Acronyms and Abbreviations

AAAQS ....Alaska Ambient Air Quality Standards
AAQS ....Ambient Air Quality Standards
ACP ....Arctic Coastal Plain
ADEC ....Alaska Department of Environmental Conservation
ADF&G ....Alaska Department of Fish and Game
AEWC ....Alaska Eskimo Whaling Commission
ANS ....Alaska North Slope
AQCR ....air quality control regions
ASRC ....Arctic Slope Regional Corporation
ASWG ....Alaska Shorebird Working Group
atm ....atmosphere (of pressure)
BA ....Biological Assessment
BACT ....Best Available Control Technology
bbl..................................barrels
bbls/d ....barrels per day
BLM ....Bureau of Land Management
BO ....Biological Opinion
BOEM ....Bureau of Ocean Energy Management
BOEMRE ....Bureau of Ocean Energy Management, Regulation and Enforcement
BOP ....blowout preventer (system)
B.P. ....Before Present
CBS ....Chukchi/Bering Seas stock of polar bears
CEQ ....Council on Environmental Quality
CFR ....Code of Federal Regulations
CO ....carbon monoxide
COMIDA ....Chukchi Offshore Monitoring in Drilling Area
CSESP ....Chukchi Sea Environmental Studies Program (Industry)
CWA..............................Clean Water Act
CZMA ....Coastal Zone Management Act
EA..................................Environmental Assessment
EFH ....Essential Fish Habitat
EIS ....Environmental Impact Statement
EJ ....Environmental Justice
EP ....Exploration Plan
ESA ....Endangered Species Act
FEIS...............................Final Environmental Impact Statement
Final SEIS ....Final Supplemental Environmental Impact Statement
FMP ....Fishery Management Plan
FONSI ....Finding of No Significant Impact
FR ....Federal Register
FWS...............................Fish and Wildlife Service
G&G ....geological and geophysical
Hz ....Hertz
IHA................................Incidental Harassment Authorization
IPCC ....Intergovernmental Panel on Climate Change
IWC ....International Whaling Commission
ITA ....Incidental Take Authorization
ITL.................................Information to Lessees (Clauses)
LA..................................Launch Area
LOA...............................Letter of Authorization
LS ....Land Segment
MAI ....Maximum Allowable Increase
MAWP ....Maximum Allowable Working Pressure

Mbbls............................ thousand barrels
MBTA .... Migratory Bird Treaty Act
Mcf .... thousand cubic feet
MLC .... mudline cellar
MMbbls .... million barrels
MMC .... Marine Mammal Commission
MMcf............................ million cubic feet
MMPA.......................... Marine Mammal Protection Act
MMS............................. Minerals Management Service
NAAQS .... National Ambient Air Quality Standards
NAB.............................. Northwest Arctic Borough
NEPA............................ National Environmental Policy Act
NHPA .... National Historic Preservation Act
NMFS .... National Marine Fisheries Service
NMML.......................... National Marine Mammal Laboratory
NO_2 .... nitrogen dioxide
NOA .... Nearest Onshore Area
NOAA .... National Oceanographic and Atmospheric Administration
NOI............................... Notice of Intent
NO_X .... nitrogen oxides
NPDES .... National Pollutant Discharge Elimination System
NPFMC .... North Pacific Fisheries Management Council
NRC.............................. National Research Council
NSB .... North Slope Borough
NSIDC.......................... National Snow and Ice Data Center
NTL .... Notice to Lessees
O_3.................................. ozone
OCS .... Outer Continental Shelf
OCSLA......................... Outer Continental Shelf Lands Act
ODPCP .... Oil Discharge Prevention and Contingency Plan
OSRP .... Oil Spill Response Plan
PM .... particulate matter
PM_{10}.............................. particulate matter equal to or less than 10 micrometers in diameter
$PM_{2.5}$ .... particulate matter equal to or less than 2.5 micrometers in diameter
Ppm............................... Parts per million
PSD............................... Prevention of Significant Deterioration'
PTS .... Permanent Threshold Shift
ROV.............................. Remotely Operated Vehicle
RUSALCA .... Russian-American Long-term Census of the Arctic
Lease Sale 193 .... Chukchi Sea OCS Lease Sale 193
SBS .... southern Beaufort Sea stock of polar bears
SEIS.............................. Supplemental Environmental Impact Statement
SHPO............................ State Historic Preservation Act
SIP .... State Implementation Plan
SO_X .... sulfur oxides
SO_2............................... sulfur dioxide
SO_4................................ sulfate
SS.................................. Subsea
TOC .... Total organic carbon
TTS............................... temporary threshold shift
TAPS .... Trans-Alaska Pipeline System
TLUI .... Traditional Land Use Inventory
ULSD............................ ultra-low sulfur diesel
USC. .... United States Code
USDOC......................... U.S. Department of Commerce
USDOI .... U.S. Department of the Interior

USEPA ..........................U.S. Environmental Protection Agency
VLOS ....very large oil spill
VOC ....volatile organic compounds
WAH ....Western Arctic (caribou) Herd
WCD..............................Worst Case Discharge
ZVSP ....Zero-offset Vertical Seismic Profile

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1.0 PURPOSE AND NEED

1.1. Introduction

In May 2009, Shell Gulf of Mexico Inc. (Shell) submitted its Chukchi Sea Exploration Plan (EP) to the Minerals Management Service (MMS), predecessor to the Bureau of Ocean Energy Management (BOEM). The 2009 Shell EP identified seven Outer Continental Shelf (OCS) lease blocks (Posey Area Blocks 6713, 6714, 6763, 6764, 6912 and Karo Area Blocks 6864 and 7007) of interest in three prospects (Burger, Crackerjack, and Southwest Shoebill) that contained five potential drill sites (Burger C, F, J, Southwest Shoebill C, and Crackerjack C). MMS subsequently prepared an Environmental Assessment (EA) and in December 2009 issued a Finding of No Significant Impact (FONSI)(MMS, 2009), and MMS conditionally approved Shell's Exploration Plan in 2009.

The exploration drilling activities proposed in the 2009 Chukchi Sea EP included the drilling of an exploration well at up to three of the above-referenced five potential drill sites using the Mobile Offshore Drilling Unit (MODU) Motor Vessel (M/V) *Frontier Discoverer*, which is now known as the M/V *Noble Discoverer* (hereafter "*Discoverer"*). Shell planned to initiate exploration drilling activities under the Chukchi Sea EP in the summer of 2010, but the exploration drilling activities were postponed when the Secretary of the Interior (Secretary) paused all exploration drilling activities in the Arctic following the Deepwater Horizon (BP Macondo blowout) incident in the Gulf of Mexico (GOM).

In May 2011, Shell filed a revised EP (EP Revision 1). This revision included Shell's plan to drill six exploration wells at only the Burger Prospect starting in 2012. BOEM approved EP Revision 1 in December 2011. In 2012, Shell mobilized the *Discoverer* and its support vessels to the Burger A drill site on the Burger Prospect. Burger A was drilled to a depth of 1,505 feet (ft.) and was temporarily abandoned in accordance with the Bureau of Safety and Environmental Enforcement (BSEE) regulations at 30 CFR 250.1721-1723.

1.2. Purpose of the Proposed Action.

In November 2013, Shell filed a revised version of its Chukchi Sea Exploration Plan. In January 2014, the U.S. Court of Appeals for the Ninth Circuit issued an opinion on Lease Sale 193 which resulted in the leases being suspended until BOEM met the requirements of the remand order. BOEM was still allowed to review exploration plans, but no decisions could be rendered on the explorations plans. Based on BOEM's requests for additional information on this EP, Shell submitted another revised version (Draft Revision 2) to BOEM in August of 2014, which replaced the November 2013 revision. On March 31, 2015, Shell filed with BOEM a final Revision 2 document (Shell Gulf of Mexico, Inc., Revised Outer Continental Shelf Lease Exploration Plan Chukchi Sea, Alaska Burger Prospect: Posey Area Blocks 6714, 6762, 6764, 6812, 6915 Chukchi Sea Lease Sale 193, Revision 2 (March 2015) (hereafter "2015 Shell EP" or Shell, 2015a), which includes Shell's plans to resume drilling operations at the currently approved drill sites at the Burger Prospect (Shell, 2015a, Table 1.a-1). This revision includes the additions of another drilling unit, the MODU Transocean *Polar Pioneer* (hereafter "*Polar Pioneer*"), and several additional support vessels. Other differences between the 2015 Shell EP and the approved EP Revision 1 are included in Table 1-1.

The purpose of Shell's Proposed Action is to evaluate the oil and gas resource potential of six leases (OCS-Y-2280, OCS-Y-2267, OCS-Y-2321, OCS-Y-2294, OCS-Y-2278, and OCS-Y-2324) (Figure 1-1). The need for this action is established by BOEM's responsibility under the Outer Continental Shelf Lands Act (OCSLA) to make OCS lands available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs.

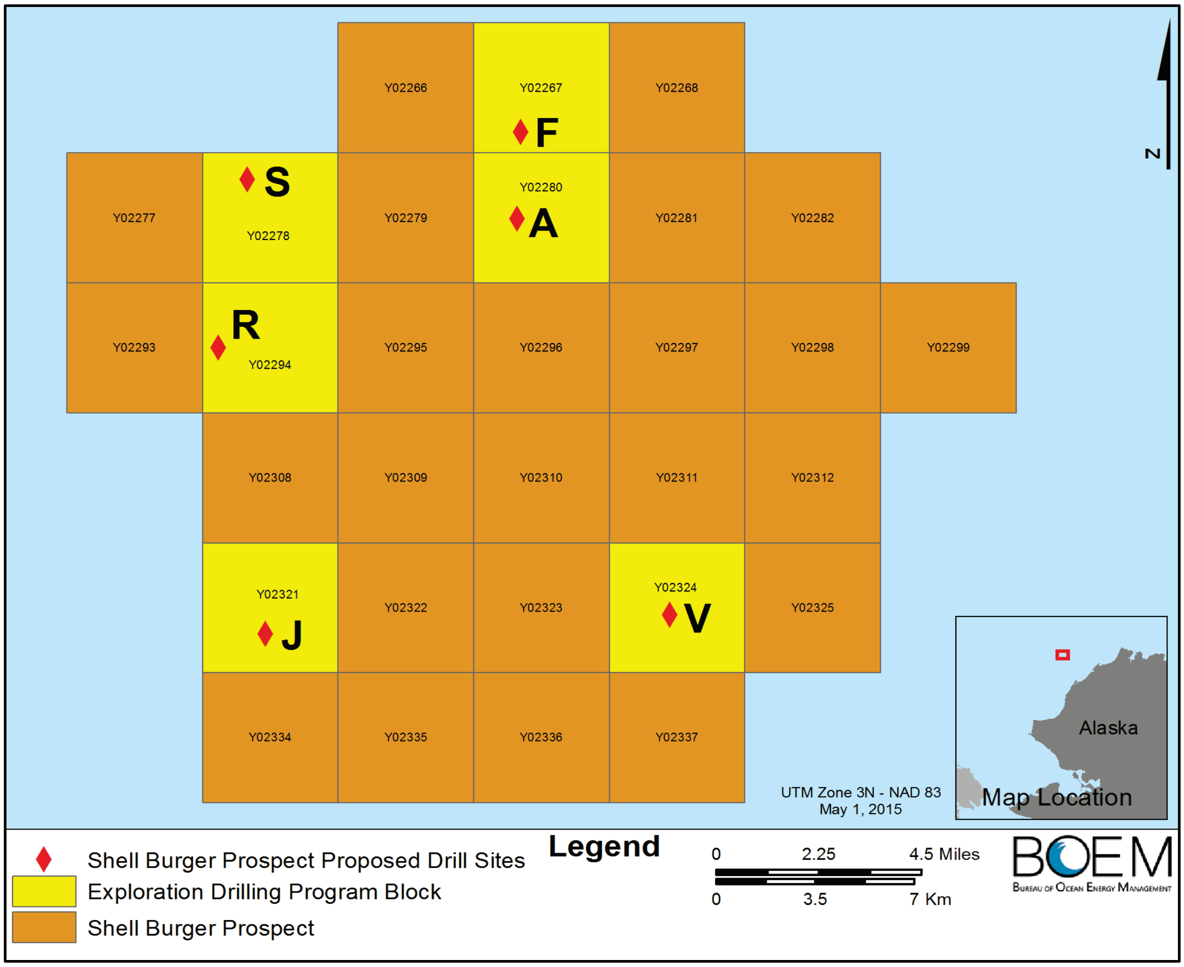

Figure 1-1. Locations of Shell's Proposed Exploratory Drilling in the Chukchi Sea. *The 2012 proposed drilling sites remain in effect.*

BOEM has prepared this Environmental Assessment (EA) to assist with bureau planning and decision making, in accordance with the following:

- The National Environmental Policy Act (NEPA)
- Council on Environmental Quality (CEQ) regulations at 40 CFR 1501.3(b) and 1508.9
- Department of the Interior (DOI) regulations at 43 CFR Part 46
- DOI policy in Section 516 of the Department of the Interior Manual (DM) Chapter 15 (516 DM 15)

1.3. Background

Shell acquired the leases through Chukchi Sea OCS Lease Sale 193 (Lease Sale 193), held in February 2008. Under OCS leasing regulations at 30 CFR 556 and operating regulations at 30 CFR 250.180, a lease expires at the end of its primary lease term unless the lessee is conducting operations on the lease. Shell's leases have a primary term of ten years (30 CFR Part 556.37). Due to litigation, the terms of the leases have been extended commensurate with the time period of the suspension of operations. The leases are now set to expire on October 12, 2020.

After completing a technical and environmental review of the initial 2009 EP, revised 2011 EP, and supporting documents, BOEM issued (on December 7, 2009, and December 16, 2011, respectively)

EAs (USDOI, MMS, 2009a and USDOI, BOEM, 2011a) and Findings of No Significant Impact (FONSI)(USDOI, MMS, 2009b and USDOI, BOEM, 2011b). The EAs and FONSIs are incorporated by reference into this document. The initial EP was approved with conditions on December 7, 2009 and the EP Revision 1 was approved with conditions on December 16, 2011. Table 1-1 compares the previously approved EP Revision 1 and the 2015 Shell EP.

Table 1-1. Comparison of the 2012 Shell EP Revision 1 and the 2015 Shell EP.

Parameter	Approved EP Revision 1	2015 Shell EP
Drilling Units	*Discoverer*	*Discoverer* and *Polar Pioneer*
MLC Construction	*Discoverer*	*Discoverer*, *Polar Pioneer*, MLC ROV system[1]
Support Vessels	Drilling Support Vessels: • Ice Management vessel (x1) • Anchor handler (x1) • OSVs (x2) • Shallow water landing craft (x1) Oil Spill Response Support Vessels: • Oil spill response vessel (OSRV) (x1) • OSR tug (x1) and barge (x1) • Oil storage tanker (OST) for recovered liquids (x1) • Oil spill containment system tug (x1) and barge (x1) • Oil spill containment system Anchor handler (x1)	Drilling Support Vessels: • Ice Management Vessels (x2) • Anchor Handlers (x3) • Supply Tugs (x2) and barges (x2) • OSVs (x3)• Support Tugs (x2) • Science vessels (x2) • Shallow water vessels (x2) • MLC ROV system vessel (x1) Oil Spill Response Support Vessels: • OSRV (x1) • OSR tug (x1) and barge (x1) • OSTs (x2) • Oil spill containment system tugs (x2) and barge (x1) • OSR tug (x1) and barge for nearshore response (x1)
Aircraft	• S-92 or AW139 for crew change • S-61, S92 or EC225 for Search and Rescue (SAR) • Fixed wing aircraft for protected species observer (PSO) flights • Fixed-wing aircraft – crew change from Wainwright to regional jet service in Barrow	• S-92 Helicopters (or similar) for crew change (x3) • S-92 Helicopter (or similar) for SAR • Fixed wing aircraft for PSO and ice monitoring flights (x2) • Fixed-wing– crew change from Wainwright to regional jet service in Barrow
Aircraft Flights	• Helicopter Crew Change Flights- Approximately 12 round trips/week for crew change/resupply • Fixed wing aircraft for PSO • Fixed wing aircraft crew change between Barrow & Wainwright up to 4 times per week	• Helicopter Crew Change Flights- Approximately 40 round trips/week for crew changes/resupply • Fixed wing aircraft for PSO and ice monitoring flights daily • Fixed wing aircraft crew change between Barrow and Wainwright once every 3 weeks
Drilling Unit Discharges	Discharges as listed in Section 6 of EP Revision 1	Revised discharges volumes/rates in Section 6 of 2015 Shell EP
Drilling Unit Authorizations	EPA issued National Pollutant Discharge Elimination System (NPDES) exploration facilities General Permit (GP) AKG-28-0000 for the Burger drill sites.	Notices of Intent (NOI) to discharge certain wastes at the Burger drill sites were filed with EPA under the new NPDES exploration facilities GP AKG-28-8100
Drilling Fluid Components	List of approved components are in Table 6.c-1 of EP Revision 1	Additional drilling components have been added and are in Tables 6.c-1 and 6.c-2 of EP Revision
Drilling Fluid Recycling	Drilling fluids to be recycled from well to well as practicable.	Drilling fluids will not be recycled from well to well.
Drilling Fluid Cooling	Drillings fluids will be cooled.	Drilling fluids will not be cooled.
BOP Test Frequency	Performance (pressure) test every 7 days	Pressure test every 14 days as per BSEE regulation at 30 CFR 250.447(b)
Shorebase	Barrow – 75 person man camp	• Barrow – lease 40 person man camp; add a kitchen unit to the 75 person man camp; add hangar space for an additional helicopter • Wainwright – additional existing yard space has been leased for response equipment storage

Parameter	Approved EP Revision 1	2015 Shell EP
Secondary Relief Well Unit for the *Discover*	*Kulluk*	*Polar Pioneer* will serve as secondary relief well unit for *Discoverer*, and *Discoverer* will serve as secondary relief well unit for *Polar Pioneer*
Air Emissions Authorization	Air emissions approved by EPA under authorization R10OCS/PSD-AK-09-01	BOEM has jurisdiction for air emissions authorization and the authorization will be addressed pursuant to BOEM regulations.
Containment System Location	Centrally located in the Chukchi Sea or Beaufort Sea	Located in or near Goodhope Bay within Kotzebue Sound
H_2S Classification	Requested 'H_2S Unknown' classification	Requests 'H_2S Absent' classification from BSEE; H_2S Contingency Plan removed

Note: [1] There are two options for construction of the mudline cellar: MLC ROV or traditional drill bit technology (MLC Bit). In their 2015 NPDES application to the EPA, Shell did not request authorization to discharge the higher volumes associated with the use of the MLC ROV. Further review and analysis would be needed by EPA before discharges can occur from the MLC ROV.

Source: 2015 Shell EP, Table 1-1.

Shell submitted its the 2015 Shell EP under BOEM operating regulations at 30 CFR 550 Subpart B. Shell proposes to drill up to six exploration wells on six leases, all of which are located on the Burger Prospect. Exploration activities would commence as soon as the 2015 open-water drilling season begins (generally July 1st) and would continue in subsequent open-water seasons until completion of the six-well plan. Shell would conduct its drilling operations using the ice-strengthened MODUs M/V *Noble Discoverer* (*Discoverer*) and *Polar Pioneer*.

In support of the 2015 Shell EP, Shell submitted:

- An environmental impact analysis (EIA) as Appendix C of the 2015 Shell EP (Shell, 2015a, Appendix C)
- Chukchi Sea Regional Exploration Program Oil Spill Response Plan (OSRP)(Shell, 2013) for the drilling program
- Environmental information and reports
- Site-specific geohazards survey data and assessment
- A Plan of Cooperation (POC) addendum to reduce potential conflicts with subsistence activities (Appendix D)
- A description of Shell's Cultural Awareness and Environmental Awareness Programs
- Other mitigation measures
- Other information as required by BOEM regulations and lease stipulations

BOEM has completed a technical and environmental review of the 2015 Shell EP and supporting information to ensure the proposed activities would be conducted in a manner that is consistent with protection of the human, marine, and coastal environments.

1.4. Previous Applicable Analyses

This Environmental Assessment has been prepared to analyze Shell's exploration activities in the Chukchi Sea. The EA is a site-specific analysis of potential impacts that could result with the implementation of a Proposed Action or alternatives to the Proposed Action. The appropriate level of NEPA review depends on the OCSLA stage (516 DM 15), the scope of the proposed activities, and the agency's findings on the potential effects of the proposed activities. The EA assists BOEM in ensuring compliance with NEPA and in making a determination as to whether any "significant" impacts could result from the analyzed actions. "Significance" is determined by the consideration of context and intensity of the impacts. BOEM has completed numerous NEPA reviews of Chukchi Sea

OCS activities. Recent NEPA reviews relevant to the Proposed Action analyzed here include the following:

- Final Second Supplemental Environmental Impact Statement – Chukchi Sea Planning Area Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska (OCS EIS/EA BOEM 2014-669) (USDOI, BOEM, 2015a) (hereafter "2015 Second SEIS")
- Final Supplemental Environmental Impact Statement – Chukchi Sea Planning Area Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska (OCS EIS/EA BOEMRE 2011-041) (USDOI, BOEMRE, 2011) (hereafter "2011 SEIS")
- Environmental Assessment -- Shell Gulf of Mexico, Inc., 2012 Exploration Drilling Program, Burger Prospect, Chukchi Sea Planning Area, and Finding of No Significant Impact (OCS EIS/EA BOEM 2011-061) (USDOI, BOEM, 2011a)
- Environmental Assessment – Shell Gulf of Mexico, Inc., 2010 Exploration Drilling Program, Burger, Crackerjack, and SW Shoebill Prospects, Chukchi Sea Outer Continental Shelf, Alaska, and Finding of No Significant Impact (OCS EIS/EA MMS 2009-061) (USDOI, MMS, 2009)
- Final Environmental Impact Statement – Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea (OCS EIS/EA MMS 2007-026) (USDOI, MMS, 2007) (hereafter "2007 FEIS")

These documents are available on the BOEM Alaska Region website at http://www.boem.gov/ak-eis-ea/. Relevant sections of these documents are summarized and incorporated by reference into this EA. This EA tiers from the 2007 FEIS (USDOI, MMS, 2007), the 2011 SEIS (USDOI, BOEMRE, 2011), and the 2015 Second SEIS (USDOI, BOEM, 2015a).

This EA also summarizes and incorporates by reference relevant information and analysis from the following documents:

- Revised Outer Continental Shelf Lease Exploration Plan Chukchi Sea, Alaska (2015 Shell EP)(Shell, 2015a)
- January 20, 2015 Biological Assessment (BA) to NMFS (USDOI, BOEM, 2015c)
- January 20, 2015 BA to U.S. Fish and Wildlife Service (USFWS)(USDOI, BOEM, 2015b)
- Letter of Authorization (LOA) and Incidental Harassment Authorization (IHA) Applications
- USFWS Biological Opinion for Oil and Gas Activities Associated with Lease Sale 193 (USDOI, USFWS, 2015) (hereafter "2015 USFWS BO").

1.5. Statutory Framework

Shell's proposed exploration drilling activities are subject to an established regulatory framework that includes Federal laws and regulations. Some, but not all, of the statutory framework governing oil and gas exploration on the OCS are listed below. A more detailed treatment of these requirements and how they relate to the Proposed Action is provided in the 2011 SEIS, Section I.D, and the 2012-2017 Five-Year Program EIS, Appendix C (http://www.boem.gov/2012-2017-FEIS-PDF/).

- BOEM and Bureau of Safety and Environmental Enforcement (BSEE) Regulations
- Outer Continental Shelf Lands Act
- Endangered Species Act
- Marine Mammal Protection Act
- Clean Water Act

- Oil Pollution Act of 1990
- National Historic Preservation Act
- National Invasive Species Act
- Magnuson-Stevens Fishery Conservation and Management Act

Water Quality Regulations

The water quality in the Chukchi Sea is consistent with the national recommended water quality criteria, established by EPA pursuant to Section 304(a) of the Clean Water Act, and no waterbodies within the Arctic region are identified as impaired (CWA, Section 303) by the State of Alaska (ADEC, 2011). EPA regulations at 40 CFR 125.121 define when marine discharges may cause an unreasonable degradation of the marine environment. Additionally, Section 403 of the Clean Water Act requires that any NPDES permit for discharge into the territorial seas, the contiguous zone and the oceans - including the outer continental shelf - satisfy the guidelines set out in Section 403(c). The Section 403 guidelines also require that EPA conduct an ODCE to make the determination of unreasonable degradation (40 CFR 125.121). This determination considers the following ten criteria (40 CFR 125.122):

- The quantities, composition, and potential for bioaccumulation or persistence of the pollutants to be discharged.
- The potential transport of such pollutants by biological, physical, or chemical processes.
- The composition and vulnerability of the biological communities that may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain.
- The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the lifecycle of an organism.
- The existence of special aquatic sites including, but not limited to, marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas, and coral reefs.
- The potential impacts on human health through direct and indirect pathways.
- Existing or potential recreational and commercial fishing, including finfishing and shellfishing.
- Any applicable requirements of an approved Coastal Zone Management Plan. (Note: The State of Alaska does not currently have an approved Coastal Zone Management Plan.)
- Such other factors relating to the effects of the discharge as may be appropriate.
- Marine water quality criteria developed pursuant to Section 304(a)(1).

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1. Summary of Alternatives

2.1.1. Alternative 1 – No Action

Under Alternative 1 – No Action, BOEM would not approve Shell's proposed exploration drilling activities. This alternative would delay or preclude Shell from evaluating potential hydrocarbon resources of certain lease blocks acquired under Chukchi Sea Lease Sale 193. This alternative would also delay or avoid potential environmental impacts associated with the Proposed Action area.

2.1.2. Alternative 2 – The Proposed Action

Under Alternative 2 – Proposed Action, BOEM would approve, with appropriate conditions, Shell's proposal to drill six exploration wells within the Burger Prospect. Activities could occur on up to six leases acquired in Chukchi Sea Lease Sale 193. These leases are OCS-Y-2280, OCS-Y-2267, OCS-Y-2321, OCS-Y-2294, OCS-Y-2278, and OCS-Y-2324 (Figure 1-1). Precise location of the drill sites is captured in Table 2-1, below. Shell proposes to commence drilling the wells during the open-water-season (July through October) of 2015 and would continue during subsequent open water seasons until all six wells are completed. Shell would conduct drilling operations from the *Discoverer* and the *Polar Pioneer.* Drilling operations would be supported by additional vessels for ice management, anchor handling, refueling, crew transport and supply, and spill response.

2.1.3. Alternative 3 – Early Season Start

Under Alternative 3 – Shell would transit through the Bering Strait and begin operations in the Burger Prospect prior to July 1. The presence of open water (<10% ice coverage, as defined in Section 3.1.3 of this EA) throughout the burger prospect area would trigger Shell to begin the early transit. This alternative could reduce the negative impacts and risks associated with oil and gas activities over several seasons by providing Shell a longer drilling season and thus opportunity to complete more work in a single season, potentially reducing the number of seasons required to complete all six wells. This alternative would require Shell to obtain a variance from the USFWS Incidental Take Regulations as described in 50 CFR 18.118(a)(4).

2.2. Other Alternatives Considered But Not Analyzed

The following concepts were considered as potential alternatives, but were not carried forward for full analysis. BOEM considered comments from the public notice of EA preparation for the the 2012 Shell EP Revision 1, public comments on the Call for Information and Nominations for Chukchi Sea OCS Oil and Gas Lease Sale 237, the proposed Requirements for Exploratory Drilling on the Arctic Outer Continental Shelf, Environmental Assessments completed by the BOEM Gulf of Mexico Region (GOMR) office, and reports from the PEW Charitable Trust on Anthropogenic Sound and Marine Mammals in the Arctic, Arctic Traditional Knowledge Brief, and Recommendations on Oil Spill Prevention, Response, and Safety in the U.S. Arctic Ocean.

In addition to the above, BOEM considered several additional alternatives raised by public comment concerning BOEM's preparation of this EA:

- Cease drilling before fall migration of beluga and bowhead whales. (Addressed below under: "Season end of September 30")
- Prevent the use of remote operated vehicles to drill mudline cellars. (The use of ROVs actually results in a total of less suspended solids; the predicted TSS concentrations from the MLC ROV excavation would be approximately one-half the point-source discharge of the MLC Bit—See Section 4.2.2 Impacts to Water Quality).

- Cease drilling well before winter sea ice could encroach as was the requirement in 2012. (Addressed in Section 2.3 Proposed Mitigation Measure).
- Limit drilling one well per summer; restrict waste disposal; limiting activities in the Hanna Shoal area. (Addressed in this section, Section 4.2.2 Impacts to Water Quality; and Section 4.2.6 Impacts to Marine Mammals, respectively.)
- Cease drilling before the fall migration of beluga whales and bowhead whales into the Chukchi Sea and before walruses gather on coastal haulouts. (Addressed below under "Season end Sept.30").
- Prevent the use of remote operated vehicles to drill mudline cellars. (Addressed above; see Section 4.2.2 Impacts to Water Quality.)

The comments for Lease Sale 237 suggested geographically-based deferrals as alternatives, as did the alternatives in the GOMR EAs, neither of which are appropriate for an Exploration Plan.

Alternatives suggested for the 2012 Shell EP Revision 1 EA included an early season halt to drilling, limiting Shell to drilling two wells per summer, and restricted discharge similar to the 2012 Shell EP Revision 1 for the Beaufort Sea. Both a one well per season and a one drilling rig in operation at a time alternative are examined in this section. Restricted discharges would not result in a measurable reduction in impacts to Water Quality, Fish, Lower Trophics, or Subsistence Harvest practices, which means is does not present a viable alternative although this could still be considered as a mitigation measure.

Other sources suggested mitigation measures to reduce the impacts of sound to marine mammals including seasonal restrictions on sound generating activities during times of high marine mammal concentrations, ramping equipment up slowly, vessel traffic speed limits, the use of "quieting technologies," and conducting additional studies.

An alternative Proposed Action that includes seasonal restrictions on sound-generating activities during times of high marine mammal concentrations would not result in measurably different impacts than those described for the current action alternatives because Shell has committed to scheduling drilling support activities so as to avoid interference with subsistence harvests (Shell, 2015, Sections 2.0 and 11.0, Appendix B). Subsistence harvests generally correspond with times of high marine mammal concentrations. In addition, Shell anticipates drilling units and support vessels will enter the Chukchi Sea through the Bering Strait on or about July 1, minimizing effects to marine mammals and birds that frequent open leads.

Ramping equipment up slowly. An alternative Proposed Action that includes ramp-ups would not result in measurably different impacts than those described for the current action alternatives. Ramp-up procedures are typically recommended or required when conducting seismic activities to avoid temporary reduction in hearing sensitivity or permanent hearing damage to marine mammals. The source levels for exploration drilling and related support activities are not high enough to cause such impacts (NMFS, 2015, Section 2.3). Consequently, mitigation as described for seismic activities including ramp ups, power downs, and shut downs should not be necessary for exploration drilling activities. ZVSPs are a type of seismic survey and under the current alternatives Shell will conduct ramp-up procedures during ZVSPs (Shell, 2015, Appendix B).

Vessel traffic speed limits. An alternative Proposed Action that includes vessel traffic speed limits more restrictive than those already committed to by Shell and required by MMPA authorizations would not result in measurably different impacts than those described for the current action alternatives. The current action alternatives already include vessel speed limits and operational restrictions when in the vicinity of certain marine mammals or in inclement weather, both as required by MMPA authorizations and as independently proposed by Shell as a mitigation measure (e.g., Shell, 2015, Section 12.0 and 13.0).

The use of "quieting technologies." An alternative Proposed Action that includes quieting technologies would not meet the Purpose and Need for this action because quieting technologies such as bubble net curtains or other damping devices have been found to perform poorly or are still considered unproven and need further investigation (Ayers, Hannay, and Jones, 2010; Stafford, 2013).

Conducting additional studies. An alternative Proposed Action that includes conducting additional studies would not result in measurably different impacts than those described for the current action alternatives because Shell already plans to conduct several types of studies as part of the Burger Prospect drilling program (Shell, 2015, Sections 10.0 and 11.0, Appendices B, C, and E). Shell also plans to continue funding of, and participation in, additional Chukchi Sea marine resource studies, including walrus and seal tagging studies, collection of data on marine subsistence use areas, and other baseline chemical, physical, and biological baseline studies. Shell has participated in these studies since 2006 (see Shell, 2015, Section 5 for a summary of study reports).

Hanna Shoal protections/Ceasing operations prior to Bowhead migration and walrus haulout. An alternative Proposed Action that includes ceasing operations prior to the fall bowhead whale migration (which passes through the Burger Prospect area; the spring migration occurs much closer to shore) and prior to walrus haulouts on ice at Hanna Shoal or on land along the U.S. Chukchi Sea coastline result in substantial temporal limitations on drilling activities. Walruses haul out on pack ice in the vicinity of Hanna Shoal as early as June and continue to forage in the Hanna Shoal area through September, moving to land-based haulouts when sea ice over the continental shelf disappears (in August through September in recent years) (Jay et al., 2012). The fall bowhead whale migration through the Chukchi Sea typically begins in late September (LGL, 2007 in Shell, 2015, Appendix C). Combined, these two events would restrict drilling activities during the entire open-water season, which would not answer the Purpose and Need of allowing for development of OCS resources

NMFS Considered Alternative (NMFS, 2015d, Draft Environmental Assessment):

Season end on Sept 30. An alternative Proposed Action that includes conclusion of operations in the Chukchi Sea on September 30 would not result in measurably different impacts to marine mammals than those described for Alternative 1 – No Action. An earlier departure from the project area would shorten the period of time during which the drilling program could occur. A shorter period of disturbance could decrease the probability of impacts and the number of marine mammals impacted and would result in a lower level of effects per season. The fleet would exit the Chukchi Sea prior to the main pulse of the fall bowhead and beluga whale migrations. NMFS analyzed the same alternative for their 2015 Draft Environmental Assessment for the Issuance of an Incidental Harassment Authorization for the Take of Marine Mammals by Harassment Incidental to Conducting an Exploration Drilling Program in the U.S. Chukchi Sea and concluded for both the Preferred Alternative (the same as the one presented in the 2015 BOEM EA for the Shell EP) and the September 30th end date Alternative that "Overall, impacts to marine mammals are anticipated to have minor to moderate effects. Impacts would only occur during the time that the animals are in the ensonified areas and are not anticipated to persist for long periods of time.

An earlier end to the drilling season could be beneficial for the subsistence harvest practiced in Barrow and Wainwright. Crew transport and other vessel traffic connected to the Proposed Action would not continue into October, which is when the fall bowhead whale hunt for Wainwright takes place. In Barrow, the fall bowhead whale hunt has started in September, but extends well into October. The impacts of October operations would, however, be mitigated by communication and agreements between Shell and these communities. Therefore, the overall difference in impacts between a September end to the drilling season and a mid-late October end would not be measurable.

2.2.1. One Well Per Season

The the 2012 Shell EP Revision 1 EA considered an alternative where Shell would limit exploration drilling to one well drilled to total depth per season. Multiple mudline cellars and "spuds" (a type of partial well where an initial casing is set) may be drilled in a given season, but Shell could only access the hydrocarbon-bearing zone or zones of one well per year. The analysis of this alternative indicated that although impacts to resources would be somewhat less per season due to the reduced duration of drilling operations per season, this slight beneficial impact would be negated by having impacts repeated each year for six consecutive years rather than, potentially, only two to three. This alternative would also spread the risk of a spill over six years rather than over two to three years. Furthermore, Shell's leases will expire in less than six years (October 20, 2020), leaving them with six potential drilling seasons, including 2015. A one well per season restriction could thus preclude accomplishment of the Proposed Action. (although it is noted that leases may be extended under certain regulatory provisions at 30 CFR 556.73 (see 30 CFR 250.171)).

2.2.2. One Drilling Unit

An alternative that considers only one drilling unit operating at a time was also considered. This alternative is similar to the One Well Per Season alternative in that it would repeat impacts over additional seasons and thus lead to greater overall adverse environmental effects over the course of the Proposed Action. These conclusions were reached based upon BOEM's analysis of the Proposed Action in the the 2012 Shell EP Revision 1 EA (which considered one rig operating per season for the same drilling sites), consideration of new information developed since publication of that EA, and the analysis of the Proposed Action in this EA. Furthermore, Shell's leases will expire in less than six years (approximately 5.5 years from publication of this EA unless the regulatory provisions of 30 CFR 250.171 are executed), leaving them with six potential drilling seasons, including 2015. Considering the unpredictable conditions in the Arctic and prior experience from 2012, it is reasonable to assume that Shell may not be able to fully complete one well each season if it is restricted to using only one drilling unit. If Shell misses that target, and the regulatory provisions of 30 CFR 250.171 are not executed, it would not be able to complete its program before the leases expire. Therefore, a one drilling unit alternative would not meet the purpose and need of the action when taking into consideration BOEM's mandate under OCSLA to allow for expeditious development of OCS resources, subject to environmental safeguards, and the lessee's objective to drill six exploration wells on the Burger Prospect.

2.2.3. Alternative Technologies

An alternative considered but not further analyzed is the use of alternative technologies to explore the oil and gas potential of the six leases identified for potential exploration. BOEM is unaware of any alternate techniques that would serve the purpose of the Proposed Action.

2.2.4. Adaptive Seasonal Restrictions

BOEM also considered developing adaptive seasonal restrictions to determine the end of each year's drilling season. Ice, weather, and other important environmental conditions vary between drilling seasons. Utilizing real-time measurements of ice, weather, and other environmental conditions, it may be possible to make more informed, yearly determinations on how long drilling operations could safely proceed. Adaptive seasonal restrictions could effectively shorten or lengthen a given drilling season, depending on actual conditions.

This concept is not carried forward for full analysis as an alternative within this EA. The 2015 Shell EP states that exploratory activities will cease on or about October 31st of each year. This independent limitation renders moot the advantages of potentially extending the drilling season should ice conditions prove favorable. Meanwhile, BOEM and BSEE already possess continuing authority over all exploratory activities on the OCS (see USDOI, BOEM, 2011a, Appendix F). If ice or other environmental conditions rendered continued exploration unsafe, BOEM and BSEE would use their existing authority to order Shell to cease exploratory activities prior to October 31st. Thus, mechanisms already exist to protect human safety and the environment in the event of unfavorable conditions.

2.2.5. Reduced Discharge

Stakeholders have also expressed concern that several waste streams associated with the proposed exploration activities—drilling fluids, drilling muds (hereafter called drilling fluids), and drilling cuttings—could lead to water quality impacts and bioaccumulation (particularly within animals harvested during subsistence activities). To address these concerns, stakeholders suggested that BOEM restrict the amount and type of wastes to be discharged, and offered Shell's reduced discharge plan for exploration drilling in the Beaufort Sea as a model for what BOEM should require as a condition of approval for the 2015 Shell EP.

The EPA recently analyzed potential impacts associated with discharges authorized under the Chukchi exploration NPDES general permit. This analysis, called the Ocean Discharge Criteria Evaluation (ODCE), was completed in compliance with the Clean Water Act Section 403. Based on the analysis in the ODCE, EPA concluded that the discharges, with the effluent limitations, requirements, and restrictions established by the general permit, that the discharges would not result in an unreasonable degradation of the marine environment.

In relevant portions of this EA, however, potential effects associated with the discharge of drilling fluids, and drilling cuttings are analyzed, particularly sections analyzing potential impacts to water quality, fish, lower trophic levels, and marine mammals. These analyses find that any effects on water quality, lower trophic levels, and fish would be localized and minor. Any impacts to marine mammals would be negligible. No threats to subsistence resources or public health were identified.

Due to the low level of impacts associated with these discharges, a reduced discharge alternative is not carried forward for full analysis within this EA.

2.3. Proposed Mitigation Measure

BOEM's Environmental Assessment (EA) of the 2015 Shell EP proposes a mitigation measure that, if implemented, would further address risks associated with late season drilling by assuring a greater opportunity for spill response and cleanup. More specifically, the proposed mitigation measure entails up to a 38-day drilling hiatus during which time no exploratory drilling operations would be allowed below the last casing point set prior to penetrating a zone capable of flowing liquid hydrocarbons in measurable quantities. The 2015 Shell EP assumes that both drilling units will be drilling at the Burger Prospect, in which case the estimated duration of flow prior to drilling a relief well to intersection with the original wellbore and killing the flow is approximately 34 days (six days to mobilize and moor and 28 days to kill the well). Should one drilling unit be as far away as Dutch Harbor, an additional four days will be required for the relief well, bringing total duration of uncontrolled flow to 38 days (10 days to mobilize and moor and 28 days to kill the well). The drilling hiatus would become effective up to 38 days prior to a "trigger date" which corresponds to BOEM's estimate of when seasonal ice may encroach within 30 kilometers of the six proposed drill sites. This measure is similar to a mitigation measure analyzed in BOEM's 2012 Shell EP Revision 1 EA (BOEM 2011-061) and implemented as a condition of BOEM's approval of the 2012 Shell EP Revision 1 (December 2011).

The latest version of this mitigation contemplates several refinements in how the "trigger date" is derived, as compared with version analyzed in 2011 during the review of the 2012 Shell EP Revision 1. This section explains those improvements and their rationale.

2.3.1. Background

In its 2011 Environmental Assessment of the 2012 Shell EP Revision 1, BOEM analyzed a proposed mitigation measure that contemplated a late season "drilling hiatus," during which certain limited activities – i.e. drilling into hydrocarbon zones – would be prohibited. This measure was intended to "further address risks associated with late season drilling by assuring a greater opportunity for spill response and cleanup," and to "[mitigate] the environmental impacts in the unlikely event of an oil spill." Three options – each representing a drilling hiatus of varying duration – were proposed and analyzed. Later, in its approval of the 2012 Shell EP Revision 1, BOEM instituted Condition No. 4, which in turn implemented an early drilling hiatus 38 days before the end of season. This period is calculated backwards from a "trigger date" which represents a conservative estimate of when ice may encroach upon the drilling area. For a more complete discussion of these concepts, see Section 2.3 of the BOEM's 2011 EA and Condition No. 4 of BOEM's December 16, 2011, letter approving, with conditions, the 2012 Shell EP Revision 1.

2.3.1.1. 2012 Drilling Hiatus

Shell commenced its exploration drilling activities in the Chukchi Sea during the summer of 2012, subject to a late season drilling hiatus to become effective as early as September 24th – 38 days prior to that season's trigger date of November 1st. Consistent with the aforementioned provision, Shell provided BOEM – and its expert partners at National Weather Service – with frequent updates regarding ocean conditions throughout the 2012 drilling season. Shell's scientists also provided the government with periodic estimates, couched by appropriate caveats and varying confidence levels, of the expected date of freeze-up. The question of whether the trigger date should be adjusted was later rendered moot by Shell's inability to field certain key oil spill response assets, and BSEE's resulting decision not to allow Shell to drill into hydrocarbon zones. Nonetheless, BOEM considered this innovative and collaborative process which transpired during the summer of 2012 to be a model for using the latest science to inform decision-making and adaptively manage activities. Eventually, persistent ice encroached upon the Burger site on November 1, 2012 – the very date estimated by BOEM.

2.3.2. Improved Methodology

In light of the continuing concerns associated with drilling into hydrocarbon zones in the late season period preceding the annual incursion of persistent sea ice and the success of the drilling hiatus concept during the 2012 drilling season, BOEM again proposes a mitigation measure that, if implemented, would create a late season "drilling hiatus." While the intent and effect of the drilling hiatus remains unchanged, BOEM proposes several improvements to the "trigger date" calculation. These refinements are consistent with the statement in Section 2.3 of the 2011 EA that "Consistent with adaptive management principles, BOEM would continue to collect more and better data as technology improves, and would refine its calculations accordingly."

The first notable change is the consideration of a ten-year data set instead of a five-year dataset. This change enables consideration of a larger statistical sample and reduces the influence of outlier years on both ends of the spectrum.

The second notable change is the consideration of "median" calendar dates instead of "earliest" calendar dates. BOEM calculated the median calendar dates of first ice encroachment for the six closely proposed drill sites to range between November 1st and November 3rd. The use of median data is considered more statistically significant than data reflective of either extremity of the dataset. According to BOEM's calculations, the median calendar date of ice encroachment varied between November 1st and November 3rd amongst the six potential drill sites, even though all the potential drill sites are in close proximity to one another. BOEM's refined methodology specifies that the earliest of the six median calendar dates would constitute the "trigger date" for all wells.

2.3.3. Proposed 2015 Drilling Hiatus

The refined methodology utilized in developing the 2015 EA results in up to a 38-day drilling hiatus calculated backwards from a proposed 2015 trigger date of November 1. This date continues to represent a conservative estimate of ice first encroachment on the drilling areas, for the following reasons:

- Due to climate change, the general long term trend is for later freeze-up in future years as compared to past years.
- BOEM's methodology considers any ice encroachment within 30 km of a proposed well as encroachment upon that drill site.
- The methodology considers any concentration and type of ice, including types and concentrations of ice in which industry may safely drill a relief well.
- The earliest of the median calendar dates associated with ice encroachment on any proposed drill site is applied uniformly as the "trigger date" for all drill sites on the Burger Prospect since the proposed sites are in proximity to one another, and have similar atmospheric, oceanographic, and sea ice conditions

Each year, BOEM would calculate a new date for each site where Shell planned to conduct exploration drilling into hydrocarbon bearing zones. BOEM would calculate the trigger date using the best information available. Currently, BOEM uses records of previous year daily ice edge from the U.S. National Ice Center. The innovative process which transpired during the summer of 2012 may in fact be used as a model for using the latest science to inform decision-making.

2.4. The Proposed Action (Alternative 2)

2.4.1. Overview

Shell's proposal is to use the MODUs *Discoverer* and *Polar Pioneer* to complete a six-well exploration drilling program at locations on the Burger Prospect in the Chukchi Sea (see Table 2-1). For analysis purposes, BOEM assumes that all six wells would be drilled; however, the information on the subsea geology and properties of the potential reservoir formations obtained from drilling the initial wells may result in Shell's canceling subsequent wells, submission of a revised EP to relocate subsequent well sites, or decision to file a Development and Production Plan. Shell's proposed activities would be conducted during the open-water season to avoid difficult ice conditions. No shallow hazards or archaeological and historical resources are present at these drill sites.

Table 2-1. Shell Proposed Lease Blocks and Drill sites – 2015 Shell EP.

Proposed Drill Site	Posey area Block	Lease Number	Coordinates (meters [m])[1]		Latitude	Longitude
			X	Y		
Burger A	6764	OCS-Y-2280	563945.26	7912759.34	N71° 18' 30.92"	W163° 12' 43.17"
Burger F	6714	OCS-Y-2267	564063.30	7915956.94	N71° 20' 13.96"	W163° 12' 21.75"
Burger J	6912	OCS-Y-2321	555036.01	7897424.42	N71° 10' 24.03"	W163° 28' 18.52"
Burger R	6812	OCS-Y-2294	553365.47	7907998.91	N71° 16' 06.57"	W163° 30' 39.44"
Burger S	6762	OCS-Y-2278	554390.64	7914198.48	N71° 19' 25.79"	W163° 28' 40.84"
Burger V	6915	OCS-Y-2324	569401.40	7898124.84	N71° 10' 33.39"	W163° 04' 21.23"

Note: Shell Lease Blocks and Drill Sites, found in the 2015 Shell EP, are the same as the 2012 sites. (Protraction NR03-02)
[1] Coordinate system is North American Datum 1983 (NAD 83) UTM Zone 3
' = minute
" = second

Source: Shell, 2015a, Table 1.a.1.

The drilling units would move through the Bering Strait and into the Chukchi Sea on or about July 1st, and would continue on to the Burger Prospect as soon as ice and weather conditions allow. Once the drilling vessel is mobilized to a drill site and securely anchored to the seafloor, drilling operations commence. Exploration drilling activities may continue until approximately October 31, ice conditions permitting.

Shell plans to drill exploration wells to a total depth (TD) below objective depth at each of the six possible drill sites. Shell may also elect to construct additional mudline cellars (MLCs), using the drilling units or the MLC remotely operated vehicle (ROV) system, and upper hole segments (i.e., "partial holes") using the drilling units, depending on the available time remaining through the drilling season. However, for the 2015 open water season, the drill bit system (MLC Bit) will be used to construct the mudline cellar. If the final well in a drilling season cannot reach objective depth by the end of the drilling season, the well will be suspended in compliance with applicable BSEE regulations and with the approval of the BSEE Regional Supervisor of Field Operations (RSFO).

No unfinished wellbore will remain open at the end of the final drilling season except in an emergency, but any well drilled during any season will be left at the end of any season in a status approved by the BSEE RSFO. If a hazardous condition occurs while drilling and requires curtailment of critical operations (or prevents initiating them, depending on the time available) operations will be conducted per the provisions of the 2015 Shell EP Critical Operations and Curtailment Plan (Shell, 2015a, Appendix F). Any well on which exploration drilling operations are suspended at the end of any drilling season will be secured and permanently abandoned prior to lease termination.

A well may also be started, temporarily abandoned due to ice, weather, or other conditions, and finished later in the same drilling season during the period covered by the 2015 Shell EP. This was an operational reality during the 1989–1991 Chukchi Sea exploration drilling period. The actual number of wells that will be drilled in a season will depend upon ice conditions and the length of time available in each exploration drilling season. The predicted "average" drilling season, constrained by prevailing ice conditions and regulatory restrictions, is long enough for a drilling unit to drill an exploration well from spud to proposed total depth (PTD) and possibly construct an additional mudline cellar (MLC) or drill and secure a partial well. Once the objective intervals are fully evaluated, each exploration well will be plugged and abandoned in compliance with BSEE regulations.

Certain conditions may trigger a suspension of activities at a drillsite prior to concluding exploration drilling activities there. Shell presents procedures for monitoring and reacting to ice in the prospect areas within its Critical Operations and Curtailment Plan (COCP) and Drilling Ice Management Plan (DIMP), which are attached as Appendices F and G of the 2015 Shell EP (Shell, 2015a). If certain conditions of the COCP are triggered by environmental conditions at a drill site, Shell would suspend drilling operation, secure the well, and move offsite if necessary. The well would either be drilled to completion later that season, during a subsequent season, or secured and permanently abandoned prior to lease termination. The uppermost part of any equipment remaining in an abandoned well will remain below the deepest known ice gouge depth below the mudline.

Shell's proposed operations must comply with applicable Federal, State, and local laws, regulations, and permit requirements. Shell's proposed operations must also comply with all lease stipulations included within Chukchi Sea OCS Lease Sale 193. BOEM and BSEE retain specific authority to require additional mitigation (including shut down) as appropriate to respond to actual conditions encountered. In addition, Shell will have trained personnel and monitoring programs in place to ensure such compliance. BOEM, BSEE, and other Federal regulatory agencies would maintain continuing oversight of all of Shell's exploration activities. The following are the major applicable permits and authorizations that impose mandatory requirements and collectively ensure safety, protect the environment, avoid interference with subsistence resources and activities, and otherwise mitigate potential adverse impacts:

- Permit to Drill, issued by BSEE
- Shell Chukchi Sea Regional OSRP (Shell OSRP), reviewed and accepted by BSEE
- Safety and Environmental Management System reviews and audits by BSEE
- Ongoing inspections by BSEE
- National Pollutant Discharge Elimination Systems (NPDES) General Permit under the Clean Water Act (CWA), issued by the U.S. Environmental Protection Agency (EPA)
- Incidental take authorizations (either Letter of Authorization [LOA] or Incidental Harassment Authorization [IHA]) issued separately by NMFS and USFWS
- Nationwide Permit No. 8 coverage under the Rivers and Harbor Act, administered in relevant part by the U.S. Army Corps of Engineers (USACE)
- State Historic Properties Office concurrence with BOEM finding of No Historic Properties Affected

2.4.2. Drill Sites and Operating Environment

More specific information on the locations of the proposed drill sites is provided in Table 2-1. Water depth at each location is approximately 150 ft or less (Shell, 2015a, Figures 1.b-3 through 1.b-8). The community in closest proximity to the planned exploration activities is Wainwright, roughly over 60 miles to the southeast. Shell retains the proposed drilling locations from the 2012 Shell EP Revision 1 (Shell, 2011).

2.4.3. Seafloor Conditions at the Drill Sites

BOEM regulations (30 CFR 550.214) require an assessment of shallow hazards prior to drilling or installing mobile drilling units for offshore oil and gas activities. Geophysical surveys conducted over potential drilling sites are analyzed to identify potential shallow hazards and conditions that would pose engineering constraints. A hazard is defined as a feature or condition that presents difficulties that cannot be easily mitigated by design, implementation, or procedures. A constraint is defined as a feature or condition that presents difficulties but can be mitigated by design, implementation, or procedures.

In 2008 and 2009, Shell conducted shallow hazards surveys at each of the six planned drill sites. Shallow hazards survey reports and assessments for each drill site were submitted to BOEM under separate cover in April 2009. No shallow hazards or archaeological and historic resources are present at these sites. Additional information regarding shallow hazards surveying at the Burger Prospect is provided in Sections 1.3 and 1.4 of the 2015 Shell EIA (Shell, 2015, Appendix C).

These leases are located on the relatively shallow continental shelf of the Chukchi Sea. The seafloor in the vicinity of each proposed well is largely flat, nearly featureless, and predominately composed of sandy mud. While ice gouges exist near several of the drill sites, they do not appear to have occurred within the last 20 years. One possible exception exists at Burger J, where “fresh-looking” gouge is reported. Additional information on bathymetry and relief at the drill sites is provided in the 2015 Shell EIA (Section 3.2.1).

2.4.4. MODUs, Support Vessels, Oil Spill Response Vessels, and Aircraft

In this 2015 Shell EP, Shell plans to drill all six exploration wells using either the *Discoverer* and/or the *Polar Pioneer*, operating simultaneously, where only the *Discoverer* was included in EP Revision 1. The *Discoverer* is ice-strengthened for operation in Arctic OCS waters and includes drilling and well control equipment. The *Polar Pioneer* is a non-self-propelled semi-submersible drilling unit capable of drilling in the arctic, and also includes drilling and well control equipment. In the event of a well control incident that called for drilling a relief well, each drilling unit will serve as its own primary relief well drilling unit and as the secondary relief well drilling unit for the other drilling unit.

The *Discoverer* is a turret-moored self-propelled MODU (Figure 2-1). Station keeping is accomplished using a turret- moored, 8-point anchor system. The underwater fairleads prevent ice fouling of the anchor lines. Turret mooring allows orientation of the vessel's bow into the prevailing metocean conditions to present minimum hull exposure to drifting ice. The vessel is rotated around the turret by hydraulic jacks. Rotation can be augmented by the use of the fitted bow and stern thrusters. Ice-strengthened sponsons have been retrofitted to the MODU's hull.

Figure 2-1. M/V *Noble Discoverer*. *Photo provided by Shell (2015).*

The *Polar Pioneer* (Figure 2-2) is a non-self-propelled, "single point mooring thruster assisted" semisubmersible offshore drilling unit of twin-hull configuration. The rig is classed by Det Norske Veritas (DNV) as a "+ A1 Column Stabilized Unit" and is capable of performing drilling operations offshore of Alaska. Positioning is accomplished with a combination of an eight-point all chain catenary mooring system and thruster assisted mooring system.

Figure 2-2. *Polar Pioneer*. *Photo provided by Shell (2015).*

The *Polar Pioneer* was built in 1985, with unlimited operation area, in accordance with the Norwegian Maritime Directorate and to DNV regulations, current at that time. While operating in Norwegian waters, the installation, with its inventory, equipment, crew and machinery was required to comply with current rules and regulations for operation on the Continental Shelf of Norway.

Detailed specifications for the *Discoverer* and the *Polar Pioneer* are provided in the 2015 Shell EP (Shell, 2015a: Table 1.c-1).

Drilling Support Vessels:

- Ice Management Vessels (x2)
- Anchor Handlers (x3)
- Supply Tug and barges (x2)
- OSVs (x3)
- Support Tugs (x2)
- Science vessels (x2)
- Shallow water vessels (x2)
- MLC ROV system vessel (x1)
- Oil Spill Response Support Vessels:
- OSRV (x1)
- OSR tug and barge (x1)
- OSTs (x2)
- Oil spill containment system tug and barge (x1)
- OSR tug and barge for nearshore response (x1)

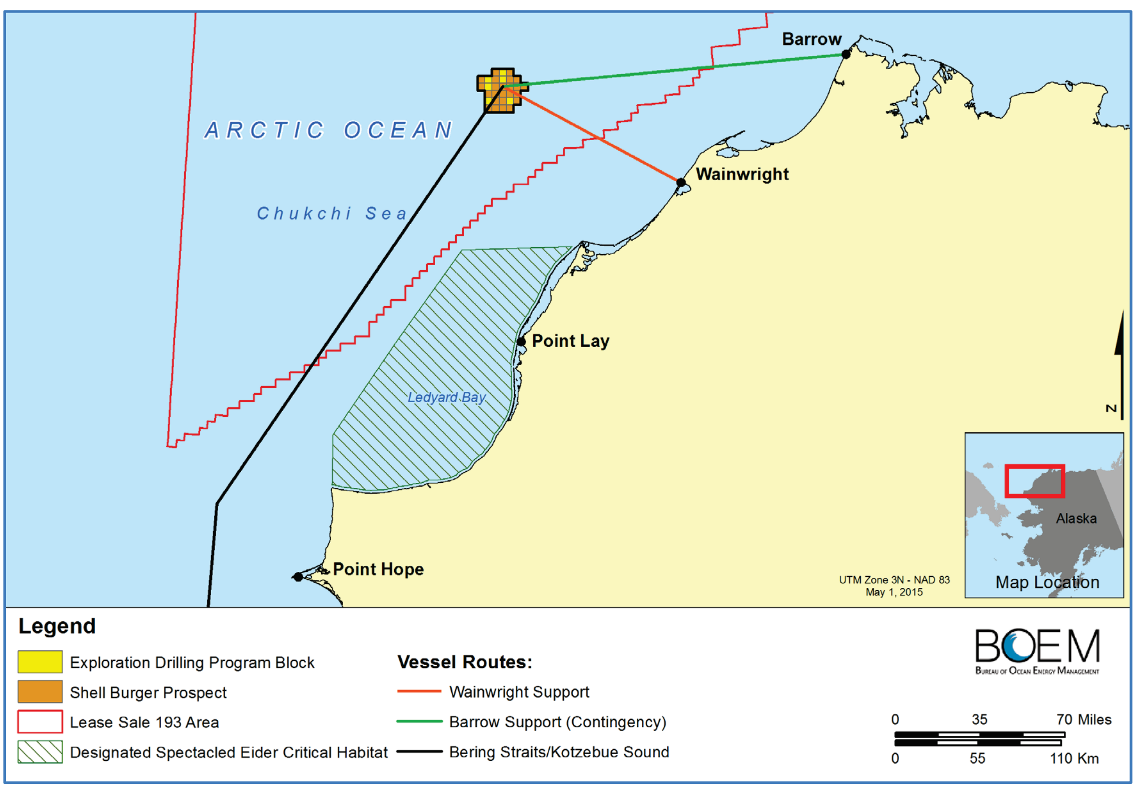

Figure 2-3. Approximate Marine Transit Routes for Support Vessels.

Figure 2-3 depicts approximate transit routes for support vessels.

Aircraft to be used in support of the Action Alternatives. Anticipated transit routes are depicted in Figure 2-4.

- S-92 Helicopters (or similar) for crew change
- S-92 Helicopter (or similar) for SAR
- Fixed wing aircraft for PSO and ice monitoring flights
- Fixed-wing– crew change from Wainwright to regional jet service in Barrow

Aircraft flights include:

- Helicopter Crew Change Flights
- Approximately 40 round trips/week for crew changes/resupply
- Fixed wing aircraft for PSO and ice monitoring flights daily
- Fixed wing aircraft crew change between
- Barrow and Wainwright once every 3 weeks
- Wainwright (contingency only)

Figure 2-3 depicts approximate transit routes for support vessels.

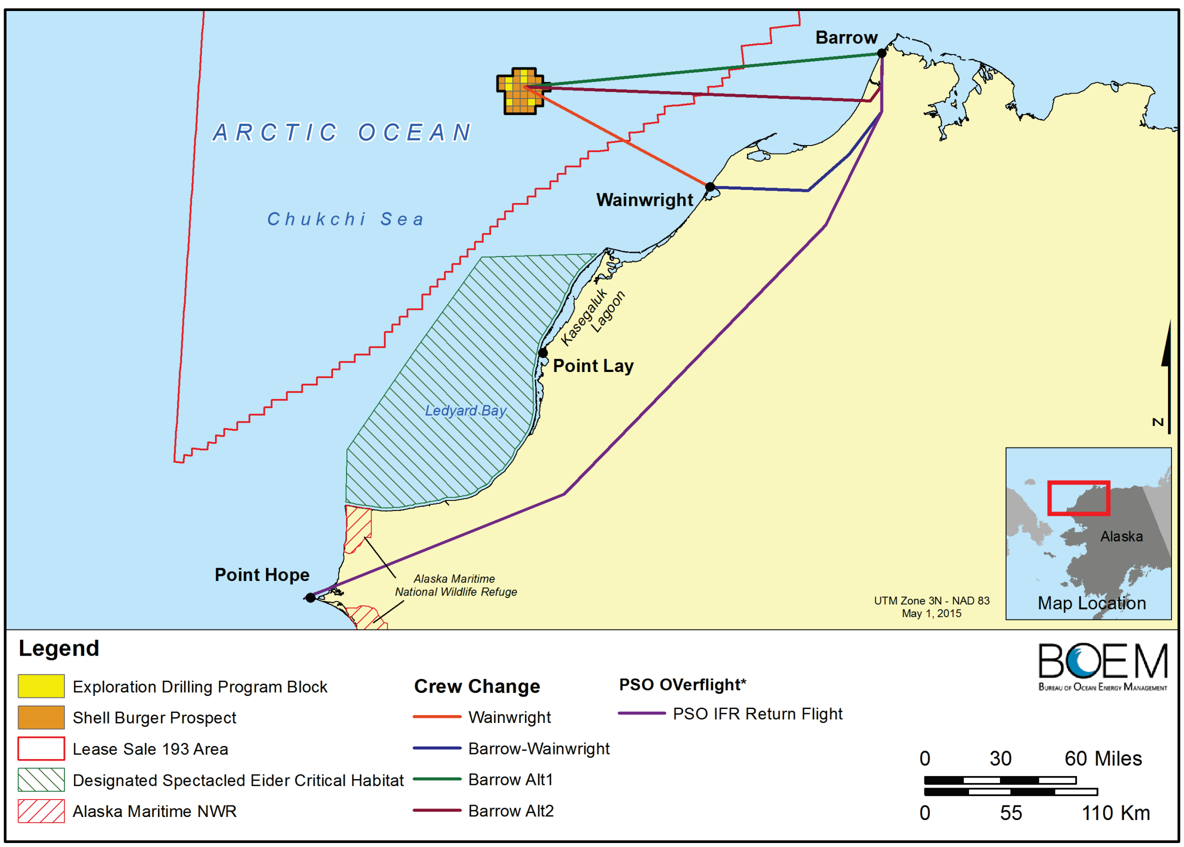

Figure 2-4. Approximate Travel Routes for Aircraft.

2.4.5. Discharges and Waste Management

The *Discoverer* and the *Polar Pioneer* will discharge several types of waste during exploration activities. These wastes include drill cuttings, spent drilling fluids, cuttings from water based intervals, domestic wastewater, excess cement, brine water from a desalination unit, (uncontaminated) deck drainage, noncontact cooling water, uncontaminated ballast water, (treated) bilge water, blow out preventer (BOP) fluid, treated sanitary wastewater, boiler blowdown, and fire control system test water. The drilling fluids to be discharged are water based mud (WBM) drilling fluids and may contain cuttings with adhered WBM. Spent drilling fluids will be discharged after each well is drilled to TD because of space restrictions on the drilling units and the need for multiple drilling fluid types. Additional information regarding these discharges, including quantities of discharges, is provided in Section 6.0 of the 2015 Shell EP and Section 2.7 of Shell's EIA. All discharges would require authorization by EPA under the Chukchi Exploration NPDES General Permit (AKG-28-8100).

Support vessels will discharge domestic waste, ballast water, bilge water, deck drainage, and treated sanitary waste. However, no untreated sanitary waste will be discharged, and no treated sanitary waste water will be discharged within three miles of the coastline. Vessel discharges within the OCS are subject to the requirements established by the U.S. Coast Guard pursuant to the Clean Water Act Section 312.

Certain non-combustible, non-hazardous wastes will be transported to shore and disposed of in an approved landfill. Regulated wastes (i.e. paint, solvents, unused chemicals, batteries, lamps, used oil, and glycol) will be transported to a licensed facility.

2.4.6. Sound Generation

Several components of the Proposed Action would introduce sound into the environment. These are summarized below and described in more detail by Shell (2015, Appendix C, Section 2.9).

2.4.6.1. Drilling Sound

Shell measured the sounds produced by the *Discoverer* while drilling on the Burger Prospect in 2012. A broadband (10 Hz – 32 kHz) source level of 182 dB was calculated for the *Discoverer* based on the measurements recorded when drilling the 26-inch hole interval. Radii to other received sound energy levels based on a best-fit relationship of these measurements are provided in Table 2-2.

Table 2-2. Radii to Other Received Sound Energy Levels.

Received Level	Drilling 26-inch Hole [1,2]	Support Vessel in DP[3]	MLC Drilling[1]	Ice Management [1,4]	Anchor Handling [1,5]
> 190 db	< 10 m	<64 m	< 10 m	< 10 m	< 10 m
> 180 db	< 10 m	<64 m	< 10 m	< 10 m	20 m
> 170 db	< 10 m	<64 m	20 m	20 m	60 m
> 160 db	< 10 m	<64 m	71 m	60 m	180 m
> 150 db	30 m	64 m	250 m	200 m	530 m
> 140 db	100 m	260 m	870 m	730 m	1,600 m
> 130 db	390 m	1,100 m	2,800 m	2,600 m	4,700 m
> 120 db	1,500 m	4,500 m	8,200 m	9,600 m	14,000 m

Notes: [1] Based on linear fit to average sound levels recorded at 4 ranges at Burger A in the Chukchi Sea in 2012; source: JASCO 2014

[2] Drilling with the *Discoverer*

[3] Based on measurement of Nordica on DP from 2013; source: Shallow Hazards Survey 90 day report, Chapter 4

[4] Ice management as conducted by the Tor Viking

[5] Measurements of anchor handling using the anchor handler Tor Viking mooring the Kulluk were collected in Beaufort Sea 2012.

Although Shell plans to conduct sound source verification (SSV) on the vessels which did not have a prior SSV in the Chukchi Sea, measurements of the sound energy generated by the *Polar Pioneer* are currently unavailable; however, sound measurements of some semi-submersibles are available in the literature. Greene (1986 *In* Richardson et al., 1995) reported measured sound energy levels generated by a semi-submersible, the SEDCO 708, while drilling in 374 ft. (114 m) of water in Bering Sea (Table 2.9-2). The SEDCO 708 is similar in size and shape to the *Polar Pioneer*. Sound measurements for two other semi-submersible drilling units were also found in the literature and the estimated source levels are presented in Table 2.9-3 of the EIA. This data and others indicate that semi-submersibles generate less underwater sound energy when drilling than drillships, probably because the rig floor and engines are on a platform elevated above the sea surface. It is therefore likely that the *Polar Pioneer* will generate less underwater sound when drilling than the *Discoverer*. Further information on the modeling of sound with two drilling units operating simultaneously, as well as additional support vessels and aircraft, is provided in Section 2.9 of the EIA.

2.4.6.2. Vertical Seismic Profile

Shell proposes to conduct Vertical Seismic Profile (VSP) for each well drilled (see Section 2.4 of Shell's EIA). A VSP gathers geophysical data in the well which is used to correlate to or "tie-in" the geophysical data collected during previous seismic surveys over the prospect. During a VSP, an airgun array is deployed at a location near or adjacent to the drilling vessel, while receivers are placed (temporarily anchored) in the wellbore. The airguns function by venting high-pressure air into the water. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by oscillation of the resulting air bubble. The sizes, arrangement, and firing times of the individual airguns in an array are designed and synchronized to suppress the pressure oscillations subsequent to the first cycle.

Shell proposes to conduct a particular form of VSP known as a zero-offset VSP (ZVSP), in which the sound source is maintained at a constant location near the wellbore. A typical sound source that may be used by Shell for its ZVSP surveys is an eight-airgun array which consists of four 150-in^3 airguns and four 40-in^3 airguns for a total size of 760 cubic inches. For each survey, Shell would use a crane to deploy the sound source over the side of the MODU to a depth of about 10-23 feet below the water surface. The receiver would be temporarily anchored in the wellbore at the appropriate depth. The sound source is then pressured up to 2,000 pounds per square inch and activated 5-7 times at approximately 20-second intervals. This process is then repeated with the receivers positioned at other portions of the wellbore until the entire exploration well is surveyed. Depending on the depth of the well and the number of anchoring points, a typical ZVSP survey is conducted during a period of about 10-14 hours.

Recorded sound levels from a similar array that was used during a 2008 seismic survey in the Beaufort Sea are discussed in Section 2.9 of the 2015 Shell EIA and are provided in Table 2-3. See Table 10.b-1 of the 2015 Shell EP for the number of potential exposures of cetaceans and pinnipeds (w/out Pacific walruses and polar bears) to received sound levels in the water of >120 dB rms generated by exploration drilling and >160 dB rms generated by ZVSP surveys during each exploration drilling season. This table compares estimate of no turnover of marine mammal populations to estimates assuming 100% daily turnover of individuals in areas exposed to Level B thresholds.

Table 2-3. Sound Source (airgun array) Specifications for ZVSP Surveys in the Beaufort.

Received Sound Level	Distance to Received Sound Level (Radius)	
190 dB re1μPa @ 1 m	1,719 ft	524 m
180 dB re1μPa @ 1 m	4,068 ft	1,240 m
160 dB re1μPa @ 1 m	12,041 ft	3,670 m
120 dB re1μPa @ 1 m	34,449 ft	10,500 m

2.4.6.3. Vessel Sound

A number of additional vessels would support the drilling units and drilling operations. Each of these vessels would contribute sound to the environment. Vessel sounds have been reported extensively (Greene and Moore, 1995; Blackwell and Greene 2002, 2005, 2006). Numerous measurements of underwater vessel sound have been performed in support of recent industry activity in the Chukchi and Beaufort Seas. Results of these measurements were reported in various 90-day and comprehensive reports since 2007. For example, Garner and Hannay (2009) estimated sound pressure levels of 100 dB at distances ranging from approximately 1.5-2.3 mi (2.4-3.7 km) from various types of barges. MacDonald et al. (2008) estimated higher underwater sound pressure levels from the seismic vessel *Gilavar* of 120 dB at approximately 13 mi (21 km) from the source, although the sound level was only 150 dB at 85 ft (26 m) from the vessel. Like other industry-generated sound, underwater sound from vessels is generally characterized by low frequencies.

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross, 1976). Propeller cavitation and singing are produced outside the hull, whereas propulsion or other machinery noise originates inside the hull. There are additional sounds produced by vessel activity, such as pumps, generators, flow noise from water passing over the hull, and bubbles breaking in the wake. Shell measured the sounds produced by support vessels while drilling on the Burger Prospect in 2012 (Bisson et al., 2013). Measured radii to received sound energy levels (SELs) (including ≥190 dB, ≥180 dB, ≥160 dB, and ≥120dB) for support vessels are provided in Tables 2.9-1 and 2.9-4 of the 2015 Shell EIA. All vessel noise decreased to 160 dB within 0.3 mi from the source and to 120 dB within <6 mi from the source.

Icebreakers contribute greater sound levels during ice-breaking activities than ships of similar size during normal operation in open-water (Richardson et al., 1995a). This higher sound production results from the greater amount of power and propeller cavitation required when operating in thick ice. Shell does not intend to break ice with its ice management vessels unless ice poses an immediate safety hazard at the drill site. The ice management vessels will instead push ice out of the area. Measured radii to sound levels (including ≥190 dB, ≥180 dB, ≥160 dB, and ≥120dB) for ice management activities conducted by the *Tor Viking* during the 2012 Shell EP Revision 1 drilling program on the Burger Prospect are provided in Table 2.9-1 of Shell's 2015 EIA.

2.4.6.4. Aircraft Sound

Several aircraft would support the *Discoverer* and *Polar Pioneer* drilling operations and introduce sound into the environment. The level and the duration of received underwater sounds depends on the altitude and aspect of the aircraft, receiver depth, and water depth. In general, received sound levels decrease as the altitude of the aircraft increases. Tables 2.9-6 and 2.9-7 of the 2015 Shell EIA provide detailed information for each type of aircraft supporting Shell's exploration activities.

2.4.7. Local Hire.

Under the Proposed Action, Shell proposes to hire local residents in some positions, as discussed below:

Protected Species Observers

Shell would employ Protected Species Observers (PSOs) to conduct vessel-based monitoring for marine mammals throughout exploration drilling operations. These PSOs will be trained, experienced field observers. The PSOs will be stationed aboard the MODUs and associated support vessels throughout the exploration drilling period. Their duties would include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the exploration drilling operations; initiating mitigation measures where appropriate; and reporting the results.

Subsistence Advisors

Shell proposes to hire Subsistence Advisors (SAs) in each of the villages along the Chukchi Sea, as well as Kotzebue. Shell would share information and maintain a dialogue with each SA, so that conflicts with subsistence may be minimized or avoided.

Community Liaison Officer

The CLO program includes community liaisons in Wainwright, Point Hope, Point Lay, Barrow, Kaktovik, Nuiqsut, Kotzebue, Nome, and Dutch Harbor that would serve as Shell's point of contact for questions regarding Shell activities and programs in the area.

Communications and Call Centers

Shell also proposes to employ local community members at its Community and Call Centers (Com Centers). These Com Centers will serve as information clearinghouses and enable communications between Shell operations and vessels, local subsistence users, and SAs.

Shell has also indicated that it would employ local residents as staff at its shorebase and, if necessary, contingency oil spill responders.

2.4.8. Analysis of Accidental Oil Spills.

No large or very large oil spills are estimated to occur as a result of the proposed exploration drilling activities. As explained below and in Appendix A (see Section A-2, p. A-2), the chance of a large or very large oil spill during exploration drilling is statistically small—since 1971, there has been one large/very large crude oil spill from a loss of well control during temporary abandonment out of more than 15,000 exploratory wells drilled. Therefore, in this document, BOEM analyzes only small spills (<1,000 bbl) specific to the Proposed Activities—see details below.

But as the Deepwater Horizon incident has demonstrated, rare accidents can occur. Each resource section in the 2015 Second SEIS (BOEM, 2015a) analyzes potential effects of large (≥1,000 bbl) or very large (≥150,000 bbl) oil spills. In the 2015 Second SEIS (BOEM, 2015), BOEM created a hypothetical scenario covering exploration and development activities occurring over a 77 year period. According to this scenario, there is a 75% chance of one or more large spills (>1,000bbl) occurring over the 77 year period; however, the data show that a large spill in the relatively short exploration phase of this period is statistically unlikely (see Appendix A, Section A-4.1.4).

To arrive at a spill volume and oil type for small (<1,000 bbl), large (≥1,000 bbl), and very large (≥150,000 bbl) spill size categories, BOEM used Shell's potential discharge volumes (Shell, 2015a, Appendix C, Table 2.10-1), summarized in Table 2-4 and in Appendix A of this EA. The potential discharge volumes are estimated without consideration of mitigation or response efforts. Mitigation and response are discussed in Sections 2.4.10 through 2.4.11 of this EA. Shell estimated a worst case discharge (WCD) volume (23,100 per day for Burger J). Shell's OSRP is designed to handle 25,000 bbl per day, with a total capacity of 750,000 bbl (i.e., 25,000 bbl/day for 30 days) Shell provided this estimate to BOEM and BSEE (USDOI, BOEM, 2011a, Appendix H). BOEM concurs on geologic grounds with Shell's assertion that the Burger J well offers the highest potential discharge volume in both daily rate and cumulative flow. BOEM also independently modeled the WCD for Shell's Burger J well and verified that Shell's estimate is sufficient (USDOI, BOEM, 2011a, Appendix H). BOEM's WCD calculation assumes no "bridging over" – a phenomenon whereby rocks, sand, clay and other debris can clog the hole and stop the blowout.

Table 2-4. Spill Volume and Oil Type Estimated for Each BOEM Spill Size Category.

BOEM Spill-Size Categories	Type	Oil Type	Potential Discharge Volume[1]	Volume estimated to reach water
Small (<1,000 bbl)	Fuel Transfer	Diesel	5-48 bbl	5-48 bbl

BOEM Spill-Size Categories	Type	Oil Type	Potential Discharge Volume[1]	Volume estimated to reach water
Large (≥1,000 bbl)	Diesel Tank	Diesel	1,555 bbl	0 bbl
Very Large (≥150,000 bbl)	Loss of Well Control	Crude Oil	750,000 bbl	121,779 bbl[2]

Notes: [1]Total volume estimated with no mitigation or response
[2]Total volume estimated with mitigation and response as described in Sections 2.4.10 and 2.4.11 of this EA.
Source: 2015 Shell EIA (Shell, 2015a, Appendix C).

BOEM determined a reasonably foreseeable spill analysis scenario for Alternative 1 – No Action, Alternative 2 – Proposed Action, and Alternative 3 –Early Season Start. To determine the specific elements of the oil spill scenario BOEM reviewed and considered published documents and NEPA assessments on the likelihood of the potential discharges in the three spill size categories. BOEM evaluated the potential impact producing factors of two small accidental oil spills for this EA. Further analytical details are found within Appendix A of this EA.

For purposes of analysis of Alternative 1 – No Action, no small, large, or very large spills are estimated to occur in the project area as a result of Alternative 1 since no exploration activities associated with drilling would occur.

For purposes of analysis of Alternative 2 – Proposed Action and Alternative 3 – Early Season Start, BOEM estimates it is likely a small refined oil spill could occur. This estimate is based on consideration of historical exploration spill sizes in the Arctic OCS and OCS oil-spill data which indicated that 99.3% of all OCS spills are <50 bbl (Anderson, Mayes, and LaBelle, 2012). Thirty-six small exploration spills have occurred while drilling 35 wells and two top holes on the Arctic OCS. During the time of this exploratory drilling, industry has had thirty-six small spills totaling 26.7 bbl or 1,120 gallons (gal). Of the 26.7 bbl spilled, approximately 24 bbl were recovered or cleaned up (USDOI, BOEM, 2015a, Appendix A, Table A.1-2). No large spills (≥1,000 bbl) or very large spills (≥150,000 bbl) are estimated to occur (based on calculations and analyses presented in Appendix A of this EA) from the proposed exploration activities.

The large and very large crude oil spill occurrence estimates are based on the following: (1) the low rate of OCS exploratory drilling well-control incidents spilling crude oil per well drilled; (2) the fact that since 1971, one large/very large crude oil spill has occurred from a loss of well control during temporary abandonment out of more than 15,000 exploratory wells drilled; (3) the low number (up to six) of exploration wells proposed in this action; (4) the fact that no crude oil would be produced and the wells would be permanently plugged and abandoned; (5) the history of Arctic OCS exploration spills, all of which have been small; (6) the fact that no large spills occurred while drilling 35 wells to depth in the Arctic OCS; and (7) pollution prevention and oil spill response regulations and methods implemented by BOEM, BSEE and Shell, respectively, since the *Deepwater Horizon* event.

Given the points made above, the most likely spill size that could occur is a small (<1,000 bbl) spill. For purposes of analysis, BOEM estimates up to two small spills could occur. BOEM chose a 48 and 5 bbl diesel fuel-transfer spill (as identified in Shell's Summary of Potential Discharges) to represent the range of spill volumes and oil type for the effects analysis of a small spill(s) for Alternative 2 – Proposed Action and Alternative 3 – Early Season Start (Shell, 2015a, Table 2.10-1; Shell, 2013, Appendix M). The spills do not occur in the same space and time. All the oil reaches the environment; the vessel or facility absorbs no oil. There is no reduction in volume due to cleanup or containment. (Pollution prevention, containment, and cleanup is analyzed separately as mitigation.) The spill(s) could occur at any time of the exploration operations (July–October). The spill(s) could occur in the Burger Area or Kotzebue Sound. These types of small spills were analyzed in the 2015 Second SEIS (USDOI, BOEM, 2015a, Appendix A).

To evaluate the potential effect of a 48 or 5 bbl diesel-fuel oil spill, BOEM estimated how much diesel fuel would evaporate, how much diesel fuel would naturally disperse, and how much diesel fuel would remain after a certain time period. The SINTEF oil weathering model (OWM) was used to generate these estimates (Reed et al., 2004). A 48 or 5 bbl diesel-fuel spill could evaporate and disperse in less than 3 or 1 days, respectively (Appendix A, Table A-7 and Shell, 2015a, Table 2.10-2). Should a 48 or 5 bbl diesel-fuel spill occur, the spill would be localized and persist less than 3 or 1 days, respectively. The SINTEF OWM estimates do not include the mitigating effects of potential containment and recovery operations to remove spilled product. Such operations would include pre-booming downwind of vessels prior to transfer operations in accordance with BOEM lease stipulations, USCG requirements, and Shell's fuel transfer operating procedures. Also, recovery equipment would be deployed for the control and removal of diesel fuel resulting from a small spill.

Likely consequences for environmental, social, and economic resources from large and very large oil spills were evaluated in the 2015 Second SEIS (from which this EA tiers) and are not further addressed in this EA.

2.4.9. Oil Discharge Prevention and Contingency Planning.

No exploratory drilling may commence prior to submittal and BSEE approval of an Oil Spill Response Plan (OSRP) that is consistent with applicable Federal regulations and guidance. The OSRP must demonstrate that the operator has the spill response resources, equipment, personnel, and strategies necessary to efficiently and effectively respond to a worst case discharge (WCD).

Shell prepared a Chukchi Sea Regional Exploration Oil Discharge Prevention and Contingency Plan (ODPCP) to support its 2010 Chukchi Sea Exploration Plan (EP). That ODPCP was approved by the State of Alaska in March 2010 and by BOEMRE (now BSEE) in April 2010. Because the 2012 Shell EP Revision 1 included changes to drilling plans and WCD volumes, amendments to the approved ODPCP were necessary. BSEE requested specific changes to the approved ODPCP by letter dated November 16, 2011. Shell revised the plan incorporating the requested changes and BSEE approved Shell's OSRP on February 17, 2012. In accordance with the regulations 30 CFR 254.30(a) Shell conducted the mandatory biennial review of their OSRP (formerly called an ODPCP) and submitted the resulting updates to BSEE on December 18, 2013. BSEE found the submission to be compliant with the regulations on June 23, 2014.

Shell discusses certain key components of its OSRP in Section 8 of the EP and Section 2.10 of the EIA.

2.4.10. Compliance with Lease Stipulations.

Shell's leases were obtained under the Chukchi Sea OCS Lease Sale 193 in February 2008. Shell's proposed exploration activities must comply with all applicable stipulations.

Stipulation 1 – Protection of Biological Resources
Stipulation 2 – Orientation Program
Stipulation 3 – Transportation of Hydrocarbons
Stipulation 4 – Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources
Stipulation 5 – Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence-Harvesting Activities
Stipulation 6 – Pre-Booming Requirements for Fuel Transfers
Stipulation 7 – Measures to Minimize Effects to Spectacled and Steller's Eiders During Exploration Activities

The full text of the lease stipulations associated with Lease Sale 193 and a summary of how Shell's proposed compliance with each stipulation are provided in Appendix G of the 2015 Shell EP.

2.4.11. Shell EP Measures to Reduce Potential Impacts.

Discussed below are additional measures that Shell would implement during its proposed exploration drilling operations. This list is taken directly from Section 12.0(c) of the 2015 Shell EP and is provided here to inform the analysis of potential environmental impacts. These measures supplement, but do not supercede, requirements imposed by applicable laws, regulations, permits, authorizations, and lease stipulations.

Communications

- Shell has developed a Communication Plan and will implement this plan before initiating exploration drilling operations to coordinate activities with local subsistence users, as well as Village Whaling Captains' Associations, to minimize the risk of interfering with subsistence hunting activities, and keep current as to the timing and status of the bowhead whale hunt and other subsistence hunts. The Communication Plan includes procedures for coordination with Com Centers to be located in coastal villages along the Chukchi Sea during Shell's proposed exploration drilling activities.
- Shell will employ local Subsistence Advisors (SAs) from Chukchi Sea villages that are potentially impacted by Shell's exploration drilling activities. The SAs will provide consultation and guidance regarding the whale migration and subsistence activities. There will be one per village, working approximately 8-hr per day and 40-hr per week during each drilling season. The subsistence advisor will use local knowledge (Traditional Knowledge) to gather data on subsistence ways of life within the community and to advise in ways to minimize and mitigate potential negative impacts to subsistence resources during each drilling season. Responsibilities include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; coordinating with the Com and Call Center personnel; and advising how to avoid subsistence conflicts. SAs will have a handbook that will specify work tasks in more detail.

Aircraft Travel

- Aircraft shall not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, in poor weather (fog or low ceilings), or in an emergency situation, while over land or sea to minimize disturbance to mammals and birds.
- Aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft (457 m) in areas of active whaling; such areas to be identified through communications with the Com Centers.
- Except in an emergency, aircraft will not operate at an altitude lower than 1,500 ft. (457 m) within 0.5 mi. (0.8 km) of polar bears when observed on land or ice.
- Helicopters will not operate at an altitude lower than 3,000 ft. (914 m) within 1 mi. (1.6 km) of walrus groups observed on land, and fixed-wing aircraft will not, except in an emergency, operate at an altitude lower than 1,500 ft. (457 m) within 0.5 mi. (805 m) of walrus groups observed on ice, or within 1 mile (1,610 m) of walrus groups observed on land.
- If aircraft must be operated below 1,500 ft. (457 m) because of weather, the operator will avoid areas of known walrus and polar bear concentrations and will take precautions to avoid flying directly over or within flying within 0.5 mi. (805 m) of these areas. Aircraft will not operate within 0.5 mi (0.8 km) of polar bears when observed on land or ice.

Vessel Travel

- The drilling units and support vessels anticipate will enter the Chukchi Sea through the Bering Strait on or about July 1, minimizing effects on marine mammals and birds that frequent open leads and minimizing effects on spring and early summer bowhead whale hunting.
- MODU and support vessel transit routes will avoid known fragile ecosystems and the Ledyard Bay Critical Habitat Unit, and will include coordination through Com Centers.
- PSOs will be aboard the drilling units and all transiting support vessels.
- Except in an emergency, vessels will not approach within 0.5 mi. (0.8 km) of walruses or polar bears when observed on ice.
- Except in an emergency, vessels will not approach within 1.0 mi. (1.6 km) of groups of walruses or 0.5 mi. (0.8 km) of polar bears when observed on land.
- Vessels should take all reasonable precautions (i.e., reduce speed, change course heading) to maintain a minimum operational exclusion zone of 0.5 mi (805 m) around groups of 12 or more walruses in the water.
- When within 900 ft (274 m) of whales, except in an emergency, vessels will reduce speed, avoid separating members from a group and avoid multiple changes of direction.
- Vessel speed is to be reduced during inclement weather conditions in order to avoid collisions with marine mammals.
- Shell will communicate and coordinate with the Com Centers regarding all vessel transit.
- Use of some lighting on the drilling units and support vessels will be minimized and shaded to reduce potential disorientation and attraction of birds and to reduce the possibility of a bird collision (Shell, 2015a, Appendix E).

