Alaska Outer Continental Shelf

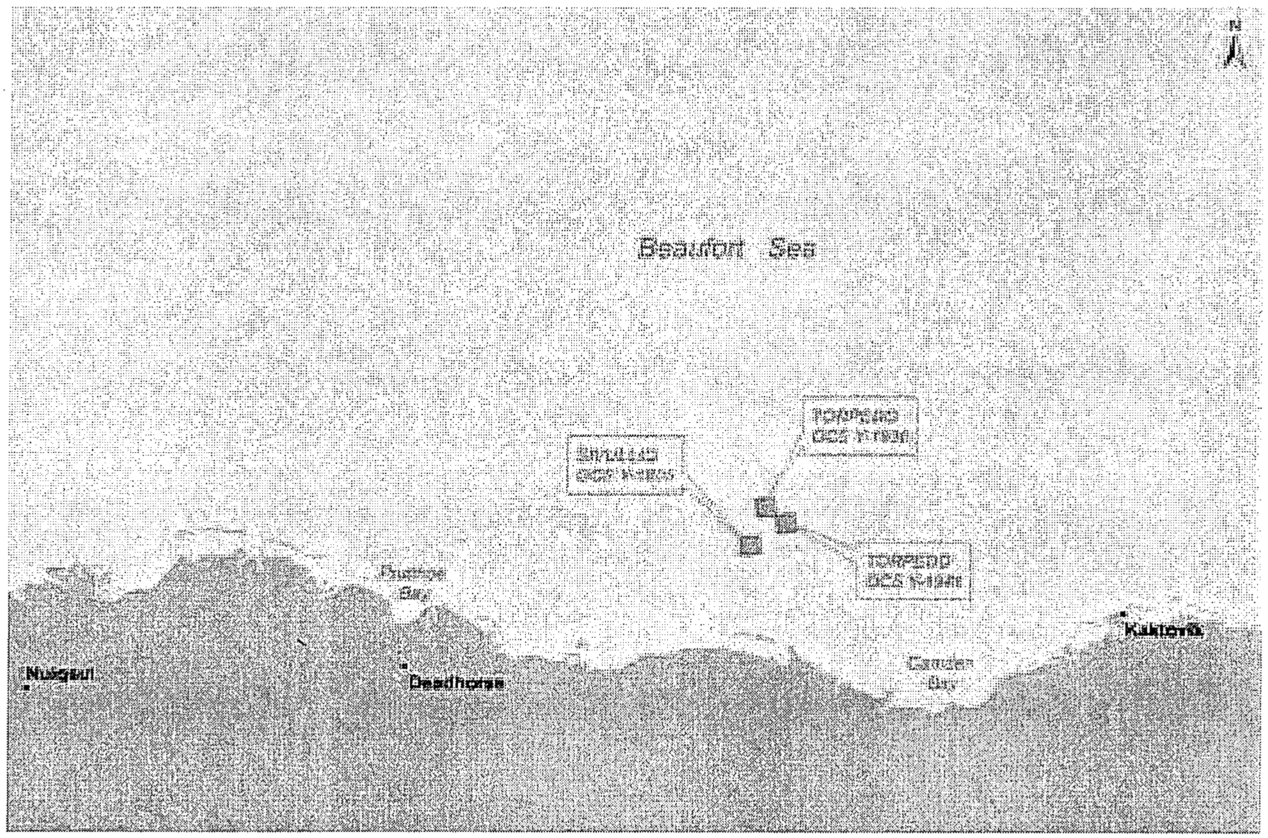
OCS EIS/EA
BOEMRE 2011-039

Beaufort Sea Planning Area

Shell Offshore Inc.
2012 Revised Outer Continental Shelf Lease Exploration Plan
Camden Bay, Beaufort Sea, Alaska
Flaxman Island Blocks 6559, 6610 & 6658
Beaufort Sea Lease Sales 195 & 202

ENVIRONMENTAL ASSESSMENT

Prepared By:
Office of Leasing and Environment
Alaska OCS Region



U.S. Department of the Interior
Bureau of Ocean Energy Management,
Regulation and Enforcement
Alaska OCS Region

August 2011

Attachment 2

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1.0 PURPOSE AND NEED

1.1. Purpose of the Proposed Action

Shell Offshore Inc. (Shell) submitted to the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) a Revised Exploration Plan (EP) *Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay,Beaufort Sea, Alaska*, (2011 Camden Bay EP) dated May 2011, deemed submitted July 5, 2011 (Shell, 2011a) to conduct exploration drilling to evaluate the oil and gas resource potential of three of the company's Outer Continental Shelf (OCS) leases north of Point Thomson near Camden Bay in the U.S. Beaufort Sea. The purpose of the 2011 Camden Bay EP is for Shell to evaluate the mineral resource potential of three lease tracts within two distinct oil and gas prospects named by Shell as "Sivulliq" (NR 06-04 Flaxman Island, block 6658, OCS-Y-1805) and "Torpedo" (NR 06-04 Flaxman Island, block 6659, OCS-Y-1936 and NR 06-04 Flaxman Island, block 6610, OCS-Y-1941) (Figure 1). The need for this action is established by BOEMRE'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.

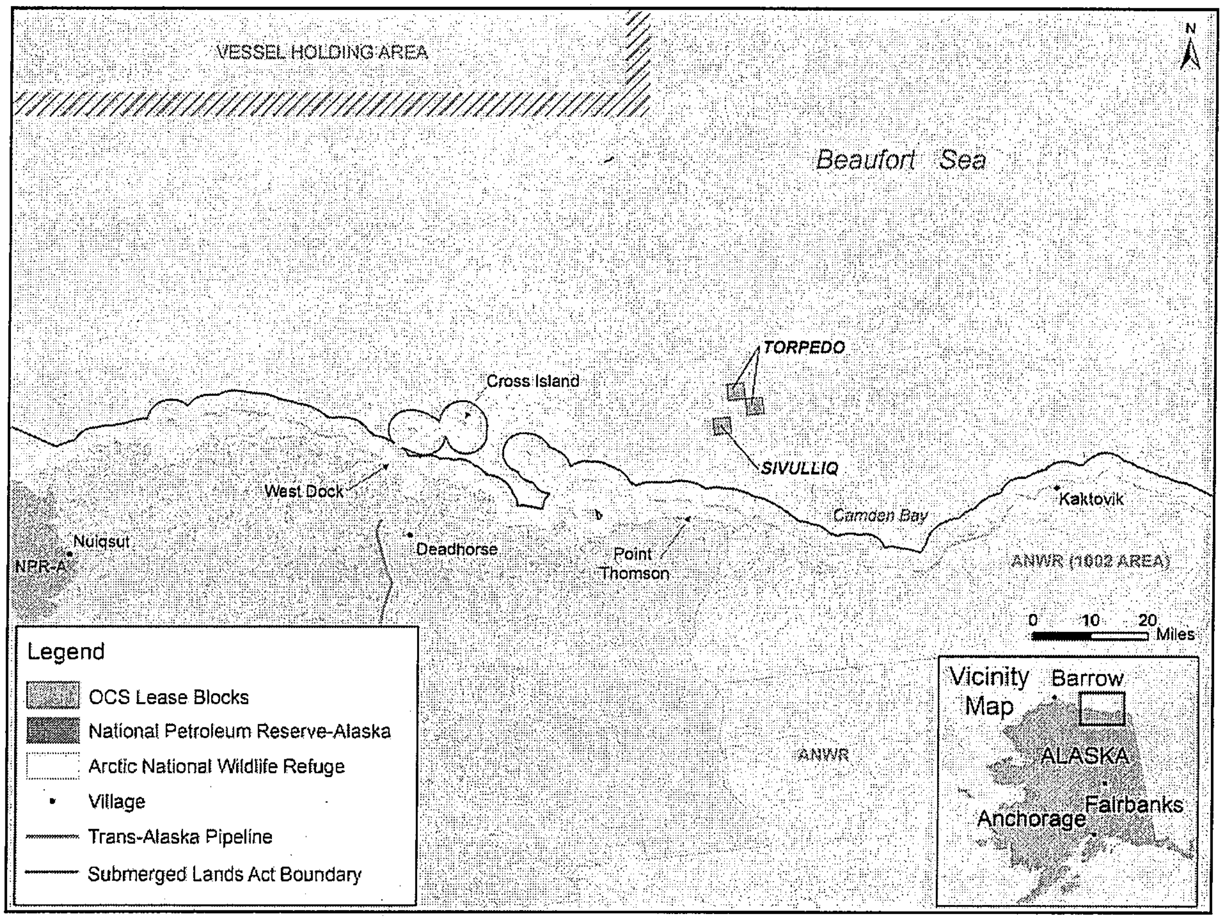

Figure 1 An overview of the locality of Shell's proposed Camden Bay exploration wells.

Shell acquired the leases through OCS Lease Sales 195 (March 2005) and 202 (April 2007). Under OCS leasing regulations at 30 CFR 256 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 lease term of ten years (30 CFR 256.37). Shell's exploration of their Beaufort Sea leases would be consistent with the overall objectives of the Outer Continental Shelf Lands Act (OCSLA) to determine the extent of the oil and natural gas resources of the OCS at the earliest practicable time.

The revised plan makes changes to Shell's *2010 Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska*, dated June 2009; deemed submitted August 10, 2009; amended September 18, 2009) (Shell, 2009). BOEMRE completed a technical and environmental review of the initial EP and supporting documents and published an Environmental Assessment (EA) (USDOI, MMS, 2009a) and a Finding of No Significant Impact (FONSI) (USDOI, MMS, 2009b) in October 2009. The EA and FONSI are incorporated by reference into this document. BOEMRE (then MMS) conditionally approved the EP on October 16, 2009.

Shell submitted a revised Camden Bay EP in 2011 under BOEMRE operating regulations at 30 CFR 250 Subpart B. Shell proposes to drill four exploration wells on three leases during successive July-October open-water-drilling seasons, starting in 2012 and continuing in following open-water seasons until completion of the four-well plan. Two wells would be drilled on each prospect (Sivulliq and Torpedo) (Figure 2). The drilling operations would be conducted using the Mobile Offshore Drilling Unit (MODU) *Kulluk* (*Kulluk*), an Arctic Class IV hull design drilling vessel. Alternatively, drilling operations could be conducted using the M/V *Discoverer* (*Discoverer*) a modern drillship that has been retrofitted and ice reinforced for operations in Arctic waters.

In support of the 2011 Camden Bay EP, Shell submitted an environmental impact analysis (2011 Camden Bay EIA) (Shell, 2011b) which is appendix F of the 2011 Camden Bay EP, a Beaufort Sea Regional oil discharge prevention and contingency plan (ODPCP) for the drilling program (Shell, 2011c), environmental information and reports, site-specific geohazards survey data and assessment, mitigation measures, and other project-specific information pursuant to 30 CFR 250.212 and 227. Shell also submitted, with the revised EP, a project-specific Plan of Cooperation (POC) addendum to reduce potential conflicts with subsistence activities, a description of their Cultural Awareness and Environmental Awareness Programs, and other information as required by BOEMRE regulations and lease stipulations.

Table 1 Comparison of Shell's 2010 Camden Bay EP and the 2012 Revised Camden Bay EP.

Parameter	Initial Camden Bay EP (2010)	Revised Camden Bay EP (2012 planned start)
Drilling seasons	July 10 - October 31, 2010.	July 10 - October 31 beginning in 2012 and continuing each subsequent open-water season until the completion of all four wells.
OCS Lease Blocks	Flaxman Island 6610 and 6658	Flaxman Island 6559, 6610, and 6658
Wells	Two - Sivulliq N and Torpedo H	Four - Sivulliq G and N; Torpedo H and J
Drilling unit	Drillship *Discoverer*	CDU *Kulluk* or Drillship *Discoverer*
Waste Discharge	Spent water-based drilling fluids; drill cuttings with adhered drilling fluids; sanitary waste; domestic waste; hazardous waste; used oil; bilge water; and ballast water discharged to ocean floor.	14,902 barrels of spent water-based drilling fluids; drill cuttings with adhered drilling fluids; sanitary waste; domestic waste; hazardous waste; used oil; bilge water; and ballast water collected, stored and then transported to an approved treatment / disposal site outside of the Alaskan Arctic.
Primary Support Fleet	Anchor handler, ice management vessel, offshore supply vessels (OSV), West Dock shuttle	Similar fleet with the following variations: OSV to collect waste streams from the *Kulluk* Deck barge and tug and waste barge and tug to store the waste streams. Additional OSV for offshore supply
Oil Spill Response	Oil Spill Response (OSR) Tug and Barge; OSR Vessel, Arctic Tanker	OSR Tug and Barge; Arctic Tanker, OSR barge carrying containment system
Air permit	*Discoverer* – Prevention of Significant Deterioration (PSD) permit authorization R10OCS/PSD-AK-2010-01	*Discoverer* – PSD permit authorization R10OCS/PSD-AK-2010-01 *Kulluk* – Minor Source Permit application for Beaufort Sea submitted February 28, 2011

The BOEMRE has completed a technical and environmental review of the revised 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.

In accordance with 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 implementing NEPA at 43 CFR Part 46, and DOI policy in Section 516 of the Department of the Interior Manual (DM) Chapter 15 (516 DM 15), BOEMRE prepared an EA to assist BOEMRE planning and decisionmaking. In keeping with CEQ regulations at 40 CFR 1506.5(a),(b) (see below) and the intent of BOEMRE operating regulations at 30 CFR 250.227, the information and analysis provided in Shell's EIA was reviewed, evaluated, verified, and the results were used to prepare this EA. A list of BOEMRE staff responsible for reviewing, evaluating, and verifying the information submitted by Shell is in Section 6.5 of this EA.

> **Sec. 1506.5 Agency responsibility.**
>
> (a) Information. If an agency requires an applicant to submit environmental information for possible use by the agency in preparing an environmental impact statement, then the agency should assist the applicant by outlining the types of information required. The agency shall independently evaluate the information submitted and shall be responsible for its accuracy. If the agency chooses to use the information submitted by the applicant in the environmental impact statement, either directly or by reference, then the names of the persons responsible for the independent evaluation shall be included in the list of preparers (Sec. 1502.17). It is the intent of this paragraph that acceptable work not be redone, but that it be verified by the agency.
>
> (b) Environmental assessments. If an agency permits an applicant to prepare an environmental assessment, the agency, besides fulfilling the requirements of paragraph (a) of this section, shall make its own evaluation of the environmental issues and take responsibility for the scope and content of the environmental assessment.

1.2. Previous Applicable NEPA Analyses, Biological Opinions and Related Analyses.

The NEPA mandates that Federal agencies conduct an environmental review of certain Federal projects at each stage of the OCSLA process. The 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 BOEMRE has completed numerous NEPA reviews of Beaufort Sea OCS activities. In recent years NEPA reviews that are relevant to the Proposed Action have included the following:

- Draft Environmental Impact Statement – Beaufort and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 (OCS EIS/EA MMS 2008-0055) (USDOI, MMS, 2008a) (hereafter "Arctic Multiple-Sale Draft EIS").
- Environmental Assessment — Shell Offshore Inc., Beaufort Sea Exploration Plan, 2007-2009 (OCS EIS/EA MMS 2007-009) (USDOI, MMS, 2007) (hereafter "2007 Beaufort Sea EP").
- Environmental Assessment — Proposed OCS Lease Sale 202, Beaufort Sea Planning Area and Finding of No Significant Impacts (OCS EIS/EA MMS 2006-001) (USDOI, MMS, 2006a) (hereafter "Sale 202 EA").
- Environmental Assessment Proposed Oil and Gas Lease Sale 195, Beaufort Sea Planning Area and Finding of No Significant Impacts (OCS EIS/EA MMS 2004-028) (USDOI, MMS, 2004) (hereafter "Sale 195 EA").
- Final Environmental Impact Statement — Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 (OCS EIS/EA MMS 2003-001) (USDOI, MMS, 2003) (hereafter "Beaufort Sea Multiple-Sale EIS").
- Final Environmental Impact Statement – Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007 (OCS EIS/EA MMS 2002-006) (USDOI, MMS, 2002) (hereafter "2002-2007 Five Year Program EIS")

These documents are available on the BOEMRE Alaska website at: http://www.boemre.gov/alaska/ref/EIS_EA.htm and http://www.boemre.gov/5-year/history2002-2007.htm. Relevant sections of the documents are summarized and incorporated by reference into this EA. This EA tiers from the Beaufort Sea Multiple-Sale EIS and the 2002-2007 Five Year Plan EIS.

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

- Environmental Assessment — Shell Offshore Inc., 2010 Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska, (OCS EIS/EA MMS 2009-0052) (USDOI, MMS, 2009a) (hereafter "2009 Camden Bay EA").
- Final Programmatic Environmental Assessment, Arctic Ocean Outer Continental Shelf, Seismic Surveys – 2006 (OCS EIS/EA MMS 2006-038) (USDOI, MMS, 2006b) June 2006. (2006 Final Seismic PEA).
- Environmental Assessment for the Shell Offshore, Inc. Incidental Harassment Authorization to Take Marine Mammals Incidental to Conducting an Offshore Drilling Project in the U.S. Beaufort Sea Under the Marine Mammal Protection Act (USDOC, NOAA, NMFS, 2007a).
- Finding of No Significant Impact for the Shell Offshore, Inc. Incidental Harassment Authorization to Take Marine Mammals Incidental to Conducting an Offshore Drilling Project in the U.S. Beaufort Sea Under the Marine Mammal Protection Act (USDOC, NOAA, NMFS, 2007b).
- NMFS Biological Opinion for Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska and Authorization of Small Takes Under the Marine Mammal Protection Act (USDOC, NOAA, NMFS, 2008)
- FWS Biological Opinion for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling (USDOI, FWS, 2009)

1.3. Statutory Framework

Shell's proposed exploration drilling activities are subject to an established regulatory framework that includes Federal and State regulations as they relate to OCS leases and oil and gas exploration activities. Some, but not all, of the statutory framework governing the exploration program is described below.

1.3.1. Outer Continental Shelf Lands Act and BOEMRE Operating Regulations

The OCSLA establishes a four-stage process for exploration and development of the OCS: (1) a five-year leasing program for the OCS; (2) individual lease sales; (3) exploration; and (4) development and production. The BOEMRE conducts appropriate NEPA review at each stage.

The BOEMRE is responsible for regulating and monitoring the oil and gas operations on the Federal OCS. The BOEMRE regulates operations to promote orderly exploration, development, and production of mineral resources; and to prevent harm or damage to, or waste of, any natural resource, any life or property, or the marine, coastal, or human environment. Regulations for on-lease oil and gas operations are specified in 30 CFR 250. Regulations for oil-spill prevention and response are specified in 30 CFR 254.

Prior to any exploration activities being conducted on a lease, an EP and supporting information must be submitted to BOEMRE for review and approval. Supporting information includes environmental information, a geohazard report, a biological report, other environmental data determined necessary, and an analysis of offshore and onshore impacts that may occur as a result of the activities.

The BOEMRE has completed a technical and environmental review of the activities proposed in Shell's EP, including an evaluation for geohazards and manmade hazards, archaeological resources (i.e., submerged vessels or geomorphological features that may have been occupied when sea levels were lower than at present), endangered species, sensitive biological features, water and air quality, oil-spill response, and other uses of the OCS.

The BOEMRE has reviewed the proposed activities for compliance with applicable lease stipulations. Lease stipulations are enforceable measures intended to mitigate potential impacts. Shell's actions in compliance with the applicable lease stipulations are presented in Section 2.3.11 of this EA.

The BOEMRE issues Notices to Lessees and Operators (NTLs) to provide clarification, description, or interpretation of OCS regulations or standards. The NTLs provide guidelines on the implementation of lease stipulations or regional requirements, and provide industry with a better understanding of the scope and meaning of regulations by explaining BOEMRE's intent of requirements. A listing of applicable NTLs is published on the Alaska Region website at: http://www.BOEMRE.gov/alaska/regs/NTLs.htm. Additional regulatory requirements and guidelines provided in NTLs since previous environmental reviews are highlighted in section 5.

Shell must conduct operations in accordance with BOEMRE's comprehensive and stringent regulations for safety and pollution prevention, which generally are requirements to use the best available and safest technology [30 CFR 250.107(c)]. Lessees are required to take precautions to keep all exploratory well drilling under control at all times.

Prior to conducting drilling operations under an approved EP, the operator is required to submit and obtain approval for an Application for Permit to Drill (APD). The APD requires detailed information about the drilling program to allow evaluation of operational safety and pollution-prevention measures. The BOEMRE will not approve an APD until all conditions of EP approval have been met.

1.3.2. Endangered Species Act

The Endangered Species Act (ESA) requires the protection and conservation of threatened and endangered species and the habitat in which they live. The Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) administer the ESA. Section 7 of the ESA governs inter-agency cooperation and consultation for oil and gas activities, including exploration. Through this consultation process, the FWS and NMFS set terms and conditions and make conservation recommendations for OCS activities to minimize potential adverse impacts to listed species and critical habitats. It is the responsibility of BOEMRE to ensure that measures to protect endangered and threatened species are implemented and followed.

Under the ESA, no incidental take of a protected species is authorized unless an Incidental Take Statement (ITS) is issued by the NMFS or FWS for the proposed activity. Any approval of Shell's EP will be a conditional approval. Under the conditional approval, an APD will not be approved and commencement of activities will not be authorized until appropriate ITSs from both NMFS and FWS have been issued.

1.3.3. Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) establishes Federal responsibility to conserve marine mammals. The NMFS has jurisdiction over all Arctic marine mammals except for the polar bear and Pacific walrus, which fall under FWS jurisdiction.

The MMPA prohibits the "taking" of a marine mammal without a permit or exemption. Section 101(a)(5)(D) of the MMPA establishes an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. The term "take" under the MMPA means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal. Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment]. Incidental take will be granted if the NMFS or USFWS finds that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. The authorization sets for the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such takings. If an activity may affect the availability of a marine mammal species or stock for taking for subsistence uses, the proposed monitoring plan must be independently peer-reviewed prior to issuance of the MMPA authorization (16 U.S.C. 1371(a)(5)(D) and 50 CFR 216.108(d)). The MMPA authorizations require that operators conduct monitoring, which should be designed to result in an increased knowledge of the species and an understanding of the level and type of takings that result from the authorized activities.

Shell has applied for an Incidental Harassment Authorization (IHA) from NMFS (dated May 2011; Shell, 2011a: Appendix C) and a Letter of Authorization (LOA) from FWS (dated May 2011; Shell, 2011a: Appendix E) as part of their exploration program. Any approval of Shell's EP by BOEMRE will be a conditional approval. Under the conditional approval, an APD will not be approved and commencement of activities will not be authorized until Shell's receipt of all necessary permits and authorizations including an IHA from NMFS and an LOA from FWS.

Shell has developed a site-specific monitoring program and adopted mitigation measures specifically designed to prevent or minimize any incidental harm to marine mammals. Those measures are summarized in Section 2.3.12 of this EA.

1.3.4. Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) mandates that a State with an approved Coastal Zone Management (CZM) plan reviews certain OCS activities to ensure that they are conducted consistently with the State's approved plan. State participation is on a voluntary basis and the State of Alaska's program ended at midnight, June 30, 2011, after the state legislature did not reauthorize statutory support for the program. Prior to June 30, 2011, the Alaska Coastal Management Program (ACMP) implemented the CZMA and required projects in Alaska's coastal zone, including potential shore bases and projects that require an OCS Plan, to be reviewed for consistency with statewide standards.

All of the work that was required to comply with the CZMA was completed for this EA. However, due to the fact that Alaska's ACMP program terminated on June 30, 2011, the ACMP Coastal Project Questionnaire and Certification Statements are no longer required for consistency review.

Although a copy of Shell's Coastal Project Questionnaire and Certification Statement was included as Section 15 of the 2011 Camden Bay EP, further work on this is no longer required. Prior to June 30, 2011, as part of BOEMRE's review process, the EP and supporting environmental information were sent to the ACMP for consistency-certification review and response. Shell is no longer required to obtain a receipt of consistency concurrence from the State of Alaska.

1.3.5. Clean Air Act

The Clean Air Act (CAA) (43 U.S.C. § 7401, et seq.) governs the control of air pollutant emissions from both stationary and mobile sources. As such, the Environmental Protection Agency (EPA) is authorized to establish National Ambient Air Quality Standards (NAAQS) to limit the concentration of harmful air emissions that, when occurring in sufficient concentrations, can harm human life and wildlife. The CAA has been amended several times since the first version in 1963. The amendments relevant to air operating permits required for the implementation of the 2011 Camden Bay EP occurred in 1977 and 1990 (Martineau and Novello, 2004). Jurisdiction for approving air operating permits depends on the type of permit and the location of the proposed federal action. State permits, such as minor-source permits, on the Alaska OCS fall under the jurisdiction of the Alaska Department of Environmental Conservation (ADEC); whereas permits for larger sources of emissions are under EPA Region 10 jurisdiction for the Alaska OCS.

The 1977 Clean Air Act Amendments established the New Source Review (NSR) program under Title I of the Act. The NSR is a pre-construction permitting program to ensure that air quality is not significantly degraded by new and modified stationary sources of emissions. The program further assures the public that the stationary source will be as clean as possible, employing the latest advancements in pollution control, referred to as Best Available Control Technology (BACT). Under the federal NSR program there are two types of permits, (1) the Prevention of Significant Deterioration (PSD) permit, required for major new or modified stationary sources of emissions in an otherwise clean-air area not in violation of the NAAQS (attainment area) (40 CFR 52.21); and (2) the NSR permit required for major stationary sources in an area already in violation of the NAAQS (nonattainment area). While these are federal rules, they can be adopted into the state administrative code and, in either case, construction cannot begin until the permit is approved and issued.

Under the 1990 Amendments, the CAA Title V operating permit program was established. This state air operating permit is issued for the purpose of enforcing minimum state standards and is issued after the major stationary source has begun to operate (post-construction). A state may also require a minor source permit. While most Title V permits are issued by state and local permitting authorities, the EPA also issues Title V permits for special circumstances, such as in Indian country and on the OCS, therefore Alaska Title V permits fall under the jurisdiction of EPA Region 10. In any of these cases, the permit constitutes an enforceable agreement between the EPA or state and the project sponsor.

On the Alaskan Outer Continental Shelf (OCS), air permits may be issued as nonattainment NSR permits, PSD attainment area pre-construction permits, Title V post-construction operating permits, minor source pre-construction State permits, or a combination of these (CAA Section 328(a)(1)). Regardless of the type of federal permit, actions on the OCS are regulated under 40 CFR Part 55.13. This regulation directs the project sponsor to comply with 40 CFR 52.21, the PSD permit regulation, and 40 CFR Part 71, the Title V regulation. The PSD permit must be obtained before construction begins (pre-construction permit) and the Title V operating permit is applied for following implementation of the Proposed Action, and thereafter on a regular recurring basis. Shell has applied for federal and/or state permits for both the drillship *Kulluk* and the drillship *Discoverer* for operations on the Beaufort and Chukchi seas. The status of the permits for each drillship is provided in Section 2.3.1, in the discussion of Alternative 2 - The Proposed Action. Any approval of the 2011 Camden Bay EP by the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) will be conditional until all required air operating permits are issued. Under the conditional approval, the Application for Permit to Drill (APD) cannot be approved by BOEMRE, and commencement of activities will not be authorized, until receipt of all necessary permits and authorizations.

1.3.6. Clean Water Act

The Clean Water Act (CWA) has several sections or programs applicable to activities in offshore waters, including U.S. Coast Guard (USCG) implementing regulations (33 CFR Part 151).

The EPA has promulgated regulations (40 CFR 125) to ensure OCS lessees do not create conditions that will pose an unreasonable risk to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean. Operational discharges are regulated by the EPA through the National Pollution Discharge Elimination System (NPDES) program. The EPA's NPDES Arctic General Permit for Offshore Oil and Gas Operations on the OCS and contiguous State Waters (Permit Number AKG280000) authorizes certain discharges from oil and gas exploration facilities located in or adjacent to the Beaufort Sea and establishes effluent limitations, monitoring requirements, and other conditions. Permitted discharges related to exploration drilling and logistics include drilling fluids and cuttings, deck drainage, sanitary waste, blowout-preventer fluid, uncontaminated ballast water, and bilge water (EPA, 2006). The current Arctic general permit, which restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions, expired on June 26, 2011. The EPA will reissue separate NPDES exploration General Permits for the Beaufort Sea and the Chukchi Sea prior to the 2012 drilling season. EPA expects that tribal consultation and public comment on the new proposed Arctic oil and gas exploration permits would occur during the fall of 2011.

Shell has submitted NOIs to EPA requesting authorization for the *Discoverer* to discharge wastes regulated under the NPDES General Permit at the Torpedo (lease blocks 6559 and 6610) and Sivulliq (lease block 6658) drill sites (NOIs dated December 16, 2010, Shell, 2011a: Appendix B). Any approval of Shell's EP will be a conditional approval. Under the conditional approval, an APD will not be approved and commencement of activities will not be authorized until Shell's receipt of all necessary permits and authorizations including Shell's receipt of the required NPDES permits.

1.3.7. The Oil Pollution Act

The Oil Pollution Act of 1990 (OPA) establishes a program governing removal of spilled oil and requiring planning for and responding to oil spills. Under OPA and BOEMRE regulations at 30 CFR 254, Shell is required to develop an Oil Discharge Prevention and Contingency Plan (ODPCP) as a fundamental component of the proposed exploration drilling program.

Shell's Beaufort Sea Regional Exploration ODPCP (Shell, 2011c) is a regional oil-spill-response plan that demonstrates Shell's capabilities to prevent, or rapidly and effectively manage, oil spills that may result from exploratory drilling operations. Despite the extremely low likelihood of a large oil-spill occurring during exploration, Shell has designed its response program for a regional capability of responding to a range of spill volumes that increase from small operational spills up to and including a Worst Case Discharge (WCD) scenario from an exploration well blowout, as required under 30 CFR 254.47. Shell's program is based on a WCD scenario that meets the response planning requirements of the State of Alaska and Federal oil-spill-planning regulations.

The ODPCP includes information regarding Shell's regional oil-spill organization and dedicated response assets, potential spill volumes, and sensitive environmental resources. The ODPCP also details Shell's spill-prevention programs, including personnel training and the procedures and management practices to prevent discharges. The spill response information addresses personnel and equipment mobilization from various locations, equipment operating characteristics, and the availability of additional response resources, both onsite and offsite.

Shell has updated and revised the Regional ODPCP to include information specific to the well sites, including worst-case discharge oil spill estimates and the worst-case discharge oil spill scenario. The revised ODPCP is currently being reviewed given this new information and appropriate actions will be taken pending the evalutation of this new information and how it impacts Shell's capability to respond to an oil spill event.

1.3.8. National Historic Preservation Act

The Archaeological Resource requirements are contained in BOEMRE operational regulations at 30 CFR 250.194. The technical requirements for the archaeological resource surveys and reports that may be required under the regulations are detailed in the Alaska OCS Region NTL 05-A02 and NTL 05-A03. These NTLS are available at: http://alaska.boemre.gov/regs/NTLS.HTM.

Information to Lessees (p) *Archaeological and Geologic Hazards Reports and Surveys* in the Final Notice of Sale for both Beaufort Sea Sale 195 and Beaufort Sea Sale 202 specified the blocks for which an archaeological report would be required. Section III.C.4.a of the Beaufort Sea Multiple-Sale EIS identified blocks having high potential for the occurrence of archaeological resources. Shell's proposed drill sites are not on blocks listed in the ITL.

Under Section 106 of the National Historic Preservation Act, BOEMRE consults with the Alaska State Historic Preservation Office (SHPO) for OCS activities during the pre-lease process. Section 106 consultation for the Beaufort Sea Planning Area was completed in conjunction with completing the Beaufort Sea Multiple-Sale EIS and again recently in conjunction with the Arctic Multiple-Sale Draft EIS (SHPO concurrence dated September 24, 2008).

The BOEMRE's review of the site-specific geophysical data indicates that there are no historic properties at Shell's proposed drill sites. On June 29, 2011, BOEMRE concluded Section 106 consultation with the Alaska State Historic Preservation Officer (SHPO). BOEMRE informed the SHPO of the determination that drilling of the four wells and related activities will have no effect on historic properties. The SHPO concurred with BOEMRE's determination of no historic properties affected on July 6, 2011.

1.3.9. National Invasive Species Act

The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA) (16 U.S.C. 4701-4751) as amended by the National Invasive Species Act of 1996 (NISA) regulates activities with a potential for introducing invasive species into the marine environment.

Potential vectors for introducing invasive species into the marine environment are ballast-water discharge, hull fouling, and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays, and ocean-bottom-survey cables). The USCG developed regulations (33 CFR 151) that implement provisions of the NANPCA and NISA. Vessels brought into State of Alaska or Federal waters would be subject to current Coast Guard regulations at 33 CFR 151, which are intended to reduce the transfer of invasive species. Section 151.2035 (a)(6) requires the "removal of fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, State, and Federal regulations." All vessels equipped with ballast water tanks must develop and maintain Ballast Water Management Plans. Ballast replacement is required by the International Maritime Organization and it must be accomplished before entering U.S. waters and reporting to the Captain of the Port, or going from one Captain of the Port zone to another.

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2.0 PROPOSED ACTION AND ALTERNATIVES

2.1. Background

Shell proposes to drill four exploration wells, two on the Sivulliq prospect and two on the Torpedo prospect, near Camden Bay in the Beaufort Sea OCS Planning Area (Figure 2). Eight OCS exploration wells were drilled in the vicinity of Shell's proposed exploration wells between 1985 and 1997. Two of these wells, drilled in 1985 and 1986, were on the Sivulliq Prospect (previously named the Hammerhead Prospect). One of the Hammerhead wells was determined to be producible under BOEMRE regulations (30 CFR 250.115). The BOEMRE estimated the reservoir contains 100-200 million barrels of oil (USDOI, MMS, 2006a).

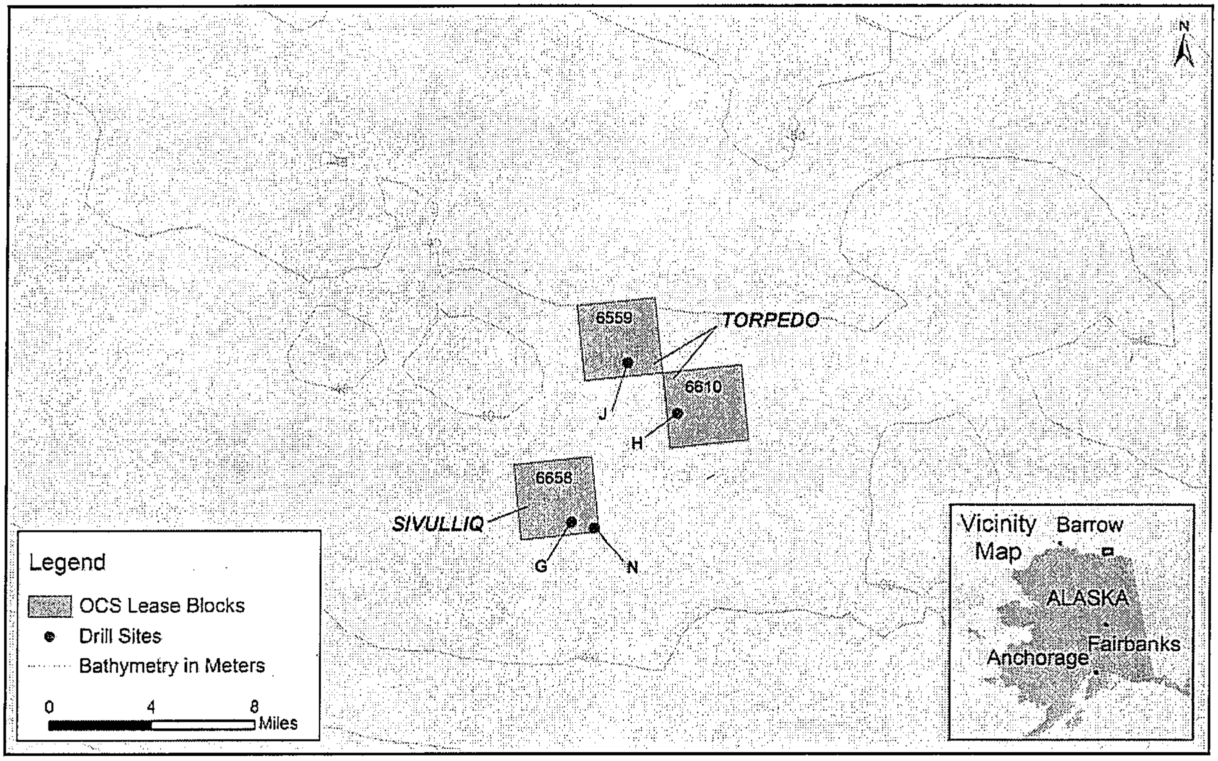

Figure 2 The Torpedo and Sivulliq Proposed Exploration Drill Sites

2.2. Summary of Alternatives

2.2.1. Alternative 1 – No Action

Under Alternative 1 – No Action, BOEMRE would disapprove Shell's proposed exploration drilling activities. This alternative would delay or preclude Shell from evaluating the potential hydrocarbon resources of three lease blocks acquired under OCS Lease Sales 195 and 202, as would any potential environmental impacts associated with Alternative 2.

2.2.2. Alternative 2 – The Proposed Action

Under Alternative 2 - The Proposed Action, Shell would drill four exploration wells on three oil and gas leases (OCS Y-1805, 1941 and 1936) acquired in Federal Beaufort Sea OCS lease sales 195 and 202 held in 2005 and 2007, respectively. Two wells each would be drilled into two distinct oil and gas prospects named by Shell as "Sivulliq" and "Torpedo." Shell proposes to drill the four wells during the open-water season (July through October) starting in 2012 and continuing until the four-well program is completed. Shell's proposed activities include a mid-drilling-season suspension of activities beginning August 25 to avoid conflicts with the fall subsistence bowhead whale hunts of the villages of Kaktovik and Nuiqsut and a reduction in the exploration drilling waste stream discharged into the Beaufort Sea and transportation of some waste to an approved treatment/disposal facility outside of the Arctic.