Exploration Drilling Operations

- Critical operations will not be started if potential hazards (ice floe, inclement weather, etc.) are in the vicinity and there is not sufficient time to finish the critical operation before the arrival of the hazard at the drill site (Shell, 2015a, Appendix F).
- The blowout prevention program will be enhanced through the use of two sets of blind/shear rams.
- For drill sites at which a MLC is drilled by bit, a ROV control panel will be subsea (SS), linked to the BOP by an umbilical, with sufficient pressured water-based fluid to operate the BOP. In the event the MLC is drilled by the MLC ROV system, no additional SS control panel is required as an ROV will have direct access to the BOP panel located in the MLC.
- Provisions for a second relief well drilling unit will be in-place in the event that the primary drilling vessel is disabled and not capable of drilling its own relief well. Both the *Discoverer* and *Polar Pioneer* will serve as its own primary relief well drilling unit. If the *Discoverer* or the *Polar Pioneer* cannot be used to drill a relief well, the other drilling unit (secondary relief well drilling unit) would be used for that purpose. The drilling units will be in the leased area operating as primary drilling units, or one may be no further distant than Dutch Harbor when the other drilling unit is drilling in hydrocarbon bearing zones. In either case, the secondary relief well drilling unit could be mobilized to the location in the Burger Prospect, moored, and drill a relief well and kill the flow within 38 days.
- Airgun arrays will be ramped up slowly during ZVSPs to warn cetaceans and pinnipeds in the vicinity of the airguns and provide time for them to leave the area and avoid potential

injury or impairment of their hearing abilities. Ramp ups from a cold start when no airguns have been firing will begin by firing a single airgun in the array. A ramp up to the required airgun array volume will not begin until there has been a minimum of 30 min of observation of the safety zone by PSOs to assure that no marine mammals are present. The safety zone is the extent of the 180 dB radius for cetaceans and 190 dB for pinnipeds. The entire safety zone must be visible during the 30-min lead-in.to an array ramp up. If a marine mammal(s) is sighted within the safety zone during the 30-min watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the safety zone or the animal(s) is not sighted for at least 15-30 min: 15 min for small odontocetes and pinnipeds, or 30 min for baleen whales and large odontocetes.

Ice Management

- Shell has developed and will implement an Adaptive Approach to Ice Management in Areas Occupied by Pacific Walruses (Shell, 2015a, Appendix J).
- Real time ice and weather forecasting will be from the Shell Ice and Weather Advisory Center (SIWAC) (Raye, 2015).

Oil Spill Response

- The primary OSR vessel will be on standby at all times when drilling into zones capable of flowing liquid hydrocarbons in measurable quantities to ensure that OSR capability is available within one hour, if needed.
- Shell will deploy an OSR fleet that is capable of collecting oil on the water in excess of the calculated WCD flow rate of a blowout in the unlikely event that one should occur. The remaining OSR support vessels will be fully engaged within 72 hours.
- In addition to the OSR fleet, oil spill containment equipment will be available for use in the unlikely event of a blowout. The containment system tug and barge will be located in or near Goodhope Bay, Kotzebue Sound. This equipment is designed for maximum reliability, ease of operation, flexibility and robustness so it could be used for a variety of blowout situations. It is anticipated that the containment system could arrive at the scene of a blowout and be capable of receiving hydrocarbons in eight to nine days, depending on weather and the characteristics of the blowout.
- Capping stack equipment will be stored as equipment aboard one of the ice management vessels and will be available for deployment within 24 hours, depending on ice, weather, and location, in the unlikely event of a blowout. Capping stack equipment consist of subsea devices assembled to provide direct surface intervention capability with the following priorities:
    - Attaching a device or series of devices (i.e. the capping stack) to the well to affect a seal capable of withstanding the maximum allowable working pressure (MAWP) and closing the assembly to completely seal the well against further flows (commonly called “Cap and Contain”)
    - Attaching a device or series of devices (i.e. the capping stack) to the well and diverting flow to surface vessel(s) (i.e. the containment system on the Arctic Challenger barge) equipped for separation and disposal of hydrocarbons (this intervention process is commonly called “Cap and Flow”)
- A polar bear culvert trap has been constructed in anticipation of OSR needs and will be available prior to commencing the exploration drilling operations.
- Pre-booming is required for all fuel transfers between vessels.

Other Environmental Conditions

As stated in Section 10.0 of the 2015 Shell EP (excerpted below), Shell would also engage in other environmental monitoring activities during exploration drilling operations:

> As part of the requirements under the Chukchi Exploration NPDES General Permit, Shell will conduct an Environmental Monitoring Program (EMP) that meets the objectives in the permit AKG-28-8100. The specific details around this monitoring program have been submitted with the NPDES NOI; however, the EMP will generally consist of a 4 phase monitoring program.
>
> - Phase I establishes the baseline conditions of the drill site prior to exploration drilling activities and will either be supported with historical data or supplemental data collected prior to exploration drilling activities. The baseline data generally consist of benthic samples, receiving water chemistry, sediment characteristics, and a visual assessment of the sea floor.
> - Phase II requires monitoring to be conducted while exploration drilling activities are occurring and consists of discharge plume monitoring, metals analysis of the drilling fluid, and. Phases III and IV are similar in nature and are conducted once exploration drilling activities are completed. Phase III monitoring will occur shortly after exploration drilling operations cease at a drill site. Phase IV is conducted no later than 15 months after exploration drilling operations cease. Benthic samples, sediment characteristics, and a sea bottom survey will be completed during these phases.
>
> The results from this monitoring program will be submitted to EPA as required in permit AKG-28-8100.

Bird and mammal observations will be made from all transiting surface operation vessels throughout exploration drilling activities in accordance with the 2015 Shell 4MP (Shell, 2015a, Appendix B) and the Bird Strike Avoidance and Lighting Plan (Shell, 2015a, Appendix E).

3.0 AFFECTED ENVIRONMENT

The following subsections summarize environmental conditions and resources found within areas that could be affected by the Proposed Action and alternatives. Each summary focuses on information relevant to understanding potential environmental impacts. More detailed discussion of the marine, coastal and human environment of the Chukchi Sea planning area is contained within the broader NEPA documents listed in Section 1.4 and incorporated into this EA by reference.

3.1. Meteorology

The Alaska North Slope (ANS), adjacent to the Chukchi Sea, is a polar climate characterized by moderate winds and cold temperatures during the winter, cool temperatures in the summer, and little annual precipitation (less than 7 inches (17.8 centimeters (cm) a year near Wainwright, Alaska) (Ahrens, 2013). The region is dominated by subfreezing temperatures for most of the year, and the Chukchi Sea is almost totally ice covered from early December to mid-May. During the winter, winds can be strong and prolonged, leading to extreme ice pressures and dangerous wind-chill conditions. A brief warm and snow-free season follows in June, July, and August. Summers over the Chukchi Sea are influenced by the Western Pacific low-pressure system, which moves northeast along the Chukchi coastline causing cloudy skies and light precipitation (USDOI, BOEMRE, 2011). During the summer, fog occurs frequently as warmer air moves over the colder water, which is sometimes covered with ice. Because of the fog, low visibility of one-half mile or less can occur, most commonly during June, July, and August.

3.1.1. Climate Change

A thorough scientific examination of climate change in the Arctic is provided by the Inter-governmental Panel on Climate Change fifth assessment synthesis report (IPCC, 2013) and the Arctic Climate Impact Assessment (ACIA, 2005). The two reviews offer the most comprehensive compilation of information available on climate change, agreeing that the Arctic is experiencing variations that are accelerating faster than previously realized (Karcher et al., 2010). Other research concurs the Arctic is undergoing a rapid transition, including surface warming (affecting cloudiness) and changes in the cryosphere—the frozen water part of the Earth system that includes sea ice (Matthes, Rinke, and Dethloff, 2009). See Section 3.1.9 of the 2015 Second SEIS for more information on Climate Change.

3.1.2. Expected Weather Conditions at the Drill Sites

Weather over the Chukchi Sea OCS is the result of a complex geographical and atmospheric environment influenced by the Brooks Range and the meteorological features of the semi-permanent Aleutian low pressure center. Dominating the Chukchi Sea from July through December, transient low pressure centers (storms) move into the region from the North Pacific. Francis and Atkinson (2012), found storm activity occurring in the fall and winter seasons is increasing in frequency, intensity, and track speed. A "storm" is defined by as a low-pressure center with a closed 925-millibar feature, usually producing a significant wave height event (SWH) of at least 1 meter (Francis and Atkinson, 2012). Most of the storms are extra-tropical cyclones (low pressure centers) on the order of 1,000s of kilometers (km) in extent. These storms rely on changes in the baroclinic atmospheric conditions, and historically can occur quite often in the fall and winter months. In 2007, 16 SWH events with waves of at least two meters were detected. The longest duration of these storms occurred from mid-September to mid-October and from November to early December. Storms with greater wave heights occurred in the latter months.

Consistent local historical meteorological data is not available for the offshore location of the Proposed Action. Therefore, the historical weather record provided by the National Weather Service for Wainwright, Alaska, the city nearest the proposed drilling site, is presumed to sufficiently represent the meteorological conditions of the drilling site (WRCC, 2012).

The Proposed Action would occur during the months from July through October. During these months the average daily high temperature is 43.9° Fahrenheit (F) / 6.6° Celcius (C) and the average daily low temperature is 32.7°F (0.4°C). The warmest month is July with an average high temperature of 50.0°F (10°C) and an average low temperature of 36.3°F (2.4°C). The interim period of late September and October occurs before the cold season begins in November. Temperatures begin to drop and are below freezing by October. The average daily high temperature during these months is 29.9°F (1.2°C) and the average daily low temperature is 20.2°F. During October, temperatures remain below freezing, ranging from 12.2°F to 23.0°F, (-11 to -5°C) and rarely drop below zero (-17.8°C) (WRCC, 2012).

Wind velocity is relatively stable during the warmer months of June through early September with average wind speeds ranging from 10-12 miles per hour (mph) (16-19 km/h). Wind speeds begin to increase in October, which is the month of peak average wind speeds. The daily average wind speed in early October is 15 mph (24 km/h), occasionally reaching near 20 mph (32 km/h). By the end of October, wind speeds drop off slightly to a level similar to the warm season (WeatherSpark.com, 2015) When considering the average wind speeds and temperatures common to the ANS, particularly in October, daily wind chills will likely range from 5°F. to -10°F. (NWS, 2009).

Operators at the drilling site should expect the majority of precipitation to occur in the summer. Average annual precipitation is 6.35 inches (in) (16.1 centimeters (cm) in Wainwright, with more than half that amount falling in July and August. When precipitation occurs, it is in the form of light rain. The amount of precipitation drops off sharply in September, with amounts averaging 0.56 in (1.4 cm) in September and 0.77 inches in October, where light rain gradually turns to light snow by October (WRCC, 2012).

3.1.3. Expected Ice Conditions at the Drill Sites

This sea-ice description builds upon discussion in Section 3.1.4 of the 2015 Second SEIS and Section 3.2.3 of the Shell EIA (Shell, 2015a, Appendix C) which are summarized and incorporated by reference. Salient points from these documents are summarized as follows. There are three general forms of sea ice in the project area (including the shorebase and areas where oil spill response could occur):

- Landfast ice, which is attached to the shore, is relatively immobile, and extends to variable distances offshore
- Stamukhi ice, which is grounded and ridged ice
- Pack ice, which includes first-year and multiyear ice and moves under the influence of winds and currents.

Shell’s proposed drilling activities are planned for the Arctic summer “open-water” season. The proposed drill sites are far seaward of the typical extent of landfast ice during the time of operations. Landfast ice could occur in areas near the Kotzebue Sound mooring, the shorebase, or where oil spill response occurs. Table 3-1 shows when headlands and straight coastlines are landfast ice free and when the first landfast ice forms by early (E), middle (M) or late (L) in the month of occurrence. During the time of proposed activities some landfast ice may occur along the coast from Cape Lisburne to Barrow in early July and from Wainwright to Barrow in late October. First landfast ice occurs in bays and lagoons as early as October (Mahoney et al., 2012, 2014).

Table 3-1. Timing of Landfast Ice Free and First Landfast Ice along the Chukchi Sea Coast.

Location	Landfast Ice Free												First Landfast Ice														
	April			May			June			July			Oct			Nov			Dec			Jan			Feb		
	E	M	L	E	M	L	E	M	L	E	M	L	E	M	L	E	M	L	E	M	L	E	M	L	E	M	L
Outer Kotzebue Sound						■	■	■	■							■	■	■	■	■	■	■	■	■	■		
Inner Kotzebue Sound						■	■	■									■	■	■	■	■	■	■	■	■	■	■
Point Hope to Cape Lisburne	■	■	■	■	■	■	■	■	■											■	■	■	■	■	■	■	■
Cape Lisburne to Wainwright					■	■	■	■	■	■						■	■	■	■	■	■	■	■	■	■		
Wainwright to Barrow									■	■					■	■	■	■	■	■	■	■	■				

Note: 1. E = Early portion of month, M= Middle portion of month, L= Late portion of month.
2. In Landfast Ice Free columns, gray boxes indicate range of time when coast first becomes ice free.
3. In First Landfast Ice columns, gray boxes indicate range of time when landfast ice first forms.
Source: Mahoney et al., 2012, Figure 5.3.2.

Stamukhi ice is not anticipated in the project area during scheduled operations. Pack ice could move into the project area during the time of operations due to wind or currents and is most likely to be first-year ice. Occasionally, there may be multi-year features. A mechanism for advecting multi-year ice features from the permanent polar pack into the Chukchi Sea was identified by Ward et al. (2015) using satellite data over the past 21 years. A combination of a flaw lead (waterway opening between pack ice and fast ice), extended flaw lead and a multi-year gateway (complex phenomenon that channels multi-year ice features from the polar pack into the Chukchi Sea) were identified that facilitate multi-year ice features entering the Chukchi Sea. Multi-year ice entered the extended flaw lead in 20 of the 21 winters and the multi-year gateway conveyed ice into the Chukchi Sea in 14 of those winters (Ward et al., 2015). The multi-year gateway has occurred less frequently since 2003-04. Ice floe frequency and intensity is unpredictable and could range from no ice to ice densities that exceed Shell's ice management capabilities, forcing MODUs to move temporarily off site (Shell, 2015a, Appendix F, COCP and Appendix G, DIMP).

Generally the pack ice retreat starts in the southern Chukchi Sea and advances northward. There can be large differences in the timing of pack ice retreat and melting between years as shown in Figure 3-1. BOEM utilized the NOAA, National Ice Center bi-weekly sea ice data to calculate the minimum ice concentrations for each week from May to December within a 30 kilometer radius from each proposed exploration well to show the generalized timing of melt and freezeup in a period of five years (2009-2014) (Figure 3-1).

Shell would move MODUs through the Bering Strait and into the Chukchi Sea on or about July 1st and then onto the Burger Prospect as soon as ice and weather conditions allow. This coincides with the retreat of the ice in most years (early June to late July; Figure 3-1). The duration of open water (less than 10% ice concentration) in the central Chukchi Sea has lengthened by up to four weeks over the past 30 years to a summer average of 17 weeks (Stroeve et al., 2014). However, the range of open water is variable from year to year and ice could be present at the proposed drill sites. High concentrations (>10%) of ice in early July may delay start of operations (Figure 3-1). The ten lowest September Arctic sea ice extents have occurred in the last ten years (2004-2014) (NSIDC, 2014).

Floating pack ice could approach established drilling operations. Shell's Drilling Ice Management Plan (Shell, 2015a, Appendix G), would be implemented to manage the ice by deflecting any ice floes that could affect the MODUs when they are drilling or anchor mooring buoys even if the drilling units are not anchored at a drill site to ensure safe operations at all times. During the 2012 drilling season, a total of seven days of active ice management by vessels occurred in support of Shell's exploration program in the Chukchi Sea (80 *FR* 11725, March 4, 2015).

Thick winter sea ice begins to form on the surface of the Chukchi Sea as early as late October or as late as mid-December. From 1996 through 2007, the onset of freeze-up (first appearance of new ice) in the vicinity of the previously drilled Burger Prospect occurred between early October and the third week of November. The offshore transition period from very open drift ice to 90% (or more) ice concentration is highly unpredictable, taking anywhere from one week to a month. Nearly complete ice cover occurred in the area offshore of Wainwright as early as October 22 and as late as December 11 (1996-2007) (Shell, 2013). Figure 3-1 and Table 3-2 show that freezeup occurred from late October to early November in the last five years.

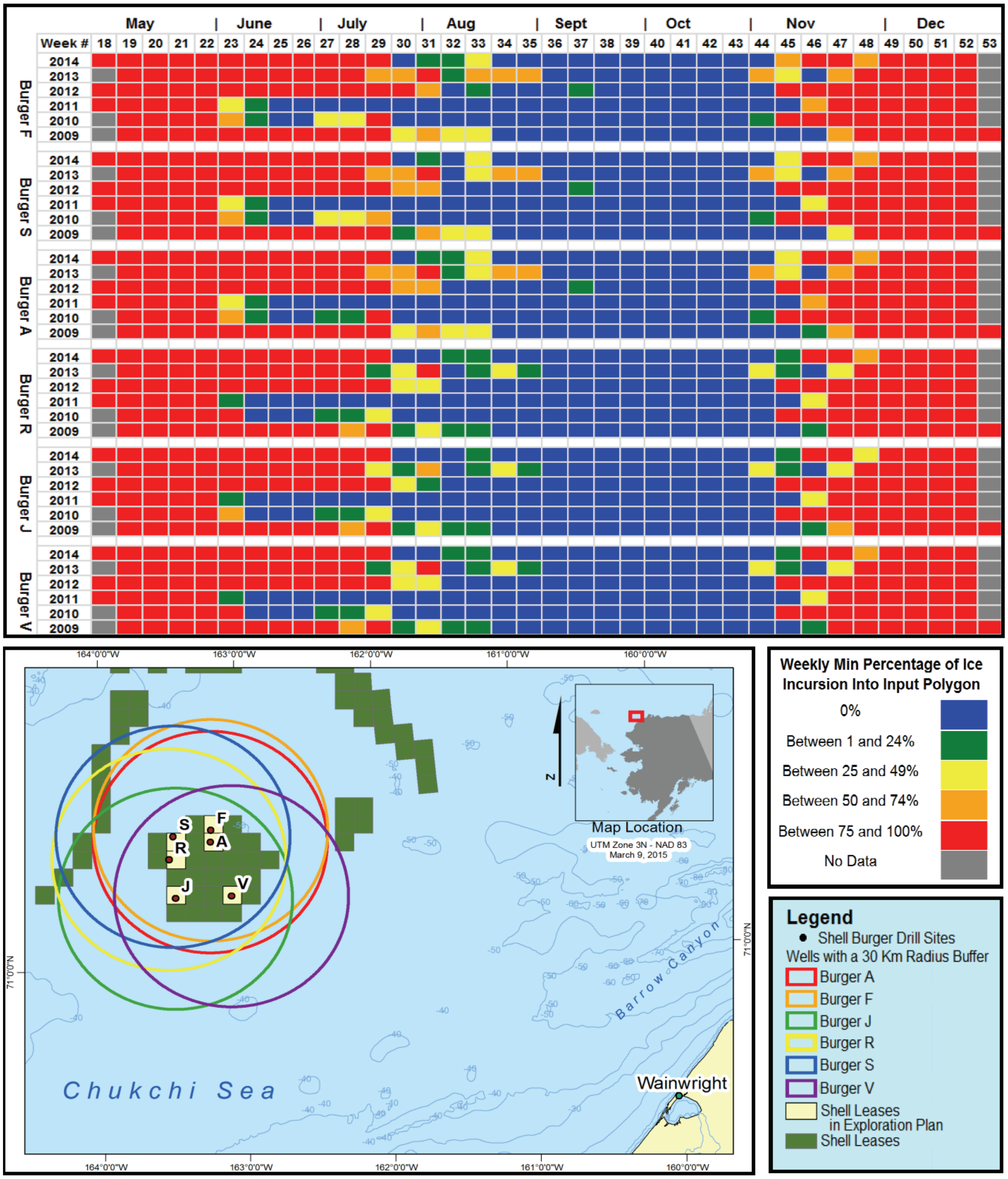

Figure 3-1. Weekly Minimum Sea Ice Concentration Adjacent to the Proposed Action Area. *Figure illustrates the minimum bi-weekly sea ice concentrations within a 30-kilometer radius of proposed Burger exploration well sites between May and December (2009-2014)(Source: BOEM 2015 analysis).*

Table 3-2. Timing of Sea Ice Formation in and Adjacent to the Burger Area.

Year(s)	Along Coast	Burger Area[1] Date	Ice Concentration	Reference
1996-2007	not applicable	Early October – Third Week of November	First appearance of new ice	Shell, 2013 p. H-13
2008	Mid October	November 10-15 November 17-18	5/10 9/10 +	Mudge et al. 2010
2009	Mid October	November 16-20 November 23-27	5/10 9/10 +	Fissel et al. 2011
2010	Early October	November 1-4 November 8	6/10 9/10	Mudge et al. 2011

Note: [1] Includes previous Burger drill sites and adjacent areas

The Arctic sea ice is undergoing rapid changes. There are reported changes in sea-ice extent, thickness, distribution, age, and melt duration. In general the sea-ice extent is becoming much less in the Arctic summer and slightly less in winter; overall, the decline in sea-ice extent is increasing (NSIDC, 2014, 2015). The thickness of ice in the project area is decreasing (Fissel et al, 2011; Leidersdorf, Scott and Vaudrey, 2012), the distribution of ice is changing, and its overall age is decreasing (Comiso, 2012). However, a slight increase in age and thickness was seen from March 2013 to March 2014 (Perovich et al., 2014). Drift speed and melt duration is increasing (Kwok, Spreen and Pang, 2013; Stroeve et al., 2014; Wang and Overland, 2015). March 2015 was the lowest ice extent in the satellite record (NSIDC, 2015). These factors lead to a decreasing perennial Arctic ice pack.

Additional information on Arctic sea ice trends, including information specific to the Chukchi Sea, is presented in Section 3.2.3 of Shell's EIA (Shell, 2015a, Appendix C) and in Appendix H, Section H.9 of Shell's Chukchi Sea Regional OSRP (Shell, 2013).

3.1.4. Expected Wave Conditions at the Drill Sites

Weingartner et al. (2013), Fissel et al. (2011) and Mudge et al. (2010, 2011) describe wave measurements in the Chukchi Sea and Burger study area (Table 3-3). Development of waves depends on wind speed and direction, on presence and distribution of ice, and on the sea depth. Strong winds are relatively rare in July and August, which hinders wave development. Waves of maximum magnitude develop in September and October.

Table 3-3. Wave Measurements in the Burger Study Area and Chukchi Sea.

Area	Start - End Date	Dominant		Average	Maximum		Reference
		Significant Wave Height	Peak Period	Significant Wave Height	Significant Wave Height	Peak Period	
Burger	10/12/2008-10/7/2009	0-1.5 m	5-7 s	1.2 m	3.6 m	10.5 s	Mudge et al., 2010
Burger	10/07/2009-7/28/2010	0.5-1.5 m	4-7 s	1.2 m	5.1 m	10.1 s	Fissel et al., 2011
Site 1	7/26/2010-7/27/2011	0.5-1.5 m	4-8 s	1.34 m	4.3 m	10.8 s	Mudge et al., 2011
Chukchi	08/18/2010-11/07/2010 05/12/2011-08/25/2011	< 2.0	4-8 s	1-2 m	3.8 m	na	Weingartner et al., 2013

The wave field consists mostly of waves at 4-8 second periods with an average significant wave height of approximately 1-2 m (3.2-6.6 ft) (Figure 3-2). Waves come mainly from the north, northeast, and northwest. The largest waves were from the northwest at about 4 -5 m (13-16.4 ft) wave height. Thompson and Rogers (2014) modeling data agree with the largest wave heights discussed above and suggest that future reductions in seasonal ice cover could generate larger waves and swells.

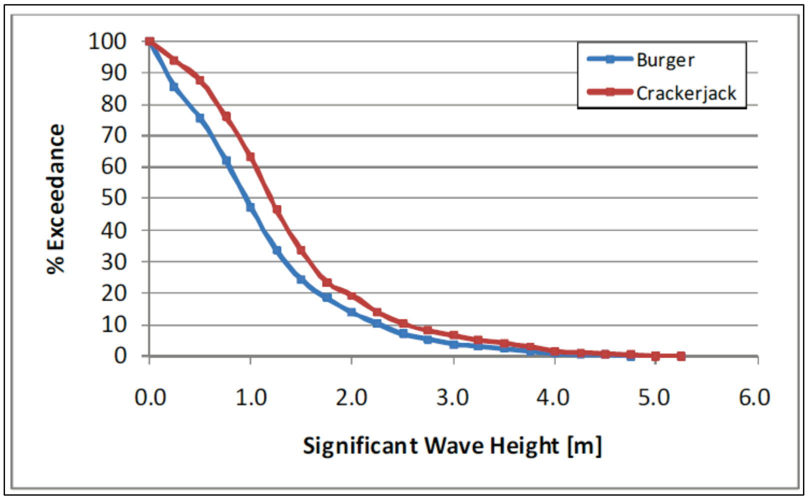

Figure 3-2. Percent Exceedance of Significant Wave Height for Burger and Crackerjack.
Source: Fissel et al. (2010).

3.2. Affected Resources

3.2.1. Air Quality

This section describes the existing condition of air quality in northern Alaska, particularly over the land areas of the western Alaska North Slope (ANS) adjacent to the Chukchi Sea, and summarizes existing sources of air pollutants. A summary of the weather and climate conditions typical for the location of the proposed exploration plan is provided in Section 3.1.

3.2.1.1. Air Quality on the Alaskan North Slope

The U.S. Environmental Protection Agency (EPA) does not specify the air quality conditions of locations over the open sea; only landside geographical locations with homogeneous air quality characteristics are classified according to quality of the air. These geographic regions are referred to as air quality control regions (AQCR). The EPA has defined the ANS to be within the Northern Alaska Intrastate Air Quality Control Region (NAI-AQCR9), which includes all the area of Alaska north of the Brooks Range (40 CFR 81.246) (EPA, 2011a).

3.2.1.2. Attainment Status

The EPA has classified the western ANS as a clean air resource (not non-attainment) because pollutant concentrations in the ambient onshore air are well below the National Ambient Air Quality Standards (NAAQS) and the Alaska Ambient Air Quality Standards (AAAQS) (EPA, 2011a).The EPA reports that the pollutant concentrations within the western ANS from the few existing sources of emissions are far below the NAAQS due to dispersion caused by nearly constant wind and precipitation over the area (Serreze and Barrett, 2011).

3.2.1.3. Existing Sources of Emissions on the North Slope

Few industrial development areas contribute to the presence of air emissions on the western ANS. The Prudhoe Bay Oil Field, adjacent to the Beaufort Sea, is the largest source of emissions on the eastern ANS. The oil field is the largest in North America, and is about 200 miles (322 km) (straight-line distance) from Barrow, Alaska, and about 280 miles (451 km) from Wainwright, Alaska, the community nearest the drilling site. Wainwright has a population of less than 600 persons (U.S. Census Bureau, 2010) and there are few sources of emissions there or in Barrow. The areas would provide small marine vessel support of Shell's 2015 EP producing emissions from shallow water landing craft for the occasional transport of supplies or crews between offshore vessels and the marine support shore base facilities. Additional new emissions would occur due to air support for the exploratory drilling plan, where air support will be based at the Barrow airport, located about 80 miles (129 km) northeast of Wainwright. Numerous regularly scheduled passenger flights of medium-range jet aircraft operate between Fairbanks and the Barrow airport to facilitate workers' rotating schedules and for delivery of equipment and supplies; these flights would occur with or without implementation of the Proposed Action and its alternatives. Implementation of the proposed exploration plan would require Shell to use the existing onshore facilities at Wainwright and Barrow. No construction of new facilities is included in the proposed exploration plan. Therefore, the only expected increase in onshore emissions associated with the proposed exploration would be the operation of helicopters, fixed-wing aircraft, and surface vehicles to transport personnel.

3.2.1.4. Black Carbon

The Alaska Department of Environmental Conservation (ADEC) reports that the Arctic atmosphere becomes contaminated with pollution through long-range transport in the winter and spring months from emissions created by the burning of heavy oils in industrialized Europe. The phenomenon usually begins in early winter and reaches a peak impact in March, after which time the haze dissipates. (ADEC, 2005). Black carbon is not a phenomena based on emission sources on the western ANS, as airborne black carbon was first reported in the 1950s, well before North Slope development took place.

The EPA has determined the regional air quality over the ANS continues to be better than the National and Alaska AAQS, even with the seasonal occurrence of black carbon. Black carbon is not a factor during the temporal scope of the drilling season (July through late October/early November), and is not expected to interfere with implementation of the Proposed Action or its alternatives.

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3.2.2. Water Quality

Water quality describes the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose such as protection of fish, shellfish, or wildlife. This discussion of Chukchi Sea water quality incorporates and summarizes information from the 2015 Second SEIS (USDOI BOEM, 2015a), 2011 SEIS (USDOI BOEMRE, 2011), and 2007 FEIS (USDOI MMS, 2007).

3.2.2.1. Water Quality in the Northeastern Chukchi Sea

Rivers and streams flowing into the U.S. Chukchi Sea are relatively unpolluted. The water quality of the Chukchi Sea meets the qualitative criteria for protection of marine life described in Section 403 of the Clean Water Act. There are no water bodies flowing into the U.S. Chukchi Sea identified as impaired by the Alaska Department of Environmental Conservation (ADEC, 2011).

Water quality in the northeastern Chukchi Sea naturally varies throughout the year, and is related to seasonal biological activity and naturally occurring processes. These processes include but are not limited to erosion of organic material along the shorelines, surface ice formation and melting, seasonal plankton blooms, seasonal changes in turbidity due to terrestrial runoff, wind speed and direction, localized upwelling of cold water, and naturally occurring oil/hydrocarbon seeps. The rivers and streams that flow directly into the northeast Chukchi Sea contribute freshwater to the marine system, affecting salinity, temperature and other aspects of water quality. River waters from the southern Chukchi coastline are carried north by the Alaska Coastal current. Inflowing Pacific Ocean current from the Bering Sea also influences the northern Chukchi nearshore environment.

Anthropogenic (human-generated) pollution in the Arctic is related to atmospheric, riverine, and marine transport pathways (AMAP, 1997). Anthropogenic pollution in the Chukchi Sea is primarily caused by pollutants entering the region by atmospheric transport and being deposited on sea ice and surface waters. AMAP (2004) indicated the presence of the pesticides was most probably a result of long-range atmospheric transport; they found the largest concentrations of pesticides in the surface microlayer of sea ice and in fog. The reported persistent organic pollutants (POPs) found in the Arctic are derived from distant sources mainly outside of the Arctic. In 1993, Chernyak, Rice, and McConnell (1996) identified POPs in the Chukchi and Bering Seas in the form of currently used pesticides. Pollutants are also transported by biota, bilge water discharges from international ship traffic, and ocean acidification from increasing carbon dioxide (CO_2) in the atmosphere (AMAP, 1997, 2004, 2011, 2013 and 2014).

The potential for ocean acidification is a concern in the Chukchi Sea (AMAP, 2013, 2014). As CO_2 increases in the atmosphere, the ocean absorbs more CO_2. Atmospheric acidification is attributed to the burning of fossil fuels which produce additional CO_2. The atmospheric CO_2 is in addition to the CO_2 that naturally flows from the nutrient-rich Pacific Ocean waters that has an abundance of particulate organic carbon (Grebmeier et al., 2006a) and results in the Chukchi Sea having a highly productive shallow continental shelf (AMAP 2013). This increase in CO_2 in seawater forces an increase in the hydrogen ion concentration while lowering the pH and bioavailability of calcium carbonate over time. See Section 3.1.6 of the 2015 Second SEIS (USDOI BOEM, 2015a).

Regional industrial impacts on water quality have been and are relatively low at this time. Five exploration wells were drilled in the Chukchi Sea between 1989 and 1991. Some trace metals, hydrocarbons, and other pollutants contributed by Bering Sea water or permitted discharges into the southern Chukchi Sea may move northward into the Proposed Action area with the Alaska Coastal Current (USDOI, MMS, 2007, Section III-19).

3.2.2.2. Water Quality in the Proposed Drilling Area

For the analysis of exploration drilling and associated support activities, information on impacts on water quality (Section 4.2.2) in the affected area is needed to model the effects of discharges. A number of publicly available reports describe the spatial and temporal variations in the circulation and water properties during 2008 – 2013 in the Northeastern Chukchi Sea. These studies include Weingartner and Danielson (2010), Weingartner et al. (2011), Weingartner et al. (2012), Weingartner et al. (2013), and Danielson et al. (2014), and additional unpublished data from BOEM’s COMIDA CAB studies in 2014.

An understanding of the vertical structure of the water column that receives the discharges is important for modelling the effects of discharges. Temperature and salinity data are used to describe the vertical profile of the water column for the analysis of discharges. Figure 3-3 illustrates two representative sampling periods of temperature and salinity collected by shipboard conductivity, temperature, and depth casts (CTD); these were gathered along transects through the center of the Six Burger Prospects during summer and fall 2011. The CTD casts show warmer, less saline waters were well-mixed at shallower depths—within about 20 m of the surface—over a stratified thinner layer where temperatures decrease (thermocline) and salinities increase (halocline). Beneath the stratified waters are colder and more saline homogenous waters. The resulting vertical profile shown in Figure 3-3 is common during among six years of sampling the open water season, along with an expected amount of annual variability.

Oceanographic investigations indicate the warmer, less saline mixed water in the upper portion of the water column is the result of northward flow from the Bering Strait of the Alaska Coastal Current and the Central Channel Current into the area of the Proposed Action. The effects of the northward flow and resulting mixed waters are discussed in detail in Section 3.1.3, Physical Oceanography, and Figure 3-3 of the 2015 Second SEIS (USDOI, BOEM, 2015a).

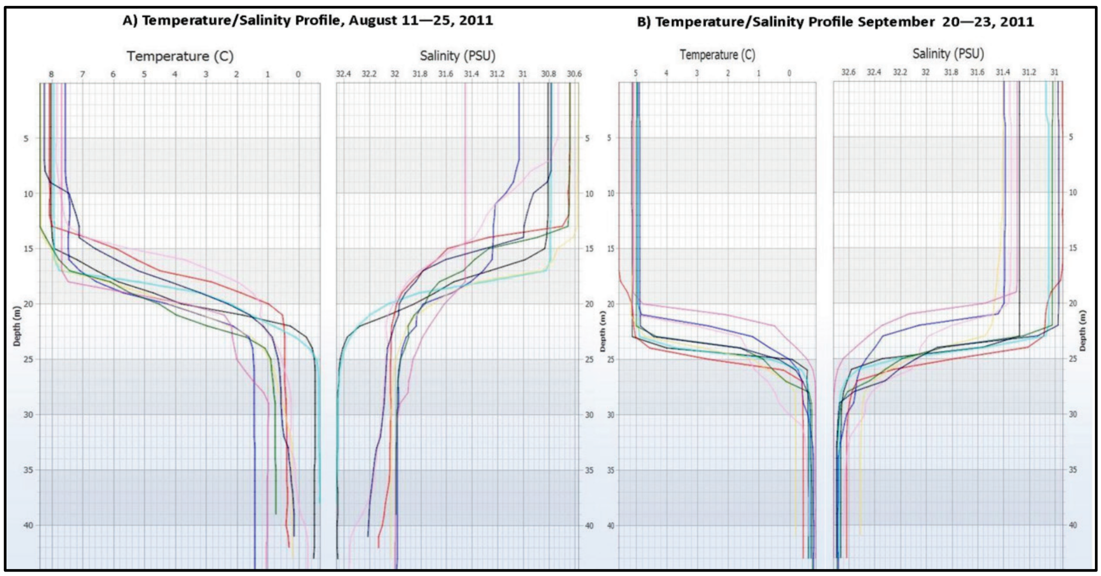

Figure 3-3. 2011 Water Column Temperatures and Salinities in the Proposed Action area. *Vertical water column profiles from CTD (Conductivity Temperature Depth) casts (colored lines) gathered along transects through the center of the Six Burger Prospects for a portion of the Open Water Season in 2011. These graphs illustrate the vertical structure of the water column as represented by the profiles of the temperatures and salinities within charts A and B.*

Trace Metals in Sediments: Recent studies have indicated trace metal concentrations in the northeastern Chukchi Sea were below toxic levels. Trefry, Trocine and Cooper (2011) and Trefry et al. (2014) studied the distribution of 17 trace metals in sediments of the northeastern Chukchi Sea during open water seasons in 2009 and 2010. They determined that sediment concentrations of potentially toxic metals (silver, cadmium, mercury, lead and zinc) remained below sediment quality criteria developed by Long et al. (1995) throughout the study area, including at the old drill sites. Elevated total mercury concentrations were identified in the sediments near two exploratory drilling sites where drilling mud and formation cuttings were discharged in1989 (Fox et al., 2014); however, total mercury in sediments correlated with silt, clay, aluminum and total organic carbon, and showed a long-term record consistent with the natural background environment. Fox et al. (2014) also showed elevated mercury in seafloor sediments at two sites within 300 m (984 ft) of two exploration wells drilled in 1989; they concluded that the source of mercury was mercury-sulfide present in the formation which was brought to the seafloor surface as cuttings from the well borehole. Additional information and more detail discussion of the trace metals see Section 3.1.6 of the 2015 Second SEIS (USDOI, BOEM, 2015a).

Hydrocarbons in Sediments: Neff et al. (2010) examined the chemical characterization of seafloor sediments in the region of the Burger and Klondike prospects in 2008. Their results showed that the concentration and distribution of hydrocarbons in surface sediments throughout the Burger and

Klondike prospects were variable. Higher concentrations were found in some surface and subsurface sediment samples at Klondike and Burger historic drill sites. With the exception of surface and subsurface sediments at the two historic drill sites, hydrocarbon concentrations at all the other sites within the prospects were within the range of background concentrations reported by other studies in Alaskan coastal and shelf sediments.

With one exception (Harvey and Taylor, 2011; Harvey et al., 2014) concentrations of polycyclic aromatic hydrocarbons (PAH) and aliphatic hydrocarbons in the surface sediments were at or below the natural background levels in surface sediments in the northeast Chukchi Sea. The authors suggest that the one exception exceeding the other samples taken in the study by 2– 20 times the concentration could be the result of a natural seep in the region or from one of the old drill sites. Additional information and more detail discussion of hydrocarbons are available in Section 3.1.6 of the 2015 Second SEIS (USDOI, BOEM, 2015a).

Nitrogen Cycling: Souza and Dunton (2012), Souza et al. (2014), and Souza, Gardner, and Dunton (2014) examined nitrogen cycling and nutrients in the water column and at the sediment-water interface in the Chukchi Sea in the summers of 2009 and 2010. In the southern Chukchi Sea their study showed high oxygen fluxes into the seafloor sediments, resulting in oxidation of porewater ammonium (NH_{4+}) and outflux of both nitrate (NO_3) and phosphate (PO_4) into the water column. Souza and others demonstrated low oxygen fluxes into the sediments and relatively low outflux of nitrogen and nitrate into the water column in the northern Chukchi Sea. Results showed that the nitrification process (ammonium to nitrite to nitrate) explains most of the uptake of ammonium that is in the water column. Additional information about nitrogen cycling is available in Section 3.1.6 of the 2015 Second SEIS (USDOI BOEM, 2015a).

Chlorophyll in the Water Column, Sediments, and Total Organic Carbon (TOC): Grebmeier and Cooper (2012) measured chlorophyll-*a* concentrations in the water column post-bloom, and found that most of the chlorophyll-*a* settled to sub-surface water and surface sediments. Higher chlorophyll-*a* values were found in surface sediments in the offshore waters of the northern Chukchi Sea (under Anadyr current water) compared to lower values in nearshore coastal water (influenced by Alaska Coastal current water). Blanchard et al. (2013a and b) measured chlorophyll-*a* and TOC in seafloor sediments at five sites in the northeastern Chukchi Sea during 2008-2010.

Total organic carbon (TOC) is the amount of carbon bound in an organic compound and used as a non-specific indicator of water quality. For marine surface sediments, TOC is the key parameter in the control of mineralization processes and the material exchange between the sediment and the ocean water. Total organic carbon (TOC) and carbon– nitrogen ratios (C/N) in the surface sediments were also determined by Grebmeier and Cooper (2012) during 2009 and 2010. The highest TOC concentrations were measured in offshore sediments in the northern and northeast Chukchi Sea, near Barrow Canyon. They suggest that these higher TOC measurements in the northern Chukchi Sea may be related to the greater occurrence of ice and ice–associated algae in the northern compared to the southern Chukchi Sea. Additional information and more detail discussion of TOC and also its relationship with chlorophyll-*a* is available in Section 3.1.6 of the 2015 Second SEIS (USDOI BOEM, 2015a).

3.2.3. Lower Trophic Levels

The affected environment of the lower trophic resources is discussed in detail in the 2011 SEIS (USDOI, BOEMRE, 2011: pp. 53-55) and is summarized below.

The Chukchi Sea shelf is among the largest and most productive of the world's continental shelves (Grebmeier et al., 2006). The high productivity of these waters has its origin in the northern Pacific currents that provide an upwelling of warm, nutrient-rich Pacific waters onto the wide expanse of the Bering Shelf and then travel northward (Pickart et al., 2009). Each of these unique water masses contributes distinct sediment loads and assemblages of phytoplankton and zooplankton (Nelson et al., 2014; Springer, McRoy, and Turco, 1989; Coyle, Chavtur, and Pinchuk, 1996). The waters of the Chukchi Sea are split into two major current flows that bifurcate into a path to the northwest into the Herald Canyon, and a path to the northeast across the Chukchi Sea and into the Beaufort Sea (Weingartner, et al., 2005; Pickart, et al., 2009). The continental shelf of the central Chukchi Sea is relatively shallow, with water depth averaging 50 meters (164 ft). Sediment composition consists of high percentages of fine sand, silt and clay (Naidu, 1988; COMIDA, 2011). No known hotspots leading to unique marine mammal or pelagic bird feeding areas, or unique biological communities, exist directly within the Burger prospect or on the proposed exploratory drilling sites analyzed in this section. Hardrock communities are known to exist southwest of Wainwright near the Skull Cliffs region (Philips, et al., 1984).

The lower trophic organisms living in the Chukchi Sea consist of three diverse and abundant groups (Bluhm, et al., 2009: Hopcroft, et al., 2008): the pelagic, epontic, and benthic communities.

Pelagic Communities. The pelagic communities consist of two major sub-groups, those that live on or near the surface (plankton) and those inhabiting the water column between the sea surface and benthic surface. The inhabitants of the pelagic realms between the surface and benthos are diverse and abundant, and form the basis for the high productivity of the area (Hopcroft, et al., 2008). Within Arctic waters, the combination of temperature, sea ice, and seasonal fluctuation in light regimes creates variation in the timing and extent of seasonal plankton blooms (Hopcroft, Kosobokova, and Pinchuk, 2009). Phytoplankton blooms (including zooplankton stocks) tend to occur in two separate events in early and late summer (generally July through August) with density and duration of blooms dependent upon weather conditions and nutrient fluxes (Kirchman, et al., 2009). The spatial distribution of phytoplankton and zooplankton communities in the Chukchi Sea has been frequently tied to the different water masses in the area. In 2008 and 2009, Hopcroft conducted an oceanographic assessment of the plankton communities in the Klondike and Burger prospect areas of the Chukchi Sea that included oceanographic and plankton data collections. These studies indicated that, despite the relative proximity of the two sites, there were statistical differences in the water masses and the plankton populations between them. Further, differences in water temperatures and spring bloom timing were also observed between the two sites (Hopcroft, Questel, and Clarke-Hopcroft, 2009, 2010). These differences may be forcing larger changes in the ecology of the region. Synthesis studies analyzing data over the past few decades indicate changes in ice patterns, wind direction and speed, and open water are effecting change in timing and intensity of plankton blooms (Grebmeier et al., 2006) Once considered a benthic-dominated ecosystem due to excess phyoplankton drifting to the bottom and fueling the benthic ecosystem, climate change may be changing the dynamics of productivity in the region to one that is less capable of supporting the current benthic biomass (Nelson et al., 2014).

Epontic Communities. Epontic organisms are the ice-dwellers that live on and within the multi-dimensional matrix of ice (Gradinger, Bluhm, and Iken, 2010). Primary production based on epontic organisms from melting ice contributes 4–26% to total primary production in seasonally ice-covered Arctic seas (Legendre et al., 1992). The mixing of nutrients and phytoplankton from the multiple watermasses creates the conditions for massive open-water plankton blooms that are further fed by ice algae and epontic organisms from the receding ice flows. This results in an excess within the pelagic column that cannot be utilized by the zooplankton (Grebmeier and Barry, 1991; Grebmeier et al., 2006), and a high benthic biomass as well (Feder, et al., 2005, 2007).

Benthic Communities. The benthic group consists of organisms living within the upper sedimentary matrix (infaunal organisms) and those living on, or strongly associated with, the benthic surface (epifaunal organisms). Benthic ecology studies by Blanchard, Parris, and Nichols (2009, 2010) found that the benthic fauna of the Burger prospect area was diverse and very abundant. Average abundance, biomass, and diversity were higher at Burger than at nearby sites. No interannual differences occurred between 2008 and 2009 (Blanchard, Parris, and Nichols, 2009, 2010). The Chukchi Sea Offshore Monitoring in Drilling Area, Chemical and Benthos (COMIDA, 2011) monitoring was carried out in an area corresponding to the Chukchi Sea Lease Sale 193, including the Burger prospect site area. This work agreed with Blanchard, Nichols, and Parris (2009) and Blanchard, et. al. 2013 in finding high diversity and biomass of invertebrate communities, including reports of high biomass of the snow crab (*Chionoecetes opilio*) and soft corals such as the sea raspberry (*Gersemia rubiformis*). Both studies found increases in biomass and diversity from south to north, and from west to east, within the lease areas of the Chukchi basin.

3.2.4. Fish

The three primary assemblages of Arctic fishes are marine fish, anadromous and migratory fish, and freshwater fish. The U.S. Chukchi Sea and western Beaufort Sea support at least 98 fish species representing 23 families (Mecklenburg, Mecklenburg, and Thorsteinson, 2002). Although the Chukchi Sea supports relatively high levels of lower trophic organisms functioning as fish prey that live in the water column, on the sea floor, and in the sediments, Chukchi Sea marine fish are not considered abundant. In contrast, fish in the Chukchi Sea are much smaller (averaging 6 inches, (USDOI, BOEM, 2015a; USDOI, BOEM, 2012), and fewer than in the rich Bering Sea fish community just to the south (Moore et al., 2014, p. 342, Table 11.1). The small fish dominating the Chukchi Sea (Priest et al., 2011) do not support a commercial fishery (NPFMC, 2009). Fish in the Chukchi Sea are an important resource to local subsistence users, (SRB&A, 1993; SRB&A, 2013a), as predators of the lower trophic foodweb that cycle energy and nutrients, and through their function as prey to upper trophic levels (Carroll et al., 2013).

Several important studies have contributed to the knowledge of the fish species that occur in the Chukchi Sea including: Norcross et al. (2010); Mecklenburg et al. (2007); Mecklenburg et al. (2002); Barber et al. (1997); Frost and Lowry (1983); Hopcroft, et al., (2008); Fechhelm et al. (1985); and Alverson and Wilimovsky (1966). A more detailed discussion of fish in the Chukchi Sea is presented in the 2011 SEIS, the 2007 FEIS, and the 2015 Second SEIS, portions of which are summarized and incorporated by reference below.

3.2.4.1. Marine Fish in the Chukchi Sea

The most common marine fishes (adult and juvenile) documented in various research cruises in the northeastern Chukchi Sea include: Arctic cod; saffron cod, Bering flounder, yellowfin sole, sculpin species , sand lance, capelin, eelpout species, snailfish, alligator fish and prickleback species (Table 3-4). The 2015 Shell EIA provides enlarged descriptions of five of the primary marine fish, Arctic cod, Arctic staghorn sculpin (*Gymnocathus tricuspus*, Bering flounder, Capelin, and Pacific Herring.

The distribution of demersal marine fish in the northeastern Chukchi Sea is a function of salinity, substrate type (sediment type and percent gravel) and bottom water temperature (Norcross et al., 2010; Barber et al., 1997; Mecklenburg et al., 2007).

Some Chukchi Sea marine fish species associate with drifting or fast ice to feed, hide, and spawn; these species are referred to as cryopelagic fishes. Most notable of the cryopelagic fish species in the northeastern Chukchi Sea is the Arctic cod, which associates with ice in various life stages and seasons for shelter and as a forage habitat to feed on microorganisms on the underside of the ice. Under-ice amphipods are an important food source for Arctic cod (Lonne and Gulliksen, 1989; Gradinger and Bluhm, 2004). Rough, irregular textures of the underside-ice may provide preferred habitat for Arctic cod to avoid predators (Cross, 1982). NOAA has conducted nearshore fish sampling along the northern Chukchi Sea coast (NOAA, 2011). Fish that were commonly captured over 15 sites were: staghorn sculpin, Arctic sculpin, saffron cod, sand lance, capelin, juvenile prickleback, and yellowfin sole.

Table 3-4. Marine Fish That Commonly Occur In the Proposed Action Area.

Common Name	Taxonomic Names
Arctic cod	*Boreogadus saida*
Saffron cod	*Eleginus gracilis*
Bering flounder	*Hippoglossoides robustus*
Yellowfin sole	*Limanda aspera*
Sculpin species	Family Cottidae
Sailfin sculpin species	Family Hemitripteridae
Pacific herring	*Clupea pallasii*
Sand lance	*Ammodytes hexapterus*
Capelin	*Mallotus villosus*
Eelpout species	Family Zoarcidae
Alaska plaice	*Pleuronectes quadrituberculatus*
Starry flounder	*Platichthys stellatus*
Bering flounder	*Hippoglossoides rubustus*
Snailfish	Family Liparidae
Alligator fish	Family Agonidae
Prickleback species	Family Stichaeidae

Harvey et al. (2011) studied hydrocarbons in sediments and the possible toxicological effects on Arctic cod in the northeastern Chukchi Sea, including the area of the Burger and Klondike prospects. They used enzymatic activity and DNA damage to assess the possible effects. The results showed some significant differences between Arctic cod specimens examined from different stations; however, there were no overall differences between stations. All Arctic cod specimens showed low levels of oxidative stress and were comparable to baseline levels reported in previous studies.

Fox et al. (2011) sampled total mercury and monomethyl mercury in eight invertebrate species and in Arctic cod in the northeastern Chukchi Sea, including the area of the Burger and Klondike prospects. Total mercury concentrations in Arctic cod averaged 130+/- 24 ng/g (dry weight, fillets) and were best related to the mercury concentrations in the sediments. Monomethyl mercury concentrations averaged 122+/- 27.4 ng/g (dry weight, fillets). Total mercury and monomethyl mercury were found to biomagnify upwards in the trophic ladder. Zinc concentrations, used as the control, did not show biomagnification.

Marine Fish in the Proposed Action Area

A BOEM field study sampled Chukchi Sea marine fish in 2012 and 2013 (Mueter, 2015) across the BOEM Chukchi Sea lease sale area including samples in the vicinity of the Proposed Action area. A review of preliminary study data within 40 miles of project area (Figure 3-4) indicates the most abundant fish in both 2012 and 2013 were Arctic cod, (80% in 2012 and 71% in 2013), capelin (12% and 11%) sandlance (2 % and 15%). Also present were Saffron cod, a number of prickleback species (Stichaeidae); several sculpin species (Cottidae) an eelpout (Zoaerchidae) a wolfish (Anarhidadidae) and an alligatorfish (Agonidae).

Industry studies of the lease sale area also provided information focused in the area of the Proposed Action area from fish surveys in 1990, and 2009-2010 (Priest et al., 2011; Goodman et al., 2013).

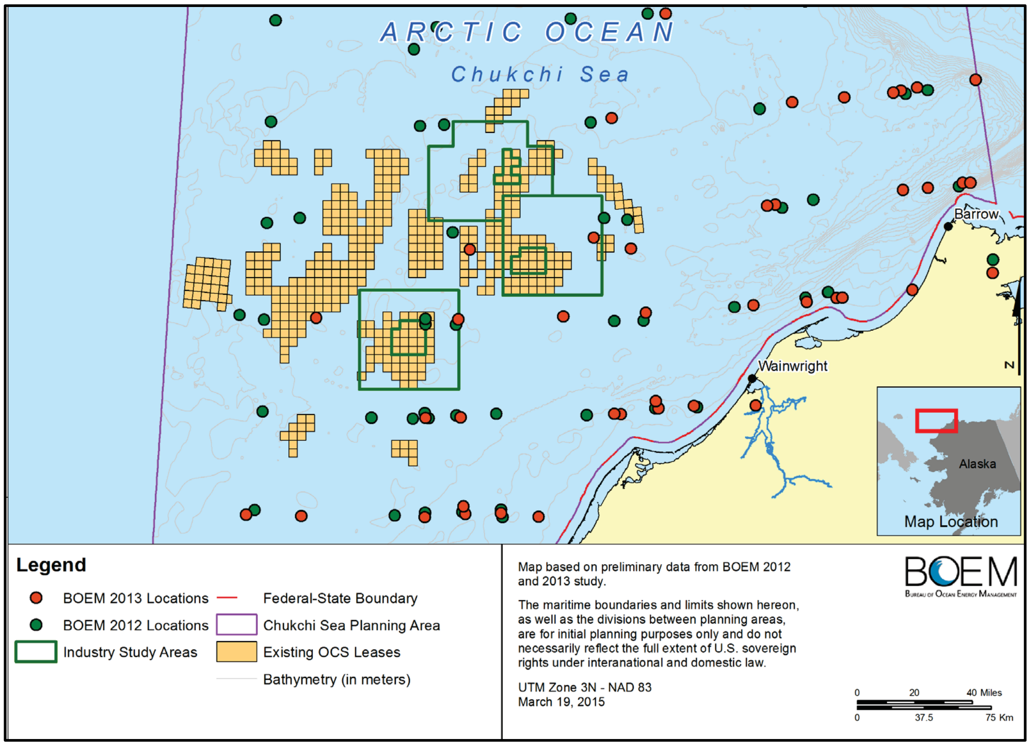

Figure 3-4. Relevant BOEM 2012-2013 Fish Study Locations. *A subset of the preliminary study data (green and red dots) near the Shell exploratory drilling locations (center green box).*

3.2.4.2. Anadromous and Migratory Fish of the Chukchi Sea

Anadromous fish that spend part of their life at sea and return to spawn in rivers and streams along the Arctic coast include five species of Pacific salmon (*Oncorhynchus spp.*) (Table 3-5). Of these five species, pink salmon (*O. gorbuscha*) and chum salmon (*O. keta*) occur most commonly in the northern Chukchi environment. Juvenile pink and chum salmon were captured in substantial numbers in offshore surveys that extended as far north as Point Lay during the autumn of 2007 (Moss, et al., 2009).

Table 3-5. Anadromous and Migratory Fish in Marine and Coastal Proposed Action Area.

Common Name	Taxonomic Name
Pink salmon	*Oncorhynchus gorbuscha*
Chum salmon	*Oncorhynchus keta*
Coho salmon	*Oncorhynchus kitsutch*
Chinook salmon	*Oncorhynchus tshawtscha*
Dolly Varden (sea-run)	*Salvelinus malma*
Rainbow smelt	*Osmerus mordax*
Arctic lamprey	*Lamptera camschatica*
Whitefish species	*Coregonus sp.*
Cisco species	*Coregonus*

Note: Table lists Anadromous and Migratory Fish Occurring in Marine and Coastal Environments in the Northeastern Chukchi Sea in the Region of Proposed Drilling and Support Operations.

Other anadromous fish in the northern Chukchi region include rainbow smelt (Osmerus), Dolly Varden-sea-run (Salvelinus) and Arctic lamprey (Lampetra), which spend some of their life in the marine environment and return to freshwater to spawn (Table 3-5). Some fish species in the Chukchi Sea follow a coastwise migration from freshwater to freshwater but do not spend substantial periods in the marine environment (e.g. some species of cisco and whitefish, Coregonus). Several fish species such as capelin, sand lance, saffron cod, and some sculpin species are not considered anadromous or coastwise migratory fish, but they move from offshore to nearshore for spawning and rearing in nearshore habitats. For a more extensive list of Chukchi Sea fish species and their life history environments refer to the 2015 Second SEIS, Section 3.2.2, and the 2011 SEIS, Appendix C.

The Shell EIA (Shell, 2015a, Appendix C) lists anadromous and amphidromos fish, and contains a list of cataloged freshwaters used by anadromous fish.

3.2.5. Birds

Most birds occurring in the Chukchi Sea area are present on a seasonal basis. During spring migration, arrival times at coastal breeding areas usually coincide with the formation of leads. Numerous species of pelagic—or marine— birds, including seabirds (such as common murre), sea ducks (such as long-tailed duck and common eider), and phalaropes, will closely follow as leads typically open up along the edge of the landfast ice. Migration times vary between species, but spring migration for most species takes place between late March and late May. Many birds that breed on the Alaska North Slope (ANS) must migrate through the southern Chukchi Sea twice each year. Departure times from the Beaufort and Chukchi Seas during postbreeding or fall migration vary between species and often by sex and age class within the same species, but most marine birds will have moved out of the Chukchi Sea by late fall before the formation of sea ice. Besides marine birds, Arctic breeding passerines and shorebirds also fly across the Chukchi on their migrations.

The following sections summarize relevant movement patterns, locations, and life history characteristics for several key avian groups. These groups include species that are the most numerous in the Proposed Action area, are particularly sensitive to certain activities, have special legal status, and/or have common life history characteristics. The groups are Threatened and Endangered Birds, Cliff-Nesting Seabirds, Bering Sea Breeders and Summer Residents, High-Arctic Associated Seabirds, Tundra-Breeding Migrants, Waterfowl and Loons, Shorebirds, and Ravens and Raptors. Only avian occurrence in nearshore and pelagic habitats is considered in this analysis because onshore construction activities will stay within existing developed footprints, use an existing gravel source, and not include any new tall structures or power lines.

3.2.5.1. Threatened and Endangered Birds

Threatened and endangered avian species regularly using the Chukchi Sea include the spectacled eider and Steller's eider (both threatened). In January 2015, BOEM provided a Biological Assessment (BA) to the USFWS for threatened and endangered species consultation that included Steller's eider and spectacled eider (USDOI, BOEM, 2015b). Descriptions are summarized and updated below.

Spectacled Eider. The spectacled eider was listed as a threatened species throughout its range under the ESA in May 1993 (58 *FR* 27474). Spectacled eiders on the Alaska North Slope (ANS) breed across the Arctic Coastal Plain (ACP) east to approximately the Canadian border. The breeding population on the ANS is the largest breeding population of spectacled eiders in North America, currently estimated at 11,254 (8,338–14,167, 95% Confidence Interval) (USFWS, 2014). The ANS population in the fall (October) is estimated to be 33,587 birds (Stehn et al., 2006). Spectacled eider density varies across the ACP (Larned, Stehn, and Platte, 2006).

Spectacled eiders make use of the spring lead system when they arrive from their wintering area in the Bering Sea before moving inland to breed. The spring lead system includes Ledyard Bay and typically has represented the only open-water area along their path.

Once tundra nesting habitats are sufficiently thawed to allow nesting (historically around June 10^{th}), most breeding pairs leave nearshore coastal areas to begin nesting—a few thousand pairs might nest on the ANS. Spectacled eider nesting density on the ACP is variable, ranging from 0 to 0.95 nests per square kilometer (Larned, Stehn, and Platte, 2006). The estimated nesting density in 2009 was 0.37 birds per square kilometer (Larned, Stehn, and Platte, 2010).

Male spectacled eiders leave the nesting area at the onset of incubation and seek open waters of the Chukchi and Beaufort Seas until they move to molting areas in Ledyard Bay, the eastern Norton Sound, or coastal Russian waters. Many postbreeding male spectacled eiders slowly begin to converge in offshore aggregations in Ledyard Bay starting in July and begin a flightless molt that lasts several weeks. Males that breed on the ACP (but return to molting areas in Russia) likely make limited use of Ledyard Bay and other coastal areas of the Beaufort or Chukchi Seas on their westward migration. Some eiders crossing to Russia may take routes roughly west of Barrow (Sexson, Peterson, and Powell, 2010; Sexson, 2011). A single spectacled eider was observed during September seabird surveys on the Burger Prospect in 2009 and 2010 (number of spectacled eiders observed in 2010 is assumed to be one). (Gall, Day, and Morgan, 2013).

Female spectacled eiders begin to move to coastal areas at the end of their nesting effort. Females whose nests fail early go to the coast and may linger in nearshore areas. Female spectacled eiders also use Ledyard Bay for flightless molt lasting a few weeks. Spectacled eider females and hatch-year birds are the last to arrive at Ledyard Bay around the end of the first week of September.

The Ledyard Bay area was designated critical habitat for the spectacled eider in 2001 (66 *FR* 9145). The Ledyard Bay Critical Habitat Unit (LBCHU) includes the waters of Ledyard Bay within about 74 km (40 nmi) from shore, excluding waters <1.85 km (~1 nmi) from shore. The LBCHU is an important molting area for ANS-breeding spectacled eiders in the summer (males) and fall (breeding females) (Sexson, Peterson, and Powell, 2010, Sexson, 2011). The molt is an energetically demanding period, and eiders are believed to use LBCHU for molting because of a combination of environmental conditions, abundance and accessibility of prey, and low level of disturbance and predation. Overall, many spectacled eiders remain in LBCHU until forced out by sea ice (typically late October through mid-November). Following the molt, spectacled eiders move to their wintering area south of St. Lawrence Island in the Bering Sea.

Steller's Eider. The Alaska breeding population of Steller's eider is listed as threatened under the ESA (62 *FR* 15244). It is the least-abundant eider in Alaska, and represents less than 5% of the worldwide breeding population. Over 95% of the Alaskan breeding population of Steller's eiders occurs on the ACP, with the nest density greatest in the vicinity of Barrow, and are therefore expected to be present in and around the Proposed Action area. The most recent available estimate for the ACP nesting population is approximately 680 (Stehn, Larned, and Platte, 2013). The average population size in the Barrow Triangle area (the northern ACP, between Barrow and the Meade River) is estimated at 332 (USFWS, 2014).

Steller's eiders are paired within flocks when they arrive on the ACP, typically from early to mid-June. They often nest on coastal wetland tundra, but some nest near shallow ponds or lakes well inland; the greatest breeding densities were found near Barrow, although they do not breed every year when present. Estimated Steller's eider density for the Barrow Triangle area ranges from <0.01 – 0.03 birds/km^2 in non-nesting years to 0.03 – 0.08 birds/km^2 in nesting years (USFWS, 2015).

Male Steller's eiders depart the ANS after the nest is initiated in mid- to late June. Female eiders and their young-of-the-year typically depart the ANS from late September to early October. Unlike spectacled eiders, Steller's eiders do not molt in the Chukchi Sea. During molt migration, Alaskan breeding Steller's eiders stop and rest in areas of the Alaska Chukchi Sea, often in nearshore waters (within 2 km or 1 nmi of shore) near Ledyard Bay and Icy Cape. There is less use at more northerly locations near Wainwright and Peard Bay. No Steller's eiders were observed in annual August-October surveys of Klondike and Burger Prospects between 2008 and 2012 (Gall, Day, and Morgan, 2013). More males than females migrate from Alaska to areas along the coast of Chukotka, while males that do not go to Chukotka spend more time on the Alaska Chukchi Sea coast.

Although Steller's eiders occur in nearshore waters of the Chukchi Sea, the total numbers probably are low given the small numbers that breed on the ANS. No Steller's eiders were observed in the

Klondike or Burger prospects during seabird surveys in 2008 and 2009, or in a larger Chukchi Sea study area including the two prospects in 2010-2012 (Gall, Day, and Morgan, 2013).

3.2.5.2. Cliff-Nesting Seabirds

Common murre and thick-billed murre. Common murres and thick-billed murres breed as far north as Cape Lisburne and farther south at Cape Thompson. The Cape Lisburne colony is estimated to support about 400,000–500,000 murres (Dragoo and Balland, 2014). Murres are primarily piscivorous and rely on dispersed schools of offshore fish such as pollock. Murre foraging areas from the two largest colonies overlap in an offshore area north of Cape Lisburne. In the fall, adult males remain with their hatch-year offspring and undergo a flightless molt in offshore molting areas north of the Bering Strait. Flightless individuals are not capable of undertaking large scale movements to other areas and tend to move south with prevailing currents.

Murres were observed in small numbers ranging up to over 800 in a transect during 2008-2012 Chukchi Sea seabird surveys; specifically, the largest numbers observed within the Burger Prospect were less than 300 thick-billed murres in September, 2012 (Gall, Day, and Morgan, 2013). Most observations of common and thick-billed murres totaled fewer than 100 during any survey period.

Horned puffin and tufted puffin. The horned puffin and the tufted puffin are found in the Chukchi Sea area, with horned puffin breeding restricted to cliff habitats like Cape Lisburne. Horned puffins are primarily piscivorous, rely on dispersed schools of offshore fish, and have been reported to forage in excess of 100 km offshore of breeding colonies. Tufted puffins breed at cliff colonies, but can also nest on suitable beach habitats by digging burrows or hiding under large pieces of driftwood or debris. Fewer than 10 horned or tufted puffins were observed during any survey period at the Burger Prospect during seabird surveys from 2008 to 2012 (Gall, Day, and Morgan, 2013).

Black-legged kittiwake. Breeding colonies of the black-legged kittiwake in the Chukchi Sea (Cape Thompson and Cape Lisburne) are at the northern limit of their breeding range in Alaska. There are about 20,000-30,000 black-legged kittiwakes breeding at the Cape Lisburne colony (Dragoo and Balland, 2014). Divoky (1987) reported about 400,000 black-legged kittiwakes from mid-July until late September in pelagic areas of the Chukchi Sea. Transect numbers in the low hundreds were observed in September within the Burger Prospect during the 2008-2012 Chukchi Sea seabird surveys (Gall, Day, and Morgan, 2013).

3.2.5.3. Bering Sea Breeders and Summer Residents

Kittlitz's Murrelet. The Kittlitz's murrelet nests as far north as Cape Beaufort (100 km northeast of Cape Lisburne) in the Amatusuk Hills. These birds are solitary nesters and extensive survey efforts are required to determine local abundance. Breeding along the ACP is unlikely due to lack of suitable habitat.

Murrelet foraging areas occur in the Chukchi Sea (Day, Gall, and Pritchard, 2011). Kittlitz's murrelets have been observed on an infrequent basis in the Chukchi Sea as far north and east as Point Barrow. Kittlitz's murrelets have not been regularly observed at sea, which suggests there is a great deal of annual variation in their occurrence in the Chukchi Sea. Small numbers of Kittlitz's murrelets were recorded during late fall seabird surveys in the Klondike and Burger Prospect areas in 2009, but none were observed in 2008, and 35 were recorded on one transect in the Hanna Shoal area in 2011 (Gall, Day, and Morgan, 2013).

Northern fulmar. The northern fulmar does not breed along the Chukchi Sea coast, and those observed in this area during the spring and summer are nonbreeders or failed breeders from southern areas. Divoky (1987) estimated 45,000 northern fulmars in pelagic waters of the southern Chukchi Sea during late August to mid-September. Fulmars totaling in the low hundreds were observed during the late summer and early fall around the Klondike and Burger prospects during the 2008-2012 Chukchi Sea Gall, Day, and Morgan (2013) seabird surveys.

Short-tailed shearwater. The short-tailed shearwater in the Chukchi Sea are most common in the southern portion, and were the second most common seabird species found in the exploration program area from late August to late September (Gall, Day, and Morgan, 2013) in all 2008-2012 survey years. Short-tailed shearwaters likely forage on dense patches of euphausiids and amphipods (small shrimp-like crustaceans) in these northern latitudes. Gall and Day (2010) suggested that the shearwaters can rapidly respond to changes in oceanic conditions and exploit food resources when and where they are available. For example, Kuletz (2011a) reported a single flock numbering over 15,000 short-tailed shearwaters in the western Beaufort Sea in late August–early September, 2011. Kuletz (2011b) reported over 4,000 shearwaters during a seabird survey in the Chukchi Sea in late August – early September 2011 (the most abundant species reported), with many flocks numbering 150–300 birds. Similarly, transects totaling in the low hundreds were observed during the early fall around the Klondike and Burger prospects during seabird surveys in 2008 and 2009 (Gall, Day, and Morgan, 2013); and during the early fall period in 2009, almost 12,000 short-tailed shearwaters were observed near the Klondike Prospect.

Storm-petrels. In Alaska, Leach's storm-petrel and fork-tailed storm-petrel do not nest in any numbers north of the Aleutian Islands, where they are both abundant. Little information is available regarding the regularity of migrations that may range into the Chukchi Sea area. Nonetheless, they do occur above pelagic waters there. In 2012, bird/vessel encounters were reported by two drilling rigs and nine support vessels operating in the Chukchi Sea. Out of 131 birds found onboard vessels, 11 were identified as Leach's or fork-tailed storm-petrels, with another 10 tentatively identified as some species of shearwater or storm-petrel.

Auklets. Three species of auklets (parakeet, least, and crested) breed as far north as the Bering Strait, but move into the Chukchi Sea from late August into early October. Kuletz (2011b) reported thousands of auklets during a seabird survey in the Chukchi Sea in late August – early September 2011, with all but a few least auklets south of Point Hope and numerous flocks of crested auklets north of Point Hope. Crested auklets were the most numerous seabird observed by Gall, Day, and Morgan (2013) during all five years of seabird surveys of the Klondike and Burger prospects in 2008-2012. Over 5,000 crested auklets were observed during the early fall at the Burger Prospect in 2009, with numbers in the thousands consistently reported during other survey periods that year. As with shearwaters, Gall and Day (2010) suggested that the auklets rapidly respond to changes in oceanic conditions and exploit food resources when and where they are available. Least auklets numbering in the low hundreds were also regularly observed during the Gall, Day, and Morgan (2013) survey periods. Parakeet auklets were observed by Gall, Day, and Morgan (2013), but in much lower numbers than crested and least.

A fourth species of auklet, Cassin's auklet, is not known to breed north of the Aleutian Islands. Two Cassin's auklets, however, were among the reported bird/vessel encounters in the 2012 Chukchi Sea Shell exploration season.

3.2.5.4. High Arctic-Associated Seabirds

Black guillemot. Black guillemot breed along the Chukchi Sea from Cape Thompson northward. Despite the relatively small breeding population in Alaska (the Chukchi and Beaufort Seas have a combined total of fewer than 2,000 nesting birds), the post-breeding population of guillemots from the U.S. and Russia is estimated to be around 70,000 in pelagic areas of the Chukchi Sea. Black guillemots remain closely associated with sea ice throughout their lifetime, where they feed extensively on Arctic cod. Small numbers of black guillemot were observed during seabird surveys around the Klondike and Burger prospects in four of five study years between 2008-2012 (Gall, Day, and Morgan, 2013).

Ross' gull. Ross' gulls may be encountered near Point Barrow. Many migrate south through the Chukchi Sea in the late fall and pass through the Bering Strait to winter in the Bering Sea. The Ross' gull was observed at the Burger Prospect and Hanna Shoal during seabird surveys between 2008-2012 (Gall, Day, and Morgan, 2013), in numbers between 20 and 135 in each large transect.

Ivory gull. Ivory gulls are closely associated with the ice edge throughout their lifecycle and small numbers migrate through in fall to wintering areas in the northern Bering Sea. The ivory gull is uncommon to rare in pelagic waters of the Chukchi Sea during summer. Two ivory gulls were observed in the late fall at the Burger Prospect during seabird surveys in 2008 and 2009, and one and then two observed in 2011 and 2012, respectively, at Hanna Shoal (Gall, Day, and Morgan, 2013).

Arctic tern. Arctic terns nest near lakes on the ACP. Aerial surveys along coastal habitats of the entire ACP typically observe fewer than 1,500 birds, with most of these along the mainland areas along the Chukchi Sea (Dau and Bollinger, 2009). Arctic terns are rare in the pelagic waters of the Chukchi Sea. Small numbers were observed during August and September in all years of the Gall, Day, and Morgan (2013) 2008-2012 Chukchi Sea seabird surveys.

3.2.5.5. Tundra-Breeding Migrants

Jaegers. The three species of jaegers (pomarine, parasitic, and long-tailed) occur in nearshore areas of the Chukchi Sea in summer until late September, when they move south to the Bering Sea. Jaegers are dispersed throughout pelagic areas of the Chukchi Sea, with no obvious high concentration areas. Small numbers of all three species were occasionally observed during the Gall, Day, and Morgan (2013) 2008-2012 Chukchi Sea seabird surveys.

Glaucous gull. Glaucous gulls are most common in the Chukchi Sea from late July to late September within 70 km of shore between Icy Cape and Barrow. Most glaucous gulls in the Chukchi Sea area breed inland near freshwater, but some breed at coastal seabird colonies. Glaucous gulls typically occur in low densities in the Chukchi Sea, but commonly congregate at food sources. Glaucous gulls were observed during the Gall, Day, and Morgan (2013) 2008-2012 Chukchi Sea seabird surveys, numbering under 90 during any particular survey period.

Passerines. Several species of passerine birds (also referred to generically as songbirds) breed in Arctic habitats in Alaska, Canada, and Russia, and follow migratory pathways across the Chukchi Sea on their way to and/or from their wintering grounds. These arctic passerine migrations have not generally been well-studied, but it is well-known that these long-distance flights are undertaken by species that winter in North America, as well as on other continents (commonly referred to as "Old World" migrants). Snow buntings and American pipits are examples of species that breed in treeless habitats in Alaska and winter farther south in North America. Old World passerines migrating across the Chukchi Sea include Arctic warbler, northern wheatear, and yellow wagtail. Passerines are largely nocturnal migrants, and do not feed in the Chukchi Sea area while migrating. Over 40% of the bird/vessel encounters recorded on drilling and support vessels in the Chukchi Sea 2012 exploration season were passerines, including two American pipits, sixteen Arctic warblers, thirteen northern wheatears, and six wagtails. Passerine species that are not common ANS breeders were also among these reports, including one each Swainson's thrush, yellow warbler, and rusty blackbird.

3.2.5.6. Waterfowl and Loons

Loons. Pacific loons are the most common loon species nesting and migrating along the Chukchi Sea coast. Red-throated loons are less common and nest on smaller ponds than Pacific loons. In spring, loons typically migrate along coastal routes, although some may use inland routes. Most of the postbreeding loon migration takes place in September. Most loons stay very close to shore during fall migration until they reach the Lisburne Peninsula, where they head farther out to sea towards the Bering Strait (Rizzollo and Schmutz, 2010). Observations of Pacific loons were most numerous during the mid-fall period at the Burger Prospect, and 181 were observed during the seabird survey there in 2009 (Gall, Day, and Morgan, 2013). In contrast, only four red-throated loons were observed in any one survey (early fall at the Hanna Shoal transect).

Yellow-billed loons typically nest near large, deep, tundra lakes where they nest on low islands or near the edges of lakes to avoid terrestrial predators. In total, there are fewer than 5,000 yellow-billed loons on the Arctic coast breeding grounds and near shore marine habitat (Earnst et al., 2005). There may be approximately 1,500 yellow-billed loons, presumably non-breeding adults and immatures, in near shore marine waters or in large rivers during the breeding season. Breeding yellow-billed loons typically remain on their lakes until young are fledged.

Most yellow-billed loons from the ACP have moved into nearshore coastal waters by September. In addition, approximately 8,000 yellow-billed loons from the Canadian Arctic travel across the Chukchi Sea during spring and fall migration between Canada and wintering grounds in eastern Asia (Schmutz et al., 2010). Most loons stay very close to shore during fall migration until they reach the Lisburne Peninsula, where they head farther out to sea towards the Bering Strait (Rizzolo and Schmutz, 2010). Yellow-billed loons were observed at the Burger Prospect during seabird surveys in 2008 and 2009 (Gall and Day, 2010). Most sightings of yellow-billed loons represented low numbers of birds during the survey period; however, 24 were observed during the early fall period in 2009. No yellow-billed loons were observed during seabird surveys in the Chukchi Sea in late August and early September 2011 (Kuletz, 2011b). Low numbers, patchy distributions, and specific habitat requirements may make yellow-billed loons more susceptible to environmental perturbations such as disturbance, habitat alterations, and oil spills than species that are more abundant, widely distributed, and able to exploit a greater diversity of habitats.

Long-tailed duck. The long-tailed duck is a common species in the Chukchi Sea after the first week of September until late October. Many long-tailed ducks molt in Kasegaluk Lagoon and Peard Bay on the Chukchi Sea coast. Molting long-tailed ducks tend to stay in or near the lagoons, feeding heavily in passes between barrier islands. Aerial surveys along coastal habitats of the entire ACP typically observe fewer than 7,500 long-tailed ducks, with about two-thirds of these associated with mainland habitats (Dau and Bollinger, 2009). Kasegaluk Lagoon and Peard Bay are important locations during molting and migration.

Fewer than 70 long-tailed ducks were observed during any survey period during the Gall, Day, and Morgan (2013) 2008-2012 Chukchi Sea seabird surveys, and most survey periods observed no long-tailed ducks. Eighteen long-tailed ducks were among the 131 birds reported on vessels in the 2012 Chukchi Sea drilling season.

Common eider. The common eider typically migrates during spring along the Chukchi Sea coast using offshore open-water leads. Common eiders nest on barrier islands or spits along the Chukchi Sea coast. Aerial surveys along coastal habitats of the entire ACP typically observe fewer than 3,000 common eider, with about half of these observed in the mainland areas along the Chukchi Sea (Dau and Bollinger, 2009)

Beginning in late June, postbreeding male common eiders begin moving towards molting areas in the Chukchi Sea; by late August, most common eiders in the Chukchi Sea are molting males. Most breeding female common eiders and hatch-year birds begin to migrate to molt locations in late August and September. Common molt areas in the Chukchi Sea are near Point Lay, Icy Cape, and Cape Lisburne. Kasegaluk Lagoon and Peard Bay also are important locations for molting and during migration. Hundreds of thousands of common eiders move through the Chukchi Sea during their migration to breeding grounds in eastern Canada.

After the molt is completed, many common eiders move offshore into pelagic waters. Forty two common eiders were observed in the early fall at the Burger Prospect during a seabird survey in 2012

(Gall, Day, and Morgan, 2013), and four were reported encountering vessels in the 2012 Chukchi Sea drilling season.

King eider. The location and timing of offshore leads along the Chukchi Sea is a major factor determining routes and timing of king eider migration. Most king eiders begin to migrate through the Chukchi Sea, including Ledyard Bay, in mid-April. Many post-breeding male king eiders move to staging areas along the Chukchi Sea in mid- to late July. The typical staging time in Ledyard Bay was 17–24 days and Ledyard Bay may be a critical stopover area for foraging and resting during spring migration (Oppel, Dickson, and Powell, 2009). Peard Bay is also particularly important to molting and migrating king eiders. Hundreds of thousands of king eiders move through the Chukchi Sea during their migration to and from breeding grounds in eastern Canada.

Thirteen king eiders were reported encountering vessels in the 2012 Chukchi Sea drilling season. No more than two king eiders were observed during each seabird survey period in 2008 at the Klondike and Burger prospects and 18 king eiders were observed in 2012 in the Hanna Shoal vicinity (Gall, Day, and Morgan, 2013).

Brant. Many brant migrate along the west coast of Alaska en-route to breeding areas on the ANS or the Canadian High Arctic. Brant typically nest on offshore spits, barrier islands, or on islands formed in large river deltas. Aerial surveys along coastal habitats of the entire ACP typically observe fewer than 2,500 brant, with about half of these observed in the mainland areas along the Chukchi Sea (Dau and Bollinger, 2009). Kasegaluk Lagoon is an important stopover location during postbreeding migration. No brant were observed during the 2008-2012 Chukchi Sea Gall, Day, and Morgan (2013) seabird surveys.

Greater white-fronted goose. The greater white-fronted goose breeds along the Chukchi Sea coast, typically within 30 km of the coast. Most greater white-fronted geese reach Alaska via overland routes. Several thousand can be observed at a time in Kasegaluk Lagoon, with migration peak in the first week of June and the last week of August. No greater white-fronted geese were observed during the 2008-2012 Chukchi Sea Gall, Day, and Morgan (2013) seabird surveys.

Lesser Snow Goose. There are very few lesser snow geese nesting in Alaska. This species nests on an island in the Kukpowruk River delta (about 60 km south of Point Lay) in the southern portion of Kasegaluk Lagoon, one of two consistently used nesting colonies for lesser snow geese. No lesser snow geese were observed during the 2008-2012 Chukchi Sea Gall, Day, and Morgan (2013) seabird surveys.

Tundra swans. Tundra swans have been observed in Kasegaluk Lagoon with flightless young-of-the-year birds indicating that tundra swans breed there. No swans were observed during the 2008-2012 Chukchi Sea Gall, Day, and Morgan (2013) seabird surveys.

3.2.5.7. Shorebirds

Although many shorebirds breed on tundra, they also rely on coastal areas such as beaches, barrier islands, lagoons, and mudflats for some portion of their lifecycle. These coastal areas are especially important habitats where shorebirds replenish energy reserves after breeding and prior to southward migration. The most common shorebird species breeding on the ACP include dunlin, semipalmated sandpiper, pectoral sandpiper, and red phalarope. Many shorebirds leaving the Beaufort Sea move west along the Chukchi Sea coast. Large numbers of shorebirds move west along the Chukchi Sea coast, stopping at high-productivity shoreline sites to replenish energy reserves and rest.

Other than phalaropes, described below, few shorebirds were observed at the Burger or Klondike prospects during the 2008-2012 Chukchi Sea Gall, Day, and Morgan (2013) seabird surveys. One western sandpiper was reported encountering a vessel in the 2012 Chukchi Sea drilling season.

Phalaropes. Both red and red-necked phalaropes are present in the Chukchi Sea during the open-water periods. Phalaropes are common in pelagic waters as well as within a few meters of shore, where their distribution typically is tied to zooplankton abundance. Due to their reliance on zooplankton, their distribution is patchy and variable; however, because they are tied to a moving prey source they may be encountered throughout the Chukchi Sea in varying concentrations. Phalaropes are one of the most abundant species groups of shorebirds that use Kasegaluk Lagoon and Peard Bay, where they stage or stop over in nearshore marine and lacustrine (lake) waters. Phalaropes were the most abundant shorebird species observed during the 2008-2012 Chukchi Sea Gall, Day, and Morgan (2013) seabird surveys, with fewer than 300 observed during any one survey period.

Dunlin. Two subspecies of Dunlin breed in Alaska. Dunlins are another of the most abundant species of shorebirds that use Kasegaluk Lagoon, where they stage or stop over in silt tidal flats and salt-grass meadows. No dunlin were identified during the 2008-2012 Chukchi Sea Gall, Day, and Morgan (2013) seabird surveys.

3.2.5.8. Raptors and Ravens

A variety of raptors and corvids (of the crow family) may be present in the coastal zone along the Chukchi Sea coast. On the ANS, raptors typically are more common within 20 km of the Brooks Range foothills and population densities are lower near the coast, especially during the breeding season. Snowy owls are the raptor most commonly encountered near coastal areas. Raptors and ravens seldom interact with the marine environment. One wayward short-eared owl was observed during the late summer period at the Burger Prospect by Gall and Day (2010) during seabird surveys in 2009.

3.2.6. Marine Mammals

Marine mammals are federally protected under the Marine Mammal Protection Act (MMPA). Requirements of this Act generally prohibit the take by injury or harassment of marine mammals. More detailed information on distribution, life history parameters, and other relevant background can be found in the 2007 FEIS (USDOI, MMS, 2007, Sections III.B.4.a and III.B.6), the 2011 SEIS (USDOI, BOEMRE, 2011, Sections III.B.4 and III.B.6), and the 2015 Second SEIS (USDOI, BOEM, 2015a, Section 3.2.4). Relevant new information and site specific information is presented here.

The Chukchi Sea supports a diverse assemblage of marine mammals. The most common marine mammals in the leased area are bowhead whales, gray whales, beluga whales, harbor porpoises, Pacific walruses, ringed seals, spotted seals, bearded seals, and polar bears. Small numbers of killer whales, minke whales, fin whales, humpback whales, and ribbon seals may be present in the leased area but not necessarily in the vicinity of the planned exploration drilling operations (see Table 3.7-1 in the Environmental Impact Assessment for Shell Gulf of Mexico, Inc.'s 2015 Exploration Plan (Shell, 2015a, Appendix C).

Bowhead, humpback, and fin whales are listed as ''endangered'' under the Endangered Species Act (ESA) and as depleted under the MMPA. Certain stocks or populations of gray, beluga, and killer whales and are listed as endangered or are proposed for listing under the ESA; however, none of those stocks or populations occur in the Proposed Action area (see NMFS, 2015b, Table 1). Polar bears and ringed seals (Arctic subspecies) are listed as "threatened' under the ESA and as depleted under the MMPA. The Beringia Distinct Population Segment (DPS) of bearded seal was listed as "threatened" under the ESA but that listing was recently vacated (Alaska Oil and Gas Association v. Pritzker, Case No. 4:13-cv-00018-RPB) and is on appeal at the U.S. Ninth Circuit Court of Appeals (Notice of Appeal, Case No. 4:13-cv-00018-RRB). Pacific walruses are a candidate species for ESA listing.

3.2.6.1. Cetaceans

Mysticete Whales

The baleen whales (mysticete) likely to occur in the proposed drilling area are the bowhead whale (*Balaena mysticetus*), fin whale (*Balaenoptera physalus*), gray whale (*Eschrichtius robustus*), humpback whale (*Megaptera novaeangliae*), and minke whale (*Balaenoptera acutorostrata*). Observations of baleen whales in the vicinity of the Lease Sale 193 area have been reported in several surveys over the past 20 years. While these surveys use different methods and occurred under different circumstances, taken together they illustrate the use of the area by whales. Results of these survey reports are given in detail in the EIA submitted by Shell; specifically Shell EIA Tables 3.7-2 to 3.7-7 (Shell, 2015a, Appendix C).