Shell would conduct drilling operations from the *Kulluk* with the option of using the *Discoverer* in lieu of the *Kulluk*. The *Kulluk* or *Discoverer* would be supported by additional vessels for ice management, anchor handling, crew transport and supplies, waste storage and transport and spill response. Additional vessels and fixed-wing aircraft would support Shell's Marine Mammal Monitoring and Mitigation Plan (4MP) and scientific research efforts. All of the vessels to be used in the Proposed Action are ice-class and specifically equipped for operating in Arctic waters.

2.2.3. Other Alternatives Considered But Not Analyzed

Other alternatives considered but not analyzed include:

- Temporally restricting the activities to one drilling season.
- The use of alternative technologies to explore the mineral potential of the three lease tracts [or the Sivulliq and Torpedo oil and gas prospects].

Conducting the exploration plan in one drilling season to limit the impacts to only one season was not analyzed further due to the inability of Shell to test all three lease tracts (four wells) in only one open-water season. The BOEMRE's evaluation does not show that a multi-year program will have additive effects on the affected resources and thus a full analysis of this proposed alternative is not necessary.

The BOEMRE is unaware of any alternative techniques that will serve the purpose of the Proposed Action. Shell's Proposed Action uses the safest technique known for determining whether a site is capable of producing hydrocarbons in sufficient quantities to justify commercial development.

2.3. Description of Alternative 2 – The Proposed Action

2.3.1. Overview

Shell's proposal, as detailed in the EP (Shell, 2011a), is to use a single MODU, the *Kulluk* (alternatively, the *Discoverer*), to complete a four-well exploration drilling program at locations near Camden Bay in the Beaufort Sea. Two wells would be drilled on each of two distinct oil and gas prospects named by Shell as "Sivulliq" (site G and N) and "Torpedo" (site H and J) (Figure 2). Shell's proposed activities would be conducted during the summer open-water season as Arctic waters are inaccessible to floating drilling units for up to eight months of the year because of pack ice. Location information for each drill site is presented in Table 2. Each drill site has been surveyed by Shell, and verified by BOEMRE, and determined not to contain any shallow hazards or archaeological and historical resources.

Table 2 Proposed Exploration Drill Sites.

Drill Site	Lease File Number	NR06-04 Lease Block Number	Surface Location (NAD 83)		PTVD[1] (ft)	Water Depth (ft)
			Latitude (N)	Longitude (W)		
Sivulliq G	OCS-Y 1805	6658	70° 23' 46.82"	146° 01' 03.46"	7,000	110
Sivulliq N	OCS-Y-1805	6658	70° 23' 29.58"	145° 58' 52.53"	7,000	107
Torpedo H	OCS-Y-1941	6610	70° 27' 01.62"	145° 49' 32.07"	10,000	120
Torpedo J	OCS-Y-1936	6559	70° 28' 56.94"	145° 53' 47.15"	9,800	124

Source: Shell, 2011a, Table 1.a-1
[1]PTVD = proposed total vertical depth

The activities are planned to begin on or about July 10th each year until the four-well program is complete. Shell's plans include a mid-drilling-season suspension of activities to accommodate fall subsistence bowhead whaling. All operations would be suspended prior to the beginning of the fall whale hunts on August 25 and all vessels, including the drillship, would proceed from the project area to an area north of 71.25°N latitude and west of 146.4° W longitude, which was mutually-agreed upon between Shell and the Alaska Eskimo Whaling Commission (AEWC). All vessels will remain in this area until the Kaktovik and Nuiqsut (Cross Island) whale hunts have concluded. Activiites may be resumed after completion of subsistence hunts (as determined by consultation with the village's Whaling Captains' Association) and extend through October 31, depending on ice and weather.

Once the drilling vessel is mobilized to a drill site and securely anchored to the seafloor, drilling operations would commence. Each Sivulliq well would take approximately 34 days to drill. Each Torpedo well would take approximately 44 days to drill. Each well would be plugged and abandoned in accordance with BOEMRE requirements upon completion of drilling (30 CFR 250(q)). Based on these operational limitations, the maximum wells drilled in one season is limited to two wells. If a well cannot be completed during the open-water season it will be capped and completed during the following open-water season.

Shell's proposed operations must comply with applicable Federal, State, and local laws, regulations, and lease and permit requirements. The BOEMRE retains the specific authority to require additional mitigation, including shut down, as appropriate to respond to actual conditions encountered. In addition, Shell would have trained personnel and monitoring programs in place to ensure such compliance. The BOEMRE 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 collectively impose mandatory requirements to ensure safety, protect the environment, avoid interference with subsistence resources and activities, and mitigate potential adverse impacts:

- National Pollutant Discharge Elimination System Permit (NPDES) under the Clean Water Act from the EPA. The EPA NPDES Arctic General Permit for Offshore Oil and Gas Operations on the OCS and contiguous State Waters Permit Number AKG280000 impose limitations on permissible discharges. Shell has submitted Notices of Intent (NOIs) to EPA requesting authorization for the *Kulluk* and *Discoverer* to discharge wastes regulated under the NPDES General Permit at the Torpedo (lease block 6610 and 6659) and Sivulliq (lease block 6658) prospects (NOIs dated October 10, 2010 and December 16, 2010; Shell, 2011a: Appendix B).
- Air Quality Permits under the Clean Air Act (CAA), issued by EPA Region 10. The EPA has the jurisdiction to approve and issue air quality permits for new oil and gas exploration operations on the Alaska OCS. These permits include the Prevention of Significant Deterioration (PSD) permit and the CAA Title V permit under 40 CFR Part 71. The PSD permit is a pre-construction permit intended to limit and regulate air emissions in an area of otherwise clean air. The CAA Title V permit is an operating permit required to assist states in controlling sources of air pollution on an ongoing basis regardless of the current status of air quality conditions. While State of Alaska permits are required for the 2012 Camden Bay EP, EPA Region 10 has the jurisdiction to approve and issue the permits, which involve operations in federal waters. These state and federal permits for each of the drillships, the *Kulluk* and the *Discoverer*, must be issued before approval of the 2012 Camden Bay EP is final. Shell has applied for multiple state and federal air operating permits for the drillship, *Kulluk*, in the application submitted on March 29, 2011. Shell has requested that review of the permits be consolidated so that only one permit is issued. The permit is currently under review by the EPA. Shell submitted revised information to EPA with regard to the PSD permits that were remanded in December 2010 for operations by the *Discoverer* in both the Beaufort and Chukchi seas. The permit relevant to operations in the Beaufort Sea is EPA Permit R10OCS/PSD-AK-10-01. The EPA Region 10 revised the permits, which were released for public comment on July 6, 2011. The comment period will end on August 5, 2011, and a public hearing is scheduled for August 4, 2011, in Barrow, Alaska. Should the permits be approved by EPA, issuance of the permits is required before the Proposed Action may begin. A more thorough discussion of the

permits, and access to the documentation, is provided in Appendix D, Air Quality, Section D-1.8, Air Operating Permits.

- Incidental Harassment Authorization (IHA) from NMFS regulating the incidental non-lethal harassment of protected species under the Marine Mammal Protection Act (MMPA) and ensuring no unmitigable adverse impact on the availability of marine mammal species or stocks for taking for subsistence uses. Shell has applied for an IHA from NMFS (dated May 2011; Shell, 2011a: Appendix C).
- Letter of Authorization (LOA) from FWS regulating the incidental non-lethal harassment of protected species under MMPA. Shell has applied for an LOA from FWS (dated May 2011; Shell, 2011a: Appendix C.
- Nationwide Permit No. 8 coverage from the U.S. Army Corps of Engineers (USACE) for compliance with the provisions of fairway regulations (33 CFR 322.5(l)) and effects on navigation and national security (33 CFR 322.5(f)) under the Rivers and Harbors Act.

Although a copy of Shell's Coastal Project Questionnaire and Certification Statement was included as Section 15 of the 2011 Camden Bay EP, Shell is no longer required to obtain a receipt of consistency concurrence from the State of Alaska because its coastal consistency program ended on June 30th, 2011.

Shell's proposed compliance with applicable OCS lease stipulations is documented in the EP and includes the following supporting information submitted with the EP:

- Shell's Environmental Orientation Program (Shell, 2011a: Section 11.0) which informs Shell personnel and contractors regarding applicable laws and compliance obligations (Lease Stipulation 2, Sales 192 and 202).
- Marine Mammal Monitoring and Mitigation Plan (4MP) (Shell, 2011a: Appendix D) to avoid impacts to marine mammals and collect scientific data on marine mammal species (Lease Stipulation 4, Sales 195 and 202);
- Plan of Cooperation (POC) Addendum (Shell, 2011a: Appendix H) to coordinate exploration activities with Alaskan Native subsistence activities to avoid unreasonable interference with subsistence resources and activities (Lease Stipulation 5, Sales 195 and 202);
- Shell's Alaska Fuel Transfer Operating Conditions and Procedures (Shell, 2011a: Section 9.0, Appendix M) (Lease Stipulation 6, Sales 195 and 202) ; and
- Bird Strike Avoidance and Lighting Plan, Beaufort Sea, Alaska (Shell, 2011a: Appendix I) (Lease Stipulation 7, Sales 195 and 202).

Under this EP, Shell would employ personnel and contractors experienced in operating in the Arctic OCS and would train employees in Federal and State laws regulating field operations. Shell has committed in its EP to local hire, local contracting, and local purchasing to the maximum extent possible (Shell, 2011b: p. xviii).

2.3.2. Drill Sites and Operating Environment

Shell proposes exploration drilling on lease OCS-Y-1805 at planned drill sites Sivulliq G and Sivulliq N, on lease OCS-Y-1941 at planned drill site Torpedo H, and on lease OCS-Y-1936 at planned drill site Torpedo J (Figures 1-1 and 1-2). The Sivulliq drill sites and the Torpedo drill sites are located on the continental shelf north of the Camden Bay area of the Beaufort Sea. Sediment at both locations is composed predominately of silty sands and mud. The water depth is approximately 110 ft (33 m) at the Sivulliq sites and 120 ft (37 m) at the Torpedo sites. The seafloor at all these locations has been extensively ice gouged.

The Sivulliq G (Flaxman Island NR06-04 Official Protraction Diagram block 6658, Lease OCS-Y-1805) drill site is located at latitude 70°23'46.82" N., longitude 146°01'03.46.5284" W in 110 feet of water.

- 16 miles (26 km) from Point Thompson
- 45 mi (72 km) from Cross Island
- 60 mi (97 km) from West Dock
- 58 mi (93 km) from Deadhorse
- 60 mi (97 km) from Kaktovik
- 119 mi (192 km) from Nuiqsut

The Sivulliq N (Flaxman Island NR06-04 Official Protraction Diagram block 6658, Lease OCS-Y-1805) drill site is located at latitude 70°23'29.58" N., longitude 145°58'52.53" W in 107 feet of water.

- 16 miles (26 km) from Point Thompson
- 47 mi (75 km) from Cross Island
- 60 mi (97 km) from West Dock
- 58 mi (93 km) from Deadhorse
- 60 mi (97 km) from Kaktovik
- 118 mi (190 km) from Nuiqsut

The Torpedo H (Flaxman Island NR06-04 Official Protraction Diagram block 6610, Lease OCS-Y-1941) drill site is located at latitude 70°27'01.62" N., longitude 145°49'32.07" W in 120 feet of water.

- 22 mi (35 km) From Point Thompson
- 50 mi (81 km) from Cross Island
- 64 mi (103 km) from West Dock
- 64 mi (103 km) from Deadhorse
- 55 mi (89 km) from Kaktovik
- 125 mi (201 km) from Nuiqsut

The Torpedo J (Flaxman Island NR06-04 Official Protraction Diagram block 6659, Lease OCS-Y-1936) drill site is located at latitude 70°28'56.94" N., longitude 145°53'47.15" W in 120 feet of water.

- 23 mi (37 km) from Point Thompson
- 48 mi (77 km) from Cross Island
- 62 mi (100 km) from West Dock
- 63 mi (101 km) from Deadhorse
- 60 mi (97 km) from Kaktovik
- 122 mi (196 km) from Nuiqsut

The two communities in closest proximity to the planned exploration activities are: Kaktovik (aka Barter Island) to the east and Nuiqsut to the west. Deadhorse, the logistics and support base for North Slope oil and gas operations, is located between the drill site locations and Nuiqsut to the west. The existing shore facilities at West Dock and facilities at Deadhorse would support the exploration activities.

2.3.3. Seafloor Conditions at the Drill Sites

The BOEMRE regulations (30 CFR 250.214) require shallow hazards assessment be conducted prior to drilling or installing mobile drilling units for oil and gas activities. Geophysical surveys conducted over the sites are analyzed to identify 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. Shell also collected shallow cores for geochemical and geotechnical studies. A summary of the shallow-hazards assessment is presented in the 2011 Camden Bay EIA, Sections 1 and 3 (Shell, 2011b). A short chronology and summary of pertinent shallow-hazards surveys and assessments are presented here.

In 1985-1986, Union Oil Company conducted shallow-hazards surveys at Sivulliq (then called Hammerhead) in the proximity of the 2012 Sivulliq and Torpedo drill sites. In 2006, Shell collected shallow-hazards data at the Sivulliq N drill site.

In 2007, Shell contracted Geo LLC to conduct shallow-hazards across the Torpedo prospect. The following parameters were assessed and analyzed for both shallow hazards and engineering constraints.

- Bathymetry
- Ice gouging
- Buried channels
- Seafloor obstructions
- Surficial sediments
- Permafrost
- Faulting
- Seismicity
- Shallow gas
- Gas hydrates
- Water column anomalies
- Archaeological features

In 2008, the historic hazard survey data was augmented with bathymetric data and data collected by remotely operated vehicle during the shallow-hazards surveys conducted by Geo LLC. These data were collected in accordance with Notice to Lessees (NTL 2005-A02).

Copies of the shallow-hazards reports for portions of the Sivulliq and Torpedo prospects were submitted to BOEMRE under separate cover in June 2007, March 2008, and March 2009. These reports are titled:

- Exploration Wellsites Clearance Assessments, Sivulliq Prospect, Beaufort Sea, Alaska, prepared by Geo LLC
- 2007 Exploration Wellsites Geohazards Assessments, Sivulliq Prospect, Beaufort Sea Alaska, Addendum 1, prepared by Geo LLC
- Exploration Wellsites Geohazards Assessments, Torpedo Prospect, Beaufort Sea, Alaska, prepared by Geo LLC
- Shallow Hazards Assessment, Sivulliq G, V, W and Supplemental N Wellsites, Blocks 6658, 6659, 6708, and 6709, Flaxman Island Area, Beaufort Sea Alaska, Report No. 27.2008-2266, prepared by Fugro Geoconsulting, Inc.
- Shallow Hazards Assessment, Torpedo, A, B, G, and H Wellsites, Blocks 6609 and 6610, Flaxman Island Area, Beaufort Sea, Alaska, Report No. 27.2008-2267, prepared by Fugro Geoconsulting, Inc.
- Drill Site Clearance Letter, Proposed Torpedo J Drill Site, Block 6559, Flaxman Island, Beaufort Sea, Alaska. Report No. 27.2010-2375-10, prepared by Frugo Geoconsulting, Inc.

The analyses found no evidence of shallow hazards, human-made obstructions (historic or prehistoric) at the Torpedo J drillsite (USDOI, MMS, 2009; Shell, 2011b: pp. 1-9 to 1-10)

Sivulliq Prospect. Based on the shallow hazards survey data, the planned Sivulliq drill sites are determined to be free of historic properties (vessels such as shipwrecks or downed aircraft) and geologic risks. Recent shallow hazards survey results for the Sivulliq drill sites did not identify any shallow hazards or constraints other than ice gouging. The installation of a mudline cellar (MLC) at the Sivulliq drill sites would mitigate this constraint. The MLC would be sufficiently deep (approximately 37 ft [11.2 m]) to ensure that, if the drill site were to be temporarily abandoned during an emergency, wellhead equipment would be below the maximum ice-scour depth of 8.2 ft (2.5 m) (Shell 2011b: p. 3-27). The wellhead equipment would thereby be protected from the maximum anticipated ice-keel scour.

The BOEMRE concurs with Shells assessment that no shallow hazards exist at the proposed Sivulliq drill sites. The BOEMRE has determined, based on agency verification of Shell's analysis, that there are no indications of historic sites or prehistoric archaeological resources at the proposed Sivulliq drill sites. The BOEMRE also reviewed the seafloor survey for potential seafloor habitat and benthic communities. No unique seafloor habitat (that would distinguish the site from the surrounding area) or benthic communities were identified at the proposed Sivulliq drill sites (Shell, 2011a, Section 11).

Torpedo Prospect. Drill sites Torpedo H and J were studied during shallow-hazards surveys conducted in 2007-2008 by Geo LLC. The shallow hazards surveys identified no historic properties (vessels such as shipwrecks or downed aircraft) or geologic risks. Recent shallow hazards survey results for the Torpedo H and J sites did not identify any shallow hazards or constraints other than ice gouging. The installation of MLCs at the Torpedo drill sites would mitigate this constraint. The MLC would be sufficiently deep (approximately 37 ft [11.2 m]) to ensure that, if the drill site were to be temporarily abandoned during an emergency, wellhead equipment would be below the maximum ice-scour depth of 4.1 ft (1.3 m) (Shell 2011b: p. 3-27). The wellhead equipment would thereby be protected from the maximum anticipated ice-keel scour.

The BOEMRE has reviewed the data and reports and concurs with Shell's assessment that no shallow hazards occur at the proposed Torpedo drill sites. The BOEMRE has determined, based on Shell's analysis, that there are no indications of historic sites or prehistoric archaeological resources at the proposed Torpedo drill sites.

The BOEMRE also reviewed the seafloor survey data for potential seafloor habitat and benthic communities. No unique seafloor habitat or communities were identified at the proposed Torpedo drill sites (Shell, 2011a, Section 11).

2.3.4. Drillship, Support Vessels, and Aircraft

Shell would conduct drilling operations using the *Kulluk* or, alternatively, the *Discoverer* using the latest drilling technologies and techniques.

The *Kulluk* has an Arctic Class IV hull design that is conically shaped and is towed to the location. The *Kulluk* is capable of drilling in water depths up to 600 ft (182.9 m) and is moored using a 12-point anchoring system. The *Kulluk* is designed to maintain its location in drilling mode in moving ice with thickness up to 4 ft (1.2 m) without the aid of active ice management. With the aid of the ice management vessels, the *Kulluk* would be able to withstand more severe ice conditions. In more open-water conditions, the *Kulluk* can maintain its drilling location during storm events with wave heights up to 18 ft (5.5 m) while drilling, and can withstand wave heights of up to 40 ft (12.2 m) when not drilling and disconnected (assuming a storm duration of 24 hours). Detailed specifications for the *Kulluk* are provided in the 2011 Camden Bay EP (Shell, 2011a: Section 1, 2011b)

The *Discoverer* is a modern drillship retrofitted for operating in Arctic OCS waters and has state-of-the-art drilling and well-control equipment. It is a 514 ft (156 m) drilling vessel with the drilling equipment on a turret amidship and an eight-point mooring system. Detailed specifications for the *Discoverer* are provided in the 2011 Camden Bay EP (Shell, 2011a: Section 1, 2011b)

The *Kulluk* or *Discoverer* would be attended by approximately eleven vessels that would be used for ice management, anchor handling, oil spill response, refueling, resupply, waste storage and transport and servicing. These vessels and their functions are identified in Table 3 and described in greater detail in the 2011 Camden Bay EIA (pp. 2-4 to 2-18). Although shell expects to use eleven support vessels, the actual number of support vessels may vary due to operational needs.

The primary ice management vessel is the *Nordica*, which would be located several miles from the drill site when not being used for ice management. *Hull 247* is used for secondary ice management and anchor handling. *Hull 247* will also serve as the tow vessel for the *Kulluk* and provide additional berthing (accommodations).

Drilling operations will require transfer of supplies from Deadhorse/West Dock and Dutch Harbor to the drilling vessels (up to 24 trips/tie ups to the *Kulluk* and 8 trips/tie ups to the *Discoverer*). The *Arctic Seal* is the designated resupply vessel to be used from West Dock. The *Harvey Spirit* will be used as the offshore resupply vessel (OSV) bringing supplies from Dutch Harbor. The *Carol Chouest* will serve as back up vessel to the *Harvey Spirit* for bringing supplies from Dutch Harbor.

Table 3 Planned Support Vessels for the *Kulluk* or *Discoverer*.

Support Vessel (or similar)	*Kulluk or Discoverer*
Primary Ice Management	*Nordica*
Secondary Ice Management / Anchor Handling	*Hull 247* (also acts as tow vessel for the *Kulluk* and a berthing vessel for OSR)
Shallow water resupply	*Arctic Seal*
Offshore Resupply Vessel (OSV)	*Harvey Spirit*
Waste Streams Transfer Vessel	*Carol Chouest*
Waste Streams Temporary Storage and Transit to Disposal Facility (deck barge and tug; [deck barge])	*Southeast Provider* and *Ocean Ranger**
Waste storage barge and tug (waste barge)	To be determined
Primary Oil Spill Response (OSR)	*Point Oliktok* Tug and *Endeavor* Barge

Support Vessel (or similar)	*Kulluk or Discoverer*
OSR Liquid Storage and Refuel Supply Vessel	*Mikhail Ulyanov*
OSR Containment System	Invader Class tug and barge
Anchor Handler – support for the Containment System Barge	To be determined

Source: Shell, 2011b: Table 2.2.1

Rather than discharge certain wastes (drilling muds and cuttings, treated sanitary waste, domestic waster, bilge water, and ballast water) from the drilling vessels into the marine environment, Shell will transfer the wastes from the drilling vessel to a deck barge and tug (Southeast Provider and Ocean Ranger) or to a waste storage barge and tug (to be identified). Because the waste barge-tug cannot safely tie to the drilling vessel, waste transfer to the barge will be accomplished using the *Harvey Spirit* or *Carol Chouest*. At the end of each drilling season, the barges and tugs will transport the stored waste out of the Arctic for disposal at an approved disposal facility.

The oil spill response (OSR) vessels would include an ice-capable Oil Spill Response Barge (OSRB) and associated tug (*Point Oliktok* tug and *Endeavor* barge), a tank vessel for storage of any recovered liquids (*Mikhal Ulyanov*), and associated smaller workboats. The OSRB and tug with a full complement of crew and spill-response equipment, with *Hull 247* providing berthing, would be staged near the drilling vessel).

Other vessels and aircraft would be deployed to the site as needed to support Shell's 4MP (Shell, 2011a: Appendix D) and scientific research efforts. There would be up to two flights per day, approximately 12 per week, by a support helicopter from the shore base to the drill site to transfer crews and supplies. A fixed-wing aircraft would be used for daily marine mammal monitoring overflights of 6 hours per day. Shell's aerial monitoring program is described in the 4MP.

The 2011 Camden Bay EIA (Shell, 2011b) lists the specifications of the drilling vessels (EIA Table 2.2-4 for the *Kulluk* and Table 2.2-5 for the *Discoverer*) and support vessels (EIA Tables 2.2-1 and 2.2-2) Shell is proposing to use.

Drilling days per drill site for the Torpedo drill sites are estimated at 44 days. Drilling days per drill site for the Sivulliq drill sites are estimated at 34 days. The days onsite for the Torpedo and Sivulliq drill sites include one day to set anchors, five days for constructing the MLC one day to remove anchors, and one day to move off of the site.

Shell's Critical Operations and Curtailment Plan (COCP) (Shell, 2011a, Section 9 and Appendix J) addresses the methods by which Shell would cease, limit, or not initiate specific critical operations due to environmental conditions that may be encountered at the drill sites.

Facilities will be consolidated at Deadhorse to support drilling, logistics, and oil spill response. Approximately 30 Shell personnel will be based in Deadhorse. Facilities include accommodations at the Prudhoe Bay Hotel and Service Area 10 facility and the use of existing facilities. No new construction is planned at Deadhorse.

Aircraft travel would be controlled by Federal Aviation Administration approved flight paths and would comply with flight restrictions imposed by the Sale 195 and Sale 202 lease stipulations regarding sensitive biological areas. A flight altitude of 1,500 ft (457 m) would be maintained by all non-marine mammal monitoring flights to minimize impacts on marine mammals, terrestrial species, and subsistence hunters. As indicated in the EP, Shell would implement 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.

2.3.5. Discharges and Waste Management

The Arctic National Pollutant Discharge Elimination System (NPDES) General Permit AKG280000 (EPA, 2006) for the offshore areas of Alaska, including the Beaufort Sea, authorizes discharges from oil and gas exploration facilities. The current Arctic general permit, which restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions, expired on June 26, 2011. The EPA will reissue separate NPDES exploration General Permits for the Beaufort Sea and the Chukchi Sea prior to the 2012 drilling season. EPA expects that tribal consultation and public comment on the new proposed Arctic oil and gas exploration permits would occur during the fall of 2011.

The EPA regulations (40 CFR 125.122) require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment. Under the NPDES General Permit AKG280000, eleven separate effluent streams are allowed for the *Kulluk* or *Discoverer*. Each effluent stream, and the associated projected amount of discharge, is listed in the 2011 Camden Bay EIA (Table 2.7.1 for Sivulliq G, 2.7.2 for Sivulliq N, 2.7.3 for Torpedo H, and 2.7.4 for Torpedo J).

Shell would only use water-based drilling fluids. Only seawater will be used during construction of the mud lined cellar (MLC), the 36-in hole section for the 30-in casing, and the 26-in hole section for the 20-inch casing. Below the 26-in hole section, Shell will use water based fluids during drilling. These water based fluids and cuttings will be collected aboard the drilling vessel, transferred to a storage vessel for ultimate transportation and disposal at an EPA-approved disposal site. The anticipated amounts of fluids and cuttings with adhered mud that will be generated, collected and disposed of per well is: Sivulliq G and N – 1,426 bbl each; Torpedo H – 3,045 bbl; and Torpedo J – 3,007 bbl. Drilling fluid volumes and chemistry would comply with NPDES General Permit conditions.

The drilling vessel (*Kulluk* or *Discoverer*) would be used to construct the MLC, set casing, and drill the well to total depth for each well (7,000 feet for Sivulliq G and N, 10,000 feet for Torpedo H and 9,800 feet for Torpedo J). Shell would recycle drilling fluids (e.g., use those fluids on multiple wells), to the extent practicable based on operational considerations (e.g., fluid properties cannot be used further after they have deteriorated a certain amount), to reduce discharges from its operations. At the end of each drilling phase, the used drilling fluids would be transported to another well for reuse, if feasible, or transferred to a storage vessel for ultimate transfer and disposal. At the end of each drilling season, up to 1,500 bbl of drilling fluids, stored in the reserve tank on board the drillship, will be transferred for disposal.

All waste not captured for off-site disposal will be discharged to the ocean through the vessels disposal caisson. The base of the disposal caisson on the *Kulluk* is approximately 38 to 41 feet (11.5 to 12.5 m) below the water surface and on the *Discoverer* is 19.6 ft (6.0 m) below the water surface.

A list of the components that may be added to the drilling fluid is summarized in the 2011 Camden Bay EIA, Table 2.7-5. The component list and the associated volumes account for drilling needs at various depths from the MLC to total depth for both the Sivulliq and Torpedo wells.

The discharge from the water cooling unit is expected reach ambient temperature at a horizontal distance of 164 ft (50 m) from the discharge point on the *Kulluk* and 256 ft (78 m) from the discharge point of the *Discoverer*.

Solid wastes (trash) would be segregated and disposed of or recycled at approved disposal or recycling facilities on land. Hazardous waste and used oil would be stored onboard in approved containers and then transferred by boat to an approved disposal facility out of the Arctic.

2.3.6. Emissions

Potential new emissions of harmful pollutants caused by a proposed oil exploration plan (EP) on the Alaska Outer Continental Shelf (OCS) must be approved by the U.S. Environmental Protection Agency (EPA), Region 10. The regulated pollutants include those controlled under the Clean Air Act (42 U.S.C. 7401) National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) and also include precursor pollutants such as Volatile Organic Compounds (VOC). These VOC compounds combine with emissions of nitrogen oxides and sunlight to form ozone, a pollutant regulated under the NAAQS. Approval for new emissions is obtained through the issuance of federal or state air quality operating permits and construction permits. The type of permit depends on the type of emission source proposed, such as new, modified, or existing; stationary or mobile; and permanent or temporary. The type of permit is also based on the location of the proposed drilling prospects, meaning whether the drillship is proposed to be located within or beyond 25 nautical miles of Alaska's seaward boundary in the Beaufort Sea (three nautical miles from shore) (40 CFR Part 55.2; Alaska Department of Natural Resources, 2005). Further, the type of permit required depends on the potential maximum annual emissions expected from the source being permitted, which would fall into one of two categories, a major source or a minor source (40 CFR 52.21(b)(1)).

Under the EPA OCS Air Regulations at 40 CFR Part 55, the activities required to implement the 2011 Camden Bay EP constitute an exploratory OCS source (new facility), attached to the seabed (stationary) in one location for less than three years (temporary), which has the potential to emit (PTE) any of the regulated air pollutants (30 CFR Part 250.302). Only the stationary-source aspects of the facility are regulated through the EPA permitting process. Shell proposes to drill from the drillship *Kulluk* with the option of using the drillship *Discoverer* in lieu of the *Kulluk*. As such, emissions from operations associated with the two drillships are addressed separately in the EPA permitting process.

Emissions on the *Kulluk* or *Discoverer* would primarily be associated with the generation of electricity, compressed air, and hydraulic energy to support drilling. All others are secondary and related to general purpose heating, transfer of materials about the deck, pumping of cement, incineration of (primarily) domestic waste, and other small emission sources. The majority of the project emissions will be generated from the *Kulluk* or *Discoverer*'s support vessels (e.g., ice management, anchor management, and oil spill response vessels).

The drilling vessels will be attended by a approximately eleven vessels that would be used for ice management, anchor handling, spill response, waste storage and transportation, refueling, resupply, and servicing. The primary sources of the emissions by the drilling vessels and support vessels would be combustion engines including the vessel engines, generators, compressors, draw works, and pumps. Emission units are associated primarily with the generation of electricity, compressed air, and hydraulic energy to support drilling. All others are secondary and related to general purpose heating, transfer of materials about the deck, pumping of cement, incineration of (primarily) domestic waste, and other small emission sources. Although shell expects to use eleven support vessels, the actual number of support vessels may vary due to operational needs.

Additional emission sources include vessels and aircraft necessary to implement the proposed 4MP, support crew and supply transport, and support scientific research. Specific details of the emissions associated with either drillship are included in the air quality analysis provided in Section 4.2.1.1., Table 10 and Table 11.

Drillship Kulluk Permit **and Emission Reduction Measures.** Shell submitted an air quality permit application for the *Kulluk* in three parts for approval to operate both within and beyond 25 nautical miles of the Alaskan seaward boundary in the Beaufort Sea. Overall, the application is intended to show operations of the proposed EP would not result in violations of the NAAQS.

Shell applied for a Minor Source permit for the *Kulluk* to operate in the Beaufort Sea on indefinite number of future drilling seasons. Shell's OCS Permit Application for a Minor Source permit for the *Kulluk* was submitted on March 29, 2011, and is available online at: http://yosemite.epa.gov/r10/airpage.nsf/Permits/Kullukap/.

The minor source permit will regulate air emissions from the *Kulluk* and from the support vessels when within 25 mi (40 km) of the anchored *Kulluk*. The implementation of best available control technology (BACT) and compliance with other provisions of the permit will ensure that air emissions are minimized.

The permit includes a description of the emission reduction measures that would limit emissions to the applicable PSD thresholds that define a major source, which is the potential to emit 250 tons per year or more of any regulated pollutant. The proposed emission reduction measures are also described in the 2011 Camden Bay EP: Section 7.0 Air Emissions Information, and in the 2011 Camden Bay EIA. The emission reduction measures proposed for the *Kulluk* include the use of:

- Selective catalytic reduction (SCR) devices as NO_X tailpipe emission controls on the primary engines. The primary generators will have oxidation catalysts installed for control of fine particulate matter with a diameter less than 2.5 micrometers ($PM_{2.5}$), VOC, and CO.
- Oxidation catalysts for control of $PM_{2.5}$, VOC, and CO emissions from the other engines normally used in the exploration drilling activities, including air compressors, the MLC, hydraulic power units (HPU), and cranes. Control of engine emissions is assumed to be 50% for $PM_{2.5}$, 80% for CO, and 70% for VOC.
- SCR device as a NO_X tailpipe emission control on the engines aboard the ice management vessels and anchor handlers.
- Ultra-low sulfur content (0.0015%) diesel fuel for both the *Kulluk* and the support vessels to reduce SO_2 emissions.

Uncontrolled emissions from implementation of the EP using the drillship *Kulluk* would be comprised primarily of NO_X emissions, with the potential to exceed the PSD threshold of 250 tons per year. Therefore, the use of the Best Available Control Technology (BACT) summarized above would be engaged to ensure the reduction of NO_X emissions below 250 tons per year. Emissions of NO_X would comprise 50.7% of total emissions of criteria pollutants. Emissions of CO would comprise 36.0% while emissions from the remaining relevant pollutants would be much lower, ranging from 1.0% for SO_2 emissions to 12.3% for PM.

Drillship *Discoverer* Permit and Emission Reduction Measures.

The *Discoverer* permit includes a description of the emission reduction measures that would limit emissions but would not decrease emissions of NO_X to a level below 250 tons per year. The proposed emission reduction measures are also described in the 2011 Camden Bay EP, Section 7.0 Air Emissions Information, and in Appendix F, the Environmental Impact Assessment. The emission reduction measures proposed for the *Discoverer* include:

- Selective catalytic reduction (SCR) device as a NO_X tailpipe emission control on the primary generators to reduce NO_X emissions to under 0.5 grams per kilowatt hour (g/kW-hr). Oxidation catalysts will be installed for control of fine particulate matter with a diameter less than 10 micrometers (PM_{10}), VOC, and CO.
- Retrofit all other engines on the *Discoverer* with Catalytic Diesel particulate Filters to reduce CO, VOC, and PM10, or use Tier 3 (low emissions) engines.
- Selective catalyst reduction and oxidation catalyst emission controls on all propulsion and generation engines on the primary ice management vessel.
- Ultra-low sulfur content (0.0015%) diesel fuel will be purchased for the *Discoverer* and the support vessels to reduce SO_2 emissions.

Emissions from implementation of the EP using the drillship *Discoverer* would be comprised primarily of NO_X emissions, with the potential to exceed the PSD threshold of 250 tons per year for emissions of NO_X. Therefore, the use of the Best Available Control Technology (BACT) and owner-requested restrictions (ORR) summarized above would be engaged to ensure NO_X emissions are reduced to the lowest reasonable and available level. Emissions of NO_X comprise 62.9% of total emissions of criteria pollutants. Emissions of CO would comprise 28.8% of total emissions while emissions from the remaining relevant pollutants is much lower, ranging from 0.25% for SO_2 emissions to 8.0% of PM.

2.3.7. Sound Generation.

The level of continuous sound introduced into the water during exploratory drilling operations is likely to differ between the *Kulluk* and the *Discoverer*.

Drilling Sound. Sounds from the *Kulluk* were measured in the Beaufort Sea in 1986 and reported by Greene (1987a, 1987b cited in Shell 2011b: Section 2.9). The back propagated broadband source level from the measurements (185.5 dB re: 1 microPascal (µPa) · m rms; calculated from the reported 1/3-octave band levels), which included sounds from a support vessel operating nearby, were used to model sound propagation at the Sivulliq prospect near Camden Bay. The model estimated that sounds would decrease to 120 dB re: 1 µPa · m rms at ~8.25 mi (~13.27 km) from the *Kulluk* (Zykov and Hannay, 2007). As a precautionary approach, that distance was multiplied by 1.5 and the resulting radius of 12.37 mi (19.91 km) was used to estimate the total area that may be exposed to continuous sounds ≥120 dB re: 1 µPa rms by the *Kulluk* at each drill site. If one well site is drilled in one season, the total area of water ensonified to 120 dB rms in each season will be 480.7 mi^2 (1,245 km^2).

Sounds generated by the *Discoverer* have not been directly measured in Alaska and noise propagation measurements are not available. However, measurements of sounds produced by the *Discoverer* were made in the South China Sea in 2009 (Austin and Warner 2010). The activities included repositioning of the ship on its turret using the thrusters, tripping, drill string handling, drilling, and anchor retrieval. Some of these activities were simulated by running most, but not all, of the required equipment. The measured underwater sound levels generated during the study of the *Discoverer* in the South China Sea are presented in 2011 Camden Bay EIA Table 2.9-1. The results of those measurements were used to model the sound propagation from the *Discoverer* (including a nearby support vessel) at planned drilling locations in the Chukchi and Beaufort Seas (Warner and Hannay, 2011). Ensonified areas from exploration drilling activities with a nearby support vessel were estimated using JASCO Applies Science's Marine Operations Noise Model (MONM) at the Sivulliq and Torpedo prospects. The model predicts the transmission loss or reduction in sound that would occur with distance from the drilling vessel. Results are presented in EIA Table 2.9-2 Sound transmission loss was found to vary with the season due to changes in water temperature and salinity.

Broadband source levels of sounds produced by the *Discoverer* varied by activity and direction from the ship, but were generally between 177 and 185 decibels (dB) re: 1 µPa · m root mean square (rms) (Austin and Warner 2010). Propagation modeling at the Sivulliq and Torpedo prospects yielded somewhat different results, with sounds expected to propagate shorter distances at the Sivulliq site (Warner and Hannay, 2011). As a precautionary approach, the larger distance to which sounds ≥120 dB (3.32 km) are expected to propagate at the Torpedo site have been used to estimate the area of water potentially exposed at both locations. The estimated 2.06 mi (3.32 km) distance was multiplied by 1.5 (= 3.09 mi [4.98 km]) as a further precautionary measure before calculating the total area that may be exposed to continuous sounds ≥120 dB re 1 µPa rms by the *Discoverer* at each drill site. Assuming one well will be drilled in each season (summer and fall), the total area of water ensonified to ≥120 dB rms in each season would be 30.12 mi2 (78 km2).