Bowhead Whale. Bowhead whale stocks occur in Arctic and sub-Arctic waters off eastern and western Canada, Alaska, Chukotka, and the sea of Okhotsk. The minimum population estimate for the western Arctic stock of bowhead whales off Alaska, western Canada, and Chukotka is 10,314 and is thought to be increasing at least 3% annually (Allen and Angliss, 2014). The Western Arctic bowhead whale stock generally occurs in seasonally ice-covered waters of the Arctic, generally north of 60° N. and south of 75° N. in the western Arctic Basin (Bering, Chukchi, and Beaufort Seas)(Moore and Reeves, 1993). They have an affinity for ice and are associated with relatively heavy ice cover and shallow continental shelf waters for much of the year. Surveys from 1990 to the present have noted that bowhead whales seasonally occur near the proposed drill sites (reported in Shell, 2015a, Appendix C). They were the second most commonly observed cetacean, second to the gray whale, in this area of the northeastern Chukchi Sea during marine mammal monitoring associated with seismic surveys in 2006-2012 (Shell, 2015a, Appendix C, Table 3.7-3). Numbers near the Burger Prospect are usually low (though variable from year to year) until the fall migration of September or October, when bowhead whale move in pulses out of the Beaufort Sea and through the Chukchi Sea.

During spring, bowheads migrate through spring lead systems to feeding areas in the eastern Beaufort Sea, and the vicinity of Barrow Canyon. All of the planned drill sites in Shell’s Burger Prospect are located seaward of the generalized spring migration route (Shell, 2015a, Appendix C, Figure 3.8.6-1). A few individuals remain scattered through the Chukchi Sea during summer (Ireland et al., 2009); however, tracking data indicates most bowheads move to or between their primary feeding areas in the Beaufort Sea (ADF&G, 2009). Moore and Reeves (1993) indicated the fall migration takes place in pulses or aggregations of whales out of the Beaufort Sea. After passing Point Barrow, the migration paths of individual bowhead whales fan out across the Chukchi Sea with most heading towards the coastal waters of Chukotka (where it is believed they feed) and then south through the Bering Strait to the Bering Sea to winter (ADF&G, 2009; Ireland et al., 2009; Quakenbush, Small and Citta, 2010; Citta et al., 2012). Iñupiat whalers report that smaller whales precede large adults and cow-calf pairs on the fall migration (Braham et al., 1984, as reported in Moore and Reeves, 1993).

Data from satellite tracking (Quakenbush, Small and Citta, 2010), agency monitoring (Clarke et al., 2011a) and industry monitoring efforts (2006–2012) (see Shell, 2015a, Appendix C) have noted bowhead movement and feeding uses in the Chukchi Sea during summer and fall. Satellite tracking data (Quakenbush, Small, and Citta, 2010) for bowhead whales from 2006–2008 and passive acoustic monitoring (Moore, Stafford, and Munger, 2010) indicated most bowhead whales pass Barrow in September and October heading towards Wrangel Island (Russia). Once near Wrangel Island whales may linger up to 21 days, before traveling Southeast to coastal waters of Chukotka where they may feed for another 59 days, before departing for the Bering Sea. However, ice cover influences the timing, duration, and path that the whales follow (Treacy, 2002). During years with higher-than-average ice coverage, bowheads tend to migrate in deeper water farther offshore (Moore, 2000).

The Bowhead Whale Aerial Survey Project (*BWASP*) and Chukchi Offshore Monitoring in Drilling Area (COMIDA) have been combined into Aerial Surveys of Arctic Marine Mammals (ASAMM).

ASAMM survey data indicate that the bowhead is found throughout the leased area, including the Proposed Action area, at certain times (Shell, 2015a, Appendix C, Figure 3.8.6-2) but especially during fall migration (Quakenbush et al., 2010). However, ice conditions may impact the timing of their presence. Bowheads were also observed in the Burger Prospect during baseline marine mammal surveys conducted as part of the Chukchi Sea Environmental Studies Program (CSESP) in 2008-2012 (Brueggeman, 2009a and 2010; Aerts et al., 2014). Funk et al., (2013) and Bisson et al., (2013a) observed very small numbers of bowheads in this portion of the Chukchi as early as July during dedicated vessel marine mammal surveys associated with Shell's seismic and drilling programs (Shell, 2015a, Appendix C, Table 3.7-3). In general, data indicate that small numbers of bowheads may be found in the Burger Prospect during Shell's planned exploration drilling program (Shell, 2015a, Appendix C, Table 3.8.6-1).

The most common prey species found in the stomachs of harvested bowheads are small shrimp-like crustaceans such as euphausiids, copepods, mysids, and amphipods (Moore, Stafford, and Munger, 2010; Lowry, Sheffield, and, George, 2004). Euphausiids and copepods are thought to be their primary prey since other crustaceans (isopods [a group of crustaceans that includes woodlice, sea slaters and their relatives] and decapods [a group of crustaceans that includes crayfish, crabs, lobsters, prawns and shrimp), and fish constitute minor fractions of their stomach contents. Carbon-isotope analysis of bowhead baleen indicates a significant amount of feeding occurs in wintering areas (Schell, Saupe, and Haubenstock, 1987). There are no known concentrations or notable feeding areas for bowhead whales in the northeastern Chukchi Sea. The nearest feeding area of particular consequence is in the vicinity of Barrow Canyon where the Beaufort and Chukchi Seas meet (Sheldon and Mocklin, 2013).

Fin Whale. Fin whales are widespread throughout temperate oceans of the world (Leatherwood et al., 1982; Perry, DeMaster, and Silber, 1999a) and in the Arctic Ocean (Allen and Angliss, 2014). Although once considered extralimital (not occurring) in the Chukchi Sea, small numbers of fin whales seasonally inhabit areas within and near the Chukchi Sea, the extreme northern edge of their range, during the open water period. Based on observations and passive acoustic detection (Hannay et al., 2009; Delarue et al., 2010), and on direct observations from monitoring and research projects of fin whales by industry (e.g., Ireland et al., 2009; Funk et al., 2010; Funk et al., 2013; Aerts et al., 2011; Aerts et al., 2014) and government (e.g., Clarke et al., 2011c; Clarke et al., 2013), fin whales are considered uncommon but regular visitors to the Alaska Chukchi Sea during the open water season (NMFS, 2015b). Fin whales have been recorded each year from 2007-2010 in fall on bottom-mounted hydrophones in the Chukchi Sea (Delarue et al., 2013) and in ship surveys in the summer and early fall of 2009, 2012, and 2013. (Aerts et al., 2014). All of these observations suggest they may be re-occupying habitat used prior to large-scale commercial whaling. However, surveys from 2008-2013 have noted no fin whales occurring in the Proposed Action area (Aerts et al., 2014).Three sightings of fin whales were recorded within the Greater Hanna Shoal Study Area (Shell, 2015a, Appendix C, Figure 3.0-1) while conducting the CSESP vessel-based marine mammal surveys during August and October 2008-2012 (Aerts et al., 2014). Data from COMIDA and ASAMM also indicate that fin whales are uncommon at the Burger Prospect. Therefore very small numbers of fin whales could potentially occur in the Burger Prospect during the planned exploration drilling program.

The North Pacific fin whale population is estimated to have ranged from 42,000-45,000 before whaling began (Ohsumi and Wada, 1974). Allen and Angliss (2014) provide a current, minimum population estimate of 1,214 for the proportion of the Northeast Pacific Stock of fin whales west of the Kenai Peninsula.

Although there may be some degree of specialization, most individuals probably prey on both invertebrates (including crustaceans and squid) and fish, depending on availability (Watkins et al., 1984; Edds and Macfarlane, 1987). There appears to be variation in the predominant prey of fin whales in different geographical areas depending on local abundance of prey species (NMFS, 2010).

Perry, DeMaster and Silber (1999a: p. 49) reported fin whales "depend to a large extent on the small euphausiids and other zooplankton" and fish. Fin whales aggregate where prey densities are high (Piatt and Methven, 1992; Moore, Stafford, and Dahlheim, 1998) chiefly in areas with high phytoplankton production and along ocean fronts (Moore, Stafford, and Dahlheim, 1998).

Gray Whale. Most of the Eastern North Pacific (ENP) Stock of gray whales spends its summer feeding in the northwestern Bering Sea, and in the Chukchi Seas (Rice and Wolman, 1971; Berzin, 1984; Nerini, 1984), migrating to winter and calve in the waters of Baja California. Gray whales prefer areas with little or no ice cover and spend most of their time in water less than 200 ft. (60 m) deep (Moore and DeMaster, 1997). They are found in the area of Shell's Burger Prospect and are often observed in the area of Hanna Shoals, a feeding area, located about 60 mi (96 km) northeast of Burger (Shell, 2015a, Appendix C, Figure 3.7.3-1).

The population size of the ENP gray whale stock has increased over several decades (Laake et al. 2012, Punt and Wade 2012) with the number of individuals at a level similar to what is believed to approximate the pre-commercial whaling population level. Carretta et al. (2013) report a minimum population estimate of 18,017 individuals for the ENP stock. Gray whales summering in the northeastern Chukchi Sea tend to use recurring feeding areas. Primary feeding areas in the Chukchi Sea include the eastern Chukchi, some shoal areas, and the western Chukchi from Wrangel Island to the Bering Strait, but they may be found throughout the Chukchi Sea in shallow waters over the continental shelf. Gray whale feeding areas offshore of northern Alaska are characterized by low species diversity, high biomass, and the highest secondary production rates reported for any extensive benthic community (Rugh et al., 1999).

Gray whales are the species of cetacean most frequently detected during marine mammal monitoring in the northeastern Chukchi Sea during the open water season (Funk et al., 2010; Brueggeman et al., 2009a and 2009b; Aerts et al. 2014; Shell, 2015a, Appendix C). Surveys from 1990 to the present have noted that, relative to other cetaceans, gray whales are relatively common near the proposed drilling sites and throughout the northeastern Chukchi Sea (Shell, 2015a, Appendix C, Tables 3.7-2 to 3.7-7).

Gray whales are primarily bottom feeders restricted to shallow continental shelf waters for feeding. They mostly remain in coastal waters although in the Chukchi and Bering Seas they feed at greater distances from shore over the shallow continental shelf. Their primary prey include swarming mysids, tube-dwelling amphipods, and polychaete worms in the Bering and Chukchi Seas, but they also consume red crabs, baitfish, and other food (crab and fish larvae, amphipods, fish eggs, cephalopods, megalops, etc.) opportunistically or off the main feeding grounds (Reilly et al., 2008).

Stoker (1990) studied a high-use area, the central Chirikov Basin between St. Lawrence Island and the Bering Strait, and found gray whales disturb at least 6% of the benthos each summer while consuming >10% of the yearly amphipod production. According to Highsmith and Coyle (1992), gray whales rely on rich benthic amphipod populations in the Bering and Chukchi Seas to renew fat resources needed to sustain them during their winter migration to and from Baja California. Nelson et al. (1993) noted that in the Chukchi Sea, within areas where gray whales were observed feeding off Wainwright, amphipod species observed were *Ampelisca macrocephala*, *A. estrichti*, *Byblis gaimardi*, *Aty1us bruggeni*, *Ischyrocerus*, *Protomedeia* spp., *Grandifoxus*, and *Erichthonius*, with amphipods comprising 24 percent of the biomass (Feder et al., 1989).

Humpback Whale. Humpback whales are found in all oceans with apparent worldwide geographical segregation into at least 10-11 distinct populations. For management purposes, the International Whaling Commission (IWC) places all humpback whales in the North Pacific Ocean into one stock (Donovan, 1991); however, NMFS recognizes three "management units" or stocks within the North Pacific. Individuals from the Western North Pacific Stock (population est. 732) and the Central North Pacific Stock Aleutians and Bering Sea feeding aggregation (population est. 2,256) could occur in the

Bering Sea with access to the Chukchi and Beaufort Seas (Allen and Angliss, 2014). Both of the stocks are increasing (Allen and Angliss, 2014).

Although once considered extralimital in the area, small numbers of humpback whales seasonally inhabit areas within and near the Chukchi Sea, the extreme northern edge of their range, during the open water period. A few have been observed in the northeastern Chukchi Sea during monitoring for seismic surveys (Funk et al., 2011, Bisson et al., 2013a), and during COMIDA aerial surveys in the Chukchi Sea (Clark et al. 2011a and b), and during shipboard surveys (Aerts et al., 2011; Aerts et al., 2014). When they are seen, humpback whales are present only in extremely low numbers (Shell, 2015a, Appendix C, Tables 3.7-2 to 3.7-7).

No humpback whales were sighted in the area during marine mammal surveys conducted during drilling of the historic Burger Prospect in 1989 and 1990 (Brueggeman et al., 1990, 1991), and no humpback whales were observed in the CSESP Burger study area while conducting baseline marine mammal surveys for the CSESP during August and October 2008-2013 (Aerts et al., 2011; Aerts et al., 2014; Shell, 2015a, Appendix C).

Humpback whales are relatively generalized in their feeding compared to some other baleen whales. In the Northern Hemisphere. Known prey includes euphausiids (krill), copepods, juvenile salmonids, *Oncorhynchus* spp., Arctic cod, *Boreogadus saida*; walleye pollock, *Theragra chalcogramma*; pollock, *Pollachius virens*, pteropods, and cephalopods (Johnson and Wolman, 1984; Perry, DeMaster, and Silber, 1999b).

Minke Whale. The distribution of minke whales is considered cosmopolitan because they can occur in polar, temperate, and tropical waters in most seas and areas worldwide. Minke whales, like some other species of cetaceans, migrate seasonally and are capable of traveling long distances. Some animals and stocks of this species have resident home ranges and are not highly migratory. The distribution of minke whales varies by age, reproductive status, and sex. Older mature males are commonly found in the polar regions in and near the ice edge, and often in small social groups, during the summer feeding season. Mature females will also migrate farther into the higher latitudes, but generally remain in coastal waters. Immature animals are more solitary and usually stay in lower latitudes during the summer. Minke whales are uncommon but regular inhabitants of the northeastern Chukchi Sea and in the Burger Prospect area (Delarue, Martin, and Hannay, 2012; also see Tables 3.7-2 to 3.7-7, Shell, 2015a, Appendix C). Minke whales found in the Chukchi Sea are believed to be migratory and travel along the coast to California (Dorsey et al., 1990).

Presently NMFS has been unable to produce a minimum population estimate for the Alaska Stock of minke whales (Allen and Angliss, 2014); however, an estimate of 1,813 was produced for the east-central and southeastern Bering Sea, based on surveys in the central-eastern Bering Sea (1999) and southeastern Bering Sea (2000). A subsequent survey of a 30-45 nm (56-83 km) zone from Kenai Fjords National Park and Preserve to the central Aleutian Islands (2001-2003) led to an estimate of 1,233 minke whales for that area, with most sightings in the Aleutian Islands and in water <200 m. deep. Most likely the Alaska stock of minke whales numbers into the thousands; however, this is speculative because only a portion of this species' range has been surveyed. Still, minke whales are the most abundant rorqual (a type of baleen whale) in the world, and their population status is considered stable through virtually all of its range (NMFS, 2015a). Minke whales opportunistically feed on crustaceans (e.g., krill), plankton (e.g., copepods), and small schooling fish (e.g., anchovies, mackerel, salmon, sand lance (Tamura and Fujise, 2002).

Odontocete Whales

The toothed whales (Odontocetes) likely to occur in the proposed drilling area are the beluga (*Delphinapterus leucas*), harbor porpoise (*Phocoena phocoena*), and killer whale (*Orcinus orca*).

Narwhals (*Monodon monoceros*) have rarely been observed in the Chukchi Sea and are considered by NMFS to be extralimital (NMFS, 2015b).

Observations of odontocete whales in the vicinity of the Lease Sale 193 area have been reported in several surveys over the past 20 years. While these surveys use different methods and occurred under different circumstances, when taken together they can help to illustrate the use of the area by whales. Results of these survey reports are given in detail in the EIA submitted by Shell for this action; specifically Table 3.7-2 to Table 3.7-7 (Shell, 2015a, Appendix C). Other information on the affected environment for odontocete whales is described below for each species.

Beluga Whale. Of the five stocks of beluga that occur in Alaska (Allen and Angliss, 2014) only the eastern Chukchi Sea and Beaufort Sea stocks occur in the leased area. Both stocks overlap in the Chukchi Sea and winter in the Bering Sea (Suydam et al., 2001; Miller, Elliott, and Richardson, 1998). Much of the Chukchi Sea stock congregates in Kasegaluk Lagoon in June and July, at which time the village of Point Lay conducts a subsistence hunt for these beluga whales. In the spring, beluga whales migrate along open leads north from their wintering grounds in the Bering Sea, often near the coast. Fall migrant beluga whales from the Canadian Beaufort Sea transit the U.S. Beaufort Sea in a more dispersed pattern, but often along the southern edge of the pack ice, to reach western Chukchi Sea waters primarily during September (Richard, Martin, and Orr, 1998). During this time, pods can number 500-1,000 individuals (Citta and Lowry, 2008). Evidence indicates that beluga whales occupy areas near or beyond the continental shelf break during summer in the eastern Chukchi Sea, often near the pack ice margin or in areas of dense ice (Suydam et al. 2005). These preferred summer habitats are well north of the revised Chukchi Sea exploration drill sites.

The estimated number of beluga whales in the eastern Chukchi Sea stock is 3,710 individuals based on 1989-1991 aerial surveys (Frost, Lowry, and Carroll, 1993; Allen and Angliss, 2014). Subsequently, partial surveys were conducted in 1998 (DeMaster, Perryman, and Lowry, 1998) and in July 2002 (Lowry and Frost, 2002). The estimated number of beluga whales in the Beaufort Sea stock is 39,258 individuals based on surveys completed in 1992 with a correction factor (Allen and Angliss, 2014). Belugas are not commonly observed in the area of the Burger Prospect but have been encountered there in small numbers during aerial and shipboard surveys (Shell, 2015a, Appendix C, Table 3.7-2 to Table 3.7-7; Figure 3.7.3-1). Protected Species Observers (PSOs) monitoring marine mammal occurrence from vessels during seismic surveys in offshore waters of the northeastern Chukchi Sea reported 46 beluga whales from marine vessels in 2006-2012 (Shell, 2015a, Appendix C, Table 3.7.3), but many more were observed during aerial surveys in more coastal waters. Belugas were not observed in the Burger Prospect area during past exploration efforts in 1989-1990 (Brueggeman et al., 1991). None were observed around the Burger Prospect during Shell's July-October 2008-2012 baseline marine mammal surveys (Shell, 2015a, Appendix C, Table 3.7.3).

Harbor Porpoise. Harbor porpoises are found in relatively shallow coastal and shelf waters less than 330 ft (100 m) in depth (Allen and Angliss, 2014). Offshore of Alaska they are found from southeast Alaska throughout the Chukchi Sea shelf (Allen and Angliss, 2014) and have been observed as far north as the Barrow area (Suydam and George, 1992) and as far east as Harrison Bay in the Beaufort Sea (Funk et al., 2010). Although there is no official designation of separate stocks of harbor porpoises in Alaska, three stocks have generally been recognized, with harbor porpoises found in the Chukchi Sea being considered part of the Bering Sea group. Harbor porpoises use echolocation to find prey while foraging (Nowak, 1999). Harbor porpoises normally travel in small groups consisting of a few individuals, but form larger groups for feeding and mating purposes. Allen and Angliss (2014) provided a minimum population estimate of 40,039 for the Bering Sea stock of harbor porpoise based on aerial surveys in June and July of 1999.

Harbor porpoises have been sighted during seismic surveys of the Chukchi Sea conducted in the nearshore and offshore waters by the oil and gas industry between July - November from 2006-2010

(Aerts et al., 2011; Funk et al., 2010; Funk et al., 2013; Reiser et al., 2011). Harbor porpoises are common cetaceans in the northeastern Chukchi Sea; they were the third most frequently sighted cetacean species in the Chukchi Sea, after gray and bowhead whales, with most sightings occurring during the Sept.- Oct. monitoring period (Funk et al. 2013; Reiser et al., 2011). Over the 2006-2010 period, six sightings of 11 harbor porpoises were reported in the Beaufort Sea, suggesting harbor porpoises are occurring more regularly in small numbers in both the Chukchi and Beaufort Seas (Funk et al., 2013). These data indicate that harbor porpoises will be encountered in the Burger Prospect area in small numbers during the drilling season.

Killer Whale. Killer whales are found throughout the world's oceans and seas, from the equator's more tropical waters to the cooler waters in the high latitudes. Killer whales with the physical characteristics of transient type whales are observed, albeit it rarely, in the northern Bering, Chukchi, and Beaufort Seas, but little is known about these whales. Of the eight killer whale stocks recognized in the Pacific, the "Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock"(PGoABS stock), occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, is the only stock likely to be encountered in the area of Shell's planned exploration drilling operations(Allen and Angliss, 2014). Based on photographic catalogues from 2001-2012 a minimum estimate of 587 killer whales comprises the PGoABS stock (Allen and Angliss, 2014). There are no known resident stocks encountered in the area of Shell's planned exploration drilling operations.

PSOs recorded observations of 17 killer whales (in eight groups) from vessels while conducting monitoring surveys for seismic surveys in the northeastern Chukchi Sea in 2006-2012 (Shell, 2015a, Appendix C, Table 3.7-3). None were observed in the prospect during historical drilling in 1989-1991 (Brueggeman et al., 1991). None were observed in the Burger Prospect area during Shell's July-October, 2008-2009 marine mammal surveys, but a few were observed elsewhere in the leased area at that time (Brueggeman et. al., 2009a, 2009b; Aerts et al., 2014). Although it is unlikely, they could be encountered in the Proposed Action area in small numbers during the planned exploration drilling program.

In addition to the species already discussed above, the following species may also be encountered by vessels transiting from Dutch Harbor to the Project Area: 1) species listed under the ESA–North Pacific right whales (*Eubalaena japonica*, endangered), sperm whales (*Physeter microcephalus,* endangered), gray whale (western North Pacific population, endangered), blue whale (*Balaenoptera musculus,* endangered); and 2) the following non-listed cetaceans; Stejneger's beaked whale (*Mesoplodon stejnegeri*), Baird's beaked whale (*Berardius bairdii*), Cuvier's beaked whale (*Ziphius cavirostris*), dall's porpoise (*Phocoenoides dalli*), and Pacific white-sided dolphin (*Lagenorhynchus obliquidens*).

3.2.6.2. Pacific Walrus

Observations of walruses in the vicinity of the Burger Prospect have been reported in several surveys over the past 25 years. While these surveys use different methods and occurred under different circumstances, when taken together they help illustrate the use of the drilling area by walrus. Results of these survey reports are given in the 2015 Shell EIA, Tables 3.7-2 through 3.7-7.

On February 10, 2011, the U.S. Fish and Wildlife Service (USFWS) completed a status review of the Pacific walrus (*Odobenus rosmarus divergens*) and determined that although listing the species as endangered or threatened was warranted, the listing was precluded by other higher priority actions (76 *FR* 7634 February 10, 2011). The Pacific walrus is currently listed as a candidate species under the ESA. The continuing loss of sea ice habitat and harvest levels are likely the biggest stressors on the population (Jay, Marcot, and Douglas, 2011). The most recent population survey was conducted in 2006. Due to weather constraints, approximately 50% of the available walrus habitat was surveyed. The final population estimate of 129,000, with a range of 55,000-550,000 (78 *FR* 35364; Speckman et al., 2011) represents a minimum population estimate since it was not possible to extrapolate from the area surveyed to the entire habitat area.

The Pacific walrus ranges from the Bering Sea to the Chukchi Sea, occasionally ranging into the East Siberian and Beaufort Seas. Walruses are migratory, moving south with the advancing ice in autumn and north as the ice recedes in spring (Fay, 1981). In the summer, most of the females and juveniles in the population move to either the western Chukchi Sea near the Wrangel and Herald Islands, or the eastern Chukchi Sea near Hanna Shoal, and several thousand (primarily adult males) aggregate and remain in the Gulf of Anadyr and in Bristol Bay (Fay, 1982; 78 *FR* 35364, June 12, 2013). Limited numbers of walruses inhabit the Beaufort Sea during the open water season, and they are considered extralimital east of Point Barrow (Sease and Chapman, 1988). Pacific walrus distribution varies with the extent of sea ice. Walruses in the Chukchi and Beaufort seas are most commonly found near the southern margins of the pack ice as opposed to deep in the pack where few open leads (polynyas) exist to afford access to the sea for foraging (Estes and Gilbert, 1978; Fay, 1982; Gilbert, 1989). Walruses feed primarily on benthic invertebrates such as clams and marine worms (Fay, 1982). They are not physiologically adapted for deep diving and concentrate foraging efforts in shallower waters, typically using the sea ice as a resting platform between feeding trips (Fay, 1982). Since 2007, walruses summering in the Chukchi Sea have increasingly relied on terrestrial haulout sites between Barrow and Cape Lisbourne due to an absence of sea ice over the Continental Shelf (Robards and Garlich-Miller, 2013). The spring migration usually begins in April, with most walruses moving north from the Bering Sea through the Bering Strait by late June. Walruses begin to migrate south with the advance of pack ice during the fall. Both of these migrations bring walrus through the proposed drilling area.

On June 12, 2013, the USFWS published new Incidental Take Regulations (ITRs) for the oil and gas industry for polar bear and walrus in the Chukchi Sea for the period of 2013-2018. The USFWS specifically identified an area surrounding Hanna Shoal, referred to as the Hanna Shoal Walrus Use Area (HSWUA), as being of particular importance for foraging walrus during the summer and fall seasons (June through September) based upon recent tagging work and changes in habitat use (Jay, Fischbach, and Kochnev, 2012). The HSWUA was delineated using walrus foraging and occupancy utilization distributions (UDs) from Jay, Fischbach, and Kochnev (2012) for the months of June through September. On 27 January, 2015, under authority granted by Section 12(a) of the OCSLA, (43 U.S.C. 1341(a)), President Barack Obama withdrew the Hanna Shoal region (as defined by the 40-meter isobath) of the Chukchi Sea planning area from disposition by leasing for a time period without specific expiration. This withdrawal prevents consideration of this area from any future oil or gas leasing for the purposes of exploration, development, or production. The withdrawal does not affect the rights under existing leases in the Hanna Shoal region (White House, 2015).

Occurrences of walruses in the area of Shell's Burger Prospect are regular and common, although the number of animals present varies depending on the location of sea ice. Peak walrus sightings can occur from early August (e.g., 2009) to October (e.g., 2012 and 2013; Aerts et al., 2014; LGL and JASCO, 2014). In most years, walruses are present within the Burger area through August, but at low densities, increasing in numbers when ice floes containing hauled out-walrus drift southwest from the Shoal. Walrus spread out widely from Hanna Shoal in September after the ice floes over Hanna Shoal melt away. Some relatively small portion of those departing walruses pass through the Burger area; the timing of that movement depends largely on the timing of ice retreat from Hanna Shoal. Acoustic detection and satellite tagging (Aerts et al., 2014; Delarue et al., 2014 in Shell, 2015c; Taylor and Udevitz, 2014 in Shell, 2015c) show that this movement away from Hanna Shoal sometimes causes a brief pulse in walrus movement through the Burger area in September, with the majority of the movement to the east of the prospect. For example, in 2007 and 2008, increased numbers of walruses were sighted from industry vessels in August, and in other years few walruses were seen (LGL and JASCO, 2014). A large number of walruses (1,042 mostly in groups of 1-4 individuals) were observed in Statoil lease blocks just north of Shell's Burger Prospect during the monitoring of Statoil's seismic survey program in August-September 2010 (Shell, 2015a, Appendix C, Table 3.7-4) and 147 were observed in 2011 during Statoil geophysical and geotechnical surveys (Table 3.7-5 in Shell, 2015, Appendix C). Most of these observations occurred on just a few days (28-31 August) when a large number of walruses moved from a receding ice edge towards land (Blees et al., 2010). In 2012, large numbers of walruses coinciding with sea ice were reported near the Burger Prospect area as late as late September (Aerts et al., 2014; Bisson et al., 2013b). A total of 11,737 walruses were observed in the Burger Prospect Study Area over six years (2008-2013) of CSESP marine mammal surveys in the northeastern Chukchi Sea (Bisson et al., 2013b; Shell, 2015, Appendix C, Table 3.7-6). Observed densities of walruses in the CSESP Burger Study Areas are presented in Table 3-6. Brueggeman et al. (1990, 1991) observed 85 walruses in or near the Burger Prospect area in 1989 and 534 in 1990 (Shell, 2015, Appendix C, Table 3.7-2), while the historic Burger well was being drilled.

Table 3-6. Pacific Walrus Densities in the CSESP Burger Study Area, 2008-2013.

Year	Walrus per km^2	Walrus per Square Kilometer (km^2)	
		July/August	September/October
2008	0.013	0.001	0.021
2009	0.029	0.040	0.004
2010	0.018	0.011	0.016
2011	0.250	0.021	0.103
2012	0.272	0.006	0.292
2013	0.090	0.041	0.061

Source: Aerts et al., 2014

During the 2012 Shell EP Revision 1drilling activities in the Burger Prospect, a total of 10,012 individuals were observed by vessel- and aerial-based monitoring programs (Bisson et al., 2013b; Thomas and Bourdon, 2013). Many of the walrus sightings were of large groups (26 individuals per sighting on average) with some groups as large as 200-300 individuals (Bisson et al., 2013b). The likelihood of encountering a walrus in or near the Burger Prospect will depend largely upon ice conditions at the time of exploration drilling activity, but it is likely that a number of walruses will occur in the area of the Burger Prospect during the planned exploration drilling program due to the Prospect’s proximity to the HSWUA.

3.2.6.3. Polar Bear

Observations of polar bears (*Ursus maritimus*) in the vicinity of the Burger Prospect have been reported in several surveys over the past 25 years. While these surveys use different methods and occurred under different circumstances, when taken together they help illustrate the use of the area by polar bears. Results of these survey reports are reported by Shell (2014, Tables 3.7-2 through 3.7-7.

The polar bear was listed by USFWS as a threatened species under the ESA on May 14, 2008 (73 *FR* 28212). The listing was based primarily on the observed and continuing decline of sea ice habitat which polar bears rely on for foraging, movements, breeding, and denning.

The polar bear population in Alaska is considered to consist of two stocks, the Chukchi/Bering Seas (CBS) stock and the Southern Beaufort Sea (SBS) stock, although there is considerable overlap between the two stocks (Amstrup et al., 2005). The two populations overlap between Point Hope and Point Barrow (Amstrup, 1995). The most recent estimate for the SBS population of polar bears is 900 (90% C.I. 606−1,212; C.V. = 0.106) (Bromaghin et al., 2015), which is based on open population capture-recapture data collected from 2001 to 2006. The SBS stock experienced a 25-50% decline in abundance from 2004 through 2006 (Bromaghin et al., 2015) but the overall survival rate stabilized from 2008 to 2010 (Bromaghin et al., 2015). There currently is no reliable estimate for the CBS stock, but the current estimate of at least 2,000 animals (Aars et al., 2006; USFWS, 2010) is sufficient for evaluating potential impacts.

Polar bear distribution is determined largely by seasonal ice. When sea ice retreats northward over deep waters not commonly inhabited by seals, polar bears may remain with the ice, fasting; others may retreat to shore. The highest concentration of polar bears near the Proposed Action area occurs on land during the open water period, when some polar bears enter the coastal environment as they abandon melting sea ice to search for food on/near land or search for suitable den sites (pregnant females). The CBS population occurs mainly on Wrangel and Herald Islands and along the Chukotka coast, while the SBS population occurs more commonly along the coast and barrier islands of the Beaufort Sea. Polar bears are found throughout the leased area when ice is present. Small numbers of polar bears have been observed during the drilling of most of the past exploration wells in the Chukchi Sea and when conducting baseline marine mammal surveys near the Burger Prospect (Aerts et al., 2011, 2012, 2013, 2014; Brueggeman 2009a, 2010; Brueggeman et al., 1990, 1991, 1992; Shell, 2015a, Tables 3.7-2 and 3.7-6). Polar bears were recorded by vessel-based observers during industry monitoring programs in three of seven years of activities from 2006–2012 (LGL, JASCO, and Greeneridge Sciences, Inc., 2014). The majority of polar bears observed during recent offshore exploration programs in the Chukchi Sea were on ice as opposed to in water. Bears observed in open water were rarely more than 20 km away from the main pack ice (LGL, JASCO, and Greeneridge Sciences, Inc., 2014). During the 2012 Shell EP Revision 1drilling activities in the Burger Prospect, 64-65 individuals were observed by vessel- and aerial-based monitoring programs (Bisson et al., 2013b; Thomas and Bourdon, 2013). Of the 64-65 sightings of polar bears, many were associated with prevalent sea-ice conditions seen in August and September of 2012. A small number of polar bears may be encountered in the Burger Prospect during the Proposed Action, dependent on ice conditions.

On December 7, 2010, USFWS published the final rule designating Critical Habitat in the *Federal Register* (75 *FR* 76086). The final rule identified geographic areas containing features considered essential for the conservation of the polar bear. On January 10, 2013, the U.S. District Court for the District of Alaska issued an order vacating and remanding to the USFWS the December 7, 2010, Final Rule designating critical habitat for the polar bear. Consequently, no critical habitat is designated for polar bears. Under the MMPA, the USFWS has promulgated ITRs for authorizing small takes of polar bears in the Chukchi Sea that might take place incidental to conducting oil and gas exploration. Prior to issuing ITRs, the USFWS evaluated the effects of authorizing such takes on polar bears and released a Biological Opinion on 20 May 2013 (USFWS, 2013a). Before issuing ITRs, the USFWS must determine that the total taking will have a negligible impact on the species and will not have an immitigable adverse impact on the availability of the species for subsistence uses.

3.2.6.4. Seals

Observations of seals during drilling operations at the Burger Prospect have been reported in several surveys over the past 26 years, most recently during the 2012 Shell EP Revision 1 Exploration Drilling (LGL and JASCO, 2014). While those surveys used different methods and occurred under varying circumstances, collectively they reflect seal distribution in the Chukchi Sea, including waters around the Burger Prospect. Other information on the affected environment for seals is described below for each species.

Bearded Seals. The bearded seal (*Erignathus barbatus*) is the largest of the northern seals (Kelly, 1988) and is largely ice-associated. Bearded seals stay mostly within the mobile pack ice, concentrating around its edge (Smith and Stirling, 1975) where they forage primarily on benthic organisms. Because of their epibenthic feeding habits, bearded seals are limited to feeding in water depths of 426 ft (130 m) or less (Nelson, Burns, and Frost, 1984). Surveys from 1990 to present indicate that bearded seals may occur near the proposed drill sites in numbers that vary from year to year.

Allen and Angliss (2014) reported no reliable population estimate for the bearded seal population in the Bering, Chukchi, and Beaufort seas exists. However, Cameron et al. (2010) estimated 155,000 bearded seals in the Beringian Distinct Population Segment (DPS) (Bering-Chukchi-Beaufort Sea subpopulation), about 27,000 of which are year-long residents in the Chukchi Sea.

Cameron et al. (2010) reported the population density of bearded seals in the Chukchi Sea to average between 0.07 and 0.14 bearded seals/km^2 based on coastal aerial surveys flown between Barrow and Shishmaref, Alaska (Bengtson et al., 2005). The population data provided in Cameron et al. (2010) and the most recent stock assessment (Allen and Angliss, 2014) are sufficient to conduct a well-informed effects analysis for this species.

Ringed Seals. Ringed seals are the most numerous and widely distributed northern pinniped, occurring in all Arctic and sub-Arctic seas where seasonal or permanent ice occurs (Kelly, 1988). The ringed seal (*Phoca hispida*) population in the Bering-Chukchi-Beaufort Seas has been estimated to number at least 1 million seals (Kelly et al., 2010). NMFS has formulated a minimum population estimate of ringed seals in the eastern Chukchi Sea at 249,000 (Allen and Angliss, 2014). Of this sub-population, some are residents in the Chukchi Sea while others are residents in the Beaufort Sea or seasonal migrants that winter in the Bering Sea, and migrate to the Chukchi or Beaufort Seas during summer. Surveys from 1990 to the present have noted that ringed seals may occur near the proposed drill sites in numbers that vary from year to year.

During summer, ringed seals are found dispersed throughout open water, though they may frequent some coastal areas. They are opportunistic feeders, eating a wide variety of pelagic and epibenthic organisms. Arctic cod are their primary prey during winter (November - April), but in late spring and summer their diet shifts to small marine crustaceans, such as gammarid and hyperiid amphipods, shrimp, euphausiids, mysids, and isopods (Lowry et al., 1980; Frost and Lowry, 1984). Ringed seal distribution and population density is believed to vary in different areas, and shift in response to prey numbers and availability during the open-water season.

In December 2012, NMFS listed ringed seals as threatened under the ESA after considering the potential future effects of climate change on the species (77 *FR* 76706, December 28, 2012). The population data provided in Kelly et al. (2010) and the most recent stock assessment (Allen and Angliss, 2014) are sufficient to conduct a well-informed effects analysis for this species.

Ribbon Seals. The Alaska stock of ribbon seals are distributed in pelagic waters across the northern North Pacific Ocean and adjacent Arctic and sub-Arctic waters (Boveng et al., 2008). Surveys from 1990 to the present have noted that ribbon seals may occur near the proposed drill sites in variable numbers from year to year. This species spends most of the year in pelagic waters near the shelf slope feeding on fishes and squid, hauling out on ice to whelp, breed, and molt in the spring and early summer. The more important whelping, reproduction, and molting areas occur in a 150 km (93 mi) band starting at the southern edge of the ice front and extending north, and usually in waters <200 m (656 ft) deep but near the shelf slope, mostly south of the Bering Strait (Boveng et al., 2008). Ribbon seals eat a variety of crustaceans (e.g., shrimps, mysiids, and crabs) and squid, but their main prey is fish species such as walleye pollock, Arctic and saffron cod, eelpout, capelin, Greenland halibut, pricklebacks herring and Sandlance (Dehn et al., 2007; Nelson and Griese, 2008).

Although are no reliable population estimate for the Alaskan ribbon seal stock (Allen and Angliss, 2014), Burns (1981) estimated between 90,000 and 100,000 ribbon seals inhabit the Bering Sea. Numbers using the Chukchi Sea are expected to be lower since most ribbon seals are believed to spend their summers in the northern Bering Sea. The National Marine Mammal Laboratory (NMML) presently uses a provisional population estimate of 49,000 ribbon seals for the central and eastern Bering Sea (Allen and Angliss, 2014). Despite any uncertainties in the most recent NMFS Stock Assessment (Allen and Angliss, 2014), the Species Status Review (Boveng et al, 2008) and the provisional population estimate permit a thorough effects analysis for this species in the Chukchi Sea.

Spotted Seals. A reliable spotted seal population estimate for the Bering, Chukchi, and Beaufort seas does not exist (Allen and Angliss, 2014). NMML developed a provisional population estimate of 101,568 +/- 17,869 spotted seals in the eastern and central Bering Sea survey areas, while others estimated 100,000–135,000 spotted seals form the Bering Sea spotted seal stock (Boveng et al., 2009). Surveys from 1990 to the present have noted that spotted seals may occur near the proposed drill sites in numbers that vary from year to year. Though the most recent NMFS Stock Assessment (Allen and Angliss, 2014) acknowledges uncertain population estimates for this species, the 2009 Status Reviews (Boveng et al., 2009) describe a provisional population estimate that, along with recent surveys in the northeastern Chukchi Sea, offer sufficient information to support a reasoned effects analysis.

The primary haulout areas used by spotted seals in the eastern Chukchi are on ice floes, Kasegaluk Lagoon, and to a lesser degree other areas with substantial areas of sand or mud bars. Spotted seals generally remain closer to the coast than other ice seal species, and evidence including a year-round presence in the southern Bering Sea, affinity for terrestrial haulouts, varied diet, and species range suggests they may not be as dependent on sea ice as other ice seal species.

Adult spotted seals eat a variety of fish, crustaceans, and cephalopods and their diet varies with age, season, and location. Young spotted seals consume euphausiids, copepods, and other crustaceans, and their preferred prey base generally increases in size as individual seals mature. Adult spotted seals consume salmon, Arctic cod, capelin and pollock, flatfishes, etcetera (Dehn et al., 2007; Nelson and Griese, 2008).

3.2.6.5. Bering Sea Pinnipeds

Harbor seals, northern fur seals, and Steller sea lions are pinniped species that occur in the Bering Sea but not in the Chukchi Sea. Harbor seals and Steller sea lions are more likely to be encountered in nearshore areas and the Pribilof Islands, while northern fur seals are more likely to be encountered in the open ocean over deep water, particularly in the vicinity of the continental shelf break and the Pribilof Islands. Northern fur seals maintain large rookeries in the Pribilof Islands, and a smaller rookery on Bogoslof Island near the Aleutian Archipelago. Steller Sea lions prefer hauling out at rocky areas with deep water, while harbor seals prefer hauling out on sand, gravel and mud bars and beaches.

Harbor seals

Harbor seals occurring between Dutch Harbor and the Seward Peninsula belong to the Bristol Bay harbor seal stock, which numbers around 18,577 (Allen and Angliss, 2014). This stock is not designated as depleted under the MMPA nor is it listed under the ESA. Harbor seals frequently habituate to vessels and human activity, and are common in coastal areas and likely to be encountered by vessels traveling to and from Dutch Harbor, Alaska.

Northern fur seals

The Eastern Pacific stock of northern fur seals numbers at around 541,317, and occurs from areas south of the Bering Strait into the North Pacific Ocean south of the Aleutian Islands (Allen and Angliss, 2014). They chiefly forage in the open ocean and major haulouts in Alaska occur in the Pribilof Islands, with a much smaller, but growing, haulout on Bogoslof Island. During the Chukchi open water season they would most likely be encountered in open water areas; however, as vessels approach the Pribilof Islands, the likelihood of sightings and encounters should increase substantially. Though not listed under the ESA, the Eastern Pacific Stock of northern fur seals has been designated as depleted under the MMPA due to an ongoing population decline from 1.8 million individuals (Allen and Angliss, 2014). The large population size of northern fur seals suggests they could be encountered by vessel traffic to and from Dutch Harbor, Alaska, but most likely in waters near their major rookeries in the Pribilof Islands.

Steller sea lions

The western stock of Steller sea lions occurs in waters of Bristol Bay and the Bering Sea in Alaska, as well as in the North Pacific Ocean and along the Russian coast. The western Pacific stock of Steller sea lions numbers around 79,300, and due to population declines is listed as endangered under the ESA and depleted under the MMPA (Allen and Angliss, 2014). They frequently occur in Dutch Harbor, Alaska where they have habituated to vessel traffic and human activity, and are likely to be encountered by vessels traveling to and from Dutch Harbor, Alaska. The waters from Dutch Harbor to 150 nmi north of Dutch Harbor are designated critical habitat for Steller sea lions.

3.2.6.6. Northern Sea Otters

The Southwest DPS of northern sea otters (*Enhydra lutris kenyoni*) may be encountered by vessels transiting from Dutch Harbor to the Proposed Action area. The USFWS listed the southwest Alaska DPS of the northern sea otter as threatened on August 9, 2005 (70 *FR* 46366). Critical habitat for the Southwest Alaska DPS of the northern sea otter was declared on October 8, 2009 (74 *FR* 51988). Critical habitat occurs in nearshore marine waters around Unalaska Island ranging from the mean high tide line seaward for a distance of 100 meters, or to a water depth of 20 meters. The species will likely only be encountered in the vicinity of the Dutch Harbor port and Unalaska Bay. Sea otters inhabit the nearshore area and it is expected that once vessels have moved into the Bering Sea, otters will no longer be present in the environment.

3.2.7. Terrestrial Mammals

Groups of caribou from the Western Arctic Herd (WAH) and Teshukpuk Caribou Herd (TCH) occur in Northwestern Alaska where some project activities such as equipment transport or staging would occur. In May and early June, Caribou from the WAH calve in the Utukok uplands on the north-facing slopes of the Brooks Range, while most TCH caribou calve near Teshekpuk Lake, Alaska. Both calving sites are outside proposed flight corridors and onshore activity areas (USDOI, BLM, 2012).

From mid-June thru late August, caribou generally seek out windy and cooler coastal and upland areas to escape swarms of mosquitos and oestrid flies. Most TCH caribou use coastal areas between Barrow and the Colville River, and in the vicinity of Peard Bay, for insect relief; WAH caribou use uplands and coastal areas south of Wainwright as described in the 2007 FEIS, Section III.B.7; 2011 SEIS, Section III.B.7; 2015 Second SEIS, Sections 3.2.5 and 4.3.8; and other literature (USDOI, BLM, 2012, Section 3.3.6.1; NOAA, 2005).

Grizzly bears are ubiquitous throughout the Arctic Coastal Plain in very low densities. The largest concentration area for grizzly bears along the Chukchi Sea coastline occurs on the Kasegaluk Lagoon coastline between Point Lay and Wainwright, Alaska (NOAA, 2005), and as identified in the 2015 Second SEIS, Sections 3.2.5 and 4.3.8. Arctic and red foxes, wolves, and other furbearers are also ubiquitous in low to moderate densities (Szepanski, 2007; Caikoski, 2010; Carroll, 2010), as are muskox. Muskox usually occur in riparian and upland areas in northwestern Alaska. Good potential muskox habitat occurs from Peard Bay south to Kasegaluk Lagoon and inland, though a dearth of muskoxen sightings in those areas have been documented (USDOI, BLM, 2012), meaning muskox should not be present in proposed flight corridors or shore-based activity areas.

While BOEM does not regulate transit from Dutch Harbor, it is anticipated that OSVs will make approximately 30 trips back and forth from Dutch Harbor to the Proposed Action area for resupply each drilling season. This will have no impact on terrestrial mammal resources.

3.2.8. Economy

OCS oil and gas activities generate economic effects on the NSB, State of Alaska, and the Federal government in the form of direct and indirect employment, personal income associated with employment, and various types of revenues accruing to each level of government. The NSB receives revenues primarily from property taxes on high value onshore oil and gas infrastructure as well as the Federal government and State of Alaska. The State of Alaska receives revenues from oil and gas activities in the form of property taxes, state corporate income tax, revenues associated with the Trans-Alaska Pipeline System (TAPS), and rentals and royalties from OCS leases as provided by Section 8(g) of OCSLA. Due to no OCS production of oil and gas, the State of Alaska does not currently receive Federal royalty revenues. Oil and gas activities generate revenues for the Federal government through royalties, bonus bids, and rental revenues.

This description of economy focuses on the economy of the NSB, as the location, timing, and scale of the proposed exploration activities are not expected to generate economic effects at the State or Federal level.

Additional information and a more detailed profile of the economy and demographics of the NSB and its communities are available in USDOI, BLM (2014), and the 2015 Shell EIA.

3.2.8.1. Local Employment and Personal Income

Descriptions of the NSB economy in the Shell EIA (Shell, 2015a, Appendix C) are incorporated by reference, and salient points are summarized below. The NSB is a mixed economy, characterized by a traditional cash economy and subsistence economy. The NSB economy is characterized by relatively high unemployment and underemployment. Training programs and workforce development will continue to be important in the future to increase the low number of NSB residents that receive direct employment and personal income in the oil industry. More direct local hire would help increase employment and personal income benefits from oil and gas activities within the local communities.

The NSB is the largest employer of permanent residents in the NSB. However, very few NSB residents have been directly employed by the oil and gas industry or supporting industries in and near Prudhoe Bay since production started in the 1970s. Local residents represent only about 1% of those hired for Alaska North Slope (ANS) oil industry related jobs, with most ANS oil-industry workers residing outside the NSB. According to the Alaska Department of Labor and Workforce Development (ADOLWD)(2014), average employment for the NSB in 2013 was 5,212. Unemployment in the NSB was 5% in 2013. Since 2000, unemployment in the NSB reached a high of 10.1% in 2004, and a low of 4.1% in 2008. Aggregate personal income for the NSB was $491 million, and per capita personal income in 2012 was $50,918. These figures are generally consistent with aggregate personal income figures over recent past years.

3.2.8.2. Revenues

The NSB government receives a large share of its revenues from property taxes levied on high value onshore and offshore oil and gas infrastructure on state land. As the depreciable value of that infrastructure decreases, the revenues accruing to the NSB from oil and gas activities also decline unless new onshore infrastructure is constructed. According to ADCCED (2013), in 2013, NSB revenues from oil and gas property taxes were $322 million, $43,959 per capita. These figures represent a significant change from recent past years' totals, as NSB's revenues from oil and gas property taxes increased by $87 million since 2008.

3.2.9. Subsistence-Harvest Patterns

Subsistence harvesting is practiced by Alaska Natives and rural residents alike and is generally considered to be hunting, fishing, and gathering for the primary purpose of acquiring traditional food.

The MMPA of 1972, as amended, limits subsistence harvest of marine mammals to Alaska Natives, and defines subsistence:

> The term "subsistence uses" means the customary and traditional uses by rural Alaska residents of marine mammals for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of nonedible byproducts of marine mammals taken for personal and family consumption; and for barter, or sharing for personal and family consumption (16 USC 1361).

Subsistence activities are assigned the highest cultural values by the Iñupiaq Eskimo of the Alaska North Slope (ANS) and provide a sense of identity, in addition to being a pivotal economic pursuit. Subsistence is viewed by Alaska Natives not just as an activity that is imbedded in the culture; it is considered as the very culture itself (Wheeler and Thornton, 2005). Subsistence activities connect generations, past and future, and involve cooperative teamwork. It fosters reconnection with the land- and seascape, and allows for integration within and outside of the community, as the harvester will share with those who hunger for a taste of familiar food, and provides a healthy nutritional basis for a household. One could say that subsistence satisfies all levels: physical, emotional, spiritual, altruistic, and nutritional. The bowhead whale is iconic as a subsistence resource and is of paramount importance to North Slope Iñupiat. Consequently, this hunt can be viewed as a proxy for the social organization pertaining to values of working together, cooperation, and sharing. The captain shares with all who attend multiple celebrations throughout the year. The hunt, quantity, and distribution of the whale prevail in any discussion about North Slope Iñupiaq Eskimo subsistence.

Bowhead whaling traditions underscore the central values and activities for the Iñupiat of the ANS. Bowhead whale hunting strengthens family and community ties and the sense of a common Iñupiat heritage, culture, and way of life; it provides strength, purpose, and unity in the face of rapid change (Galginaitis, 2013; EDAW, 2007; USDOI, MMS, 2009). As shown in Table 3-7, bowhead whales are harvested by every North Slope Borough (NSB) coastal community, although Chukchi communities harvest whales in the spring and Beaufort Sea communities harvest whales in the fall. Two communities, Barrow and Wainwright, harvest whales semi-annually in both the fall and spring.

Table 3-7. Bowhead Whales Landed by Year.

Year	Kaktovik	Nuiqsut	Barrow	Wainwright	Point Lay	Point Hope	Kivalina	Little Diomede	Wales	Gambell	Savoonga	Quota	Total Lost	Total Landed
1974	2	0	9	1	X	7	0	X	0	2	0	0	**34**	**21**
1975	0	0	10	0	X	4	0	X	0	1	0	0	**28**	**15**
1976	2	0	23	3	X	12	0	X	0	1	7	0	**43**	**48**
1977	2	0	20	2	X	2	1	X	0	2	0	0	**82**	**29**
1978	2	0	4	2	X	2	0	X	0	1	1	20	**06**	**12**
1979	5	0	3	1	X	3	0	X	0	0	0	27	**15**	**12**
1980	1	0	9	1	X	0	0	X	1	1	2	26	**28**	**15**
1981	3	0	4	1	X	4	0	X	0	1	2	27	**11**	**15**
1982	1	1	0	2	X	1	0	X	0	2	1	27	**11**	**08**
1983	1	0	2	2	X	1	0	X	1	1	1	27	**09**	**09**
1984	1	0	4	2	X	2	1	X	0	0	2	43	**13**	**12**
1985	0	0	5	2	X	1	0	X	1	1	1	26	**06**	**11**
1986	3	1	8	3	X	2	0	X	0	3	0	26	**08**	**20**
1987	0	1	7	4	X	5	0	X	0	2	1	32	**09**	**20**
1988	1	0	11	4	X	5	0	X	0	2	0	35	**06**	**23**
1989	3	2	10	2	X	0	0	X	0	0	1	44	**08**	**18**

Year	Kaktovik	Nuiqsut	Barrow	Wainwright	Point Lay	Point Hope	Kivalina	Little Diomede	Wales	Gambell	Savoonga	Quota	Total Lost	Total Landed
1990	2	0	11	5	X	3	0	X	0	4	5	47	**14**	**30**
1991	2	1	12	4	X	6	1	X	1	1	0	41	**19**	**28**
1992	3	2	22	0	X	2	1	0	0	4	4	54	**12**	**38**
1993	3	3	23	5	X	2	0	0	0	4	1	54	**11**	**41**
1994	3	0	16	4	X	5	2	0	1	1	2	52	**12**	**34**
1995	1	4	19	5	X	1	1	0	1	4	4	68	**14**	**40**
1996	1	2	24	3	X	3	0	0	0	3	2	77	**05**	**38**
1997	4	3	30	3	X	4	0	0	0	3	1	76	**18**	**48**
1998	3	4	25	3	X	3	0	0	0	0	3	82	**13**	**41**
1999	3	3	24	5	X	2	0	1	0	1	3	82	**05**	**42**
2000	3	4	18	5	X	3	0	0	1	0	1	82	**12**	**35**
2001	4	3	27	6	X	4	0	0	0	2	3	82	**22**	**49**
2002	3	4	22	1	X	0	0	0	0	2	5	82	**11**	**37**
2003	3	4	16	5	X	4	0	0	0	1	2	82	**06**	**35**
2004	3	3	21	4	X	3	0	0	0	2	0	82	**07**	**36**
2005	3	1	29	4	X	7	0	1	1	2	7	82	**13**	**55**
2006	3	4	22	2	X	0	0	0	0	0	0	82	**08**	**31**
2007	3	3	20	4	X	3	0	0	0	4	4	82	**22**	**41**
2008	3	4	21	2	X	2	0	0	0	2	4	82	**12**	**38**
2009	3	2	19	1	1	1	0	0	0	1	3	82	**07**	**31**
2010	3	4	22	3	0	2	0	0	0	6	5	82	**26**	**45**
2011	3	3	18	4	1	3	0	0	0	4	2	82	**13**	**38**
2012	3	4	24	4	1	5	0	0	1	9	8	82	**10**	**59**
2013	3	4	22	3	0	6	0	0	0	2	6	82	**11**	**46**
Total	**95**	**74**	**636**	**117**	**3**	**125**	**7**	**2**	**9**	**82**	**94**		**552**	**1,244**

Notes: In 1980, Shaktoolik landed its only bowhead whale.

A zero (0) does not indicate an absence of hunting effort; in some years, some communities struck and lost whales and did not land any. In other years, a community may have made an effort to hunt but not struck and lost or landed any bowhead whales, or a community may not have made an effort to whale. There is not any way to differentiate between these examples. An X means that the community had not yet been granted a quota to hunt whales.

Sources: Downs, M. and D. Calloway, 2008; NMFS, 2013b; Suydam et al., 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014.

Although bowhead whaling traditions are significant, harvest of other wild resources, including other marine mammals, caribou, and fish are important to the local inhabitants in providing variety to the diet and needed nutrition, as well as satisfying household nutritional needs. These subsistence resources may also be shared throughout the social community network and consumed at celebratory feasts.

Shell proposes to begin operations on its Chukchi Sea Burger Prospect on or after July 1, 2015 and cease operations on or around October 31. This would be after the conclusion of the spring bowhead whale hunts in Point Hope, Point Lay, Wainwright, and Barrow.

Beluga whale are also routinely harvested by subsistence communities along the east Chukchi Sea and in Kotzebue Sound communities as illustrated in Table 3-8, below.

Species harvested prior to July 1 and after October 31 are also addressed in the 2007 FEIS, the 2011 SEIS, and the 2015 Second SEIS (USDOI, MMS, 2007; USDOI, BOEMRE, 2011; USDOI, BOEM, 2015a).

Table 3-8. Beluga Whale Harvests, E. Chukchi Sea and Kotzebue Sound--1987-2007.

Year	Buckland	Deering	Kotzebue / Noatak	Kivalina	Point Hope*	Point Lay	Wainwright	Barrow*	Total E. Chukchi/ **Kotzebue Stock	Total Beaufort Sea Stock
1987	7	0	2	0	40	22	47	0	**78**	**40**
1988	17	0	8	1	59	40	3	0	**69**	**59**
1989	0	0	37	0	17	16	0	1	**53**	**18**
1990	31	n.d.	6	1	16	62	0	0	**100**	**16**
1991	0	n.d.	11	1	39	35	5	1	**52**	**40**
1992	4	n.d.	5	0	15	24	20	0	**53**	**15**
1993	0	0	6	0	79	77	0	2	**83**	**81**
1994	0	0	7	0	53	56	0	5	**63**	**58**
1995	1	0	4	0	nd	31	0	0	**36**	**n.d.**
1996	5	2	68	0	15	41	0	2	**116**	**17**
1997	1	0	7	1	32	3	4	8	**16**	**40**
1998	1	0	4	0	52	48	38	1	**91**	**53**
1999	0	n.d.	2	0	33	47	3	1	**52**	**34**
2000	1	0	0	1	16	0	0	1	**2**	**17**
2001	18	n.d.	9	0	24	34	23	1	**84**	**25**
2002	2	0	4	3	23	47	37	1	**93**	**24**
2003	0	0	0	0	34	36	38	2	**74**	**36**
2004	0	0	1	0	29	53	0	1	**54**	**30**
2005	0	0	1	0	11	41	1	7	**43**	**18**
2006	0	0	2	0	0	29	0	1	**31**	**1**
2007	4	0	9	0	31	37	11	2	**61**	**33**
2008	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	**n.d.**	**n.d.**
2009	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	**n.d.**	**n.d.**
2010	0	0	0	2	62	23	9	2	**34**	**64**
2011	0	0	30	2	32	22	10	6	**64**	**38**
Total	**92**	**2**	**223**	**12**	**712**	**824**	**249**	**45**	**1402**	**757**

Notes: *Point Hope and Barrow harvest Beaufort Sea stock. All other communities harvest Eastern Chukchi Sea stock.

**It appears as though the Kotzebue Sound belugas may belong to a distinct genetic stock, but positive identification has not yet been established.

Sources: Frost, K. and R. Suydam, 2010: 295; Suydam, R., 2009:64; Alaska Beluga Whale Committee, 2008, 2012)

Subsistence Communities

Barrow

Barrow's subsistence-harvest areas are depicted in detail on Maps 1-16 of a BOEM study, *Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow* (SRB&A, 2010). As previously noted, Barrow residents hunt the bowhead whale during both spring and fall. In the spring, whaling may continue through June. In the fall, in September and October, hunters in skiffs head eastward from Point Barrow (Nuwuk) to intercept whales migrating west. The hunt takes place in open water up to 30 mi offshore (SRB&A, 2010; USDOI, MMS, 2009).

Beluga whales are occasionally obtained in July and August in ice-free waters on both sides of the barrier islands of Elson Lagoon (USDOI, MMS, 2009).

Ducks are hunted west of Nuwuk Point and southwest to Piqniq, particularly when winds are from the northeast. This is considered a leisurely activity – a time to relax, beachcomb, and reconnect with nature. Ducks are hunted in June, and the months of July through September are also important duck hunting months (SRB&A, 2010).

Caribou, the primary terrestrial source of meat for Barrow residents, is available throughout the year, with peak-harvest periods in the spring and also from late June through late October. A popular hunt among some hunters during the open water season, particularly in late summer and fall, is cruising the coastline in search of caribou in close proximity to the beach (USDOI MMS, 2009; SRB&A, 2010). The majority of caribou are hunted from July through September, with the peak month being August. When the weather is hot and mosquitos are thick, hunters will travel as far as Wainwright. Many prefer to hunt before the caribou enter the fall rut. After that time, hunts focus on females (SRB&A, 2014).

Ringed seals are hunted in June and throughout the summer and, to a lesser extent, in the winter, with the highest number of hunts occurring in July followed by August. Ringed seals are harvested off Nuwuk Point west to Nulavik and Nunavak, and hunters travel as far west as Peard Bay (SRB&A, 2010).

The hunting of bearded seals is an important activity in Barrow. Bearded seal is a preferred food and their skins are used to cover skin boats used in spring whaling. Most bearded seals are harvested directly off Point Barrow and as far west as Peard Bay. They are only hunted when ice is present. The primary month of effort is July followed by August, although they are also harvested in June (SRB&A, 2010).

Barrow residents harvest marine and freshwater fish. Capelin, char, cod, grayling, salmon, sculpin, trout, and whitefish are harvested. Fishing occurs primarily in the summer and fall months and peaks in September and October. Most fishing occurs inland, particularly in lakes and rivers that flow into the southern end of Dease Inlet (USDOI, MMS, 2009).

Walruses are harvested in June and during the summer, west of Point Barrow and southwest to Peard Bay. Most hunters travel no more than 15-20 mi from Barrow to hunt walrus, although hunters have traveled up to 40 mi to hunt walrus. The major walrus-hunting effort occurs from late June through mid-September, with the peak season in July (SRB&A, 2010).

Wainwright

Marine subsistence is limited to those who own or have access to a boat. Moreover, marine subsistence requires specific skills and knowledge (TK, or traditional knowledge) (SRB&A, 2014; Georgette and Loon, 1993). A BOEM study documented marine subsistence harvests at Wainwright over three seasons. The consultants provided hunters with Global Positioning unit Systems (GPS), downloaded hunting tracks and waypoints, and documented hunters' observations (SRB&A, 2014). The composite map of marine subsistence displays an intensity of use that is so pervasive that individual hunting tracks merge to a solid polygon offshore of Wainwright from north of Point Belcher to 10 mi south of Wainwright. Hunters traveled as far as 40 mi offshore. Marine harvest depended upon access to sea ice, winds, currents, weather, and availability of migratory species (Figure3-5).

Wainwright's subsistence-harvest areas are depicted in detail in maps 2 through 53, 101, and 103 (SRB&A, 2014). A summary of Wainwright's preferred subsistence resources appears in Tables II.C-4 through III.C-6 in the 2007 FEIS (USDOI, MMS, 2007). Wainwright's annual harvest of bowhead and beluga whales is shown herein (Tables 3-7 and 3-8).

Bowhead whales are Wainwright's most important marine resource. The spring hunt can continue into the month of June, depending upon the availability of the whales and the success of the hunting crews. In 2010, Wainwright harvested a bowhead whale in the fall for the first time in generations and has resumed a fall bowhead whale hunt on an annual basis (SRB&A, 2014).

In its study *Traditional Knowledge Regarding Bowhead Whales in the Chukchi Sea*, BOEM funded the collection of traditional knowledge (TK) regarding bowhead whales so that it could be combined with data from the satellite telemetry study for a more complete understanding of the migrations and local movements of bowhead whales. Information from this study (Quakenbush and Huntington, 2010) that is relevant to the current analysis includes observations that, on a few occasions, whales have been seen in July near Wainwright and Icy Cape. In October, whales have been seen a few times near Wainwright, but they do not generally follow the coast southward from Barrow.

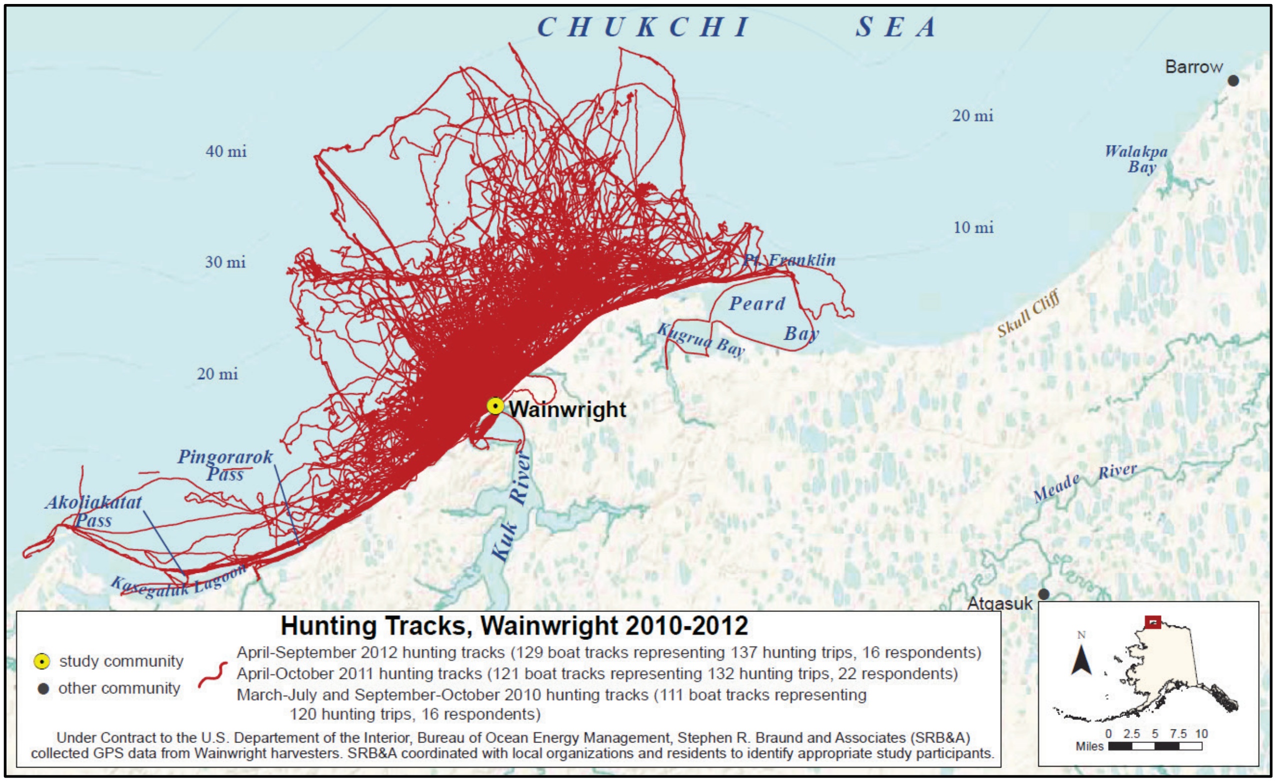

Figure 3-5. Wainwright Marine Subsistence Hunting Tracks, 2010-2012. *SRB&A worked with active subsistence harvesters in Wainwright to identify appropriate study participants and provide fishermen with GPS to track their hunting movements over the three years. Source: SRB&A, 2014, Map 101.*

Beluga whales are available to Wainwright hunters and are harvested in July (SRB&A, 2014). Since 1990, the beluga harvest has ranged from 38 animals in 1998 to 11 harvested in 2010 (Table 3-8).

Caribou are the primary source of meat for Wainwright residents. Caribou are often taken after the shorefast ice moves out, and continues into June. This activity peaks in July, continuing through August until subsistence efforts turn inland (SRB&A, 2014).

As with other marine harvest efforts, Wainwright residents' seal hunting peaks in July, with an emphasis on bearded seals (SRB&A, 2014). Seal hunting occurs within 20 mi from shore (SRB&A, 2014, Map 11-13).

The presence of walruses near Wainwright is variable on a seasonal basis. Walruses have been known to overwinter in the area. Walrus hunts occur in June. The peak hunting period occurs from July to August when the southern edge of the pack ice retreats. Hunters prefer to harvest walruses south of Wainwright, so northward-moving pack ice can carry them homeward as they butcher their catch on the ice. Walrus hunting during August can occur up 40 mi from shore (USDOI, MMS, 2009; SRB&A, 2014).

Wainwright residents harvest a variety of fish in most marine and freshwater habitats along the coast and in lagoons, estuaries, and rivers. The most important local fish harvest occurs from September through November in the freshwater river drainages. Marine fishing occurs from Peard Bay to Icy Cape (USDOI MMS, 2009).

While many waterfowl are taken during the spring bowhead whale hunt, later in the season hunters will focus solely on hunting waterfowl in the marine environment. During the fall migration, hunting success is limited (SRB&A, 2014).

Point Lay

Point Lay's subsistence-harvest areas are depicted in detail in Maps 54-100, Map 102, and Map 103 (SRB&A, 2014). A summary of Point Lay's annual harvest of bowhead whales and beluga whales can be found in Tables 3-7 and 3-8 herein.

In 2008, Point Lay received a quota from the International Whaling Commission (IWC) to hunt bowhead whales, and since then, has successfully landed a whale in three years between 2009-2013 The hunts can occur in June (Table 3-7) (SRB&A, 2014).

Point Lay's most important subsistence marine resource is the beluga whale, and the community depends on this species more so than any other Native community in Alaska. A major community activity is a single cooperative hunt in the summer that may occur in late June or as late as the second week in July, depending upon the timing of the migration. The beluga whales migrate past the outer coast of the barrier islands, where they are intercepted herded into Kasegaluk Lagoon for harvest offshore of the community (SRB&A, 2014). The estimated annual harvest has varied over the past three decades, with recent harvests topping just over 20 beluga whales (Table 3-8).

Caribou are a significant subsistence resource in Point Lay. Hunters prefer hunting caribou during the months of August, September, and October (USDOI, MMS, 2009).

Bearded seals and ringed seals are hunted from June through September. Point Lay hunters begin the spring seal hunt in April. The seal-harvest area ranges from Cape Beaufort in the south to Icy Cape in the north. Sealing generally occurs no more than 25-30 mi offshore (USDOI, MMS, 2009; SRB&A, 2014).

Fishing and time spent at fish camps is an important community activity for Point Lay residents. The most intense marine fishing with set gill nets starts in July and peaks in August. Chum, pink, and king salmon (rarely) are caught, as well as herring, smelt, flounder, arctic char, grayling, and broad whitefish. Marine fishing takes place in late July and August (SRB&A, 2014).

Walruses are hunted from Icy Cape, south of Wainwright, to Point Franklin, north of Wainwright, and as far as 20 mi offshore. Distances and hunting ranges vary annually depending on currents, wind, and ice. During the study period recording marine subsistence, Point Lay residents reported that during 2010 and 2011, no participant reported walrus hunting – indeed, one participant stated that the community had not seen walruses on the ice in five to six years. In 2012, participants reported three trips for walrus hunting located within Kasegaluk Lagoon extending north to Icy Cape (SRB&A, 2014).

Migratory birds are an important food source for Point Lay residents, with hunting and egging occurring in June. In late August and early September, geese are hunted as they fly south (USDOI, MMS, 2009).

Point Hope

The primary subsistence-harvest areas for Point Hope are shown in Figures III.C.1 through III.C.7 of the 2007 FEIS (USDOI, MMS, 2007). See Tables III.C-9 through III.C-12 for a summary of Point Hope's subsistence harvest resources for 1992 of the Chukchi Sea Planning Area EIS (USDOI, MMS, 2007).

Beginning in late March or early April through June, the bowhead whale is available in the Point Hope area. No other marine mammal is harvested with the intensity and concentration of effort that is focused on the bowhead whale. The traditional whaling season runs from mid-April to late May (USDOI, MMS, 2009) and would be concluded before drilling activities begin (Table 3-7).

Point Hope hunters actively harvest the beluga whale during the offshore spring bowhead whaling season (late March-early June) and along the coast later in summer (July-late August/early September) (USDOI, MMS, 2009). In fact, annual beluga whale harvest totals are second only to Point Lay (Table 3-8).

Caribou is the primary source of meat for Point Hope residents. Although caribou are available throughout the year, peak harvest times occur from February to March and from late June through mid-November (USDOI, MMS, 2009).

Seals are available to Point Hope residents from October through June; however, because of the availability of bowhead, bearded seal, and caribou during various times of the year, seals are harvested primarily during the winter months, from November through March (USDOI, MMS, 2009). Most bearded seals are harvested during May and June, sometimes as late as mid-July, as the landfast ice breaks up into floes. Drilling and associated activities would be over 180 mi way from seal hunts.

Point Hope residents harvest a variety of fish during the entire year. Fishing occurs from coastal fish camps (often converted from spring camps for hunting bearded seals and walruses) located along the shore from Cape Thompson north to Kilkralik Point. In the fall, residents harvest grayling and whitefish on the Kukpuk River during the October upriver fishing period. Fishing occurs exclusively in nearshore or onshore coastal areas (USDOI, MMS, 2009) that are not expected to experience impacts from Shell's drilling and support activities.

Point Hope Iñupiat traditionally have used walrus; however, the increasing importance of the walrus as a subsistence resource is directly tied to its fluctuating population. Walruses are harvested during the spring marine mammal hunt. Although the walruses are hunted primarily during late May and early June, they are hunted by boat during the rest of the summer along the northern shore, especially along the rocky capes and other points where they tend to haul out (USDOI, MMS, 2009).

Throughout the year, waterfowl and other migratory birds are a preferred source of food for Point Hope residents. Most bird hunting occurs in spring in nearshore coastal areas (USDOI, MMS, 2009).

Northwest Arctic Borough (NAB)

Past land use and ownership of Goodhope Bay. The Pittaġmiut (also referred to as the Pittaimiut) were the Iñupiaq nation that owned the Goodhope Bay territory until their extinction as a sustainable tribe, presumably from disease and famine, by 1880 (Burch et al., 1992; Magdanz and Utermohle, 2002; Petroff, 1884; Ray, 1975). The Pittaímiut, called thus after the Iñupiaq name for the Goodhope River, are the least known of all Iñupiat nations of Northwest Alaska.

Current Subsistence Use. The best available information indicates that marine subsistence use of Kotzebue Sound peaks in intensity a month earlier than among NSB coastal community, winding down in June and early July in contrast with marine subsistence on the ANS, which peaks in July. All NAB communities are subsistence communities, and all coastal communities and the community of Noatak (situated inland along the Noatak River) traditionally begin marine mammal harvesting in the late spring when the ice melts enough to harvest ringed seals in open leads. May is the last month that ringed seals will still float because of their thick blubber, and families, harvest as many as 50 per household (Burch et al., 1992; Uhl and Uhl, 1977).

Bearded seals are also harvested. Their meat is dried and stored in oil rendered from the blubber (although with the arrival of freezers, meat may also be frozen for consumption during the ensuing months). All of the "black meat," as dried bearded seal meat is called, is prepared in June, before the weather becomes too hot and the insects too thick. Each family may take 10 to 20 of these seals weighing 300- to 600-pounds each. Hunters based in Kotzebue may wait until mid-June to hunt bearded seal (Burch et al., 1992).

Beluga whales are hunted in the shallower waters near Sisualik at the end of June by hunters from Kotzebue and Noatak. Additional beluga drives are or were conducted in the vicinity of Deering and Buckland (Table 3-8). The most productive beluga hunting areas prehistorically and historically were along the inner northern, eastern, and extreme eastern sections of Kotzebue Sound. The two most important driving areas were off Sisualik at the mouth of the Noatak River in the north, and in the shallower parts of Eschscholtz Bay, the most southeastern extension of Kotzebue Sound. At these camps, beluga hunting occurs from ice breakup until the midsummer. Harvesting beluga whales was more productive than seal hunting and takes precedence over other activities. At the same time, on the outer Kotzebue Sound shores, particularly at Cape Espenberg (which defines the south entrance of Kotzebue Sound and is due west of Goodhope Bay) seal hunting was the paramount activity noted by Lucier during his mid-twentieth century field work (Lucier and VanStone, 1995).

The subsistence resources described above are commonly harvested from the vicinity of Deering (roughly Cape Deceit eastward) on the south shore of Kotzebue Sound to the head of the sound. The best available information denotes that specific subsistence harvesting in the vicinity of Goodhope drainage is the occasional "jack-rabbit" (Arctic hare) hunt (Georgette and Loon 1993). Another indication of subsistence hunting is the statement that "At outer Kotzebue Sound shores, particularly at capes Krusenstern and Espenberg, seal hunting [rather than beluga whale hunting] is paramount" (Lucier and VanStone, 1995). Cape Espenberg defines the south entrance to Kotzebue Sound; seal hunting at Cape Espenberg is not mentioned in any contemporary subsistence study (Burch et al., 1992; Georgette and Loon, 1993; Magdanz and Utermohle, 2002). Moreover, hunting seals at Cape Espbenberg may have been discontinued after households replaced dog teams with snowmachines, reducing the amount of subsistence food required for harvest.

Anthropogenic noise is of concern to Iñupiat beluga whale hunters. The availability of beluga is highly variable from one season to the next as can be seen on Table 3-8, and Burch (et al., 1992) noted that in the 1980s, this variability prompted observations by hunters that the noise made by outboard motor adversely affected the beluga, especially past Kotzebue. This traditional knowledge (TK) regarding how anthropogenic noise negatively affects beluga whales has been documented elsewhere (Morseth, 1997; Huntington, et al., 1999; Mymrin et al., 1999; Suydam, 2009; Beauparlant, 2014). Many accounts are specific to the Kotzebue Sound beluga, describing deflection, skittishness, and avoidance that may affect their availability in ensuing seasons.

Commercial Fishing. Kotzebue Sound District commercial salmon fishery began in 1962 and operates through the present day. Gear is limited to set nets that cannot exceed 150 fathoms per permit holder. Chum salmon (also known as dog salmon, *Oncorhynchus nerka*) are the targeted species, with the season generally starting in mid-July and running through August. Permit holders withhold some of the salmon and all Dolly Varden, whitefish, and sheefish for personal use (Menard and Kent, 2014, 2015). The two major drainages supporting runs of chum salmon are the Noatak and Kobuk rivers (Bird, 1982). Other popular fish sites are the beaches near Kotzebue, Sisualiq, and creeks in the immediate area of Kotzebue and Sisualik (Georgette and Loon, 1993). Most commercial fishermen use open skiffs 22- to 24-feet long with nets set in nearshore channels of drainages to intercept the fish (Georgette and Loon, 1993).

Timing. As described in detail above, marine subsistence harvests cease after the beluga drives in late June-early July because summer heat resulted in spoilage of meat (Burch et al., 1992; Georgette and Loon, 1993). This practice may have eased somewhat with the advent of the home freezer, although this change has not been recorded in the literature. Moreover, according to Seaman et al. (1986), beluga whales are most abundant in coastal waters in July and August but the peak time for beluga abundance did not coincide with the most opportune times for driving them in shallow bays of Kotzebue Sound, which occurred from June typically through early July (Lucier and VanStone, 1995). Burch (et al., 1992) observed that July was a period of rest before harvesting fish, berries, and caribou in the late summer and fall.

3.2.10. Sociocultural Systems

Sociocultural systems encompasses three organizing, interrelated concepts: social organization, cultural values, and institutional organizations of communities. This section describes the existing sociocultural systems. Potentially affected tribes, communities, and corporations are described in Section 3.3 in the 2015 Second FEIS (USDOI, BOEM, 2015a).

Social organization corresponds most closely to existing structure at the household and community level that manages vital resources, which includes subsistence harvest but also encompasses all manner of economic resources involving the broader cash economy. The analytic focus here is on households, families, and wider networks of kinship and friends that, in turn, are embedded in groups that are responsible for acquiring, distributing, and consuming available local resources. In many ways, this element describes the nongovernmental characteristics of the community. Potential effects to social organization could be realized if project-related activities disrupt subsistence activities, change the demographics of the area, alter employment or income characteristics of the area, or otherwise affect the social well-being of local residents.

Cultural values correspond to the Iñupiat traditional emphasis on maintaining a close relationship with natural resources, with particular focus on kinship, maintenance of the community, cooperation, and sharing. Subsistence is a central activity that embodies these values, with bowhead whale hunting the paramount subsistence activity. Potential effects to cultural values could be realized if project-related activities alter subsistence harvest, erode known archaeological or cultural sites, or alter processes that maintain cultural continuity. This element overlaps closely with both social organization and institutional formation.

Institutional formation corresponds primarily to the structure and functions of borough, city, and tribal government, and related formal organizations such as the Alaska Native Regional and various village for-profit and not-for-profit corporations, and nongovernmental organizations. Potential effects to institutional formation could be realized if project-related activities affect how institutions are structured or how they function to provide services and foster community well-being or serve to maintain cultural preferences. These community structures and institutions are formed in large measure by Alaska Natives who live with a consciousness of traditional knowledge and present day awareness of their own cultural foundations and precepts.

The existing sociocultural system can be affected in a negative manner through any of these key structuring elements if the primary foundation of the system ─ subsistence harvest, sharing, and consumption practices ─ become significantly disrupted. Likewise, the sociocultural system can be variously affected in either a positive or negative manner if regional economic revenue occurs on a scale sufficient to create substantial local changes in demography, employment, commodity pricing, or community prosperity (USDOI, MMS, 2006a; Picou et al., 2004). Because of the mixed cash-subsistence economy, subsistence-harvest patterns as described in Section 3.2.9 are relevant here, as well as the potential regional economic effects that could potentially follow from exploring the Burger Prospect as described in Section 3.2.8.

3.2.11. Public Health

The health and welfare of the residents of the NSB is a primary concern in any decision regarding proposed OCS oil and gas activity in the Chukchi Sea. A detailed discussion of public health within Chukchi Sea coastal communities is provided in the Shell EIA (Shell, 2015a, Appendix C) and in Section 3.3.4 of the 2015 Second SEIS, salient points of which are incorporated by reference and summarized below. This description of public health focuses only on the public health issues of the NSB as it relates to the activities in the 2015 Shell EP. The location, timing, and scale of the proposed exploration activities are not expected to generate effects on many of the main public health issues described in Shell EIA (Shell, 2015a, Appendix C). The public health issues related to oil and gas activities in the NSB include:

- General health
- Psychosocial health
- Accidental injuries
- Nutrition (subsistence)
- Contaminant exposure to environmental pollutants
- Noncommunicable disease
- Sanitation
- Health services infrastructure
- Cultural stress mitigation

Indicators of general population health include life expectancy, mortality rates, infant mortality, and general health and well-being surveys. ANS communities have experienced a decline in epidemic infectious disease, with mortality rates declining and life expectancy increasing, though the life expectancy of Alaska Natives in NSB is still shorter than Alaska residents overall and the national average. Infant mortality rates have experienced a general decrease over time, though it can fluctuate due to a relatively low birthrate in the region. Since the era of epidemic infectious diseases, the health status of ANS communities is now characterized by increases in diabetes, cancer, and ongoing social and psychological stress and change. The leading causes of death in the NSB are cancer, heart disease, unintentional injury, chronic respiratory diseases, and suicide. Availability of subsistence resources can also influence public health outcomes.

3.2.12. Environmental Justice

Alaska Iñupiat Natives are residents of the communities of the North Slope Borough (NSB) and the contiguous Northwest Arctic Borough (NAB), a recognized U.S. minority group, and the predominant residents of the NSB and the NAB. The ethnic compositions of Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope are shown in in the 2007 FEIS (USDOI, MMS, 2007, Table III.C-15). Table III.C-15 shows that these communities are classed as minority communities on the basis of their proportional American Indian and Alaska Native membership. The same conclusion is the case for NAB in vicinity of Goodhope Bay, Kotzebue Sound. Low income commonly correlates with Alaska Native subsistence based communities in rural Alaska; however, subsistence-based communities in the region qualify for Environmental Justice analysis based on their racial/ethnic minority definitions alone (U.S. Census Bureau, 2000, 2002, 2010). Alaska Natives are the only minority population – indeed, the only population – allowed to hunt for marine mammals in the U.S. Chukchi Sea region. There are not substantial numbers of “other minorities” in potentially affected Iñupiat communities.

3.2.13. Archaeological Resources

Potential submerged archaeological resources in the project area range from historic to prehistoric. Historic resources include man-made objects or structures older than 50 years, such as shipwrecks, abandoned relics of historic importance, or submerged airplanes. The likelihood of historic resources occurring is determined by historical records, and such areas are tentatively identified in the Alaska Shipwreck Database (USDOI, BOEM, 2011c). No such objects are listed for the area defined by activities described in the 2015 Shell EP (USDOI, MMS, 2007, Section III.C.4; USDOI, BOEMRE, 2011a: Section III.C.4; Shell, 2015a, Section 3.3.6; USDOI, BOEM, 2014). Although the BOEM shipwreck database identified two historic shipwrecks that occurred in the OCS Chukchi Sea, the *Henry Kneeland* and the *Ontario*, in 1864 and 1899 respectively, in actuality there was only one – the *Henry Kneeland*, a whaling ship was struck by ice and filled instantly on June 22, 1864. The *Ontario*, a whaling bark, actually went ashore nine miles north of Mys Chaplina (“Indian Point”), Chukotka (Bockstoce, 2006). Research for this EA identified three shipwrecks at Herald Shoal, north of the Proposed Action area. These shipwrecks are not yet incorporated in the BOEM shipwreck database. These are the *Mercury,* the *Mount Wollaston*, and the *Vigilant*, all whaling barks from New Bedford that went aground near Herald Shoal ("Herald Island" or "Ostrov Geralda" in 1879. All hands were tragically lost from all three ships. The "Lucretia" from San Francisco also went aground here in 1889; the fate of the hands on board was not recorded (Bockstoce, 2006).

Prehistoric submerged archaeological resources may occur in areas that were sub-aerially exposed during the low stand of sea level approximately 20,000 years before present, an area which encompasses activities described in the 2015 Shell Final Revised Chukchi Sea EP (Shell, 2015a). Relict terrestrial landforms such as preserved levees or terraces associated with paleo-river channels, river confluences, ponds, lakes, lagoons, or paleo-shorelines are areas where archaeological sites are most likely to occur. No prehistoric resources are expected in some areas of the shelf in water depths less than 60 meters, where: (1) there are no Quaternary sediments, and (2) where extensive ice gouging has reworked the Quaternary section (USDOI, MMS, 2007, Section III.C.4; USDOI, BOEMRE, 2011: Section III.C.4; Shell, 2011: Section 3.10). It cannot be assumed that archaeological resources subject to erosional processes during the Holocene-Pleistocene interface would not be considered significant due to the lack of stratigraphic context.

The coastline of the ANS is an extensive area for the presence of archaeological resources. Other sites, which provide unique information about the region and its people, include buildings, shipwrecks, plane wrecks, and archaeological sites. These additional sites have been cataloged in the Alaska Heritage Resource Inventory maintained by the State of Alaska (http://dnr.alaska.gov/parks/oha/ahrs/ahrs.htm) and the Cultural Resource Site Inventory and Traditional Land Use Inventory (TLUI) maintained by the NSB. Several sites from these three inventories exist in the vicinity of Wainwright (North Slope Borough, Coastal Management Program, Map 2, Traditional Land Use and Archaeological Sites). The Borough’s Iñupiat History, Language and Culture Division has instituted clearance procedures for protecting activities and values at historic, archaeological, and cultural sites, including TLUI sites, near development activities (http://www.north-slope.org/departments/planning/ihlc.php).

BOEM's review of the site-specific geophysical data indicates that it is unlikely that historic properties will be affected. The geohazard survey did not identify any shipwrecks or other seabed features with potential as archaeological resources. Subseabed analysis displayed that drilling will not penetrate paleo-landforms that might contain archaeological sites. The SHPO has concurred with the finding that No Historic Properties Will be Affected in 2012, and there is no new information that would modify or change this finding. No sites have definitively been identified in the Alaska OCS region of the East Chukchi Sea.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1. Expected Operating Conditions

4.1.1. Climate Change

Greenhouse gas (GHG) emissions are one of the causes of climate change. This section discusses the potential effects of the Action Alternatives on climate change and how GHG emissions and particulate matter have the potential to influence climate change, particularly in the Arctic.