When an ice-management vessel is transiting open-water, the sound generated is less than when the vessel is managing or breaking ice. The greatest sound generated during ice-breaking operations is produced by cavitations of the propeller as opposed to the engines or the ice on the hull (Richardson et al. 1995a). Ice-management activities may be necessary in early July or towards the end of operations in late October, if ice is present. Little to no ice management is expected to occur during the bowhead migration. Based on measurements in Greene (1987), sounds produced by an icebreaker, the Robert Lamonte, actively managing ice in this area were estimated to fall below 160 dB rms at <100 m from the vessel and to fall below 120 dB rms at ~8 km from the vessel. For estimation purposes, Shell assumed that most ice-management activities would occur at a distance of 10-15 km from the drilling operation and that one-third of that distance band would be exposed to ≥160 dB rms at some point by those activities. This area lies outside of the area exposed to ≥160 dB rms by the *Discoverer*. Waters are ≤40 m deep in areas that may be exposed to sounds ≥160 dB by both the *Discoverer* and ice-management activities. The ice-management area is 10-15 km around the drill site. The ice-management area plus the area an additional 8 km beyond the ice-management area potentially would be exposed to sounds levels of ≥120 dB rms by any ice-management activities.

Shell would verify the modeled sound-level radii though field measurements. Acoustic monitoring would measure the sound decibels produced by drilling activities, including variations with time, distance, and direction from the drillship. Acoustic monitoring would measure the sound levels produced by support vessels, including ice-management vessels. Drilling and vessel sounds would be measured and recorded using two methods, which may be used separately or together. The first method employs hydrophones mounted on the seafloor around the drilling vessel. This system would be located within 1,640-3,281 ft (500-1,000 m) from the drilling vessel. These hydrophones would feed real-time sound data to the drillship. An activity log would correlate sound levels with vessel activities. The second method for recording sound levels would employ additional hydrophone systems at various distances and locations around operations. Acoustic data from the second system would be stored digitally for later retrieval. Drilling sound monitoring equipment would be deployed soon after the drilling vessel is onsite and before drilling commences.

Vertical Seismic Profile. Shell may conduct a geophysical survey referred to as Vertical Seismic Profiling (VSP) at each drill site where a well is drilled (Shell, 2011b). During VSP surveys, an airgun array is deployed at a location near or adjacent to the drilling vessel, while receivers are placed (temporarily anchored) in 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. Typical high-energy airgun arrays emit most energy at 10-120 Hz. However, the pulses contain significant energy up to 500-1,000 Hz and some energy at higher frequencies (Goold and Fish, 1998; Potter et al., 2007). The estimated source level used to model sound propagation from the airgun array is ~241 dB re 1μPa · m rms, with most energy between 20 and 140 Hz.

The sound source (airgun array) is fired repeatedly, and the reflected sonic waves are recorded by receivers (geophones) located in the wellbore. The geophones, typically a string of them, are then raised up to the next interval in the wellbore and the process is repeated until the entire wellbore has been surveyed, typically over a period of 10 – 14 hours. The purpose of the VSP is to gather geophysical information at various depths, which can then be used to tie-in or ground-truth geophysical information from the previous seismic surveys with geological data collected within the wellbore. Typical receivers would consist of a Schlumberger wireline four-level Vertical Seismic Imager (VSI) tool, which has four receivers 50 ft (15.2 m) apart.

Shell will likely be conducting a particular form of VSP referred to as a ZVSP, in which the sound source is maintained at a constant location near the wellbore. A typical sound source that would be used by Shell for the Camden Bay exploration drilling is the ITAGA eight-airgun array, which consists of four 150-in.3 (2,458-cm3) airguns and four 40-in.3 (655-cm3) airguns. These airguns can be activated in any combination and Shell would utilize the minimum airgun volume required to obtain an acceptable signal. 2011 Camden Bay EIA (Table 2.9-6) lists specifications for the sound source of the airgun array.

Sound propagation measurements will be performed on the drilling vessel and the ZVSP airgun source in the first drilling season, once it is on location near Camden Bay. The results of those measurements will be used during the season to implement mitigation measures as required by the permit.

Other Sound

Vessel Sound. In addition to either drilling vessel, various types of vessels will be used in support of the operations including ice management vessels, anchor handler, OSV(s), and oil-spill response vessels (Shell, 2011b). 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 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 at relatively 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. 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.

Aircraft Sound. Aircraft would not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing, or taking off; providing assistance to a whaler; or in poor weather (low ceilings) or any other emergency situations. Aircraft engaged in marine mammal monitoring would not operate below 1,500 ft (457 m) in areas of active whaling; such areas would be identified through communications with established Communication Centers. Except for fixed-wing aircraft (airplanes) engaged in marine mammal monitoring, aircraft would use a flight path that keeps the aircraft at least 5 mi (8 km) inland until the aircraft is directly south of its offshore destination; then at that point, they would fly directly north to their destination. As a result of community input during Government-to-Government meetings held by BOEMRE for Shell's 2007 EP, the inland helicopter route was developed to mitigate potential interference with subsistence caribou hunting along the coast. Helicopters would be used for air support and crew changes. The level and duration of sound received underwater from helicopters depends on altitude and water depth. Received sound level decreases with increasing altitude. At an altitude of 1,000 ft (305 m), there were no measured sound levels at a water depth of 121 ft (37 m) (Green, 1985, cited in Richardson et al., 1989).

2.3.8. Local Hire

Shell has several programs that involve the training and subsequent hiring of local residents. These programs include the following:

- Marine Mammal Observer (MMO) program
- Subsistence Advisor (SA) program
- Communication and Call Centers (Com Centers) program

The MMO program employs, among others, local Iñupiat residents to monitor and document marine mammals in the project area. The MMOs participate in intensive training for marine mammal identification and documentation, and in computer use and health and safety regulations.

The SA program recruits a local resident from each village to communicate local concerns and subsistence issues from residents to Shell. The SA speaks with other village members and documents subsistence information. Shell may use that information to develop appropriate mitigation measures to address issues related to subsistence activities and avoid potential conflicts with exploration activities.

The Com Center program involves hiring one or two individuals from each of the Beaufort Sea and Chukchi Sea villages. These individuals monitor and relay radio transmissions between subsistence vessels and industry vessels. This sharing of information is intended to reduce or eliminate the potential conflict between subsistence users and industry vessels.

In the EP, Shell has committed to efforts to hire and train local residents for the exploration program. Providing these employment opportunities to local residents creates the potential for positive economic benefits to the communities most affected by Shell's activities. These efforts also would provide a conduit for communication between Shell and residents.

2.3.9. Analysis of Accidental Oil Spills

The BOEMRE analyzed a range of oil spill sizes, grouped by category from small (<1,000 bbl) to very large (≥150,000 bbl), and likely consequences to environmental, social, and economic resources in the Beaufort Sea Multiple-Sale EIS from which this EA tiers. The BOEMRE updated those oil spill and impact analyses in the Sale 195 EA, Sale 202 EA, 2009 Camden Bay EA and the Arctic Multisale EIS, which this EA incorporates by reference.

The BOEMRE used Shell's potential discharge volumes, summarized below in **Error! Reference source not found.** and in Appendix A of this EA, as the spill volume and oil type for each of BOEMRE's small (<1,000 bbl), large (≥1,000 bbl), and very large (≥150,000 bbls) spill size categories (Shell, 2011a: Table 2-1). The potential discharge volumes are estimated without mitigation or response efforts. The effects of mitigation and response are discussed in Sections 5.5 – 5.7, and a detailed description of the very large oil spill volume estimate is provided in Table 19.

Table 4 Estimated spill volume and oil type in each BOEMRE spill size category from Shell's potential discharge volumes.

BOEMRE Spill-Size Categories	Type	Oil Type	Potential Discharge Volume[1]	Volume estimated to reach water
Small (<1,000 bbl)	Fuel Transfer	Diesel	48 bbl	48 bbl
Large (≥1,000 bbl)	Diesel Tank	Diesel	1,555 bbl	0 bbl
Very Large (≥150,000 bbl)	Blowout	Crude Oil	480,000 bbl	142,020 bbl[2]

Note: 1Total volume estimated with no mitigation or response
2Total volume estimated with mitigation and response as described in Sections 5.5.2 – 5.6 of this EA.

The BOEMRE reviewed and considered published documents and NEPA assessments on the likelihood of the potential discharges in the three spill size categories to determine a reasonably foreseeable spill analysis scenario for the no action and Proposed Action alternative in order to evaluate the potential impact producing factors of an accidental oil spill for this EA. Further analytical details are found within Appendix A of this EA.

For purposes of analysis of the no action alternative, no small, large, or very large spills are estimated to occur since no exploration activities occur.

For purposes of analysis of the Proposed Action alternative, BOEMRE estimates it is likely a small refined oil spill could occur. This estimate is based on the 35 exploration spills while drilling 35 wells on the Arctic OCS. No large spills (≥1,000 bbl) or very large (≥150,000 bbls) crude oil spills are estimated, 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: (1) the low rate of OCS exploratory drilling well-control incidents spilling fluids per well drilled; (2) since 1971, only one very large spill has occurred during temporary abandonment out of more than 15,000 exploratory wells drilled; (3) the low number (four) of exploration wells proposed in this action; (4) 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) No small spills occured while drilling 36 wells in the Arctic OCS; and (7) pollution prevention and oil spill response regulations and methods implemented by BOEMRE and Shell, respectively, since the Deepwater Horizon event discussed in Section 0.

Based on the six points listed above for large and very large spills, and that a small spill is considered likely to occur during exploration activities the most likely size spill occurring from the Proposed

Action would be a small (<1,000 bbl) spill. For purposes of analysis, the BOEMRE chose a 48-bbl fuel-transfer spill, as identified in Shell's Beaufort Sea ODPCP Summary of Potential Discharges, for a representative spill volume and oil type for the effects analysis of a small spill (Shell, 2011c, Table 2-1).

To provide information to evaluate the potential effect of a 48-bbl diesel-fuel oil spill, the BOEMRE estimates 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 using the SINTEF oil weathering model (OWM). A 48-bbl diesel-fuel spill could evaporate and disperse in less than 3 days (Appendix A: Table A-4). The SINTEF OWM estimates of a 48-bbl (7.6 m^3) fuel spill do not include the mitigating effects of potential containment and recovery operations to remove spilled product. Pre-booming downwind of vessels prior to transfer operations would be used in accordance with BOEMRE lease stipulations, USCG requirements, and Shell's operating procedures. Response equipment and trained personnel deploy recovery equipment for the control and removal of diesel fuel spilled into the environment mitigating the impacts of a small spill. Should a 48-bbl diesel-fuel spill occur, the spill would be localized and persist less than 3 days.

2.3.10. Oil Spill Prevention and Contingency Planning

As required by both Federal and State regulations, Shell has developed and would implement a comprehensive Oil Discharge Prevention and Contingency Plan (ODPCP) (Shell, 2011c) during its exploration drilling operations. The ODPCP must be reviewed and approved by both Federal and State regulators to ensure that Shell has the spill-response resources necessary to respond to any spill that might occur.

Shell's Beaufort Sea Regional Exploration ODPCP is a regional oil-spill-response plan that demonstrates Shell's capabilities to prevent, or rapidly and effectively manage, oil spills that may result from exploratory drilling operations. Despite the extremely low likelihood of a large oil-spill occurring during exploration, Shell has designed its response program for a regional capability of responding to a range of spill volumes that increase from small operational spills up to and including a Worst Case Discharge (WCD) scenario from an exploration well blowout, as required under 30 CFR 254.47. Shell's program is based on a WCD scenario that meets the response planning requirements of the State of Alaska and Federal oil-spill-planning regulations.

Shell has designed its response program based on a regional capability of responding to a worst case discharge (WCD) from an exploration well blowout. A dedicated OSRB would be staged in the vicinity of the drilling vessel when critical drilling operations into hydrocarbon-bearing zones are underway and possess sufficient capacity to provided containment, recovery, and storage for the initial operational period. Two vessel of opportunity skimming systems (VOSS) would also be employed to assist with containment and recovery operations. Shell also will mobilize an OSRB from operations in the Chukchi Sea to be on-site within 42 hours following notification to further support containment and recovery operation. An arctic oil storage tanker (OST) would arrive at the recovery site to provide interim storage of recovered fluids. The OST would possess sufficient capacity to store all recovered liquids from a 30-day blowout. Skimming and lightering operations would be conducted on a 24-hour basis ensuring uninterrupted recovery operations as skimming vessels transfer recovered fluids to the OST on a rotational basis.

Shell's primary response action contractors are Alaska Clean Sea (ACS) and Arctic Slope Regional Corporation Energy Services - Response Operations, LLC (AES-RO). The AES-RO's response personnel and oil-spill-response equipment would be maintained on standby while critical drilling operations into hydrocarbon-bearing zones are underway; and provide offshore response operations in the unlikely event of an oil-spill incident. The ACS provides manpower and equipment resources from Deadhorse for Beaufort Sea spill containment and recovery. The ACS and AES-RO would conduct response activities in both open ocean and near shore enviroments using the the ACS Technical Manual and the Shell Beaufort and Chukchi Seas Regional Tactics Manual.

2.3.11. Compliance with Lease Stipulations

Shell's leases were obtained under the Beaufort Sea Oil and Gas Lease Sale 195 on March 30, 2005, and the Beaufort Sea Oil and Gas Lease Sale 202 on April 18, 2007. Identical lease stipulations were included in both sales. A summary of the lease stipulations and Shell's planned actions to comply with each stipulation is provided below. The full text of the lease stipulations for Sale 195 is available on the BOEMRE website at: alaska.boemre.gov/cproject/beaufortsale/FNOS195Package/ 04.%20%20FNOS%20Stipulations.pdf. The full text of the Sale 202 stipulations is on the BOEMRE website: www.boemre.gov/alaska/cproject/beaufortsale/Sale202/FNOS/FNOS202package.htm. The BOEMRE' analysis of the effectiveness of the stipulations is in the Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003: Section II.H.1).

Stipulation No. 1 - Protection of Biological Resources

If biological populations or habitats that may require additional protection are identified in the lease area by the RS/FO, the RS/FO may require the lessee to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The RS/FO shall give written notification to the lessee of the RS/FO's decision to require such surveys.

Shell Actions: As required by 30 CFR 250.214, and as specified in BOEMRE Alaska OCS Region NTL 05-A01, Shell acquired shallow-hazards surveys over the planned drill sites. The surveys' data includes detailed bathymetry and identification of seafloor features through the use of subbottom profilers and side scan sonar methods.

Recently acquired shallow-hazards survey data over the Sivulliq and Torpedo drill sites in 2006, 2007, 2008, and 2009 did not identify any special benthic communities at these drill sites. Hard-bottom biological communities have high species diversity and provide valuable habitat for fish and invertebrates. To date, no confirmed boulder patch-type habitat has been identified at either of the planned drill sites. No other biological resources that require additional protection were found. The BOEMRE has reviewed the submitted survey data and assessments, and concurs with Shell's conclusions.

During 2008, Shell commissioned both biological and chemical studies of water and sediment samples at and around the proposed drill sites (Shell, 2011a: Section 5.0a).

To establish a baseline data set in advance of future oil and gas exploration, samples were collected in and around the planned Sivulliq N drill site (12 locations), around the 1985 Hammerhead well (10 locations), along a possible pipeline corridor (5 locations), and at random in the project area (19 locations). The sample locations and a more detailed account of the results of the sampling are discussed in the 2011 Camden Bay EIA (Shell, 2011b).

The following samples types were collected:

- Seafloor surface sediment samples
- Sediment cores, 3- 4 in (8-10 cm) in length
- Hydrographic profiles and water samples

Stipulation No. 2 - Orientation Program

The lessee shall include in any exploration or development and production plans submitted under 30 CFR 250.203 and 250.204 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the RS/FO. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. This guidance would include the production and distribution of *information cards on endangered and/or threatened species in the sale area. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel would be operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.*

Shell Actions: Shell has provided a proposed orientation program for Shell and contractor personnel involved in Shell's exploration activities. Shell submitted an orientation program to BOEMRE for review. BOEMRE reviewed the program and determined it satisfied the requirements of the stipulation. All Shell and contractor personnel involved in field exploration activities would attend the orientation training annually. All other Shell and contractor personnel would attend the orientation program at least once at the time they join the team. Shell would maintain a record, not to exceed five years, of all personnel who attend the program, including relevant attendee and program information.

Shell's orientation program addresses environmental, social, and cultural concerns specific to the project area. The program is designed to increase sensitivity and understanding by Shell and its contractors of community values, customs, and lifestyles of the local communities, and how to avoid conflicts with subsistence activities. The program stresses the importance of not disturbing local communities, archaeological resources, and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provides guidance on how to avoid disturbance of these resources.

Shell's Cultural Awareness Program addresses the following:

- Alaska Native Ethnic Composition
- Formation of regional corporations, and region within which Shell is working
- Brief history of land claims
- Comparison of cultural values of Alaskan Natives vs. non-Natives
- History of the North Slope
- Cultural diversity
- Patterns of language
- Communication skills and body language
- Guidelines on cultural artifacts
- Local community values and customs
- Whaling

Shell's Environmental Awareness Program addresses the following:

- Endangered Species Act (ESA)
- Endangered and threatened species
- Sensitive Habitats on the North Slope
- Marine mammal interactions
- MMPA of 1972
- Wildlife interactions
- Prohibited activities of hunting, trapping, and fishing
- Environmental requirements for air, spills, and waste
- Environmental training
- Conflict Avoidance Agreements

Stipulation No. 3 - Transportation of Hydrocarbons

This stipulation is not applicable to the activities described in the EP.

Stipulation No. 4 - Industry Site-Specific Bowhead Whale Monitoring Program

Lessees proposing to conduct exploratory drilling operations, including seismic surveys, during the bowhead whale migration would be required to conduct a site-specific monitoring program approved by the RS/FO; unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with the North Slope Borough (NSB) and the Alaska Eskimo Whaling Commission (AEWC), determine that a monitoring program is not necessary. The RS/FO would provide the NSB, AEWC, and the State of Alaska a minimum of 30 but no longer than 60 calendar days to review and comment on a proposed monitoring program prior to approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced.

Shell Actions: Shell submitted a copy of their 4MP, which is also included in Shell's application for an IHA (Shell, 2011a: Appendix D and Appendix C, respectively). Shell's 4MP is a combination of active monitoring of the project area and the implementation of mitigation measures designed to minimize project impacts to marine resources. The 4MP describes a site-specific bowhead whale monitoring program. The BOEMRE has determined that the level and scope of the monitoring program would enable Shell to assess when bowhead whales are present in the vicinity of the proposed lease operations and the extent of behavioral effects on bowhead whales because of the operations. A summary of key components of the 4MP is presented below.

Marine Mammal Observers: The presence of MMOs onboard all vessels would be a core component of compliance with the 4MP. The drillship, ice-management vessels, and all other support vessels would have MMOs on duty during drilling operations to monitor for marine mammals and to advise on mitigation measures. All support vessels would have MMOs on duty during transit and other related activities. If marine mammals are observed within or about to enter specific safety radii around the proposed drilling operation, mitigation would be initiated by vessel-based MMOs. The MMOs would be responsible for collecting basic data on observations of marine mammals and birds and for advising on appropriate mitigation measures. Observations made by MMOs serve as the primary basis for estimation of impacts to marine mammals and birds.

Aerial Monitoring Program: The main goal of the aerial monitoring program is to monitor marine mammal populations and movements in support of the vessel-based 4MP during the drilling program. Aerial monitoring, designed primarily for detecting cetaceans, would be used to identify any large-scale distributional changes of cetaceans relative to the activities and add to the existing database on the abundance and distribution of observed species.

Passive Acoustic Program: The acoustic program would characterize the sounds produced by the drilling activities and support vessels, and document the potential reactions of marine mammals in the project area, particularly bowhead whales, to those sounds and activities. A combination of acoustic recorder technologies would be used to document the overall distribution of marine mammals in the project area; the distribution of marine mammals in relation to drilling activities; to add clarity to drilling sound levels, character, and propagation; and to document presence of marine mammals. This would be accomplished by deploying several acoustic recorder buoys in a wide area surrounding the planned drill sites.

Sound Modeling: Sound modeling is required for the proposed activities. Shell's sound modeling is summarized in Shell's IHA and LOA applications (Shell, 2011a: Appendixes C and E, respectively) where the size of the 180 and 190 dB re 1 μPa (rms) safety radii were modeled. These radii would be used to initiate mitigation during initial drilling activities, at which time an acoustics contractor would measure underwater sound propagation from the drilling activities to empirically determine the size of safety radii (see Sound Source Verification below). Additional modeling using field data would be done during the drilling season. The sound data would enable Shell to refine sound-level thresholds and use the thresholds to more accurately define marine mammal take estimates.

Sound Source Verification: Field measurement of the sound-propagation profiles of the drillship and support vessels would be conducted during operations.

Stipulation No. 5 - Plan of Cooperation

Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities (including, but not limited to, bowhead whale subsistence hunting). Prior to submitting an exploration plan or development and production plan (including associated oil-spill contingency plans) to BOEMRE for activities proposed during the bowhead whale migration period, the lessee shall consult with the directly affected subsistence communities, Barrow, Kaktovik, or Nuiqsut, the NSB, and the AEWC to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts. Through this consultation, the lessee shall make every reasonable *effort, including such mechanisms as a conflict avoidance agreement, to assure that exploration, development, and production activities are compatible with whaling and other subsistence hunting activities and would not result in unreasonable interference with subsistence harvests.*

Shell Actions: Lease Stipulation 5 requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas activities and subsistence resources and subsistence hunting activities of the residents of the North Slope. Specifically, Lease Stipulation 5 requires the operator to consult directly with potentially affected North Slope subsistence communities, the NSB, and the AEWC. Consultation is "to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts." Lease Stipulation 5 requires the operator to document its contacts and the substance of its communications with subsistence stakeholder groups during the operator's consultation process. The requirements of Lease Stipulation 5 parallel requirements for incidental take authorizations from FWS and NMFS under MMPA at 50 CFR 216.104(a)(12).

Shell's Plan of Cooperation Addendum (POC) (Shell, 2011a: Appendix H) identifies the measures Shell has developed and would implement during its proposed exploration drilling program to minimize any adverse effects on the availability of marine mammals for subsistence uses. The POC addendum details Shell's communications and consultations with local communities concerning its proposed exploration drilling program, potential conflicts with subsistence activities, and means of resolving any such conflicts. Summaries of the substance of Shell's communications, and responses thereto, are included in the POC. A summary of Shell's POC meetings is provided below. Table 4.2-1 of the POC provides a list of public meetings attended by Shell as it developed the POC (Shell, 2011a: Appendix H). Attachment B of the POC provides tables summarizing the feedback at each meeting, Shell's responses to the feedback, and any mitigation measures developed using information received during the meetings (Shell, 2011a: Appendix H). Attachment B of the POC also includes copies of the sign-in sheets from the meetings and the presentation materials used at the meetings (Shell, 2011a: Appendix H). The BOEMRE concludes that methods of proposed operations, safeguards and mitigation measures detailed in the POC and EP meet the requirements of Stipulation 5 (Lease Sales 195 and 202). The mitigation measures in the POC would be requirements of plan approval and are assumed to be part of the proposed activities for the analysis in this EA.

In preparation for its revised Camden Bay exploration drilling program, Shell engaged in an active consultation program with both Federal and State regulatory agencies, as well as local governments and interested residents of the NSB communities. Consistent with Shell's obligations under Lease Stipulation 5, as well as the requirements of the FWS and NMFS under MMPA, Shell has communicated and consulted extensively with North Slope subsistence groups and their representatives and has committed to continuing to build on these relationships.

Affected and subsistence communities that were consulted regarding Shell's proposed activities include Barrow, Kaktovik, and Nuiqsut. Beginning in January 2011, Shell held one-on-one meetings with representatives from the NSB and Northwest Arctic Borough (NWAB), subsistence-user group leadership, and Village Whaling Captain Association representatives. Several one-on-one meetings were also held throughout the villages.

Stipulation No. 6 - Pre-Booming Requirements for Fuel Transfers

Fuel transfers (excluding gasoline transfers) of 100 barrels or more occurring 3 weeks prior to or during the bowhead whale migration would require pre-booming of the fuel barge(s). The fuel barge must be surrounded by an oil-spill-containment boom during the entire transfer operation to help reduce any adverse effects from a fuel spill. This stipulation is applicable to the blocks and migration times listed in the stipulation on Industry Site-Specific Bowhead Whale-Monitoring. The lessee's oil-spill-contingency plans must include procedures for the pre-transfer booming of the fuel barge(s).

Shell Actions: Shell's fuel-transfer plan – Alaska Fuel Transfer Operating Conditions and Procedures – is included as in the 2011 Camden Bay EP (Shell, 2011a: Section 9.0 and Appendix M). The fuel-transfer plan establishes special operating conditions and procedures for vessel-to-vessel fuel transfers. The fuel-transfer plan affirms that booming equipment would be deployed for all fuel oil transfers. Shell's fuel-transfer plan does not fully comply with the requirement of the lease stipulation to surround the fuel barge. The U.S. Coast Guard previously expressed concerns about the appropriateness and safety of encircling the fuel barge or vessel, as required by Lease Stipulation 6. As a condition of approval of the initial exploration plan (Shell, 2009), Shell would be required to either modify their fuel-transfer plan to comply with the stipulation or provide justification of how their proposed alternative configuration would provide an equivalent level of response preparedness (Shell, 2011a, Section 11).

Stipulation No. 7 - Lighting of Lease Structures to Minimize Effects to Spectacled and Steller's Eiders

In accordance with the Biological Opinion for the Beaufort Sea Lease Sale 186 issued by the Fish and Wildlife Service (FWS) on October 22, 2002, and FWS' subsequent amendment of the Incidental Take Statement on September 21, 2004, lessees must adhere to lighting requirements for all exploration or delineation structures so as to minimize the likelihood that migrating spectacled or Steller's eiders would strike these structures. Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration/delineation structures to minimize the likelihood that spectacled or Steller's eiders would strike those structures. These requirements establish a coordinated process for a performance based objective rather than pre-determined prescriptive requirements. The performance based objective is to minimize the radiation of light outward from exploration/delineation structures.

Shell Actions: Lighted vessels and structures in open-waters pose a collision risk to many species of birds. Growing scientific evidence indicates some bird species are attracted to light sources, which may increase the risk of bird strikes. Most related studies conclude that increased darkness coupled with inclement weather increases attraction by birds to lighted vessels and structures. Birds drawn to light often become disoriented and collide with these structures, which may result in injury and death.

Shell's Bird Strike Avoidance and Lighting Plan, Camden Bay, Alaska (lighting plan) (Shell, 2011a: Appendix I) outlines Shell's bird strike avoidance strategy for drilling operations near Camden Bay for 2011. Emphasis is on the prevention of bird strikes into the drillship by threatened spectacled eiders (*Somateria fischeri*) and Steller's eiders (*Polysticta stelleri*). The chances of bird strikes to the drillship are considered to be low. This low probability of bird strikes would be reduced further by Shell's implementation of the lighting modifications as specified in their lighting plan. In addition, if a bird strike is observed, reporting the bird strike and the conditions under which it occurred would help in better understanding the risks of bird strikes associated with the drillship.

2.3.12. Other Mitigation

Some of the additional mitigation measures Shell has adopted and would implement during its exploration drilling operations are presented below. Shell first presented their planned mitigation measures to community leaders and subsistence users in January 2009 and Shell states that the measures have since evolved in response to comments and concerns expressed during the consultation process.

Protection of Subsistence Activities. To minimize any cultural or resource impacts to subsistence whaling activities from its exploration operations, exploration drilling activities at the Sivulliq or Torpedo drill sites are planned to begin on or about July 10 and run through October 31, with a suspension of all operations beginning August 25 for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. During the suspension for the whale harvests, the *Kulluk* or *Discoverer* and support vessels will leave the Camden Bay project area and move to an area north of 71.25°N latitude and west of 146.4° W longitude as mutually agreed upon between Shell and AEWC. Should the drilling vessel or support vessels anchor during the suspension, none will anchor in known environmentally, or archaeologically sensitive areas. Shell will return to resume activities after the subsistence bowhead whale hunts conclude. Exploration drilling activities will be completed by October 31, depending on ice and weather.

In addition to the adoption of this suspension measure, Shell would implement the following additional mitigation measures to ensure coordination of its activities with local subsistence users to minimize further the risk of impacting marine mammals and interfering with the subsistence hunt:

- To minimize impacts to marine mammals, birds, and subsistence activities, the drilling vessel and support vessels will transit north through the Bering Strait on or after July 1. The drilling vessel and support fleet will transit through the Chukchi Sea along a route that lies offshore of the polynya zone. In the event the transit outside of the polynya zone results in Shell having to break ice (as opposed to managing ice by pushing it out of the way), the drilling vessel and support vessels will enter into the polynya zone far enough so that ice breaking is not necessary. If it is necessary to move into the polynya zone, Shell will notify the local communities, via the Com Centers, of the change in the transit route. As soon as the fleet transits past the ice, it will exit the polynya zone and continue a path in the open sea toward the Camden Bay drill sites.
- 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 and Beaufort Seas during Shell's proposed exploration drilling activities.
- Shell will employ local Subsistence Advisors (SA) from the Beaufort and 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 SA per village, working approximately 8-hrs per day and 40-hrs per week during the drilling seasons. The SA will use local knowledge (Traditional Knowledge) to gather data on subsistence lifestyle within the community and to advise Shell in ways to minimize and mitigate potential negative impacts to subsistence resources during the 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. Shell will provide the SA's with a handbook that will specify work tasks in more detail.
- Aircraft will 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. Aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft (457 m) in areas of active whaling; such areas will be identified through communications with the Com Centers.
- Except for airplanes engaged in marine mammal monitoring, aircraft shall use a flight path that keeps the aircraft at least 5 mi (8 km) inland until the aircraft is south of its offshore destination, then at that point it shall fly directly north through the Mary Sachs Entrance (Mary Sachs Entrance is the name of a channel between barrier islands, located south of the drill site area) to its destination. Shell reserves the right to use an alternative flight route in the event that transit through the Mary Sachs Entrance is unsafe due to weather, other environmental conditions, or in the event of an emergency.

Protection of Marine Mammals and other Wildlife. Marine mammal mitigation measures would use MMOs to minimize disturbance to marine mammal resources and interference with the subsistence hunt of those resources. The MMOs would be stationed on all drilling and support vessels to monitor the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals. The MMOs would initiate mitigation measures when appropriate. The MMOs would visually survey inside the exclusion zone (area within isopleths of specific sound level for different species) and operational zones (areas of prescribed proximity that may require avoidance measures for marine mammals). For vessels in transit, if a marine mammal is sighted from a vessel within its acoustic or operational safety radii, the Shell vessel would take appropriate mitigation measures, which may include reducing speed, changing course to avoid the animals, avoiding multiple course changes, avoiding separating members from a group, or minimizing vessel activities. Specifically, moving vessels would avoid polar bears, walrus, and groups of whales by a distance of 1,500 ft (457 m), and would reduce speed if within 900 ft (274 m) of other marine mammals. Full activity would not be resumed until all marine mammals are outside of the exclusion zone and there are no other marine mammals likely to enter the exclusion zone. The complete MMO protocol is included in the 4MP (Shell, 2011a: Appendix D).

Shell's Aerial Survey Program, described in the 4MP, would enhance the monitoring of onboard MMOs and acoustic monitoring. Aerial surveys would begin 5-7 days prior to field operations and continue 5-7 days after operations at a site are complete. Aerial surveys would occur daily during operations, subject to weather and flight conditions, and follow predetermined survey grids tailored for Shell's specific operations. Each survey flight would have two monitors seated at bubble windows (to facilitate downward viewing) on either side of the aircraft. Aerial monitors would be in real-time communication with operating vessels. Aerial monitors would advise vessels of the presence of marine mammals in the project area and collect data on the distribution, numbers, and movements of marine mammals near the drilling vessel and support vessels.

Anchored vessels would remain at anchor and continue ongoing operations if approached by a marine mammal. The anchored vessel would remain in place and continue ongoing operations to avoid possibly causing avoidance behavior by suddenly changing sound energy conditions.

While onsite, the drillship would remain at anchor and continue ongoing operations if approached by a marine mammal (i.e., no predetermined "real-time" mitigation would be implemented for anchored vessels). Modeled sound radii indicate that the drillship activities would generate a 120 dB re 1 μPa at 13.27 km from the *Kulluk* and 3.32 km from the *Discoverer* (Shell, 2011a: Table 10.b-1, page 10-4). The NMFS uses a 120-dB rms isopleth to indicate where Level B harassment begins for continuous acoustic sources, such as drillships.

Aerial monitors would record data on observable effects, if any, to migrating whales (e.g., the distance between the operations and the whale(s)).

Shell provided a plan to ensure that potential threats are adequately addressed regarding polar bears and Pacific walrus (Shell, 2011a: Appendix E).

In addition, Shell would implement the following measures to further minimize disturbance to marine mammals (Shell, 2011a : Section 12; Shell, 2011b, Section 2.11 and Section 4.3.3):

- A marine mammal monitoring protocol;
- Aircraft will not operate within 1,000 ft (300 m) of marine mammals;
- Aircraft and vessels would not operate within 0.5 mi (800 m) of walrus, or polar bears when observed on land or ice;
- All vessels must maintain cruising speed not to exceed 9 knots while transiting the Beaufort Sea. This measure would reduce the risk of ship-whale collisions.
- Vessel speed to be reduced during inclement weather conditions to avoid collisions with marine mammals;
- All vessel transit routes will avoid known fragile ecosystems and critical habitat areas, including the Ledyard Bay Critical Habitat Unit, and will include coordination through Com Centers.
- When within 900 ft (274 m) of marine mammals, vessels will reduce speed, avoid separating member from a group and avoid multiple course changes.

- A polar bear culvert trap would be established for oil-spill response needs near Point Thompson or Kaktovik prior to drilling.
- Airguns will be ramped up slowly during Vertical Seismic Profiling 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 MMOs 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; and
- Lighting on the drilling vessel will use ClearSky lighting and would be shaded. ClearSky lighting is designed to minimize the disorientation and attraction of birds to the lighted drilling vessel to reduce the possibility of a bird collision (see the Bird Strike Avoidance and Lighting Plan in Appendix I of the revised Camden Bay EP).

Reduced Discharge

- Shell will collect (not-discharge) used drilling mud and cuttings-with-adhered-drilling mud from well sections below the 26-in. (20-in. casing) hole section. Sanitary waste water, domestic wastes, bilge water and ballast water will also be collected (not discharged). These waste streams will be transported out of the Arctic to an approved disposal facility.
- Drilling mud will be cooled to mitigate any potential permafrost thawing or thermal dissociation of any methane hydrates encountered during drilling, if such materials are present at the drill site.
- Drilling muds will be recycled to the extent practicable based on operational considerations (e.g., whether mud properties have deteriorated to the point where they cannot be used further) so that the volume of the spent mud is reduced.

Pollution Prevention Measures. In addition to the maintenance and implementation of its ODPCP, Shell would implement the following additional measures to further minimize the chance of an oil spill that might impact marine mammals and interfere with the subsistence hunt:

- Shell has established and would follow transit routes that avoid known fragile ecosystems and critical habitat areas to reduce the possibility of impacting those resources in the unlikely event of a vessel accident that resulted in a diesel spill.
- Shell has developed and would implement an Ice Management Plan (IMP) (Shell, 2011a: Section 9.0 and Appendix K) to ensure real-time ice and weather forecasting to identify conditions that might put operations at risk and modify its activities accordingly. The IMP also contains ice-threat classification levels depending on the time available to suspend drilling operations, secure the well, and escape from advancing hazardous ice.
- Shell has developed and would implement a Critical Operations and Curtailment Plan (COCP) (Shell, 2011a: Section 9.0 and Appendix J), which establishes protocols to be followed in the event potential hazards, including ice, are identified in the vicinity of the drilling operations (e.g., ice floes, inclement weather, etc.). Like the IMP, the COCP threat classifications are based on the time available to prepare the well and escape the location. The COCP also contains provisions for not initiating certain critical operations, if there is insufficient time available before the arrival of the hazard at the drill site.

- Shell has engineered each of its exploration wells (hole sizing, mud program, casing design, casing cementing depth, wellhead equipment, etc.) specifically to minimize the risk of uncontrolled flows from the wellbore due to casing or other equipment failures.
- Shell requires its drilling supervisors, toolpushers, drillers, and assistant drillers to hold an International Association of Drilling Contractors (IADC) WellCap (or equivalent) certificate showing mastery of well-control procedures and principles, and its crews must participate in regular training and drills in kick control to minimize the risk of a well-control event that might lead to a spill.
- Shell would use state-of-the-art automatic kick-detection equipment, including pit-volume totalizers, a flow detector, and various gas detectors placed about the rig, to provide early warning of a potential well-control event.
- The blowout preventer Shell would install on the high-pressure wellhead housing on the 20-in conductor casing on each exploration well includes redundant mechanical barriers to provide multiple means of closing in the well to prevent oil flow to the surface.
- Shell would install multiple barriers, including manual and automated valves, on the drilling rig to prevent flows from coming up the drill string.
- Shell has developed and would implement a Well Control Contingency Plan (WCCP) (Shell, 2011a: Section 9.0 and Appendix L) in the extremely unlikely event of a well-control event to minimize the risk of oil coming in contact with the water. As part of the WCCP, Shell would prepare a Relief Well Drilling Plan for each location in advance of spudding the well to ensure that a relief well can be started quickly to kill the well.
- Shell has developed and would implement a Fuel Transfer Plan (FTP) (Shell, 2011a: Section 9.0 and Appendix M), which requires, among other things, the deployment of containment boom prior to any refueling operation.
- Shell would station and maintain its OSRVs in the immediate vicinity of its drilling operations to ensure timely response to any spill event.
- In addition to the OSR fleet, capping stack equipment will be available for use in the unlikely event of a blowout. The capping stack system will be carried as equipment on an ice management vessel and the containment barge will be located in the Beaufort Sea where it can respond as required as discussed in Section 5.5.2.
- Capping Stack equipment will be stored aboard one of the ice management vessels and will be available for immediate deployment 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 to the well to affect a seal capable of withstanding the maximum anticipated wellhead pressure (MAWP) and closing the assembly to completely seal the well against further flows (commonly called "capping and killing")
  - Attaching a device or series of devices to the well and diverting flow to surface vessel(s) equipped for separation and disposal of hydrocarbons (commonly called "capping and diverting")

2.3.13. Environmental Monitoring

In addition to monitoring of marine mammals, a comprehensive environmental monitoring program will be implemented during exploration drilling operations (Shell, 2011a: Section 10). A dedicated science vessel staffed by a team of physical and biological oceanographers will be responsible for assessing pre-drilling, during, and post drilling conditions in both biota and water and sediment quality. All drilling locations have been sampled at multiple times during the last three years to provide a baseline understanding of pre-existing conditions and interannual variability at these sites.