The activities associated with the 2105 Shell EP would produce GHG emissions, including carbon dioxide, methane and other gases—as described in Sec. 4.2.1—that would contribute to climate change. Climate change is a global phenomenon, and predicting climate change impacts requires consideration of large scale or even worldwide GHG emissions, not just emissions at a local level. Moreover, the current state of climate science does not enable us to relate specific sources of GHG emissions, such as from the 2015 Shell EP, to specific climate-related regional or global impacts. What the impact from specific sources would be, if any, depends on emissions associated with the implementation of the Proposed Action and emissions from other sources throughout the world. Even a small amount of GHG emissions contributes to the global total; it is the global total of the many relatively small sources that results in climate change. In addition, because some GHG gases, such as CO_2, may persist in the atmosphere for up to a century, the potential impacts of any source may extend well beyond the drilling season.

The greatest potential annual amount of CO_{2e} emissions (carbon dioxide equivalent) from the Proposed Action is projected to be 0.19 million metric tons (192,911 metric tons) during each season of drilling. This amount—compared, for example, to the annual GHGs emitted in the United States during 2013 (the latest full year of data) which was 6.526 billion metric tons of emissions of CO_{2e}—means that 0.0030% of CO_{2e} emissions in the United States would be from the annual implementation of the Proposed Action.

Implementation of the Proposed Action would also release particle pollution. Fine particles ($PM_{2.5}$) can exist in the atmosphere for several weeks and have local short-term impacts on climate. Light-colored particles reflect and scatter incoming solar radiation, which has a mild cooling effect, while dark-colored particles (often referred to as “soot,” “black carbon,” and “Arctic Haze” in the Arctic) absorb radiation and have a warming effect. While the IPCC (2013) recognizes the potential for “black carbon” (light-absorbing carbon) to deposit on snow and ice, altering the albedo, and enhancing melting, considerable uncertainty exists regarding the net impact of such atmospheric particles on climate. The particulate matter (PM) emissions from implementation of the Proposed Action would occur in the summer months, when ice is at its lowest coverage, which supports the conclusion that the contribution of PM emissions from the Proposed Action to Arctic Haze would be at the very minimum.

4.2. Affected Resources

The following subsections analyze potential effects on environmental resources as a result of Alternative 1 - No Action, Alterative 2 - Proposed Action, and Alternative 3 – Early Season Start. Under each resource category, there is analysis of the potential effects associated with each alternative. Both action alternatives (Alternative 2 – Proposed Action and Alternative 3 – Early Season Start) contemplate Shell’s proposal to drill six exploration wells.

Further variations may occur in terms of the length of a given drilling season. Shell proposes to drill up to October 31, but would not necessarily remain in the Proposed Action area until that date each year. An early departure from the drilling area would also be more likely should the late-season drilling mitigation described in Section 2.3 be instituted. The effects analyses for each resource in Chapter 4 also account for potential variations in timing of activities within individual seasons.

Potential cumulative effects are then discussed under each resource category. Each cumulative effects subsection discusses past, present, and reasonably foreseeable future actions that could affect each resource, and analyzes the potential for each of the three alternatives to contribute (either incrementally or synergistically) to these impacts.

As explained in detail in Section 2.4.8 and Appendix A, it is likely that a small refined oil spill (small fuel spill) could occur. These are accidental events that are assumed to occur for the purpose of analysis, and are treated as an impact producing factor in the effects analysis below. BOEM chose a 48 or 5 bbl diesel fuel-transfer spill (as identified in Shell's summary of Potential Discharges) to represent the range of spill volumes and oil type for the effects analysis of a small spill(s) for Alternatives 2 and 3. On the contrary, no large (>1,000 bbl) or very large (>150,000 bbl) oil spills are estimated to occur as a result of the proposed exploration drilling activities. As explained in Section 2.4.8 and in Appendix A (see Section A-2, p. A-2), the chance of a large or very large oil spill during exploration drilling is statistically small—since 1971, there has been one large/very large crude oil spill from a loss of well control during temporary abandonment out of more than 15,000 exploratory wells drilled. Therefore, in this document, BOEM analyzes only small spills (<1,000 bbl) specific to the Proposed Activities.

But as the Deepwater Horizon incident has demonstrated, even rare accidents can occur. For detailed information about the potential effects of large (≥1,000 bbl) or very large (≥150,000 bbl) oil spills, readers are referred to the analyses in the 2015 Second SEIS (BOEM, 2015a). These analyses remain sufficient to account for any potential effects of large and very large spills in the Chukchi Sea, including potential spills from Shell's activities under this Exploration Plan (estimated potential discharge volumes of 1,555 bbl diesel spill and 750,000 bbl oil spill). No further treatment of large or very large oil spills is provided in this document.

With respect to the likelihood of a large or very large oil spill under Shell's EP, note that in the 2015 Second SEIS (BOEM, 2015a), BOEM created a hypothetical scenario covering exploration and development activities occurring over a 77 year period. According to this scenario, there is a 75% chance of one or more large spills (>1,000bbl) occurring over the entirety of that 77 year period; however, the data show that a large spill in the relatively short exploration phase of this period is statistically unlikely (1 in 15,000 since 1971 as explained above; also see Appendix A, Section A-4.1.4). Large or very large spills (while still rare) are more likely, and assumed for the purposes of analysis, to occur during the development and production phase of activities under the 2015 Second SEIS hypothetical scenario.

In section4.2 The analyses in this section apply a scale to categorize the potential impacts to specific resources and evaluate the significance of those impacts. The scale takes into account the context and intensity of the impact based on four parameters: detectability, duration (i.e., short-term or long-lasting), spatial extent (i.e., localized or widespread), and magnitude (i.e., less than severe or severe, where the term "severe" refers to impacts with a clear, long lasting change in the resource's function in the ecosystem or cultural context).

Analysts used the best available information and their professional judgment to determine where a particular effect falls in the continuum on a relative scale from "negligible" to "major." Any impacts that would have fallen into the category of "major" would have been considered to be significant under NEPA. No major impacts were found in the analysis of the 2015 Shell EP in this EA. For biological resources, impacts were determined based on changes on the stock or population, rather than the individual level.

A level of effects determination (i.e. negligible, minor, moderate or major) is provided for each alternative. These determinations are based on the definitions provided in the 2015 Second SEIS, Section 4.2 – Impacts Scale (Page 161):

- **Negligible:** Little or no impact*
- **Minor:** Impacts are short-term and/or localized, and less than severe
- **Moderate:** Impacts are long lasting and widespread, and less than severe
- **Major:** Impacts are severe

* The term "negligible" as used in this EA does not have the same meaning as the term "negligible impact" under the MMPA regulations. The Impacts Scale employed in this EA uses the term "negligible" for activities with "little or no impact." It is used to describe and summarize impacts for a variety of resources. While BOEM's definition was chosen for uniformity in NEPA application across all resources (this definition is used in the 193 Second SEIS and by other agencies as well), the definition of "negligible impact" under NMFS and USFWS regulations is written in terms specific to authorizing the incidental take of marine mammals. Under the MMPA, a "negligible impact" is "an impact resulting from the specific activity that cannot be reasonably expected to, and is not reasonably expected to, adversely affect the species or stock through effects on annual rates of recruitment or survival." For these reasons, any direct comparison of levels of effects included in this EA with NMFS or USFWS determinations under the MMPA is inappropriate. As discussed in Section 2.4.1 of this EA, Shell's exploration activities must adhere to the conditions of required MMPA authorizations that would limit impacts on marine mammals to the level of negligible impact under the MMPA.

In applying this scale and the terms that describe impact categories (levels of effect), analysts took into consideration the unique attributes and context of the resource being evaluated. For example, for impacts to biological resources, attributes such as the distribution, life history, and susceptibility of individuals and populations to impacts were considered, among other factors. For impacts to subsistence activities, factors considered include the fundamental importance of these activities to cultural, individual and community health, and well-being. Based on these unique characteristics, impacts to subsistence activities are considered long-lasting and severe, and thus, major and significant, if they would disrupt subsistence activities, make subsistence resources unavailable or undesirable for use, or only available in greatly reduced numbers for a substantial portion of a subsistence season for any community.

In developing this impacts scale, BOEM considered the approaches used by other Federal agencies in their NEPA analyses of other proposed Federal actions, including other actions in the Arctic. Examples include the approaches set forth in the Final Programmatic EIS for the Atlantic OCS Proposed Geological and Geophysical Activities (USDOI, BOEM, 2014b); National Petroleum Reserve in Alaska (NPR-A) Final Integrated Activity Plan/EIS (USDOI, BLM, 2012); Alaska Stand Alone Gas Pipeline EIS (USACE, 2012b); and the Point Thomson EIS (USACE, 2012a).

4.2.1. Air Quality

BOEM considered the following sections and appendices of the 2015 Shell EP air quality analysis supporting the proposed drilling plan, which are summarized in this and subsequent sections of the air quality assessment:

- Sec. 7.0 Air Emissions Information
- Sec. 13.0 Support Vessels and Aircraft Information
- Sec. 14.0 Onshore Support Facilities Information
- Environmental Impact Analysis (EIA) (Appendix C of the EP)
    - Sec. 4.1 Impacts on Air Quality
    - Sec. 2.8 Air Emissions
    - Attachment A, Air Quality Impact Analysis Background, Modeling, and Impact Criteria
    - Attachment B, Air Quality Technical Report [impacts to] Onshore Areas

- Appendix K AQRP and NEPA Emission Inventories

Elevated concentrations of the criteria and precursor pollutants in the ambient air have been shown to cause harm to human health and the natural environment (40 CFR § 50.21(b)). Under NEPA, quantification of the emissions projected to occur due to a proposed Federal action is the first step in discerning the potential impact of new emissions. The projected emissions may include the proposed use of control technologies to reduce emissions. When such technologies are identified in the exploration plan and the projected emissions are calculated based on such emission reductions, the operator(s) are required to use the technology and verify the rate of emissions would not exceed the rate reported in their exploration plan. The emissions rates projected for the 2015 Shell EP Proposed Action and its alternatives include the following criteria and precursor pollutants:

- Carbon monoxide (CO), a criteria pollutant
- Nitrogen oxides (NO_x), a criteria pollutant and ozone precursor pollutant
- Sulfur dioxide (SO_2), a criteria pollutant
- Particulate matter (fine particles, $PM_{2.5,}$ and coarse particles, PM_{10}), criteria pollutants
- Lead (Pb), a criteria pollutant
- Volatile organic compounds (VOC), an ozone precursor pollutant but not a criteria pollutant; and
- Greenhouse gases, carbon dioxide (CO_2), and methane (CH_4), and nitrous oxide (N_2O), not criteria pollutants but gases that EPA has determined endanger human health and the environment (75 Fed. Reg. 66496, Tuesday, December 15, 2009)

Ozone

Ozone (O_3) is a criteria pollutant but is not directly emitted by any source. Rather, the molecules of O_3 are formed through a complex photochemical process involving emissions of VOC, molecules of NO_x, abundant sunlight, and heat. Thus there is no practical way to measure or control "tailpipe" emissions of O_3 or predict where O_3 would form as the result of emissions of the O_3 precursor pollutants from a particular source or sources. Further, O_3 is a regional phenomenon that forms in the atmosphere, often miles away from the source of the precursor pollutants, as a result of transport by the wind, through areas where conditions are favorable for O_3 formation. Consequently, the formation of O_3 is usually predicted through computer simulated photochemical modeling on a large regional, or even hemispheric scale (Godowitch, Gilliam, and Rao, 2011). Due to the obvious constraints of such an extensive analysis for a project-level analysis, the EPA estimates that project-level emission rates of VOC and NO_x may be used to infer a relationship that serves as an indicator of the potential for O_3 formation (40 CFR § 93.158(b)(1) & (2)). The relationship between O_3, NO_x, and VOC is driven by complex nonlinear photochemistry, where some atmospheres are NOx-sensitive, and others VOC-sensitive:

- A NO_x-sensitive atmosphere (or NO_x-limited) is where there are low concentrations of NO_x and high concentrations of VOC, where O_3 increases with increasing NO_x and changes little in response to increasing VOC from new sources.
- The opposite is the case for a VOC-sensitive atmospheres (or VOC-limited) where there are high concentrations of NO_x and low concentrations of VOC, where O_3 increases with increasing VOC and changes little in response to increasing VOC from new sources; in these types of atmospheres, O_3 can actually increase with decreasing NO_x emissions.

Sillman (1999), Liang and Jacobson (1999), and Godowitch, Gilliam, and Rao (2011) suggest that the ambient ratio of new VOC:NO_x emissions is directly related to the instantaneous rate of O_3 production, and it may be possible to make inferences about the production rate of O_3 based on the emissions rate of VOC:NO_x. The location of such formations, however, would not be predictable.

This relationship is discussed in detail in Shell's Environmental Impact Analysis (EIA), Sec. 4.1.1 Ozone (Shell, 2015).

The physical atmospheric conditions necessary for ozone formation, namely, sunlight and heat, and background emissions of VOC that characterize a more NO_x-sensitive atmosphere, are not present over the Chukchi Sea OCS or over the adjacent land areas of the western ANS. Thus, ozone is not a pollutant of concern for air quality impacts on the western ANS due to the Proposed Action or its alternatives.

Greenhouse Gases (GHG) and Climate Change

This discussion of GHG tiers to Sec. 3.1.9 *Climate Change* of the 2015 Second SEIS, and considers the 2015 Shell EP, EIA Sec. 3.1.2 *Climate Change*, where salient points of these sections are summarized.

Greenhouse gases (GHG) are chemical compounds that contribute to the greenhouse effect (warming of the air near the earth's surface) by absorbing infrared radiation from the sun. When an overabundance of GHG is present in the lower atmosphere, too much heat can be trapped, and the net temperature of the earth increases. Some GHG, such as carbon dioxide occur naturally and are emitted to the atmosphere through natural processes. Other GHGs are created and emitted solely through human activities. The three most abundant GHG caused by human activities are:

- Carbon dioxide (CO_2) - CO_2 enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), and other carbon-based fuels. CO_2 is removed from the atmosphere when it is absorbed by plants as part of the biological carbon cycles. CO_2 is not destroyed in the atmosphere over time; some molecules may remain in the atmosphere for 50 to 500 years (USDOI, BOEM, 2015a).
- Methane (CH_4) - CH_4 is emitted during the production and transport of coal, natural gas, and oil and as a result of livestock and agricultural practices and processes. Methane remains in the atmosphere for approximately 12 years. Pound for pound, the warming impact from emissions of CH_4 is over 20 times greater than CO_2 (USDOI, BOEM, 2015a).
- Nitrous oxide (N_2O) - N_2O is emitted from the combustion of fossil fuels and during agricultural and industrial activities (EPA, 2011d). Nitrous oxide molecules remain in the atmosphere for an average of 120 years, and is then transformed through further chemical reactions. The warming impact of one pound of N_2O is over 300 times that of one pound of CO_2 (USDOI, BOEM, 2015a).

The Council on Environmental Quality (CEQ) issued draft guidance stating that climate change is a reasonably foreseeable impact of GHG emissions. While GHG are not regulated for oil and gas exploration under NEPA, in response to the new guidance from the CEQ an accounting of projected emissions of GHG is included in the assessment of impacts to provide for better and more informed Federal decisions regarding GHG emissions and effects of climate change consistent with existing NEPA principles and policies. See Section 4.1.1 for the discussion of Climate Change in this EA.

As stated in Section 4.3.3 of the 2015 Second SEIS, the exploration activities under the Proposed Action would produce GHG emissions, including carbon dioxide, methane, and nitrous oxide. These GHG emissions would contribute to climate change. Climate change is a global phenomenon, and predicting climate change impacts requires consideration of large scale or even worldwide GHG emissions, not just emissions at a local level. Moreover, the current state of climate science does not enable us to relate specific sources of GHG emissions, such as the Proposed Action, to specific climate-related regional or global impacts. What the impact from specific sources would be, if any, depends on emissions from the Proposed Action together with emissions from all other sources of GHGs throughout the world. In addition, because some GHG gases, such as CO_2, may persist in the atmosphere for up to a century, the potential impacts of any source may extend well beyond the active lifetime of the Proposed Action.

As stated in Section 3.1.9 of the 2015 Second SEIS, the Earth's climate is naturally variable. After exiting an ice-age some 20,000 years ago, the Earth is now in a warming trend. Fluctuations in the global climate are the natural consequence of the Earth's energy budget (radiation balance), which is the system of heat transfer between the Earth and the Sun; a natural process that seeks equilibrium. When the system's natural radiation balance is upset by excess GHGs in the atmosphere, net warming occurs. Evidence from ice-core data from Antarctica shows the sinuous historical record of temperature versus the concentration of GHGs over a period of 420,000 years before present (B.P.) (refer to the 2015 Second SEIS, Figure 3-7 Chronological Temperature and CO_2 Concentrations (USDOI, BOEM, 2015a).

As with many fields of science, uncertainties exist in the field of climate change. Outstanding questions remain such as how much and at what rate warming will occur, and how such effects will globally influence precipitation, storms, and wildlife habitat, etc. The science used to predict the consequences of global emissions is continually developing. The International Panel on Climate Change (IPCC) released its Fifth Assessment Report (AR5) in 2013 providing updates, including updates with respect to climate changes in the Arctic. While the science is evolving, scientists generally agree the warming trend is accelerating at an unusually rapid rate in the Arctic and is caused by increased emissions of GHG produced by human activities. For example, the 2014 United Nations Framework Convention on Climate Change (UNFCCC) suggests that climate change is attributable to human activities that have altered atmospheric composition and caused climate variability beyond what can be explained by natural causes. The IPCC estimates global net warming will occur in the future as the mean surface temperature increases up to 3.7°F/1.48°C by the year 2100. While there may be periods during that time when the global temperature will cool or remain steady, it is believed the average trend will be a net increae in temperature.

As stated in Section 3.1.9.2 of the 2015 Second SEIS, geophysical, biological, oceanographic, atmospheric, and anthropogenic sources provide evidence of the climate changing in the Arctic in recent decades. For example, temperature recordings taken by the National Weather Service Office in Barrow from 1961 through 2010 and compiled by the Western Regional Climate Center in Reno, Nevada provide evidence of the warming in the Arctic. The temperature recordings show that Barrow's mean temperature increased from 9.4°F/-12.6°C during the 30 years from 1961-1990, to 11.8°F/-11.2°C during the 30 years from 1981–2010, an increase of 2.4°F/1.4°C.

Evidence of the Arctic climate warming is also supported by traditional knowledge from Alaska Native communities along the Beaufort and Chukchi Seas. Residents of these communities have reported changes in thickness of sea-ice, increased snowfall, drier summers and falls, warmer temperatures, forest decline, reduced river and lake ice, permafrost degradation, increased storms and coastal erosion, and ozone depletion.

Emissions Impact Analysis

The computer simulation of air dispersion is the second step in discerning the potential impact of new emissions. The analysis is based on the maximum annual emissions projected to occur during a year's drilling season under the unique conditions specified in the 2015 Shell EP.

The projected emissions, not including GHGs and VOC, are translated into pollutant concentrations using computer simulated dispersion models following the guidelines provided in 40 CFR Part 51 Appendix W *Guideline on Air Quality Models*. The potential for adverse air quality effects is assessed by comparing the concentration of projected emissions, together with the existing concentrations of background pollution (collectively the "design concentration"), to the National and Alaska's Ambient

Air Quality Standards (AAQS). The National AAQS are summarized in Table 4-1 along with the State of Alaska Ambient Air Quality Standards (ADEC, 2015).

Table 4-1. Ambient Air Quality Standards (AAQS) – National and Alaska.

Criteria Pollutants	Pollutant Averaging Periods	National AAQS		Alaska AAQS(μg/m^3)
		Primary Standards (μg/m^3, except where noted)	Secondary Standards (μg/m^3)	
Carbon Monoxide (CO)	1-hour	40,000	None	40,000
	8-hour	10,000		10,000
Nitrogen Dioxide (NO_2)	1-hour	188	None	188
	Annual	100	Same as Primary	100
Sulfur Dioxide (SO_2)	1-hour	196	None	196
	3-hour		1300	1,300
	24-hour			365
	Annual			80
Coarse Particulate Matter (PM_{10})	24-hour	150	Same as Primary	150
Fine Particulate Matter ($PM_{2.5}$)	24-hour	35	Same as Primary	35
	Annual	12	0.15	15.0
Ozone (O_3)	8-hour	0.075 ppm	Same as Primary	.075 ppm
Lead (Pb)	3-month	0.15	None	0.15

Note: There are no standards for volatile organic compounds, VOC. Ozone is always measured in parts per million (ppm).

Source: 40 CFR Part 50. ADEC, 2015.

Inferences can be made when comparing the design concentrations to the AAQS, which may be considered the "ambient air ceilings" above which adverse effects could occur. Thus, when projected emissions from a Federal action result in design concentrations that exceed the AAQS, the effects would be considered significant. Conversely, design concentrations that do not exceed the AAQS would not result in significant effects.

4.2.1.1. Alternative 1 – No Action

Under this alternative, the 2015 Shell EP would not be approved and no new direct or indirect emissions would occur. As such, this alternative would have no impact on air quality.

4.2.1.2. Alternative 2 – The Proposed Action

Under this alternative BOEM would approve, with conditions, Shell's proposal to drill six exploration wells within the Burger Prospect. Activities could occur on up to six leases acquired in Chukchi Sea Lease Sale 193 shown in Figure 1-1 and detailed in Table 2-1 of this EA. Shell proposes to commence drilling the wells during the open-water-season (July through October) of 2015 and would continue during subsequent open water seasons until all six wells are completed. Shell would conduct drilling operations from two Mobile Offshore Drilling Units (MODUs), the drillship *Discoverer* and the semi-submersible *Polar Pioneer*. Drilling operations would be supported by additional vessels for ice management, anchor handling, refueling, crew transport and supply, and spill response. Each annual drilling season is assumed to occur over a maximum of 120 days. Regardless of Shell's start date, this air quality assessment is valid for a drilling season not to exceed 120 days.

Projected Emissions

Sources of potential new emissions are identified in the 2015 Shell EP to include the drilling units, the *Discoverer* and the *Polar Pioneer*, support vessels, support aircraft, onshore support facilities, and vehicles. Any sources of emissions that would not operate but for the operations proposed under the EP are included in Shell's analysis of projected emissions of the 2015 Shell EP, Appendix K. The transient nature of the support vessels is such that emissions from these vessels are assumed to always operate within 25 statute miles (40.2 kilometers, km) of the *Discoverer* and the *Polar Pioneer* site, while each of the two drilling units are securely anchored to the seafloor.

The methods and procedures used to prepare the inventory of projected emissions for the NEPA air quality analysis of onshore and offshore emissions incorporates by reference the following sections of the 2015 Shell EP, Appendix K *AQRP and NEPA Emission Inventories*:

- Sec. 1.0 *Drilling Units and Support Vessels* - Identification of all emission sources
- Sec. 2.0 *Offshore Air Emissions* – Emission factors and activity levels
- Sec. 3.0 *Onshore Air Emissions* – Emission factors and activity levels
- **Attachment B** *NEPA Offshore Emission Inventory* – emission factors and emission calculations
- **Attachment C** *NEPA Onshore Emission Inventory* –EDMS LTO emissions; MOVES factors
- **Attachment D** *Emission Inventory Supporting Details* – factors, reductions and engine capacity
- **Attachment E** *Supplemental Information* – EPA coordination
- **Attachment F** *References* - Engine performance specifications; stack testing results

Sources of potential emissions are identified in the 2015 Shell EP to include both offshore and onshore sources of emissions. Offshore sources include the drilling units, the Discoverer and the Polar Pioneer, support vessels (e.g., ice management, supplies, oil spill support), and support aircraft (i.e., helicopters). Details of the emissions projected for offshore sources are contained in the 2015 Shell EP, Appendix K, Attachment B.

The EP proposes to support the offshore drilling program with an onshore support facility located in the Barrow area. Details of the emissions projected for onshore support sources are contained in the 2015 Shell EP, Appendix K, Attachment C. The facilities include:

- Support personnel camp, housing 75 persons in Barrow
- Kitchen, dining, and recreation facility adjacent to the 75-person camp in Barrow
- Hangar and warehouse at the Barrow airport with a boiler for heating
- Helicopter and fixed-wing aircraft operations at the Barrow airport for transport of personnel and some equipment to vessels at the Burger Prospect and for marine mammal surveys and ice surveys

Any sources of emissions that would not operate, or emissions that would not occur but for the operations proposed under the EP are included in Shell's analysis of projected emissions (Shell 2015a, Appendix K). Shell's projected emissions reflect the highest annual, or in this case seasonal, emissions due to the proposed drilling, and the emissions would be the same for each year's drilling season. Projected emissions include sources operating within the Chukchi Sea OCS Planning Area in support of the EP, and also include emissions from the operation of supply vessels operating from Dutch Harbor. The NEPA air emissions analysis includes the application of certain emission controls, either in the form of fuel restrictions or the application of control technology, each in an effort to reduced emissions (Shell 2015a, Appendix K, Attachment D). The emission-source controls are summarized under Mitigation Sec. 4.2.1.5 of this EA. The results of the analysis of maximum projected emissions per drilling season are summarized in Table 4-2.

Table 4-2. NEPA Offshore, Onshore, and Aircraft Projected Annual Emissions - Controlled.

Emission Source	Rate of Emissions (short tons/year, except metric tons for CO_{2e})							
	NO_x	CO	PM_{10}	$PM_{2.5}$	VOC	SO_2	Pb	CO_{2e}
Offshore Sources								
Discoverer	394.3	100.1	15.7	15.7	22.3	2.8	0.047	29,143
Polar Pioneer	481.5	75.7	24.7	24.7	23.6	2.8	0.039	31,741
Discoverer Support Vessels	356.4	75.2	15.7	15.7	24.2	3.3	0.085	28,714
Polar Pioneer Support Vessels	395	118.4	9.9	9.9	28.5	2.6	0.029	30,488
Common Support Vessels	872.3	225.1	45.4	45.4	47.2	6.5	0.3	69,080
Subtotal Offshore	**2,500**	**595**	**111**	**111**	**146**	**18**	**0.5**	**189,166**
Onshore Sources								
Aircraft	0.8	6.1	0.2	0.2	6.6	0.3	--	536
Hangar/Storage Building	0.4	0.3	0.0270	0.027	0.019	2.10 E-2	1.8 E-6	383
NARL Camp	29.2	8.2	0.7	0.7	2.6	2.00 E-1	5.5 E-4	2,823
Vehicles	0.0057	0.0043	2.6 E-5	2.6 E-5	6.3 E-4	2.00 E-5	--	3.0
Subtotal Onshore	30.40	14.60	0.92702	0.9270	9.2196	0.52102	5.52 E-4	3745
Total Projected Emissions	**2,530**	**609**	**112**	**112**	**155**	**18.5**	**0.50**	**192,911**

Note: NARL is the Naval Arctic Research Laboratory. All columns may not sum exactly due to rounding. Projected emissions include consideration of emission reduction controls.

Sources: 2015 Shell EP (Shell, 2015a, Appendix K, Table 19, NEPA Offshore Projected Annual Emissions, and Table 25 NEPA Onshore Projected Annual Emissions; ; BOEM Analysis for of Emissions from a Second Oil Tanker and Offshore Helicopter, 2015).

Dispersion Analysis of Offshore and Onshore Source Emissions

The impact from new emissions due to the implementation of a Federal action is assessed by translating the projected emissions given in Table 4-2, excluding GHGs, which are controlled emissions, into pollutant concentrations, and after including background pollutant levels, comparing the "design concentration" to the NAAQS.

The methods and procedures used to conduct the air dispersion analysis incorporates by reference the following sections of the 2015 Shell EP, Appendix C Environmental Impact Analysis (EIA), Attachment B Air Quality Technical Report – Onshore Areas:

- Sec. 2.4 Spatial and Temporal Relationships of Offshore Drilling Program Emission Units
- Sec. 4.0 Offshore Exploration Program Analytical Methods – Dispersion modeling
- Sec. 5.0 Drilling Program Modeling Results
- Sec. 6.0 Onshore Activity – Dispersion modeling
- Sec. 6.1.2 Onshore Program Modeling Results
- Sec. 7.0 Cumulative Exploration Program Concentrations

Dispersion modeling mathematically predicts the concentration of pollutants from a point, area, or volume source, given a specific averaging period and pollutant, for a specific downwind location (receptor). Dispersion is a complex process that requires the input of locations for each pollutant source and a receptor grid. The computer model used for a dispersion analysis must be one approved by the EPA and included on the list of preferred or approved models as given in 40 CFR Part 51 Appendix W Guideline on Air Quality Models, where each model has specific requirements for the use of site-specific meteorology. Finally, after onshore results are evaluated to find the maximum effects, by pollutant averaging period, the background concentrations are added to the modeled data and compared to the NAAQS.

Location of Emission Sources

The location of the emissions sources are important in dispersion modeling as local winds pick up the pollutants and transport them to other locations. Therefore, each source must be assigned a location.

All the engines aboard the drilling units, the Discoverer and the Polar Pioneer, are located on the drilling unit, which are considered point sources. The two drilling units would not be operating on the same lease block at any time. The distance between the drill sites would vary from 3 km to 21 km, depending on which drill sites are active at a given time. To obtain the most conservative results, the drilling units are assumed to operate at the two lease blocks closest to the shore, (blocks J and V), where the drilling units would be approximately 14 km (8.7 statute miles) apart, as shown in the 2015 Shell EP, Sec. 16.0 EIA, Attachment B, Sec. 4.1, Figure 5 Orientation of Model Emissions Sources. The drilling units would never be closer to shore than 64.7 statute miles (104.1 km). (Shell, 2015a, Sec. 7.0 (d)).

The transient nature of the support vessels is such that emissions from these vessels is assumed to occur over a delineated geographical area, and are treated as area sources. The location and size of these areas are shown in the 2015 Shell EP, Sec. 16.0 EIA, Attachment B, Sec. 4.1, Figure 5 Orientation of Model Emissions Sources.

The location of onshore sources are described in the 2015 Shell EP, Sec. 16.0 EIA, Attachment B Sec. 6.1.1 Dispersion Modeling and illustrated in 2015 Shell EP, Sec. 16.0 EIA, Attachment B, Sec. 6.1.2, Figure 8 Receptors used in Onshore Facility Modeling Analysis. Onshore sources are modeled using a combination of point and area sources in and around Barrow, Alaska. For instance, emission sources associated with the personnel camp are modeled as separate point sources; the aircraft emissions were modeled as area sources at the Barrow Airport.

Receptors

Separate receptor grids, or domains, were used for offshore and onshore sources because of their unique locations. The onshore domain for predicting onshore impacts from onshore sources is separate from the onshore domain for predicating onshore impacts from offshore sources. The offshore and onshore sources are separated by a distance of over 135 statute miles, and considering the prevailing direction of the moderate winds from the southeast in Barrow, as compared to the lighter prevailing winds over the drilling site from the north and northeast, an overlap in impact areas is not likely. Offshore sources would be expected to affect the land areas between Wainwright, Alaska, and Pt. Lay, Alaska. The onshore receptor grid used to predict impacts from offshore sources is illustrated in the 2015 Shell EP, Sec. 16.0 EIA, Attachment B, Sec. 4.2.3, Figure 6 Onshore Receptors Used in the CALPUFF Modeling. Onshore impacts from onshore sources would be expected to occur in and around Barrow, and the domain is illustrated in 2015 Shell EP, Sec. 16.0 EIA, Attachment B, Sec. 6.1.2, Figure 8 Receptors Used in Onshore Facility Modeling Analysis.

Computer Models and Meteorology

The California puff (a short burst of pollutant gas) model, CALPUFF v 5.8, was used to model dispersion of all the offshore vessel emissions. CALPUFF is a model listed as approved by the EPA in 40 CFR Part 51 Appendix W Guidelines on Air Quality Models. The CALPUFF model is valid for predicting pollutant concentrations at a receptor located greater than 50 km (31.1 statute miles) from the source. Details of how the CALPUFF model was used, the default assumptions and site-specific input data is given in the 2015 Shell EP, Appendix C EIA, Attachment B, Section 4.2.7 CALPUFF. BOEM estimated the onshore impact of helicopter emissions occurring on and near the drilling units, and emissions from the second oil tanker, using the Gaussian Dispersion Model with default assumptions that would ensure the most conservative results. Although not required under any regulation, the CALPUFF model was used to predict the contribution of emitted SO_2 and NO_x

emissions to form secondary aerosols and assess $PM_{2.5}$ concentrations (see Sec. 4.2.5 Secondary Aerosols in this EA).

Each dispersion model used for this air quality analysis requires a specific dataset of meteorological data to perform the dispersion process on the emissions. CALPUFF is run with the application of meteorological data using the Weather Research Forecast (WRF) model to construct the meteorological fields, and using the Mesoscale Model Interface Format (MMIF) tool to process and reformat the WRF output for input into CALPUFF, for the time period July to November for 2007 through 2009. A discussion of the details of the WRF data is given in the 2015 Shell EP, Appendix C EIA, Attachment B, Section 4.2.4 Mesoscale Model Interface Format and Weather Research Forecast.

Onshore sources of emissions were dispersed using the American Meteorological Association/EPA Regulatory Model (AERMOD), which is the appropriate model to use when predicting pollutant concentrations at receptor s located less than 50 km (31.1 statute miles) from the source. AERMOD is a model listed as approved by the EPA in 40 CFR Part 51 Appendix W Guidelines on Air Quality Models. Details of how the AERMOD model was used, the default assumptions and site-specific input data is given in the 2015 Shell EP, Appendix C EIA, Attachment B, Section 6.1.1 Dispersion Modeling.

A discussion of the details of the meteorological dataset given in the 2015 Shell EP, Appendix C EIA, Attachment B, Sec. 6.1.1 Dispersion Modeling is incorporated into this section and summarized here. For the AERMOD modeling, meteorological data reflecting both surface and upper air information was available from the Barrow Airport National Weather Service automated weather station. A five-year dataset covering the years 2008 through 2012 was applied to AERMOD using the AERMET meteorological preprocessor.

Background Concentrations

When determining the appropriate background concentrations to use for a NEPA offshore air emissions impact analysis, the concentrations should reflect the condition of the ambient air within the onshore area of expected impact due to emissions from the Federal action. The background concentrations are the result of local natural processes and anthropogenic sources, together with pollutants transported into the area from other sources. Background concentrations are derived from the evaluation of data sampled and analyzed using air monitoring devices, and estimate the likely magnitude, spatial, and temporal variability of pollutants across an area (McKendry, 2006). Monitoring data may be obtained from EPA-owned, state-owned, or industry-owned devices that use EPA-approved equipment and methods.

Two areas are of interest when considering the onshore impact area from emissions caused by offshore and onshore sources associated with Shell's Proposed Action and its alternatives. Emissions from offshore sources are likely to cause maximum onshore impacts over onshore areas more than 65 statute miles (104.6 km) from the drilling sites, likely between the communities of Wainwright and Pt. Lay. Emissions from onshore sources would likely cause maximum onshore impacts in the immediate vicinity of the sources, which are located in and near the community of Barrow, Alaska.

Background concentrations are used in conjunction with the computer-simulated predicted impacts to determine if emissions from the Proposed Action would cause or contribute to violations of the NAAQS. There is a monitoring station in Wainwright, one of the few monitors on the coast of the Chukchi Sea, which is operated by Shell under a monitoring plan approved by EPA on January 5, 2009. The monitor samples and measures concentrations of all the criteria and precursor pollutants except lead and VOC. The monitor also samples nitric oxide (NO) emissions in the ambient air.

The EPA reviewed the quarterly reports from Shell's Wainwright monitor and analyzed the data from the collection period November 8, 2008 through October 31, 2009 for consistency with the monitoring plan and 40 CFR § 52.21. EPA concluded the data, with the exception of the $PM_{2.5}$ data, collected from March 6, 2009 until October 31, 2009 was appropriate for use as representative background air quality levels for their permitting action that occurred in 2010. EPA reports the problem with the $PM_{2.5}$ sampling has since been corrected. This information is a summary of the methods and procedures used to develop background concentrations for Shell's Chukchi Sea OCS Prevention of Significant Deterioration (PSD) permit, support documentation, Statement of Basis, Sec. 5.2.6 (EPA, 2010c).

BOEM also considered the methods and procedures used by Shell to develop additional background concentrations provide in the 2015 Shell EP, Appendix C Environmental Impact Analysis (EIA), Attachment B, Sec 3.2 Existing Air Quality Conditions, Table 3 Maximum Existing Ambient Air Concentrations. The onshore background concentrations approved by EPA for the Wainwright area are summarized in Table 4-3.

Table 4-3. Onshore Background Concentrations.

Pollutant	Averaging Period	EPA-Approved Background	Shell-Developed Background		National and Alaska AAQS ($\mu g/m^3$)
		Wainwright ($\mu g/m^3$)	**Pt. Lay** ($\mu g/m^3$)	**Wainwright** ($\mu g/m^3$)	
NO_2	1-hour	1/	44	40.1	188
	Annual	2.0	1.4 2/	1.4	100
PM_{10}	24-hour	114	24	23.6	150
$PM_{2.5}$	24-hour	23	5.5	5.5 3/	35
	Annual	3.3	2.0	2.0 3/	12
CO	1-hour	1,050	1490	953	40,000
	8-hour	941	1280	946	10,000
SO_2	1-hour	1/	11.6	8.1	196
	3-hour	17	14.1	12.8	1,300
	24-hour 2/	10	13.4	2.2	365
	Annual 2/	0.5	4.8	0.4	80

Notes: [1] EPA, Region 10, did not develop a background concentration for the 1-hour standards for NO_2 and SO_2.
[2] Wainwright data was determined to be more representative (Shell, 2015a).
[3] Pt. Lay data was determined to be more representative (Shell, 2015a).

Source: EPA. Statement of Basis for Proposed OCS Prevention of Significant Deterioration. 2010. Shell Gulf of Mexico, Inc. Frontier Discoverer Drillship, Chukchi Sea Exploration Drilling Program. Permit No. R10OCS/PSD-AK-09-01. Sec. 5.2.6, Table 5-11 Background Ambient Concentrations for Use with Offshore and Onshore Impact Analysis. Shell, 2015a.

Secondary Formation of $PM_{2.5}$

Although not required, the CALPUFF model is used to predict the contribution of emitted SO_2 and NO_x emissions to form secondary aerosols and assess $PM_{2.5}$.

Modeling Results – Onshore Impacts from Offshore Sources

The results of CALPUFF modeling reflect the onshore impacts from the source-controlled estimate of offshore emissions. The project-related concentrations are combined with the background concentrations (Table 4-3), and compared to the AAQS (Table 4-1). The results are given in Table 4-4.

Table 4-4. Computer Simulation Dispersion Onshore Modeling Results – Offshore Sources.

Pollutant	Pollutant Averaging Period	Shell's Modeled Results (µg/m³)	Onshore Background Concentration (µg/m³)	Design Concentration (µg/m³)	National and Alaska AAQS (µg/m³)
NO_2	1-hour	36	44 [1/]	80	188
	Annual	0.03	2	2.03	100
PM_{10}	24-hour	4	114	118	150
	Annual	0.02		0.02	--
$PM_{2.5}$	24-hour	4	23	27	35
	Annual	0.02	3.3	3.32	12
CO	1-hour	12	1,050	1,062	40,000
	8-hour	8	941	949	10,000
SO_2	1-hour	0.1	11.6 [1/]	11.7	196
	3-hour	0.1	17	17.1	1,300
	24-hour	0.03	10	10.03	365
	Annual	0.0002	0.5	0.5002	80

Note: "—" denotes no NAAQS has been established for this pollutant and averaging period or if established prior, the standard has been revoked by EPA.

[1/]EPA's Statement of Basis did not provide an onshore background concentration for the 1-hour average concentration of NO_2 nor the 1-hour average concentration of SO_2. For these two pollutant averaging periods, BOEM applied the background concentrations provide by Shell.

Source: Shell. 2015. EP, EIA, Attachment B, Sec. 5, Table 4 Maximum Predicted Concentrations Attributable to Offshore Sources; BOEM Analysis of Second Oil Tanker, 2015; and Sec. 3.2 Table 3 Maximum Existing Ambient Air [Background] Concentrations. EPA, 2010.

The locations of the highest concentrations are shown in the 2015 Shell EP, EIA, Attachment B, Sec. 5, Figure 7. The highest concentrations are mostly clustered in the area of the community of Icy Cape, Alaska, approximately half-way between Wainwright and Point Lay. The project-related concentration of NO_2 has the greatest impact at 36 µg/m³. The high value for the NO_2 emissions is due to the nature of drilling operations offshore and the use of ocean vessels. The drilling units and vessels burn diesel fuel, which have a higher emission value for NO_2 than any other pollutant. Thus, one would expect this pollutant concentration to be higher than the other pollutants. Notice also that the background is relatively high for NO_2 emissions. This is likely due to the burning of fuel oil for heat and other industrial uses on the western ANS. The higher rate of NO_2 emissions can be seen in Table 4-2. Conversely, the relatively low 24-hour average concentration of PM_{10} and $PM_{2.5}$ related to the project is increased by the higher background concentrations already present in the area around Wainwright.

Data presented in Table 4-4 demonstrates that none of the onshore modeled results from offshore sources exceed the NAAQS, even with the addition of the background concentrations.

Modeling Results – Onshore Impacts from Onshore Sources

The results of AERMOD modeling reflect the onshore impacts of onshore sources of emissions. The results of modeling onshore sources using AERMOD, including aircraft, are summarized in Table 4-5, which reflect the most representative maximum onshore concentrations predicted over an area of at least 20 square km (12.4 square statute miles).

Table 4-5. Computer Simulation Dispersion Onshore Modeling Results – Onshore Sources.

Pollutant	Pollutant Averaging Period	Shell's Modeled Results (µg/m³)	Onshore Background Concentration (µg/m³)	Design Concentration (µg/m³)	National and Alaska AAQS (µg/m³)
NO_2	1-hour	94	44 [1/]	138	188
	Annual	1	2	3	100

Pollutant	Pollutant Averaging Period	Shell's Modeled Results (µg/m³)	Onshore Background Concentration (µg/m³)	Design Concentration (µg/m³)	National and Alaska AAQS (µg/m³)
PM_{10}	24-hour	6	114	120	150
	Annual	0.03		0.03	—
$PM_{2.5}$	24-hour	6	23	29	35
	Annual	0.03	3.3	3.33	12
CO	1-hour	1,198	1,050	1051.198	40,000
	8-hour	326	941	1267	10,000
SO_2	1-hour	19	11.6 [1/]	30.6	196
	3-hour	30	17	47	1,300
	24-hour	8	10	18	365
	Annual	0.01	0.5	0.51	80

Note: "—" denotes no NAAQS has been established for this pollutant and averaging period or if established prior, the standard has been revoked by EPA.

[1/] EPA's Statement of Basis did not provide an onshore background concentration for the 1-hour average concentration of NO_2 nor the 1-hour average concentration of SO_2. For these two pollutant averaging periods, BOEM applied the background concentrations provide by Shell.

Source: Shell. 2015a. Appendix C, Attachment B, Sec. 5, Table 5.

Data presented in Table 4-5 demonstrates that none of the onshore modeled results from onshore sources exceed the NAAQS, even with the addition of the background concentrations.

The locations of the highest pollutant concentrations resulting from onshore sources of emissions occur very near the camp located at the Naval Arctic Research Laboratory (NARL), where the maximum 1-hour and 8-hour average CO concentrations are 1,198 $\mu g/m^3$ and 326 $\mu g/m^3$, respectively. These concentrations occur near the runway end a the Barrow, Alaska, airport and are caused by the takeoffs and landings of fixed-wing aircraft that are powered by piston engines that use low-lead gasoline.

The next highest concentration is the 1-hour average concentration of NO_2 emissions at 94 $\mu g/m^3$. The high concentration of NO_2 is due to the generators used to provide power to the camp, and the diesel-powered generators used for the kitchen, dining, and recreation facility. The generators for the camp represent the majority of emissions of NO_2 from onshore sources. The highest annual average concentrations of NO_2 and $PM_{2.5}$ are also a result of the generators for the NARL camp.

The remainder of the highest concentrations from onshore sources occurs near the airport at Barrow, Alaska. The maximum annual average concentration of SO_2 occurs on the north side of the airport near where the helicopters operate. The remaining maximum concentrations occur near the runway.

While the rate of emissions from these sources is much lower than for the offshore facilities, the maximum concentrations occur just yards away from the sources, where the land areas nearest the offshore sources are at least 64.7 statute miles (104.1 km) away resulting in much lower concentrations onshore. However, the pollutant concentrations from these onshore sources would fall quickly with distance due to the much lower rate of emissions; whereas, the strength of the offshore emissions causes their impact to be more widespread and farther reaching over the onshore areas, causing some overlap of the impacts.

Greatest Air Quality Impacts

The greatest impacts from offshore sources occur south of Wainwright, whereas the greatest impacts from onshore sources occur in and around Barrow. Shell examined the output data from the modeling results to determine areas where impacts from offshore and onshore might overlap. This overlap occurs in and around Barrow, where the impacts from onshore emissions is higher when compared to the impacts from the offshore emissions originating from a distance of over 100 miles (160.9 km). Thus, the combined effect of the overlapping impacts determine the area of greatest effect from the proposed drilling. The results are shown in Table 4-6.

Table 4-6. Greatest Potential Onshore Air Quality Impacts.

Pollutant	Pollutant Averaging Period	Shell's Modeled Results in Barrow from Offshore Sources (μg/m^3)	Shell's Modeled Results from Onshore Sources (μg/m^3)	Onshore Background Concentration (μg/m^3)	Design Concentration (μg/m^3)	National and Alaska AAQS (μg/m^3)
NO_2	1-hour	8	94	44	146	188
	Annual	0.008	1	2	3.01	100
PM_{10}	24-hour	1.4	6	114	121	150
	Annual	0.008	0.03	None	0.038	--
$PM_{2.5}$	24-hour	1.4	6	23	30.4	35
	Annual	0.008	0.03	3.3	3.3	12
CO	1-hour	3.3	1,198	1,050	2,251	40,000
	8-hour	1.9	326	941	1,269	10,000
SO_2	1-hour	0.03	19	11.6	30.6	196
	3-hour	0.02	30	17	47.0	1,300
	24-hour	0.006	8	10	18.0	365
	Annual	0.00004	0.01	0.5	0.51	80

The greatest air quality impact from proposed drilling, when considering some of the offshore emission sources are controlled, would occur in the area around Barrow, particularly around the airport. However, the data in Table 4-6 demonstrates that the greatest potential onshore impact from offshore and onshore sources would not have the potential to exceed either the National or Alaska AAQS. When considering the impacts to air quality would be short-term and/or localized, and less than severe, then pursuant to Sec. 4.2 of this EA, the air quality impacts of the emissions from implementation of the Proposed Action would not exceed minor air quality effects.

4.2.1.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st. Under Alternative 3, Shell may begin drilling in advance of July 1, 2015, depending on whether there is open water present in the project area. The air quality analysis presented under Alternative 2 – Proposed Action is valid for a maximum drilling season of 120 days, regardless of start date. However, should the drilling begin earlier than July and drilling continue for more than 120 days, emissions would increase each day as given in Table 4-7.

Table 4-7. NEPA Offshore, Onshore, and Aircraft Projected Emissions – Controlled (Alt. 3).

Emission Source	Rate of Emissions (short tons/day, except metric tons for CO_{2e})							
	NO_x	CO	PM_{10}	$PM_{2.5}$	VOC	SO_2	Pb	CO_{2e}
Offshore Sources								
Discoverer	3.3	0.8	0.1	0.1	0.2	0.02	0.0004	243
Polar Pioneer	4.0	0.6	0.2	0.2	0.2	0.02	0.0003	265

Emission Source	Rate of Emissions (short tons/day, except metric tons for CO_{2e})							
	NO_x	CO	PM_{10}	$PM_{2.5}$	VOC	SO_2	Pb	CO_{2e}
Discoverer Support Vessels	3.0	0.6	0.1	0.1	0.2	0.03	0.001	239
Polar Pioneer Support Vessels	3.3	1.0	0.1	0.1	0.2	0.02	0.0002	254
Common Support Vessels	7.3	1.9	0.4	0.4	0.4	0.1	0.003	576
Subtotal Offshore	**20.8**	**5.0**	**0.9**	**0.9**	**1.2**	**0.2**	**0.004**	**1,576**
Onshore Sources								
Aircraft	0.01	0.1	0.002	0.002	0.1	0.003	NA	4.5
Hangar/Storage Building	0.0033	0.0025	2.3 E-4	2.3 E-4	1.6 E-4	1.8e-4	2.0 E-8	3.2
NARL Camp	0.2	0.1	0.01	0.01	0.02	0.002	5.0 E-6	24
Vehicles	4.8 E-5	3.6 E-5	2.2 E-7	2.2 E-7	5.3 E-6	1.7 E-7	None	0.03
Subtotal Onshore	**0.3**	**0.1**	**0.01**	**0.01**	**0.1**	**0.004**	**4.6 E-6**	**31**
Total Projected Emissions	**21.1**	**5.1**	**0.9**	**0.9**	**1.3**	**0.2**	**0.004**	**1,608**

Note: NARL is the Naval Arctic Research Laboratory.

Sources: BOEM, 2015.

Conclusion

BOEM estimates that drilling could continue for an additional 30 days without changing the overall impacts as described for Alternative 2 – Proposed Action. A full 30 days of additional drilling would be unlikely, given the possibility of ice cover. Compared to Alternative 2 – Proposed Action, Alternative 3 – Early Season Start would have the greater impact to air quality. Extending drilling longer than 120 days adds to the emissions budget in the area; dispersion/dilution would continue to occur on those additional days (i.e. it is not simply increasing the emissions budget and dispersing this higher amount of pollution over the same 120 days). However, if the additional drilling time reduces the number of drilling seasons that would otherwise be required to drill all six wells, then the short-term impact may be greater during one season, but the overall effect would be the same. Therefore, the impacts to air quality would be short-term and/or localized, and less than severe. Pursuant to Sec. 4.2 of this EA, the air quality analysis of the emissions from implementation of Alternative 3 would cause minor air quality effects.

Small Fuel Spill

This analysis of a small fuel spill tiers to the 2015 Second SEIS, Section 4.3.2.1 *Evaporative Emissions* (pp. 182) and *Small Refined Oil Spills* (pp. 192). Salient points are included below along with additional information on air quality. A small oil spill would result in relatively low emissions of VOC over a small area, and evaporation would continue until the mass of oil is evaporated or removed from the water surface. Air quality impacts from an oil spill are measured by the volume of VOC that may be released into the lower atmosphere due to evaporation of the oil, relative to the reaction of these VOC with other elements in the atmosphere to form ozone. The volume of VOC emissions resulting from small refined oil spills, when considering the levels of NO_x emissions likely already emitted from exploration activities is not expected to be sufficient to create conditions favorable for the formation of ozone, and would support a finding of negligible effects.

Level of Effect

Upon reviewing the relevant documents, and after evaluating the results of the projected emissions in Tables 4-2 and 4-6, and the impact analysis presented in Tables 4-4 and 4-5, BOEM expects much the same level of effect as characterized in the 2015 Shell EP. When combined with background concentrations, the project-related emissions would not have the potential to exceed any of the National or Alaska AAQS over the onshore areas of Alaska. In addition, the impacts to air quality under the Alternative 2 – Proposed Action and Alternative 3 – Early Season Start would be short-term and/or localized, and less than severe. Pursuant to Sec. 4.2 of this EA, the air quality analysis of the emissions from implementation of the Proposed Action or Alternative 3 would cause minor air quality effects.

4.2.1.4. Cumulative Effects

A description of the relevant additional activities that are recent, ongoing, or reasonably foreseeable, and that could result in measurable adverse cumulative air quality impacts, is provided in Appendix B of this EA. Alternative 2 – Proposed Action and Alternative 3 – Early Season Start include the temporary use of marine vessels, aircraft, and surface vehicles; these are pollutant sources that could contribute to the emission budget within the western ANS. Pollution from the proposed drilling could add to pollution from other activities in the region to reach an adverse cumulative effect on air quality. Specifically, any additional activities occurring during the same time period and causing impacts in the same general area may cause emissions to build up in the atmosphere to levels harmful to human health or wildlife, particularly when combined with existing emissions in the area. However, in consideration of the prevailing wind conditions over the open sea and the distance of the proposed drilling sites from the shoreline, emissions from the proposed drilling—when combined with other operations in the Chukchi Sea—would likely be diluted and dispersed resulting in pollutant concentrations far below the air quality standards at the shoreline. The reasonably foreseeable cumulative effects would occur at nearly the same level each season that Shell conducts exploratory drilling operations under this EP. For the life of the project, impacts to air quality from Alternatives 2 and 3, and from reasonably foreseeable cumulative activities would amount to a minor level of effect. The level of air quality effect when considered together with the emissions from the Proposed Action and its alternatives would be short-term and/or localized, and less than severe. Thus, the air quality cumulative effects associated with the implementation of the EP would be minor.

Alternative 3 would not contribute any different incremental impacts to air quality than Alternative 2. The impacts to air quality from Alternative 2 and from reasonably foreseeable activities would amount to no more than a minor incremental contribution to the cumulative effect.

4.2.1.5. Mitigation

Shell is required to report the actual emissions from engines for which controls are indicated in the EP. Likewise, emissions based on fuel used by vessels for which fuel restrictions were applied will also be reported to the BOEM Regional Supervisor. These data will be compared to the projected emissions reported in the EP. This is because Shell's projected controlled emissions for the drilling season presented in Table 4-2 are the result of applying mechanical emission reduction controls to certain engines, and restrictions on the use of fuel for certain vessels. The details of these mitigation strategies are found in the 2015 Shell EP, Appendix K, Sec. 2.1, Table 5 Support Vessel Proposed Annual Fuel Restrictions, Sec. 2.2, Table 6 Units with Emission Controls (excluding the *Discoverer*), and Sec. 2.4, Table 17 Particulate Matter Emissions Controls.

4.2.2. Water Quality

The type and degree of effects on water quality from discharges into the marine environment are mainly influenced by several physical factors including: rate of discharge, depth of discharge, concentration of contaminants, currents, bathymetry, water stratification layers, oxygen concentration and water temperature. These factors are considered in BOEM's analyses in the 2015 Second SEIS (USDOI BOEM, 2015a, Section 4.3.1. Water Quality). Detailed information on the various types and properties of discharges from routine oil and gas activities is contained in the 2007 FEIS (USDOI, MMS, 2007, Section IV.C.1.a(4)). Additionally, Section 403 of the CWA requires EPA to ensure that its NPDES permitting decisions do not result in an unreasonable degradation of the marine environment. EPA evaluated the impacts of wastewater discharges associated with the Chukchi Exploration NPDES General Permit (AKG-28-8100) and has made the determination that the discharges will not result in an unreasonable degradation of the marine environment. (EPA, 2012a, b) Additional background information is contained in the following documents:

- Chukchi Sea Environmental Monitoring Program Requirements Summary (EPA, 2012c)
- Results from Chukchi Sea Permit Dilution Modeling Scenarios (EPA, 2012d)

4.2.2.1. Alternative 1 – No Action

Under this alternative, the proposed exploration drilling would not be approved, and no impacts to water quality would result.

4.2.2.2. Alternative 2 – The Proposed Action

The Proposed Action's discharges would be conducted under the conditions of the Chukchi Exploration NPDES General Permit. The GP authorizes 13 types of exploration drilling discharges from exploratory facilities. The discharges associated with the Proposed Action and authorized by the GP include: water-based drilling fluids and drill cuttings, deck drainage, sanitary waste, domestic waste, desalination unit waste, blow-out preventer fluids, boiler blowdown, fire control system test water, noncontact cooling water, uncontaminated ballast water, bilge water, excess cement slurry, and muds, cuttings, and cement at the seafloor. The GP limits the content, volume, and rate of the discharges to ensure impacts on water quality do not occur and monitoring to verify the limitations are met. Operating within the GP limits to avoid or minimize adverse effects would be considered a required mitigation.

Only discharges from offshore oil and gas exploration facilities are authorized by the GP and would not result in unreasonable degradation of ocean waters (EPA, 2012b). Non-hazardous solid waste, hazardous waste and used oil generated by the Proposed Action would be stored and taken to an approved onshore waste facility. The EPA evaluated the potential for unreasonable degradation of the marine environment and determined that discharges authorized by the GP will not result in (EPA 2012a) (40 CFR 125.121(e)):

- Significant adverse changes in the ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities
- Threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms
- Loss of aesthetic, recreational, scientific, or economic values that are unreasonable in relation to the benefit derived from the discharge

Other regulations establish effluent limitations to control materials that contain constituents in the waste streams of the support vessels. Discharges associated with the support vessels in the OCS would be conducted under the International Convention for the Prevention of Pollution from Ships (Marine Pollution or MARPOL) Annex IV and USCG regulations at 33 CFR Part 159. Domestic wastewater and treated sanitary waste discharges from support vessels, operating within would be required to be in MARPOL compliance. Additionally, the GP has requirements that apply to all discharges, including, but not limited to:

- No discharge of floating solids, debris, deposits, foam, scum or other residues of any kind
- No discharge of diesel oil, halogenated phenol compounds, trisodium nitrilotriacetic acid, sodium chromate, or sodium dichromate

EPA has determined that the discharges authorized by the Chukchi Exploration NPDES General Permit would not result in discharges of pollutants in quantities or composition that would bioaccumulate or persist in the marine environment (EPA 2012a, Criteria 1).

Impacts of Drilling Wastes on Water Quality

The Proposed Action would result in higher levels of suspended solids, turbidity, hydrocarbons, metals, and temperatures in the water column. The 2015 Second SEIS water quality analysis of exploration lists each type of activity that would affect water quality (in USDOI, BOEM, 2015a, Section 4.3.1.1, Tables 4-5 and 4-6) and describes the environment affected and the depth of each discharge. The depths of the Proposed Action's discharges would be either within 10 m (33 ft) of the surface at the six proposed drilling sites, or between the seafloor and the 10 m (33 ft) above the seafloor. The upper portion of the water column would be within the well-mixed waters above the thermocline and halocline (Section 3.2.2 and Figure 3-3).

Drill Cuttings and Drilling Fluids. Effects on water quality from discharges of water-based drilling fluids and drill cuttings are anticipated to be short-term and localized. In the well-mixed waters above stratified waters, particles discharged to the ocean from drilling activities are typically diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold after a transport time of about 10 minutes at a distance of about 100 m (328 ft) from the drilling unit (Neff, 2005; Neff, 2010). Material discharged during drilling would be similar in composition to naturally-occurring seafloor sediments and its contribution to turbidity from waves and currents would be about the same as the sediments existing at the seafloor before drilling activities (USDOI, BOEM, 2011a, Section 4.2). Volumes of drilling fluids and drill cuttings that would be generated and discharged, per well, are provided by Shell (2015a, Appendix C, Table 2.7-1 and Table 2.7-2).

Mudline Cellars (MLC): Seafloor material would be excavated to construct MLCs at five of the proposed six drilling sites (one MLC, at Well Site A, was constructed in 2012). The MLC construction would increase sediment, suspended solids, and turbidity in the lower water column, resulting in an increase in total suspended solids (TSS) above background levels, dependent upon sediment grain size and composition. Cuttings from the MLC excavations would be deposited on the seafloor below the temperature and salinity stratification layer. The volume and area disturbed to construct a MLC by ROV would increase by a factor of 6 beyond the volume and area disturbed by using the MLC Bit from a drilling unit (Shell, 2015a, Appendix C, Table 2.3-4 (page 2-18)); also the MLC ROV would require an additional OSV type support vessel. However, the predicted TSS concentrations from the MLC ROV excavation would be approximately one-half the point-source discharge of the MLC Bit (Shell, 2015a Appendix C, Table 4.2.1-4. (page 4-30)). The differences between the two methods of MLC construction are negligible for TSS regarding overall discharge, and impacts to water quality are short-term and minimal, given the overall TSS discharge from each proposed exploratory well. While not a direct concern of water quality, volume of drill cutting and the area impacted from the MLC ROV discharge could be a concern to other resources. Currents and severe storm events could resuspend and transport these newly deposited seafloor sediments.

BOEM (2015a, Section 4.4.3.1 Conclusions) concludes that impacts from drill cuttings and fluids, as well as from MLC construction would be minor, short-term, and local, as described in Shell's 2015 EIA Section 4.2.1 discussion of drilling wastes on water quality:

> The impacts to water quality would cease when the discharge is concluded. Impacts to water quality from the discharge of drilling wastes and cement will be localized, and will occur over a short period of time (weeks to months during exploration drilling at an individual drill site). The model results indicate that plumes with TSS concentrations above ambient levels are unlikely to extend from one drill site to another for even the closest drill sites. The most likely drilling scenario would have the drilling units 7 to 10 mi (11.3 to 16.1 km) apart. Drill sites in proximity to each other would be subject to the same current regime and plumes would flow in the same direction. Therefore, water quality impacts from drilling two wells concurrently

with two drilling units would be similar to the effects of drilling two wells at different times with the same drilling unit. (Shell, 2015a, Appendix C, Section 4.2.1)

Impacts of Other Permitted Discharges on Water Quality

Other permissable discharges include the non-drilling wastewater discharges from the drilling units and similar wastewaters discharged from the support vessels.

Domestic and sanitary wastewaters, deck drainage, cooling water, ballast water, desalination wastes, boiler blowdown, and fire control system test water are other wastes that would result from the Proposed Action from drilling units. Limitations listed in the 2015 Shell EIA Table 4.2.2-1 regulate the graywater discharges from the drilling units. The compositions, projected rates, and projected volumes of these discharges are presented in the 2015 Shell EIA Section 2.0, Tables 2.7-4 and 2.7-5. The discharges from the drilling units would be conducted in accordance with, and authorized under, the Chukchi Exploration NPDES General Permit, which contains a number of conditions that place limitations on effluent constituents and discharge rates, and mandates discharge monitoring and reporting (EPA, 2012a). The GP also prohibits discharging oil, grease, and detergents from deck drainage activities; typically these include wash-water used to wash equipment, and as well as spilled drilling fluids.

Support vessels discharges are regulated by MARPOL as mentioned above and enforced by the USCG or EPA. MARPOL regulates oil pollution, the control of noxious substances, harmful substances, sewage, and garbage from ships. If the MLC ROV method is approved, an additional support vessel would have discharges regulated by MARPOL. Support vessels engaged in the exploration drilling operations would not be required to treat graywater prior to discharge as long as only phosphate free, water soluble, nontoxic, biodegradable soaps and solutions are used during daily operations. By regulation and treaties, all food waste must be incinerated or transported to waste containment sites onshore. Sanitary wastes would be processed onboard by marine sanitation devices (MSD) prior to discharge according to the limitations in the 2015 Shell EIA (Shell, 2015a, Appendix C, Table 4.2.2-2).

Non-point source activities that disrupt the seafloor sediments setting/retrieving anchors. Anchoring the MODUs would disturb the seafloor. These processes would introduce suspended sediments and turbidity into the lower water column. Sediments would then be deposited on to the seafloor down-current from anchoring locations. The impact to the sediments and water quality would be minimal, short-lived, and local.

Small Fuel Spill

Two small oil spills (<1000 bbl) are estimated for this EA as a potential of 5 bbl or 48 bbl diesel spills. Effects of either on water quality would be dependent upon sea conditions at the time of the spill. Managing fuel transfers to occur when seas are calm would reduce the risk of a fuel spill and setting pre-booms downwind would expedite the recovery of a fuel spill would minimize the adverse effects of a fuel spill. Limiting fuel transfers to calm periods would be an additional mitigation to lessen impacts. Pre-booming is Lease Stipulation 6. With high wind conditions and rough seas, the diesel would be rapidly diluted and dispersed and effects of the spill would be negligible. In calmer waters evaporation of the diesel would be rapid, and the area covered by dispersion of the remaining hydrocarbons would be dependent upon wind speed, wind direction, and water temperature. According to the Shell's EIA (Shell, 2015a) diesel fuels are not likely to form emulsions; due to the low viscosity of diesel, light distillates tend to evaporate and disperse readily into the water column by even gentle wave action. Also, Shell (2015a) indicates there is a high potential for dissolution of the diesel to occur from surface sheens and droplets dispersed in the water column. The effects of a small spill on water quality would be minimal, short-term, and localized.

Transit from Dutch Harbor

While BOEM does not regulate transit from Dutch Harbor, it is anticipated that OSVs will make approximately 30 trips back and forth from Dutch Harbor to the Proposed Action area for resupply each drilling season. The OSVs are required to operate in compliance with MARPOL and USCG requirements; therefore these transits will have negligible to minimal impact on water quality resources.

Conclusion

Considering effects on water quality from all exploration activities, and as concluded in the 2015 Second SEIS Section 4.3.1, the impacts on water quality from routine oil and gas activities would be minor because potential adverse effects would be localized and short-term. Additionally, the effects of climate change would be on-going (USDOI, BOEM, 2015a, Section 3.1.9). As a result, ocean acidification and other shifts in the environmental baseline may interact with anticipated effects of the Scenario on water resources (USDOI, BOEM, 2015). Impacts to water quality would be short-term and minimal or less.

4.2.2.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st. The types of discharges into the water column would not differ under Alternative 3 as compared with the Proposed Action. The physical condition of warmer waters of the Alaska Coastal Current and Central Channel Current would displace the ice and the warmer mixed water with a lower salinity would be within about 20 m of the surface. The thermocline and halocline would be present, as well as colder more saline waters near the seafloor.

This alternative could result in the Proposed Action being accomplished in fewer total seasons. Although this could reduce the overall impacts to water quality associated with the project as impacts would accrue over a shorter time frame, this benefit would be balanced by the greater impacts associated with longer seasons. Possible effects on water quality may vary slightly due to the potential of colder, more saline winter water masses in the vicinity of the Burger prospect. Early season residence of these colder waters may continue to exist due to lack of influence from physical forcing factors initiated by ice melt, radiative energy absorbed by open waters, and wind energy. The possibility of differing water masses may alter stratification between bottom and surface waters over the proposed drill sites as a result of this earlier occupation. Potential of higher density water masses may slightly increase water column residence time and change deposition rates of suspended sediments or mixing of effluents from casison or sediments from MLC construction and drilling fluids. If drilling could continue for up to an additional 30 days and the number of drilling seasons required to drill the six wells are reduced, the short-term impact may be greater during one season, but the overall effect would be the same. Therefore, the impacts to water quality would be minor, short-term, localized, and less than severe, consistent with the analysis provided for The Proposed Action in Section 4.2.2.2. Mitigation measures would remain identical to the Proposed Action.

4.2.2.4. Cumulative Effects

Cumulative effects are discussed in detail in the 2015 Second SEIS (USDOI, BOEM, 2015a, Chapter 5) and other past, present, and reasonably foreseeable future actions regardless that may present additive effects when considered in conjunction with this 2015 Shell EP are discussed in Appendix B of this document. The other activities that would have a cumulative impact with the Proposed Action on the water quality include marine vessel traffic, scientific research activities, and oil and gas related activities. The impacts from past, present and reasonably foreseeable actions on water quality are minor. Either action alternative would contribute minor to moderate impacts to water quality in addition to the impacts from past, present and reasonably foreseeable actions, as noted in the 2015 Second SEIS (USDOI, BOEM, 2015a, Table 5-13 and Section 5.2.1.3).

Alternative 3 would not contribute any different incremental impacts to water quality than Alternative 2. The impacts to water quality from Alternative 2 and from reasonably foreseeable activities would amount to no more than a minor incremental contribution to the cumulative effect.

4.2.3. Lower Trophic Levels

4.2.3.1. Alternative 1 – No Action

Under the No Action alternative, the proposed exploration activities would not be approved, and no effects to lower trophic resources would occur.

4.2.3.2. Alternative 2 – The Proposed Action

Alternative 2 is the Proposed Action, wherein Shell intends to drill six exploratory wells on six separate sites within the Burger Prospect in the northeast Chukchi Sea. Up to three wells could be drilled to total depth (and an additional MLC constructed) in a given season, if conditions allow.

Effects on the lower trophic resources could result from the following:

- Sediments displaced during anchoring of all vessels including drilling rigs
- Construction of the MLCs and subsequent release of materials during drilling phases
- Potential construction of accessory MLCs and partial wells beyond the six wells outlined in the proposed exploration plan
- Discharges permitted through the EPA NPDES
- MARPOL regulated discharges
- Potential of invasive species introduction
- Potential liquid hydrocarbon spills during vessel refueling

The effects on lower trophic populations would include the deposition of mercury, barium, and hydrogen sulfide on surface sediments due to sediment disruption, suspension, and deposition, and the perturbation of benthic environments due to ice gouging or advection of sediments from the Alaskan, Anadyr, Bering Sea, or Siberian Coastal currents. There are no known sensitive or unique biological communities within the leases of the proposed exploration drill sites that would be affected by these activities.

Anchoring. Both the *Discoverer* and *Polar Pioneer* and their respective anchor handling vessels would deploy and retrieve eight anchors at each of the six total exploration sites during the proposed exploration period. There is also the potential that either or both drill ships could need to reposition the drill rig and re-anchor during drilling activities at any one exploration site. Anchor configuration and size used during anchoring of both vessels will be similar, both operating with 9-15 metric ton anchors of similar design. Anchor line scars will be different due to a use of unique combinations of wire and chain (Table 4-8) and result in similar displacement of sediment during anchor and cable or chain placement and retrieval. The total sediment volume displaced by the eight anchors used to moor the *Discoverer* during drilling operations, including anchor and chain scar volume during one deployment and retrieval event, is estimated at 150,776 ft^3 (4,529 m^3). Assuming eight deployments and retrievals of anchors--to account for two supplemental events where an MLC is constructed, or an adjustment of the drilling rig over one MLC that demands the anchors be repositioned at the site—the total sediment displaced, suspended, and deposited would be 1,206,208 ft^3 (36,230 m^3). In the case of the *Polar Pioneer*, the volume of displaced sediments during anchor displacement and retrieval would be similar to the volumes calculated for the *Discoverer*. The difference in volume resulting from chain or wire scarring from the two rigs is not enough to accurately measure, and anchor measurements used by the two vessels are identical.

Table 4-8. Anchor and Chain Specifications for the *Discoverer* and *Polar Pioneer*.

Specification	*Discoverer*	*Polar Pioneer*
Anchors	9-15 metric ton Stevshark, 8 each	9-15 metric ton Stevshark, 8 each
Anchor Lines	2.75 in (7 cm) wire rope and 2.5 in (6-cm) chain	3.3 in (8.8 cm) K-4 chain
Anchor Line Length	(8 each) 2,750 ft. (838 m) wire + 1,150 ft. (351 m) chain (useable) per anchor	(8 each) 6,458 to 6,675 ft. (1,969 to 2,035 m) chain per anchor

Note: This table introduces actual equipment installed, and is not an estimate of planned anchor radii at the drilling locations. All of the anchor line lengths listed here are greater than the proposed anchor radii.

A detailed discussion of anchor deployment, retrieval, and resulting discharges can be found in the 2015 Shell EIA, Section 2.3.

The process of anchoring vessels during drilling activities results in disturbed and suspended sediment within the pelagic water column. This sediment drifts with the current and is deposited over benthic environments, thus burying the underlying benthic communities. Recolonization of benthic communities would begin within one year, but growth of benthic organisms such as mollusks or polychaete to size ranges that would be utilized by benthic foragers such as walruses or bearded seals would take several years. However, the limited spatial coverage of these events, estimated to be no more than several hundred yards of coverage per well site (Fluid Dynamix, 2014a) would result in a negligible level of effect. For a more detailed explanation of recolonization of disturbed benthic communities, refer to Section 4.3.4 of the 2015 Second SEIS (USDOI, BOEM, 2015a).

Drilling. A MLC would be constructed at each drill site as preparation for the drilling operations. The MLC is a circular hole drilled into the hard mud under the surface of the benthic environment at the seafloor for containment and protection of equipment needed for drilling and well capping operations. Two methods of drilling MLCs are proposed in this document, one using a dedicated vessel based MLC ROV equipped with bits designed to dig sediments, another using a MLC drill rig based system accomplishing the same objective using different technologies. The MLC ROV would have sloped sides creating a larger volume of material, while the rig-based MLC would have perpendicular sides and less volume of displaced sediment. Displaced sediment volumes would also be dependent upon sediment types, with higher mud percentage in the substrate resulting in increased displaced volume. Both methods would produce diameters of at least 20 ft (6.1 m), with a depth of approximately 40 ft (12.2 m) below mudline. Estimated volume of displaced or disturbed sediment per MLC ROV system is approximately 152,712 ft^3 (27,197 m^3). Estimated volume of displaced or disturbed sediment per rig-based MLC system is approximately 20,781 ft^3 (3,700 $m^{3)}$. The effects of suspension of discharges and sediments from drilling operations would include drilling discharges. The net effect of MLC and drilling discharges would result in a localized loss of some pelagic organisms as a result of their inability to carry out metabolic functions caused by the temporary effects of sediment suspension in the water column. Loss of these organisms would be localized and they would likely be replaced by advection of currents carrying organisms from downstream locations. Sediment displaced during creation of the MLC would result in localized loss of pelagic organisms due to sediment suspension, and burial of benthic organisms as a result of deposition of sediments. Both actions would create a localized and temporary loss of pelagic and benthic communities affected by the suspension and deposition of the displaced sediments, resulting in a negligible level of effect.

Permitted NPDES discharges would include water-based drilling fluids and drill cuttings, deck drainage, sanitary waste, domestic waste, desalination unit waste, blow-out preventer fluids, boiler blowdown, fire control system test water, noncontact cooling water, uncontaminated ballast water, bilge water, excess cement slurry, and muds, cuttings, and cement at the seafloor. These would cause local and temporary effects to surface and pelagic environments and would result in a negligible level of effect.

While BOEM does not regulate transit from Dutch Harbor, it is anticipated that OSV's will make approximately 30 trips back and forth from Dutch Harbor to the Project Area for resupply each drilling season. This will have a negligible level of impact on lower trophic resources due to the lack of disturbance to plankton masses when boats are in transit. Discharges, small fuel spills, and potential of introduction of invasive species are mitigated by NPDES, and USCG regulations, and oil spill plans.

Invasive Species. Several factors may potentially introduce invasive species during the Proposed Action. These include the use of equipment imported from other regions that may contain viable life stages of invertebrate organisms, the presence of fouling organisms on hulls or propellers, and the release of ballast waters not properly discharged in transit. In conducting its proposed exploration activities, Shell would be responsible for preventing the introduction of invasive species through compliance with the National Invasive Species Act and policies of the USCG Ballast Water Management provisions. Therefore, the anticipated level of effect associated with the potential introduction of invasive species is negligible.

Small Fuel Spill. Effects of two small oil spills (<1000 bbl) are estimated for this EA as a potential of 5 bbl or 48 bbl diesel spills. Effects of either on lower trophic resources would be dependent upon sea conditions at the time of the spill. With high wind conditions and rough seas, the diesel would be rapidly diluted and dispersed and effects of the spill would be negligible. In calmer waters evaporation of the diesel would be rapid, and the area covered by dispersion of the remaining hydrocarbons would be dependent upon wind speed, wind direction, and water temperature. Population level losses of benthic organisms due to hydrocarbon poisoning would not occur due to dispersion of hydrocarbons and localized and temporary effects of the small amounts of hydrocarbons at the benthic surface. Effects on pelagic organisms would be localized, and the levels of effect would be negligible.

Summary and Conclusion of Potential Impacts. In summary, all the above effects from Alternative 2-Proposed Action on pelagic, benthic, and epontic lower trophic organisms would be limited by the number of wells actually constructed per open water season. Drilling all six wells within fewer seasons would create displacement, suspension, and deposition of sediments at a higher annual level than any other alternative discussed. It would also increase the accumulations from release of discharges during drilling operations, and from drill and support ship discharges, as described in Section 2 of the Shell EIA. The total effects of these activities would be negligible. This determination is due to the potential of loss of benthic resources being compounded by the time required for resettlement and growth. These benthic lower trophic resources are important to trophic relationships in the region due to their capacity as bioturbators that increase the potential for regional productivity, and their potential as food resources for pelagic birds and marine mammals in the region. If the six-well drilling program extends beyond two or three seasons, the potential for effects on benthic invertebrate populations would decrease due to a reduction of areal coverage of sediment and resulting cumulative effects. Recolonization of benthic habitat would proceed at a faster rate with less areal coverage, and reduction of overall sediment load would allow slightly faster recovery of the benthic surfaces of the leased area if only two wells were drilled in one season, due to slightly lower impacts of cumulative effects. The result would be negligible effects on the lower trophic resources. This would also result in reducing effects on productivity and, in turn, reduce effects on upper level trophic resources such as pelagic bird and marine mammal populations.

4.2.3.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st. Potential effects on Lower Trophic resources include greater disruption of phytoplankton and zooplankton communities in the course of vessel traffic due to the possibility of small diesel fuel spills (5 bbl to 48 bbl), greater potential introduction of invasive species, discharges resulting from normal vessel operations during transit including bilge water releases, sanitation discharges, domestic wastewaters, and treated deck drainage in a given year than would probably occur during the Proposed Action. This increase in level of effects would remain negligible, consistent with the analysis of the Proposed Action. Small fuel spills would likely be dissipated within 48 hours due to evaporation and dissipation of fuel at the water surface. The introduction of invasive species is unlikely due to the normal operations of transit not leading to the range of activities associated with drilling operations, i.e. the vessel would be in transit with few chances of release of viable life stages of biologically active organisms. Ballast water releases would be mitigated under regulations of the National Invasive Species Act and the USCG Ballast Water Management provisions. Discharges from vessel are mitigated under MARPOL regulations regarding vessels underway and in transit, unless the vessels and in state water, in which the Vessel General Permit would apply. Overall, even with a theoretical additional 20 to 30 days of drilling operations, Alternative 3 would have a negligible, short term and localized level of effect on lower trophic resources.

4.2.3.4. Cumulative Effects

Cumulative effects are discussed in detail in the 2015 Second SEIS (USDOI, BOEM, 2015a, Chapter 5) and in Appendix B of this document, and are summarized below.

The cumulative effects on surface and pelagic resources of the lower trophics include climate change and warming of surface temperatures, changes in sea ice resulting in an increase in length of the open water season, potential increases in severe weather activities, and ocean acidification stemming from these changes. Anthropogenic effects include deposition of soot from air emissions, accidental spills of petroleum byproducts from vessel activities, release of effluents from drilling and support vessels, and surface disturbance from the passage of military, research, recreation, subsistence, and industry marine vessels and aircraft. These activities present a potential for adverse effects on trophic resources, but the advection of water masses through the proposed exploration drilling sites would probably prevent population effects on the pelagic lower trophic resources, and would make the cumulative effects negligible, localized, and temporary.

Natural effects specific to the benthic environment include ice gouging and ice melt from glaciers and winter snow cover. These contribute to the seasonal influx of nutrients and sediments to rivers and streams within drainages for waters of the Alaskan, Anadyr, Bering, Chukchi, and Siberian currents. Ultimately, such nutrients and sediments will be deposited over benthic environments. Anthropogenic effects include release of drilling fluids and other permitted discharges, anchor deployment and retrieval, and all subsequent release and deposition of permitted discharges and sediments during drilling activities. Anchoring activities will occur during deployment and retrieval of data collection buoys. Other ancillary activities are benthic sampling including fish trawls, van Veen grabs, vibracore, and cone penetration tests conducted for biological, chemical, and geological analysis. These activities present a potential for adverse environmental effects, but the sand, silt, and mud substrate of the benthic environments would make the cumulative effects negligible, local, and temporary.

The reasonably foreseeable cumulative effects are likely to occur at similar levels each season that Shell conducts exploratory drilling operations. If for any reason (e.g. any variations of the proposed mitigation measures or selection of Alternative 3 – Early Season Start are chosen) Shell concludes work and exits the drilling area earlier than the October 31st exit date, potential effects would be reduced due to the reduced time spent pursuing drilling activities. For the life of the project, the impacts to lower benthic resources from the Proposed Action and from reasonably foreseeable activities amount to a negligible level of effect.

Alternative 3 would not contribute any different incremental impacts to lower trophics than Alternative 2. The impacts to lower trophics from Alternative 2 and from reasonably foreseeable activities would amount to a negligible incremental contribution to the cumulative effect.

4.2.4. Fish

This section analyzes potential effects on fish as a result of Alternative 1 – No Action; Alterative 2 – Proposed Action, and Alternative 3 – Early Season Start. Under each resource category, there is analysis of the potential effects associated with each alternative. Both action alternatives (Alternatives 2 and 3) contemplate Shell's proposal to drill six exploration wells.

4.2.4.1. Alternative 1 – No Action

Under Alternative 1, the proposed drilling program would not be approved, and there would be no direct or indirect effects on fish caused by this action.

4.2.4.2. Alternative 2 – The Proposed Action

The effects under this alternative would result from drilling up to six exploration wells. The types of effects on fish that could occur under this alternative include the following: sound from operations, bottom disturbance and discharge, suspended sediments, permitted discharges, shore based facilities and fuel spills.

Sound from Operations

The Proposed Action would expose fish to sound associated with vessel engines, excavation of mud cellars, drilling, anchoring, ice management, aircraft traffic, and vertical seismic profiling.

Pelagic and epipelagic species that primarily inhabit the water column and the sea surface in the area of drill sites include Arctic cod, salmon, herring, capelin, and Dolly Varden. The recently hatched larval lifestage of sculpins and other fish that are considered bottom dwelling in their adult stages would also be present on the sea surface and in the water column (2015 Second SEIS, Section 3.2.2). Effects of sounds from operations would be experienced by pelagic fish, including most life stages of Arctic cod, salmon, herring, and capelin that inhabit the project area; mature migrating Dolly Varden that may migrate through the project area, and the early larval lifestages of bottom dwelling fish. Effects of sound from operations would be experienced by benthic bottom dwelling sculpins and other fish living on or near the sea bottom including Arctic cod, sculpin, pricklebacks, eelpouts, snailfish, wolfish and alligatorfish.

Sound introduced into the environment through these activities could affect fish through interference with sensory orientation and navigation, decreased feeding efficiency, disorientation, scattering of fish away from a food source, and redistribution of fish schools and shoals (Fay, 2009; Radford et al., 2010; Simpson et al., 2010; Slabbekoorn, et al., 2010; Purser and Radford, 2011). Sound and visual cues from aircraft taking off and landing could also cause startle effects to epipelagic fish at the water surface.

Sedentary, burrowing, territorial, benthic-obligated fish, shallower near-shore fish, fish eggs and fish larvae in the area of the MODU would be exposed to higher noise levels due to their limited swimming behaviors, obligate life history characteristics, behavioral traits, or spatial limitations. Fish in this category in the drilling area include sculpin, pricklebacks, eelpouts, snailfish, wolfish and alligatorfish, and recently hatched larval fish of all species. Foraging and reproduction behaviors of these benthic-obligate fish could be affected negatively by noise from the proposed activities, e.g., if fish are forced away from their preferred habitats, or if reproductive behaviors are persistently interrupted. However, because of the limited swimming behavior of these fish, they are not as likely to move large distances as far or as fast as 1k/hr.

Under Alternative 2 – Proposed Action, if all exploration activities are concentrated within two to three seasons, the level of sound in a given year would be greater and would occur across a larger spatial area. A drilling operation has a single source of sound emanating from a fixed location. In most cases these fish are expected to temporarily (on the order of hours, days or weeks) move away from noise disturbance when possible. Because the noise would be somewhat regular in type and source, it is possible that some fish species may become habituated and may not exhibit behavioral responses to the noise.

Displacement of fish migrating to spawning grounds—most notably herring, capelin and arctic cod—could delay spawning and decrease viability of eggs. Displacement of subsistence species such as Dolly Varden, saffron cod, salmon and whitefish (Table 3-5) could impact subsistence fisheries locally and temporarily, depending on when and where the fish were displaced to.

Within the foodweb, temporary and minor displacement of fish prey would occur (see lower trophics Section 4.2.3 above; USDOI, BOEM, 2015a, Sections 4.3.4, 4.5.5). The effects of sound from operations on the fish predators and fish prey are temporary and negligible in most cases except for occasions where reproductive life cycle is disturbed, possibly causing effects on subsistence species in later year classes.

In summary, effects of sound from vessel and drilling operations on fish, fish prey, and subsistence harvest would be temporary displacement (on the order of hours, days or weeks), localized primarily within the project area, minor, and in most cases not expected to radiate up the food chain.

Bottom Disturbance and Discharge

Excavating mud cellars (MLC), drilling wells, and anchoring drill ships would directly disturb benthic habitat, introduce sediment into the water column, and cause deposition onto down-current benthic habitat. These discharges and disturbances are quantified in the 2015 Shell EP, Tables 2.b-1, 2, b-2, 6.b-1.

Table 4-9. Coverage Areas for Various Depths of Drilling Waste at Each of the Six Drill Sites.

	2 m (79.6 in) deep waste	1 m (39.3 in) deep waste	10 cm (3.9 in) deep waste	1 cm (0.4 in) deep waste
Hectares (acres) covered per site at mean 7 cm/sec current speed (0.16 miles per hour)	0.11 (0.28)	0.12 (0.29)	0.35 (0.86)	1.07
Hectares covered from all six drill sites at mean 7 cm/sec current speed (0.16 miles per hour)	0.7 (1.7)	0.7 (1.8)	2.1 (5.2)	6.4 (15.9)
Hectares covered per site at maximum 25 cm/sec current speed (0.56 miles per hour)	0.4 (1.0)	1.0 (2.4)	2.2 (5.5)	
Hectares covered from all six drill sites at maximum 25 cm/sec current speed (0.56 miles per hour)	2.4 (6.0)	5.8 (14.4)	13.4 (33.2)	

Notes Equivalents used for calculations: 1 centimeter per second = 0.0223 miles per hour; 25cm/sec=0.5587 mi/hr. 1 ft^2 =0.093m^2 1 hectare = 2.4711 acres
Drill Cuttings, Drill Fluids, and Muds Discharge Modeling for Burger J Well
Source: Fluid Dynamix, 2014a; 2015 Shell EIA, pp. 2-16

The total amount of fish benthic habitat on the sea bottom locally and temporarily disturbed due to deposition of sediments is estimated at between 10 mm and 2 meters (0.4 79.6 inches) deep. Benthic habitat temporarily disturbed by anchoring or ROV is estimated at 14.9 hectares (36.9 acres) per well (USDOI, BOEM, 2015a, Table 4-10).

Hydrocarbon concentrations, including polycyclic aromatic hydrocarbons (PAH) and some metals, could become elevated in the lower water column and seafloor sediments from discharge of drill cuttings. BOEM monitoring (Dunton, et al 2012) found no evidence that showed bioaccumulation of hydrocarbons and 17 trace metals in sediments except barium at two previous drilling sites. Therefore, impacts to fish from hydrocarbon concentrations would be negligible.

BOEM studies have documented that barite is elevated beyond background levels for decades at two nearby historical drill sites (Dunton, et al 2012). Surveys around two exploratory oil and gas drilling sites that were occupied in 1989 showed that Barium concentrations were as high as 10,000 *u*g per gram within 200 meters of one drilling site relative to background values of ~700 µg/gram. However, these sites were drilled and deposits were released during a time period when older drilling fluids were used that contained concentrations of chemicals that no longer are used by industry. Barium enrichment was from barite drilling mud additives that were discharged to the seafloor (Trefry et al., 2014). According to the EPA Ocean Discharge Criteria Evaluation (ODCE) for Oil and Gas Geotechnical Surveys and Related Activities NPDES General Permit 5-27 Final – January 2015, the EPA general permit for geotechnical surveys and related activities in federal waters of the Beaufort and Chukchi Seas, concentrations of barium were at background levels for 42 of the 46 stations [in the Beaufort Sea]. However, concentrations from four surface samples collected within ~100 meters of the former Hammerhead drill site, plus samples from sediment cores at two stations at the former drill site contained elevated barium concentrations. It was concluded that the barium enrichment was most likely due to the presence of barite from residual drilling mud and cuttings.

Barite from discharged drilling fluids can have an effect on fish prey but can have an effect on fish prey such as copepods or other small bottom foraging invertebrates (Duesterloh, Jeffrey, and Barron, 2002) but has not been found to exhibit toxicity in fish themselves. For example, in a laboratory experiment conducted on newly hatched capelin (a common foraging fish) and first stage larval snow crabs, exposures to barite at concentrations of up to 1,000 mg/l for up to 24 hrs had no toxic effects (Payne, et. al., 2011). There was also no evidence in the BOEM study that indicated bioaccumulation of these substances above natural concentrations.

Under the Proposed Action, fish would be exposed to excavation and sedimentation effects for two or more open water seasons during which the effects of seafloor disturbance and sediment introduction and transport on fish could occur. Benthic habitat would be covered by excavated materials and drill cuttings temporarily and locally, and the process of recolonization would begin immediately (see the 2015 Second SEIS, Lower Trophic Section 4.3.4). The areas of excavation and sedimentation will be greater if an ROV is used to excavate the mudline cellar excavation than if a traditional drill is used to excavate the mudline). The increase in sediment disturbance will lead to greater downstream deposition of sediment , thus causing a greater impact to the benthic surface through temporary loss of benthic communities. These effects from benthic habitat disturbance would be experienced primarily by bottom dwelling fish, including Arctic cod, sculpin, pricklebacks, eelpouts, snailfish, wolfish and alligatorfish. In most cases these fish are expected to move away from bottom disturbance and deposition areas and take up residence outside the disturbed area. Benthic obligate species that are bound behaviorally not to move from their territories may experience interruption of reproductive behaviors, smothering, smothering of benthic prey, physiological or toxicological effects. The 14.9 hectare (36.9 acre) loss of habitat is considered minor. A small number of fish, including Arctic cod, salmon, herring, and capelin Dolly Varden could be subject to delays or displacement during spawning or migration.

Suspended Sediments

During drilling, fish in both the water column and on the bottom, including Arctic cod, herring, capelin, salmon, sculpin, pricklebacks, eelpouts, snailfish, wolfish and alligatorfish, would be exposed to high suspended sediment and turbidity that could affect visibility (feeding ability), interrupt reproductive behaviors, and smother the eggs and fish themselves if they are not able to move from the area. The newly deposited cuttings on the seafloor could resuspend into the water column via currents or severe storm events and have continuing effects.

Table 4-10. Total Suspended Solids Concentration from the Discharge Source.

	1 m from discharge	10 m from discharge	100 m from discharge	300 m from discharge
At mean 7 cm/sec current speed			6.1-368.7 mg/l	1.3-109.7 mg/l
Total Suspended Solids, mg/l in mg/l units at mean 25 cm/sec current speed			11.7 0 287.8 mg/l	3.8-97.7 mg/l
Total Suspended Solids in mg/l units interval 1 only if excavation of mudline cellar by ROV		3398.2 mg/l		

Note: BOEM calculated average surface current speeds from Aug to Oct, 2009-2011 as 18.28 cm/sec.
Drill Cuttings, Drill Fluids, and Muds Discharge Modeling for Burger J Well Drilled by a Subsea ROV and the Drill Ship Nobel Discoverer Located Offshore Chukchi Sea, Alaska.

Source: Fluid Dynamix, 2014a.

According to the EPA ODCE for Oil and Gas Geotechnical Surveys and Related Activities NPDES General Permit 5-27 Final – January 2015, the EPA general permit for geotechnical surveys and related activities in federal waters of the Beaufort and Chukchi Seas “includes production and drilling platforms, ice islands, anchor structures for floating exploration drilling vessels, and potential buried pipeline corridors. Under relatively calm conditions, turbidity levels are likely to be less than 3 Nephelometric Turbidity Units (NTU) and may be in excess of 80 NTU during high wind conditions. (EPA, 2015).

Effects of high suspended sediment and turbidity from excavation and drilling of the mudline cellar, conductor (level 2 in Table 4-10 above) and surface casing (level 3) will result in discharges released directly into the water 8 feet above the sea floor (Shell, 2015a). Discharges from drilling of the lower sections to the full well depth will be released directly to the surface water layer at about 22 feet (6.7 meters) below the surface. Resuspension or deposition processes tend to occur near the seafloor with some particles gradually being redeposited. Studies have shown that bioaccumulation of barium and chromium can occur in benthic organisms but pollutant accumulation ceases once organisms are removed from the contamination source (Trefry et al., 2014).

The Proposed Action discharges could reduce fish visibility and feeding ability. The effect would be experienced by pelagic fish, including most life stages of the pelagic fish Arctic cod, salmon, herring, capelin that inhabit the project area, mature migrating Dolly Varden that may migrate through the project area. Early larval lifestages of sculpins and other fish that are considered bottom dwelling in their adult stages would also be present in the water column (USDOI, BOEM, 2015a, Section 3.2.2; Thorsteinson and Love, 2015) and experience high suspended sediment and turbidity. Effects of suspended sediment caused by the bottom disturbance and deposition from operations would be experienced by sculpins and other fish living on or near the sea bottom including Arctic cod, sculpin, pricklebacks, eelpouts, snailfish, wolfish and alligatorfish. In most cases these fish are expected to temporarily move away from high levels of suspended solids and turbidity. Water based drilling fluids and cuttings discharged to the ocean are typically diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold after a transport time of about 10 minutes at a distance of about 100 m (328 ft) from the drilling unit (Neff, 2005; Neff, 2010). Based on laboratory research of fish swimming ability (Videler and Wardle, 1991; Hemelrijk, et al., 2014) average size.15 m (6 inch) sculpin and other benthic fish inhabiting the bottom could theoretically swim 176 meters away in 7 minutes. The post-hatching larval stages and smaller adults and juveniles would not be likely to be able to move away from the suspended solids and turbidity and would be subject to higher sub-lethal injury or mortality effects. Given the medium resiliency of most of these fish species, (Chapter 3 of this EA) the effects on fish populations within the drilling area would not be expected to last longer than 4.4 years. Recovery could take up to fourteen years for impacts to the low resiliency fish such as Bering flounder.

Displacement of fish migrating to spawning grounds most notably herring, capelin and arctic cod could delay spawning and decrease viability of eggs. Of greater concern but still in the category of minor, is the effect on spawning aggregations, migrations and harvest of subsistence fish. Larval and juvenile fish in both the water column and on the bottom could suffer mortality. Displacement of subsistence species such as Dolly Varden, saffron cod, salmon and whitefish could decrease or increase success of subsistence fisheries locally and temporarily, depending on where and when they experience the high suspended sediment loads and turbidity.

Temporary and minor displacement of fish prey would occur. The effects on the fish, subsistence users of these fish, the fish predators and the fish prey are all temporary and minor or negligible in most cases but possibly where reproductive life cycle is disturbed, causing effects in later year classes. In summary, effects of suspended sediment and turbidity from operations on fish, fish prey (Section 4.2.3), and habitat would be localized, temporary and minor in most cases and not expected to radiate up the food chain. Effects are not expected to noticeably radiate within the foodweb other than minor and temporary displacement of fish prey and fish that function as the prey base to human subsistence users, marine mammals, birds and other fish. Effects on subsistence harvest could temporarily increase or decrease depending on whether subsistence species might be displaced closer to or more distant from subsistence harvest seasons and areas near the coast.

Permitted Discharges

Cooling Water

The highest volume is used to evaluate potential impacts; accordingly, approximately 107,314 bbl of cooling water at 4.2-16.1 ^{o} C (approximately 8 to 32 ^{o}F) per day would be discharged from the MODU at up to 12.1 ^{o} C (25 ^{o} F) above ambient sea temperature during drilling. Fluid Dynamix (2014b) indicates project area surface temperature of 4 ^{o} C and bottom depths (43.9-45.7 meters) temperatures of -0.5 ^{o} c July-October. The effect would dissipate within 164 horizontal feet. Desalination brine would be discharged with slightly higher salinity and other dissolved constituents than the ambient receiving water. Treated sanitary waste would introduce organic materials and could cause temporary localized biological oxygen demand and increased suspended solids, however the Chukchi exploration NPDES general permit establishes effluent limits of 30/60 mg/l average monthly and max daily limits for BOD and TSS.

Fish in the area of drilling would be exposed in each drilling season to discharge of cooling water, desalination brine, domestic wastewater, treated sanitary wastewater, and drilling fluids. Based on past experience there may be hydrogen sulfide released and discharged to the sea floor when drilling through old cement plugs (Shell, 2015a). Wastewater, including hydrogen sulfide would be discharged at 22 feet below the sea surface, above the temperature-salinity gradient, where it would mix with the surface waters. Dispersion rates of these discharges would likely not affect fish life stages beyond egg and larval development. Effects would be negligible.

According to estimates in the discharge reports forwarded with the Shell Exploration Permit Application (Fluid Dynamix, 2014b, appendices B-G), during drilling, the Discoverer (one of the two drill ships slated to operate under the exploration permit) would discharge a maximum of approximately 107,314.29 barrels per day (bbls/day) of noncontact cooling water from six point discharge sources: engine room, motor control center (MCC) room, generator room (diesel generator I), generator room (diesel generator II), silicon controlled rectifier (SCR) room, and main deck. The volumes of the noncontact cooling water discharges from the six point sources are approximately: 34,285.71, 17,142.86, 17,485.71, 17,485.71, 20,571.43, and 342.86 bbls/day, respectively for a total noncontact cooling water discharge of 107,314.29 bbls/day affecting a maximum area of 1.34 hectares.

Most Pelagic fish, such as Arctic cod, pink salmon, chum salmon, herring, capelin and larvae of Pelagic fish near the point of discharge for these wastes would likely move away from the higher temperature discharges. Fish eggs and larval stages of fish would be unable to leave the immediate area of discharge and would experience minor effects.

Displacement is not expected to noticeably affect pelagic fish other than minor and temporary displacement of fish within 50 meters of the hot non-contact cooling water discharges as a prey base to human subsistence users (Section 3.2.9 of this EA) marine mammals, birds, and other fish. Temporary and minor displacement of fish prey would affect the fish only temporarily. The effects on the fish, subsistence users of these fish, the fish predators and the fish prey are all temporary and minor or negligible.

Other waste water

Fish inhabiting the bottom that could be affected by hydrogen sulfide released and discharged to the sea floor when a well is reopened include Arctic cod, sculpin, pricklebacks, eelpouts, snailfish, wolfish and alligatorfish.

In summary, under Alternative 2 – Proposed Action, the effects of wastewater discharges on fish could all occur over several seasons.

While BOEM does not regulate transit from Dutch Harbor, it is anticipated that OSV's will make approximately 30 trips back and forth from Dutch Harbor to the Project Area for resupply each drilling season. This will have a negligible impact on fish resources due to the fact noise and permitted discharges from vessels in transit are generally considered localized and temporary.

Both benthic and pelagic fish of most species and life stages near the drill sites would be affected by these discharges during each drilling season. In summary, effects of permitted discharges from operations on fish, fish prey fish, and habitat would be localized, temporary and range from negligible to minor.

Small Fuel Spill

There is a potential for small fuel spills (<1,000 bbl) during fuel transfers between vessels. Section 2.4.8 estimates two potential spills 48 bbl (2,016 gallons) and 5 bbl (210 gallons) of diesel fuel for the Proposed Action. A fuel spill of this size and type would introduce hydrocarbon toxicity effects to the surface water. Pelagic fish adults, juveniles, eggs, and the recently hatched larvae (including the larvae of most benthic fish species) would be exposed.

A small fuel spill in the drilling locations

Effects of a small fuel spill in the vicinity of the drilling operation would be experienced by pelagic fish, including most life stages Arctic cod, salmon, herring, capelin and the early larval lifestages of sculpins, sculpin, pricklebacks, eelpouts, snailfish, wolfish and alligatorfish that inhabit the water column in the project area,. The subsistence species Dolly Varden (Seitz, Courtney, and Scanlon, 2014) and pink and chum salmon (Moss et al., 2009) migrating through burger could also be affected by a fuel spill at or near the MODU. In most cases these fish are expected to temporarily move away from the fuel spill.

Effects of a small fuel spill from operations are unlikely to be experienced by fish living on or near the sea bottom including Arctic cod, sculpin, pricklebacks, eelpouts, snailfish, wolfish and alligatorfish.

Anadromous subsistence fish (Table 3-5) at the surface, including pink and chum salmon (Moss et al., 2009), Dolly Varden (Seitz, Courtney, and Scanlon, 2014), saffron cod (Mueter, 2015), and whitefish, might be tainted with the fuel and thus subsistence users might avoid their normal subsistence harvest activities and consumption. Effects could be longer if their reproductive life cycle was disturbed, causing effects in later year classes.

Of greater but still minor concern is the effect on spawning aggregation migrations and harvest of subsistence fish. Displacement of subsistence species such as Dolly Varden, saffron cod, salmon and whitefish (Table 3-5) could decrease or increase success of subsistence fisheries locally and temporarily. Dolly Varden and salmon are both documented in the Chukchi Lease Area (Seitz, Courtney, and Scanlon, 2014; Moss et al., 2009).

The effects on the fish, the fish predators and the fish prey are all temporary and minor or negligible in most cases but possibly where reproductive life cycle is disturbed, causing effects in later year classes.

Generally, fuel spills could cause minor mortalities and localized to fish inhabiting the immediate area. Of greater concern however, are aggregations of spawners, especially Arctic cod spawning aggregations under the ice or near the coast, coastal spawners such as capelin, herring and sand lance or anadromous spawning runs migrating to freshwater could be subjected to a one-time oilspill event. Because spill can be trapped near the coastline or under ice,

In summary, effects of small fuel spills from operations on fish, fish prey, and habitat would be localized, temporary and minor in most cases and not expected to radiate up the food chain.

Summary of Effects of Alternative 2 – Proposed Action

In summary, activities under an exploration permit to drill six exploration wells approximately 60 miles off the coast of the U.S. Chukchi Sea and that could affect fish include sound from operations, bottom disturbance and discharge, suspended sediments, permitted discharges, shore based facilities and fuel spills.

The primary fish that inhabit the pelagic water column and sea surface Arctic cod, salmon, herring, capelin, and Dolly Varden and the recently hatched larval lifestage of fish that inhabit the benthic sea floor as adults including sculpin, pricklebacks, eelpouts, snailfish, wolfish and alligatorfish. The primary species that form spawning, migrating aggregations include herring, capelin and arctic cod. The primary subsistence species harvested are Dolly Varden, saffron cod, flounder, salmon and whitefish.

These analyses find that most activities including sound from operations, discharge, suspended sediments, permitted discharges, shore based facilities and small fuel spills would be temporary (hours, days, weeks), and localized displacement resulting in minor effects. Displacement of fish migrating to spawning grounds most could delay spawning and decrease viability of eggs. Mortalities and sublethal injuries from exploration activities could be expected on a limited number of small, juvenile or recently hatched larval fish.

A longer term but still localized and minor effect is destruction of 14.9 hectares (36.9 acres) of benthic fish habitat disturbed or covered by 10 mm to 2 meters (0.4 to 79.6 inches) of debris which could last on the order of years or decades. The areas of excavation and sedimentation will be greater if an ROV is used to excavate the initial level 1 mudline cellar excavation than if a traditional drill is used to excavate the mudline cellar (where the Blow Out Preventer (BOP) is installed below the surface).

Within the foodweb, loss of fish prey are also expected to be temporary (hours, days, weeks), and localized. Direct effects on fish radiating up the food chain to fish predators including subsistence users, whales, seals, birds and other fish and is expected to be negligible.

4.2.4.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors occurring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st.

Effects on fish resources from early start of drilling seasons would be similar to those in Section 4.2.4.2 of this document. These effects may include local disruption of salmon migrations to spawning grounds and disruption of life cycles, small fuel spills, and potential introduction of invasive species. These disruptions would include a localized loss of eggs and larval fish of species that exhibit early season development as a result of breeding under the ice in winter, such as Arctic cod. These effects would be caused by suspension and subsequent deposition of sediment from MLC construction, drilling fluids, muds, and cuttings release and deposition, small fuel spills, potential introduction of invasive species, and release of effluents including bilge water releases, sanitation discharges, domestic wastewaters, and treated deck drainage. Effects on fish developmental stages of could also be caused by deposition of trace metals and bioaccumulation in the environment from trace metals released from synthetic drilling muds and drill cuttings.

Mitigation actions would include adherence to the following provisions. Small fuel spills would likely be dissipated within 48 hours due to evaporation and dissipation of fuel at the water surface. The introduction of invasive species is unlikely due to ballast water releases being mitigated under regulations of the National Invasive Species Act and the USCG Ballast Water Management provisions. The GP requires that an environmental monitoring program will be in place to monitor potential effects of drill mud and cuttings releases. Sediment sampling and analysis will be conducted before, during, and after drilling activities to ensure compliance with composition of drilling muds and composition of drill cuttings releases in regard to trace metals that may lead to bioaccumulation in the environment (EPA, 2012a).

This alternative could result in the Proposed Action being accomplished in fewer total seasons. Although this could reduce the overall impacts to fish resources associated with the project because impacts would accrue over a shorter time frame, this benefit would be offset by the impacts associated with longer seasons. Regardless, Alternative 3 would have a minor level of effect on fish resources.

4.2.4.4. Cumulative Effects

Cumulative effects are discussed in detail in the 2015 Second SEIS (USDOI, BOEM, 2015a, Section 5.2.4) and in Appendix B of this document. The number of marine cargo, tourism and research vessels and barges in the Chukchi region is increasing as ice cover is reduced. This increases the risk of vessel accidents, vessel groundings, potential oil and cargo spills, permitted discharges, and introduction of marine invasive species. Commercial fishing is prohibited in the U.S. Arctic (NPFMC, 2009) and would not have an effect in the near future. Subsistence fishing that occurs in coastal villages is likely to continue at a similar level. These ongoing effects would be the background in which Shell's proposed exploration activities would occur.

Climate change is having an effect on the Arctic environment now and is anticipated to have major effects in the future, including warming sea surface, reduction in sea ice and increased ocean water acidity. These factors are and will continue to affect fish and fish habitat in a substantive way in the Chukchi Sea. The effects of climate change are expected to be greater than the effects of offshore oil and gas development in the Chukchi Sea (USDOI, BOEM, 2015a, Chapter 5, Section 5.2.4) including the Alternative 2 – Proposed Action or Alternative 3 – Early Season Start.

Under Alternative 2 – Proposed Action, the effects of the proposed exploration drilling would add a negligible to minor effect to the other ongoing activities described here. These effects would be additive and primarily related to benthic habitat alternation, noise disturbance to fish and water quality effects on fish and fish habitat. In summary, effects of Shell's proposed operations on fish, fish prey, and habitat would be localized, temporary and minor in most cases. The radiation of these effects up the foodweb to fish predators and subsistence users is expected to be negligible.

Alternative 3 would not contribute any different incremental impacts to fish than Alternative 2. The impacts to fish from Alternative 2 and from reasonably foreseeable activities would amount to no more than a negligible to minor incremental contribution to the cumulative effect.

4.2.5. Birds

Section 3.2.5 describes the status of birds in the Proposed Action area. Recent site-specific information is consistent with previous descriptions, and existing information is sufficient to fully evaluate the potential effects of the Proposed Action. Additional species of birds that do not occur in the Proposed Action area may occur in the Bering Sea when project-associated vessels are transiting; however, none of these species are expected to experience effects, or greater than negligible effects, from the relatively few (30 or fewer; see Table 13.a-3 of Shell EP) and brief transits, and therefore are not included in the following analysis.

Several impact-producing factors associated with oil and gas exploration have been identified and are described in detail in Section 4.3.6.1 of the 2015 Second SEIS (USDOI, BOEM, 2015a) and Biological Opinion (USFWS BO) (USFWS, 2015). Many of these IPFs are expected to have no or negligible effect on birds. The vertical seismic profiling component of the Proposed Action would occur in a localized area and be of short duration, and no adverse effects to birds from this activity are anticipated.

Similarly, drilling noise would radiate from the site during active operation, but birds are not expected to approach the activity in ways that could harm them. Any displacement effects are anticipated to be extremely small, less so than those effects caused by the presence of the drilling structure. Onshore construction activities will stay within the existing developed footprint of the Barrow vicinity and use an existing gravel source: no habitat loss will be incurred, and impacts of disturbance to breeding eiders or their nesting habitat will be insignificant. No new tall structures or power lines are planned, so land-based collision risk will be insignificant.

The most important impact-producing factors associated with the Proposed Action are:

- **Vessel presence and noise:** Some marine and coastal birds avoid close contact with vessels and can be temporarily displaced from localized areas when vessels transit through coastal and pelagic areas.
- **Aircraft presence and noise:** Some marine and coastal birds can be disturbed and/or temporarily displaced from localized areas when aircraft transit through coastal and pelagic areas. Low-level flights are more likely to affect species that are sensitive to noise and vessel presence or are in a particular area because they are molting, brood-rearing, or resting. Fewer disturbance events would result in less effect than frequent or repeated disturbance events.
- **Avian Collisions:** Some birds, for example eiders, shearwaters, and auklets, may be more prone to collisions with structures and vessels than others because of their typical flight pattern or attraction to artificial light. Bird species that fly low over water have a greater potential to collide with offshore structures and ships, especially under conditions of poor visibility such as fog, precipitation, and darkness, and these can be injured or killed. Birds have only a restricted range of flight speeds that can be used to adjust their rate of gain of visual information as their environment changes (Martin, 2011).

- Some birds can also be attracted to and can become disoriented by lights from vessels, which can impede migration and increase the risk of collisions and result in injury or death. Studies in the North Sea indicated that different colored lights cause different responses (Poot et al., 2008). White lights caused attraction, red caused disorientation, and green and blue caused a weak response. White lights were replaced with lights that appeared green, and this resulted in 2 to 10 times fewer birds circling the offshore platforms.
- **Small Fuel Spills:** Small fuel spills can occur during vessel operations, such as fuel transfers. As explained in greater detail in Section 4.3.6.1 of the 2015 Second SEIS (USDOI, BOEM, 2015a), spilled hydrocarbons can adversely affect marine and coastal birds because these species spend so much time on the water surface and are highly susceptible to mortality if contacted. BOEM assumes that any bird contacted by hydrocarbons would die.

Effects resulting from impact-producing factors are often similar among all bird groups described in Section 3.2.5. Therefore effects are discussed generally below, with species-specific differences identified.

4.2.5.1. Alternative 1 – No Action

Under Alternative 1, the proposed exploration activities would not be approved, and there would be no disturbance to any resources attributable to the proposed exploration drilling activities. There would be no effects to birds.

4.2.5.2. Alternative 2 – The Proposed Action

Alternative 2 includes vessel and aircraft activities that could affect birds in the Chukchi Sea. Several species of birds could be subject to collisions with vessels and offshore structures. Also, up to two small spills (estimated at up to 48 bbl of diesel fuel) are anticipated to occur during the project period. This alternative would have no more than a minor level of effect on birds.

Threatened and Endangered Birds

Two species of birds that occur in the Proposed Action area are listed as threatened under the Endangered Species Act (ESA; 16 U.S.C. § 1531 et seq.): spectacled eider (*Somateria fischeri*) and the Alaska breeding population of Steller's eiders (*Polysticta stelleri*). ESA-designated critical habitat located within the Proposed Action area is the Ledyard Bay Critical Habitat Unit (LBCHU), so designated for molting spectacled eider. The short-tailed albatross (*Phoebastria albatrus*), which is listed as endangered under the ESA, ranges only as far as the Bering Sea. This species is not anticipated to be affected by vessel transit, which is not known to pose disturbance or collision hazards for albatross when not associated with fishing, and, at 30 trips, is relatively minimal and will not pose additional fuel contamination risks.

Vessel Presence and Noise. Routine vessel support associated with the drilling operation is mitigated by these vessels using the shortest route between shorebases and offshore drilling facility (see Figure 2-3). Lease Stipulation 7 contains seasonal restrictions that will serve to limit vessels supporting Shell's drilling operations from transit into the LBCHU during the sensitive molt period when birds are unable to fly. Routine vessel traffic has limited potential to disturb non-molting (i.e., flight-capable) birds and could temporarily move them a short distance to another location. Some marine and coastal birds have the potential to habituate to regular vessel traffic (Schwemmer et al., 2011). These small effects from the Proposed Action are not anticipated to persist from one year to another.

Aircraft presence and noise. Routine aircraft support associated with the drilling operation is mitigated by flight restrictions in Lease Stipulation 7 that minimize disturbance while providing for aircraft safety. Aircraft would typically fly at >1,500 altitude along the shortest route between the shorebases and offshore drilling facility (see Figure 2-4).

Avian Collisions. Spectacled and Steller's eiders, like other seaducks using the area, are at increased risk of striking vessels and structures because they fly low and fast over the ocean and may not be able to react in time to avoid them (USFWS, 2013c; Johnson and Richardson, 1982). A study on the effects of anti-collision strobe lighting systems on Northstar Island for eiders and other birds in the Beaufort Sea indicated a significant slowing of eider flight speeds at night and movement away from the island when strobe lights (40 flashes per minute) were used. Effectiveness was inconsistent and unclear, however, because "non-eider" species did not appear to avoid the island, and also may have been attracted by the lights in some cases (Day et al., 2003; Day, Prichard, and Rose, 2005). Shell is also required under Stipulation 7 of its lease to make efforts to reduce light radiating from exploration vessels and structures.

To date, no ESA-listed eiders have been reported to collide with exploration vessels or structures. Lighting mitigation measures cannot be assumed to be totally effective, however, and there is still the potential for some bird collision mortality. To address the potential for spectacled and Steller's eiders to collide with structures in the Chukchi Sea, BOEM developed a collision rate in the 2015 Second SEIS (see Section 4.3.6.1). Although limited, the best data available for estimating collision risk to listed eiders for oil and gas activities in the Chukchi Sea is "bird encounter" (i.e., birds found on ships, alive or dead) data that was recorded by vessels participating in the 2012 Shell EP Revision 1 partial drilling season in the Chukchi, including Bering Sea transits. These estimates cover all vessel trips, including the up to 30 resupply transits from Dutch Harbor-which BOEM considered in this analysis although it does not regulate these trips. One hundred thirty one bird:vessel encounters were reported (USDOI, BOEM unpublished data 2014). As explained further in Section 4.3.6.1 of the 2015 Second SEIS, these 131 vessel encounters, when extrapolated for a full season of 180 days yield annual rates of 53 encounters per drill ship and 11 encounters per other ("support") vessel. With 2 drill ships and 28 (tug and barge units are counted as two separate support vessels) support vessels total planned for the 2015 Shell EP operations, a rough annual encounter rate of 414 birds is expected. All bird:vessel encounters are assumed to be fatal collisions for purposes of analysis. As for seaduck species, they accounted for 27% of the original 131 total. No listed eiders were among those reported. Twenty-seven percent of 414 yields an annual mortality estimate of 121 seaducks. This is a rough estimate only, as it depends on less than one year's data and several assumptions (e.g., all vessels operating equally and affecting encounter rates independently; transit rate is less important than vessel number; season length is maximized at 180 days; all encounters detected and recorded, etc.), but it is based on the best available data. Listed eiders would be a smaller subset of this seaduck total.

Furthermore, while it is true that there is a bird group, albatrosses, that occurs in the Bering Sea that does not range in to the Chukchi Sea action area and includes 3 species of albatross (black-footed, Laysan, and short-tailed, the latter being listed as endangered throughout its range under the ESA), none of them would be likely to be affected by 2015 Shell EP project actions. Vessel/aircraft disturbance, fuel contamination, and vessel strikes would be expected to have no to the most negligible of impacts, as there is no evidence that vessel/aircraft disturbance or vessel strikes on boats that are not fishing impact these species, and the fuel contamination risk for the Bering Sea transit mentioned is extremely minimal since no spills from collisions are anticipated.

Using these same Shell data, the USFWS BO (USFWS, 2015, Section 5.2.2.5) calculated approximate collision losses of seven spectacled eiders and one or fewer Steller's eider per 5-year drilling program in the Chukchi Sea leased area, and issued an incidental take statement for these numbers. The USFWS BO further states that the USFWS anticipates the likelihood of listed eider collisions with vessels and drilling units during the five years for which they analyzed to be low because 1) eider density in the Chukchi Sea lease area is low; 2) the number of vessels is low relative to the size of the Proposed Action area; 3) activities are not permitted within the LBCHU when the highest concentrations of listed eiders would be present; and 4) mitigation measures for vessel lighting may reduce the potential for attracting or disorienting eiders in flight.

The numbers of spectacled and Steller's eiders potentially lost to collisions as a result of the actions of the 2015 Shell EP is expected to be less than the estimates in the USFWS BO incidental take statement because the 2015 Shell EP Proposed Action area is smaller than the LS 193 action area, the number of support vessels is lower (28 versus 31). For this analysis of bird strikes, it is assumed that the number of years of operation is only two, rather than five. This relatively low mortality rate would not impact any one species to a population-level effect. BOEM typically passes on requirements (e.g., terms and conditions, reasonable and prudent measures) in the BOs to the operator through conditions of approval on the plans.

Small Fuel Spills. Section 2.4.9 describes spill prevention and response. While there is some potential for a fuel spill during the proposed operations (Section 2.4.8), few threatened or endangered birds are anticipated to occur in the Proposed Action area and few could be exposed to an accidental spill. Many offshore birds would likely avoid spill response activities. The most likely outcome is an accidental small spill that is immediately contained and would have a negligible level of effect on threatened and endangered birds. The effects evaluated could occur each season that Shell conducts exploratory drilling operations under this exploration plan. Consecutive years of activity would not have an additive effect.

If a small accidental spill—potential discharge estimated at 48 bbl or 5 bbl for this EA—were to escape containment or response measures, it would not persist very long (≤3 days), resulting in few opportunities to contact many threatened and endangered birds. Spill response measures include immediate attention to the LBCHU, the boundary of which is located about halfway between the drilling sites and shore. Spectacled eiders and other (flightless) molting birds in the LBCHU would be most vulnerable after mid-July. The vessel activity associated with spill response could have limited success in keeping molting seaducks away from a spill because the birds are flightless. Furthermore, later in the open-water season, new migrants could arrive in a spill area on a regular basis, making hazing more difficult. Limited mortality from a small spill would be considered a minor level of effect.

Cliff-Nesting Seabirds

This group of birds includes murres (*Uria* spp.), puffins (*Fratercula* spp.), and black-legged kittiwakes (*Rissa tridactyla*). Black-legged kittiwakes have been recorded in high numbers for the pelagic waters of the Chukchi Sea overall (Divoky, 1987), but neither they nor other cliff-nesting seabirds are known to occur in high densities within the Proposed Action area. Vessel and aircraft traffic are not anticipated to result in more than a negligible level of disturbance to cliff-nesting seabirds because they typically occur at low density in the area of exploration activity, and sensitive life stages are not subject to other than occasional vessel passage or aircraft overflight. No murres, puffins, or kittiwakes were among the 131 bird:vessel encounters recorded in 2012, and few collisions by these species are anticipated.

As noted above under Threatened and Endangered Birds, bird strike monitoring and reporting will be a condition of BOEM approval of the EP. In the event of unanticipated mortality levels, Shell and BOEM would work together to develop additional mitigation measures. Any adverse effects from a small spill would not be greater than those described for threatened or endangered birds. Mitigation measures intended to avoid or minimize adverse effects to threatened eiders also afford protection to cliff-nesting seabirds.

Bering Sea Breeders and Summer Residents

This group includes Kittlitz's murrelet (*Brachyramphus breverostris*), northern fulmar (*Fulmarus glacialis*), short-tailed shearwater (*Ardenna* (formerly *Puffinus*) *tenuirostris*), storm-petrels (*Oceanodroma* spp.), and auklets (*Aethia* spp.). Lighting attraction and disorientation appear to be significantly responsible for seabird members of this group colliding with vessels and structures. For example, Dick and Donaldson (1978) reported collisions by crested auklets (*Aethia cristatella*) so numerous as to threaten to capsize an 86-ft long vessel when the vessel was using high-intensity lighting. Additional reports included in Dick and Donaldson (1978), Black (2005), and deMarban and Medred (2006) describe other similar occurrences by pelagic species such as shearwaters, storm-petrels and whiskered auklets (*Aethia pygmaea*). Because several species of pelagic seabirds can occur in dense flocks in the Chukchi Sea and have the potential to be in the vicinity of or move past drilling structures and vessels engaged in exploration activities, it is likely that some birds will accidentally collide with exploration vessels and other structures and be injured or killed. Twenty-seven of the 131 bird:vessel encounters recorded in 2012, or 21%, appeared to be storm-petrels or auklet species that breed or summer in the Bering Sea. Following the analysis discussed above for threatened and endangered birds, 21% of an estimated 414 bird strikes yields a rough annual mortality estimate of 87 Bering Sea breeders and summer resident seabirds. As noted above under Threatened and Endangered Birds, bird strike monitoring and reporting will be a condition of BOEM approval of the EP which will allow BOEM the opportunity to work with Shell on further mitigation measures in the event of unanticipated mortality levels. Lighting protocols of Stipulation 7 of the lease sale are expected to reduce risk of avian light attraction. Based on the Poot et al. (2008) results discussed in Section 4.2.5, above, a further mitigation measure could be the replacement of white lights on one drilling unit with green-spectrum lights, accompanied with monitoring and comparison of attraction/collision results for both drilling units in order to facilitate adaptive management. Given that the pelagic seabird populations (especially shearwaters and auklets) in the Chukchi Sea are robust and number in the tens of thousands, an estimate of collision mortality of fewer than 100 individuals of any one species during the entire drilling program would not be considered more than a minor level of effect.

Vessel and aircraft traffic are not anticipated to result in more than a negligible level of disturbance to Bering Sea breeders and summer residents because they are not subject to other than occasional vessel passage or aircraft overflight. Adverse effects from a small spill would not be greater than those described for threatened or endangered birds. Mitigation measures intended to avoid or minimize adverse effects to threatened eiders also afford protection to Bering Sea breeders and summer residents.

High Arctic-Associated Seabirds

Vessel and aircraft traffic are not anticipated to result in more than a negligible level of disturbance to high Arctic-associated seabirds because they typically occur at low density in the area of exploration activity and are not subject to other than occasional vessel passage or aircraft overflight. Of all members of this group, one arctic tern (*Sterna paradisaea*) was identified among the 131 bird:vessel encounters recorded in 2012. Very low numbers of collisions by this species group are anticipated. Adverse effects from a small spill would not be greater than those described for threatened or endangered birds. Mitigation measures intended to avoid or minimize adverse effects to threatened eiders also afford protection to high Arctic-associated seabirds in those areas. As noted above under Threatened and Endangered Birds, bird strike monitoring and reporting will be a condition of BOEM approval of the EP which will allow BOEM the opportunity to work with Shell on further mitigation measures in the event of unanticipated mortality levels.

Tundra-Breeding Migrants

This group includes jaegers (*Stercorarius spp.),* glaucous gull (*Larus hyperboreus*), and various species of passerines. Vessel and aircraft traffic are not anticipated to result in more than a negligible level of disturbance to tundra-breeding migrants because they typically occur at low density in the area of exploration activity and are not subject to other than occasional vessel passage or aircraft overflight. Any high density flocks of passerines in the area would be migrating across in flight only, primarily at night, and therefore unlikely to be subject to disturbances. Fifty-three passerines of at least eight species were identified among the 131 bird:vessel encounters recorded in 2012; no jaegars or gulls were identified. Following the analysis discussed above, 44% of an estimated 414 bird strikes yields a rough annual mortality estimate of 182 passerines. Passerines are believed to be most at risk, particularly from attraction to vessel lights, during nocturnal migrations or migrations in times of poor visibility. As noted above under Threatened and Endangered Birds, bird strike monitoring and reporting will be a condition of BOEM approval of the EP, facilitating possible adaptive management in the event of unanticipated mortality levels. As discussed above for Bering Sea Breeders and Summer Residents, Stipulation 7 lighting protocols are expected to reduce avian light attraction risk, and further mitigation for this risk may be accomplished with replacement of white lights with green lights. Replacement can occur on one drilling unit, and the monitoring of avian attractions/collisions can be compared between the two units to facilitate adaptive management. The activities associated with the 2015 Shell EP are anticipated to be localized and short-term, however, and a rough estimate of collision mortality of fewer than 100 individuals of any one species during the entire drilling program would not be considered more than a minor level of effect. Adverse effects from a small spill would not be greater than those described for threatened or endangered birds, and would be even less so for passerines which do not use the aquatic environment. Mitigation measures intended to avoid or minimize adverse effects to threatened eiders also afford protection to tundra-breeding migrants in those areas.

Waterfowl and Loons

A variety of species are included in this group, including, but not limited to, king and common eiders. Vessel traffic is not anticipated to result in more than a negligible level of disturbance to waterfowl and loons because they typically occur at low density in the area of exploration activity and are not subject to other than occasional vessel passage. Adverse effects from a small spill would not be greater than those described for threatened or endangered birds.

As with threatened eiders, similar waterfowl species (i.e., common and king eiders) are prone to collide with offshore vessels and structures. The episodic nature of these events suggests that several birds in a flock could be killed at one time during any one year. Thirty-five waterfowl of 3 species (long-tailed ducks, king eiders, and common eiders) were identified among the 131 bird:vessel encounters recorded in 2012. Eleven of the 35 were king eiders found alive on one ship on one morning in October. No loons were among the 35. Following the analysis discussed above, 27% of an estimated 414 bird strikes yields a rough annual mortality estimate of 112 seaducks. As noted above under Threatened and Endangered Birds, bird strike monitoring and reporting will be a condition of BOEM approval of the EP, facilitating possible adaptive management in the event of unanticipated mortality levels. Given that common eider and king eider populations are robust, no more than a minor level of effect on species in the waterfowl and loon group from avian collisions is anticipated. Mitigation measures intended to avoid or minimize adverse effects to threatened eiders also afford protection to waterfowl and loons in those areas.

Shorebirds

Vessel traffic is not anticipated to result in more than a negligible level of disturbance to shorebirds because they typically occur at low density in the area of exploration activity and are not subject to other than occasional vessel passage. Ten shorebirds of at least 3 species (red-necked phalarope, red phalarope, and western sandpiper; not all were confirmed) were identified among the 131 bird:vessel encounters recorded in 2012. Following the analysis discussed above, 8% of an estimated 414 bird strikes yields a rough annual mortality estimate of 33 shorebirds. The low numbers of collisions by this species group would result in a negligible level of effect. Adverse effects from a small spill would not be greater than those described for threatened or endangered birds. Mitigation measures intended to avoid or minimize adverse effects to threatened eiders also afford protection to shorebirds in those areas. As noted above under Threatened and Endangered Birds, bird strike monitoring and reporting will be a condition of BOEM approval of the EP, facilitating possible adaptive management in the event of unanticipated mortality levels.

Raptors and Ravens

Activities associated with the Proposed Action are not anticipated to affect raptors and ravens (*Corvus corax*) because onshore development is limited to the existing development footprint.

4.2.5.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st.

The most important IPFs associated with Alternative 3 are the same as those for Alternative 2 – Proposed Action: vessel and aircraft presence and noise, avian collisions, and small fuel spills. The effects associated with these IPFs in Alternative 3 will not differ measurably from the effects of the Proposed Action in Alternative 2. This is because bird presence and abundance is not likely to be any higher than July 1 or later; vessel and aircraft traffic are not anticipated to result in more than a negligible level of disturbance to birds; avian collision numbers were conservatively estimated for Alternative 2 using a maximum 180-day season length and therefore remain the same as for Alternative 2; and estimated fuel spill numbers are generally dependent on vessel number, not days operated and do not differ from those of Alternative 2. In summary, the primary effect, avian collisions, could result in annual mortality to ESA-listed and other bird species. While the impacts to marine and coastal birds from Alternative 3 are expected to result in no more than a minor level of effect, this alternative could result in the Proposed Action being accomplished in fewer total seasons, and overall would reduce the possible risk to birds.

4.2.5.4. Cumulative Effects

Appendix B of this EA describes other past, present, and reasonably foreseeable future events that could occur in the Proposed Action area and could affect bird populations. Activities that impact birds include disturbances from vessel or low-level aircraft traffic, maritime spill accidents (i.e., bulk fuel deliveries to coastal villages), and bird collisions with vessels and structures in marine and coastal habitats would continue. Many of these activities include vessel and aircraft operations that are not subject to altitude or route restrictions and can affect birds. For a detailed analysis of cumulative impacts to birds, see the 2015 Second SEIS, Section 5.2.5.

Alternative 1 would not have an incremental contribution to the cumulative effect.

Alternative 2 would contribute to the collective impacts on bird populations in the Proposed Action area. The reasonably foreseeable cumulative effects will occur at nearly the same level each season that exploratory drilling operations are conducted. Alternative 2 could result in short-term effects from vessels and aircraft, but these effects are localized and would not persist from one year to the next. The primary effect, avian collisions, could result in annual mortality to ESA-listed and other bird species. The impacts to marine and coastal birds from Alternative 2 and from reasonably foreseeable activities would amount to no more than a minor level of cumulative effect.

Alternative 3 – Early Season Start would not contribute any different incremental impacts to birds than Alternative 2. The impacts to birds from Alternative 2 and from reasonably foreseeable activities would amount to no more than a minor incremental contribution to the cumulative effect.

4.2.6. Marine Mammals

This analysis tiers to the 2007 FEIS (Sections IV.C.1.h. and IV.C.3.g.), 2011SEIS (Section IV.C.1.h), and 2015 Second SEIS (Section 4.3.7); it applies the results of those analyses to the site specific information gleaned from the 2015 Shell EP and 2015 Shell EIA (Sections 4.77 and 4.83). Relevant information from each of these documents is incorporated and summarized below as applicable. BOEM has identified the following as having potential to affect marine mammals:

- Drilling
- Zero-offset Vertical Seismic Profile (ZVSP)
- Vessel Traffic
- Ice Management
- Aircraft Traffic
- Discharges
- Petroleum Spills

The greatest potential for the Proposed Action to impact marine mammals is through noise. Sounds are important to marine mammals because they use sound to navigate, communicate, find open water, avoid predators, and find food. Ambient or background sound levels in the Chukchi Sea have been measured at 80-100 dB under relatively calm seas (Brueggeman et al., 1990). Concern has focused on the intensity of impacts to marine mammals from sounds related to drilling, aircraft, and vessels, and its potential to cause deflection of whales from hunting and migration areas, avoidance of important habitat (e.g., Hanna Shoal Walrus Use Area (HSWUA)), masking of environmental sounds and intra-species communication, and physiological damage to marine mammals such as hearing impairment and induced stress response (78 *FR* 35364, 12 June 2013; 80 *FR* 11726, 4 March 2015; NMFS, 2015c; USFWS 2013a, 2013b; 2015). Avoidance behavior in response to sound energy noise by marine mammals such as temporary deflection from feeding areas or migration corridors is the most likely behavioral response expected as a result of Shell's exploration drilling activities in the Chukchi Sea (Erbe, 2010; Richardson et al., 1995; Southall et al., 2007). Extremely loud sounds could cause temporary or permanent damage to hearing ability (Erbe, 2010; Finneran and Branstetter, 2013; Richardson et al., 1995; Southall et al., 2007; Tyack, 2009; Weilgart, 2007). Concerns that sound energy introduced into the environment of marine mammals could cause masking (the covering of sound that would otherwise have been heard) are present. Masking can interfere with the detection of important natural sounds. Underwater sound energy could possibly mask environmental sounds or communication between marine mammals (Clark et al., 2009; Erbe, 2010; Finneran and Branstetter, 2013; Holt et al., 2015 Jensen et al. 2009; Richardson et al., 1995).

Anthropogenic sound is a potential stressor for marine mammals (Erbe, 2011; NMFS, 2015c; Romano et al., 2004; Wright et al., 2007). Repeated or prolonged stress response can have adverse health impacts (Atkinson et al., 2015). Stress might be a direct result of noise (e.g., an unknown noise is detected) or an indirect result of noise (e.g., masking) (Erbe, 2011). The onset of stress might correspond to fairly low noise levels that induce a behavioral disturbance (Erbe, 2011). The majority of research on stress response to anthropogenic noise has focused on terrestrial species although there is an increasing effort to understand the physiology of stress response in marine mammals (Atkinson et al., 2015). Shell's exploration drilling program includes mitigation measures to minimize potential behavioral disturbances to marine mammals (Appendix C), as will MMPA incidental take authorizations from NMFS and USFWS (e.g., 78 *FR* 35364, 12 June 2013; 80 *FR* 11726, 4 March 2015). These measures are expected to reduce potential impacts of stressors to marine mammals.

Because of concern over potential impacts to marine mammals from anthropogenic sound, sound propagation modeling is often used to identify estimated areas that could be ensonified by proposed activities. Ensonification associated with previous Arctic offshore exploration have only considered sound sources independently of each other when estimating continuous sound levels ≥120 dB re 1μPa rms. Because many of the continuous sounds from the proposed exploration drilling program would occur concurrently at one or more locations, sound propagation modeling for Shell's exploration drilling program to estimate areas ensonified by the Proposed Action was considered the concurrent operation of numerous sound sources and the additive acoustic effects from combined sound fields when estimating exposure areas of levels ≥120 dB re 1 μPa rms. These "activity scenarios" considered additive acoustic effects from multiple sound sources at nearby locations. The area ensonified to ≥160 dB re 1μPa rms from ZVSP, a pulsed sound source, was treated independently from the activity scenarios for continuous sound sources for purposes of assessing affects to animals. The sound propagation modeling is further described in Section 4.0 of the 2015 Shell Outer Continental Shelf Exploration Plan EIA, Chukchi Sea, Alaska (Shell, 2015a, Appendix C), in Section 5.2 of Shell's Drilling Rig Separation Distance Impact Analysis, Exploration Drilling Program, Chukchi Sea, Alaska (Shell, 2015), in NMFS' Proposed IHA for Shell for the Take of Marine Mammals Incidental to an Exploration Drilling Program in the Chukchi Sea (NMFS, 2015c; 80 FR 11726, 4 March 2015). Modeling resulted indicated that the largest area estimated to be exposed to continuous sounds ≥120 dB re 1μPa rms during a single activity scenario was 2,046.3 km^2 and resulted from concurrent mudline cellar (MLC) construction at two different sites and anchor handling at a third site. Model results indicated that sound propagation from combinations of activities such as concurrent drilling and anchor handling in close proximity have a negligible impact on the area ensonified (NMFS, 2015c; Shell, 2015c; 80 *FR* 11726, 4 March 2015). In general, scenarios that involved anchor handling and/or MLC construction resulted in the largest estimated areas that would be ensonified to levels ≥120 dB re 1 μPa rms (Shell, 2015c). It should be noted that these activities are generally of short duration (one to 10 days). Activity scenarios that involved drilling and/or DP vessel operations produced the smallest acoustic footprints.

Noise from aircraft traffic associated with proposed exploration activities may cause some temporary behavioral disturbance, and possibly deflection away from the sound source. A marine mammal under water would typically only hear an aircraft at low altitude when it is within the area 13 degrees on either side of the vertical from where the animal is located (Richardson and Malme, 1993). According to Shell, aircraft associated with the Proposed Action will adhere to the mitigation measures developed to reduce potential aircraft noise impacts to marine mammals.

Vessel noise, vessel traffic, icebreaking, and ice-management could also have some level of effects on any pinnipeds or cetaceans visiting the vicinity of drilling or drilling support operations. Discharges of wastewater, drill cuttings, and drilling fluids are unlikely to have any identifiable effects to marine mammals. The area disturbed or buried under sediments that precipitate out of the water column would only affect a relatively tiny portion of the sea floor. Additional analysis on the potential for the Proposed Action to affect lower trophic resources utilized by marine mammals is provided in Section 4.2.3.

Shell, through its EP (including appendices), has committed to a number of measures to reduce impacts to marine mammals. In addition to these measures, Shell has applied to NMFS and USFWS for take authorization under the MMPA, and through these applications, it has proposed additional measures to reduce impacts. NMFS has published a draft IHA, which sets forth additional mitigations (NMFS, 2015c). While USFWS has not yet issued an LOA or draft LOA, BOEM has no reason to believe that the standard mitigation measures developed over the years would not be required or would be drastically changed. Accordingly, the foregoing analysis assumes that all of these measures to reduce impacts to marine mammals will be in place. A complete list of the measures assumed to be in place for purposes of marine mammal analysis in this EA is set forth in Appendix C."

4.2.6.1. Alternative 1 – No Action

Under Alternative 1, the proposed exploration activities would not be approved, and there would be no effects on marine mammals.

4.2.6.2. Alternative 2 – The Proposed Action

Under Alternative 2, it is likely that some marine mammals will be present in the Proposed Action area when the exploration drilling operations are ongoing. Potential adverse effects on marine mammals from the proposed exploration activities are organized first by species and then by mechanism of effect.

Cetaceans

Cetaceans include the Mysticete whales (bowhead, gray, fin, humpback, and minke whales) and Odontocetes (beluga, harbor porpoise, and killer whales). Three of these species (bowhead, humpback, and fin whales) are listed as endangered under the ESA. Densities of cetaceans are anticipated to be very low to low in the project area (see Chapter 3) and few animals are expected to come into contact with proposed exploration activities on or near the Burger Prospect. Since impacts to all cetaceans would be similar, they are grouped for this analysis.

Noise exposure, habitat degradation, and vessel activity, which could possibly lead to ship strikes, are the primary mechanisms by which activities associated with the Proposed Action in the Chukchi Sea could affect cetaceans. The impacts of anthropogenic noise on marine mammals has been summarized in numerous articles and reports including Richardson et al. (1995), Cato, McCauley, & Noad (2004), NRC (2003, 2005), Southall et al. (2007), Nowacek et al. (2007), and Weilgart (2007).

The following analysis of potential impacts from drilling operations is summarized from the 2015 Second SEIS (USDOI, BOEM, 2015a), Shell's EIA for this action (Shell, 2015, Appendix C), NMFS' proposed IHA for Shell for the take of marine mammals incidental to an exploration drilling program in the Chukchi Sea (NMFS, 2015c), and NMFS' Draft EA (NMFS, 2015d) for the Shell IHA.

Drilling

This section summarizes and incorporates by reference the analysis from the NMFS EA (NMFS, 2015d, Section 4.1.1.1 (1)) on the 2015 proposed IHA (NMFS, 2015c) for Shell.

Exploration drilling will be conducted from the MODUs *Discoverer* and *Polar Pioneer*. Underwater sound propagation during exploration drilling results from the use of generators, drilling machinery, and the MODUs themselves. Sound levels during vessel-based operations may fluctuate depending on the specific type of activity at a given time and aspect from the vessel. Underwater sound levels may also depend on the specific equipment in operation. Lower sound levels have been reported during well logging than during drilling operations (Greene, 1987a), and underwater sound appeared to be lower at the bow and stern aspects than at the beam (Greene, 1987b). Gray whales occur in the northeastern Chukchi Sea during the summer and early fall to feed. Hanna Shoal, an area northeast of Shell's proposed drill sites, is a common gray whale feeding ground. This feeding ground lies outside of the 120-dB and 160-dB ensonified areas from Shell's activities. While some individuals may swim through the area of active drilling, it is not anticipated to interfere with their feeding at Hanna Shoal or other Chukchi Sea feeding grounds (80 *FR* 11726-11775, 4 March 2015).

Most drilling sounds generated from vessel-based operations occur at relatively low frequencies below 600 Hz, although tones up to 1,850 Hz were recorded by Greene (1987b) during drilling operations in the Beaufort Sea. At a range of 0.17 km (0.11 mi), the 20-1000 Hz band level was 122-125 dB re 1µPa rms for the drillship *Explorer I*. Underwater sound levels were slightly higher (134 db re 1µPa rms) during drilling activity from the Explorer II at a range of 0.20 km (0.12 mi); although tones were only recorded below 600 Hz. Underwater sound measurements from the Kulluk in 1986 at 0.98 km (0.61 mi) were higher (143 dB re 1µPa rms) than from the other two vessels. Measurements of the *Discoverer* on the Burger prospect in 2012, without any support vessels operating nearby, showed received sound levels of 120 dB re 1 µPa rms at 1.5 km (0.93 mi). The *Polar Pioneer*, a non-self-propelled, semi-submersible drilling unit, is expected to introduce less sound into the water than the *Discoverer* during drilling and related activities.

Deflection of cetacean species due to the physical presence of the MODUs or support vessels would be uncommon. Even if animals may deflect because of the presence of the MODUs, the Chukchi Sea's migratory corridor is much larger in size than the length of the drilling units, and animals would have other means of passage around the MODUs. In sum, the physical presence of the MODUs is not likely to cause a material deflection to migrating marine mammals. The lower level of sound produced by the MODUs may have less impact on cetaceans than would 3D seismic (survey) sound. Moreover, any impacts would last only as long as the MODUs are actually present. Possible disturbance of marine mammals during drilling activities will be mitigated through implementation of several vessel based mitigation measures outlined in NMFS, 2015d.

Zero-offset Vertical Seismic Profile (ZVSP)

This section summarizes and incorporates by reference the analysis from the NMFS EA (NMFS, 2015d, Section 4.1.1.1 (2)) on the 2015 proposed IHA (NMFS, 2015c) for Shell and the NMFS proposed IHA for Shell (NMFS, 2015c, pages 11772-11775).

Two sound sources have been proposed by Shell for the ZVSP surveys. The first is a small airgun array that consists of three 150 in3 (2.46 L) airguns for a total volume of 450 in3 (7.37 L). The second ZVSP sound source consists of two 250 in3 (4.09 L) airguns with a total volume of 500 in3 (8.194 L). Typically, a single ZVSP survey will be performed when the well has reached Proposed Total Depth (PTD) or final depth although, in some instances, a prior ZVSP will have been performed at a shallower depth. A typical survey would last 10–14 hours, depending on the depth of the well and the number of anchoring points, and include firings of up to the full array, plus additional firing of the smallest airgun in the array to be used as a "mitigation airgun" while the geophones are relocated within the wellbore.

Airguns function by venting high-pressure air into the water. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by oscillation of the resulting air bubble. The sizes, arrangement, and firing times of the individual airguns in an array are designed and synchronized to suppress the pressure oscillations subsequent to the first cycle. A typical high-energy airgun arrays emit most energy at 10–120 Hz. However, the pulses contain energy up to 500–1000 Hz and some energy at higher frequencies (Goold and Fish, 1998; Potter et al., 2007).

When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Based on available behavioral data, audiograms have been derived using auditory evoked potentials, anatomical modeling, and other data, Southall et al. (2007) designate "functional hearing groups" for marine mammals and estimate the lower and upper frequencies of functional hearing of the groups. The functional groups analyzed in this EA and the associated frequencies are indicated below (though animals are less sensitive to sounds at the outer edge of their functional range and most sensitive to sounds of frequencies within a smaller range somewhere in the middle of their functional hearing range):

- Low frequency cetaceans (13 species of mysticetes): functional hearing is estimated to occur between approximately 7 Hz and 30 kHz

- Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales): functional hearing is estimated to occur between approximately 150 Hz and 160 kHz
- High frequency cetaceans (eight species of true porpoises, six species of river dolphins, Kogia, the franciscana, and four species of cephalorhynchids): functional hearing is estimated to occur between approximately 200 Hz and 180 kHz

Of the eight cetacean species likely to occur in the Proposed Action area, five are classified as low-frequency cetaceans (i.e., bowhead, fin, minke, humpback, and gray whales), two are classified as mid-frequency cetaceans (i.e., beluga and killer whales), and one is classified as a high-frequency cetacean (i.e., harbor porpoise) (Southall et al., 2007). A species functional hearing group is a consideration during analysis of effects of exposure to sound on marine mammals.

Impacts from ZVSP surveys would be mitigated to minor by conditions in the NMFS proposed IHA for Shell (NMFS, 2015c); airgun arrays will be ramped up slowly during ZVSPs to warn cetaceans in the vicinity of the airguns and provide time for them to leave the area and avoid potential injury or impairment of their hearing abilities. Ramp ups from a cold start when no airguns have been firing will begin by firing a single airgun in the array. A ramp up to the required airgun array volume will not begin until there has been a minimum of 30 minutes (min) of observation of the safety zone (the extent of the 180 dB radius for cetaceans) by PSOs to assure that no cetaceans are present. The entire safety zone will be visible during the 30-min lead-into an array ramp up. If a cetacean is sighted within the safety zone during the 30-min watch prior to ramp up, ramp up will be delayed until the cetacean is sighted outside of the safety zone or the animal(s) is not sighted for at least 15– 30 min: 15 min for small odontocetes, or 30 min for baleen whales and large odontocetes.

More detailed description of the potential noise effects on cetaceans is provided in Section 4.3.7 of the 2015 Second SEIS (USDOI, BOEM, 2015a).

Vessel Traffic

This section incorporates the analysis from the NMFS EA (NMFS, 2015d, Sections 4.1.1.1 (4) and Section 4.1.1.2) on the 2015 proposed IHA (NMFS, 2015c) for Shell and the NMFS proposed IHA for Shell (NMFS, 2015c, pages 11772-11775). If the mitigations in the draft NMFS IHA for this activity (NMFS, 2015c) are finalized and applied to this activity, the impacts would be as follows.

In addition to the MODUs, various types of vessels will be used in support of the operations including ice management vessels, anchor handlers, OSVs, and OSR vessels. Sounds from boats and vessels have been reported extensively (Greene and Moore 1995; Blackwell and Greene 2002, 2005, 2006). Numerous measurements of underwater vessel sound have been performed in support of recent industry activity in the Chukchi and Beaufort Seas. Results of these measurements were reported in various 90-day and comprehensive reports since 2007. For example, Garner and Hannay (2009) estimated sound pressure levels of 100 dB re 1 µPa rms at distances ranging from ~1.5 to 2.3 mi (~2.4 to 3.7 km) from various types of barges. MacDonnell et al. (2008) estimated higher underwater sound pressure levels from the seismic vessel *Gilavar* of 120 dB re 1 µPa rms at ~13 mi (~21 km) from the source, although the sound level was only 150 dB re 1 µPa rms at 85 ft (26 m) from the vessel. Like other industry-generated sound, underwater sound from vessels is generally at relatively low frequencies. During 2012, underwater sound from ten (10) vessels in transit, and in two instances from vessels towing or providing a tow-assist, were recorded by JASCO in the Chukchi Sea as a function of the sound source characterization (SSC) study required in the Shell 2012 Chukchi Sea drilling IHA. SSC transit and tow results from 2012 include ice management vessels, an anchor handler, OSR vessels, the OST, support tugs, and OSVs. The recorded sound pressure levels to 120 dB re 1 µPa rms for vessels in transit primarily range from ~ 0.8 – 4.3 mi (1.3 - 6.9 km), whereas the measured 120 dB re 1 µPa rms for the drilling unit *Kulluk* under tow by the *Aiviq* in the Chukchi Sea was approximately 11.8 mi (19 km) on its way to the Beaufort Sea (LGL and JASCO, 2014).

Measurements of vessel sounds from the 2012 Shell EP Revision 1 drilling program in the Chukchi Sea are presented in detail in their Comprehensive Monitoring Report (LGL and JASCO, 2014).

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross, 1976). Propeller cavitation and singing are produced outside the hull, whereas propulsion or other machinery noise originates inside the hull. There are additional sounds produced by vessel activity, such as pumps, generators, flow noise from water passing over the hull, and bubbles breaking in the wake. Icebreakers contribute greater sound levels during ice-breaking activities than ships of similar size during normal operation in open water (Richardson et al., 1995). This higher sound production results from the greater amount of power and propeller cavitation required when operating in thick ice.

Reactions of cetaceans to vessels often include changes in general activity (e.g. from resting or feeding to active avoidance), changes in surfacing-respiration-dive cycles, and changes in speed and direction of movement. Animals' past experiences with vessels are important in determining the degree and type of response elicited from an animal-vessel encounter. Whale reactions to slow-moving vessels are less dramatic than their reactions to faster and/or erratic vessel movements. Some species have been noted to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Wartzok et al., 1989; Richardson et al., 1995; Heide-Jorgensen et al., 2003).

Collisions with vessels are possible but highly unlikely. Ship strikes of cetaceans can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds (Knowlton and Kraus, 2001). Massive propeller wounds can be immediately fatal. If more superficial, whales may be able to survive the collisions (Silber, Bettridge, & Cottingham, 2009). Vessel speed is a key factor in determining the frequency and severity of ship strikes, with the potential for collision increasing at ship speeds of 15 knots and greater (Laist et al., 2001; Vanderlaan and Taggart, 2007).

Incidence of injury caused by vessel collisions appears to be low in the Arctic. Less than 1% of bowhead whales have scars indicative of vessel collision. This could be due to either collisions resulting in death (and not accounted for) or a low incidence of co-occurrence of ships and bowhead whales (George et al., 1994).

Impacts from vessel traffic will be mitigated by conditions in the NMFS proposed IHA for Shell (NMFS, 2015c); all vessels will reduce speed to a maximum of 5 knots when within 900 ft (300 yards/274 m) of whales; the vessels capable of steering around such groups will do so; vessels will not separate members of a group of whales from other members of the group; vessels will avoid multiple changes in direction and speed when within 900 ft (300 yards/274 m) of whales; and when weather conditions require, such as when visibility drops, support vessels will reduce speed and change direction, as necessary (and as operationally practicable), to avoid the likelihood of injury to whales.

Ice Management

This section incorporates the analysis from the NMFS EA (NMFS, 2015d, Section 4.1.2.5) on the 2015 proposed IHA (NMFS, 2015c) for Shell.

Ice management or icebreaking activities include the physical pushing or moving of ice in the proposed exploration drilling area and to prevent ice floes from striking the drilling unit. Shell does not expect to have to manage pack ice during the majority of the drilling season. The majority of the ice management or icebreaking should occur in the early and latter portions of the drilling season. Landfast ice would not be present during Shell's Proposed Action.

Ice management vessels are likely to be the most intense sources of sound associated with the exploration drilling program (Richardson et al., 1995). Ice management vessels, during active ice management, may have to adjust course forward and astern while moving ice and thereby create greater variability in propeller cavitation than other vessels that maintain course with less adjustment. The drilling units maintain station during drilling without activation of propulsion propellers. Richardson et al. (1995) reported that the noise generated by an icebreaker pushing ice was 10-15 dB re 1 µPa rms greater than the noise produced by the ship underway in open water. It is expected that the lower level of sound produced by ice management would have less impact on cetaceans than would ZVSP survey sound.

Cetaceans are not dependent on sea ice for resting, breeding, or molting as are ice seals. Therefore, ice-management or icebreaking related to the Proposed Action is not expected to have any habitat-related effects that could cause material or long-term consequences for cetacean populations.

Aircraft Traffic

This section incorporates the analysis from the NMFS EA (NMFS, 2015d, Section 4.1.1.1 (3)) on the 2015 proposed IHA (NMFS, 2015c) for Shell and the NMFS proposed IHA for Shell (NMFS, 2015c, pages 11772-11775).

Helicopters may be used for personnel and equipment transport to and from the MODUs and support vessels. Under calm conditions, rotor and engine sounds are coupled into the water within a 26º cone beneath the aircraft. Some of the sound will transmit beyond the immediate area, and some sound will enter the water outside the 26º area when the sea surface is rough. However, scattering and absorption will limit lateral propagation in the shallow water.

Dominant tones in noise spectra from helicopters are generally below 500 Hz (Greene and Moore, 1995). Harmonics of the main rotor and tail rotor usually dominate the sound from helicopters; however, many additional tones associated with the engines and other rotating parts are sometimes present. Because of doppler shift effects, the frequencies of tones received at a stationary site diminish when an aircraft passes overhead. The apparent frequency is increased while the aircraft approaches and is reduced while it moves away.

Aircraft flyovers are not heard underwater for very long, especially when compared to how long they are heard in air as the aircraft approaches an observer. If conditions in the NMFS IHA for Shell (NMFS, 2015c) are implemented, (aircraft will not fly within 1,000 ft (305 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs, landings, or in emergency situations) while over land or sea), it will limit the received levels at and below the surface and effects will be negligible to cetacean populations.

Discharges

For further analysis on impacts to water quality from discharges see Section 4.2.2 (Water Quality) in this EA.

Shell will discharge drilling wastes to the Chukchi Sea under the EPA's National Pollutant Discharge Elimination System (NPDES) General Permit for Oil and Gas Exploration Activities on the Outer Continental Shelf in the Chukchi Sea (AKG-28-8100; NPDES exploration facilities GP). This permit establishes various limits and conditions on the authorized discharges, and the EPA has determined that with these limits and conditions the discharges will not result in any unreasonable degradation of the marine environment (see Section 4.2.2.2 above; EPA, 2012a). The primary effect of the drilling waste discharges will be increases in total suspended solids (TSS) in the water column and localized increase in sedimentation on the sea floor. Discharges of drilling wastes could potentially displace marine mammals a short distance from a drilling location. However, it is likely that marine mammals will have already avoided the area due to sound energy generated by the drilling activities.

Baleen whales, such as bowheads, tend to avoid MODUs at distances up to 12 mi (20 km). Therefore, it is highly unlikely that the whales will swim or feed in close enough proximity of discharges to be affected. The impact of drilling waste discharges would be localized and temporary. Drilling waste discharges could displace endangered whales (bowhead and humpback whales) a short distance from a drill site. Effects on the whales present within a few meters of the discharge point would be expected, primarily due to sedimentation. However, endangered whales are not likely to have long-term exposures to drilling wastes because of the episodic nature of discharges (typically only a few hours in duration).

Like other baleen whales, gray whales will more than likely avoid drilling activities and therefore not come into close contact with drilling wastes. Gray whales are benthic feeders; the seafloor area covered by accumulations of discharged drilling wastes will be unavailable to the whales for foraging purposes. Such impacts have negligible effects on individual whales and no effect on the population, because such areas of disturbance will be few and in total will occur over a very small area representing an extremely small portion of available foraging habitat in the Chukchi Sea. Other baleen whales such as the minke whale, which could be found near the drill site, would not be expected to be affected.

Discharges of drilling wastes are not likely to affect beluga whales and other odontocetes such as harbor porpoises and killer whales. These marine mammals will likely avoid the immediate areas where drilling wastes will be discharged. Discharge modeling performed for both the *Discoverer* and the *Polar Pioneer* based on maximum prevailing current speeds of 9.84 in/s (25 cm/s), shows that sedimentation depth of drilling wastes at greater than 0.4 in (1 cm) thickness will occur within approximately 1,641 (500 m) of the drilling unit discharge point (Fluid Dynamix, 2014a). Concentrations of TSS, a transient feature of the discharge, are modeled to be below 15 mg/L at distances approximately 3,281 ft (1,000 m) from the drilling unit discharge point. Therefore, it is highly unlikely that beluga whales will come into contact with any drilling discharge and impacts are not expected.

Oil Spills

This section incorporates the analysis from the 2015 Second SEIS and from the NMFS EA (NMFS, 2015d, Section 4.1.1.4) on the 2015 proposed IHA (NMFS, 2015c) for Shell.

Small Fuel Spill. For purposes of analysis, BOEM estimates up to two small spills could occur. BOEM chose a 48 or 5 bbl diesel fuel-transfer spill to represent the range of spill volumes and oil type for the effects analysis of a small spill(s).See Section 2.4.8 for more information on how BOEM arrived at a spill volume and oil type for small (<1,000 bbl spills).

The specific effects an oil spill would have on cetaceans are not well known. While mortality is unlikely, exposure to spilled oil could lead to skin irritation, baleen fouling (which might reduce feeding efficiency), respiratory distress from inhalation of hydrocarbon vapors, consumption of some contaminated prey items, and temporary displacement from contaminated feeding areas. Geraci and St. Aubin (1990) summarize effects of oil on marine mammals, and Bratton et al. (1993) provides a synthesis of knowledge of oil effects on bowhead whales. The number of cetaceans that might be contacted by a spill would depend on the size, timing, and duration of the spill and where the oil is in relation to the animals. Whales may not avoid oil spills, and some have been observed feeding within oil slicks (Goodale, Hyman, and Winn, 1981).

In the case of an oil spill occurring during migration periods, cleanup activities may impact migrating cetaceans more than the oil itself. Human activity associated with cleanup efforts could deflect whales away from the path of the oil. However, noise created from cleanup activities likely will be short term and localized. In fact, whale avoidance of cleanup activities may benefit whales by displacing them from the oil spill area.

After reviewing the potential effects of this type of a spill on cetaceans, a negligible level of effects applies because the small spill(s) would quickly disperse, volatilize, and break up, making it insufficient to produce any chronic effects, mortality, or population level effects on cetaceans in the Chukchi Sea.

Transit from Dutch Harbor

While BOEM does not regulate transit from Dutch Harbor, it is anticipated that OSVs will make approximately 30 trips back and forth from Dutch Harbor to the Proposed Action area for resupply each drilling season. Species that may be encountered around Dutch Harbor and on transit to the Proposed Action area include the following species: bowhead whales, fin whales, humpback whales, North Pacific right whales, sperm whales, gray whales, blue whale, minke whales, killer whales, beluga whale, Stejneger's beaked whale, Baird's beaked whale, Cuvier's beaked whale, dall's porpoise, harbor porpoise, and Pacific white-sided dolphin. Impacts to these cetacean species from this vessel traffic could include vessel strikes and small fuel spills.

Collisions with vessels are possible but highly unlikely. Ship strikes of cetaceans can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds (Knowlton and Kraus, 2001). Massive propeller wounds can be immediately fatal. If more superficial, whales may be able to survive the collisions (Silber, Bettridge, & Cottingham, 2009). Vessel speed is a key factor in determining the frequency and severity of ship strikes, with the potential for collision increasing at ship speeds of 15 knots and greater (Laist et al., 2001; Vanderlaan and Taggart, 2007).

Impacts from vessel traffic can be mitigated if all vessels reduce speed to a maximum of 5 knots when within 900 ft (300 yards/274 m) of whales; the vessels capable of steering around such groups do so; vessels do not separate members of a group of whales from other members of the group; vessels avoid multiple changes in direction and speed when within 900 ft (300 yards/274 m) of whales; and when weather conditions require, such as when visibility drops, support vessels reduce speed and change direction, as necessary (and as operationally practicable), to avoid the likelihood of injury to cetaceans. In addition, travel speeds of 10 knots while transiting through right whale critical habitat would reduce the chance of a vessel strike with this endangered cetacean. To reduce the impact of a vessel strike on this critically endangered whale to zero, vessels could avoid right whale critical habitat altogether by detouring around the area.

After reviewing the potential effects of small fuel spills on the above cetaceans, BOEM finds a negligible level of effects applies because the small spill(s) would be insufficient to produce any population level effects on cetaceans in Dutch Harbor and along the transit route.

With mitigation measures (see Section 2.3) vessel traffic from Dutch Harbor will have a negligible impact on cetaceans.

Conclusion

The specified activity involves the drilling of exploratory wells and associated activities in the Chukchi Sea during the open-water season. The impacts to cetaceans that are reasonably expected to occur will be acoustic in nature.

The most likely impacts of the Proposed Action could be behavioral disturbance reactions from the introduction of noise into the marine environment and vessel and aircraft activity. There is also a potential for some acoustic masking in baleen whales, as the frequencies of their hearing and vocalizations overlap with the frequencies of much of the equipment to be used during the exploration drilling operations. It is less likely that masking would occur in odonotocetes because of the higher frequencies of their hearing and vocalizations. Impacts from drill cuttings, drilling fluids, and other discharges are likely to be minor, if they occur at all. Additionally, impacts from small fuel spills are anticipated to be minor.

Several of the cetacean species that may occur in the Proposed Action area are migratory and therefore are just moving through the area at certain times. The two species that are most likely to be migrating through the area (i.e., the Chukchi Sea) during the time frame of Shell's proposed operations are the bowhead whale and the beluga whale. However, the spring migrations for these species will be completed prior to the beginning of Shell's operations. While some animals of both species remain in the Chukchi Sea during the summer months, the majority of these species occur in the area during the fall migration. These species typically migrate from the Canadian Beaufort Sea into U.S. waters in September and October. Therefore, impacts to the beluga and bowhead whale populations are anticipated to be minor because of their migratory patterns. Gray whales also conduct long annual migrations from Mexico to the Arctic (Rugh et al., 1999), moving northward from mid-February to May and returning south out of the Chukchi Sea in October and November (Rice, Wolman & Braham, 1984). However, while in the Chukchi Sea, gray whales are not migrating. Instead, these are their summer feeding grounds. While it is possible for large numbers of gray whales to occur in the Chukchi Sea during the majority of Shell's proposed operations, the majority of animals are seen within 31.1 mi (50 km) of shore (i.e., closer to shore than Shell's proposed operations) and impacts from exploration activities are anticipated to be minor.

Although bowhead and beluga whales will be calving during the time period of Shell's activities, they are not expected to be impacted significantly. While Shell's exploration drilling program will overlap temporally with the beluga calving season, it will not overlap spatially. Tagging data from the 1990s indicates that belugas from the eastern Beaufort Sea stock will be in Canadian waters (i.e., Mackenzie Delta and Amundsen Gulf) in the summer (July and August) and do not start migrating through the Beaufort Sea until September but do so far offshore (Richard, Martin & Orr, 1998; CDFO, 2000). In the summer months, belugas from the eastern Chukchi Sea stock are typically found in Kasegaluk Lagoon and Kotzebue Sound (Suydam et al., 2001). Shell will transit far offshore so as not to disturb the summer beluga hunts conducted in Kasegaluk Lagoon and therefore will avoid interactions with mothers and calves. Tagging data of belugas from this stock have also indicated that they travel far offshore in the Beaufort Sea to Canadian waters later in the summer (Suydam et al., 2001). Based on this information, it is unlikely that many beluga mother/calf pairs will pass within the 120 dB ensonified areas of Shell's Chukchi Sea exploration drilling programs. Temporal segregation by size and sex class occurs during the spring and fall bowhead whale migrations. In the spring, the first wave consists of sub-adults, the second of larger whales, and the third is comprised of even larger reverse order is seen in the fall throughout the migration corridor (Koski and Miller, 2009; Noongwook et al., 2007); however, the cows with calves typically occur later in the migration in the fall as well. Shell's operations will not begin until the end of the spring migration, thus avoiding impacts to mother/calf pairs. Although there is a chance of some bowhead cow/calf pairs reaching the Chukchi Sea before the end of Shell's operations in that location. Mitigation and monitoring measures will ensure that impacts to any beluga or bowhead whales that do occur in the vicinity of the program will be at the lowest level practicable.

Harbor porpoise, minke and killer whales, and to a lesser extent humpback and fin whales are found in the Chukchi Sea during the summer and/or fall seasons. Some of them are also found in the Beaufort Sea, to a lower degree. However, these species are not expected to occur in high numbers in the vicinity of either drilling program. Feeding, calving, and other life history functions are not conducted in these areas. Overall, impacts to cetacean populations are anticipated to have negligible to minor effects. NMFS evaluated 'takes' under the MPPA to cetaceans for Shell's 2015 exploration activities and determined "Any takes that occur are anticipated to result from noise propagation from the drillship [MODU], ice management/icebreaking activities, and the airguns used for the ZVSP surveys and would take the form of Level B behavioral harassment." No mortality to any cetaceans is anticipated (NMFS, 2015c and d). The estimated percent of a cetacean population that would be harassed in 2015 ranges from 0.1 (humpback whales) -13.5% (bowhead whales) (NMFS 2015d, Table 5). Impacts would only occur during the time that the animals are in the ensonified areas and are expected to be short-term in duration and limited to behavioral disturbance. In order to reduce impacts on cetaceans to the lowest level practicable, Shell will be required to implement the mitigation, monitoring, and reporting measures described in NMFS, 2015c and d.

Underwater noise generated from Shell's proposed exploration drilling activity may potentially affect cetacean prey species, which are fish species and various invertebrates in the Proposed Action area. This is discussed further in this EA in Sections 4.2.3 (Lower Trophic Levels) and 4.2.4 (Fish). Impacts to cetacean prey species are anticipated to be localized to areas very small in comparison with available foraging habitat in the Chukchi Sea. Any effects to prey species from the Proposed Action would have a negligible impact on cetaceans.

After reviewing the potential effects of a small fuel spill on cetaceans, a negligible level of effects applies because the small spill(s) would quickly disperse, volatilize, and break up, making it insufficient to produce any chronic effects, mortality, or population level effects on cetaceans in the Chukchi Sea.

Mooring of the MODUs, construction of MLCs, and drilling discharges will result in some seafloor disturbance and temporary increases in water column turbidity. This may impact some cetacean habitat and is discussed further in this EA in Section 4.2.2 (Water Quality). Seafloor disturbance and increased turbidity are anticipated to be short-term and localized to areas very small in comparison with available cetacean habitat in the Chukchi Sea. These potential impacts would have a negligible impact on cetacean habitat.

Pacific Walrus

Potential impacts to Pacific walruses from exploratory drilling in the Chukchi Sea were analyzed in depth in

- The 2015 Second SEIS (USDOI, BOEM, 2015a)
- Final Environmental Assessment for the Final Rule to Authorize the Incidental Take of Small Numbers of Pacific Walruses (*Odobenus rosmarus divergens*) and Polar Bears (*Ursus maritimus*) During Oil and Gas Industry Exploration Activities in the Chukchi Sea (USFWS, 2013b, Section V.B.1)
- The Biological Opinion for Polar Bears (*Ursus maritimus*) and Conference Opinion for Pacific Walrus (*Odobenus rosmarus divergens*) on the Chukchi Sea Incidental Take Regulations (USFWS, 2013a, pp. 44-48)
- Shell's EIA for this action (Shell, 2015a, Appendix C, Sections 4.8.3 and 6.3.6)
- Shell's Drilling Rig Separation Distance Impact Analysis, Exploration Drilling Program, Chukchi Sea, Alaska (Shell, 2015, Sections 5 and 6)
- Shell's April 20, 2015, Supplement to Request for Letter of Authorization (LOA) for the Incidental Take of Polar Bears and Pacific Walrus; Exploration Drilling Program, Chukchi Sea, Alaska

These documents are incorporated here by reference and relevant information is summarized in the sections that follow.

Exploration drilling on the Burger Prospect could impact walruses through disturbance, displacement, impacts to prey species, or accidental petroleum spills. Females with young calves are most vulnerable to disturbance events because the calves cannot remain in the water as long, cannot swim as far, and are more vulnerable to trampling when large groups of walruses stampede off of haulouts (Udevitz et al., 2013; 76 *FR* 7634, 10 February 2011). The vast majority of walruses (approximately 70%) encountered during industry exploration programs from 2006–2012 did not exhibit an observable reaction to exploration activities (Table 4-11; Shell, 2015 and 2015b). The most common reaction by walruses during this period—approximately 23% of individuals—was an "attention" response (i.e., looking at a vessel). The remaining walruses encountered during industry exploration programs from 2006–2012, approximately 7%, reacted by approaching, avoiding, or fleeing exploration activities (Table 4-11; Shell, 2015 and 2015b).

Table 4-11. Vessel Based PSO Pacific Walrus Sightings and Reaction Behaviors --2006-2012[1].

Year	Walrus Reaction					
	None	Attention	Approach	Avoidance	Flee	Unknown
2006	1,215	60	2	0	0	0
2007	2.472	814	18	55	62	0
2008	649	102	10	2	28	0
2009	87	40	3	1	0	0
2010	936	351	24	126	135	0
2011	42	59	5	37	4	0
2012	5,800	2,312	61	110	394	1

Note: [1] Table displays numbers of Pacific walrus sightings and reaction behaviors recorded by vessel-based PSOs during offshore oil and gas exploration programs in the northeastern Chukchi Sea in 2006-2012.
The numbers of individual walruses that demonstrated a reaction are considered to be overestimates since reactions were assigned to all individuals within a group regardless of whether only some individuals in the group demonstrate a reaction. Multiple-counting of individuals and associated reactions was also known to occur.

Source: Shell, 2015b

Drilling

The primary effects on walruses from exploration drilling are disturbance and temporary displacement. Noise and activity associated with drilling may displace some walruses from the immediate area of the specific drill sites (with ongoing operations). Walruses may be displaced from the immediate area of different drill sites over the course of two or more open water seasons. No hearing threshold criteria data exist for walruses; however, underwater audiograms for walruses show a strong similarity to those for otariids (Kastak et al., 2004, 2007, as referenced in Finneran and Jenkins, 2012) and the otariid thresholds are used for walruses (Finneran and Jenkins, 2012). The Permanent Threshold Shift (PTS) threshold for continuous underwater noise for Pacific walruses is 235 dB 1μPa rms. The Temporary Threshold Shift (TSS) threshold is 229 dB 1μPa rms (Figure 4-1; USDOI, BOEM, 2015a, Section 4.3.7.1). Individual sound source levels for the proposed drilling activities are not expected to rise to the level of PTS or TTS (Figure 4-1; LGL et al., 2014). Sound propagation modeling as described in Section 4.0 of the 2015 Shell Outer Continental Shelf Exploration Plan EIA, Chukchi Sea, Alaska (Shell, 2015a, Appendix C), in Shell's Drilling Rig Separation Distance Impact Analysis, Exploration Drilling Program, Chukchi Sea, Alaska (Shell, 2015, Section 5.2) and in NMFS' Proposed IHA for Shell for the Take of Marine Mammals Incidental to an Exploration Drilling Program in the Chukchi Sea (NMFS, 2015c; 80 FR 11726, 4 March 2015) indicated that the largest area estimated to be exposed to continuous sounds ≥120 dB re 1μPa rms during a single activity scenario was 2,046.3 km^2 and resulted from concurrent mudline cellar (MLC) construction at two different sites and anchor handling at a third site. Model results indicated that sound propagation from combinations of activities such as concurrent drilling and anchor handling in close proximity have a negligible impact on the area ensonified compared with activities occurring successively at individual drill sites (Shell, 2015; NMFS, 2015c; 80 *FR* 11726, 4 March 2015). During the 2012 Shell EP Revision 1 drilling activities at the Burger Prospect, 42 sightings of 574 walruses were recorded during drilling activities (Bisson et al., 2013). The most common reaction to vessels involved in drilling activities was no reaction (45% of walrus sightings (19 of 42)), followed by looking at the vessel(s) (36% of sightings (15 of 42)) (Bisson et al., 2013). Thirty-eight sightings of 94 walruses were observed during drilling activities but outside the ≥120 dB (rms) radii for these activities. The remaining 480 walruses observed during the 2012 Shell EP Revision 1 drilling activities in the Chukchi Sea were in areas where received sound levels (RSLs) in the water were estimated to be ≥120 dB (rms); however, 474 of these individuals (99%) were hauled out on ice and likely would not have been exposed to levels of sound comparable to those in the water. The remaining six walruses observed during drilling periods were in the water where estimated RSLs were ≥120 but <160 dB (Bisson et al., 2013).

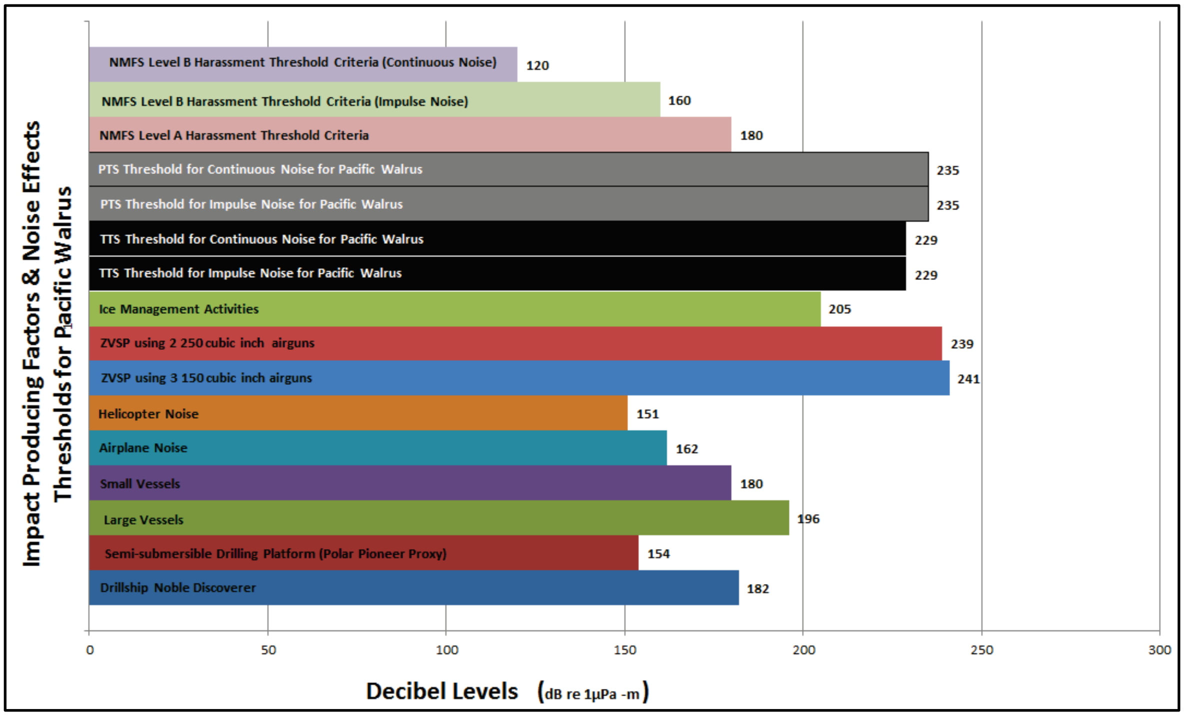

Figure 4-1. IPF and Noise Thresholds for Walrus. *No hearing threshold criteria data exist for walruses or polar bears; however, underwater audiograms for walruses show a strong similarity to those for otariids (Kastak et al., 2004, 2007 in Finneran and Jenkins, 2012) and the otariid ear is very similar to the ear of other carnivores, such as polar bears. Therefore otariid PTS and TTS thresholds are used for walruses and polar bears (Finneran and Jenkins, 2012).*

Sources: 2015 Second SEIS (Section 4.3.7.1, p. 274-281; LGL Inc., et al. 2014).