Meteorological and physical oceanographic characteristics that will be monitored continuously at each location throughout the drilling process include: surface wind direction and speed, ambient air temperature, current speed and direction throughout the water column, water temperature through the water column and salinity through the water column.

Water chemistry and characteristics that will be monitored will include assessment of metals and organics through the water column at multiple fixed and random locations around the drilling operation. These measurements will be made regularly before, during, and after drilling and will capture conditions during all noteworthy phases of drilling operations and potential discharge. Physical characteristics of the water column will also be assessed including turbidity, temperature, and oxygen content in an effort to document and model plumes of released discharges.

Biological observations will include assessments of benthos, epibenthos, zooplankton and phytoplankton, and fishes. In addition to characterization of the communities of these organisms at and near the drillsites before, during, and after operations, samples of biota will be collected before and after operations for tissue analysis for metals and organics.

Bird and mammal observations will be made from all surface operation vessels throughout the exploration drilling activity in accordance with the 4MP and Bird Strike Lighting and Avoidance Plan (Shell, 2011a: Appendix I).

3.0 AFFECTED ENVIRONMENT

Introduction

The following sections summarize environmental conditions and resources in areas that could be affected by the Proposed Action and No Action alternative. The summaries are focused on aspects of resources that are relevant to an analysis of potential effects from the Proposed Action and alternatives. Information relevant to the analysis of potential effects that has become available subsequent to the 2009 Camden Bay EA is indicated and summarized. A detailed discussion of the marine, coastal, and human environment of the Beaufort Sea planning area is contained in the lease sale NEPA documents listed in Section 1.2 which are incorporated by reference into this EA.

3.1. Meteorology

3.1.1. Climate Change

Climate describes the behavior pattern of weather in a particular region, or globally, over a long period of time, usually exceeding 30 years, whereas weather describes the changing conditions at smaller defined locations over a short period of time, minutes to months. Generally, climate is what to expect and weather is what happens; and meteorology is the underlying science that studies the physics, chemistry, and dynamics of both. Meteorological studies that investigate weather and climate are ongoing, particularly with respect to the factors that drive climate change, which in the Arctic include the movement of heat, water, pollutants, and salinity into the region through atmospheric and oceanic circulation. Also ongoing are the expansion and further development of the current suite of computer models that simulate impacts from climate change. While not every contributing factor is well-represented in the current models, the existing suite of models used to simulate climate change in the Arctic is able to represent some aspects fairly well (Clow et al., 2011).

While climate is considered long-term average weather, there are mechanisms that cause repeated, and predictable, short term systematic changes, such as El Niño and La Niña. These two mechanisms occur every two to seven years and directly involve the tropical Pacific but have a global impact. Conversely, a long time-scale climate mechanism is associated with the high latitudes of the Arctic, referred to as the Arctic Oscillation (AO). Occurring every 10 to 30 years, the AO is characterized by changes in the severity of winter weather and the frequency of storms. Fluctuating between positive and negative phases, the AO phase defines the location of pressure systems that drive weather systems. In the positive phase, there is higher pressure at the middle latitudes while lower pressure rests over the Arctic. This phase steers storms farther north and brings wet and warmer weather to Alaska. In the negative phase the situation is reversed. There is higher-than-normal pressure over the Arctic and lower-than-normal pressure in the middle latitudes causing cold air to plunge into the middle United States. Thus, the climate in the Arctic 'oscillates' between the positive and negative phases, and is currently in the negative phase of Arctic warming (Vincent and Renwick, 2011).

Research focusing on future atmospheric circulations suggests the 21st century will bring a change in the distribution of winter storms in the Arctic. Some studies indicate winter weather in the Arctic, usually driven by the semi-permanent Aleutian low pressure center, might track further north to the west coast of Alaska with increasing frequency; this could cause an increase in the frequency of storms, particularly in the winter (Chapman and Walsh, 2007). Other studies suggest there is no general agreement that the number and/or intensity of Northern Hemisphere storms have changed over the past decades (Bader et al., 2011). In any case, the exploration operations proposed by Shell for the Beaufort Sea would occur in the summer through the end of October. Therefore, while the anticipated frequency and intensity of winter storms in the Beaufort and Chukchi seas remains debatable (Clow et al., 2011), an increase in frequency or intensity of winter storms over the short-term period of exploration would not impact the Proposed Action.

Along with the changes in atmospheric circulation, adjustments in oceanic circulation are causing an increase in the loss of sea ice in the Arctic. The loss of sea-ice could increase the presence of internal waves bringing deep waters to the surface, which are rich in nutrients. Consequently, there may be effects to habitat and other natural resources that could change the distribution and abundance of particular species. These conditions could shift migration routes or affect food sources of species or species groups. Storm surges may produce changes in the dynamics of rivers and deltas affecting habitat and some populations of fish species (Weller, 1998). Further, the loss of sea-ice could increase wave action that would contribute to degradation of the coastline of the Beaufort Sea. The likelihood of permafrost degradation is a concern and is expected to continue for decades (Clow et al., 2011). However, permafrost degradation along the coast will continue with or without OCS exploration projects. No permanent onshore infrastructure vulnerable to permafrost degradation would be developed during exploration operations.

The extent of sea-ice cover over time affects current prevailing atmospheric conditions by changing the exchange of heat, momentum, and moisture. Thus, the decrease in sea-ice cover would increase the availability of water vapor in the precipitation process (Bader, et al., 2011). Combined with the possible change in track of the Aleutian low pressure center to a more northerly location, the increase in water vapor available above the ocean surface could cause an increase in the amount of precipitation over the Arctic. However, there has been no prediction in the magnitude of the increase, which would reduce the salinity of the upper portion of the ocean (Clow et al., 2011).

A thorough scientific examination of climate change in the Arctic is provided by the Intergovernmental Panel on Climate Change (IPCC, 2007a) 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 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) . While some aspects of the Arctic climate that drive the changes are not yet represented in the current simulation models, the existing suite of models used to simulate climate change in the Arctic is able to represent other aspects fairly well (USGS, 2011). The BOEMRE is actively engaged in updating general circulation models for use in OCS decision making. A recent workshop on OSRA Hindcast specifically addressed these uncertainties in modeling with general circulation models and provided recommendations for BOEMRE to consider. There is a potential for climate change impacts to natural resources, and those impacts are considered in the individual evaluations provided in Section 4.0, Environmental Consequences, where relevant.

3.1.2. Expected Weather Conditions at the Drill Sites

The annual prevailing winds along the northern Alaska coastline of the Beaufort Sea vary somewhat by season and flow predominately from the east most of the year, turning west in December and January (WRCC, 2011). Average wind speeds throughout the year are less than 15 miles per hour (mph) with lower wind speeds in the summer than in winter. A multiyear meteorological study that includes data from stations along the coastline at Barter Island, Kaktovik, Deadhorse, and Nuiqsut provides a trend for wind patterns on the North Slope that are influenced by the Brooks Range (Veltkamp and Wilcox, 2007). The study shows that the regardless of whether the winds are from the east or west, the flow over the eastern portion of the Beaufort Sea coastline is influenced by the orographic effects of the Brooks Range, and can effect wind direction as far as 30 miles offshore along the area extending from Camden Bay to Mackenzie Bay. The influence of the Brooks Range causes wind to flow roughly parallel to the north side of the range in a general northeast to southwest orientation. While the incidence of wind channeling is strongest on the eastern coastline near Barter Island, orographic influence of the range is present all along the coast. Influence from the mountain range decreases to the west and shows little influence at Barrow where wind direction is influenced largely by surface pressure systems rather than any orographic feature.

With little warning, occasional sudden storms can occur in the Alaskan Beaufort Sea where the lack of natural wind barriers results in unrestricted winds. These storms bring cold temperatures and occur most frequently between September and November. Consequently, strong storms may occur around the close of the drilling season proposed in the EP. The storms can produce gale-force winds up to 46 mph and hurricane strength winds (greater than 74 mph) have been recorded in the region (Veltkamp and Wilcox, 2007). The combined effect of high winds during storms and cold temperatures makes the North Slope of Alaska a risk to persons exposed for even brief periods of time. Frostbite can occur following less than five minutes of exposure when the wind chill drops as low as minus 90 degrees Fahrenheit (deg. F) during these storms (NWS, 2009). In gale-force wind conditions, the sea begins to roll, spray reduces visibility, and waves can be as high as 20 feet (NWS, 2008).

On average, semi-permanent low pressure systems produce summer storms that bring more than half of the annual five inches of total precipitation to the North Slope (Ahrens, 2009). Most of the rainfall occurs from June until October, during the proposed drilling season for the EP. The relative humidity during the summer is usually around 85%. Average minimum temperatures stay above freezing from May until October, which would be true throughout the drilling season proposed in the EP. The highest average temperatures occur in the summer months of June through August when the greatest amount of precipitation occurs. Average temperatures in the summer average around 38 deg. F and by winter, temperatures are bitterly cold averaging around minus 11° F (Veltkamp and Wilcox, 2007). When considering the average wind speeds and temperatures common to the North Slope, wind chills will likely be around minus 10° F by late September (WRCC, 2011; NWS, 2001).

3.1.3. Expected Ice Conditions at the Drill Sites

The sea-ice descriptions in Sale 193 Revised SEIS (USDOI, BOEMRE, 2011), Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008), and the 2011 Camden Bay EIA (Shell, 2011b) are incorporated by reference and salient points are summarized as follows. There are three general forms of sea ice in the project area: (1) landfast ice, which is attached to the shore, is relatively immobile, and extends variable distances offshore; (2) stamukhi ice, which is grounded and ridged ice; and (3) pack ice, which includes first-year and multiyear ice, which moves under the influence of winds and currents. The proposed drill sites are seaward of the typical extent of landfast ice during the time of operations (Wendler, G., M. Shulski, and B. Moore, 2010). Stamukhi ice is not anticipated in the project area at the time of operations. Pack ice could move into the project area during the time of operations due to wind or currents. Freeze-up analysis in 2009 and 2010 indicates initiation of freeze-up occurring in the later part of October (Coastal Frontiers Corp and Vaudrey andAssociates, Inc. 2010, Coastal Frontiers Corp. 2011). In 2008, 2009 and 2010, Shell deployed on-ice buoys near the project area (AES-RTS, 2009a, 2009b, 2011). While the overall trend of the buoy movement was to the northwest, the buoys recorded periods with little to no movement or movement back to the east or southeast.

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 decreasing in area and thickness (Figure 3) and is younger (Maslanik et al., 2011). Satellite data shows a decreasing trend of 2.7% per decade from 1979-2010 in March (Perovich et al., 2010) and an 11.5% per decade decrease for September (NSIDC, 2010), and the decline in sea-ice extent is increasing. The thickness of Beaufort sea ice is decreasing (Alfred Wegener Institute for Polar and Marine Research, 2011). The distribution of ice is changing, and its age is decreasing. The melt duration is increasing. These factors lead to a decreasing perennial arctic ice pack. Many scientists believe that the Arctic will become ice free in the summer, but at this time there is considerable uncertainty about when that would happen. (See also USDOI, BOEMRE, 2011: USDOI, MMS, 2003, 2004, 2006a, and 2008a).

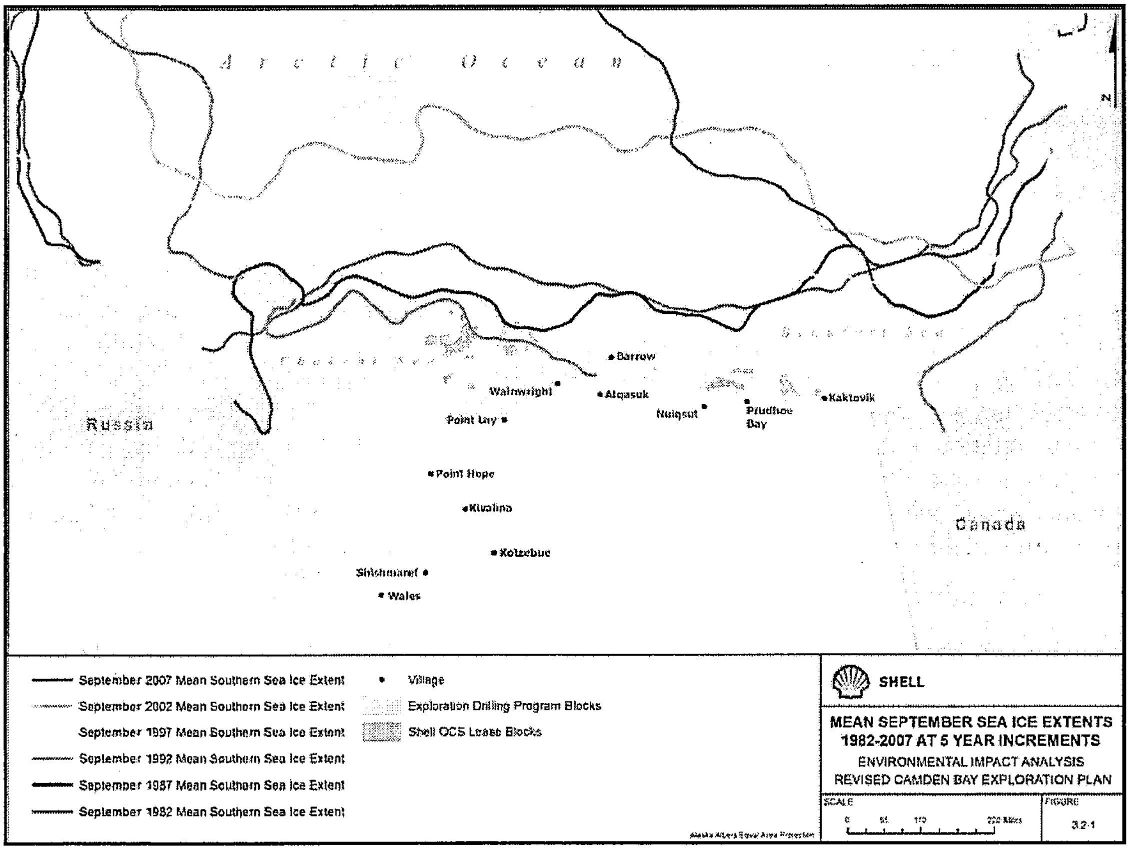

Figure 3 Mean September Sea Ice Extents 1982 to 2007 at 5-Year Increments (Shell, 2011a)

3.2. Potentially Affected Resources.

3.2.1. Air Quality.

Outside air becomes polluted and air quality conditions deteriorate when small particles, liquids, and potentially harmful gases are released into the atmosphere by a variety of sources. The emission sources may be natural or man-made, and may be stationary or mobile. Natural (biogenic) sources of air pollutants include, but are not limited to, volcanoes and forest fires that produce dust and smoke; sea salt aerosols; and vegetation that is a source of pollen and organic compounds during evaporation (EPA, 2010d). Man-made (anthropogenic) sources are related to human activities such as transportation (motor vehicles, aircraft, and marine vessels); industrial and residential heating; construction; and specifically any activity associated with the combustion of fossil fuels (EPA, 2010d). Stationary anthropogenic sources are fixed-site producers of emissions, which are primarily power-generating-plants requiring fuel combustion, and industrial processes, such as refineries, chemical manufacturing facilities, and smelting (EPA, 2010f). A drillship temporarily anchored to the seabed floor on the Outer Continental Shelf (OCS) is also considered a stationary source (40 CFR Part 55). All other anthropogenic sources are mobile and either move under onboard power or can be moved from place to place. Mobile sources account for more than half of all the air pollution in the United States, where the primary source is the automobile (EPA, 2010e). Other mobile sources include marine vessels, aircraft, equipment used for construction, agriculture, and recreation. Regardless of the type of emissions source, or whether sources are permanent or temporary, emissions can build up in the atmosphere in concentrations larger than what can be tolerated without humans suffering some sort of harm.

This section describes the existing air quality environment of the area likely to be affected by the Proposed Action described in the 2011 Camden Bay EP. The contents of this section provide an overview of the federal and state regulatory framework governing air quality relative to the operation and location of the Proposed Action. Also included is an examination of the existing condition of air quality in northern Alaska, particularly over the land areas of the North Slope adjacent to the Beaufort Sea. The comprehensive evaluation and analysis of air quality is provided in Appendix D, Air Quality. A summary of the weather conditions typical for the location of the Proposed Action is provided in Section 0.

Regulatory Overview. Elevated concentrations of air pollution in the ambient air, which is outside air where the general public has access, have been shown to cause harm to human health and the natural environment (EPA, 2010a). As such, federal and state air agencies are obliged to develop plans, regulations, and guidelines to protect ambient air as a natural resource (EPA, 2010b). The following sections explore the various regulatory provisions established to protect air quality, particularly in the area of the Proposed Action. A thorough review of all the rules, regulations, and guidelines that apply to an air quality assessment for an OCS exploration plan is provided in Appendix D, *Air Quality*.

Clean Air Act. The Clean Air Act, including the 1990 Amendments (CAA), is the comprehensive law giving the Environmental Protection Agency (EPA) authority to clean up areas of polluted air in the United States. Originating in 1963, the CAA is revised periodically to expand and refine programs to protect the nation's ambient air. Through these revisions, the CAA gives authority to the EPA to establish and maintain maximum limits defining healthful concentrations of pollutants in the ambient air, referred to as the National Ambient Air Quality Standards (NAAQS). The NAAQS include the six pollutants referred to as criteria pollutants, which are carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter, both coarse (PM_{10}) and fine ($PM_{2.5}$), lead (Pb), and ozone (O_3) (40 CFR Part 50). The State of Alaska adds ammonia (NH_3) and reduced sulfur compounds (RSC) to the listed regulated pollutants (18 AAC Part 50.010). The NAAQS are compared to actual monitored data, which discloses the average concentration of air pollutants over a period of time, such as an 8-hour average or annual average, at a specific geographical location. Geographical areas that are shown to meet the NAAQS are designated by the EPA as attainment areas. Areas that exceed the standards are designated nonattainment and are subject to rules that require additional analyses and a demonstration of compliance to the CAA. A complete description of the NAAQS and definitions for attainment and nonattainment areas are given in Appendix D, Air Quality.

The CAA establishes air permitting programs, specifically a program for the prevention of significant deterioration (PSD) for areas of the country already in compliance with the NAAQS (Martineau and Novello, 2004). These permits are usually required for federal actions proposed for the OCS, and there is a section of the CAA that is relevant specifically to federal actions proposed to occur on or above the OCS. Title III Section 328, Air Pollution from Outer Continental Shelf Activities (42 USC 7627) directs the EPA to establish requirements for the control of air pollution from sources on the OCS in order to maintain the NAAQS. Other operating and pre-construction permits may also be required, such as those required under CAA Title V.