The proposed drill sites are in a central area near the Hanna and Herald Shoal areas and approximately ≥7 miles south of the Hanna Shoal Walrus Use Area (HSWUA), areas that are very productive for benthic invertebrates (Dunton, 2013 in USFWS, 2013a; Grebmeier et al., 2006a). Walruses could be displaced from specific drill site areas during active drilling; however, in recent years the sea ice has retreated too far northward for walruses to easily access these areas during the late summer and early fall open water season (Jay, Fischbach, and Kochnev, 2012). Walruses could be temporarily displaced from a small portion of HSWUA if the area ensonified by drilling program activities extends into HSWUA. The actual area ensonified would depend upon the type of sound source(s), which drill site at which the activity was occurring, and the month (as the boundary of HSWUA varies temporally). Any displacement would be localized and temporary; and would affect only a small portion of the larger HSWUA. Sound propagation modeling for the Proposed Action indicates that activity scenarios that involved longer duration activities (e.g., drilling and/or DP vessel operations) produced the smallest acoustic footprints (Shell, 2015c). Mitigation measures outlined in the 2015 Shell 4MP (Shell, 2015a, Appendix B), *Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan* (Shell, 2015b), *Adaptive Approach to Ice Management in Areas Occupied by Pacific Walrus* (Shell, 2015a, Appendix J), and other mitigation required by management agencies in MMPA incidental take authorizations, are expected to reduce the potential for impacts to walruses from the Proposed Action.

The footprint of the drill rigs and the activities associated with the drilling (crew change outs, re-supply vessels, possibly an icebreaker conducting ice management activities, spill response vessels on stand-by) could displace walruses from the immediate area. The estimated surface area disturbed by MLC construction would be 6,450 ft^2 (this area would increase to 40, 416 ft^2 if an ROV were used to construct the MLC) (Shell, 2015a). In addition, approximately 160,640 ft^2 total would be scarred by the anchors used to anchor the drill rigs (including contingency for re-setting 16 anchors, if necessary) (Shell, 2015a). These areas would not be available as foraging habitat until benthic invertebrates had time to re-colonize the area after the drill site had been abandoned. Dunton et al. (2012) found healthy benthic communities in 2008 at sites in the Chukchi Sea that had exploration wells drilled in 1989. Two drill rigs active during the open water season would have a relatively small footprint when compared to the available habitat and would likely have minor impacts to walruses in the Chukchi Sea. Terrestrial haulouts are unlikely to be disturbed by exploration drilling because the drill sites are located more than 64 miles from the coastline.

Zero-offset Vertical Seismic Profile

Walruses use sound for communication and spend a great deal of time foraging underwater, and could be exposed to sound from ZVSPs. Marine mammals may experience TTS after exposure to seismic pulses (Erbe, 2010; Kastak et al., 2005; Weilgart, 2013); however, this has not been documented for walruses. Individual sound source levels from ZVSPs (239-241 dB could rise to the level of PTS or TTS (Figure 4-1; LGL et al., 2014). Walruses have good low-frequency hearing (Kaselein et al., 2002) and may be susceptible to masking of biologically significant signals by low frequency sounds, such as airgun pulses from seismic surveys (Gordon et al., 2003); however, existing data suggest that walruses typically display no reaction when exposed to pulsed sound levels ≤160 dB re 1μ Pa (rms) and continuous sound associated with drilling ≤120 dB re 1μ Pa (rms) (Hartin et al., 2013; LGL and JASCO, 2014; Small, Moore, and Stafford, 2011). ZVSPs would take place over a period of 10-14 hours at every well drilled, and individual sound source levels from ZVSPs (239-241 dB re 1μ Pa (rms) could rise to the level of PTS or TTS (Figure 4-1; LGL et al., 2014) for individual walruses if they are in close proximity. Walruses are likely to avoid the drill site area due to the noise and activity, which lessens the likelihood of their exposure. Noise from ZVSPs would not impact walruses within HSWUA because the radius for the area ensonified by ≥160 dB re 1 μPa rms is <5 mi and the closest drill site to HSWUA is >7 mi (Shell, 2015c; 80 *FR* 11726, 4 March 2015). Protected Species Observers (PSOs) will be on watch during operations to avoid conducting ZVSP when walruses are present within the area ensonified at 180 dB. Some walruses may move further away from the drilling operations if in the area when ZVSP occurs. Any impacts are likely to be limited to displacement of foraging walruses or to walruses swimming through the area. No ZVSPs were conducted during the 2012 Shell EP Revision 1 drilling activities because the well was not drilled to total depth (the typical point at which a ZVSP is performed). Monitoring requirements and mitigation measures, including ramp-up procedures, are expected to minimize interactions with large aggregations of walruses during Shell's open-water season activities. Any effects to walruses from ZVSPs would be short in duration and would have a minor overall impact on Pacific walruses.

Vessel Traffic

Walruses on ice and walruses in water react differently to encounters with vessels. Walruses in water show little concern about approaching vessels and will dive or swim away (Fay et al., 1984). Observations of walruses in water from industry vessels show avoidance of vessels more often than walruses on ice; however, their reactions are less severe (LGL, unpublished data in Shell, 2015b). Walruses in water were commonly observed diving or swimming away at a moderate speed (avoidance), while walruses on ice were observed moving from the ice in to the water (escape reaction); however, the majority of walruses, whether on ice or in water, did not exhibit a discernible reaction (Shell, 2015b).

Brueggeman et al. (1990, 1991) monitored the behavior of walruses in response to vessels associated with exploration drilling at the Burger Prospect in 1989 and 1990. They reported that none of the observed groups of walruses exhibited escape behavior in response to anchored or drifting vessels, while responses to moving vessels varied, ranged from nothing to approaching the vessel or escape behavior, and varied with distance; most reactions occurred when the vessel approached within about 550 yd (500 m) of the walruses. During industry programs in the Chukchi Sea between 2006 and 2012, walruses most commonly exhibited no detectable reaction; however, approximately 23% of walruses exhibited an attention reaction, or “looking” at the vessel (Table 4-11). Regardless of the vessel activity during recent exploration programs, approximately 4% of walruses exhibited an escape reaction (movement from the ice to the water or vigorously swimming away from the vessel) (Shell, 2015b). Of the 238 groups of walruses recorded during general vessel activities (i.e., activities other than those associated with drilling, ice management, and anchor handling) conducted during Shell’s 2012 exploration drilling program at the Burger Prospect, 59% (140 of 238 sightings) exhibited no reaction to vessels, 23% (55 of 238 sightings) looked at the vessel(s), 10% (23 of 238 sightings) changed direction, and 3% (7 of 238 sightings) increased speed (Bisson et al., 2013); documentation that supports the findings by Brueggeman et al. (1990, 1991) and Fay et al. (1984).

The fleet associated with the proposed drilling operation could come into contact with individual or groups of walruses during transit from Dutch Harbor and other locations or while at a drill site. Shell anticipates that OSV's will make approximately 30 trips back and forth from Dutch Harbor to the Proposed Action area for resupply each drilling season. Walruses may move through the drill site areas while foraging or transiting between ice and shore (Aerts et al., 2012; Jay, Fischbach, and Kochnev, 2012). If pack ice remains in the area when drilling begins, walruses may be associated with the pack ice. If the ice is far from the activity area, few walruses are likely to be encountered. However, small numbers of walruses might also be encountered in open water as they migrate from offshore feeding areas to terrestrial haulouts, which has occurred in recent years as sea ice melted or receded beyond the shelf break (LGL and JASCO, 2014). Repeated disturbance from vessel traffic could cause walruses to abandon an area, which would have energetic costs and has the potential to separate calves from their mothers (Garlich-Miller et al., 2011). In most cases, impacts to walruses would be limited to temporary displacement from the area of activity. Individual sound source levels for vessels associated with the Proposed Action are not expected to rise to the level of PTS or TTS (Figure 4-1; LGL et al., 2014). The identified vessel routes between the prospect and Barrow traverse the southern portion of the HSWUA (Shell, 2015a). This area was identified by USFWS and delineated based on high utilization of the area by tagged walruses (Jay, Fischbach, and Kochnev, 2012). The boundary of HSWUA changes by month through the June-September seasonal time frame in relation to monthly changes in the densities and distributions of walruses using the area (78 *FR* 35364, 12 June 2013). For much of the drilling season the extent of the HSWUA will be smaller than its maximum extent and the vessel route will lie outside its boundary. Shell is currently in discussion with USFWS with respect to the approach to operations that may occur in and around the HSWUA during and related to drilling activities, in order to minimize potential disturbance to walruses. The details of the monitoring and mitigation measures that are to be utilized in relation to the HSWUA will be fully documented in the MMPA authorization (Shell, 2015a).

Impacts to walruses would be greatest if they were displaced from the HSWUA high-density foraging habitat such as HSWUA and were unable to compensate by successful foraging elsewhere, or if individuals were flushed from large terrestrial haulouts; however, mitigation measures as described in Section 2.3 and in the 2015 Shell 4MP (Appendix B, Shell, 2015a), Shell’s *Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan* (Attachment E, Shell, 2015b), will reduce contacts and avoid incidental takes of walruses during transit to and from the site, are expected to minimize potential for displacement. Because Shell will comply with applicable MMPA authorizations, the impacts of vessel traffic associated with the Proposed Action on Pacific walruses are anticipated to be minor.

Ice Management. Ice management operations are expected to have the greatest potential for disturbances to walruses. Response distances of walruses to open water vessels and icebreakers are expected to vary, depending on the size of the ship, engine power, and mechanical characteristics of the icebreaker; vessel activities; noise-propagation conditions; the age and sex of individuals exposed; and the activities they are engaged in when exposed (78 *FR* 35364, 12 June 2013). When comparing the reaction distances of walruses to icebreaking ships versus other ships traveling in open water, Fay et al. (1984) found that walruses reacted at longer distances to icebreakers. Fay et al. (1984) noted that male walruses entered the water and swam away when the vessel was 0.1–0.3 km away while females and young reacted similarly when the ship was 0.5–1 km away. Brueggeman et al. (1991) reported that walruses moved 20-25 km from active icebreaking operations, where noise levels were near ambient. In another study of 202 walrus groups observed on ice floes during icebreaking activities, approximately 32% dove into the water and approximately 6% became alert when on the ice when approached (Brueggeman et al., 1990, 1991, 1992). Concurrent aerial surveys indicated that walruses hauled out on ice floes may have avoided icebreaking activities within 10–15 km (Brueggeman et al., 1990). Of the 18 groups of walruses recorded during the seven days of active ice management activities conducted during the 2012 Shell EP Revision 1 drilling program at the Burger Prospect, 78% (14 of 18 sightings) exhibited no reaction to vessels and 22% (4 of 18 sightings) looked at the vessel(s) (Bisson et al., 2013).

During the Proposed Action, icebreakers may assist vessels in transit to and from locations during ice conditions, and support MODU operations if ice moves into the operating theater or during late fall ice conditions. Ice management would occur at distances of up to 20 miles upwind or upcurrent from the drill rigs. If pack ice is located within 10 to 20 miles (16 to 32 km) of the drilling unit, walruses would likely be affected. Currents in the Chukchi Sea often cause ice to accumulate around Hanna Shoal and the waters between Hanna Shoal and the Burger Prospect may be an area where active ice management is required. Effects would likely be limited to slight changes in distribution with some walruses avoiding the area or retreating to the center of the ice floe. All such impacts to Pacific walruses would be minor and temporary lasting only as long as the ice and walruses, which are moving with wind and current, are in the area. Individual sound source levels for ice management activities associated with the Proposed Action are not expected to rise to the level of PTS or TTS (Figure 4-1; LGL et al., 2014). In consultation with the USFWS, Shell developed the *Adaptive Approach to Ice Management in Areas Occupied by Pacific Walrus* (Appendix J of Shell, 2015a), which details specific actions to be taken prior to initiating ice management activities, when ice management activities are being considered in areas where walruses could be present. Adherence to this plan and/or other mitigation measures, as dictated by management agencies, is expected to lessen the potential for impacts to walruses from ice management activities.

Aircraft Traffic

Sources of flights in the Proposed Action include industry crew changes, industry marine mammal surveys, and ice surveys. Most offshore aircraft traffic in support of Shell's proposed drilling plan involves straight line flights for personnel transport and fixed-wing aircraft engaged in monitoring activities, primarily from Barrow (although Wainwright may be used as a contingency flight route) (Shell, 2015a and Shell, 2015a, Appendix C). Individual sound source levels for aircraft associated with the Proposed Action are not expected to rise to the level of PTS or TTS (Figure 4-1; LGL et al., 2014).

Walruses sometimes demonstrate responses to in-air sound, specifically aircraft, although individuals appear to be less sensitive to aircraft (Brueggeman, 1990; Fay et al., 1984). Walruses may be displaced from ice floes or terrestrial haulouts temporarily by aircraft or may expend energy reserves avoiding aircraft (Brueggeman, 1990; Brueggeman et al., 1991). Females with calves react most readily to potential disturbance events (Fay et al., 1984; USFWS, 2013b in USFWS, 2013a). During the 2012 Shell EP Revision 1 drilling activities at the Burger Prospects, 30 walruses hauled out on ice entered the water as the search-and-rescue helicopter departed the *Nordica*. PSOs communicated the position of the walruses, which were ~2.5 km (1.6 mi) from the vessel, to pilots before the helicopter departed. Vessels with helicopter decks were moved to distances >7 km (4.3 mi) from known walruses-on-ice prior to helicopter flights to/from the vessel after 6 Aug, and there were no additional observations of walruses entering the water during helicopter operations in the Chukchi Sea for the duration of the 2012 Shell EP Revision 1 program (Bisson et al., 2015).

As walruses spend more time ashore due to receding sea ice, the potential for disturbance events increases. Increases in physiological stress of adults or juveniles may reduce fitness and have implications for productivity and survivorship over time (Garlich-Miller et al., 2011; Jay, Marcot, and Douglas, 2011; Jay, Fischbach, and Kochnev, 2012; Seymour, 2014). However, mitigation measures as described in Section 2.3 and in the 2015 Shell 4MP (Shell, 2015a, Appendix B), Shell's *Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan* (Attachment E, Shell, 2015b), will reduce contacts and avoid incidental takes of walruses during transit to and from the site, and are expected to minimize potential for disturbance. Shell is currently in discussion with USFWS with respect to the approach to operations that may occur in and around the HSWUA during and related to drilling activities. Adherence to these and other mitigation measures, as dictated by management agencies, are expected to help to lessen the potential for impacts to walruses from aircraft traffic. Thus aircraft traffic associated with the Proposed Action is expected to have at most minor impacts to individual walruses, and negligible population level effects.

In addition to the mitigation measures described in Section 2.3 and as otherwise required by MMPA incidental take authorizations, potential disturbance to Pacific walruses could be reduced by relocating vessels with helicopter decks away from walruses-on-ice prior to helicopter flights to or from the vessel. BOEM recommends that Shell discuss with USFWS to identify an appropriate exact distance for relocation. In absence of this discussion, a distance of >7 km (4.3 mi), consistent with Shell's procedures after the 6 August 2012 incident, would minimize potential for similar events during the Proposed Action.

Discharges

Exploration drilling could result in the disposal of drilling fluids or cuttings onto the seafloor under terms of an EPA NPDES permit. The accumulation of these sediments on the seafloor could result in a direct loss of walrus foraging habitat. Exploration drilling fluids and cuttings may cause localized contamination of the seafloor in the Chukchi Sea. Trefry, Trocine, and Cooper (2012) found higher mercury levels at three stations within 500 m of the 1989 exploration wells at Burger and Klondike in the Chukchi Sea than at the other 106 stations tested in the Chukchi Sea. A similar study (Shell, 2009) in the Beaufort Sea did not find any residual contamination. Measurements by Neff et al. (2010) in the CSESP Burger Study Area found average concentrations of various hydrocarbons and all metals except for arsenic and barium to be lower than those reported for average marine sediment. Trefry, Trocine, and Cooper (2012) confirmed findings by Neff et al. (2010) that concentrations of all measured hydrocarbon types were well within the range of non-toxic background concentrations reported by other Alaskan and Arctic coastal and shelf sediment studies.

Pacific walruses are a long lived species that feed primarily on benthic invertebrates, some of which are known to concentrate contaminants (Doroff and Bodkin, 1994). Warburton and Seagers (1993) compared metal concentrations from 56 Pacific walrus liver and kidney samples collected from 1986 to1989 with 57 samples collected in 1981 to 1984 (Taylor, Schliebe, and Metsker, 1989). While still low, trace levels of selenium, arsenic and lead increased significantly between the two time periods. Selenium was the highest at 17.6 parts per million (ppm). Levels of cadmium and mercury did not increase; however, cadmium levels remained high (mean of 166.5 ppm). Both cadmium and mercury appear to be naturally occurring in the Chukchi Sea. Tsygankov, Boyarova, and Likyanova (2014) measured levels of cadmium, lead, and mercury in the muscle and liver tissues of Pacific walruses collected from the Bering Sea in 2011 and found the concentrations of these heavy metals to be lower compared to those in marine mammals from other regions of the world. While few studies have focused on the potential relationship between health and contaminant levels in walruses, the existing research has not identified any health impacts (Calle et al., 2002; Lipscomb, 1995; Wolkers et al., 2006).

The discharge of drilling fluids and cuttings during exploration activities is not expected to cause population-level effects to walruses, either through direct contact, or by affecting prey species. Any effects would be localized primarily around the exploration drilling sites because of the rapid dilution/deposition of these materials. The effects from such discharges are expected to be localized to a small proportion of available marine mammal habitat. Authorized discharges from exploration drilling are anticipated to result in a negligible level of effect on the Pacific walrus population.

Small Fuel Spill. The potential impacts of small oils spills have been analyzed in 2015 Second SEIS (USDOI, BOEM, 2015a; see also Appendix A of this EA) and are summarized here. For the purpose of analysis, it is estimated for this EA that two temporally and geographically separate 48 or 5 bbl spills of diesel fuel could occur. A small spill would dissipate over a few days and impacts from a small spill could result in a minor impact to some walruses if individuals come into direct contact with spilled fuel or experienced disturbance from cleanup activities. Because walruses are likely to avoid and disperse from areas with lots of human activity (such as cleanup crews or drilling operations), it is likely that those walruses that are not oiled immediately would avoid the area of the spill while cleanup activities were ongoing, and therefore no population-level impacts are anticipated.

Conclusion

In summary, the proposed exploration activities would occur near an area which often features high seasonal use by walruses, particularly females and calves, which are the more sensitive to disturbance. Depending on ice conditions and other factors influencing walrus distribution, a number of walruses could be temporarily disturbed when present within the vicinity of operations. Discernible behavioral responses such as displacement and avoidance could also result. However, these impacts would be limited to the time period and the general location in which activities are occurring, and are therefore expected to be short-term and localized. The Proposed Action is not expected to lead to the mortality of any individual walruses, and would not affect recruitment to the Pacific walrus population. Impacts to walruses from the Proposed Action are therefore expected to be minor.

As discussed in Section 2.4.1 of this EA, Shell's exploration activities must adhere to the conditions of required MMPA authorizations that would limit impacts on marine mammals to the level of negligible impact under the MMPA.

Polar Bear

This section refers to the Chukchi Bering Seas (CBS) stock of polar bears and the Southern Beaufort Sea (SBS) stock of polar bears. There is a substantial area of overlap between the two stocks, and activities in the northeastern Chukchi Sea would have the potential to impact both populations (78 *FR* 35364, 12 June 2013). Potential impacts to polar bears from exploratory drilling in the Chukchi Sea were analyzed in depth in the 2015 Second SEIS (USDOI, BOEM, 2015a), Final Environmental Assessment for the Final Rule to Authorize the Incidental Take of Small Numbers of Pacific Walruses (*Odobenus rosmarus divergens*) and Polar Bears (*Ursus maritimus*) During Oil and Gas Industry Exploration Activities in the Chukchi Sea (USFWS, 2013b, Section V.B.1), the Biological

Opinion for Polar Bears (*Ursus maritimus*) and Conference Opinion for Pacific Walrus (*Odobenus rosmarus divergens*) on the Chukchi Sea Incidental Take Regulations (USFWS, 2013a, pp. 39-44), the 2015 Biological Opinion for Oil and Gas Activities Associated with Lease Sale 193 (USFWS, 2015, Sections 5.3 and 5.5.9), Shell's EIA for this action (Shell, 2015a, Appendix C, Sections 4.8.2 and 6.3.6), and Shell's 2015 Application for Incidental Harassment Authorization for the Non-Lethal Taking of Polar Bears and Pacific Walrus in Conjunction with Planned Exploration Drilling Activities During 2015, Chukchi Sea, Alaska (Shell, 2015b, Sections 7, 9, and 10). These documents are incorporated here by reference and relevant information is summarized in the sections that follow. Limited information is available regarding functional hearing limits of polar bears in water and no hearing threshold criteria exist for polar bears (Finneran and Jenkins, 2012). The otariid ear is very similar to the ear of other carnivores, and therefore otariid PTS and TTS thresholds are used for polar bears (Finneran and Jenkins, 2012). Because otariid thresholds are also used for walruses, the potential for a single sound source associated with the Proposed Action to cause PTS or TTS in polar bears would be the same as described previously for walruses (Figure 4-1).

In general, polar bears are widely dispersed when on sea ice and few polar bears transit through the open water as far offshore as the Proposed Action area is located (+60 miles from the Alaska coastline) (Durner et al., 2004). The Proposed Action area covers a small area of the Chukchi Sea and adjacent regions where polar bears are expected to occur during the open water season (73 *FR* 33212, 11 June 2008; 78 *FR* 35364, 12 June 2013). Polar bears are common outside the Proposed Action area, including a large proportion of the Chukchi/Bering Sea population found in the western Chukchi Sea region of Russia and individuals from the southern Beaufort Sea Population that, although do occur in the Chukchi Sea, predominately utilize habitats in the central Beaufort Sea (73 *FR* 33212, 11 June 2008). Polar bears have been observed in the northeastern Chukchi Sea during the open water season, primarily when the pack ice is in the immediate vicinity (Aerts et al., 2011, 2012, 2013, 2014; Brueggeman 2009, 2010; Brueggeman et al., 1990, 1991, 1992; Shell, 2015a, 2015b; Wilson et al., 2014).

Exploratory drilling projects have the potential to disturb polar bears that are swimming between the pack ice and shore. Swimming can be energetically expensive for polar bears, particularly for bears that engage in long-distance travel between the leading ice edge and land (Monnett and Gleason, 2006; Pagano et al., 2012). Bears that encounter open water exploratory drilling operations may be temporarily deflected from their chosen path, and some may choose to return to where they came from (USFWS, 2013b). However, bears swimming to shore are most likely heading for reliable food sources (i.e., areas where ringed seal concentrations are high or Alaska Native-harvested marine mammal carcasses are on shore), for which they have a strong incentive to continue their chosen course (Bentzen et al., 2007; Koski et al., 2005; USFWS, 2012b in USFWS, 2013a). Therefore, although some bears may be temporarily deflected and/or inhibited from continuing toward land due to exploratory drilling operations, this interruption likely would be brief in duration. Due to the vast area over which polar bears travel and their dispersed distribution, the number of bears affected in this manner likely would be very small.

The majority of polar bears encountered (approximately 55%) during industry exploration programs from 2006–2012 did not exhibit an observable reaction to exploration activities (Table 4-12; Shell, 2015a and 2015b). The most common reaction exhibited by polar bears during this period, in approximately 33% of individuals, was an "attention" response, which USFWS does not consider to be biologically significant (78 *FR* 35364, 12 June 2013). The few remaining polar bears encountered during industry exploration programs from 2006–2012 reacted by approaching, avoiding, or fleeing activities (Table 4-12; Shell, 2015a and 2015b).

Table 4-12. Vessel Based PSO Polar Bear Sightings and Reaction Behaviors --2006-2012[1].

Year	Polar Bear Reaction					
	None	Attention	Approach	Avoidance	Flee	Unknown
2006	0	1	0	0	0	4
2007	0	0	0	0	0	0
2008	7	0	0	0	0	0
2009	0	0	0	0	0	0
2010	0	0	0	0	0	0
2011	0	0	0	0	0	0
2012	41	27	4	2	1	0

Notes: [1] Table displays numbers of polar bear sightings and reaction behaviors recorded by vessel-based PSOs during offshore oil and gas exploration programs in the Northeastern Chukchi Sea in 2006-2012.

The numbers of individual polar bears that demonstrated a reaction are considered to be overestimates due to multiple-counting by different PSO teams and also by the same individuals being tallied on multiple days.

Source: Shell, 2015b

Drilling

Polar bears are closely tied to the presence of the sea-ice platform for the majority of their life functions, including hunting (Amstrup, 2003). It is unlikely that open-water exploration drilling in the northeastern Chukchi Sea will impact polar bears or the abundance and availability of ringed and bearded seals, which are the primary prey of polar bears. Exploration drilling operations have a localized footprint of a few thousand square feet per well; in this case, more than 60 miles offshore. The MODUs and associated vessels will move out of the Chukchi Sea towards the end of the open water season.

During Chukchi Sea drilling operations in 1990, bears were widespread along the ice edge and somewhat evenly spaced (Brueggeman et al., 1991). After drilling began, bears were recorded from <2 km from the drill sites to >74 km from the drill sites. All polar bears observed during the study were associated with the pack ice. Results from monitoring during numerous oil and gas exploration programs (including seismic and G&G surveys and exploratory drilling) in 2006–2012 were similar to earlier studies, supporting a much stronger relationship between polar bear distribution and sea ice than with exploration activities (LGL, 2014 in Shell, 2015b) and a finding supported by scientific research efforts (Durner et al., 2009; Stirling et al., 1993). During the 2012 Shell EP Revision 1 drilling activities in the Chukchi Sea, no polar bears were observed while drilling was being conducted (Bisson et al., 2013) With the exception of two hours on September 10, the *Discoverer* did not begin drilling in the Chukchi Sea in 2012 until September 23 and the last vessel-based polar bear sighting in the Chukchi Sea in 2012 was recorded on 22 September (Bisson et al., 2013).

Consistent with previous determinations made by the USFWS (USFWS, 2013a) the potential impacts to polar bears from the drilling activity are anticipated to be short-term and behavioral in nature, and are expected to have a negligible impact on polar bear populations. Adherence to mitigation measures provided by management agencies as well as those described in Appendix C, in the 2015 Shell 4MP (Shell, 2015a, Appendix B), and in Shell's *Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan* (Shell, 2015b, Attachment E) will further reduce the potential for impacts to polar bears from exploration drilling activities associated with the Proposed Action.

ZVSP

The proposed ZVSP airgun array has been estimated to reach 160 dB in water, but to decrease below that level at less than 4 km from the drilling units (Shell, 2015a and 2015b). Polar bears are unlikely to be exposed to the sound energy generated by the ZVSP survey sound source located 10 to 23 ft. (3 to 7 m) below the sea surface because received levels of airgun sounds are reduced near the surface because of the pressure release effect at the water's surface (Greene and Richardson, 1988; Richardson et al., 1995) and most bears recorded near industry activities are on ice instead of in the water (e.g., Bisson et al., 2013). Polar bears in the water are also unlikely to be exposed to underwater sounds because they generally swim with their heads out of the water or at the surface, and polar bear diving activity is typically shallow and of short duration (Richardson et al., 1995; Stirling, 1974). Additionally, although the in-water auditory abilities of polar bears have not been studied, their hearing is presumably adapted for in-air hearing (Owen and Bowles, 2011).

The planned ZVSP survey duration will be about 10 to 14 hr at each drill site (Shell, 2015a). The potential for exposure of polar bears to sound energy from the ZVSP surveys is low given the density of polar bears in the Chukchi Sea, the frequency of observations at historical exploration drilling operations, and the short duration of ZVSP surveys. The 2015 Shell 4MP includes shutdown requirements if polar bears are observed within the area ensonified by the ZVSP survey (Shell, 2015a, Appendix B).

ZVSP survey sound energy is expected to have negligible effect on the overall abundance of the principle prey species (ringed seal and bearded seal). These prey species may avoid the immediate area surrounding the drilling unit and sound source, but any such avoidance would be temporary. Adherence to mitigation measures provided by management agencies as well as those described in Appendix C, in the 2015 Shell 4MP (Shell, 2015a, Appendix B), and in Shell's *Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan* (Attachment E, Shell, 2015b) will further reduce the potential for impacts to polar bears from ZVSPs. In summary, negligible impacts to polar bears are anticipated from the vertical seismic profiling planned under the Proposed Action.

Vessel Traffic

Most vessel operations associated with the proposed exploration drilling plan, including transit from Dutch Harbor will take place far offshore and in open water and are not expected to encounter polar bears. Few polar bears exhibited escape reactions when encountered by oil and gas exploration vessels in the Chukchi Sea from 2006 to 2012 (Table 4-12; LGL, 2014 in Shell, 2015b). Only one polar bear was observed fleeing an encounter from industry vessels in the three different years that polar bears were observed in the Chukchi Sea during this period (LGL, 2014 in Shell, 2015b). Nineteen polar bear sightings were recorded during the 2012 Shell EP Revision 1 drilling activities in the Chukchi Sea when vessels were engaged in general vessel activities (i.e., activities not directly associated with anchor handling, drilling, or ice management) (Bisson et al., 2013). The most common reaction types observed from both moving and stationary vessels were looking (nine sightings) and no reaction (seven sightings). These records were primarily of resting polar bears on ice. There were two records of a "swim towards" movement recorded from moving vessels and involved the same individual polar bear. Both times the vessels were moving slowly away (>2 knots) and eventually outdistanced the swimming bear. Pack ice was at least 10 km away in all instances of polar bears approaching project vessels in the Chukchi Sea during the 2012 Shell EP Revision 1 drilling activities (Bisson et al., 2013). Impacts to bears from vessels are likely to be limited to short-term disturbance and displacement from the immediate area of activity, resulting in some expenditure of energy, and as previously discussed, the number of bears potentially affected by vessel traffic is expected to be low due to low density of polar bears in the Chukchi Sea.

Adherence to mitigation measures under the MMPA authorizations as well as those described in Appendix C, in the 2015 Shell 4MP (Shell, 2015a, Appendix B) and in Shell's *Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan* (Shell, 2015b, Attachment E) will further reduce the potential for impacts to polar bears from vessel traffic. In summary, impacts from vessel traffic associated with the Proposed Action may result in minor impacts to a few individuals, but are likely to have a negligible impact on polar bear populations.

Ice Management. If icebreaking is needed to transit in or out of the Chukchi Sea, or if icebreakers need to manage ice that has approached the drill rigs during active drilling, then polar bears may be encountered. Shell's ice management plan is to avoid pack ice by moving the drill rigs offsite if necessary. Although this is for the safety of the ship and crew, it also reduces the likelihood of a need for icebreaking or encounters with polar bears. Shell's intention is to wait to enter the Chukchi Sea until on or about July 1 when the ice has receded north of the drill site. During transit into the Chukchi Sea, Shell may encounter some broken melting ice. During transit out of the Chukchi Sea, Shell may encounter some first year ice. While at the drill site, ice management may involve nudging floes of ice away from the drill ship. This is usually done by using propwash to push the ice floe into a different part of the current so that it will flow past the drill rigs rather than into the drill rigs.

Polar bears may approach or avoid ice breakers (78 *FR* 35364, 12 June 2013). During Chukchi Sea drilling operations in 1990, 23 polar bears were observed during ice reconnaissance and four of these were observed near the drill site (Brueggeman et al., 1991). Of the 23 bears observed during ice management activities, five did not respond, nine watched the icebreaker pass them, seven slowly walked or swam away from the ship, and two walked toward the ship. Responses were limited to these brief changes in behavior. A total of 25 polar bear sightings were recorded during periods of ice management during the 2012 Shell EP Revision 1 drilling activities in the Chukchi Sea (Bisson et al., 2013). It is difficult to estimate the number of unique individuals as opposed to multiple resightings of the same bears by different vessels over the span of several days. Of the sightings recorded, the most common reaction was no reaction (48%, 12 of 25 sightings), followed by looking (44%, 11 of 25 sightings). PSOs reported two sightings where the reaction was an increase in speed (Bisson et al., 2013). The behavioral responses and temporary displacement that may potentially result from exposure of polar bears to ice management activities of the Proposed Action may result in minor impacts to a few individuals, but are likely to have a negligible impact on polar bear populations. Adherence to mitigation measures under the MMPA authorizations as well as those described in Appendix C, in the 2015 Shell 4MP (Shell, 2015a, Appendix B) and in Shell's *Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan* (Shell, 2015b, Attachment E) will further reduce the potential for impacts to polar bears from ice management activities.

Aircraft Traffic

Sources of flights in the Proposed Action include industry crew changes and industry marine mammal surveys. Flights during crew change outs will follow a fixed route from Barrow (although Wainwright may serve as a contingency route) to the drill sites over open water and are unlikely to disturb polar bears. Polar bears may be displaced from ice floes or terrestrial sites temporarily during marine mammal surveys, which will follow a sawtooth pattern near shore. Behavioral reactions of polar bears to aircraft depend on the lateral distance, flight altitude, and the type of aircraft. Reactions range from no detectable response to running away from aircraft. During aerial surveys conducted by USFWS, researchers reported 14.2% to 28.9% of polar bears changed their behavior when surveys were conducted at an altitude of 300 feet (Rode, 2008, 2009, 2010 in USFWS, 2015). The probability of potential impacts to polar bears from aircraft associated with the Proposed Action is much lower than the aforementioned USFWS surveys because MMPA authorizations require industry aircraft to maintain a 1,500 ft minimum altitude (Shell, 2015a, Appendix B). Impacts from these short term temporary disturbances are limited to some expenditure of energy for individual bears.

As polar bears spend more time fasting onshore due to receding sea ice, the potential for small repeated energetic costs to have health impacts increases. Increases in physiological stress of adult or juveniles may reduce fitness and have implications for productivity and survivorship over time (Boonstra et al., 2001; Bromaghin et al., 2015; Rode et al., 2010, 2014, 2015). Adherence to mitigation measures under the MMPA authorizations as well as those described in Appendix C, in the 2015 Shell 4MP (Shell, 2015a, Appendix B) and in Shell's *Polar Bear, Pacific Walrus, and Grizzly*

Bear Avoidance and Human Encounter/Interaction Plan (Shell, 2015b, Attachment E) will further reduce the potential for impacts to polar bears from vessel traffic. In summary, aircraft traffic associated with the Proposed Action may result in minor impacts to a few individuals, but is likely to have a negligible impact on polar bear populations.

Onshore Support Activities

Most polar bears occur in the active ice zone, far offshore, hunting throughout the year, although they spend a limited time on land to feed or move to other areas (USFWS, 2015). Polar bears present onshore in the vicinity of Shell's shorebase operations could be affected, however adverse impacts are not expected. To prevent human-polar bear interactions that may lead to the injury or killing of a bear in defense of human life, Shell has requested MMPA authorization to deter polar bears away from facilities (e.g., shorebase facilities). If authorized deterrence events were to occur, most are not likely to involve contact with the bear and would likely cause only minor, temporary behavioral changes (e.g., a bear runs or swims away) (USFWS, 2015). While deterring a polar bear will affect its short-term behavior, it is unlikely to significantly reduce the animal's survival (USFWS, 2015). All shorebase expansions planned for Proposed Action would occur on existing gravel pads, and would have no effect on polar bears or polar bear habitat, because the land has been previously disturbed and human presence already exists at the sites. Polar bears generally do not den along coastal areas of the Chukchi Sea (USFWS, 2015). Furthermore, the proposed activities will occur during the open water season when polar bears are not in dens (USFWS, 2013a, 2013b; 78 *FR* 35364, 12 June 2013). Construction is not expected to affect polar bears because noise related to construction will be minimal and temporary. Adherence to mitigation measures provided by management agencies as well as those described in Appendix C, in the 2015 Shell 4MP (Shell, 2015a, Appendix B) and in Shell's *Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan* (Shell, 2015b, Attachment E) will further reduce the potential for impacts to polar bears from onshore support activities associated with the Proposed Action. Therefore these activities may result in minor impacts to a few individuals, but are likely to have a negligible impact on polar bear populations.

Discharges

The discharge of drilling fluids and cuttings during exploration activities is not expected to cause impacts to polar bears, either through direct contact, or by affecting prey species. Any effects would be localized primarily around the exploration drilling sites because of the rapid dilution/deposition of these materials. The effects from such discharges are expected to be localized to a small proportion of available marine mammal habitat.

Small Fuel Spill. The potential impacts of small oil spills have been analyzed in the 2015 Second SEIS (USDOI, BOEM, 2015a; see also Appendix A of this EA) and are summarized here. For the purpose of analysis, it is estimated for this EA that two temporally and geographically separate 48 or 5 bbl spills of diesel fuel could occur. A small spill would dissipate over a few days and impacts from a small spill could result in a minor impact to some polar bears if individuals come into direct contact with spilled fuel or experienced disturbance from cleanup activities. Given the dispersed distribution of polar bears and because it is likely that a small spill persisting for less than 2-30 days would affect few polar bears, resulting in a negligible level of effect on the polar bear population.

Conclusion

The specified activity involves the drilling of exploratory wells and associated activities in the Chukchi Sea during the open-water season. The most likely impacts of the Proposed Action to polar bears could be behavioral disturbance reactions and localized, temporary displacement of some individuals from vessel and aircraft activity are anticipated to have negligible impacts on polar bears. Likewise, impacts from drill cuttings, drilling muds, and other discharges, and from small fuel spills are anticipated to be negligible. The overall impact to polar bears from the Proposed Action is anticipated to be negligible.

Seals

Pinnipeds share many anatomical and behavioral similarities. For this reason, the phocid seals were categorized into a single "functional hearing group" by Southall et al. (2007) for the purposes of noise impact assessment on seals. Because of the difficulties associated with performing physiological studies on seals in the wild, some species have been studied more extensively than others. Though the type and quantities of studies performed on pinnipeds varies greatly among different species, shared biological and behavioral similarities permit the use of existing information on one seal species as a close proxy for others. Consequently, it is most efficient to analyze bearded, ribbon, ringed, and spotted seals collectively as ice seals, to avoid redundancy.

Figure 4-2 shows noise levels from most activities in the Proposed Action remain too low to temporarily or permanently affect the hearing abilities of ice seals. Only the VSP airguns could potentially alter the hearing abilities of any seals, and only within a few meters of the firing airguns. Source noise levels at the remaining IPFs would be insufficient to produce temporary or lingering effects to seal auditory capabilities.

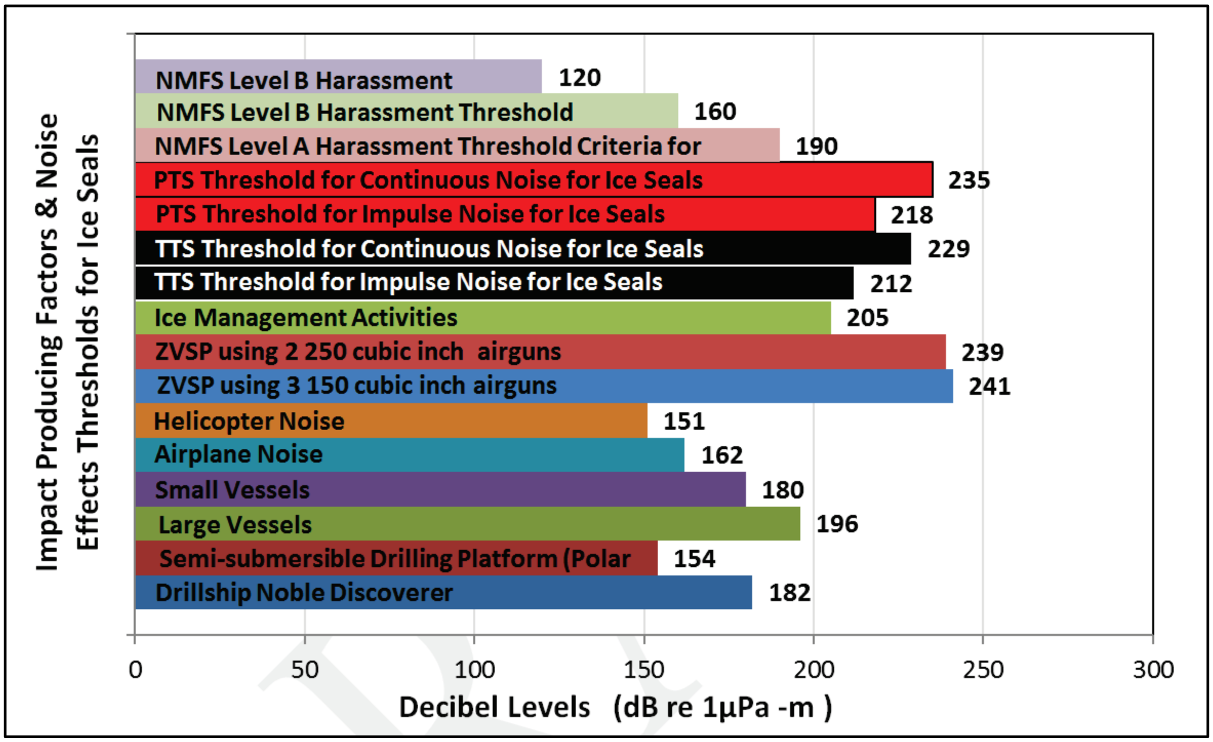

Figure 4-2. Comparison of NMFS Noise Level Criteria and estimated source Noise levels. *The bar chart compares noise levels at source with best estimates of TTS/PTS hearing thresholds and MMPA marine mammal harassment criteria used by the NMFS. (Sources: 2015 Shell EP (Table 2.9-1); 2015 Shell 4MP (p. 5-7); 2015 Shell EIA (p. 2-40 thru 2-43), 20l5 Second SEIS (Section 4.3.7.1, p 273-281); Ciminello et al. 2013).*

Figure 4-3 shows overlap of noise frequency bandwidths between the IPFs in the Proposed Action and the frequency bandwidth used by ice seals. While all of the IPFs produce noise within the bandwidth used by ice seals, fixed-wing aircraft and noises from the *Discoverer*, when it's drilling, would occur over the greatest portion of the bandwidth audible to phocid seals. Drilling noise is mostly propagated at frequencies below 32 kHz, about 48 kHz below the highest audible frequencies for ice seals. Fixed-wing aircraft produce noises in frequencies that almost completely overlap the frequency spectrum audible to seals. Figure 4-3 is portrayed on a logarithmic scale, meaning the bottom to top increase in frequencies incrementally occurs on an order of magnitude (1, 10, 100, 1000, etc.) rather than linearly (1, 2, 3, 4….or 10, 20, 30…). Consequently, subtle changes at the higher frequencies lose meaning, while differences in the lowest frequencies could be over-emphasized. Nonetheless, because of the range in frequencies being discussed, a logarithmic metric of measure that can accurately compare bandwidths is necessary, since a linear portrayal would be too large and unwieldy and would not illustrate subtle differences in measurements.

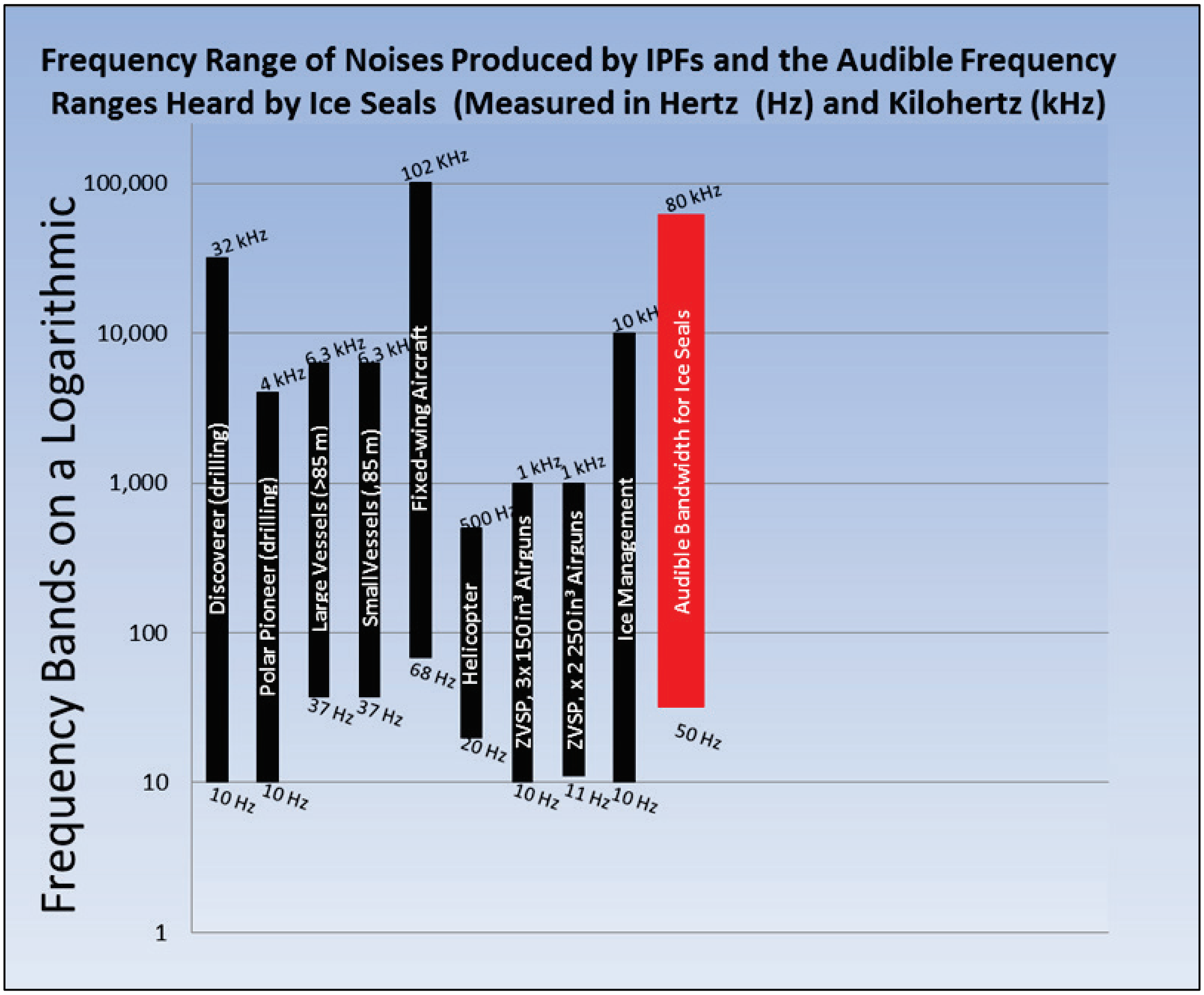

Figure 4-3. Ice Seal Hearing Compared to Proposed Action Noises. *Figure illustrates the frequency range of noises produced by IPFs and the audible frequency ranges heard by ice seals (measured in Hertz (Hz) and Kilohertz (kHz). (Sources: 2015 Second SEIS (Section 4.3.7.1, p. 274-281; LGL, JASCO, and Greeneridge Sciences, Inc., 2014).*

Figure 4-3 also illustrates the improbability of a seal having its entire audible spectrum masked. Because the values in Figure 4-3 are based on measurements at the source, they do not account for attenuation into the environment, particularly for fixed-wing aircraft which would fly at altitudes >1,500 ft, allowing most of the source levels and frequencies to attenuate before contacting the water surface.

Taken together, Figures 4-2 and 4-3 reveal that it is unlikely the complete audible bandwidth for seals could be subject to masking by Proposed Action activities. These figures also show that only the ZVSP airguns have the potential to elicit a Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS); any such effects would only occur in the lower 1/80th of a seal's audible bandwidth and only if the affected seal were close enough to the noise source for decibel levels to rise above the TTS or PTS threshold for that seal (NMFS, 2015c, Figure 11; 80 *FR* 11726, 4 March 2015 (Table 1)).

The following analyses for different IPFs that could affect ice seal species supplement the analyses made most recently in Section 4.3.7.1 of the 2015 Second SEIS and in the proposed IHA for the Proposed Action (NMFS, 2015c; 80 *FR* 11726, 4 March 2015).

Drilling

Ringed seals have demonstrated very limited responses to drilling activities. While monitoring marine mammal distribution and reactions to drilling in the Beaufort Sea with the *Kulluk*, Brewer et al. (1993) observed ringed seals approaching within 33 ft (10 m) of the drilling vessel and concluded that seals were not disturbed by drilling activity. While monitoring seals at another Beaufort Sea drill site, Gallagher, Brewer, and Hall (1992) observed seals within 115 ft (35 m) of the drillship *Northern Explorer II*, indicating a high level of tolerance to such sounds and activities. Other studies of drilling activities in the Beaufort Sea have shown minor and temporary disturbance effects. Frost and Lowry (1988) concluded that local ringed seal populations were less dense within a 2-nautical mile buffer of manmade islands and offshore wells that were being constructed in 1985-1987. Moulton et al. (2003) found less marked differences in ringed seal densities on the same locations to be higher in years 2000 and 2001 after a period of habituation. More recent marine mammal monitoring the 2012 Shell EP Revision 1 drilling season in the Chukchi and Beaufort Seas support these earlier observations (LGL, JASCO, and Greeneridge Sciences, Inc., 2014). Thus, it seems ringed seals may be somewhat disturbed by drilling operations for a period of time, until the activity has been completed. Adult ringed seals likely habituate to long-term effects of drilling, artificial island construction, and continuous operations that cumulatively create a much greater level of disturbance than what is proposed.

Sound energy introduced into the environment of marine mammals has the potential to cause masking (covering of sounds that would otherwise have been heard) of other sounds that are present in the environment. Masking can interfere with the detection of important natural sound sources and underwater drilling sounds could possibly mask some environmental sounds (Terhune, 1981) or communication between marine mammals (Perry and Renouf, 1987). However, in a study conducted by Cummings, Holliday, and Lee (1984), in which breeding ringed seals were subjected to recordings of industrial sounds, there were no documented effects on ringed seal vocalizations.

Figure 4-2 shows decibel levels produced by the *Discoverer* would be insufficient to elicit a TTS or PTS and would occur in the bottom 32 kHz of the frequency bandwidth used by seals, while source levels for the *Polar Pioneer* would most likely occur in the bottom 6 kHz of the audible frequency bands.

Because of the short duration of the proposed activities, unremarkable biological site characteristics, and the observed effects of offshore drilling on seals, measureable population level effects are not anticipated to occur. Consequently, drilling noise is expected to have a negligible level of effects on bearded, ribbon, ringed, and spotted seals in the vicinity of the prospects.

ZVSP

Seals do not echolocate as do cetaceans, and use their tactile senses and vision to forage instead of sound. Ringed seal reactions to seismic surveys are expected to be restricted to small distances and brief durations, with no long-term effects. Southall et al. (2007) proposed that auditory (PTS) injury could occur in seals exposed to single sound pulses at 218 dB re: 1 µPa in water; however, injury from most large seismic surveys would only occur if animals entered the zone immediately surrounding the source. The sound levels produced by the ZVSP airguns are relatively small and are insufficient to elicit a TTS or PTS in any known seal species beyond a few meters from the airgun (NMFS, 2015c; 80 *FR* 11726, 4 March 2015 (Table 1)).

Most ice seals spend greater than 80% of their time submerged in the water (Gordon et al., 2003) and some could be exposed to sounds from ZVSP surveys that occur in their vicinity. Underwater audiograms for ice seals suggest that they have very low hearing sensitivity below 1 kHz, though they can hear underwater sounds at frequencies up to 60 kHz, making calls between 90 Hz and 16 kHz (Thomson and Richardson, 1995; Richardson et al., 1995). The auditory bandwidth for pinnipeds in water is approximately 50 Hz to 80 kHz (Figure 4-3), and while seismic activity can contain sound up to 1 kHz, most of the emitted sound is less than 200 Hz, putting seismic noise at the very lowest end of the auditory spectrum for seals. Gordon et al. (2003) suggested that phocids may be susceptible to the masking of biologically important signals by low frequency sounds, such as those from seismic surveys; while brief, small scale masking episodes might have few long term consequences.

Reported seal responses to seismic surveys have been variable and often contradictory, although they suggest ice seals often remain within a few hundred meters of large airgun arrays that are firing (Blees et al., 2010; Brueggeman et al., 1991; Harris, Miller, and Richardson, 2001; Miller and Davis, 2002; LGL, JASCO, and Greeneridge Sciences, Inc., 2014).

ZVSP operations have a limited potential to affect fishes and some invertebrate species that seals consume (USDOI, MMS, 2006b). Potential impacts to prey species are analyzed in Sections 4.2.3 and 4.2.4, Lower Trophics and Fish. If seismic surveys cause prey items to become scarce, either because they move out of an area or become more difficult to catch, seal distributions and feeding rates could be affected, especially those of newly weaned ringed seal pups (Gordon et al., 2003). It is also possible that damaged or disoriented prey could attract ice seals to seismic-survey areas, providing robust short-term feeding opportunities (Gordon et al., 2003).

Pinnipeds are unlikely to show a strong avoidance reaction to the 450 and 500 in^3 airgun arrays that would be used for the ZVSP program. Additionally, ZVSP operations should not last more than 10-14 hours, which lessens the chance of a seal being affected by airgun noise. Visual monitoring from seismic vessels has shown only slight avoidance of large airgun arrays by seals, who displayed small changes in behavior (LGL, JASCO, and Greeneridge Sciences, Inc., 2014). Consequently, the ZVSP seismic activities are expected to have a negligible level of effects on ice seals, which would avoid the immediate area around the airguns for a few hours.

Vessel Traffic

Most likely some seals will be present in the project area when the exploration drilling operations are occurring, though seals appear to be fairly tolerant of vessel traffic. The most common seal species (in likely order of occurrence) are ringed, spotted, and bearded seals, with very low ribbon seal occurrences.

The 2015 Shell EIA states that vessel speed will be reduced during inclement weather conditions in order to avoid accidental strikes to marine mammals (p. 4-91). NMFS (2013a) concluded the probability of a BOEM authorized ship striking a ringed or bearded seal was sufficiently small as to be discountable, and that seals are well-equipped to respond to any displacement that might occur resulting from a passing ice-breaker (Shell, 2015a, Appendix C, p.4-143, para 6).

Vessel traffic may temporarily displace seals from preferred feeding areas or resting areas, or it may briefly alter travel routes of individual seals, resulting in small energetic costs that are not measurable. Richardson (1995) found that vessel noise does not seem to strongly affect ice seals already in the water, but seals on haulouts often respond more strongly to the presence of vessels by slipping into the water. Brewer et al. (1993) reported observations of ringed seals following ice management vessels in the Beaufort Sea, apparently feeding on fish and plankton in the disturbed waters.

During open water surveys in the Beaufort and Chukchi Seas (Harris, Miller, and Richardson, 2001; Blees et al., 2010; and Funk et al., 2010) ringed and bearded seals showed slight aversions to vessel activity. Funk et al. (2010) noted—among vessels operating in the Chukchi Sea where received sound levels were <120 dB—40% of observed seals showed no response to a vessel's presence, slightly more than 40% swam away from the vessel, 5% swam towards the vessel, and the movements of 13% of the seals were unidentifiable. In the same Chukchi Sea surveys, 60% of the observed seals "…exhibited no reaction to vessels…", and 27% displayed an "attention" response (they looked at the vessels). In concurrent surveys conducted in the Beaufort Sea where sound levels were <120 dB, approximately 30% of observed seals showed no reaction to vessel activity, 50% looked at the vessel, and 10% entered the water. Funk et al. (2010) concluded that bearded seals were more likely to occur near the pack ice margin than in open water, and that it is likely some individuals near the vessels were displaced to a limited extent. Brueggeman (2010) noted that in 2008 and 2009 ringed seal behavior was dominated by swimming (49%), diving (20%), and "attention" response (18%).

Blees et al. (2010) reported a total of 16 ringed seals and 69 bearded seals were observed by monitoring vessels where the received noise levels were <120 dB during Statoil's 2010 seismic surveys in the Chukchi Sea. Of those observations, the seals responded mainly by looking at the vessel (56.7%) or showed no reaction at all (32.8%). Blees et al. (2010) noted seals responded to the vessel by looking (37.5%) or simply did not respond to the vessel's presence (62.5%) when the M/V Geo Celtic was performing non-seismic activities. Summarily, the majority of seals encountered by Statoil's monitoring vessels reacted by looking at the vessel (51%) or by showing no obvious reaction (39%). Consequently, ringed seals did not appear to be affected by vessel traffic with background noises below 120 dB in the 2006-2008 (Funk et al., 2010) or the 2010 (Blees et al., 2010) surveys, when they were in open water conditions and not hauled out on ice. However, in Blees et al. (2010) ringed, bearded, ribbon, and spotted seals were collectively grouped together in the analyses. Blees et al. (2010) noted seal observations by individual species; however, their analysis for sighting rates used the cumulative number of ice seal observations as a collective group rather than individual species, which would have been much lower. More recent observations from the 2012 Shell EP Revision 1 drilling season (LGL, JASCO, and Greeneridge Sciences, Inc., 2014) yielded similar results to those made in earlier exploratory drilling programs in the Chukchi Sea.

Vessels could strike a small number of seals in open water conditions. Seals that closely approach larger vessels may potentially be drawn into bow-thrusters or ducted propellers. In recent years, gray and harbor seal carcasses have been found on beaches in eastern North America and Europe with injuries indicating the seals may have been drawn through ducted propellers (Thompson et al., 2010). However, adult seals are agile and should easily avoid vessels in open water conditions, and no similar seal mortalities have been observed in Alaska to date.

Considering most sea ice is absent from the project area during the open water season, and the small impacts of vessel traffic on seals, the effects, including those resulting from the up to 30 resupply trips from Dutch Harbor, are expected to be brief and negligible—mostly resulting in temporary avoidance responses by seals such as slipping off of ice and into the water, diving, or briefly avoiding approaching vessels.

Ice Management. The Proposed Action includes ice management and the potential for icebreaking in certain circumstances. Bearded seals showed very limited reactions to icebreaking and have been observed approaching to within 656 ft (200 m) of ice breakers (Brewer et al., 1993). Reeves (1998) reported some ringed seals have been killed by icebreakers moving through fast-ice breeding areas, and that the passing icebreakers could have far-reaching effects on the stability of large areas of sea ice. This project, however, would occur during the open-water season, long after sea ice retreats north of the prospect areas and after all of the shorefast ice has melted. The whelping and molting seasons for all four seal species would conclude in May-July, prior to the commencement of the Proposed Action. As fewer seals are likely to linger in the prospect areas after the sea ice has retreated north, no seals should be injured or killed by icebreaking activities. Consequently icebreaking and ice-management should have negligible effects on seals, resulting at most in temporary avoidance in the open water.

Aircraft Traffic

A study noting counts of ringed seal calls in water performed by Calvert and Stirling (1985) suggests seal abundance in an area subjected to low-flying aircraft and other disturbances was similar to what was observed in less disturbed areas. Concentrations of animals hauled out on land seem to react more severely than the scattered small groups found on the sea ice in spring; in summer spotted seals haul out in large numbers on the sand bars near Kasegaluk Lagoon. Surveys by Rugh, Shelden, Withrow (1997) found spotted seals showed immediate reactions to the presence of survey aircraft at altitudes up to 4,500 ft (1,370 m) and up to 2 km away. Shell's flight routes would go directly from Barrow or Wainwright out to sea, or 5 mi inland between Barrow and Wainwright, so disturbances of spotted seals at terrestrial haulouts are not expected.

Any other disturbances of seals by Shell's aircraft would be temporary and localized to small numbers of seals hauled out on remnant ice floes or already in the water. The potential impacts on seals from aircraft traffic would be mostly mitigated by the proposed flight corridor (Shell, 2015a, Figure 13.e-2), which minimizes the portion of flights over coastal waters. Flights between Barrow and Wainwright would occur inland of Peard Bay to minimize effects on subsistence and subsistence resources including seals.

Shell has incorporated other measures to reduce the chance of disturbing seals by restricting aircraft to altitudes above 1,500 ft (457 m), unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, or in cases where personal safety requires lower altitudes. Aircraft traffic and noise would have a negligible level of effect on ice seals.

Discharges

The Proposed Action entails the discharges of wastewater, drill cuttings, and drilling fluids. As noted above, the areas affected by these discharges would be small, would recover quickly, and would be in the general proximity of activities causing enough noise to discourage visitation by seals. Identifiable impacts to seals from discharges are therefore unlikely.

Small Fuel Spill. The potential effects of a 48 or 5 bbl oil (the amount estimated for a small spill in this EA) or fuel spill on seals and persisting for only a few days as described in the 2015 Shell EIA (Table 2.10-1) a negligible level of effects to ice sales would occur. Such a small spill would be insufficient to produce any persistent or lingering effects on seals. Because seals are believed to have the ability to detect and avoid oil spills (Geraci, 1990; St. Aubin, 1990) it is unlikely any would be able or willing to enter an area covered by a small spill and contact the seal, particularly during the short duration of the spill and the small geographic area that would be affected. Moreover, the weathering process should quickly break up or dissipate oil/fuel through the local environment to harmless residual levels that would eventually become undetectable. For these reasons, a small fuel spill would have negligible impacts on ice seals.

Bering Sea Pinnipeds

While BOEM does not regulate transit from Dutch Harbor, Dutch Harbor is being considered in the analysis of the EA. Shell anticipates that OSV's will make approximately 30 trips back and forth from Dutch Harbor to the Proposed Action area for resupply each drilling season. Because Bering Sea pinnipeds are classified within the same functional hearing group that ice seals are, and because of shared anatomical and environmental characteristics, the effects of vessel traffic on them would be the same or less than those for ice seals. Dutch Harbor, Alaska is an extremely busy commercial port and thousands of vessels pass through the area annually. In spite of the high level of vessel traffic, harbor seals and northern fur seals commonly occur throughout the Bering Sea. Steller sea lions remain listed under the ESA, but their decline in numbers has not been attributed to vessel traffic levels, and periodically Steller sea lions visit boat docks, and coastal haulout areas in and around Dutch Harbor, as do harbor seals. The ease of habituation to shipping vessels, and commercial activities suggests harbor seals and Steller sea lions might not be adversely affected by vessel traffic to any substantial degree. Northern fur seals mostly feed in the open ocean in deep water near the continental shelf break and it is anticipated that few would be affected by vessels in the Proposed Action. Consequently a negligible level of effects to harbor seals, northern fur seals, and Steller sea lions is anticipated for project-associated vessel traffic to and from Dutch Harbor, Alaska.

Northern Sea Otters

While BOEM does not regulate transit from Dutch Harbor, it is anticipated that OSVs will make approximately 30 trips back and forth from Dutch Harbor to the Proposed Action area for resupply each drilling season. Impacts to the Southwest DPS of northern sea otters from this vessel traffic could include vessel strikes and small fuel spills. However, with mitigation measures on vessel speed, boat strikes will be decreased to the lowest level possible and will have a negligible impact on this listed stock of northern sea otters. In addition, after reviewing the potential effects of small fuel spills on northern sea otters, BOEM finds a negligible level of effect applies because the small spill(s) would be insufficient to produce any population level effects on northern sea otters in Dutch Harbor and along the transit route.

Sea otter critical habitat is a narrow band of shallow habitat close to shore therefore it is anticipated that OSVs will only enter into critical habitat when docking in Dutch Harbor because boat size and maneuverability makes transit that close to shore in shallow water hazardous. The critical habitat at the port in Dutch Harbor has already been degraded due to the presence of the existing infrastructure. Vessel traffic due to this Proposed Action will not further impact critical habitat quality nor will it cause loss of critical habitat. BOEM has determined that transit activities in and near Dutch Harbor have no impacts on sea otter critical habitat.

4.2.6.3. Alternative 3 – Early Season Start

Cetaceans – Alternative 3

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS (for certain MMPA conditions) and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st. Ice conditions may impact the timing of cetacean presence in the Chukchi Sea and Proposed Action area. Therefore, presence of most cetaceans in the Proposed Action area is dependent on open water availability rather than calendar date. However, the assumption of this analysis for Alternative 3 is that open water season will remain July-October.

In accordance with the analysis on Alternative 2 – Proposed Action, the most likely impacts of the Proposed Action for Alternative 3 could be behavioral disturbance reactions from the introduction of noise (drilling, ZVSP, vessel and aircraft noise, and ice management) into the marine environment and vessel and aircraft traffic. However, because of Spring movement patterns of some cetaceans into and through the Proposed Action area, activities prior to July (Alternative 3) could impact more cetaceans than activities after July 1st (Alternative 2) and may result in disturbance of more animals. The two species that are most likely to migrate through the area (i.e., the Chukchi Sea) prior to July are the beluga and bowhead whale. In the spring, beluga whales concentrate and migrate along open leads north from their wintering grounds in the Bering Sea, often near the coast. In addition, much of the Chukchi Sea stock of beluga whales (3,710 individuals; Frost, Lowry, and Carroll, 1993; Allen and Angliss, 2014) congregates in Kasegaluk Lagoon in June and July. During spring, bowheads migrate through spring lead systems to feeding areas in the eastern Beaufort Sea, and the vicinity of Barrow Canyon. Bowhead whales have an affinity for ice and are associated with relatively heavy ice cover that will likely be present in the Proposed Action area prior to July. Temporal segregation by size and sex class occurs during the spring (and fall) bowhead whale migrations. In the spring, the first wave consists of sub-adults, the second of larger whales, and the third is comprised of even larger whales (Koski and Miller, 2009; Noongwook et al., 2007); however, the cows with calves typically occur later in the migration. If Shell's operations occur prior to July at the end of the spring migration, there may be impacts to bowhead mother/calf pairs.

Harbor porpoise, minke, gray, and to a lesser extent humpback, fin, and killer whales are found in the Chukchi Sea during the summer and/or fall seasons and a start date prior to July would have impacts similar to those described for Alternative 2 – Proposed Action. The mitigation measures described for Alternative 2 would reduce the impacts to these species for Alternative 3 to the lowest level practicable.

Overall, Alternative 3 – Early Season Start is anticipated to have a minor level of effect on cetacean stocks. No mortality to any cetaceans is anticipated from Alternative 3 and all 'takes' would be at the MMPA Level B behavioral harassment level. Impacts would only occur during the time that the animals are in the ensonified areas and are expected to be short-term in duration and limited to behavioral disturbance. Although Alternative 3 could result in the Proposed Action being accomplished in fewer total seasons, which could reduce the overall impact to cetaceans associated with the project because impacts would accrue over a shorter time frame, this benefit would be offset by the greater impacts associated with an earlier and longer longer seasons. Cetaceans using Spring migratory corridors in the Chukchi Sea and cetaceans that frequent open leads in the Spring could be disturbed if the Shell MODUs and support vessels enter the Chukchi Sea through the Bering Strait prior to July. Currently the draft NMFS IHA (NMFS 2015c) for Shell exploration activities in the Chukchi Sea in 2015 does not cover cetacean takes prior to July.

Pacific Walrus – Alternative 3

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS (for certain MMPA conditions) and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st.Except as discussed below, the type, magnitude, duration, and geographical extent of potential impact factors to walruses from Alternative 3 are anticipated to be identical to those described for Alternative 2 – Proposed Action.

An earlier arrival at the project area would lengthen the period of time during which the drilling program could occur. A longer period of disturbance could increase the probability of impacts and the number of walruses impacted and would result in a greater level of effects per season. The fleet would likely operate in the drill site area for a longer time period each year, which would increase the time period during which impacts could occur. In addition, an earlier arrival at the project area could increase the probability of impacts to walruses because pack ice is more likely to be present in the vicinity of the project area earlier in the season (USDOI, BOEM, 2015a; USFWS, 2013b). The presence of pack ice could also increase the need for ice management and consequently impacts to walruses from this activity. Compliance with mitigation measures would minimize the potential impact to walruses from ice management and other drilling program activities.

However, Alternative 3 could have a lesser total adverse effect on walruses than Alternative 2 because the longer period of time could potentially allow a larger proportion of the drilling program to be completed in a given open-water season. Under Alternative 3 the drilling program could be completed in fewer seasons, therefore adverse effects could thus recur for a much shorter time period.

An earlier transit through the Bering Strait could also increase potential impacts to migrating walruses. Walruses (primarily females and young) migrate northward through the Bering Strait into the Chukchi Sea between mid-April and the end of June (Fay, 1982; Fay et al., 1984; Huntington, Nelson, and Quakenbush, 2012; Jay et al., 2010; Jay, Fischbach, and Kochnev, 2012; Oceana, Inc. and Kawerak, Inc., 2014; USFWS, 2013a, 2013b). Under Alternative 3, the drill rigs and support vessels would travel through the Bering Strait during the latter part of the migration, increasing the potential for disturbance and temporary displacement of walruses by vessel noise and presence. As discussed in Section 4.2.6.2, Pacific Walrus, Vessel Traffic subsection, disturbance and displacement could result in increased energetic costs, lost foraging opportunities, and calf-cow separation. Transit through the Bering Strait prior to July 1 could only occur if variances are issued by the USFWS and NMFS. The issuance of a variance by USFWS would be based upon review of seasonal ice conditions and available information on walrus and polar bear distribution in the area of interest in order to assess whether animals have dispersed from concentrations around the spring lead system (USFWS, 2013b, 78 *FR* 35364, 12 June 2013). For the purposes of this analysis BOEM therefore assumes that if Alternative 3 is selected walruses would be dispersed from the confines of the spring lead system by the time the drilling rigs and support vessels move northward through the Bering Strait. Compliance with mitigation measures would minimize the potential impact to migrating walruses from vessel traffic.

Overall, Alternative 3 – Early Season Start is anticipated to have a minor level of effect on Pacific walrus. No mortality to any walruses is anticipated from Alternative 3 and all ‘takes’ would be at the MMPA Level B behavioral harassment level. Impacts are expected to be short-term in duration and limited to behavioral disturbance and temporary displacement. Although Alternative 3 could result in the Proposed Action being accomplished in fewer total seasons, which could reduce the overall impact to walruses because impacts would accrue over a shorter time frame, this benefit would be offset by the greater impacts associated with an earlier and longer seasons.

Polar Bear – Alternative 3

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS (for certain MMPA conditions) and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st. Except as discussed below, the type, magnitude, duration, and geographical extent of potential impact factors to polar bears from Alternative 3 are anticipated to be identical to those described for Alternative 2 – Proposed Action.

An earlier arrival at the project area would lengthen the period of time during which the drilling program would operate each year, increasing the time period during which impacts to polar bears could occur. Additionally, an earlier transit through the Bering Strait could increase the potential for disturbance to bears from vessel traffic because in May and June polar bears are often found in relatively shallow continental shelf waters associated with ice as they move northward from the northern Bering Sea, through the Bering Strait into the southern Chukchi Sea (USFWS, 2013b). The increase in potential disturbance to migrating polar bears would not be substantial because migration into the Chukchi Sea generally occurs between March and May (Voorhees, Sparks, and Stickman, 2012); few bears would be expected to be present during June when Shell would transit through the Bering Sea. However, Alternative 3 could have a lesser total adverse effect on polar bears than Alternative 2 because the longer period of time could potentially allow a larger proportion of the drilling program to be completed in a given open-water season, potentially reducing the total number of years required to complete the program.

Polar bears remain in the consolidated pack ice of the Chukchi Sea as long as sea ice remains available, and move through the Chukchi Sea Planning Area in search of prey (USDOI, BOEM, 2015a). Under Alternative 3, the number of polar bears potentially impacted by the drilling program could be greater than under Alternative 2 is selected because pack ice is more likely to be present in the vicinity of the project area earlier in the season (USDOI, BOEM, 2015a). In addition, the presence of pack ice could require greater ice management efforts, increasing the probability of impacts to polar bears from this activity.

Ringed seals, polar bears' primary prey, concentrate at the edges of shorefast and pack ice during their molting period in late spring and early summer (Oceana, Inc. and Kawerak, Inc, 2014). An earlier initiation of the drilling program as proposed in Alternative 3 increases the probability of impacts from vessel traffic and ice management to this species during a period when they are particularly vulnerable to physiological consequences of disturbance (see Section 4.2.6.2, Seals subsection, for discussion of impacts to ringed seals). Disturbance and displacement of ringed seals could cause localized, short-term changes in distribution, making them less available to foraging polar bears. Conversely, seals that experience repeated disturbance and/or displacement could become temporarily exhausted, making them more susceptible to polar bear predation. Compliance with mitigation measures would minimize the potential impact to polar bears and their prey from ice management and other drilling program activities.

Overall, Alternative 3 – Early Season Start is anticipated to have a minor level of effect on polar bears. No mortality to any polar bears is anticipated from Alternative 3 and all 'takes' would be at the MMPA Level B behavioral harassment level. Impacts are expected to be short-term in duration and limited to behavioral disturbance and temporary displacement. Although Alternative 3 could result in the Proposed Action being accomplished in fewer total seasons, which could reduce the overall impact to polar bears because impacts would accrue over a shorter time frame, this benefit would be offset by the greater impacts associated with an earlier and longer seasons.

Seals - Alternative 3

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st. The effects on ice seals under Alternative 3 would not significantly differ from those described in Alternative 2 - Proposed Action, with the exception of vessel disturbances.

Though "open water" conditions might exist in vicinity of the Proposed Action, wind and currents could rapidly move large amounts of floating sea ice into the burger prospect. Such events could bring ice floes carrying molting or whelping seals in close proximity to exploration activities. Ice seals typically whelp from mid-March to mid-May and molt from late May to mid-July (Cameron et al. 2010; Kelly et al. 2010; Boveng et al. 2009; Boveng et al. 2008). The Bering Strait is one location where ice seals congregate due to the constriction of the ocean (Arctic Council, 2009).

Though unlikely, activities in Alternative 3 could occur early enough in the season to affect seal pupping or disturb ice molting seals. Molting seals need to remain hauled out to allow their skin to dry and their skin temperature to warm, before physiological processes force their pelt and outer layers of skin to shed. Disruptions to a seals annual molt cycle, such as vessels scaring seals into the water, could result in additional energetic and other physiological costs to each seal affected. If such disruptions occurred on multiple occasions negligible to minor effects could occur to individual seals.

Due to uncertainties in weather, and sea ice movements in the Leased Area it is presumptuous to assume earlier operations would equate to fewer years of activity on Shell's leases. However, if weather and sea ice permit season-long activities, the level of effects on ice seals should not change from what has already been described under Alternative 2 if avoidance mitigations are included.

Such effects could be further avoided if Shell were to avoid hauled out seals as described in the 2013 BO (NMFS, 2013a, Section 2.4.2.3 Exposure to Vessel Traffic) and if the avoidance mitigations for walrus haulouts (Shell, 2015a, Appendix C: p 4-132, “0.5 mi vessel avoidance of walruses on ice”)) are used as a proxy mitigation for ice seals.

The effects of Alternative 3 on seals would be similar to those described for Alternative 2 if the avoidance mitigation for Pacific walruses is applied to molting or whelping seals.Those effects would be negligible to minor, consisting of Level B harassment, and would not involve mortalities or recurring effects on pinnipeds.

4.2.6.4. Cumulative Effects

Marine mammals in the Chukchi Sea could be adversely affected by aircraft and marine vessel traffic, subsistence and commercial harvest activities, oil and gas related activities, and climate change. Potential cumulative effects on marine mammals in the Chukchi Sea from reasonably foreseeable past, present, and future activities have been analyzed in the 2015 Second SEIS (USDOI, BOEM, 2015a, Section 5.2.6) and are summarized below. Additional detailed discussion of cumulative impacts to marine mammals in the Chukchi Sea is presented in the Final Environmental Assessment for the Final Rule to Authorize the Incidental Take of Small Numbers of Pacific Walruses (*Odobenus rosmarus divergens*) and Polar Bears (*Ursus maritimus*) During Oil and Gas Industry Exploration Activities in the Chukchi Sea (USFWS, 2013b, Section V.B.4), the Biological Opinion for Polar Bears (*Ursus maritimus*) and Conference Opinion for Pacific Walrus (*Odobenus rosmarus divergens*) on the Chukchi Sea Incidental Take Regulations (USFWS, 2013a, pp. 48-50), the 2015 Biological Opinion for Oil and Gas Activities Associated with Lease Sale 193 (USFWS, 2015, Section 6), Shell’s EIA for this action (Shell, 2015a, Appendix C, Sections 5.2, 5.3.1, and 5.4.4) for the Shell proposed IHA.

Aircraft and Marine Vessel Traffic. Activities entailing the use of marine vessels and aircraft can impact marine mammals by temporarily altering their behavior. Potential behavior changes include deflections away from vessels or aircraft, cessation of calling, masking of received sounds, temporary separations of mother/calf pairs and interruptions of foraging, and resting or other behaviors, all of which have energetic costs. Temporary disturbances resulting from exploration activities associated with Alternative 2 – Proposed Action could add incrementally to temporary disturbances resulting from other activities in the region to have an adverse cumulative effect on marine mammals. Specifically, any additional activities occurring during the same time period and in the same general area, and requiring the use of large marine vessels or aircraft, may cause additional disturbances to these species. Appendix B of this EA describes the potential for ongoing aerial and vessel based wildlife surveys, routine vessel passage through the area for cargo transport, aerial wildlife surveys, and routine aerial transport of cargo and passengers. Aircraft traffic is expected to continue at approximately the same levels, although oil and gas industry use of aircraft is likely to increase as a result of increased interest in Alaska North Slope (ANS) exploration (NMFS, 2013). Vessel traffic through the Bering Strait has risen steadily over recent years and the U.S. Coast Guard anticipates a continued increase in vessel traffic in the Arctic (NMFS, 2013). The incremental impacts of Alternative 2 in conjunction with aircraft and vessel traffic activities in the region are expected to have a negligible incremental level of cumulative effect on these species and not extend beyond the lifetime of the Proposed Action.

Subsistence Activities. Subsistence hunting and other community activities associated with regional native villages such as Wainwright, Point Lay, and Barrow have persisted for millennia, and are expected to continue during the period of the Proposed Action. Temporary disturbances resulting from exploration activities associated with Alternative 2 could add incrementally to short-term, localized displacement and disturbance of marine mammals resulting from subsistence activities. This contribution would be minimal because the majority of the activities associated with the Proposed

Action are located far outside of subsistence harvest areas and existing lease stipulations and other mitigation measures (e.g., MMPA authorizations) seek to prevent the temporal and spatial overlap of industry and subsistence activities. The Proposed Action is anticipated to result in no serious injury or lethal take of marine mammals. The incremental impacts of Alternative 2 – Proposed Action in conjunction with subsistence activities in the region are expected to have a negligible level of cumulative effect on these species over the lifetime of this project.

Oil and Gas Related Activities. Oil and gas activities could have minor to moderate effects on marine mammals in and around the Leased Area, mostly through vessel traffic and elevated noise levels that could prove deleterious to individual animals. Since the early 1900s, oil and gas exploration has occurred on the ANS, and development and production have occurred since the early 1970s. More recently, exploration has occurred on the OCS and in onshore areas of the ANS. Other current and ongoing activities related to oil and gas, such as vessel and air traffic in state waters and onshore, are expected to remain at their current levels for the duration of the Proposed Action.

Appendix B of this EA describes additional industry activities that may occur during the timeframe of the Proposed Action. These include potential Ancillary Activities and G&G activities; however, no notices or permit for these activities have been submitted to BOEM. Temporary disturbances and displacement resulting from exploration activities associated with Alternative 2 – Proposed Action could add incrementally to potential impacts from ancillary and G&G activities, however, these effects would be short-term and localized, and the NEPA, ESA, and MMPA IHA process would limit the potential for separate industry activities to occur concurrently in time and space. The incremental impacts of the Alternative 2 in conjunction with other oil and gas related activities in the region are expected to have a negligible level of cumulative effect on these species over the lifetime of this project.

Climate Change. Decreasing sea ice may be changing patterns of habitat use for marine mammals, increasing the available range of some whales (Clarke et al., 2013), but decreasing available habitat for ice seals, polar bears, and walruses (Garlich-Miller et al., 2011; Hunter et al., 2010; Kovacs et al., 2011; Laidre et al., 2015). These changes are anticipated to have a growing impact over the long term for ringed and bearded seals and not so much for spotted and ribbon seals; however in the near-term, climate change should have little immediate effect on any ice seal species in the Chukchi Sea. Changes in sea ice extent related to climate change are altering the behavior and foraging opportunities of cetaceans, walruses, and polar bears (Pilford et al., 2015; Prop et al., 2015). Shoreline and barrier islands along the Chukchi Sea coastline are increasing in importance as habitat for the latter species, while increased sightings of cetacean species such as gray whales, humpback whales, and killer whales in the Chukchi Sea are indicative of a northward expansion in their ranges (Clarke et al., 2013). While major shifts in their productivity or migrations have yet to be measured to date, bowhead whales are expected to be adversely affected if sea ice losses continue because of increases in predators (i.e., killer whales), and due to potential decoupling of the benthic-pelagic foodweb. These changes are likewise anticipated to have a growing impact over the long term for ice seals, particularly ringed seals, which build their pupping lairs on sea ice (Quakenbush, Citta, and Crawford, 2011; Stirling and Smith, 2004). growing impact over the long term for ice seals, particularly ringed seals, which excavate their pupping lairs in sea ice (Quakenbush, Citta, and Crawford, 2011; Stirling and Smith, 2004). Ice seals in the Chukchi Sea would continue to be most adversely affected by predation and subsistence activities, and eventually climate change which would lead to sea ice loss, food web changes, and increasing amounts of marine vessel and aircraft traffic.

Climate change effects are difficult to predict, and no marked effects from climate change are anticipated over the small number of years necessary to complete the Proposed Action. The incremental increase of effects caused by the Proposed Action to existing and future impacts of climate change would be negligible and would not change the overall level of cumulative impacts to marine mammals from other past, present, and reasonably foreseeable future actions.

Predation. Predation will continue to have the greatest impact on ice seals, gray whales, and beluga whales that occur in the Chukchi Sea, but less so for other marine mammal species. Shell's Proposed Action should not significantly contribute to the impacts of predation on marine mammal populations.

Conclusion- Alternative 2

The Proposed Action would create negligible long-term detrimental effects and a few positive effects on marine mammal in the Chukchi Sea, but would not significantly add to the larger past, present, and reasonably foreseeable future cumulative effects.

Conclusion- Alternative 3

Alternative 3 – Early Season Start would not contribute any different incremental impacts to marine mammals than Alternative 2. The impacts to marine mammals from Alternative 2 and from reasonably foreseeable activities would amount to a negligible incremental contribution to the cumulative effect.

4.2.7. Terrestrial Mammals

This analysis tiers to the 2015 Second SEIS, Section 4.3.8 and incorporates by reference Sections IV.C.11 of the 2007 FEIS (USDOI, MMS, 2007), and the 2011 SEIS (Section IV.C.11) (USDOI, BOEMRE, 2011). The effects on terrestrial mammals of the exploration drilling proposed here would be the same as was described in these documents, which are summarized and incorporated below.

4.2.7.1. Alternative 1 – No Action

If Alternative 1 is selected, the proposed exploration activities would not be approved, and there would be no effects on terrestrial mammals.

4.2.7.2. Alternative 2 – The Proposed Action

The Western Arctic (WAH) and Teshekpuk Lake Caribou Herds (TCH), less than ten grizzly bears or moose, a few muskoxen, and foxes could be affected by aircraft travel along the proposed flight path between Barrow and Wainwright, Alaska. As discussed in the 2007 FEIS (USDOI, MMS, 2007, Section IV.C.3.i), 2011 SEIS (USDOI, BOEMRE, 2011, Sections IV.C.11 and IV.E.12), the 2015 Second SEIS (USDOI, BOEM, 2015a, Sections 4.3.8 and 4.5.8), and in the NPRA FEIS (USDOI, BLM, 2012, Section 4.3.9) studies and observations of caribou, muskox, moose, and grizzly bears indicate flights above 1,000 ft AGL have little effect upon them. The presence of man camps near Barrow and Wainwright could have some effects on terrestrial mammals if safety protocols and appropriate garbage disposal protocols are not implemented. Implementation of a wildlife interaction plan and proper garbage disposal would negate effects on terrestrial mammals by providing no attractants to scavengers, or predators.

Aircraft Noise

Caribou from the WAH and TCH, less than ten grizzly bears, and a few furbearers could be affected by aircraft travel along the proposed flight path between Barrow and Wainwright, Alaska described in the 2015 Shell EP (Shell, 2015a, Figure 13.e-2) and without mitigations, could elicit injurious escape reactions among caribou, separate caribou cows from their calves, or drive caribou from insect relief areas (Calef, DeBock, and Lortie, 1976; USDOI, BLM, 2012; BOEM, 2015a;BOEMRE, 2011; and MMS, 2007).

The proposed minimum flight altitude of 1,500 ft (457 m) (safety allowing) would mitigate the effects of air travel between Barrow and Wainwright on all terrestrial mammals, as discussed in previous analyses (USDOI, BLM, 2012; USDOI, BOEM, 2015a; and USDOI, BOEMRE, 2011).

Onshore Support Activities

Terrestrial mammals do not typically avoid most buildings or facilities unless some sort of activity occurs at the site. Caribou often use the Trans-Alaska Pipeline as shade on sunny days and as relief from insect harassment in areas where the pipeline is elevated, so it is reasonable to assume some terrestrial mammals would position themselves around buildings for protection from bad weather or insects when possible or when scavenging. Proper refuse management and restricting interactions between workers and wildlife would reduce any adverse effects of man camps on terrestrial mammals to negligible. Arctic foxes and red foxes in Alaska are often carriers of rabies, which is a potential health threat to humans. Grizzly bears in the Arctic can be aggressive and their presence could pose a threat to workers onshore. Without the implementation of a wildlife interaction plan and adequate garbage disposal there is a strong likelihood of grizzly bears and foxes repeatedly visiting the man camps, with conflicts arising. Under such conditions, aggressive bears might be killed in defense of human lives, or foxes could be eradicated to prevent rabies from being transmitted to workers. Implementing a wildlife interaction plan would reduce the effects on terrestrial mammals to negligible by removing attractants to scavenging bears and foxes; these measures would also improve the safety of workers.

Under Alternative 2 – Proposed Action, there would be a negligible level of effects on some terrestrial species as a result of aircraft traffic and noise.

With the 1,500 ft minimum altitude for aircraft operations Shell has proposed aircraft presence and noise under Alternative 2 would have a negligible level of effects on terrestrial mammals within a few miles of the inland flight corridor between Barrow and Wainwright, Alaska. Likewise, the presence of man camps would have negligible effects on terrestrial mammals if an interaction plan is in place at the camp sites and if proper garbage disposal is performed.

All other effects from the Proposed Action including small oil/fuel spills, discharges, and any air/water quality, or vessel traffic effects, etc. would too far removed from the coast to affect any terrestrial mammals. These issues were identified and examined in the 2007 FEIS ((Section IV.C.3.i)), 2011 SEIS (Sections IV.C.11 and IV.E.12), the 2015 Second SEIS (Section 4.3.8), and in the 2012 BLM NPRA FEIS (USDOI, BLM, 2012 (Section 4.3.9) Therefore, negligible effects are anticipated for terrestrial mammals from Alternative 2 – Proposed Action.

4.2.7.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS (for certain MMPA conditions) and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st.

Due to the limited differences in impacts between Alternative 2 and Alternative 3 on terrestrial mammals, cumulative impacts should be the same as described for Alternative 2.

Alternative 3 would not contribute any different incremental impacts to terrestrial mammals than Alternative 2. The impacts to terrestrial mammals from Alternative 2 and from reasonably foreseeable activities would amount to no more than negligible incremental contribution to the cumulative effect.

4.2.8. Economy

The description and analysis of effects on the economy below focuses on the economy of the NSB, as the location, timing, and scale of the activities described in the 2015 Shell EP are not expected to generate economic effects at the State or Federal level.

4.2.8.1. Alternative 1 – No Action

Under the Alternative 1, the proposed exploration activities would not be approved, and no effects on the economy would occur.

4.2.8.2. Alternative 2 – The Proposed Action

Descriptions of the NSB economy in Section 4.11.8 of the 2015 Shell EIA (Shell, 2015a, Appendix C), and Section 4.3.10 of the 2015 Second SEIS (USDOI, BOEM, 2015a), are incorporated by reference, and salient points are included below. Additional information on the NSB economy is also provided.

Employment and Personal Income. Shell's OCS exploration plan promises to provide specific benefits to some local residents in and around Barrow, Wainwright, Point Hope, and Point Lay. Shell's proposed exploration drilling would offer employment to a relatively small number of local NSB residents, but more than previously proposed projects in the area. The PSO program would employ local Iñupiat residents to monitor and document marine mammals in the project area. The Subsistence Advisor program would recruit a local resident from each village to communicate local concerns and subsistence issues from residents to Shell. Shell's Com Center program would involve hiring individuals from Chukchi Sea villages. A more detailed discussion of local hire can be found in Section 2.4.7.

Even with the potential employment and related personal income associated with the proposed activities, employment opportunities for local residents, especially Alaska Natives, would remain comparatively low in oil industry-related jobs on the Alaska North Slope (ANS). Goods and services would be obtained from local village contractors, when available, during the duration of the project. The proposed activities are short term and temporary and are expected to have a negligible effect on the economy of the NSB or communities of Barrow, Wainwright, Point Hope, and Point Lay. These effects do not constitute a significant change in the impacts previously identified and evaluated in the approved with conditions 2012 Shell EP Revision 1 (USDOI, BOEM, 2011a) and the 2015 Second SEIS (USDOI, BOEM, 2015a).

Revenues. The proposed exploration activities will not require development of additional onshore oil and gas infrastructure from which the NSB and State of Alaska would receive property tax revenues, and so the direct and indirect effects on revenues are expected to be negligible.

Small Fuel Spill. It is reasonably likely that the Proposed Action could result in a small oil spill. For the purpose of analysis, a 5-48 bbl fuel transfer spill was estimated for this EA. A 5-48 bbl diesel spill would disperse and evaporate within 1 or 3 days, generating negligible employment, personal income, and revenues during that time.

In the event of small accidental oil spills during exploration, the number of workers employed for cleanup would depend on several factors. These include the procedures called for in the OSRP, how well-prepared with equipment and training the entities responsible for cleanup are, how efficiently the cleanup is executed, and how well coordination of the cleanup is executed among numerous responsible entities. In general, however, small oil spills tend to be contained at the initial spill site. Consequently, impacts to the economy from small refined oil spills would have little measurable impact on employment, income, and revenues, and would be considered negligible.

4.2.8.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS (for certain MMPA conditions) and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st. A short extension to the time allowed for drilling operations would have a minimal impact, positive or negative, to the economy. As is the case with Alternative 2 – Proposed Action, impacts to the economy under Alternative 3 would be negligible. If Alternative 3 results in fewer seasons, impacts to the economy would still be negligible, because fewer seasons would entail an even lower number of jobs, income, and revenues resulting from exploration activities.

4.2.8.4. Cumulative Effects

A thorough discussion of past, present, and reasonably foreseeable future actions affecting the Chukchi Sea environment is provided in Appendix B of this EA.

Activities associated with Alternative 2 - Proposed Action are short term and temporary, involving relatively low levels of new employment and associated income, and no generation of property tax revenues accruing to the NSB or State of Alaska, and therefore, when added to the past, present, and reasonably foreseeable economic impacts, are expected to have a negligible cumulative effect on employment, income, and revenue levels of the NSB.

Under Alternative 3 – Early Season Start, Shell would transit through the Bering Strait and into the Chukchi Sea prior to July 1. A short extension to the time allowed for transit through the project area would have a minimal impact, positive or negative, to the economy. As is the case with Alternative 2, impacts to the economy under Alternative 3 would be negligible. If Alternative 3 results in fewer seasons, impacts to the economy would still be negligible as fewer seasons would entail an even lower number of jobs, income, and revenues resulting from exploration activities.

4.2.9. Subsistence-Harvest Patterns

This section provides analysis of effects on subsistence harvest patterns that may result from each of the alternatives.

4.2.9.1. Alternative 1 – No Action

Under Alternative 1, the proposed exploration activities would not be approved, and there would be no disturbance to any resources attributable to the proposed exploration drilling activities. There would be no effects on subsistence activities or resources.

4.2.9.2. Alternative 2 – The Proposed Action

Subsistence uses in relation to the time and location each species is harvested are discussed in Section 3.2.9. Communities include Chukchi coastal communities of the North Slope Borough (NSB): Barrow, Wainwright, Point Lay, and Point Hope, and the Northwest Arctic Borough (NAB) communities of Kotzebue Sound: Kotzebue and Deering, as well as any summer camps, Buckland, and Selawik that could be affected by vessel moorage in Goodhope Bay, or when vessels are moored and associated noise, such as generators and traffic to accommodate crew disrupted migratory subsistence harvests. Adverse effects would result when activities described in the Proposed Action cause interference or disruption of subsistence activities. An example of this would be when the physical presence of drilling units prevents a harvest activity from occurring in an area. Additional adverse effects would result if the subsistence resource itself is adversely affected and therefore not available, available in reduced numbers, or otherwise made undesirable for harvest. An example of this would be noise from a drilling unit causing bowhead whales to deflect from an area where hunting and harvest usually occur. The exploration activities or their residual effects would need to overlap in space and time with subsistence resources for the effect to be realized.

Potential effects will primarily result from vessel presence and vessel traffic interacting with subsistence activities, vessel and air traffic noise causing diversion of the resource away from the location of subsistence activities, and the increased level of activities offshore and onshore being incompatible with subsistence activities.

The Proposed Action would occur in the summer and fall, from early July to late October. By July, the Iñupiat from Barrow, Wainwright, Point Lay, and Point Hope have completed the spring bowhead whale hunt and many other activities described in Chapter 3. Beluga hunting can continue through mid-July at Point Lay and Wainwright. It should be borne in mind that beluga hunts occur close to shore, and exploration drilling will occur at least over 60 miles west of the shore, so would be unlikely to have more than a negligible effect on the subsistence harvest. Crew transport would not occur in the vicinity of Point Lay. Beluga hunting in Wainwright occurs after the Point Lay hunt, and takes place several miles south of the crew transportation corridors. Beluga hunting in Kotzebue Sound is generally completed by the beginning of July. Close coordination with hunters in each potentially affected community and the AEWC, and the use Communication Centers would mitigate effects to achieve a negligible to moderate range of effects on Subsistence Harvest Patterns.

Table 4-13 indicates the occurrence and timing of subsistence activities for each village. It also documents the exploration activities that would or would not overlap in the space or time that the resource is normally hunted and harvested. Drilling activities on the Burger Prospect are not expected to result in adverse effects on subsistence activities. No documented subsistence activities have occurred at the proposed offshore drill sites, so the activities do not overlap in space. Similarly, activities associated with the exploration occur before or after the time when some key subsistence animals are normally hunted or harvested. As an example, because Shell will not begin activities until after the spring bowhead whale hunt is completed in the Chukchi Sea, there is no overlap in time between exploration and harvest.

Most of the effects from the proposed activities result in avoidance behavior by the animal being hunted, which may divert the animal away from the location of subsistence activities or from air or boat crew transit from Wainwright or Barrow. Typical behaviors include:

- Bowhead whales may exhibit temporary avoidance behavior if approached by vessels at a distance of 1-4 km (0.62 to 2.5 mi), with behavioral changes lasting a few minutes in the case of vessels and up to 30 to 60 minutes in the case of seismic activity. Most bowhead whale reactions to aircraft result from exposure to helicopter activity; little response to fixed-wing aircraft has been reported. One study indicated that most reactions occurred when the helicopter was at altitudes ≤492 ft (150 m) and lateral distances ≤820 ft (250 m; Nowacek et al., 2007).
- Beluga whales, seals, walruses, and polar bears may be startled or annoyed by or flee intense noise with vessel traffic temporarily displacing (within 1-3 km [0.62 to 1.9 mi]) or interfering with marine mammal migration, and change local distribution for a few hours to a few days. Aircraft effects are expected to be local and transient for seals. Walruses exhibit little reaction to aircraft above 305 m (1000 feet) but traffic may disturb walruses and seals from haulouts and cause them to enter the water.
- Caribou reaction to aircraft flying below 305 m (1,000 feet) include startle, forcing herds and individuals to scatter, separating cows from calves, and possibly causing injury during panic.

- Reaction of birds to vessel traffic could displace birds from the area where the activity is occurring with little direct mortality. Aircraft noise could disturb birds, causing them to flush or move away from noise and approaching low-flying aircraft.

Table 4-13. Potential Effects of Proposed Action on Subsistence Resources by Community.*

Subsistence Resource	Point Hope	Point Lay	Wainwright	Barrow	Goodhope Bay
Bowhead Whale Spring Hunt	Completed prior to start of exploration activities. No overlap in space or time. Therefore, no effect.	Completed prior to start of activities. No overlap in space or time. Therefore, no effect.	Completed prior to start of activities. No overlap in space or time. Therefore, no effect.	Completed prior to start of activities. No overlap in space or time. Therefore, no effect.	Not traditionally undertaken, no overlap in space and time. Therefore no effect.
Bowhead Whale Fall Hunt	Not traditionally undertaken. In addition, no overlap in space. Therefore, no effect	No overlap in space. Therefore, no effect.	Potential direct and indirect effect from vessel and aircraft transit.	Potential direct and indirect effect from aircraft transit	Not traditionally undertaken, no overlap in space and time. Therefore no effect
Beluga	Overlap in time, no overlap in space. Therefore, no effect.	Overlap in time, no overlap in space. Therefore, no effect.	Potential effect from vessel and aircraft transit.	Potential effect from aircraft transit	May overlap in time, no overlap in space. Therefore, no effect.
Caribou	Overlap in time, no overlap in space. Therefore, no effect.	Overlap in time, no overlap in space. Therefore, no effect.	Potential effect from vessel and aircraft transit.	Potential effect from aircraft transit	Overlap in time, no overlap in space. Therefore, no effect.
Pacific Walrus	Overlap in time, no overlap in space. Therefore, no effect.	Overlap in time, no overlap in space. Therefore, no effect.	Potential effect from vessel and aircraft transit.	Potential effect from aircraft transit	Not traditionally undertaken. In addition, however, no overlap in space. Therefore, no effect
Bearded Seal	No overlap in time or space. Therefore, no effect.	No overlap in time or space. Therefore, no effect.	Potential effect from vessel and aircraft transit.	Potential effect from aircraft transit	No overlap in time or space. Therefore, no effect.
Ringed Seal	No overlap in time or space. Therefore, no effect.	No overlap in time or space. Therefore, no effect.	Potential effect from vessel and aircraft transit.	Potential effect from aircraft transit	No overlap in time or space. Therefore, no effect.
Spotted Seal	No overlap in time or space. Therefore, no effect.	Overlap in time, no overlap in space. Therefore, no effect.	Potential effect from vessel and aircraft transit.	Potential effect from aircraft transit	No overlap in time or space. Therefore, no effect.
Ribbon Seal	No overlap in time or space. Therefore, no effect.	No overlap in time or space. Therefore, no effect.	Potential effect from vessel and aircraft transit.	Potential effect from aircraft transit	No overlap in time or space. Therefore, no effect.

Note: * Table summarizes potential for the proposed activities to affect subsistence resources for Chukchi Sea communities and at Goodhope Bay, Kotzebue Sound.

Table 4-13 indicates that effects on marine subsistence and caribou hunting in Wainwright and Barrow could range from minor to moderate, depending upon the adherence to and effectiveness of mitigation measures and Lease Sale stipulations. Hunts that could be affected in Wainwright and Barrow could include the bowhead whale fall hunt, beluga harvests, shoreline caribou harvests, walruses, and bearded, spotted, ringed, and ribbon seals hunted from Wainwright and Barrow. It will be crucial for Shell to communicate with subsistence hunters and local harvest associations in Wainwright and Barrow (including local Whaling Captain Associations, the AEWC, and the NSB Department of Wildlife) in order to achieve a negligible level of effect on subsistence harvests of these species in Wainwright and Barrow.

Mitigation measures incorporated into proposed activities to minimize vessel and marine mammal interaction and subsistence activities include:

- MODU and support vessel transit routes will avoid the Ledyard Bay Critical Habitat Unit, and will include coordination through Communication Centers (Com Centers).
- PSOs will be aboard the two MODUs and all support vessels.

- Shell will communicate and coordinate with the Com Centers, including one for Kotzebue Sound, regarding all vessel transits to ensure conflicts do not develop with active subsistence harvesting activities for vessel transit and crew transits.

As shown in Figure 2-3 (marine vessel routes) and Figure 2-4 (flight corridors), Point Hope and Point Lay summer and fall subsistence harvest areas would be out of range of any potential disturbance or disruption from Shell’s activities and thus would not involve direct or indirect effects. The Proposed Action’s mitigation measures put into place for Point Lay and Point Hope, such as the Com Centers and Shell’s subsistence advisor program, would help ensure that communities and harvesters are informed as to Shell’s activities offshore. Impacts to Point Hope, Point Lay, and Goodhope Bay subsistence activities are not expected to occur as long as mobilization began on or after July 1; therefore, the level of impact would range from negligible to minor. Subsistence resources could be rarely but periodically affected in any event, though there would be no apparent effect on subsistence harvests. Impacts to Barrow and Wainwright subsistence activities are expected to range from negligible to minor as long as Shell utilizes Com Centers and adheres to vessel corridors and flight corridors and altitude.

The primary helicopter route between the shorebase and the Proposed Action area would be from the Barrow airport where the helicopters are stationed (Shell, 2015a, Figure 13.e-2). Helicopters would alternatively travel between Barrow or Wainwright and the Burger Prospect as much as 40 roundtrips a week over identified marine subsistence harvest areas for both communities. The proposed alternative overland flight corridor between Barrow and Wainwright crosses a marine area used by Wainwright for subsistence and a landmass that is recognized as being subsistence territory used by the Iñupiat of Barrow, Atqasuk, and Wainwright. Past subsistence use has been prolonged and consistent, as evidenced by the numerous house sites, camps, and other cultural features that dot the landscape (SRB&A, 1989a, 1989b, 2010, 2014; USDOI, BOEMRE, 2011).

Active subsistence harvesters have expressed concerns about disruption or displacement of caribou and other wildlife by noise, with noise from helicopters being one source of particular concern (SRB&A, 2010, 2014). For example, Point Hope hunters report that while preparing to hunt “the caribou would be spooked by a small airplane flying around. Hunters reported that the caribou are taking a difficult route and they believe it is because of an airplane flying low near the mountains” (Umiak LLC, 2010). Point Lay hunters have expressed concerns that helicopter traffic is scaring caribou farther away from traditional hunting areas (ASRC Energy Services, 2009). Similarly, the Wildlife Director for the Native Village of Barrow raised a concern in a meeting regarding affects from helicopter traffic, suggesting that there be no flying overland between Barrow and Wainwright because of observations that the caribou are being disturbed (Umiak LLC, 2010). Most recently, subsistence hunters at Point Lay and Wainwright observed that in some cases, vessels on the horizon resulted in no impacts on subsistence activities. On other occasions, hunters observed that offshore vessel traffic did result in disturbance, but in other occasions, vessels affected subsistence. A Wainwright hunter reported that a USCG ship had scared walruses in the water away from the hunters, and in Point Lay, barge traffic was identified as contributing to poor beluga harvests. Subsistence hunters described frequent disturbances from both fixed wing aircraft and helicopters. Some stated that the aircraft deflected resources by flying too low. Examples of deflection included caribou and beluga. One individual stated that he was bothered by the nearby presence of aircraft while beluga hunting even though the animals did not appear to be disturbed (SRB&A, 2014). Mitigation suggested by active harvesters to reduce the effects of overflights on subsistence resources includes (SRB&A, 2009):

- Planning ahead of time and locating activities to minimize exposure of wildlife to noise
- Learn from local subsistence advisors and other experts the areas and times that are most sensitive for wildlife

- Set altitude minimums by activity
- Put in place a real-time monitoring and response communication system so harvesters out on the land and water can communicate directly with dispatchers
- Alert harvesters to planned activities
- Provide means for harvesters and pilots to learn from each other and exchange ideas to minimize impacts.
- Conduct an annual survey of harvesters to monitor harvest success and reports of impacts to activities. Hold an annual workshop to discuss and respond to results.

A more refined series of mitigation measures includes the following recommendations (SRB&A, 2013b):

- Improve communication protocols to make them more readily understandable.
- Provide better training to pilots/captains.
- Hire local and knowledgeable residents to help facilitate and avoid conflicts.
- Include subsistence representatives in conducting required mitigation and monitoring activities, particularly aircraft overflights.
- Include subsistence representatives in conducting agency studies conducted in the area.

Many of these suggested measures are included in the mitigations that have been incorporated into the Proposed Action to minimize effects from aircraft on subsistence activities and ensure communications with subsistence hunters, which include:

- Except in an emergency, aircraft shall not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing, or taking off, in poor weather (fog or low ceilings), or in an emergency situation, while over land or sea to minimize disturbance to mammals and birds.
- Except in an emergency, aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft (457 m) in areas of active whaling; such areas to be identified through communications with the Com Centers.
- Except in an emergency, aircraft will not operate within 0.5 mi (0.8 km) of walruses or polar bears when observed on land or ice.
- Shell will also implement non-PSO flight restrictions prohibiting aircraft from flying within 1,000 ft (300 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs and landings or in emergency situations) while over land or sea. This flight will also help avoid disturbance of and collisions with birds.
- Implementation of a Communication Plan and will implement this plan before initiating exploration drilling operations to coordinate activities with local subsistence users, as well as Village Whaling Captains' Associations, to minimize the risk of interfering with subsistence hunting activities, and keep current as to the timing and status of the bowhead whale hunt and other subsistence hunts. The Communication Plan includes procedures for coordination with Com Centers to be located in coastal villages along the Chukchi and Beaufort Seas and in the vicinity of Goodhope Bay during Shell's proposed exploration drilling activities.
- Shell will employ local subsistence advisors (SAs) from the Chukchi Sea villages that are potentially impacted by Shell's exploration drilling activities. The SAs will provide consultation and guidance regarding the whale migration and subsistence activities. Incorporating mitigation measures described in this section, and employing adaptive management techniques including SA guidance on whale migration and subsistence

activities will increase and encourage communication and observations and experience from local knowledge holders. This engagement will provide Shell with the agility to align with local and traditional knowledge.

Subsistence harvesters have expressed concerns about more outsiders present in hunting areas, making it difficult to hunt safely and without fear of misrepresenting subsistence hunting (SBR&A, 2009, 2014). The BOEM-approved Shell Cultural Awareness Program developed in response to BOEM Stipulation No. 2, Orientation Program, is “designed to increase sensitivity and understanding by Shell and its contractors of community values, customs, and ways of life in the area they will be working, and how to avoid conflicts with subsistence activities” (Shell, 2015a). This measure should mitigate the concerns expressed by subsistence harvesters, although it will only be applicable to Shell employees and their contractors.

Wainwright would be about 78 mi and Barrow would be about 150 mi distant from drilling activities, respectively, and most summer and fall subsistence resource populations and harvests would be out of range of any potential direct disturbance from drilling activities. If the alternative aircraft route is used, helicopter traffic originating in Barrow will fly down the coast to Wainwright before proceeding offshore in a route intended to minimize effects to subsistence harvest activities. Vessel traffic to and from Wainwright would traverse marine subsistence areas.

Wainwright’s spring bowhead whale hunt, typically completed in June, would be completed prior to the start of exploration activities. Subsistence hunts for polar bear, walruses, bearded seals, fur seals, fish, beluga whales, and birds would occur either in nearshore coastal areas at least 40 mi from activities or in the spring and winter seasons when drilling and vessel and helicopter traffic would not be present. In Wainwright, walrus hunting during August can occur up 40 mi from shore, still 20 mi from proposed activities (SRB&A, 2014). Walruses present within the vessel/flight corridor potentially could be disrupted or displaced by these activities, rendering subsistence harvest activities less- or un-successful, but IHA and LOA monitoring requirements, minimum flight elevations of 1,500 ft, or 3,000 ft altitude above walruses, and coordination with community Com Centers, ice monitoring, and subsistence advisors would likely mitigate potential disturbance to walruses so that the resulting impacts would be no more than minor. Caribou hunting occurs in late summer and fall when caribou congregate along the coast between Barrow and Wainwright. It is expected that maintaining 1,500 ft while transiting both the inland and coastal flight corridors between the two communities would not disrupt caribou movements or the subsistence hunt, and overall effects would range from negligible to minor.

Wainwright’s fall bowhead whale hunt could be affected by aircraft and vessel traffic associated with exploration activities. The location of the past harvest is northeast of Wainwright and close to shore, away from the vessel and aircraft route to the Burger Prospect, depending on whale migration routes. Adherence to the mitigation measures would limit the effects of exploration-related air and vessel traffic on the fall bowhead whale harvest to range from negligible to minor.

The effects described above could occur on an annual basis but do not persist past the end of each year’s activities. If exploration activities terminate prior to the end of October in any year, the types and level of impacts would be as described above because of the location and timing of subsistence activities, with the exception of the fall bowhead whale hunts conducted in October at Wainwright and Point Barrow. Terminating exploration activities prior to the end of October in any year would eliminate potential conflicts in October with Wainwright and Barrow. If the exploration activities continue past two or three years, the effects for each additional year would be the same as described above. Effects on subsistence activities for Barrow and Wainwright could occur from incidental or accidental interactions between exploration drilling activities and subsistence activities because mitigation measures eliminate or practically reduce effects from routine activities. In addition, the effects on subsistence activities that occur are short term and are not expected to persist past the end of each year's drilling season. However, with adaptive management, effects that accidentally or incidentally occur in one year would be recognized and measures would be applied to activities where necessary to prevent recurrence in subsequent years.

The oil-spill analysis has determined that there is a chance for two accidental small oil spills that likely would be operational in nature. For the purpose of this analysis, two 48 bbl or less fuel transfer spills were chosen. A 48 bbl diesel spill would evaporate and disperse in less than 3 days before contacting critical nearshore subsistence areas. As required by Lease Stipulation 6, oil-spill containment booms would be deployed during any refueling activity, and would contain a small oil spill if one should occur.

The perception that an oil-spill could contaminate subsistence foods, particularly marine mammals or fish, might be of concern to the Iñupiat at Barrow, Wainwright, Point Lay, and Point Hope and near Goodhope Bay in terms of potential effects on health. Because subsistence activities do not occur in the vicinity of proposed drilling and any associated spill source, the short-term effects of the analyzed small spill on subsistence activities are expected to be negligible to minor. No long-term effects are anticipated as effects are not expected to persist past the end of the drilling season.

Subsistence Air Quality

Shell prepared an analysis of air quality impacts in certain offshore areas that are used by Alaska Native communities for subsistence activities. This analysis of offshore subsistence area air quality considers the relevant portions of the 2015 Shell Air Quality Technical Report of Offshore Subsistence Area (Shell, 2015a, Appendix C, Attachment C).

The basic assumptions, methods, analyses, and procedures Shell used in this analysis are identical to those described in Sec. 4.2.1 Air Quality with the following exceptions:

- The locations of predicted maximum concentrations are offshore in a specific area defined by Shell as the "Subsistence Use Area"
- The criteria used for evaluation of these impacts are based on occupational criteria and not on the ambient air quality standards designed to protect sensitive populations such as the elderly, sick, or very young

Shell's offshore air quality analysis involved two steps:

1. Develop an inventory of projected emissions that identifies short-term and annual emissions related to the drilling program
2. Apply dispersion modeling to estimate the resulting air pollutant concentrations in the ambient air. The dispersion analysis considered only short-term impacts (1-hour averages) as subsistence activities are not likely to linger in a single location for up to 24 hours

Criteria applied to evaluate the results of the dispersion analysis are developed relative to the Occupational Safety and Health Administration's (OSHA) exposure standards and thus have a built-in margin of safety (Shell, 2015a, Appendix C, Attachment C).

Subsistence Area Evaluation Criteria

This discussion of air quality impacts to offshore marine subsistence activities incorporates the discussion and data presented in the 2015 Shell EP, Appendix C EIA, Attachment A, Arctic Offshore Air Quality Impacts, and Attachment C, Sec. 3.1 Evaluation Criteria, which is summarized in this section.

Air quality impacts are usually determined in terms of whether concentrations of air pollutants exceed prescribed criteria; that criteria are usually the National Ambient Air Quality Standards (NAAQS). However, the NAAQS are established at sufficiently low levels to protect human health with a margin of safety, including the health of sensitive individuals like asthmatics, the elderly, the chronically ill, and the very young. The subsistence use area is not readily accessible to the public and those who are able to reach the area are likely to be healthy individuals capable of hunting, fishing, or working on commercial vessels. These individuals are present in one specific location only for limited periods of time and are assumed to be healthier than the more susceptible population that NAAQS are designed to protect. Therefore, in this context the NAAQS are a very conservative measure of impacts to air quality in offshore subsistence use areas.

The criteria applied in the current evaluation are based on the Occupational Safety and Health Administration (OSHA) standards designed to ensure safe and healthy working conditions. Based on these standards, Shell has developed criteria to protect subsistence area users in offshore locations, which while based on OSHA standards are more protective than OSHA exposure standards. Given that some members of the native population may be more susceptible to the health effects of air pollutant exposure due to genetic predisposition, and might conceivably engage in subsistence activities offshore, the standards are more stringent than the OSHA standards to even more fully protect the subsistence worker population. Thus, Shell suggests that the population accessing the offshore subsistence use area, particularly those who travel in boats far offshore to hunt, generally comprises persons for whom these OSHA-based standards provide appropriate health protection.

Background Concentrations

The EPA has not established offshore background concentrations for 1-hour average concentration exposures to the criteria pollutants, except for CO. Therefore, the best available data to reflect background concentrations over the near-shore areas of the majority of marine subsistence activities is are the Wainwright onshore background concentrations developed by Shell and based on their monitored data from an air quality device located in Wainwright. The methods and procedures used by Shell to develop the Wainwright background concentrations is incorporated by reference from the following sections of the 2015 Shell EP, Appendix C Environmental Impact Analysis (EIA), Attachment B, Sec 3.2 Existing Air Quality Conditions, Table 3 Maximum Existing Ambient Air Concentrations.

Subsistence Area Receptors

The area Shell defines as the Subsistence Use Area is illustrated in the 2015 Shell EP, EIA, Section 4.2.3, Figure 5 Subsistence Area Receptors. This area is consistent with the map of subsistence hunting patterns in Section 3.2.9, Figure 3-5 Wainwright Marine Subsistence Hunting Tracks 2010-2012, in this EA. The area corresponds with the known subsistence use areas documented in the 2015 Shell EP, EIA, Sec. 3.11.6, Figure 3.11.6-11 Selected Barrow, Point Hope, Point Lay, Wainwright Subsistence Areas. The Burger site, several villages, and a 4 kilometer (km) receptor grid mesh size are shown on the plot in Figure 4-4, showing a total of 1,800 receptors. The analysis assumes the *Discoverer* and the *Polar Pioneer* are located at the drill sites in Lease Blocks V and J, respectively.

Figure 4-4 shows the isopleths resulting from dispersion of both offshore and onshore emissions in the offshore area designated for subsistence activities. Shell prepared similar illustrations for all the criteria pollutant averaging periods, except ozone and lead. All the additional illustrations show concentrations that are lower than shown in Figure 4-4 for NO_2, but are in the same general location offshore.

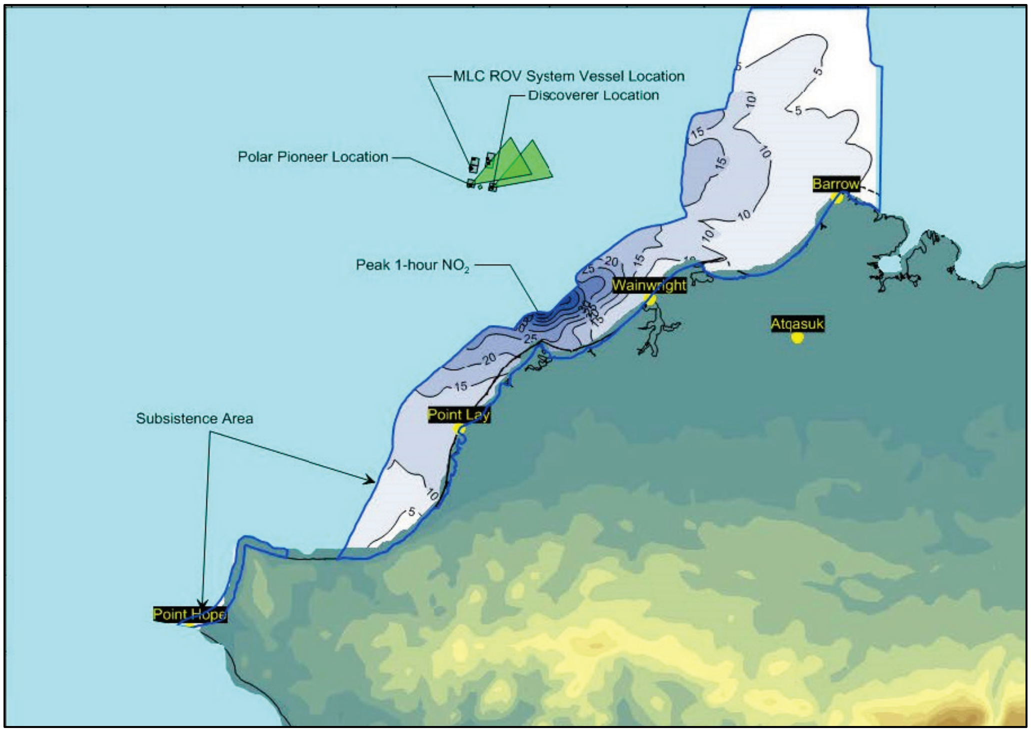

Figure 4-4. Isopleths of Peak 1-hour NO_2 Concentration in the Subsistence Area. *Table measurements are in micrograms per cubic meter, µg/m³. Source: Shell, 2015a. EIA, Attachment C, Figure 7.*

Dispersion Modeling

Shell's air quality analysis of the subsistence area was performed using the California CALPUFF dispersion model, designed to predict pollutant concentrations at receptors located greater than 50 km (30.1 miles) from the source. Results of the analysis, and the addition of offshore background concentrations, are provided in Table 4-14.

Table 4-14. Maximum Predicted Concentrations at Offshore Subsistence Area Receptors

Pollutant	Averaging Period	Shell's Modeled Results ($\mu g/m^3$)	Background Concentrations[1] ($\mu g/m^3$)	Design Concentrations ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Shell Offshore Subsistence Area Criteria ($\mu g/m^3$)
NO_2	1-hour	52.1	40.1	92.2	188	3,760
PM_{10}	1-hour	24.4	60	84.4	--	500
$PM_{2.5}$	1-hour	24.4	14	38.4	--	500
CO	1-hour	16.2	953	969.2	40,000	55,000
SO_2	1-hour	0.1	8.1	8.2	196	5,200

Note: [1] Background concentrations are developed by Shell and documented in the 2015 Shell EP, EIA, Table 3.1.3-1.

Source: Shell. 2015 EIA, Attachment C, Sec. 5, Table 4 Maximum Predicted Concentrations at Offshore Subsistence Area Receptors.

The maximum offshore concentrations occur at the seaward edge of the subsistence area, west of Wainwright, as shown in the 2015 Shell EIA, Attachment C, Sec. 5, Figure 6 *Location of Receptors for Peak Model Predictions in Subsistence Area.* The isopleths of modeling results for all the pollutants analyzed are illustrated in the 2015 Shell EIA, Sec. 5, Figure 7 through Figure 11.

The isopleths show that concentrations of NO_2 are the highest concentrations of any pollutant analyzed for the subsistence area. The maximum is clearly visible in the illustration offshore just southwest of Wainwright. All of the figures show the maximum concentrations in approximately the same location. None of the pollutants, even when background concentrations are included, exceed the short-term National Ambient Air Quality Standards (NAAQS), where a 1-hour standard is established (40 CFR Part 50). Regarding the pollutants for which there is no 1-hour NAAQS, the concentrations are well below the hourly criteria based on OSHA standards. Based on this data, there would be minor effects to the subsistence area relative to air pollutants that would occur due to the implementation of the Proposed Action and its alternatives.

Conclusion

With Shell's adherence to proposed mitigation, monitoring, communication, and response plans, short-term effects from drilling and air and vessel traffic on subsistence harvest resources range from negligible to minor.

4.2.9.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st.

June is one of the most active months for marine subsistence hunters. Large numbers of pinnipeds float by on ice bergs, and are harvested on their way north. Cetaceans also migrate during June, and occasionally spring bowhead whaling extends into June at Wainwright and Barrow. Belugas are hunted in June in Kotzebue Sound, Kivalina, Point Hope, Point Lay, and Wainwright. . Moreover, the spring bowhead whale hunt extends into June at Barrow, Wainwright, Point Lay, Point Hope, and Kivalina, and June represents an important month for harvesting pinnipeds and waterfowl.

Shorefast ice behaves differently than ocean ice, and cannot be predicted on an annual basis. Open ocean may not mean the shorefast ice has moved out or that there are no icebergs carrying migrating species northward. The marine subsistence resources upon which the Iñupiat depend may migrate at different times in June; there is no fixed date for their migration, which has been especially noticeable in recent years.

If Shell were to progress to the drill site in June rather than July 1 or thereafter, it is assumed they would use ice management vessels to moor support vessels in Goodhope Bay. This could create a conflict because subsistence hunters in Kotzebue Sound hunt belugas in June.

Although Alternative 3 could result in fewer seasons of exploration effort due to the early start, the perceived benefit might be more apparent than real, as an earlier start has the potential to affect cetacean, pinniped, and waterfowl subsistence hunts in coastal communities from Barrow to Kotzebue Sound.

A mitigation measure that could avoid potential conflicts would be realigning air traffic from Barrow to exploration vessels in the Chukchi Sea by heading northwest. This would keep air traffic from passing over the spit of land that terminates with Point Franklin, which would avoid Wainwright on-ice bowhead whaling camps. Air traffic would need to coordinate closely with the Barrow Whaling Captain's Association, the Wainwright Whaling Captain's Association, the AEWC, and the NSB Department of Wildlife Management; the Point Lay, Point Hope, and Kivalina Whaling Captain's Associations; and NWABs Department of Wildlife.

Mitigation measures for reducing effects on the subsistence beluga whale hunt would be to limit air and boat traffic to the corridors identified by Shell and to maintain prescribed speeds/altitudes. Avoidance of Wainwright, Point Lay, Point Hope, and Kivalina during the beluga hunt would mitigate impacts to beluga whales. This could be readily achieved by adhering to the aforementioned transportation corridors from Barrow to the exploration vessels.

In Goodhope Bay, to coordinate moorage of vessels, close coordination with the AEWC, the NWAB Wildlife and Planning Departments, and whaling associations; or, community meetings at Kotzebue, Buckland, Noatak, Selawik, and Buckland should be maintained, as the greatest source of disruption might be from the transportation vessels rather than the moored vessels. Communication and the timing of vessel traffic from Kotzebue to Goodhope Bay should be coordinated to avoid disruption of the beluga migration into and out of Kotzebue Sound and beluga birthing or feeding sites.

A stricter mitigation measure would be no vessel traffic from the Goodhope Bay moorage site to Kotzebue or back during beluga migrations.

These levels of close communication and coordination would likely reduce potential conflicts to a minor level of effect.

4.2.9.4. Cumulative Effects

This section discusses the effects on subsistence resources which result from known past, present and reasonably foreseeable future activities and the incremental contribution of the Proposed Action and alternatives to the Proposed Action. The past, present, and reasonably foreseeable future activities have been identified in Appendix B of this EA.

Vessel traffic, specifically marine vessel traffic, is an important impact source of anthropogenic sound introduced to the Chukchi Sea during the Proposed Action timeframes.

Other vessel traffic is not controlled by the Proposed Action, and should be assumed to continue through the period of the exploration activities, including the fall whaling hunt at Barrow and Wainwright. These vessels could be icebreakers, USCG vessels, vessels operated by NGOs, foreign vessels, cargo vessels, other supply ships and tugs and barges, cruise ships, and vessels associated with scientific endeavors. The USCG estimates that from 2008 to 2010 the number of vessels in the Arctic increased from more than 100 to more than 130, and the number of transits through the Bering Strait increased from more than 245 to more than 325 (USCG, 2011). Vessel tracks from 2009 indicate vessel transits in the vicinity of Barrow and Wainwright are concentrated to the west and south of the communities along the coast (Marine Exchange of Alaska, 2011). This area corresponds to the subsistence use areas described in Section 3.2.9 for those communities.

Air traffic not associated with the Proposed Action may involve flight patterns at a lower altitude than the 1,500 ft (457 m) level that will be industry's standard for this project. Other air traffic associated with basic village transportation, freight and mail, and scientific endeavors would continue unabated. As noted in Section 4.2.9, Alaska Native subsistence harvesters have expressed concern about impacts on marine mammals and caribou. Air traffic noise has the potential to disrupt and disturb subsistence species, and thus harvesters from Chukchi villages.

Activities described in the exploration plan would increase the number of marine vessel transits in the Chukchi Sea from mobilization of the drilling fleet in July, logistic support of activities of the offshore supply vessel during the drilling season (between Dutch Harbor/Kotzebue and the drill site, approximately 30 round trips). While BOEM does not regulate transit from Dutch Harbor, it is anticipated that OSV's will make up to 30 trips back and forth from Du Harbor to the Project Area for resupply each drilling season. There will be seven OSR support vessels, three of which will be staged in Goodhope Bay, and four of which will remain in the vicinity of the drill units. All these vessels will observe the vessel travel mitigation measures designed to avoid or minimize effects on subsistence activities. This will have a negligible effect on subsistence as long as Shell heads seaward from Kotzebue Sound in a westerly direction and then north to the Burger Prospect, maintaining a distance of 40 mi offshore.

Offshore operations will be serviced by up to three helicopters operated out of an onshore support base at Barrow to transport crews between the onshore support base and the drilling units and support vessels with helidecks. The helicopters will also be used to haul small amounts of food, materials, equipment, and samples between vessels and the shorebase. Approximately 40 Barrow-Burger Prospect round trip helicopter flights will occur each week for crew changes. Additionally, a helicopter based in Barrow will provide crew transport between Barrow and Fairbanks. Shell will also have a dedicated helicopter for Search and Rescue that will stay grounded at the Barrow shorebase location except during training drills, emergencies, and other non-routine events. All helicopter flights will observe the aircraft travel mitigation measures designed to avoid or minimize effects on subsistence activities.

Fixed wing aircraft will be used to transport crews, materials, and equipment between Wainwright and hub airports such as Barrow or Anchorage. It is anticipated that there will be one round trip flight every three weeks. There will be two additional fixed wing aircraft for daily offshore aerial wildlife monitoring flights, and ice reconnaissance flights around the Burger Prospect. These flights will occur at an altitude of approximately 3,000 ft (914 m), to avoid affecting walruses.

Incremental impacts of Alternative 2, the Proposed Action on subsistence resources would be negligible to minor for routine activities such as vessel and aircraft operations, and negligible for an oil spill from a vessel. The Proposed Action’s contribution to cumulative effects would be negligible to minor and would result in no change to the major level of effect for subsistence resources from past, present, and reasonable foreseeable future actions.

Alternative 3 would not contribute any different incremental impacts to subsistence resources than Alternative 2. The impacts to subsistence resources from Alternative 2 and from reasonably foreseeable activities would amount to no more than a negligible to minor incremental contribution to the cumulative effect.

4.2.10. Sociocultural Systems

This section describes the direct and indirect effects on sociocultural systems that may result from the Proposed Action and alternatives described in Chapter 2.

4.2.10.1. Alternative 1 – No Action

Under Alternative 1, the proposed exploration activities would not be approved and there would be no disturbance to any resources attributable to the proposed exploration drilling activities. There would be no effects on sociocultural resources.

4.2.10.2. Alternative 2 – The Proposed Action

Under the Proposed Action, incidental or accidental encounters that could disrupt subsistence harvest of resources would come primarily from vessel traffic and aircraft traffic associated with transporting crews, supplies, or samples. Because of the negligible to minor subsistence effects described in Section 4.2.9 from vessel traffic interacting with subsistence activities, vessel and air traffic noise causing diversion of the resource away from the location of subsistence activities, negligible effects on social organization and institutional arrangement are not expected to occur. Offshore activities are likely to add to concerns of NSB and NAB residents regarding the potential effects of oil spills from the activities. Onshore supply base operations using existing facilities could result in concern over encroachment of oil facilities on the community, but these would be negligible to minor and could be offset by the benefits of increased opportunity from direct and indirect employment in the communities. The negligible effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

BOEM's oil-spill analysis has determined that two fuel transfer spills 48 bbl or less may occur during the Proposed Action. A 48 bbl or less diesel spill (the potential discharge estimated for this EA) would evaporate and disperse in less than 3 days before contacting critical nearshore subsistence areas. As required by Lease Stipulation 6, oil-spill containment booms would be deployed during any refueling activity, and would contain a small oil spill if one occurred.

BOEM concludes that the key structuring elements of the existing social organization, social organization, cultural values, and institutional formation would not have a significant effect. These short-term, localized effects do not persist across seasons and are limited in time and locations. The Proposed Action should have slight measurable impacts, which are short-term and localized. The impact to sociocultural systems is anticipated to be minor. Existing lease sale stipulations, conflict avoidance mechanisms, long term monitoring, and other mitigating factors are anticipated to provide sufficient protection to avoid significant sociocultural effects.

4.2.10.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st.

Impacts to sociocultural systems from an early season start are closely tied to impacts to subsistence harvest resources. As stated in Section 4.2.9.3 of this EA, June is one of the most active months for marine subsistence hunters. If Shell is does achieve a variance from FWS to transit through the Bering Strait early, the increased traffic could impact subsistence resources and thus sociocultural systems in a negative manner. This alternative would only be of benefit to sociocultural systems if it resulted in a reduction in the overall number of seasons Shell operated in the project area.

Impacts of this Alternative could be mitigated through close coordination and communication with coastal subsistence communities and by coordinating efforts with both the AEWC, the North Slope Borough Department of Wildlife, and the Northwest Arctic Borough Planning Department, (since an early start would likely result in moorage at Goodhope Bay). These efforts could reduce effects to the minor-moderate range.

4.2.10.4. Cumulative Effects

This section discusses the effects on sociocultural systems which result from known past, present, and reasonably foreseeable future activities, and the incremental contribution of the Proposed Action. Relevant past, present, and reasonably foreseeable future activities have been identified in the 2015 Second SEIS. The potential for the Proposed Action and alternatives to contribute to cumulative effects is assessed below.

Direct, indirect, and synergistic cumulative effects on sociocultural systems have been discussed in previous analyses (USDOI, MMS, 2007; USDOI, BOEMRE, 2011; USDOI, BOEM, 2015a; SRB&A, 2009; Ristroph, 2010). These ongoing effects include the following trends:

- Adaptation to introduction of new technology, pressures, and legal/regulatory actions introduced through successive waves of contact between Alaska Natives and non-Natives, starting with whaling in the 19th century through oil and gas development in the 21st century.
- Continuation of pattern of centralized leadership of whaling captains and their families, cultural and nutritional dependence on subsistence foods, reliance on sharing and kinship,

connection to family camps and traditional use areas, and a desire to control destination of their communities.

- Stress created by fear of an oil spill, a predevelopment impact-producing agent that is distinct from potential effects from routine operations.
- Positive effects from higher income and community infrastructure and services made possible from oil and gas activity.
- Continued adaptation of the communities to changing conditions brought about by changing climatic conditions in the Arctic.

These trends will continue over the period covered by the exploration plan. Overall, the effect of these trends could constitute a minor to moderate effect on sociocultural systems.

Activities described in the exploration plan would incrementally contribute to some of the trends described above. For example, OCS activity contributes to the fear of an oil spill. There will be some population growth as a result of the influx of project workers into the communities. The effects on sociocultural systems would be offset by the very short term nature of this, not expected to persist beyond the end of the exploration drilling program. Mitigation measures, such as the orientation program, the plan of cooperation, and measures to minimize or avoid effects on subsistence, reduce the project's effects to a negligible to minor level. Some positive effects, such as project-level employment of ANS residents and increased economic activity for Native corporations will occur. These effects would occur over the life of the exploration program.

The incremental cumulative effect of the Proposed Action on sociocultural resources could be minor to moderate and would result in no change in the major level of effect for sociocultural systems from past, present, and reasonably foreseeable future actions.

The activities that occur under this Alternative 3 would incrementally contribute to some of the trends described above, and would have approximately the same effect as the Proposed Action, except that the effects would potentially occur over fewer drilling seasons after the commencement of activities.

The incremental cumulative effect of Alternative 3 on sociocultural resources would be negligible to minor. Incremental contributions from Alternative 3 would result in no change in the major level of effect for sociocultural systems from past, present, and reasonable foreseeable future actions.

4.2.11. Public Health

This analysis tiers to Section 4.3.13 of the 2015 Second SEIS and incorporates Section 4.11.9 of the 2015 Shell EIA (Shell, 2015a, Appendix C), by reference. Salient points are included below, along with additional information on public health in the NSB.

4.2.11.1. Alternative 1 – No Action

Under Alternative 1, the proposed exploration activities would not be approved, and no effects to public health would occur.

4.2.11.2. Alternative 2 – The Proposed Action

The activities associated with the 2015 Shell EP would be staged out of the Barrow, Wainwright, Point Hope, and Point Lay communities. Goods and services would be obtained from local village contractors, when available, for the duration of this project. These business interactions are not expected to adversely affect public health. Personnel traveling to these communities in support of Shell's operations will receive a 'fitness to work' medical review to prevent the spread of communicable diseases between Shell personnel and any local residents with whom Shell personnel come into contact. Impacts related to air quality, emissions, and water quality remain the same as those previously identified and evaluated in the approved with conditions 2012 Shell EP Revision 1

(USDOI, BOEM, 2011a) and are incorporated by reference. As in the 2012 Shell EP Revision 1, the proposed activities in the 2015 Shell EP involve worker enclaves (largely self-contained mancamps), drilling activities that will occur at a significant distance from onshore population centers, and permitted discharges to water and air that are expected to diffuse before reaching those onshore population centers, the activities associated with the Proposed Action would result in negligible impacts to public health.

Small Fuel Spill. It is reasonably likely that the Proposed Action could result in a small oil spill. For the purpose of analysis, a 5 or 48 bbl fuel transfer spill was estimated for this EA. A spill of this size and type would disperse and evaporate within 3 days, prior to reaching onshore communities or nearshore subsistence areas, resulting in negligible impacts to public health.

4.2.11.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st. A short extension to the time allowed for exploration activities in the Proposed Action area would have a minimal impact to public health. As is the case with Alternative 2 – Proposed Action, impacts to public health under Alternative 3 would be negligible. If Alternative 3 results in fewer seasons, impacts to public health would still be negligible, as fewer seasons would entail fewer exploration activities impacting public health.

4.2.11.4. Cumulative Effects

A thorough discussion of past, present, and reasonably foreseeable future actions affecting the Chukchi Sea environment is provided in Appendix B.

With the implementation of the mitigation described in Section 2.3 and the subsections above, the cumulative effects from Alternative 2, the Proposed Action of the 2015 Shell EP (Shell, 2015a) in combination with other 2015 survey activities described in Appendix B are considered to be negligible. These effects do not constitute a significant change in the impacts to public health previously identified and evaluated in the approved with conditions 2012 Shell EP Revision 1 (USDOI, BOEMRE, 2011).

Under Alternative 3 – Early Season Start, Shell would transit through the Bering Strait and into the Chukchi Sea prior to July 1, 2015. A short extension to the time allowed for transit through the project area would have a minimal impact to public health. As is the case with Alternative 2, impacts to public health under Alternative 3 would be negligible.If Alternative 3 results in fewer seasons, impacts to public health would still be negligible as fewer seasons would entail fewer exploration activities impacting public health.

Alternative 3 would not contribute any different incremental impacts to public health than Alternative 2. The impacts to public health from Alternative 2 and from reasonably foreseeable activities would amount to a negligible incremental contribution to the cumulative effect.

4.2.12. Environmental Justice

Significant effects with respect to environmental justice include impacts on human health or environment that cause disproportionate, high adverse effects on minority or low-income populations (CEQ, 1997). This threshold would be reached in the event of significant impacts to subsistence harvest patterns, sociocultural systems, or public health. Tainting of subsistence foods from oil spills and contamination of subsistence foods from pollutants would contribute to potential adverse human health effects. Concerns that subsistence foods could be contaminated could also affect human health.

4.2.12.1. Alternative 1 – No Action

Under Alternative 1, the proposed exploration activities would not be approved, and there would be no disturbance to any resources attributable to the proposed exploration drilling activities. There would be no effects on environmental justice.

4.2.12.2. Alternative 2 – The Proposed Action

This analysis considers the Proposed Action's direct and indirect effects on subsistence, sociocultural systems and public health as factors that would most affect environmental justice. Because the analyses above conclude that the Proposed Action would result in negligible to minor direct and indirect effects to these resources, it follows that the Proposed Action would have negligible to minor direct and indirect effects on environmental justice. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The negligible effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

This conclusion is supported by the environmental justice analysis conducted by EPA for the Clean Air Act permits related to the Proposed Action, which concluded:

> …the activities proposed to be authorized…will not cause or contribute to air quality levels in excess of health-based standards for SO_2, CO, PM_{10}, $PM_{2.5}$, Ozone or NO_2. Region 10 therefore concludes that there will not be disproportionately high and adverse human health or environmental effects with respect to these air pollutants on minority or low-income populations residing in the North Slope, including coastal communities closest to the proposed operations. In reaching this conclusion, Region 10 considered the impact on communities while engaging in subsistence activities in areas where such activities are regularly conducted. (EPA, 2011b).

The oil-spill analysis estimated two accidental small oil spills that likely would be operational in nature. For the purpose of this analysis, two fuel transfer spills (48 or 5 bbl) were estimated. Two small (48 bbl or less) diesel spills would each evaporate and disperse in less than 3 days before contacting critical nearshore subsistence areas. As required by Lease Stipulation 6, oil-spill containment booms would be deployed during any refueling activity, and would contain a small oil spill if one occurred.

The perception that subsistence foods might be contaminated, particularly marine mammals or fish, might be of concern to the Iñupiat at Barrow, Wainwright, Point Lay, and Point Hope, and communities in the vicinity of Goodhope Bay, in terms of potential effects on health. Because subsistence activities do not occur in the vicinity of proposed drilling and any associated spill source, the short-term effects of the analyzed small spill on subsistence activities are expected to be negligible to minor. No long-term effects are anticipated as effects are not expected to persist past the end of the drilling season. Therefore, small oil spills would amount to a negligible to minor effect.

4.2.12.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st.

4.2.12.4. Cumulative Effects

This section discusses effects from known past, present, and reasonably foreseeable future activities and the incremental contribution of the Proposed Action on environmental justice.

Incidental or accidental short term encounters with subsistence harvesters can be further eliminated through effective communication between the communities and BOEM and/or industry. The communication center operation and the subsistence advisor program are mitigation measures identified in the description of the Proposed Action and are examples of remedies for these types of disruptions.

This analysis considers that cumulative effects on subsistence, sociocultural, and public health are factors that would most affect environmental justice. Because the analysis concludes that cumulative effects on subsistence and local economic opportunities would be negligible, it follows that there would be negligible cumulative effects on environmental justice. The reasonably foreseeable cumulative effects may occur at similar levels each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the impacts to environmental justice from the Proposed Action and from reasonably foreseeable cumulative activities would amount to a negligible level of effect.

Alternative 3 would not contribute any different incremental impacts to environmental justice than Alternative 2. The impacts to environmental justice from Alternative 2 and from reasonably foreseeable activities would amount to no more than a negligible incremental contribution to the cumulative effect.

4.2.13. Archaeological Resources

The NSB zoning ordinances ensure protection of onshore archeological and cultural resources. NSB Municipal Code 19.70.050(E) states that development which is likely to disturb certain cultural or historic sites be required to avoid the sites or that proponents be required to consult with appropriate local, state, and Federal agencies and survey and excavate the site prior to disturbance. NSB Municipal Code 19.70.050(F) requires that development not significantly interfere with traditional activities at cultural or historic sites. NSB Municipal Code 19.70.050(G) requires that development not cause surface disturbance of newly discovered historic or cultural sites prior to archaeological investigation.

Additional requirements pertaining to archaeological resources are contained in the National Historic Preservation Act (NHPA) and its implementing regulations, Alaska Historic Preservation Act (AHPA), and in BOEM operational regulations at 30 CFR 550.194. The technical requirements for the archaeological resource surveys and reports that may be required under the regulations are detailed in the Alaska OCS Region Notice to Lessees (NTL) 05-A03. Under Section 106 of the NHPA, BOEM consults with the Alaska State Historic Preservation Office (SHPO) for OCS activities during the pre-lease process, and at each subsequent NEPA step.

4.2.13.1. Alternative 1 – No Action

Under Alternative 1, the proposed exploration activities would not be approved, and there would be no disturbance to any resources attributable to the proposed exploration drilling activities. There would be no effects on archaeological resources.

4.2.13.2. Alternative 2 – The Proposed Action

Exploration activities could impact offshore resources through vessel mooring, mudline cellar construction, discharge of drill cutting and drill fluids, and onshore construction activities.

Analysis for each drill site and anchor location (shown in the 2015 Revised Shell EP (Figures 1.b-3 through 1.b-8), indicates that activities will avoid all sidescan sonar contacts and magnetic anomalies. Discharges of drilling fluids and cuttings would be dispersed before reaching the seafloor and would be deposited on top of the thin veneer of Holocene-age sediments that already cover any prehistoric cultural resources in the area. Drilling cuttings produced during mudline cellar construction (MLC) and drilling of the uppermost well interval will also be discharged on the seafloor surface. Seismic and geohazard site assessments of the drill site did not identify any potential cultural resources on or below the seafloor.

Offshore archaeological sites could be disturbed by unit anchor arrays, estimated surface area of disturbance for drilling exploration MLCs, by a remote operated underwater vehicle (ROV) and estimated seafloor area disturbed directly by cuttings from MLC construction. MLC cuttings will be disposed of on the seafloor adjacent to the MLC. After the MLC construction, when the ROV is no longer used for excavation and a pipe connects the drill unit with the excavation, the cuttings will be piped to the drill unit where they will be disposed of into the Chukchi Sea. During the latter stage, fluid dynamics will enter into the equation; it is likely that heavier cuttings may settle beneath the drill unit, but lighter sediments may drift and settle dispersed from the drill unit. Each anchor array will result in seafloor disturbance of 3.75 acres (for a total of 22.5 acres of seafloor disturbance for six exploration wells). The density of anchoring activity increases the potential to damage archaeological resources, although the use of dynamically-positioned response vessels would minimize the occurrence of anchoring. No permafrost has been identified as occurring in the vicinity of the drill sites, so thawing and other cryogenic processes need not be considered.

No impacts to onshore archaeological resources are expected since Shell plans to use existing facilities at Barrow and Wainwright.

The effects of activities would be on a site-by-site basis regardless of the year in which the activity occurs.

Analysis of the shallow hazards survey reports and archaeological assessments listed in the 2015 Shell EP (Shell, 2015a, Section 5) indicates the following:

- Numerous side scan sonar targets are distributed across the survey areas. None of the targets were deemed in the analysis to be archaeologically significant.
- Numerous magnetic anomalies are distributed across the survey areas. Many of the anomalies form linear strings which closely correspond to fault picks, may represent subsurface geological features, or are unattributed. None of the magnetic anomalies corresponded to side scan sonar targets. None of the anomalies are deemed to be archaeologically significant.
- The previous point notwithstanding, a cluster of seven magnetic anomalies south of the Burger V drill site cannot be identified through geophysical data, are of unknown origin, and will be avoided by all activities, such as anchoring, associated with exploration.
- Pleistocene buried channels were identified in the area of Burger A, F, and S. Channel levees, internal strata and overbank deposits have been eroded and removed during subsequent marine transgression and covered with a thin veneer of Holocene age material. There are no landforms identified by the surveys which would be considered high probability areas for prehistoric occupation.
- Comparison of the reports listed above with the 2015 Shell EP Figures 1.b-3 through 1.b-8 indicates that anchor locations will avoid sidescan sonar targets and magnetic anomalies.

Shell describes the shallow hazards and archaeological surveys in Section 5 of the 2015 Shell EP. The 2015 Shell EP states that all of the side-scan sonar contacts and magnetic anomalies will be avoided during the exploration drilling operations (Shell, 2015a).

In Goodhope Bay, no new impacts have been identified in this analysis that were not previously disclosed in the 2015 Second SEIS (USDOI, BOEM, 2015a). Based on the above information, no historic or prehistoric properties are likely to be affected by the activities proposed in the 2015 Shell EP. Therefore, the Proposed Action will have a negligible effect on archaeological resources. If exploration activities terminate prior to the end of October in any year the types and level of impact would be as described above.

The oil-spill analysis has determined that there is a chance for two accidental small oil spills that likely would be operational in nature. For the purpose of this analysis, two (48 or 5 bbl) fuel transfer spills were estimated. A 48 bbl diesel spill would evaporate and disperse in less than 3 days before contacting critical archaeological resources on the nearshore. As required by Lease Stipulation 6, oil-spill containment booms would be deployed during any refueling activity, and would contain a small oil spill if one should occur. As there are no identified archaeological resources in the area of any of the drill sites, effects on historic resources from the initial event and offshore spill are not likely to occur.

4.2.13.3. Alternative 3 – Early Season Start

Alternative 3 allows drilling operations to begin before July 1st, which is the Proposed Action start date. An early start is predicated on the combination of the following factors all occuring for the action to proceed: favorable seasonal ice conditions, acknowledgment and agreement from Alaska Native communities in the case of planned subsistence harvests in the areas of interest, and a variance from USFWS and NMFS allowing Shell to transit through the Bering Strait and into the Chukchi Sea prior to July 1st.

Impacts to Archaeological resources from an early season start would be similar to those identified for Alternative 2 – Proposed Action. There would be no measureable positive or negative effects of either an increased season length or an overall reduction in the number of seasons taken to complete the project. Alternative 3 will have a negligible effect on archaeological resources.

4.2.13.4. Cumulative Effects

This section discusses the effect to the archeological resources which result from known past, present and reasonably foreseeable future activities and the incremental contribution of the Proposed Action and any alternatives to the Proposed Action.

Natural processes such as ice gouging, bottom scour, thermokarst erosion, and shoreline erosion have the greatest cumulative effect on archaeological resources in the Chukchi Sea area. These natural processes are ongoing and continue to have destructive effects on prehistoric and historic archaeological sites (USDOI, MMS, 2007; USDOI, BOEM, 2015a).

Other OCS oil and gas activities in the Chukchi Sea could disturb the seafloor and effects have been described in the 2015 Second SEIS, Section 5.2.14 (USDOI, BOEM, 2015a). They will have negligible effects on archaeological resources from the projects. Similarly, construction of onshore infrastructure to support exploration activities will be limited and take place near population centers, most notably Wainwright. State and NSB policies on coastal development help ensure protection of archaeological resources similar to that afforded federally-authorized activities.

This Proposed Action would have a negligible effect on archaeological resources. The incremental contribution of the activities associated with this alternative result in no change in the negligible level of effect for this resource.

Alternative 3 would not contribute any different incremental impacts to archaeological resources than Alternative 2. The impacts to archaeological resources from Alternative 2 and from reasonably foreseeable activities would amount to no more than a negligible incremental contribution to the cumulative effect.

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5.0 CONSULTATION AND COORDINATION

The following subsections describe formal and informal consultations undertaken by BOEM with respect to the Proposed Action, as well as public involvement in the development of this Environmental Assessment. Also provided is a list of EA reviewers and preparers.

5.1. Endangered Species Act Consultation

Section 7(a)(2) of the ESA requires each Federal agency to ensure that any action that they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the adverse modification of designated critical habitat. To satisfy its ESA obligations BOEM consults with NMFS and USFWS regarding potential impacts to listed species and designated critical habitat under each Service's jurisdiction.

In association with the 2011 SEIS (USDOI, BOEMRE, 2011) BOEM conducted consultations with NMFS and the USFWS. Both consultations proceeded as interim step consultations, where the Services evaluated the lease sale and exploration phase and determined whether those activities would be expected to jeopardize the continued existence of listed species or result in adverse modification of designated critical habitat. Under incremental step consultation, the Services must also determine that there is a reasonable likelihood that future activities (e.g., development and production) will not jeopardize the continued existence of the species nor result in adverse modification of designated critical habitat. In 2012, the USFWS issued its Biological Opinion (BO) for Lease Sale 193, as well as past and proposed lease sales and subsequent exploration activities in the Beaufort and Chukchi Planning Areas (USFWS, 2012). The USFWS 2012 BO concluded that oil and gas leasing and exploration activities in the BOEM Final SEIS would not likely jeopardize the continued existence of polar bears, spectacled eiders, Steller's eiders, Kittlitz's murrelets, and yellow-billed loons, nor would the activities adversely modify polar bear or spectacled eider designated critical habitat (USFWS, 2012). In 2013, NMFS issued its most recent BO for lease sales and activities described in the 2011 SEIS (NMFS, 2013). The NMFS concluded that the oil and gas leasing and exploration activities in the BOEM Final SEIS would not likely jeopardize the continued existence of bowhead whale, fin whale, humpback whale, North Pacific right whale found only in the Bering Sea, the Arctic subspecies of ringed seal, the Beringia DPS bearded seal, and the Steller sea lion.

In light of the updated scenario analyzed in the 2015 Second SEIS (USDOI, BOEM, 2015a), BOEM and BSEE reinitiated Section 7 consultations with both NMFS and USFWS. Consultation with NMFS is ongoing.

Consultation with USFWS was completed on March 30, 2015, concluding with the BO for Oil and Gas Activities Associated with Lease Sale 193 (USFWS, 2015), which determined that oil and gas leasing and exploration activities described in the 2015 Second SEIS would not likely jeopardize the continued existence of polar bears, spectacled eiders, and Steller's eiders and would not adversely modify spectacled eider critical habitat (USFWS, 2015). At the same time that USFWS issued its 2015 BO, USFWS issued an addendum in light of Shell's EP and potential activities onshore near Barrow. In consideration of the potential activities in Barrow, USFWS issued a concurrence, that onshore activities near Barrow identified in Shell's EP would not be likely to adversely impact eiders.

The USFWS recently determined that the Pacific walrus warranted listing, but that listing was precluded by higher priorities (76 *FR* 7634, February 10, 2011). The Pacific walrus is currently considered a candidate species. During the process of developing and promulgating ITRs (50 CFR Part 18) under the MMPA in 2013 for the Chukchi Sea, USFWS issued a BO that determined that promulgating ITRs would not likely jeopardize the continued existence of the polar bear or Pacific walrus (USFWS, 2013).

Although the USFWS issued, in March 2015, a new BO to close out the consultation on Lease Sale 193, on May 6, 2015, BOEM asked for concurrence from USFWS on BOEM's finding of *may affect, not likely to adversely affect* for Shell's planned resupply trips to and from Dutch Harbor. BOEM is awaiting the USFWS response to this request, but there is no other pending consultation with USFWS regarding Lease Sale 193 or the Shell Revised EP.

A 2015 consultation with NMFS is on-going. The March 30, 2015 USFWS BO is available on BOEM's website at: http://www.boem.gov/ak-consultations/.

5.2. Marine Mammal Protection Act

To ensure compliance with the Marine Mammal Protection Act (MMPA), BOEM would require Shell to obtain an incidental authorization (IHA) from NMFS and letter of authorization (LOA) from USFWS before Shell commences BOEM-permitted exploration activities. Mitigation measures are included in the IHA and LOA to ensure least practicable adverse impact on marine mammal species or stocks to ensure that potential impacts to marine mammal populations will be negligible and have no unmitigatable adverse impacts on the availability of marine mammals for subsistence uses. Shell has applied to NMFS for an IHA for incidental take of whales and seals, and to USFWS for an LOA for the take of polar bears and Pacific walrus, under the current Chukchi Sea ITRs (USFWS 2013; 78 *FR* 35364).

5.3. National Historic Preservation Act Consultation

Consultation for this action was concluded in 2011-2012 during the Environmental Analysis of the 2012 Shell Chukchi Sea EP. The six exploration wells are in the exact locations as those identified in correspondence to the Alaska SHPO on November 29, 2011. On December 30, 2011, the SHPO concurred with the finding that no historic properties would be affected – a finding that still is valid four years after the initial consultation. The SHPO policy on consultation is that if the Proposed Action does not change, SHPO correspondence is valid for a period of up to 5 years.

5.4. Esssential Fish Habitat (EFH) Consultation

The Magnuson-Stevens Fishery Conservation and Management Act (as amended) requires Federal agencies to consult with NMFS regarding actions that may adversely affect designated Essential Fish Habitat (EFH). In 2006, BOEM consulted with NMFS regarding the potential effects on EFH for all five species of Pacific salmon, Arctic cod, and saffron cod for Lease Sale 193, Chukchi Sea. This process culminated in a document entitled "Chukchi Lease Sale 193 Essential Fish Habitat Consultation." In August 2009, EFH was designated for Arctic cod, saffron cod, and opilio crab. In July 2011, BOEM submitted an additional EFH assessment and formal determination to NMFS which addressed these newly-designated EFH (2011 SEIS, VI.C.2. p. 321). On February 10, 2012, BOEM sent a determination to NMFS regarding Shell's planned 2012 exploration activities on six leases within the "Burger "prospect in the Chukchi Sea, the same leases in this Proposed Action. On March 20, 2012, NMFS reviewed and concurred with BOEM's determination and the mitigation measures proposed by BOEM. These mitigation measures are addressed in the 2015 Shell EP and exploration activities conducted under that plan (Shell, 2015a) BOEM determined that additional consultation was not required for sale and exploration activities considered in 2015 Second SEIS. NMFS concurred that no additional consultation was necessary and that further consultation would be initiated prior to approval of any Development and Production Plan.

5.5. Tribal Consultation

The Bureau of Ocean Energy Management (BOEM)–Alaska Region is determined to carry out the tenets and spirit of Executive Order 13175 requiring Federal agencies to consult, on a government-to-government basis, with federally-recognized Indian tribes (Alaska Native tribes and communities) when developing Federal policies with tribal implications.

The consultation purpose is to "*have an accountable process to ensure meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications*." The order requires the head of each agency to designate an official "with principal responsibility for the agency's implementation" of the order.

Secretary of the Interior Ken Salazar issued Order 3317 on December 1, 2011, to update, expand, and clarify the Department's policy on consultation with Indian tribes in compliance with E.O. 13175. In summary, Order 3317 states that USDOI officials must demonstrate a meaningful commitment to consultation "*by identifying and involving Tribal representatives in a meaningful way early in the planning process," and that consultation aims to create effective collaboration emphasizing "trust, respect, and shared responsibility...*"

BOEM has determined that oil and gas leasing activities in the Chukchi Sea have tribal implications for the several village tribes along the Chukchi Sea coast, along with one regional tribal entity. BOEM has offered to consult with each of these tribal governments at venues within various North Slope villages, or in the alternative, via telephone (an accepted communications practice among tribal members and within the villages of the Northwest Arctic Borough and North Slope Borough).

Though the timing of the 2015 Spring Whaling Season was a significant factor for the Tribes, BOEM recently concluded Government-to-Government consultations regarding Shell's exploration activities. BOEM consulted with the Native Village of Wainwright, the Native Village of Barrow, the Iñupiat Community (ICAS) of the Arctic Slope, and the Kotzebue IRA.

BOEM met with the AEWC as well. The members of the AEWC include Whaling Captains and crews from villages all along the Chukchi and Beaufort Seas. Though this was not specifically a consultation, it was nonetheless a valuable meeting during which practical information and points of interest were shared between BOEM and AEWC.

A time for Government-to-Government consultation with the Native Village of Point Lay remains to be set (as the village is engaged with the spring whaling season); BOEM is in active contact awaiting an opportunity to coordinate an agreeable time to consult with the Tribal leadership.

The Tanana Chiefs Conference declined an offer for Government-to-Government consultation regarding Shell's proposed exploration activities at this time.

5.5.1. ANCSA Consultation

On August 10, 2012, the Department of the Interior issued a Policy on Consultation with Alaska Native Claims Settlement Act (ANCSA) Corporations. In this policy, Secretary of the Interior Ken Salazar restated a provision of ANCSA requiring that "[t]he *Director of the Office of Management and Budget [and all Federal agencies] shall hereafter consult with Alaska Native corporations on the same basis as Indian tribes under Executive Order 13175*."

Additionally, the policy "*distinguishes the Federal relationship to ANCSA Corporations from the government-to-government relationship between the Federal Government and federally recognized Indian Tribes... and [states that] this Policy will not diminish in any way that relationship...*"

The ANCSA Corporations have not expressed desire for consultation regarding Shell's proposed exploration activities.

5.6. Reviewers and Preparers

Name	Title	Contribution
Preparers and Project Management		
Gene Augustine	Biologist	Water Quality
Scott Blackburn	Chief, Environmental Analysis Section 1	Project Manager
Jerry Brian	Economist	Economy/Public Health
Campbell Chris	Sociocultural Specialist	Sociocultural/Subsistence/Environmental Justice/Archaeological Resources
Christopher Crews	Biologist	Ice Seals, Terrestrial Mammals
Maureen DeZeeuw	Wildlife Biologist	Birds
Verena Gill	Biologist	Cetaceans
Dan Holiday	Biologist	Lower Trophic Levels, Cumulative Effects, Fish and Essential Fish Habitat
Melanie Hunter	NEPA Coordinator	Project Coordinator
Caron McKee	Technical Writer/Editor	Technical Editor
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Jill-Marie Seymour	Biologist	Polar Bear and Walrus, ESA Coordination
Caryn Smith	Oceanographer	Oil / Fuel Spills
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Reviewers		
Curtis Jennifer	NEPA Reviewer, EPA	Document Reviewer
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Schuler Alan	Engineer 1, Alaska Department of Environmental Conservation (ADEC)	Document Reviewer
Shaw Hanh	Manager, Oil and Gas Energy Sector, EPA	Document Reviewer
Smith Louise	Biologist, Fairbanks Field Office, USFWS	Document Reviewer
Winalski Dawn	Assistant Borough Attorney, North Slope Borough	Document Reviewer

5.7. Public Involvement

BOEM provided opportunities for public involvement regarding the 2015 Shell EP and the preparation of this Environmental Assessment. These opportunities included:

Soliciting public comments on the 2015 Shell EP. When BOEM "deemed submitted" the EP, a 21-day public comment period was then initiated from April 10, 2015 to May 1, 2015. Comments were received through Regulations.gov at Docket # BOEM-2015-0039.

Soliciting public comments on the preparation of this EA. When BOEM "deemed submitted" the EP, BOEM then notified the public that the agency was preparing on Environmental Assessment and requested public input. A 10-day public comment period was initiated from April 10, 2015 to April 20, 2015. Comments were received through Regulations.gov at Docket # BOEM-2015-0025.

All comments, including some that were delivered after the formal comment period were reviewed and considered in the preparation of this EA.

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Appendix A

Analysis of Accidental Oil Spills

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Appendix A. Analysis of Accidental Oil Spills

A-1. Introduction

This Appendix describes the results of the oil-spill analysis and includes the supporting documentation for those results. The oil-spill analysis considers the potential accidental oil spill discharges and their likelihood of occurrence, and then outlines the accidental oil spill scenario framework for the impact analysis of the alternatives in this EA. The Mobile Offshore Drilling Units (MODUs), drilling, vessels, and fuel-transfer activities are described in the 2015 Shell Revised Chukchi Sea Exploration Plan (hereafter "2015 Shell EP") for Alternative 2-The Proposed Action, and Alternative 3- Early Season Start (referred to as "the Action Alternatives"), were evaluated for both routine operations and accident conditions. Oil spills do not occur as a routine activity. Therefore, oil spills are not considered a routine impact-producing factor. Oil spills are considered accidental events, and the Clean Water Act and the Oil Pollution Act include both regulatory and liability provisions that are designed to reduce damage to natural resources from oil spills. Therefore oil spills are treated as an accidental impact-producing factor. An accident is an unplanned event or sequence of events that results in an undesirable consequence. In this analysis the undesirable consequence is an oil spill in the environment.

BOEM carefully and thoroughly analyzed a range of oil spill sizes (from small (<1,000 bbl) to very large (≥150,000 bbl)) and the likely consequences to environmental, social, and economic resources in the 2015 Sale 193 Final Second SEIS (hereafter "2015 Second SEIS"). This Appendix and the oil spill analysis in this EA tier from the 2015 Second SEIS (Sections 4.1.2.5, 4.3, 4.4, 4.5 and Appendix A). A small diesel fuel spill was analyzed in the 2009 and 2011 Chukchi Sea EAs and is summarized and incorporated by reference. This Appendix also summarizes and incorporates sections 2.10 of the 2015 Shell EIA by reference. Brief summaries, where relevant, are provided below, and the information is updated and augmented by new material as needed.

Section A-2 below begins with the summary of estimated oil spill factors (number, size, source, oil type, duration, likelihood of occurrence, weathering characteristics) which collectively make up the oil spill scenario. The accidental oil spill scenario is used for impact analysis in Section 4.0 for Alternative 1-No Action, and the Action Alternatives in this EA. The remainder of this Appendix provides the information supporting the estimated oil spill factors.

A-2. Summary: Potential Oil Spill Size Categories

There are three potential size categories of oil spills in connection with exploratory operations in the Action Alternatives: (1) a large spill (≥1,000 bbl) from exploration operations; (2) a very large spill (≥150,000 bbl) from a well-control incident; and (3) a small spill (<1,000 bbl) from exploration operations. Historical and modeling oil spill data demonstrates that the frequency of a large spill occurring during exploration is low and, therefore, this EA does not analyze the impacts of a large spill from exploration operations as reasonably foreseeable impacts. The occurrence of a very large spill resulting from a well-control incident is similarly very low. Nonetheless, this EA tiers to the BOEM's prior analyses of the impacts of a large and very large oil spill in the 2015 Second SEIS (Sections 4.3, 4.4 and 4.5) and includes an analysis of the impacts from a large or very large spill for purposes of analysis only. See further discussion in Section 4.0 of this EA.

For purposes of the oil spill analyses for Alternative 1-No Action, no small, large, or very large spills are estimated to occur in the project area. In Alternative 1, none of the exploration activities described in the proposed action occur so there is no possibility of spills from exploration operations in the project area or Kotzebue Sound.

For purposes of the oil spill analyses for the Action Alternatives, it is likely that up to two small spills could occur. BOEM estimates a 48 or 5-bbl diesel fuel-transfer spill for the volume and type of a small spill, as identified in the Shell Chukchi Sea Regional Oil Spill Response Plan-Revision 2 (Shell OSRP) summary of potential discharges (Shell, 2013: Table N.4-1 and Appendix M).

For purposes of the oil spill analyses for the Action Alternatives, no large or very large crude or diesel oil spills are estimated from exploration activities. This is based on a review of potential discharges, historical oil spill and modeling data, and likelihood of large or very large oil spill occurrence. This estimate is based on:

(1) The low rate of OCS exploratory drilling well-control incidents spilling fluids per well drilled

(2) Since 1971 one OCS spill (large/very large) has occurred during temporary abandonment while drilling more than 15,000 exploratory wells

(3) The low number (six) of exploration wells being drilled from this proposed action

(4) No crude oil would be produced and the wells would be permanently plugged and abandoned

(5) The history of exploration spills on the Arctic OCS, all of which have been small

(6) The fact that no large spills occurred while drilling 35 exploration wells to depth in the Arctic OCS

(7) Pollution prevention and oil spill response regulations and methods, implemented by BOEM, BSEE and Shell, since the Macondo Well 252 blowout (hereafter called the Deepwater Horizon (DWH) event (USDOI, BOEM, 2012, Section 4.3.3.3.4; USDOI, BOEM, 2015, Section 4.4.1.1; Shell, 2013, 2015).

A-2.1. Summary: Small Spills (<1,000 bbl) From Exploration Activities

Historical Beaufort Sea and Chukchi Sea OCS exploration spill data suggest that a small spill is likely to occur. Thirty five exploration wells were drilled in the Arctic OCS from 1981-2003 and two top holes through 2012. During that time period 36 small spills have occurred spilling a total of 26.7 bbl (of which 24 bbl was recovered). The most likely cause of a small oil spill during exploration could be operational, such as a fuel hose rupture. The largest Arctic OCS exploration spill was less than 20 bbl (Section A-3.1). For purposes of analysis of the Action Alternatives, a 48 or 5-bbl diesel fuel-transfer spill was estimated as the small spill volume and oil type. The spill(s) are estimated to last less than 3 or 1 days, respectively, on the surface of the water, based on oil weathering model calculations. Section 4.0 of this EA analyzes the impacts of such small spills in each of the EA sections on oil spill impacts to specific resources. Lease Stipulation 6 and Shell’s fuel transfer plan require pre-booming during fuel transfers, which would reduce or negate adverse effects from a small diesel fuel-transfer spill.

A-2.2. Summary: Large Spills (≥1,000 bbl) From Exploration Activities

Historical OCS crude and condensate spill data demonstrates that a large spill is unlikely to occur as a result of either Action Alternative. No oil will be produced. All wells will be permanently plugged and abandoned in accordance with BOEM and BSEE requirements on completion of drilling. Since 1971, one OCS spill (large/very large) has occurred during temporary abandonment from a well-control incident while drilling approximately 15,000 OCS exploration wells. All fuel-storage tanks will be internal to the MODUs and should an internal storage tank rupture, it is unlikely a large diesel fuel spill would reach water. Onshore storage tanks are double-walled with a containment dike for 110% of the volume. A large spill from onshore storage tanks, internal diesel fuel tanks or a well-control incident escalating into uncontrolled flow is unlikely in connection with the exploration activities set forth in the 2015 Shell EP, and therefore, this EA does not analyze the impacts of such a large spill scenario, but tiers to previous analysis of large spills in the 2015 Second SEIS (USDOI, BOEM, 2015 pp. 163-452).

A-2.3. Summary: Very Large Oil Spills (≥150,000 Bbl) From Exploration Activities

A very large oil spill (VLOS) from a well-control incident during OCS exploratory drilling is a similarly unlikely occurrence. There is abundant and reliable scientific data on the infrequency of an exploration well-control incident occurring and releasing fluids, and further support for this conclusion is set forth below. A very large spill from a well-control incident is unlikely in connection with the exploration activities set forth in the 2015 Shell EP, and therefore, this EA does not analyze the impacts of such a scenario, but tiers to analysis of very large oil spills in the 2015 Second SEIS.

BOEM analyzed the potential impacts of a very large oil spill from a well-control incident escalating into a long duration flow (USDOI, BOEM, 2015, pp. 452–620). There are no site-specific anomalies that differentiate a very large oil spill release at Launch Area (LA) 11 from Shell's leases, and the oil-spill contacts are statistically similar. Thus, BOEM has analyzed the potential impacts from a very large well-control incident escalating into a loss of well control where fluids are released into the Chukchi Sea and tiers to that analysis. This impact analysis in 2015 Second SEIS considers the impact without mitigation and then further considers spill response as mitigation. Shell's OSRP response scenario addresses the potential immediate release of crude oil to the environment by a loss of well-control during drilling. Shell's OSRP demonstrates the access to sufficient equipment and personnel needed to respond to a Worst Case Discharge flow rate of 25,000 barrels of oil per day (bopd) for 30 days.

A-3. Oil-Spill Volume and Type Estimates

Oil spills are an issue of great public concern in relation to the offshore oil and gas industry. With the exception of rare events like the *Deepwater Horizon* (DWH), the discharges of oil in the sea have declined over the years, even though petroleum consumption is increasing (USDHS, USCG, 2012; USEIA, 2014). Possible causes for the decline in oil discharges include passage of the Oil Pollution Act of 1990 (OPA 90), technology improvements, and implementation of safety-management systems that put into practice risk-reduction interventions. Although total oil spill volumes are decreasing, even with consumption of oil increasing, the *Deepwater Horizon* (DWH) Event has heightened the industry's, regulators' and publics' awareness of the potential impacts of very large oil spill events.

Using information from the Shell OSRP, EP and EIA, BOEM reviewed and evaluated available information regarding the small, large, and very large oil spill volume estimates, oil spill types and the likelihood of the potential discharges and determined a reasonably foreseeable spill analysis scenario. Analysts used the reasonably foreseeable spill analysis scenario to evaluate the potential oil spill impacts on their resources in Section 4 of this EA for the Action Alternatives. No oil spills are estimated to occur for Alternative 1-No Action.

A-3.1. Oil Spill Potential Discharge Volume

BOEM verified and then used Shell's potential discharge volumes (summarized below in Table A-1) as the likely spill volume and oil type for each of BOEM's small (<1,000 bbl), large (≥1,000 bbl), and very large (≥150,000 bbls) spill size categories (Shell, 2013, Appendix M; Shell, 2015, Table 2.10-1). Within each of BOEM's spill-size categories, the estimated potential discharge volume is considered the representative volume for that size category (without pollution prevention and oil spill response measures). A 48 or 5-bbl diesel-transfer spill is the estimated volume range of a small spill; a 1,555-bbl diesel-fuel tank-rupture spill is the estimated volume of a large spill, and the blowout worst-case discharge (WCD) of 750,000 bbl is the estimated volume of very large oil spill (without pollution prevention and oil spill response measures). Section A-3.2 below describes why and how Shell calculated the WCD for a loss of well control and BOEM's verification of the WCD.

Table A-1. Relationship of EP Potential Discharge Volumes to BOEM Spill Size Categories.

BOEM Spill-Size Categories	Type	Cause	Product	Size	Duration	Prevent Potential Discharge
Small <1,000 bbl	Transfer from fuel tanker to MODUs	Hose rupture	Diesel	Approximately 2,000 gallons 48 bbl or 5 bbl [1, 2]	5.5 minutes[1, 2]	Transfer procedures in place; minimized by the weather restrictions, during unfavorable wind or sea conditions. Transfers are announced in advance; and verbal communication, in combination with visual inspection, is the best method of discharge detection. Booming is in place during transfer.
Large ≥1,000 bbl	Diesel Tank	Tank rupture (MODUs and onshore storage tanks)	Diesel	1,555 bbl[2]	Minutes to hours [2]	The diesel tanks are internal to each MODU rather than deck-mounted, where the potential for marine spills is much greater. As a result, a scenario involving tank rupture has not been included in the oil-spill-response plan, but will be monitored as part of an ongoing tank inspection program. Onshore storage tanks double-walled with containment dike for 110% of volume.
Very Large ≥150,000 bbl	Loss of Well Control Escalating to Blowout	Uncontrolled flow at the mudline	Crude Oil	750,000 bbl	30 days	Blowout prevention equipment and related procedures for well-control. Layer I includes proper well planning, risk identification, training, routine tests, and drills on the rig. Layer II includes early kick detection and timely implementation of kick-response procedures. Layer III involves the use of mechanical barriers, including, but not limited to, blowout preventers, casing, and cement. Testing and inspections are performed to ensure competency.

Notes: [1]Shell (2013, Appendix M, Section M.2.3)
[2]Shell (2015, Appendix C, Table 2.10-1)
Source: USDOI, BOEM, 2015.

A-3.2. Worst-Case Discharge Calculation for the Oil Spill Response Plan

The BOEM and BSEE regulations set forth how the volume for a WCD calculation is determined for an Exploration Plan or oil-spill-response planning scenario (30 CFR Part 254.47(b), BOEM NTL 2015-001 and 30 CFR 550.213(g) respectively). The WCD volume and storage capacities are calculated to address BOEM and BSEE's need to determine the adequacy of the company's spill-response capabilities and are shown in Table A-2.

Table A-2. Estimates of Cumulative WCD Volume by Citation and Source.

Citation	Source	Type and Location	Product	Size (bbl)	Duration
30 CFR 254.47(b)	Shell (2013, Appendix C; 2015, Table 8.d-1)	Uncontrolled flow at the mudline	Crude oil	750,000	30 days
30 CFR 550.213(g) and BOEM NTL 2015-N01	Shell (2015, Table 2.g-1)	Uncontrolled flow at the mudline	Crude oil	<295,426-669,479[1]	Burger J, S, A, V, F, R. wells 34-38 days to drill a relief well
BOEM Verification	BOEM (2011,Appendix H)	Uncontrolled flow at the mudline	Crude oil	253,234-279,954	Burger J well 34-38 days to drill relief well

Note: [1]The size in bbl range is estimated from the lowest bopd rate multiplied by the shortest number of days to drill a relief well from a second rig to the cumulative volume for Burger J.

BSEE requires the WCD to be based upon the daily volume possible from an uncontrolled blowout flowing for 30 days (30 CFR 254.47(b)-Determining the volume of oil of your worst case discharge scenario). The Shell planning scenario considers a daily release of 25,000 bbl of crude oil for 30 days (750,000 bbl total). This volume exceeds Shell's WCD calculated for the Burger J, S, A, V, F, R. wells (Shell, 2015, Section 2(g)) (Shell calculated Burger J as highest WCD at 23,100 bbls/day).

Shell's OSRP demonstrates access to sufficient equipment and personnel needed to respond to a well blowout with a 25,000 barrels of oil per day flow rate and total volume of 750,000 bbl.

Other BOEM regulations (30 CFR 550.213(g)-Blowout scenario) require a scenario for a potential blowout that will have the highest volume and maximum duration for a given well. Shell's blowout scenario provides for transiting and drilling a relief well for Burger J, S, A, V, F, R wells in up to 34–38 days. The resulting estimated daily spill volume for Burger J, S, A, V, F, R wells ranges from 8,689–23,100 bopd (Shell, 2015, Table 2.g-1). Again, these oil spill volumes are calculated without factoring in any well bridging, intervention or response. Burger J is the highest flowing well. The cumulative volume ranges from 603,564–669,479 bbl for 34 and 38 days, respectively (Shell, 2015: Section 8, Table 8.d.2). These volumes are below the 750,000 bbl used for planning purposes in Shell's OSRP (Shell, 2013, Appendix C).

The daily flow rate for a loss of well control resulting in a blowout is based on the WCD estimate provided by Shell and verified by BOEM (BOEM, 2011, Appendix H). The WCD estimate does not reduce the cumulative volume by including intervention or response in the calculation. BOEM, Resource Evaluation conducted a verification of the WCD model submitted by Shell and concurs that the Burger J well has the highest potential discharge volume in both daily rate and cumulative flow. BOEM WCD results find that the cumulative discharges are all less than the cumulative discharges forecast by Shell's WCD model (BOEM, 2011, Appendix H). BOEM estimates the cumulative oil discharge at 34 and 38 days for the Burger J well is 253,234 and 279,954, respectively. BOEM further estimates the cumulative discharge at the end of day 90 is 613,076 bbl (BOEM, 2011, Appendix H).

A-3.3. Comparison of WCD to Very Large Oil Spill

BOEM reviewed the VLOS elements analyzed in the 2015 Second SEIS (Appendix A, Table A-3) to determine if the WCD estimates provided in the 2015 Shell EP are within the scope of the VLOS scenario. In calculating the flow rate, length of flow, and volume, the 2015 Second SEIS analysis did not consider a reduced volume that may be achieved through the use of oil spill countermeasures.

Table A-3. Comparison of VLOS Scenario Elements to Shell WCD Information.

Description	Chukchi Sea Second SEIS	Burger J	Relative Change
Flow Rate	61,000-20,479 bopd	25,000 bopd[1]	Less than ½ the flow initially
Length of Flow	39-74 days	30 days	Shorter duration
Volume	2.2 Million barrels[2]	750,000 barrels	About 1/3 of the size
Oil Type	35 °API	30° API	Light versus medium crude
Location	Subsurface or Surface	Surface or Subsurface (subsurface modeled for WCD)	Subsurface likely will surface within 1,000 m of the location of loss of well control

Source: Shell (2015) and BOEM (2011, Appendix H).
Key: °API = American Petroleum Institute gravity (API)
Bopd = barrels of oil per day
[1]Provided as required by 30 CFR 550.213(g), 550.219(a)(2)(iv) and 254.47(b)

The Burger J well was selected as the basis for comparison as it has the highest calculated WCD of the six exploration wells proposed in 2015 Shell EP (Shell, 2015: Table 2.g-1). BOEM analysis (BOEM, 2011, Appendix H) establishes an initial flow rate of 13,091 bopd which differs from that provided by Shell's estimate of 23,100 bopd (BOEM, 2011, Appendix H). This EA considers mitigation measures incorporated into 2015 Shell EP including the use of a capping and containment system to stem the discharge of oil to the marine environment within 15 days of a loss of well control incident. It is important to note that the volume of a very large oil spill estimated from a loss of well control event at Burger J is within the range analyzed in the 2015 Second SEIS for both BOEM's and Shell's WCD scenario.

BOEM determined that the very low-probability, very large oil spill scenario and conclusions with respect to the effects analysis provided in the 2015 Second SEIS remain valid. That analysis is sufficient to inform the decision maker of the effects of a low-probability, very large oil spill in the vicinity of the Proposed Action. In addition, the use of a capping stack, located adjacent to the project area and containment system located in Kotzebue Sound, could limit further the amount of oil reaching the sea surface and spreading.

A-4. Historical and Modeled Oil Spill Information

The following sections review the historical and modeled information on crude and condensate spills from exploration operations and well-control incidents during all drilling operations. The historical oil spill and model data indicate it is unlikely a large or very large oil spill will result from a well-control incident during exploration drilling or other exploration operations. The Arctic OCS historical oil spill data indicate a small refined spill is likely to occur during exploration operations.

A-4.1. Vessel Spills

The potential for large spills of diesel fuel from an OSV into the marine environment was considered. OGP (2010) reports vessel accident frequencies (per ship year) for all sea going merchant ships > 100 gross tons as 3.0×10^{-3} or total loss and 9.3×10^{-3} for serious casualty. While an offshore supply vessel could contain up to 14,192, bbl of fuel, the release of a large spill volume is unlikely. The fuel storage is divided into several tanks, some of which may be vulnerable but the bulk of the fuel would be positioned in locations beyond a potential breach of the hull. The likelihood of a collision and hull breach is considered remote. BOEM estimates an offshore vessel accident resulting in a large fuel spill is unlikely to occur.

In addition to the low frequency of occurrence, Shell and its contractors have measures in place to further reduce the potential for vessel collision and other accidental hazards that may result in spills from offshore vessels. These measures include: (1) Adherence to standard navigation procedures, USCG regulations, and safety zones around the MODUs, (2) COCP- Shell has developed a COCP, which has procedures to aid operations personnel in determining the correct procedures to follow when storm conditions are anticipated. Implementing the procedures will ensure the safety of any personnel onboard, minimize the risk of damage to equipment, and minimize the chance of a discharge attributable to the severe weather conditions (3) DIMP –Shell has a drilling and ice management plan to reduce ice hazards and (4) Reduced speeds during fog or inclement weather to reduce the chance of impacting marine mammals.

A-4.2. Historical Refined and Crude Spills from Exploration Operations on the Beaufort and Chukchi Outer Continental Shelf and Canadian Beaufort

BOEM estimates the chance of a large (≥1,000 bbl) oil spill from OCS exploratory activities to be very low. On the Beaufort Sea and Chukchi Sea OCS, the oil industry drilled 35 exploratory wells from 1981-2003 and two top holes in 2012. During this exploratory drilling, industry had 36 small spills totaling 26.7 bbl or 1,120 gallons (gal). Of the 26.7 bbl spilled, approximately 24 bbl (90%) were recovered or cleaned up (USDOI, 2015, Appendix A, Table A.1-2). During the 2012 exploration drilling activities, no spills of 1 barrel or more (BOEM/BSEE reportable quantities) occurred on the Arctic OCS. Only tiny spills (drips and drops) of hydraulic lube oil and gasoline for activities associated with the exploration program on the Arctic OCS were reported to the agencies and the National Response Center (NRC).

All the exploration spills on the Beaufort and Chukchi Seas OCS have been small, with the largest spill approximately 20 bbl. OCS petroleum spill data shows that 99.3% of all spills on the OCS are <50 bbl and 98.5% are <10 bbl in size (Anderson, Mayes, and LaBelle, 2012, Figure C-3). Based on the historical OCS spill data and Arctic OCS exploration spill data, small spills of diesel, refined fuel, or crude oil may occur. Shell estimates a small spill size of 48 or 5 bbl for a transfer of diesel fuel during refueling operations in their potential discharge estimates. BOEM estimates a small spill is likely and is a reasonably foreseeable scenario during exploratory drilling in the Chukchi Sea. The historical data shows small spills often are into containment or contained on vessels, platforms, facilities, or gravel islands, or onto ice, and may be cleaned up (USDOI, 2015, Appendix A, Table A.1-2).

No large exploration spills occurred on the Beaufort and Chukchi seas OCS from 1981-2012 (USDOI, 2015, Appendix A, Table A.1-2). One large exploration spill occurred in the Canadian Beaufort Sea from an exploration well site, when the island eroded during a storm and a facility fuel tank was damaged, spilling approximately 2,440 bbl of diesel P-50 fuel oil (Hart Crowser, 2000). Diesel tanks used for the Action Alternatives are internal to the MODUs and erosion would not be a causal factor for a large oil spill. If the internal diesel fuel tanks on the MODUs failed or leaked, it is unlikely a large spill would reach water.

A-4.3. Historical Crude and Condensate Oil Spills from Well-Control Incidents on the OCS and Alaska North Slope

The Gulf of Mexico, Pacific and Alaska OCS data show that a large/very large spill likely would not result from a well-control incident. BOEM considers well-control incidents that result in pollution to the environment to be very unlikely events. Well-control-incident events often are equated with very large oil spills because these spills receive media attention. However, in the last 39 years very few OCS well-control-incident events have resulted in spilled oil, and the volumes spilled often are small with the exception of the *Deepwater Horizon*. Five OCS well-control-incident events ≥1,000 bbl occurred between 1964 and 1970 and a sixth, the DWH event, occurred in 2010 in the Gulf of Mexico. Following the Santa Barbara well-control incident in 1969 and two large well control incidents in 1970 in the Gulf of Mexico OCS, amendments to the OCS Lands Act and implementing regulations significantly strengthened safety, inspection, and pollution-prevention requirements for OCS offshore activities. Well-control training, redundant pollution-prevention equipment, subsurface safety devices and regular inspections were among the provisions adopted in the regulatory program (Visser, 2011). The year 1971 is considered reflective of the modern OCS regulatory environment. For 39 years no OCS well control incidents resulted in a large or very large oil spill. In 2010 and 2011 new regulations were again implemented to significantly strengthen safety, inspection, and pollution-prevention requirements for OCS offshore activities after the DWH event. These new regulatory reforms are discussed in in detail in USDOI, BOEM (2012, Section 4.3.3.3.4; 2015, Section 4.4.1.1.).

On February 24, 2015 BOEM and BSEE published proposed rule "Oil and Gas and Sulphur Operations on the Outer Continental Shelf-Requirements for Exploratory Drilling on the Arctic Outer Continental Shelf". The proposed regulations codify requirements that all Arctic offshore operators and their contractors be appropriately prepared for Arctic conditions and that operators develop an integrated operations plan that details all phases of the exploration program for purposes of advance planning and risk assessment. With an emphasis on safe and responsible exploration, the proposed rule also would require operators to submit region-specific oil spill response plans, have prompt access to source control and containment equipment, and have available a separate relief rig to timely drill a relief well in the event of a loss of well control. The proposed rule continues to allow for technological innovation, as long as the operator can demonstrate that the level of its safety and environmental performance satisfies the standards set forth in the proposed rule (80 *FR* 9916, February 24, 2015). On April 13, 2015 BSEE published a proposed rule which addresses the range of systems and equipment related to well control operations. The measures are designed to improve equipment reliability, building upon enhanced industry standards for blowout preventers and blowout prevention technologies. The rule also includes reforms in well design, well control, casing, cementing, real-time well monitoring and subsea containment. The proposed rule would address and implement multiple recommendations resulting from various investigations of the Deepwater Horizon incident (80 FR 21504).

A-4.3.1. OCS Well Control Incident Rates

OCS well control incidents were discussed in USDOI, BOEM (2011, Appendix A, Section A.1.c; 2012, Section 4.4.3; 2015, Section 4.4.1.4) and Bercha (2014a). The term “loss of well control” was first defined in the 2006 update to the incident reporting regulations (30 CFR 250.188). Prior to this 2006 update, the incident reporting regulations included the requirement to report all blowouts, and the term blowout was undefined.

The risk of an unlikely or rare event, such as a loss of well control incident spilling crude oil, is determined using the best available historical data. The historical data indicates that loss of well control events resulting in oil spills are infrequent occurrences, and those resulting in large accidental oil spills are even rarer events (Anderson and Labelle, 2000; Anderson, Mayes, and LaBelle, 2012; Bercha Group, Inc. 2014a, b; Izon, Danenberger, and Mayes, 2007; Ji, Johnson, and Wikel, 2014; Robertson et al., 2013; USDOI, BOEM, 2012, Section 4.4.3). This conclusion is also supported by the Norwegian SINTEF Offshore Blowout Database, which tracks worldwide offshore oil and gas blowouts where risk-comparable drilling operations are analyzed (OGP, 2010; DNV, 2010; DNV, 2011). Blowout frequency analyses of the SINTEF database suggest the highest risk operations are associated with exploration drilling in high-pressure, high-temperature conditions (DNV, 2010; DNV, 2011) that are not expected to occur in the Burger Area. Further, new drilling regulations and recent advances in containment technology may reduce the frequency and size of oil spills from OCS operations (DNV, 2010; DNV, 2011).

The Five-Year Program Final PEIS (USDOI, BOEM, 2012, Section 4.3.3.2) provides a detailed discussion of the OCS well control incidents and risk factors that could contribute to a long duration loss of well control. Risk factors include geologic formation and hazards; water depth and hazards, geographic location (including water depth); well design and integrity; loss of well control prevention and intervention; scale and expansion; human error; containment capability; response capability; oil types and weathering/fate; and specific regional geographic considerations, including oceanography and meteorology.

Quantifying the frequency of VLOSs from a loss of well control event is challenging as relatively few large oil spills that can serve as benchmarks have occurred on the OCS (Scarlett et al., 2011). Prior to the DWH event, the three largest blowout spills on the OCS were 80,000 bbl, 65,000 bbl, and 53,000 bbl in volume. All of these spills occurred before 1971. Since 1971, substantial new regulatory requirements have been implemented to improve safety and reduce the likelihood of such spills occurring (Visser, 2011). From 1971–2010, with the additional regulatory requirements in place, fewer than 50 well control incidents occurred on the OCS from more than 41,800 wells drilled and almost 16 Bbbl of oil produced (USDOI, BOEM, 2012). Collectively, these 50 incidents comprised a total of 2,000 bbl of crude or condensate oil spilled, with the largest individual spill—other than the DWH event—being 450 bbl. The DWH event was the only loss of well control escalating into a blowout that caused a large or very large oil spill to occur between 1971 and April 2015 (USDOI, BOEM, 2012, BSEE, 2015).

Based on an analysis of this historic data from both the 1971-2010 (the modern regulatory era) and the 1964-1971 time frames, the frequency of a loss of well control occurring and resulting in a VLOS of different volumes was determined (USDOI, BOEM, 2012, Figure 4.4.3-1). This analysis, which is set forth in the Five-Year Program Final PEIS, was used to calculate the frequency (per well) of a spill exceeding 2.2 Mbbl, which is the VLOS volume assumed for the purpose of analysis in USDOI, BOEM (2015). This frequency was determined to be $>10^{-4} - <10^{-5}$ per well (USDOI, BOEM, 2012, Table 4.3.3). This frequency translates to approximately 1 in 10,000 wells to 1 in 100,000 wells.

Estimates of return rates for very large spills are still being refined due to the limited data available for analysis. Ji, Johnson and Wikel (2014) estimated a return period of an OCS oil spill of one million barrels or more is estimated to be 165 years, with a 95% confidence interval between 41 years and more than 500 years. Yang et al., (2013) used a precursor-based hierarchical Bayesian approach to examine an approach for the potential frequency of another DWH blowout and spill. Using data on accident precursors, certain data assumptions about the DWH blowout and spill, and an event tree analysis, the authors used the DWH accident as a case study for their statistical approach, which resulted in a frequency result that was approximately 0.000316 over a ten year period. This translates to a frequency of one similar spill event in more than 3000 years. As noted in these two approaches, the methods for evaluating frequency of a very large oil spill event are still being refined and are the continuing subject of further research using sophisticated analytical techniques. Nevertheless, both of these approaches illustrate that another very large spill is very unlikely over the short period of the exploration activities.

A-4.3.2. OCS and North Sea Well Control Incident Duration

This section summarizes information from well-control incidents that occurred during drilling from 1992 through 2006 on the OCS and includes all well-control incidents from drilling, even if no pollution occurred to the environment (Izon, Danenberger, and Mayes, 2007). Overall, the 1992-2006 period saw an improvement (decrease) in well-control-incident duration. Like the previous study (Danenberger, 1993), a significant number of well-control-incident events were of short duration. During the current study, 49% of the well-control incidents stopped flowing in 24 hours or less, compared with 57% during the previous study. In the current study, 41% lasted between 1 and 7 days, compared with 26% during the previous study. There were fewer well-control incidents that lasted more than 7 days. The well-control incident with the longest duration during the current study period was 11 days, compared with more than 30 days in the previous period (Izon, Danenberger, and Mayes, 2007).

The SINTEF blowout database was used to plot the duration of offshore blowouts in the U.S. and North Sea from 1980-2011. Ninety percent of offshore blowouts were 9 days or less in duration and 50% were 1.5 hours or less in duration (Bercha, 2014a).

A-4.3.3. Historical Exploration Well-Control Incidents on the Alaska North Slope and Surrounding Area

Historically, no exploration drilling blowouts occurred as a result of Chukchi Sea and Beaufort Sea OCS exploration drilling, nor have any occurred from the 84 exploration and 14 deep stratigraphic test wells drilled within the Alaska OCS. One exploration drilling blowout of gas occurred on the Canadian Beaufort Sea. Up to 1990, 85 exploratory wells were drilled in the Canadian Beaufort Sea, and one shallow-gas blowout occurred. A second incident was not included at the Amaluligak wellsite with the Molikpaq drill platform because it did not qualify as a blowout by the definition used in other databases. In that incident, there was a gas flow through the diverter, with some leakage around the flange (Devon Canada Corporation, 2004).

Since the 2012 Shell Chukchi Sea EP EA (USDOI, BOEM, 2011), one gas blowout occurred on the Alaska North Slope (ANS). On February 15, 2012, Repsol had a blowout from an exploration well on the Qugruk #2 pad (Q2 pad), on the Colville River Delta, approximately 18 miles northeast of Nuiqsut and approximately 150 miles southeast of Barrow (70° 27’ 19” N, 150° 44’ 52” W). The blowout from a shallow gas pocket released an unknown quantity of gas and approximately 42,000 gallons (gal) (1,000 bbl) of drilling mud (ADEC, 2012). The well ceased flowing on February 16, 2012. Of the 11 blowouts on the ANS, 10 were gas and 1 was oil. The one oil blowout was from drilling in the 1950s, which would not be relevant by today’s regulatory standards. Two studies confirmed that no crude oil spills ≥100 bbl from blowouts occurred from 1985-2010 (Hart Crowser, Inc., 2000, Robertson et al., 2013). The remaining blowouts released dry gas or gas condensate only, resulting in minimum environmental impact (NRC, 2003).

A-4.4. Historical Exploration Well-Control Incidents on The OCS and Canadian Beaufort

Thirty-five (35) exploration wells were drilled between 1981 and 2003 in the U.S. Chukchi and Beaufort Seas and two top holes were drilled in the Chukchi Sea in 2012. One exploration drilling blowout of gas has occurred on the Canadian Beaufort. Up to 1990, 85 exploratory wells were drilled in the Canadian Beaufort Sea, and one shallow-gas blowout occurred.

From 1971-2010 industry has drilled approximately 223 exploration wells in the Pacific OCS, 46 in the Atlantic OCS, 15,138 in the Gulf of Mexico OCS, and 84 in the Alaska OCS, for a total of 15,491 exploration wells. From 1971-2010, there were 77 well-control incidents associated with exploration drilling. Of those 77 well-control incidents, 14 resulted in spills of (1) drilling mud with oil or synthetic oil, (2) crude or (3) condensate. With the exception of the DWH event of 4.9 million barrels, spill sizes ranged from 0.5 bbl to 200 bbl (USDOI, BOEM, 2011, Appendix A, Table A-5). One OCS spill (large/very large) occurred from 1971-2010 during temporary abandonment of an exploration well. In summary, out of the more than 15,000 exploration wells drilled, one crude oil spill (large/very large) occurred during temporary abandonment and 13 small spills resulted in drilling mud oil, crude or condensate reaching the environment from well-control incidents during exploration drilling (USDOI, BOEM, 2011, Appendix A, Table A-5).

A-4.5. Fault Tree Model Exploration Well-Control Incident Frequencies

Bercha Group Inc. (2014b) developed an oil-spill occurrence fault-tree model to estimate the oil-spill rates associated with exploration, development and production for Arctic OCS locations. The information from Bercha Group Inc. (2014b) was used in the 2015 Second SEIS oil-spill analyses in the Chukchi Sea which estimated a mean number of 1.4 large spills (≥1,000 bbl) over the 51 year exploration and oil development and production Scenario life of the lease sale which included drilling 30-40 exploration and delineation wells, 400-457 production wells, 190-210 offshore pipeline miles and producing 4.3 Bbbl of crude oil and condensate. The annual spill rates were added to estimate the mean spill rate over the life of the Scenario. Based on the mean spill number over the life of the Scenario BOEM estimated a 75% chance of one or more spills occurring over the 51 year life of the scenario.

The majority of the Scenario fractional mean spill estimate was attributed to the development phase (Bercha Group Inc., 2014b, Table 6.2) with pipelines contributing the most, followed by platforms and then wells. Exploration, development and production wells contributed 2% to the spill frequency, with development and production contributing 87% of the 2%. Thirty to 40 exploration wells contributed a spill frequency of 0.074 spills per thousand years.

Because limited historical spill data for the Arctic exist, Bercha incorporated Gulf of Mexico and Pacific OCS and North Sea data and modified the existing base data using fault trees to arrive at oil-spill frequencies for future exploration, development, and production scenarios. For offshore exploration drilling, Bercha (2014b) used historical oil well blowout statistics derived from Bercha (2014a) for non-Arctic drilling to estimate the expected size and frequency distribution of loss of well control spills with release to the environment. Bercha (2014b) reported the historical loss of well control spill frequency for non-Arctic exploration well drilling as 0.217×10^{-4} per well for a blowout ≥150,000 bbl (23,848 m^3).

Where historical statistics are limited, it is possible to add variability in the fault tree, through a Monte Carlo simulation, to reduce the uncertainty in the fault tree analysis. To model the historical data variability for Arctic exploration well blowouts, Bercha applied a numerical simulation approach to develop the probability distribution for blowouts of 150,000 bbl (23,848 m^3) or greater, and arrived at a frequency ranging from a low of 0.095 x 10^{-4} per exploration well drilled to a high of 0.442 x 10^{-4} per exploration well drilled (Bercha 2014b, Table 2.9). The expected value for a blowout of this size was computed to be 0.25 x 10^{-4} per well (Bercha 2014b, Table 2.9). To address causal factors associated with blowouts, Bercha applied adjustments for improvements to logistics support and drilling contractor qualifications that resulted in minimally lower predicted frequencies for Arctic drilling operations. No fault-tree analysis or unique Arctic effects were applied as a modification to existing spill causes for exploration, development, or production drilling frequency distributions. For exploration wells drilled in analogous water depths to planned Chukchi Sea wells (30-60 m), Bercha (2014b) estimated the adjusted expected value frequency is 0.362 per 10^{-4} per well for a blowout sized between 10,000 bbl (1,590 m^3) and 149,000 bbl (23,689 m3), and 0.225 x 10^{-4} per well for a blowout >150,000 bbl (23,848 m^3) (Bercha, 2014b, Table 4.1.3).

The adjusted frequencies discussed above were applied in a fault tree model to estimate the rate of large and very large oil spills. Both the historical non-Arctic frequency distributions and spill causal distributions were modified to reflect specific effects of the Arctic setting, and the resultant fault tree model was evaluated using Monte Carlo simulation to adequately characterize uncertainties treated as probability distribution inputs (described above) to the fault tree.

A-4.6. Historical Worldwide Offshore Well Control Incident Spills ≥150,000 Barrels

Very large spills (≥150,000 bbl) happen very infrequently, and there are limited data for use in BOEM's statistical analysis and predictive efforts. The chance of a very large spill occurring is very low. Five of the six well control-incident events ≥1,000 bbl in the OCS database occurred between 1964 and 1970 (USDOI, BOEM, Appendix A, Table A-5). The sixth OCS well control incident resulting in a large spill was the DWH event. Although no official volume has been determined by BOEM or BSEE it is clear from the spill volume estimates that the Deepwater Horizon exceeds the threshold of a VLOS. The current government estimate is 4.9 million bbls and is greater than the 150,000 barrel threshold for a VLOS (Lubchenco et al. 2010; McNutt et al. 2011). The United States District Court for the Eastern District of Louisiana found that 4.0 million barrels of oil was released from the reservoir. After subtracting the 810,000 barrels of oil collected the court found that 3.19 million barrels of oil discharged into the Gulf of Mexico (U.S. District Court-Louisiana, 2015).

Internationally, from 1965 through 2010, seven offshore oil well control incidents, resulting in an oil spill of greater than or equal to 150,000 bbl, were identified from the peer reviewed or "gray" literature (Table A-4). One of the well control incidents was the result of military action. There were roughly 1.066 trillion barrels of oil produced worldwide from 1965–2010 (British Petroleum, 2011). BOEM compares numbers of very large oil spills to overall production because the number of exploration wells worldwide is not publically and readily available. Using the 6 very large oil spills which were not a result of war, these data provide an approximate rate of about 1 very large offshore oil spill worldwide for approximately every 180 Bbbl of oil produced. Using international data increases the size of the data set and is more likely to capture rare events. However, it assumes that non-US events are relevant to US events to the extent that technology, maintenance, operational standards and other factors are equal. However, this is not likely to be the case (especially in cases of military action).

Table A-4. Historical Very Large Oil Spills from Offshore Well Control Incidents 1965-2010.

Name	Company	Spill Source	Activity	Location	Oil	Begin	End	Duration (Days)	Bbls	Source
Deep Water Horizon/ Macondo MC 252	BP	Expl. Well	Temporary Abandonment	U.S. OCS, Gulf of Mexico	Crude	4/20/ 2010	7/15/ 2010	87	3,190,000-4,900,000	McNutt et al. 2011. National Oil Spill Commission 2011, U.S. District Court, 2015
Ixtoc	PEMEX	Expl. Well	Drilling	Mexico, Gulf of Mexico	Crude	6/3/ 1979	3/23/ 1980	295	3,500,000	OSIR, 1998; Etkin, 2009; Fingas, 2000; USDOC, NOAA, 1992.
Dubai		Dev. Well	Drilling			1973			2,000,000	Gulf Canada Resources Inc. 1982
Nowruz Oil Field No. 3 Well*	Iranian Offshore Oil	Platform	Production	Iran, Persian Gulf	Crude	2/4/ 1983	9/18/ 1983	224	1,904,762	OSIR, 1998; Etkin, 2009; Fingas, 2000; USDOC, NOAA, 1992.
Abkatun 91	PEMEX	Prod. Well	Workover	Mexico, Gulf of Mexico, Bay of Campeche	Crude	10/ 23/ 1986		15	247,000	OSIR, 1998; Etkin, 2009; Fingas, 2000;
Ekofisk Bravo Platform B14	Phillips Petroleum	Prod. Well	Workover	Norway, North Sea, Ekofisk Oil Field	Crude	4/22/19 77	4/30/ 1977	8	202,381	OSIR, 1998; Etkin, 2009; Fingas, 2000; USDOC, NOAA, 1992.
Funiwa No. 5 Well	Nigerian National Petroleum	Prod. Well	Drilling	Nigeria, Niger Delta/ Atlantic Ocean	Crude	1/17/19 80	2/1/ 1980	14	200,000	OSIR, 1998; Etkin, 2009; Fingas, 2000; USDOC, NOAA, 1992.

Note: * Military attack-related events; cells with no data means the information is not readily available in the open literature.
Source: USDOI, BOEM, (2011) compiled from cited references

A-5. Oil-Spill Analysis Framework

There are three potential size categories of oil spills in connection with exploratory operations in the Action Alternatives: (1) a large spill (≥1,000 bbl) from exploration operations; (2) a very large spill (≥150,000 bbl) from a well-control incident; and (3) a small spill (<1,000 bbl) from exploration operations. Historical and modeling oil spill data demonstrates that the frequency of a large spill occurring during exploration is low and, therefore, this EA does not analyze the impacts of large spills from exploration operations as being reasonably foreseeable. The occurrence of a very large spill resulting from a well-control incident is similarly very low. Nonetheless, this EA tiers to BOEM's prior analyses of the impacts of a large and very large oil spill in the 2015 Second SEIS. See further discussion in Section 4.0 of this EA. It is likely a small spill(s) could occur during exploration operations and the oil spill analysis scenario further includes small oil spill factors.

A-5.1. Small Oil Spills

This section provides the small oil spill analysis framework used for the determination of impacts in Section 4.0 of this EA for the Action Alternatives. For purposes of the oil spill analyses for the Action Alternatives, no large crude or diesel oil spills are estimated from exploration and delineation drilling activities. This is based on a review of potential discharges, historical oil spill and modeling data, and the likelihood of oil spill occurrence. This estimate is based on:

- The low rate of OCS exploratory drilling well-control incidents spilling crude oil per well drilled

- The fact that, since 1971, one OCS crude oil spill (large/very large) has occurred during temporary abandonment (converting an exploration well to a development well) while more than 15,000 exploratory wells were also drilled
- The low number (6) of exploration wells being drilled as a result of this proposed action
- The fact that no crude oil would be produced from the exploration wells, and the wells would be permanently plugged and abandoned
- The history of exploration spills on the Arctic OCS, all of which have been small
- The fact that no large spills occurred while drilling 35 exploration wells to depth in the Arctic OCS 1981-2012
- The fact that 99.3% of all OCS petroleum spills are <50 bbl and 98.5% are <10 bbl
- Pollution prevention and oil spill response regulations and methods, implemented by BOEM, BSEE, and the operators and since the Deepwater Horizon spill have reduced the risk of spills and diminished their potential severity (USDOI, BOEM, 2012, Section 4.3.3.3.4; 2015, Section 4.4.1.1.; Shell, 2015).
- Fuel tanks are internal to the MODUs, onshore tanks have 110% containment and offshore vessel collision rates are remote.

Historical Beaufort Sea and Chukchi Sea OCS exploration spill data, discussed in Section 1.3.1, suggest that the most likely cause of an oil spill during exploration could be operational, such as a hose rupture, and the spill could be relatively small. For purposes of analysis, up to a 48-bbl diesel fuel-transfer spill was chosen as one spill volume in the small spill category and 5-bbl was selected as the typical volume. This was based on historical exploration spill sizes in the Beaufort and Chukchi OCS, and OCS oil-spill data, which indicated that 99.3% of all OCS spills are <50 bbl and 98.5% are <10 bbl (Anderson, Mayes, and LaBelle, 2012, Figure C-3) and estimates of USCG Worst Case Discharge, average most probable discharge and maximum most probable discharge for exploration plans (Shell, 2013, Appendix M, Shell, 2015).

The WCD (for the purposes of the USCG) was calculated by Shell based on the definition contained in 33 CFR 154.1029(b) (2). Operators used the following values: (1) Maximum Time to Discover Release: 5 minutes; (2) Maximum Time to Shutdown Pumping: 0.5 minutes (30 seconds) (3) Maximum Transfer Rate: 320 gpm (based on representative fuel transfer pumps on the oil spill response vessel = 7.6 bbl/min; (4) Total Line Drainage Volume: 163 gal (assuming a 4-inch by 820-ft marine hose between the pump manifold on the fuel barge and the delivery flange on the inlet piping at the MODU) or 3.9 bbl. The total volume was 48 bbls (Shell, 2013, Appendix M). The maximum most probable discharge is 5.0 bbl of diesel fuel. It was calculated from the definition contained in 33 CFR 154.1020 (the lesser of 1,200 bbl or 10% of the volume of the WCD).

Small spills could occur during exploration and delineation drilling activities. In this analysis BOEM assumes up to two offshore transfer fuel spills occur. BOEM assumes one is a WCD (for purposes of the USCG; 48 bbl) and one is a maximum most probable discharge (5 bbl) for a potential volume up to 53 bbl. These spills do not occur in the same space and time. The volumes range from 5 up to 48 bbl of fuel spilled.

The 48 bbl or 5 bbl spill is estimated to last less than 3 days or1 day respectively on the surface of the water, based on the SINTEF Oil Weathering Model calculations. In terms of timing, a small spill from the exploration activities could happen at any time from July to October. Conservatively, BOEM assumes that the vessel would not retain any of the of diesel fuel, and depending on the time of year, a small spill could reach the vessel and then the environment. The environment could be open water or open water and ice. The analysis of a small spill examines the weathering of the estimated 48 or 5 bbl diesel fuel spill. BOEM estimates the following fate of the diesel fuel without cleanup.

BOEM summarizes below the estimates for the fate and behavior of diesel fuel in the analysis of the effects of oil on environmental, economic and social resources in Section 4.0. BOEM outlines the scenario assumptions for a small spill to provide a consistent analysis of small oil spill impacts by resource:

- Up to two small spills could occur.
- The spills do not occur in the same space and time.
- The spill(s) size volume is 5 or 48 bbl.
- The oil type is diesel fuel.
- All the oil reaches the environment; the vessel or facility absorbs no oil.
- The spills could occur into open water or open water and ice.
- There is no reduction in volume due to cleanup or containment. (Pollution prevention, containment and cleanup is analyzed separately as mitigation and as disturbance.)
- The spill(s) could occur at any time of the exploration operations (July–October).
- The spill(s) could occur in the Action Area or Kotzebue Sound
- The spill weathering is as shown in **Error! Reference source not found.**5, and the spill(s) lasts less than 3 days or 1 day on the water.
- The spill starts within Launch Area 11 (USDOI, BOEM, 2015, Appendix A, Map A-5, Page A-73) or within Kotzebue Sound.
- The time and chance of contact from an oil spill are calculated from an oil-spill-trajectory model
- The chance of contact is analyzed from the location where it is highest when determining effects.

A-5.1.1. Modeling Simulations of Oil Weathering

To judge the effect of a small oil spill, BOEM makes estimates regarding how much oil evaporates, how much oil is dispersed, and how much oil remains after a certain time period. BOEM derives the weathering estimates of diesel fuel oil from the SINTEF Oil Weathering Model Version 3.0 (Reed et al., 2004) modeling results for up to 30 days. Table A-5 summarizes the results BOEM estimates for the fate and behavior of a 48-bbl diesel fuel spill. BOEM's estimate is slightly more conservative than the estimate in the 2015 Shell EIA, Table 2.10-2 ,which used the ADIOS2 model and a water temperature 2 degrees higher. Both models provide a reasonable estimated range of the fate and behavior of diesel fuel under slightly different environmental conditions. Based on modeling simulations and historical response experience, a small, 48-bbl or 5-bbl diesel fuel oil spill will be localized and short term.

Table A-5. Fate and Behavior of a Hypothetical 48 or 5-Barrel Diesel Fuel Oil Spill.

Scenario Element	Summer Spill[1]						
48 -Barrel							
Time After Spill in Hours	1	2	3	6	12	24	48
Oil Remaining (%)	96	91	84	65	31	4	0
Oil Naturally Dispersed (%)	3	7	12	28	57	79	83
Oil Evaporated (%)	1	2	4	7	12	17	17
Thickness (mm)	0.7	0.5	0.5	0.3	0.1	0.1	0

Scenario Element	Summer Spill[1]						
5 -Barrel							
Time After Spill in Hours	1	2	3	6	12	18	24
Oil Remaining (%)	92	82	71	41	8	1	0
Oil Naturally Dispersed (%)	5	13	22	47	74	80	81
Oil Evaporated (%)	3	5	7	12	18	19	19
Thickness (mm)	0.3	0.2	0.2	0.1	0.1	0.1	0.1

Notes: Calculated with the SINTEF oil-weathering model Version3.0 of Reed et al. (2004) and assuming marine diesel.
[1] Summer (June through October), 12-knot wind speed, 2 degrees Celsius water temperature, 0.4-meter wave height.

A-5.1.2. Spill Prevention and Response for Small Oil Spills

Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, the process of Shell's FTP (Shell 2015, Appendix I) for fuel transfers between vessels would be utilized in accordance with BOEM lease stipulation No. 6, USCG requirements, and Shell's operating procedures. Shell's operating procedures ensure that transfer operations would be scheduled at least 24 hour in advance allowing operations personnel to review the planned transfer, ensure suitable weather conditions will occur, make appropriate notifications and ensure response personnel and equipment is properly staged and boom deployed as required. Transfer operations would be visually monitored at all times and in conjunction with continuous communications to provide prompt discharge detection and control. Prior to initiating any fuel transfer operations, a pre-transfer conference is conducted between the fuel vessel, the receiving vessel, and response team personnel. During the transfer, the person-in-charge of the fuel transfer operation on each vessel, as well as the officer in the wheelhouse of the fuel vessel and the deck watch of the vessels involved in the fuel transfer, shall remain in radio contact. In addition, the deck watch of each vessel will have visual contact during the operation. The response team pre-deploys containment boom, as per the FTP, configured to minimize the effects of wind and currents to the extent possible. Response workboats will remain on standby during the entire transfer operation to tend boom, monitor the transfer process, and detect any discharges (Shell, 2015, Appendix C, p. 2-46, Appendix I).

A-5.2. Large and Very Large Accidental Oil Spills

This EA tiers to previous analyses of large and very large accidental oil spills in the 2015 Second SEIS. After the Exxon Valdez oil spill in 1989, BOEM, Alaska OCS Region analyzed very large spills in several OCS locations, three of which were in the Chukchi Sea (USDOI MMS, 1990a, b, 1991, 1995a, b, 1996, 1998, 2002, 2003a, b; USDOI, BLM and MMS, 1998, 2003; USDOI, BLM, 2005, USDOI, BOEMRE, 2011, USDOI, BOEM, 2015). The frequency of a very large spill (≥150,000) is very low, but its potential effects were most recently analyzed in the 2015 Second SEIS, Section 4.4. The spill scenario was based on an initial flow rate of 61,000-bbl declining to 20,479-bbls at 74 days and totaling approximately 2.2 MMbbl. In the unlikely event of a very large accidental oil spill, the potential for major impacts exist as was identified in the 2015 Second SEIS, Section 4.5.

The chance of a large (≥1,000 bbl) spill during exploration activities is also low, but the potential consequences were analyzed in the 2015 Second SEIS, Section 4.3. Based on OCS median spill sizes, BOEM) estimated a 5,100-bbl diesel, condensate or crude oil spill from a facility or a 1,700-bbl crude or condensate oil spill from a pipeline for purposes of analyzing a large spill volume (Anderson, Mayes, and LaBelle, 2012).

The conditional probabilities estimated by the Oil-Spill Risk Analysis (OSRA) model (expressed as percent chance) of a spill ≥1,000 bbl contacting environmental resource areas or land segments within a given time frame from launch areas (LAs 1, 4, 5, 6, 10 and 11) and pipeline segments (PLs 2, 3, 5, 6, 8 and 9) assuming a spill occurs are discussed in the 2015 Second SEIS. In the unlikely event of a large or very large accidental oil spill, there is potential for minor to major impacts as identified in those analyses (USDOI, BOEM, 2015, Sections 4.3, 4.4 and 4.5).

A-5.3. Hydrocarbon Spill Transport and Trajectory Analysis

The previously referenced large and very large oil spill analyses considered surface releases. Subsurface releases are estimated to rise to the surface in the moderate water depths (<50m) of the drill sites in a short period of time and within 1,000-2,000m of the release site (Daling et al., 2003). West (2014) reached a similar conclusion that subsurface releases reach the surface within a minimal distance of the release site. The Action Alternatives area water depths are relatively shallow (<46m (Shell, 2015: Figures 1.b-3 through 1.b-8)). A subsurface release or a surface release would be represented by LA11 for the proposed Shell exploration well locations in the Action Alternatives.

A-5.3.1. Conditional Probabilities

The summer (June 1 – October 31) conditional probabilities (expressed as percent chance) from Launch Area (LA) 11 (USDOI, BOEM, 2015, Appendix A: Tables A2-25 through A2-27, A.2-31 through A.2-33 and A.2-37 through A.2-39) were compared to the summer conditional probabilities from representative launch points representing Shell's 2015 proposed exploration wells on the Burger lease blocks. The chance of a large spill contacting, assuming a large spill occurs, is summarized specifically for the LA11 and compared to the Shell 2015 lease blocks where exploration wells are proposed (Tables A-8 and A-9). The estimated conditional probabilities do not factor in pollution prevention, pre-booming or spill response; these are considered mitigation, and is analyzed and discussed as such in the impact sections of each resource. A successful or partially successful spill response would reduce the chance of spill contact or make contact nonexistent to some resources.

The 2015 Shell EIA (Shell, 2015: Appendix C, Table 6.2-1 and 6.2-2) shows Environmental Resource Areas (ERAs) and Land Segments (LSs) in the nearshore region with a chance of contact from LA11 greater than or equal to 0.5% during summer. Tables A-7 and A-8 summarize the chances of contact below for all environmental resource areas (ERAs), land segments, and grouped land segments from Sale 193 LA11 and Shell's 2015 Burger lease blocks with a chance of contact greater than or equal to 0.5%. Figures A.1-2 through 4, in the 2015 Second SEIS, Appendix A (USDOI, BOEM, 2015), show the locations of ERAs, land segments, and grouped land segments.

A-5.3.1.1. Comparison to Shell 2015 Proposed Exploration Wells.

The conditional probabilities of contact from LA11 (USDOI, BOEM, 2015 Appendix A, Map A-5, Page A-73) were compared to Shell's Lease Blocks (OCS-Y-2280, 2267, 2321, 2294, 2278 and 2324) for proposed exploration wells on the Burger prospect. The chance of a large spill contacting, assuming a large spill occurs, is summarized specifically for the LA11 and compared to four groups of lease blocks which are representative of the six wells Shell proposes to drill on those lease blocks.

Table A-6. Proposed Drill Sites and Lease Block Numbers.

Proposed Drill Site	Block	Lease Number	Latitude	Longitude
Burger A	6764	OCS-Y-2280	N71° 18' 30.92"	W163° 12' 43.17"
Burger F	6714	OCS-Y-2267	N71° 20' 13.96"	W163° 12' 21.75"
Burger J	6912	OCS-Y-2321	N71° 10' 24.03"	W163° 28' 18.52"
Burger R	6812	OCS-Y-2294	N71° 16' 06.57"	W163° 30' 39.44"
Burger S	6762	OCS-Y-2278	N71° 19' 25.79"	W163° 28' 40.84"
Burger V	6915	OCS-Y-2324	N71° 10' 33.39"	W163° 04' 21.23"

Launch points, from the 2015 Second SEIS OSRA model, were compared to the Shell OCS Lease blocks, 2267 and 2280, 2278, 2321, and 2294 and 2324 (Table A-6, above). The OSRA modeling group, in Herndon, Virginia, chose representative launch points from the 2015 Second SEIS OSRA model (Li, Johnson, and Murphy, 2015) to compile summer conditional probabilities for 3, 10 and 30 days for land segments, grouped land segments and environmental resource areas for Burger A&F, J, R&S and V.

The existing conditional probability information for LA11 (USDOI, BOEM, 2015, Appendix A) was determined to be representative for the Shell's 2015 proposed exploration wells A, F, J, R, S and V on lease blocks (OCS-Y-2280, 2267, 2321, 2294, 2278 and 2324) on the Burger prospect. In general, conditional probabilities from the Shell blocks are lower for nearshore areas and higher for ERAs directly adjacent to the blocks (Tables A-7 and A-8).

Table A-7. Summer - Percent Chance of a Spill contacting an ERA within 3, 10, or 30 days.

ID	Environmental Resource Area Name	LA 11			Burger A&F			Burger J			Burger R&S			Burger V		
		3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days
0	Land	2	15	37	:	8	26	1	11	31	:	9	28	1	12	32
1	Kasegaluk Lagoon Area	1	3	4	:	:	1	:	1	2	:	:	2	:	1	3
2	Point Barrow, Plover Islands	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
3	SUA: Uelen/Russia	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
6	Hanna Shoal	2	6	11	3	9	17	1	6	13	2	8	15	1	5	12
7	Krill Trap	:	3	6	:	4	7	:	4	7	:	4	7	:	4	8
10	Ledyard Bay SPEI Critical Habitat Area	8	11	13	:	1	3	:	2	5	:	2	4	:	3	5
11	Wrangel Island 12 nm & Offshore	:	:	3	:	:	4	:		3	:	:	4	:	:	3
12	SUA: Nuiqsut:Colville Delta	:	:	:	:	:	1	:	:	1	:	:	1	:	:	1
15	Cape Lisburne Seabird Colony Area	:	2	4	:	:	2	:	1	3	:	:	2	:	:	2
16	Barrow Canyon	1	11	18	1	11	17	1	12	18	1	11	17	1	14	21
18	Murre Rearing and Molting Area	:	3	9	:	1	7	:	2	8	:	2	8	:	2	7
19	Chukchi Spring Lead System	4	6	8	:	2	4	:	3	5	:	2	4	1	4	6
20	East Chukchi Offshore	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
23	Polar Bear Offshore	4	5	7	:	:	2	:	:	2	:	:	2	:	1	2
26	AK BFT Bowhead FM 5	:	:	:	:	:	1	:	:	:	:	:	:	:	:	
27	AK BFT Bowhead FM 6	:	:	:	:	:	:	:	:	1	:	:	:	:	:	1
28	AK BFT Bowhead FM 7	:	:	:	:	:	:	:	:	1	:	:	:	:	:	1
29	AK BFT Bowhead FM 8	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
30	Beaufort Spring Lead 1	:	1	2	:	1	2	:	1	2	:	1	2	:	1	2
31	Beaufort Spring Lead 2	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
38	SUA: Pt. Hope : Cape Lisburne	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
39	SUA: Pt. Lay : Kasegaluk	1	3	5	:	1	2	:	1	3	:	1	2	:	1	3
40	SUA: Icy Cape : Wainwright	14	27	34	4	12	18	9	19	26	5	14	21	12	22	28
42	SUA: Barrow : East Arch	:	4	7	:	5	8	:	4	7	:	4	8	:	5	8
43	SUA: Nuiqsut : Cross Island	:	1	3	:	1	4	:	2	4	:	1	3	:	2	4
47	Hanna Shoal Walrus Use Area	27	37	46	56	65	70	23	38	47	32	46	54	27	41	49
50	Pt Lay Walrus Offshore	12	18	21	1	3	6	:	6	10	:	3	7	:	5	9
51	Pt Lay Walrus Nearshore	1	3	5	:	:	1	:	1	2	:	1	2	:	1	2
52	Russian Coast Walrus Offshore	:	2	10	:	:	7	:	1	9	:	1	8	:	1	8
53	Chukchi Spring Lead 2	5	5	5	:	1	1	:	:	:	:	:	:	:	1	1
54	Chukchi Spring Lead 3	4	7	9	1	4	6	2	5	7	1	4	6	2	6	8
55	Point Barrow, Plover Islands	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
56	Hanna Shoal Area	6	13	17	10	19	23	4	13	18	6	16	20	6	14	19
57	Skull Cliffs	1	6	10	1	4	7	1	5	9	1	4	7	1	6	10
58	Russian Coast Walrus Nearshore	:	:	3	:	:	2	:	:	3	:	:	2	:	:	2
59	Ostrov Kolyuchin	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
61	Pt Lay:Barrow BH GW SFF	31	44	53	21	33	43	25	38	47	19	32	42	33	44	52
63	North Chukchi	:	:	:	:	:	1	:	:	1	:	:	1	:	:	1
64	Peard Bay Area	2	13	21	2	12	19	2	14	21	1	13	19	3	16	24

ID	Environmental Resource Area Name	LA 11			Burger A&F			Burger J			Burger R&S			Burger V		
		3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days
66	Herald Island	:	:	1	:	:	2	:	:	1	:	:	2	:	:	1
68	Harrison Bay				:	:		:	:	1	:	:	:	:	:	1
69	Harrison Bay/Colville Delta						1			1						1
70	North Central Chukchi	:	:	1	:	:	2	:	:	1	:	:	1	:	:	1
74	Offshore Herald Island	:	:	2	:	:	3	:	:	3	:	:	3	:	:	2
80	Beaufort Outer Shelf 1	:	:	1	:	1	2	:	1	2	:	:	2	:	:	2
82	N Chukotka Nrshr 2	:	:	4	:	:	3	:	:	4	:	:	4	:	:	4
83	N Chukotka Nrshr 3	:	:	4	:	:	3	:	:	4	:	:	4	:	:	3
86	Harrison Bay				:	:		:	:	1	:	:		:	:	1
91	Hope Sea Valley	:	:	3	:	:	3	:	:	3	:	:	3	:	:	3
101	Beaufort Outer Shelf 2	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
102	Opilio Crab EFH	:	1	3	:	:	2	:	:	2	:	:	2	:	:	2
103	Saffron Cod EFH	13	33	47	5	22	35	7	25	40	5	22	36	10	29	43
105	Fish Creek	:	:	:	:	:	:	:	:	:	:	:	:	:	:	1
107	Pt Hope Offshore	:	:	2	:	:	1	:	:	1	:	:	1	:	:	1
108	Barrow Feeding Aggregation	:	3	5	:	4	6	1	4	5	:	4	6	1	4	6
111	AK BFT Outer Shelf&Slope 2	:	:	:	:	:	1	:	:	:	:	:	:	:	:	1
112	AK BFT Outer Shelf&Slope 3	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
113	AK BFT Outer Shelf&Slope 4	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
114	AK BFT Outer Shelf&Slope 5	:	:	1	:	:	2	:	:	1	:	:	1	:	:	1
115	AK BFT Outer Shelf&Slope 6	:	:	2	:	1	3	:	:	2	:	:	2	:	1	2
116	AK BFT Outer Shelf&Slope 7	:	1	3	:	1	4	:	1	3	:	1	4	:	1	4
117	AK BFT Outer Shelf&Slope 8	:	1	4	:	2	6	:	1	4	:	2	6	:	1	5
118	AK BFT Outer Shelf&Slope 9	:	1	5	:	2	6	:	2	5	:	2	6	:	2	5
119	AK BFT Outer Shelf&Slope 10	:	6	14	:	7	14	:	6	14	:	6	13	:	8	16
120	Russia CH GW Fall 1&2	:	1	4	:	:	3	:	:	4	:	:	3	:	:	3
121	Cape Lisburne : Pt Hope	:	1	2	:	:	1	:	:	1	:	:	1	:	:	1
122	North Chukotka Offshore	:	:	1	:	:	2	:	:	2	:	:	2	:	:	1
123	AK Chukchi Offshore	:	2	4	1	3	6	:	3	5	1	4	6	:	2	5
124	Central Chukchi Offshore	:	1	5	:	1	5	:	1	5	:	1	5	:	1	5

Notes: ** = Greater than 99.5 percent; : = less than 0.5 percent; LA = Launch Area Rows with all values less than 0.5 percent are not shown.

Table A-8. Summer - Percent Chance of a Spill contacting an LS or GLS within 3, 10, or 30 days.

ID	Land Segment	LA 11			Burger A&F			Burger J			Burger R&S			Burger V		
		3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days
7	Kosa Bruch	:	:	:	:	:	1	:	:	:	:	:	:	:	:	:
8	E. Wrangel Island, Skeletov	:	:	:	:	:	1	:	:	1	:	:	1	:	:	1
23	Emuem, Tenkergin	:	:	:	:	:	1	:	:	:	:	:	:	:	:	:
25	Laguna Amguema, Yulinu	:	:	1	:	:	:	:	:	:	:	:	1	:	:	1
26	Ekugvaam, Kepin, Pil'khin	:	:	1	:	:	:	:	:	1	:	:	:	:	:	1
27	Laguna Nut, Rigol'	:	:	1	:	:	1	:	:	1	:	:	:	:	:	1
28	Vankarem,Vankarem Laguna	:	:	1	:	:	:	:	:	:	:	:	:	:	:	1
29	Mys Onman, Vel'may	:	:	1	:	:	:	:	:	1	:	:	1	:	:	:
30	Nutepynmin, Pyngopil'gyn	:	:	1	:	:	:	:	:	:	:	:	:	:	:	1
31	Alyatki, Zaliv Tasytkhin	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
65	Buckland, Cape Lisburne	:	:	1	:	:	:	:	:	:	:	:	:	:	:	:
73	Tungaich Point, Tungak Creek	:	:	1	:	:	:	:	:	:	:	:	:	:	:	:
74	Kasegaluk Lagoon, Solivik Isl.	:	:	1	:	:	:	:	:	1	:	:	:	:	:	1
75	Akeonik, Icy Cape	:	1	1	:	:	:	:	:	:	:	:	:	:	:	:
76	Avak Inlet, Tunalik River	:	:	1	:	:	:	:	:	:	:	:	:	:	:	:

ID	Land Segment	LA 11			Burger A&F			Burger J			Burger R&S			Burger V		
		3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days
77	Nivat Point, Nokotlek Point	:	:	1	:	:	:	:	:	:	:	:	:	:	:	:
78	Point Collie, Sigeakruk Point	:	1	2	:	:	:	:	:	1	:	:	:	:	:	1
79	Point Belcher, Wainwright	1	2	3	:	1	1	:	2	3	:	1	2	:	1	2
80	Eluksingiak Point, Kugrua Bay	:	2	3	:	1	2	:	1	3	:	1	2	1	2	3
81	Peard Bay, Point Franklin	:	:	1	:	:	1	:	:	1	:	:	1	:	1	1
82	Skull Cliff	:	:	1	:	:	1	:	:	1	:	:	1	:	1	1
83	Nulavik, Loran Radio Station	:	1	1	:	:	1	:	:	1	:	:	1	:	1	1
84	Will Rogers & Wiley Post Mem.	:	2	3	:	2	3	:	2	3	:	2	3	:	2	4
85	Barrow, Browerville, Elson Lag.	:	4	6	:	3	6	:	4	7	:	4	6	:	5	7
ID	**Grouped Land Segment Name**															
133	Mys Blossom	:	:	1	:	:	2	:	:	1	:	:	2	:	:	2
135	Kolyuchin Bay	:	:	2	:	:	1	:	:	2	:	:	1	:	:	2
136	Ostrov Idlidlya	:	:	1	:	:	:	:	:	1	:	:	:	:	:	1
137	Mys Serditse Kamen	:	:	1	:	:	:	:	:		:	:	:	:	:	:
138	Chukota Coast Haulout	:	:	1	:	:	1	:	:	1	:		1	:	:	1
144	Alaska Maritime Wildlife Refuge	:	:	1	:	:	:	:	:		:	:	:	:	:	:
145	Cape Lisburne	:	:	1	:	:	:	:	:		:	:	:	:	:	1
146	Ledyard Bay	:	:	1	:	:	:	:	:		:	:	:	:	:	1
147	Point Lay Haulout	1	1	2	:	:	1	:	:	1	:	:	1	:	:	1
148	Kasegaluk Brown Bears	1	2	4	:	:	1	:	:	1	:	:	1	:	1	2
149	National Petroleum Reserve Alaska	1	4	7	:	2	6	:	3	6	:	2	6	1	4	8
150	Kasegaluk Lagoon Special Use Area	:	1	1	:	:	1	:	:	:	:	:	:	:	:	:
151	Kuk River	:	3	5	:	1	2	:	2	3	:	1	2	:	1	3
152	TCH Insect Relief/Calving	:	2	4	:	2	3	:	3	5	:	2	3	:	3	4
154	Teshekpuk Lake Special Use Area	:	:	:	:	:	:	:	:	1	:	:	1	:	:	1
174	Russia Chukchi Coast Marine Mam.	:	:	10	:	:	8	:	:	9	:	:	9	:	:	9
175	Russia Chukchi Coast	:	:	10	:	:	8	:	:	9	:	:	9	:	:	9
176	United States Chukchi Coast	2	11	19	:	5	11	1	7	13	:	5	12	1	8	15
177	United States Beaufort Coast	:	4	7	:	4	7	:	4	9	:	4	7	:	5	8

Notes: ** = Greater than 99.5 percent; : = less than 0.5 percent; LA = Launch Area Rows with all values less than 0.5 percent.are not shown. .Source: USDOI, BOEM 2015

A-6. References

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Appendix B

Cumulative Effects

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Appendix B. Cumulative Effects

B-1. Cumulative Effects Defined

The Council on Environmental Quality (CEQ) Regulations defines cumulative effects at 40 CFR 1508.7:

> **Sec. 1508.7 Cumulative impact.**
>
> "Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

B-2. Cumulative Effects Scenario

The scope of this assessment includes the incremental impact from the action alternatives plus the aggregate effects of other activities that are known to occur or that can be reasonably expected to occur at the same time as, and in the vicinity of the Proposed Action, and which have a potential to affect the same resources as the Proposed Action.

This cumulative effects scenario tiers from information provided in Chapter 5 of the Lease Sale 193 Final Second SEIS (USDOI, BOEM, 2015). That information is incorporated by reference and summarized below. Further, it is updated to consider the years 2015 through 2017 and reflect the past, present, and reasonably foreseeable activities which may occur within the special confines and within the time period of the Proposed Action.

B-3. Impact Sources

The main sources of impacts which could have a cumulative impact with the Proposed Action on the resources in the Arctic OCS are:

1. Marine vessel traffic
2. Aircraft traffic
3. Subsistence and other community activities
4. Scientific research activities
5. Oil and gas-related

B-3.1. Marine Vessel Traffic

Past marine vessel traffic has been associated with subsistence hunting, oil exploration, research, and military activities. Weather and ice have traditionally limited marine vessel traffic in the proposed exploration area to the open-water period of July through September.

Overall, the number of marine vessels in the Chukchi Sea has increased in recent years due to advances in the technology of ice strengthening and ice breaking capacities of marine vessels, changes in ice cover and classification of ice, and increased interest in scientific and economic pursuits in the area. Vessel traffic related to the Proposed Action would include drillships and support vessels. Other reasonably foreseeable traffic in the U.S. Chukchi Sea includes small craft involved in the fall whaling hunt at Barrow and Wainwright; USCG vessels; cargo vessels; other supply ships, tugs, and barges; cruise ships; and vessels associated with scientific endeavors. USCG District 17

(2013) has reported that during the period from 2008 to 2012, annual vessel traffic transiting the Bering Strait, which is the entry and exit point to the Western Arctic and the Chukchi Sea, increased from 220 to 480 vessels a year (a more than 100% increase). The growth rate was particularly high for tanker vessels. Tugs and other nearshore cargo vessels made up the second and third largest categories of recorded movements. Smaller vessel traffic specific to subsistence hunting will likely remain relatively constant while vessel traffic specific to supply of native villages will likely increase (AMSA, 2009). The estimated number of miles of vessel traffic in the Chukchi Sea for July through October increased from approximately 2,000 miles in 2006 to more than 11,500 miles in 2010 (Marine Exchange of Alaska, 2011). Vessel tracks from 2009 indicate vessel transits in the vicinity of Barrow and Wainwright are traditionally concentrated along the coast (Marine Exchange of Alaska, 2011).

Marine vessels are the greatest contributors of anthropogenic sound introduced to the Chukchi Sea. Sound levels and frequency characteristics of vessel sound generally are related to vessel size and speed. Larger vessels generally emit more sound than do smaller vessels. Same size class vessels travelling at higher rates of speed generally emit more sound than the same vessels travelling at lesser speeds. Vessels underway with a full load, or vessels pushing or towing loaded non-powered vessels, generate more sound than unladen vessels in a similar size class. The most common sources of marine vessel mechanical components that generate sound waves are propulsion engines, generators, bearings, and other mechanical components, as well as fathometers and other vessel navigation and operations equipment, all of which create and propagate sound into the marine environment through the vessel hull. The most intense level of sound pressure introduced into the water from an underway marine vessel originates from cavitation associated with the action of spinning propellers. Moored vessels generate sound from the operation of engines and pumps. Cranes or other similar operational equipment performing construction activities or other work functions at docks may transmit sound directly to the environment or indirectly through propagation of sound waves through the hull.

It is reasonably foreseeable that vessel traffic will increase over the proposed period of the exploration plan. This traffic would likely include industry activities in the form of seismic surveys, seafloor archaeological and biological surveys, seafloor geotechnical programs, biological monitoring surveys, research activites, coastwise commercial and community vessel traffic, and military actions. Migratory species such as birds and marine mammals could potentially experience multiple encounters with these vessels and vessel noise along their routes. Those encounters, depending on the species and vessel activity, could have cumulative, synergistic effects from multiple encounters during migration.

B-3.2. Aircraft Traffic

Past air traffic activities in the area of the proposed exploration drilling and support activities have been limited to movement of people and supply materials between industry operations, native villages, and military outposts.

Air traffic has increased in recent years, mostly from increases in academic and commercial ventures, and increases in military operations. Aircraft traffic in the Arctic includes fixed wing and helicopter flights for research programs and marine mammal monitoring operations; cargo flights for supplies to villages and for commercial ventures including oil and gas related activities (such as crew changes and supply flights); flights for regional and inter-village transport of passengers; air-ambulance and search and rescue emergency flights; general aviation for the purpose of sport hunting and fishing or flightseeing activities; and multi-governmental military flights. Air traffic not associated with the proposed project may involve flight patterns at a lower altitude than the 1,500-ft limit required for aircraft related to the Proposed Action. Shell calculated that an average of 306 commercial flights per month occurred from Wainwright airport between July and October, 2000 to 2008 (Shell, 2011, Appendix F, Table 4.1.11-6).

Air traffic is expected to continue at present levels for the reasonably foreseeable future.

B-3.3. Subsistence Activities

Subsistence hunting and other community activities associated with regional native villages such as Wainwright and Point Lay have persisted for millennia, and are expected to continue during the period of proposed activities. Additional information regarding these activities is provided in Chapters 3 and 4.

Overall, vessel traffic associated with subsistence and other native village activities within the Proposed Action Area is expected to be consistent with the level of traffic observed in recent years. Most vessel traffic in the region is nearshore, or is a result of exploration activity and academic or industry research efforts. Nearshore traffic is expected to consist of barges (with their associated towing /pushing vessels) transiting through the area during open water conditions within 12.5 mi (20 km) of the coast. With the reduction in ice cover and increase in open water season, cumulative vessel traffic in the region due to military, tourism, and foreign shipping interests may increase (Arctic Marine Shipping Assessment, 2009).

B-3.4. Scientific Research Activities

A sizable scientific research effort by governmental, non-governmental, and academic organizations operating from marine vessels and aircraft occurs annually in the Chukchi Sea. Programs conducted by these organizations are expected to continue throughout the Proposed Action. Marine environmental baseline studies involve deployment of oceanographic equipment for collecting water and sediment samples, and use of nets and trawls for fish sampling and collection of phytoplankton, zooplankton, benthic invertebrates, and pelagic invertebrates. Continuing Actions include:

- Observations of marine and coastal birds and marine mammals using standardized survey transect methods and passive acoustic monitoring.
- Deployment of Metocean buoys and acoustic wave and current meters for studies of physical oceanography, climate, and ice movement.

Previous environmental assessments, such as the environmental impact assessment for Shell's Chukchi Sea marine research program, describe the techniques used and the effects of these programs in detail (USDOI, BOEM, 2015).

Pacific Arctic Group (PAG). Ongoing activities in the general Beaufort and Chukchi Sea regions include multinational efforts carried out by the Pacific Arctic Group (PAG). Organized under the International Arctic Science Committee (IASC), the PAG mission is to serve as a Pacific Arctic regional partnership to plan, coordinate, and collaborate on science activities of mutual interest to the Arctic region. Some of these activities could coincide in time and space with Shell's proposed exploration plan activities. The Diversified Biological Observatory (DBO) is a multi-national cooperative effort coordinated by the PAG, with the USA, Canada, Russia, Japan, China, and South Korea contributing cruise data from past, ongoing, and planned research programs. The programmatic sampling includes continuation of collections from prior and existing research stations, including BOEM-funded projects. Focus is on four geographical research areas within the Bering Sea, Bering Strait, Chukchi Sea, and Beaufort Sea. This work includes the synthesis of studies in fields including physical oceanography, marine chemistry, biological oceanography and marine biology (primary productivity, zooplankton, phytoplankton, ice algae, epontic, pelagic, and benthic collections), and marine mammal and marine bird ecology (PAG, 2014).

Arctic Marine Biodiversity Observing Network (AMBON) July – August 2015-2017. This study will build on historical and emerging DBOs by developing a prototype ecosystem-based marine biodiversity network that will spatially overlap offshore oil and gas lease areas in the Chukchi Sea. The purpose of this work is monitoring multiple trophic levels and species, and is to be directed and informed by historical data and past modeling efforts from previous DBO and BOEM-funded collections. Such a network will expand upon planned and recently-launched observing sites, systems, and programs, employ innovative techniques for data discovery and methods that dynamically interrelate data sets and add value to existing monitoring data, and collaborate with the U. S. Integrated Ocean Observing System (U.S. IOOS) participants and funding agencies to optimize data management and modeling capabilities.

Arctic Whale Ecology Study (ARCWEST). August–September 2015. NOAA Fisheries and National Marine Mammal Laboratory. The ARCWEST (NMML, 2013) is a multiyear BOEM-funded study which was started in 2007 that focuses on late summer oceanography and prey densities relative to whale distribution over continental shelf waters within 100 miles north and east of Point Barrow, Alaska. National Marine Mammal Laboratory (NMML), will conduct aerial surveys, acoustic monitoring, and boat-based surveys to provide information on the spatial and temporal distribution of bowhead whales in the study area.

Chukchi Sea Acoustic Oceanographic Zooplankton (CHAOZ). July – September, 2015. CHAOZ goals are to conduct passive acoustic/biological/biophysical surveys of whales, their prey, and their environment in the Bering, Chukchi, and Beaufort seas for at least the 2015 field season. The study includes research vessel transects from Wainwright, Icy Cape, Point Lay, Cape Lisburne, and Point Hope into the Chukchi and Bering seas for deployment of acoustic and ice buoys, CTD casts, zooplankton sampling, and for collection of marine mammal observation data. In addition, biological and population studies of large whales will be continued by deploying radio and satellite transmitters on whales, conducting photo-identification, and biopsy sampling.

Hanna Shoal Ecosystem Study (Hanna Shoal). July – October 2015, with similar proposed operating schedules through 2016. This research project will include benthic sampling, food web analysis, and contaminant measurements and focuses on the Hanna Shoal area, located between the boundary of the Chukchi and Arctic Ocean waters and the Burger prospect. Water column primary and secondary production and biomass also will be measured. Cruise zooplankton data will be supplemented by data from moored zooplankton-sensing acoustic Doppler current profilers (ADCP) (units that are capable of distinguishing copepod and euphausid biomass signatures). Moored and shipboard instruments of currents, sea ice drift, and hydrography (including geochemistry) will examine circulation and density fields. Instrument moorings will be used for long term profiling of temperature and salinity, including under ice measurements in winter. Additional oceanographic data may be obtained from other projects such as the proposed extension of the Chukchi oceanographic study. These data include HF radar, moored ADCPs, meteorological buoys, and gliders. Formal integration with the results of other BOEM-funded projects will be made through the planned "Marine Mammal/Physical Oceanography Synthesis" to provide upper trophic components to the study. Coordination will occur with other international, NSF, NOAA, ADEC, and industry research in the Chukchi Sea.

Summary of Research Activities

It is reasonable to foresee there will be further research efforts in this region during Proposed Action, due to continuing interest in the changing ice and climate patterns. For example, the PAG, organized under the International Arctic Science Committee, plans, coordinates, and collaborates on science activities of mutual interest to the Arctic region. It is not presently known exactly what research PAG will conduct, but it is reasonably foreseeable that the projects specified above are only a sample of the total research that will be conducted in the Chukchi during the duration of the proposed activities.

B-3.5. Oil and Gas Related Activities

Past oil and gas related activities in the Chukchi Sea OCS include exploration wells drilled at the Burger prospect in 1990 and at the Klondike prospect in 1989, exploration seismic surveys, shallow geologic hazards surveys, geotechnical sampling programs, baseline biological studies and surveys, and other environmental studies and sampling programs.

Other current and ongoing activities related to oil and gas, such as vessel and air traffic in state waters and onshore, are expected to remain at their current levels for the duration of the Proposed Action.

Additional industry activities that may occur during the timeframe of the Proposed Action include potential Ancillary Activities and G&G activities. However, no exploration plans for these or similar activities have been submitted to BOEM.

BOEM has two lease sales scheduled in the 2012-2017 Five Year OCS Oil and Gas Leasing Program. Leases issued as a result of this lease sale would likely lead to proposals to conduct exploration activities. Further, there is a recurring interest in conducting Geological and Geophysical activities in the Arctic. It is reasonably foreseeable that one or more such surveys could occur during the timeframe of the Proposed Action. BOEM would complete environmental evaluations, including cumulative effects analysis, for any such proposed activities.

B-4. Climate Change and Ocean Acidification

Climate change is an ongoing consideration in evaluating cumulative effects on environmental resources of the Arctic region (NOAA, 2015). It has been implicated in changing weather patterns, changes in the classification and seasonality of ice cover, ocean surface temperature regimes, and the timing and duration of phytoplankton blooms in the Chukchi Sea. These changes have been attributed to rising CO_2 levels in the atmosphere and corresponding increases in the CO_2 levels of the waters of the world’s oceans. These changes have also led to the phenomena of ocean acidification (IPCC, 2014). This phenomenon is often called a sister problem to climate change, because they are both attributed to human activities that are leading to increased CO_2 levels in the atmosphere. The capacity of the Arctic Ocean to uptake CO_2 is expected to increase in response to climate change (Bates and Mathis, 2009). Further, ocean acidification in high latitude seas is happening at a more advanced rate than in other areas. This is due to the loss of sea ice that increases the surface area of the Arctic seas. This exposure of cooler surface water lowers the solubility of calcium carbonate, which results in lower saturation levels of calcium carbonate within the water, and in turn leads to lower available levels of the minerals needed by shell-producing organisms, such as pteropods, foraminifers, sea urchins, and molluscs (Fabry et al., 2009; Mathis, 2011).

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Appendix C

Marine Mammal Mitigation Measures

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Appendix C. Marine Mammal Mitigations

C-1. Marine Mammal Mitigations

In analyzing potential impacts to marine mammals from Shell's proposed Chukchi Sea exploratory drilling program, BOEM assumed implementation of the mitigation measures described below. These mitigation measures are typically required by MMPA authorizations and by lease sale stipulations.

C-1.1. General Offshore Exploration Activities

Offshore exploration activities will be authorized only during the open-water season, defined as the period July 1 to November 30. Exemption waivers to the specified open-water season may be issued by the Service on a case-by-case basis, based upon a review of seasonal ice conditions and available information on marine mammal distributions in the area of interest.

C-1.2. General Onshore Exploration Support Activities

All personnel and activities will comply with Shell's *Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan, Exploratory Drilling Program, Chukchi Sea, Alaska*, which details bear avoidance and encounter procedures and training; bear guard training; safety and communication procedures; Shell's Food Waste Management Plan, and reporting.

C-1.3. Vessel Traffic

The transit of operational and support vessels through the specified geographic region is not authorized prior to July 1. This operating condition is intended to allow marine mammals the opportunity to disperse from the confines of the spring lead system and minimize interactions with subsistence hunters. Exemption waivers to this operating condition may be issued by NMFS and USFWS on a case-by-case basis, based upon a review of seasonal ice conditions and available information on marine mammal distributions in the area of interest.

The transit route for the drilling units and drilling support vessels will avoid known fragile ecosystems and the LBCHU, and will include coordination through Communication Centers as described in Shell's Marine Mammal Mitigation and Monitoring Plan (hereafter "2015 Shell 4MP").

All vessels shall reduce speed to a maximum of 5 knots when within 900 ft (300 yards/274 m) of whales. Those vessels capable of steering around such groups should do so.

Vessels may not be operated in such a way as to separate members of a group of marine mammals from other members of the group.

Avoid multiple changes in direction and speed when within 900 ft (300 yards/274 m) of whales.

Vessels should take all reasonable precautions (i.e., reduce speed, change course heading) to maintain a minimum operational exclusion zone of 0.5 mi (0.8 km) around groups of 12 or more walruses in the water.

When weather conditions require, such as when visibility drops, support vessels must reduce speed and change direction, as necessary (and as operationally practicable), to avoid the likelihood of injury to marine mammals.

Except in an emergency, vessels will not approach within 0.5 mi. (0.8 km) of walruses or polar bears when observed on ice. BOEM also recommends that vessels not approach within 0.5 mi of ice seals (i.e., ringed seals, bearded seals, ribbon seals, and spotted seals) when observed on ice.

Except in an emergency, vessels will not approach within 1.0 mi. (1.6 km) of groups of walruses or 0.5 mi. (0.8 km) of polar bears when observed on land.

PSOs will be aboard the drilling units and all transiting support vessels.

Shell will communicate and coordinate with the Communication Centers regarding all vessel transits.

C-1.4. Ice Management

Shell has developed and will implement an Adaptive Approach to Ice Management in Areas Occupied by Pacific Walruses (Shell, 2015a, Appendix J). This plan includes:

- Use of real time ice and weather forecasting from the Shell Ice and Weather Advisory Center and USGS tagged animals, and NMFS aerial survey flights (ASAMM) to generate daily assessments of the potential need to manage ice and the potential for such activities to interact with walruses;
- Daily communication of risk assessment to USFWS via email;
- Maintenance of a 24-hour duty phone by both Shell and USFWS for the purpose of consultation.

If ice management is needed and walruses have the potential to be present, Shell will notify USFWS via email and provide phone or in-person updates as needed during normal business hours. Ice management can proceed with care if the entire ice floe and surrounding area can be visualized and no walruses are hauled out on the ice.

If walruses are present and hauled out on ice which poses an imminent threat to vessels and/or drilling operations and ice management is needed:

1. The on duty compliance representative for Shell will notify a designated USFWS representative by calling a duty phone to engage in real-time consultation.
2. The Shell drilling supervisor will be engaged to evaluate the status of drilling operations and the potential for implementation of ice avoidance measures that may include cessation of drilling activities and moving off hole in extreme cases. If such alternatives are available and can be implemented, these procedures will be implemented.
3. Real-time communications will be established with the lead PSO on the ice management vessel(s) to assess the proximity and status of walruses hauled out on ice floes that need to be managed. Descriptions of the situation will be shared with the consultation team.
4. If the team agrees that ice management can go forward, the vessel will approach the ice floe slowly in an effort to provide walruses an opportunity to react to the approaching vessel and choose to avoid most safely. Video cameras and still cameras will be used to document procedures and results to enhance the understanding of the risks posed by ice management activities.
5. Real time consultation will continue as long as ice management is required, or until the consultation team agrees that procedures are going forward successfully.
6. A post action report will be filed with USFWS within 24 hours. To the extent that communications will allow the transfer of still frame and video, photographic documentation will be included.
7. If real-time consultation cannot be established, and, if ice management cannot be avoided to protect vessels and critical drilling operations, Shell will proceed slowly, exercising all due care for walruses and monitoring and documenting any reactions to the ice management.

C-1.5. Aircraft Traffic

Aircraft shall not fly within 1,000 ft (305 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs, landings, marine mammal monitoring, or in emergency situations) while over land or sea, except as noted below.

Aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft. (457 m) in areas of active whaling; such areas to be identified through communications with Communication Centers and Subsistence Advisors as described in the 2015 Shell 4MP.

Except in an emergency, aircraft will not operate at an altitude lower than 1,500 ft. (457 m) within 0.5 mi. (0.8 km) of polar bears when observed on land or ice.

Helicopters will not operate at an altitude lower than 3,000 ft. (914 m) within 1 mi. (1.6 km) of walrus groups observed on land, and fixed-wing aircraft will not, except in an emergency, operate at an altitude lower than 1,500 ft. (457 m) within 0.5 mi. (805 m) of walrus groups observed on ice, or within 1 mile (1,610 m) of walrus groups observed on land.

If aircraft must be operated below 1,500 ft. (457 m) because of weather, the operator will avoid areas of known walrus and polar bear concentrations and will take precautions to avoid flying directly over or within flying within 0.5 mi. (805 m) of these areas.

C-1.6. Protected Species Observers

Designate trained Protected Species Observers (PSO) to be aboard both drilling units, ice management and anchor handler vessels and all ocean-going support vessels. The PSOs are required to monitor for marine mammals in order to implement the mitigation measures. Utilize two NMFS-approved, vessel-based PSOs (except during meal times and restroom breaks, when at least one PSO shall be on watch) to visually watch for and monitor marine mammals near the drilling units or support vessels (from nautical twilight-dawn to nautical twilight-dusk) and before and during start-ups of airguns day or night. The vessels' crew shall also assist in detecting marine mammals, when practicable.

PSOs shall have access to reticle binoculars (7x50), bigeye binoculars (25x150), and night vision devices. PSO shifts shall last no longer than 4 consecutive hours and shall not be on watch more than 12 hours in a 24-hour period. PSOs shall also make observations during daytime periods when active operations are not being conducted for comparison of animal abundance and behavior, when feasible.

When a mammal sighting is made, the following information about the sighting will be recorded by the PSOs:

1. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from the PSO, apparent reaction to activities (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and behavioral pace
2. Time, location, speed, activity of the vessel, sea state, ice cover, visibility, and sun glare
3. The positions of other vessel(s) in the vicinity of the PSO location
4. The ship's position, speed of support vessels, and water temperature, water depth, sea state, ice cover, visibility, and sun glare will also be recorded at the start and end of each observation watch, every 30 minutes during a watch, and whenever there is a change in any of those variables

PSO teams shall consist of trained observers and experienced field biologists. An experienced field crew leader will supervise the PSO team onboard the survey vessel. New observers shall be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations.

PSOs will complete a two or three day training session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2015 open-water season. The training session(s) will be conducted by qualified marine mammologists with extensive crew-leader experience during previous vessel-based monitoring programs. A marine mammal observers' handbook, adapted for the specifics of the planned program, will be reviewed as part of the training PSO training that is conducted prior to the start of the survey activities shall be conducted with all PSOs being trained at the same time in the same room. There shall not be separate training courses for the different PSOs. PSOs shall be trained using visual aids (e.g., videos, photos), to help them identify the species that they are likely to encounter in the conditions under which the animals will likely be seen.

Zero-offset Vertical Seismic Profile (ZVSP) Mitigation and Monitoring Measures

1. PSOs shall conduct monitoring while the airgun array is being deployed or recovered from the water.
2. PSOs shall visually observe the entire extent of the exclusion zone (EZ) (180 dB re 1 µPa rms for cetaceans and walruses, and 190 dB re 1 µPa rms for pinnipeds and polar bears) using NMFS-qualified PSOs, for at least 30 minutes (min) prior to starting the airgun array (day or night). If the PSO finds a marine mammal within the EZ, Shell must delay the seismic survey until the marine mammal(s) has left the area. If the PSO sees a marine mammal that surfaces then dives below the surface, the PSO shall continue the watch for 30 min. If the PSO sees no marine mammals during that time, they may assume that the animal has moved beyond the EZ. If for any reason the entire radius cannot be seen for the entire 30 min period (i.e., rough seas, fog, darkness), or if marine mammals are near, approaching, or in the EZ, the airguns may not be ramped-up. If one airgun is already running at a source level of at least 180 dB re 1 µPa (rms), the operator may start the second airgun without observing the entire EZ for 30 min prior, provided no marine mammals are known to be near the EZ.
3. Establish and monitor a 180 dB re 1 µPa (rms) and a 190 dB re 1 µPa (rms) EZ for marine mammals before the airgun array is in operation. Before the field verification tests, described below, the 180 dB radius is temporarily designated to be 1.28 km and the 190 dB radius is temporarily designated to be 255 m.
4. Implement a ''ramp-up'' procedure when starting up at the beginning of seismic operations. During ramp-up, the PSOs shall monitor the EZ, and if marine mammals are sighted, a powerdown, or shut-down shall be implemented as though the full array were operational. Therefore, initiation of ramp-up procedures from shut-down requires that the PSOs be able to view the full EZ;
5. Power-down or shutdown the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant EZ. A shutdown means all operating airguns are shutdown (i.e., turned off). A power-down means reducing the number of operating airguns to a single operating airgun, which reduces the EZ to the degree that the animal(s) is no longer in or about to enter it.
6. Following a power-down, if the marine mammal approaches the smaller designated EZ, the airguns must then be completely shutdown. Airgun activity shall not resume until the PSO has visually observed the marine mammal(s) exiting the EZ and is not likely to return, or has not been seen within the EZ for 15 min for species with shorter dive durations (small odontocetes and pinnipeds) or 30 min for species with longer dive durations (mysticetes).
7. Following a power-down or shutdown and subsequent animal departure, airgun operations may resume following ramp-up procedures described above.
8. ZVSP surveys may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire relevant EZs are visible and can be effectively monitored; and

9. No initiation of airgun array operations is permitted from a shutdown position at night or during low-light hours (such as in dense fog or heavy rain) when the entire relevant EZ cannot be effectively monitored by the PSO(s) on duty.

C-1.7. Monitoring Measures

Aerial Survey Monitoring. Shell must implement the aerial survey monitoring program detailed in the 2015 Shell 4MP.

Acoustic Monitoring. Field Source Verification: Shell is required to conduct sound source verification tests for the MODUs, support vessels, and the airgun array not measured in previous seasons. Sound source verification shall consist of distances where broadside and endfire directions at which broadband received levels reach 190, 180, 170, 160, and 120 dB re 1 mPa (rms) for all active acoustic sources that may be used during the activities. For the airgun array, the configurations shall include at least the full array and the operation of a single source that will be used during power downs. The test results for the airgun array shall be reported to NMFS within 5 days of completing the test. A report of the acoustic verification measurements of the ZVSP airgun array will be submitted within 120 hr after collection and analysis of those measurements once that part of the program is implemented. The ZVSP acoustic array report will specify the distances of the exclusion zones that were adopted for the ZVSP program. Prior to completion of these measurements, Shell will use the radii outlined in the ZVSP mitigation condition above.

Acoustic ''Net'' Array. Deploy acoustic recorders widely across the U.S. Chukchi Sea and on the prospect in order to gain information on the distribution of marine mammals in the region. This program must be implemented as detailed in the 2015 Shell 4MP.

C-1.8. Reporting Requirements

BOEM expects that the following reports are required by NMFS and by USFWS. BOEM further requires that each report generated pursuant to this section be copied to BSEE-Alaska Region. Within 5 days of completing the sound source verification tests for the airguns, Shell shall submit a preliminary report of the results to NMFS and USFWS.

Reporting Requirements - NMFS

1. Report on the results of the acoustic verification measurements of the MODUs and support vessels, not recorded in previous seasons, will be reported in the 90-day report. The report should report down to the 120-dB radius in 10-dB increments
2. Submit a draft report on all activities and monitoring results to NMFS within 90 days of the completion of the exploration drilling program. This report must contain and summarize the following information:
   (a). Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals)
   (b). Sound source verification results for MODUs and vessels recorded in 2015
   (c). Analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare)
   (d). Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover
   (e). Sighting rates of marine mammals during periods with and without exploration drilling activities (and other variables that could affect detectability), such as:
      1) Initial sighting distances versus drilling state
      2) closest point of approach versus drilling state

3) observed behaviors and types of movements versus drilling state
4) numbers of sightings/individuals seen versus drilling state
5) distribution around the survey vessel versus drilling state; and
6) estimates of take

(f). Reported results from all hypothesis tests should include estimates of the associated statistical power when practicable;
(g). Estimate and report uncertainty in all take estimates. Uncertainty could be expressed by the presentation of confidence limits, a minimum maximum, posterior probability distribution, etc.; the exact approach will be selected based on the sampling method and data available
(h). The report should clearly compare authorized takes to the level of actual estimated takes
(i). If, changes are made to the monitoring program after the independent monitoring plan peer review, those changes must be detailed in the report.

3. The draft report will be subject to review and comment by NMFS. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS. The draft report will be considered the final report for this activity if NMFS has not provided comments and recommendations within 90 days of receipt of the draft report.
4. A draft comprehensive report describing the aerial, acoustic, and vessel-based monitoring programs will be prepared and submitted within 240 days of the date of the NMFS IHA Authorization. The comprehensive report will describe the methods, results, conclusions and limitations of each of the individual data sets in detail. The report will also integrate (to the extent possible) the studies into a broad based assessment of all industry activities and their impacts on marine mammals in the Arctic Ocean during exploration.
5. The draft comprehensive report will be subject to review and comment by NMFS, the Alaska Eskimo Whaling Commission, and the North Slope Borough Department of Wildlife Management. The draft comprehensive report will be accepted by NMFS as the final comprehensive report upon incorporation of comments and recommendations.

In the unanticipated event that the drilling program operation clearly causes the take of a marine mammal in a manner prohibited by the IHA, such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), Shell shall cease operations as rapidly as safe operations permit and immediately report the incident by phone or email to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, by phone or email and the Alaska Regional Stranding Coordinators.

The report must include the following information:

(a). Time, date, and location (latitude/longitude) of the incident
(b). The name and type of vessel involved
(c). The vessel's speed during and leading up to the incident
(d). Description of the incident
(e). Status of all sound source use in the 24 hours preceding the incident
(f). Water depth
(g). Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility)
(h). Description of marine mammal observations in the 24 hours preceding the incident
(i). Species identification or description of the animal(s) involved
(j). The fate of the animal(s)
(k). Photographs or video footage of the animal (if equipment is available)

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with Shell to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. Shell may not resume their activities until notified by NMFS via letter, email, or telephone.

1. In the event that Shell discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), Shell will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, by phone or email and the NMFS Alaska Stranding Hotline and/or by email to the Alaska Regional Stranding Coordinators. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with Shell to determine whether modifications in the activities are appropriate.
2. In the event that Shell discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in the NMFS IHA (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), Shell shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, by phone or email and the NMFS Alaska Stranding Hotline and/or by email to the Alaska Regional Stranding Coordinators, within 24 hours of the discovery. Shell shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. Activities may continue while NMFS reviews the circumstances of the incident.

Reporting Requirements – USFWS

Holders of Letters of Authorization must report the results of specified monitoring activities to the USFWS's Alaska Regional Director. In-season reports include activity progress reports, walrus observation reports, polar bear observation reports, and notification of incident reports. An after-action monitoring report must be provided to USFWS within 90-days of completing the year's activities.

Activity Progress Reports. Operators must keep the Service informed on the progress of authorized activities by:

(a). Notifying the Service at least 48 hours prior to the onset of activities
(b). Providing weekly progress reports of authorized activities noting any significant changes in operating state and or location; and
(c). Notifying the Service within 48 hours of ending activity

Walrus Observation Reports. The operator must report, on a weekly basis, all observations of walruses during any Industry operation. Information within the observation report will include, but is not limited to:

(a). Date, time, and location of each walrus sighting
(b). Number of walruses: sex and age
(c). Observer name and contact information
(d). Weather, visibility, and ice conditions at the time of observation
(e). Estimated range at closest approach
(f). Industry activity at time of sighting
(g). Behavior of animals sighted
(h). Description of the encounter
(i). Duration of the encounter; and
(j). Actions taken

Polar Bear Observation Reports. The operator must report, within 24 hours, all observations of polar bears during any Industry operation. Information within the observation report will include, but is not limited to:

(k). Date, time, and location of observation
(l). Number of bears: sex and age
(m). Observer name and contact information
(n). Weather, visibility, and ice conditions at the time of observation
(o). Estimated closest point of approach for bears from personnel and facilities
(p). (Industry activity at time of sighting, possible attractants present
(q). Bear behavior
(r). Description of the encounter
(s). Duration of the encounter; and
(t). Actions taken

Notification of Incident Report. Reports should include all information specified under the species observation report, as well as a full written description of the encounter and actions taken by the operator. The operator must report to the Service within 24 hours:

(a). Any incidental lethal take or injury of a polar bear or walrus; and
(b). Observations of walruses or polar bears within prescribed mitigation-monitoring zones.

After-action Monitoring Reports. The results of monitoring efforts identified in the marine mammal monitoring and mitigation plan must be submitted to the Service for review within 90 days of completing the year's activities. Results must include, but are not limited to, the following information:

(a). A summary of monitoring effort including: total hours, total distances, and distribution through study period
(b). Analysis of factors affecting the visibility and detectability of walruses and polar bears by specified monitoring
(c). Analysis of the distribution, abundance, and behavior of walrus and polar bear sightings in relation to date, location, ice conditions, and operational state; and
(d). Estimates of take based on density estimates derived from monitoring and survey efforts