Federal OCS Air Regulations. Pursuant to CAA Section 328, the EPA establishes requirements to control air pollution from sources on the OCS, including Alaska. The requirements are published in the Code of Federal Regulations (CFR), Title 40, Part 55, and are referred to as the federal OCS Air Regulations (40 CFR Part 55). The federal OCS Air Regulations make a distinction between OCS sources located within 25 miles of the State's three- mile seaward boundary and sources located beyond the 25- mile threshold. The federal OCS Air Regulations provide an outline of the federal air quality requirements that apply at an OCS source relative to the 25-mile threshold, and describes the operating permit requirements.

Alaska Air Quality Control Rules. Air quality management is regulated by the Alaska Department of Environmental Conservation (ADEC). The ADEC is responsible for the control of anthropogenic sources of emissions in all parts of Alaska, including permitting requirements and mitigating measures to conserve the clean air resources that are enjoyed in many locations in Alaska. These mitigation measures and controls are summarized in the Alaska State Air Quality Control Plan (AQCP) (ADEC, 2008). Those portions of the AQCP that address federal air quality control requirements are submitted for EPA approval and become part of the federally-required Alaska State Implementation Plan (SIP). In addition, the AQCP contains state requirements and control measures that are not necessarily required by the EPA and are not included in the SIP. The entire AQCP is adopted by reference into the Alaska Administrative Code (AAC) (18 AAC 50), making the SIP an enforceable plan that outlines how the state will achieve and maintain the established state and federal air quality standards.

Air Quality on the Alaskan North Slope. The 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). Sources of emission on the OCS that are within 25 miles (46.3 km) of the State's 3 mi (5.6 km) seaward boundary (a total of 28 mi (51.8 km)), are subject to the local requirements of the Corresponding Onshore Area (COA), which would be the onshore area that is geographically closest to the OCS source (40 CFR 55(3)(b)). The COA for the Proposed Action would be Alaska's North Slope, adjacent to the Beaufort Sea. The EPA has defined Alaska's North Slope 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 Part 81.246), and is designated as a Class II area (18 AAC Part 50.015). The EPA has classified the North Slope as a clean air resource (attainment) as pollutant concentrations in the area are well below the NAAQS and the Alaska Ambient Air Quality Standards (AAAQS) (EPA, 2011).

Attainment Status. The EPA reports that the pollutant concentrations within the North Slope Borough from the very few sources of emissions are far below the NAAQS throughout the AQCR9 due to dispersion caused by nearly constant wind and low precipitation over the area (Serreze and Barrett, 2011). The wind is also the long-range transport mechanism of anthropogenic pollution from sources on the Eurasian continent during the winter and early spring.

Existing Sources of Emissions on the North Slope. There are few industrial development areas on the North Slope to contribute to the budget of air emissions. The largest source of emissions is the Prudhoe Bay Oil Field, the largest oil field in North America. Prudhoe Bay is a large work camp for the oil and gas industry employing over 5,000 workers in drilling, pipeline operations, and cargo transportation. Most inhabitants of Prudhoe Bay are employees of companies supporting oil drilling or oil production, including Shell. A small petroleum refinery operates on-site to supply vehicle fuel for workers and equipment on the oil field. Operations on the site include flaring, which is the controlled burning of natural gas. Emissions from a flare stack are comprised mainly of water vapor and carbon dioxide. At the Prudhoe Bay site, flaring is used for power generation and to control equipment pressure. Natural gas is used to heat the buildings and to generate electricity. Numerous flights of medium-range jet aircraft operate at the nearby airport at Deadhorse to facilitate the workers' rotating schedules and for delivery of equipment and supplies; a state-owned heliport is located at Prudhoe Bay. Implementation of the proposed exploration plan would require Shell to use the existing onshore facilities and no new construction is planned. Therefore, there would be no expected increase in onshore emissions associated with the proposed exploration.

Arctic Haze. The ADEC reports the Arctic atmosphere becomes contaminated with anthropogenic pollution through long-range transport from Europe and Russia in the winter months. Meteorological studies support the suggestion that about 95% of the pollution is coming from Europe and Russia propelled by winds associated with the seasonal Siberian high-pressure system (Serreze and Barrett, 2011). The phenomena is referred to as Arctic haze, and consists of mostly sulfur oxides and soot, but includes both gaseous and aerosol components. The phenomenon usually begins in early winter and reaches a peak impact in March, after which time the haze dissipates. The haze particles are very lightweight, with a diameter usually in the range of 0.4-0.8 micrometers, so the particles may be suspended in the air for weeks, allowing light to scatter, which affects visibility. Based on haze composition and the source regions, the primary contributors to Arctic haze are coal burning and metal smelting. In the absence of Arctic haze, visibility in the area is greater than 160 Statute Miles (mi) (257 km). The EPA has determined the regional air quality over AQCR9 continues to be better than the NAAQS even with the seasonal occurrence of Arctic haze. Arctic haze would only be visible during the last stages of the Proposed Action, mostly likely in late October in the phenomena's initial stages, and is not expected to interfere with exploration operations.

3.2.2. Water Quality.

There is very little development in the watersheds of the U.S. Arctic and because of this nonpoint pollution runoff from watersheds into the Beaufort Sea is limited. The rivers, lakes and wetlands of the region carry naturally-occurring loads of sediment, trace metals and hydrocarbons into the Alaskan Beaufort Sea environment. The pathways of wind, currents, precipitation and drifting sea-ice affect the water quality of the Beaufort Sea through long-range transport of constituents and contaminants. Pollutants such as polycyclic aromatic hydrocarbons can be transported long distances and ultimately affect the U.S. arctic. The sources of these global contaminants include: airborne industrial pollutants, vessels, existing oil and gas operations, coastal development runoff and discharges. Pollution in the arctic is described in "Arctic Pollution Issues: A State of the Arctic Environmental Report" (Arctic Monitoring and Assessment Program, 1997) and is incorporated here by reference.

Beaufort Sea waters are influenced by mixing by wind and storms, spring river runoff, and sea ice formation and melt. Trefry and Trocine (2009) conducted vertical water column profiles at 8 stations in Camden Bay over 4 days in August 2008 (depths 22-38 m) to obtain discrete baseline data on temperature, salinity, pH, dissolved oxygen, turbidity, total suspended solids (TSS) and particulate organic carbon (POC). At the four more offshore, deeper sites (33-38m), strong temperature stratification was observed at depths greater than 20-25 m (6 °C at the surface, 0.3 °C below 25 m). Salinity at these four deeper sites also showed a marked change below 25 m, increasing from 27-28 ppt at the surface to 31-32 ppt below 25 m. At the four stations that were nearer to shore and more shallow (22-31 m), stratification was less strong, particularly for salinity. Lower water temperatures at these sites were generally measured below 25 m, however, the most shallow site (22 m) showed a relatively uniform vertical profile of 4 – 5 °C.

During the four days of sampling, concentrations of dissolved oxygen were at 89% to 104% saturation. pH ranged from 7.8 to 8.4. Turbidity was low and relatively similar across all samplings (1.8 to 3 NTU). Total suspended solids (TSS) ranged from 0.26 ± 0.13 mg/L (at 2 to 3m) and 0.73 ± 0.31 mg/L (10 to 25 m). Concentrations of particulate organic carbon (POC) averaged 26% (at 2 to 3 m layer) and 11% (at 10 to 25 m layer) of the TSS, indicating that the surface contained a relatively higher concentration of POC than deeper waters. Table 5 presents a summary of the range of measurements collected over all 8 stations.

Table 5 Water column measurements in Camden Bay, Alaska, over four days in August 2008 (after Trefry and Trocine, 2009)

Variable	Surface Water	Bottom Water (>20m)
Salinity (ppt)	25.3 to 29.2	29.7 to 31.7
Temperature (°C)	4.3 to 6.4	0.24 to 0.38
Turbidity (NTU)	1.8 to 2.6	2.0 to 3.0
pH	7.8 to 8.4	7.7 to 8.0
Dissolved Oxygen (mg/L)	9.5 to 10.4	11 to 12.2
Oxygen Saturation (%)	89 to 98	96 to 104
TSS (mg/L)	0.26 ± 0.13	0.73 ± 0.31
POC (mg/L)	0.066 ± 0.038	0.081 ± 0.0.025
POC as % of TSS	25.7 ± 6.4	10.0 ± 3.5

Water quality in the Beaufort Sea has been documented through many studies and regulatory programs over years. Specific to the proposed exploration sites, Trefry and Trocine (2009) found background (non-elevated) levels of total metals in surface and subsurface sediment samples in the immediate vicinity of the Sivulliq drill site; an exception was elevated concentrations of total barium in eight out of 42 sediment samples. The authors attributed these elevated barium measurements to past discharges of drilling mud and cuttings. Trefry and Trocine also found that total petroleum hydrocarbons and total polycyclic aromatic carbons were at background levels (non-elevated) at 45 of 46 sample locations in the area; the one exception was a sample taken near an earlier drill site.

Dunton et al. (2009) found that inorganic nitrogen in the water column in the Sivulliq area of Camden Bay was close to undetectable, but that ammonium in sediment pore-water was high, indicating active biogeochemical processes between the water column and pore water in the benthic sediments. They also found through isotope studies that carbon in the area is derived primarily from marine sources, not terrestrial sources. The water column production, they conclude, is coupled with the benthos, providing a strong feedback between the sediments and overlying water.

Ocean acidification in the marine environment is a concern in the Beaufort Sea. As carbon dioxide (CO_2) increases in the atmosphere, the ocean absorbs more CO_2. This increase in CO_2 in seawater forces an increase in hydrogen ion concentration and a lowering of pH over time. Decreasing pH changes the equilibrium of the inorganic carbon system in the sea by reducing the concentration of carbonate ions (CO_3^{-2}), an essential molecule for many organisms that produce structures of calcium carbonate ($CaCO_3$).

Seawater worldwide is normally alkaline; however, seawater is now acidifying and losing its buffering alkalinity, causing pH to decrease to levels exponentially below its historic global average of 8.1. The average pH of ocean water worldwide is predicted to continue to decrease in the future (Caldeira and Wickett, 2003, 2005). If carbon dioxide in the atmosphere continues to increase at today's rate, the rate of pH decrease towards the end of this century is predicted to be even greater than the current rate of pH decrease (IPCC, 2007a; Steinacher et al., 2009).

Other factors such as seawater temperature, the presence or absence of ice, the degree of freshwater input, the degree of mixing and increases in phytoplankton also affect the amount of CO_2 taken up by the sea. Therefore, other aspects of climate change, such as melting ice, increased riverine discharge, storm frequency and intensity, and changes in precipitation type, volume and timing also play into acidification of the ocean (IPCC, 2007a; Mathis, Cross and Bates, 2011).

The greatest degree of ocean acidification worldwide is predicted to occur in the Arctic Ocean. This amplified scenario in the Arctic is due to the effects of increased freshwater input from melting ice and snow and increased CO_2 uptake by the sea as a result of sea ice retreat (Steinacher et al, 2009). Measurements in the Canada Basin of the Arctic Ocean demonstrated that over 11 years, melting sea ice forced change in pH and the inorganic carbon equilibrium, resulting in decreased saturation of calcium carbonate in the seawater (Yamamoto-Kawai, 2009). Bates, Mathis and Cooper (2009) showed the effects of decreasing pH on the saturation states of inorganic carbonate in the Chukchi and Beaufort Sea.

Increasing ocean acidification is predicted to cause changes in ecosystem processes and present additional stressors to organisms (Fabry et al, 2008; Yamamoto-Kawai, 2009; Steinacher, 2009; Bates, Mathis, and Cooper, 2009). Decreased thickness of calcium carbonate structures has been shown, and in some cases, increased structure thickness has been demonstrated (Reis et al, 2009). Decreased pH can also affect other important physiological functions such as cell function in marine biota, some of which are important species in the Arctic (Fabry et al, 2008; Dupont et al, 2008).

Additional information on the water quality and water chemistry in the Beaufort Sea is presented in the following NEPA documents and is incorporated here by reference: Arctic Multiple-Sale Draft EIS USDOI, MMS, 2008a); and the 2009 Camden Bay EA (USDOI, MMS, 2009).

Existing Regulatory Control of Discharges. The principal regulatory method for controlling pollutant discharges into waters of the U.S. is the Clean Water Act (CWA) of 1972, as amended. Section 402 establishes the National Pollution Discharge Elimination System (NPDES). The General NPDES Permit issued by EPA for offshore oil and gas exploration facilities in Alaska (AKG280000) permits authorized discharges, with restrictions, into the Beaufort Sea. EPA regulations (40 CFR 125.122) require a determination that the permitted discharge will not cause unreasonable degradation of the marine environment. EPA issued an NPDES Vessel General Permit (VGP) for "Discharges Incidental to the Normal Operation of a Vessel;" the EPA VGP for Alaska was finalized in February, 2009 (EPA, 2009). The final VGP applies to owners and operators of non-recreational vessels that are 79 feet (24.08 meters) and greater in length, as well as to owners and operators of commercial vessels of less than 79 feet which discharge ballast water.

The latest information on water-quality standards for the EPA is available in 40 CFR § 131 or at the agency's internet web site at www.epa.gov. State of Alaska water quality standards are available in 18 AAC 70 or at the Alaska Department of Environmental Conservation website (ADEC, 2011).

3.2.3. Lower Trophic Levels

The lower trophic organisms living within the Beaufort Sea of the Alaska OCS consist of three diverse and abundant groups (Hopcroft et al., 2008). These are the pelagic, the epontic, and the benthic organisms. The components of the pelagic communities are made primarily of two groups living at the surface and near-surface levels, the phytoplankton and zooplankton. Phytoplankton are the one-celled algae adapted to living in the photic zone (the upper areas where light adequate for phytoplankton penetrates the water) in the upper layers of the ocean surface (Steidinger and Garcces, 2006). Within Arctic waters, the combination of cold temperature, sea ice, and seasonal fluctuations in light regimes creates variation in the timing and extent of seasonal blooms. Phytoplankton blooms (with concurrent zooplankton and meroplankton stocks) tend to occur in two separate events of early and late summer, generally from July to August, with density and duration dependent upon weather conditions and nutrient fluxes (Kirchman et al, 2009). Zooplankton consist of the metazoan, or multi-celled organisms including permanent residents of the planktonic mass such as copepods, and the animals exhibiting complex life cycles that include a developmental stage within the plankton blooms such as the larvae of fish, crustaceans, barnacles, polychaetes, and mollusks (Brusca and Brusca, 2002). The pelagic expanses between the surface and the benthic realms are diverse and abundant, and include the larvaceans, pteropods, ctenophores, jellyfish, salps, squid, and other invertebrate organisms that contribute to the productivity of the region (Hopcroft et al., 2008).

The epontic organisms are the ice-dwellers, organisms that live on or in the matrix of the ice during the winter season (Gradinger, Bluhm, and Iken, 2010). Essential in the primary productivity of the region (Lee et al., 2008) these organisms include the ice algae, amphipods, nematodes, polychaetes, and euphausiids (Hopcroft et al., 2008). Although essential to the primary productivity of the region, these organisms are not present in abundance during the July through October exploration activities described in the 2011 Camden Bay EP.

The final group are the benthic organisms, consisting of both those groups living within the upper sedimentary matrix (infaunal organisms) and those living on or just above the benthic surface, or strongly associated with the benthic surface (epifaunal organisms). Offshore benthic communities can be quite diverse, but organisms commonly found in surveys include echinoderms, sipunculids, mollusks, polychaetes, copepods, and amphipods (Dunton, Schonberg, and McTigue, 2009; Rand and Logerwell, 2011). Most seafloor substrates on the Beaufort Sea OCS consist of aggregations of fine sands, muds, and silts, with percentages of substrate consisting of mud ranging from 17% to 84% (cANIMIDA, 2010; Trefry and Trocine, 2009). Limited extents of scattered cobblestone or pebbles are found at shallower depths (Dunton, Schonberg, and McTigue, 2009). Historically, ice gouging in the area of the proposed site has had effects to depths of up to 8.2 ft (2.5 m) (Gradinger and Bluhm, 2005) above the projected 41 ft (12.5 m) depth of the MLC. A focus on differences in communities based on physical factors is addressed in the BOEMRE-sponsored cANIMIDA studies on hydrocarbon chemistry and substrate composition (cANIMIDA, 2010), the Beaufort Sea Multiple-Sale EIS, and the 2006 Final Seismic PEA. No known unique geological surface features, key reproductive sites, or unique biological communities exist at the proposed drill sites.

3.2.4. Fish and Essential Fish Habitat.

3.2.4.1. Fish

Spring melt and river runoff greatly influence the characteristics of the inshore and nearshore Beaufort Sea. This freshwater influx sets up a band (2-10 km) of brackish waters along the coast that then breaks down in later summer due to decreased runoff and mixing by wind. This Beaufort Sea inshore habitat and the fish that depend on the band were examined by Craig (1984). He found that arctic cisco, least cisco and Arctic char were dominant species in the coastal Beaufort. In late summer two marine species, Arctic cod and four-hour sculpin, moved nearshore as the salinity in the band increased.

Jarvela and Thorsteinson (1999) studied the occurrence of epipelagic fish along the eastern Beaufort Sea coast up to 30 km offshore. The study area stretched from the Colville River east to the U.S.-Canada boundary, including Camden Bay. The most abundant epipelagic fish caught were Arctic cod, capelin and snailfishes. Surface water temperatures and salinities varied seasonally and interannually and this influenced the spatial and temporal distribution patterns of the fish species. From 2004 to 2009, nearshore fishes were sampled with a beach seine and bottom trawl near Cooper Island, a barrier island in the western Beaufort Sea. A total of 2,807 fish representing 16 species were captured in all sampling periods and with both gear types. Some of the more abundant species captured were capelin, Arctic cod, and slender eelblenny (Johnson et al., 2010).

In the summer of 2008, a field survey of fish and benthic invertebrates of the Beaufort Sea was conducted by NOAA, University of Washington and University of Alaska (Logerwell et al., 2010; Rand and Logerwell, 2011; Logerwell et al., 2011). They began sample transects 20-30 km off the Beaufort coastline between Point Barrow and Cape Halkett (approximately 180 km west of Camden Bay). Following are some of the important findings from the 2008 Beaufort survey:

- 36 taxa of fish were caught and identified
- Across all bottom trawls, 6% of all weight was comprised of vertebrate fish species and 94% by weight was invertebrates
- Arctic cod (*Boreogadus saida*) were the most abundant fish caught during the 2008 survey, both by weight and numbers. Walleye pollack (*Theragra chalcogramma*) were present, but primarily as subadults
- Fifteen species of smaller fish (eelpouts and sculpins) contributed a great number of fish to the total catch of the 2008 survey, however, they did not contribute much in terms of total biomass (weight)
- The pollock caught in the survey were in densities far lower than in the Bering Sea where they are fished commercially
- No specimens of adult or juvenile Pacific salmon species (*Oncorhynchus sp.*) were captured during sampling in the 2008 survey
- The dominant benthic species at the shelf break (arctic cod, opilio crab, eelpouts) were associated with cold, high salinity water derived from the Chukchi Sea
- Comparing the results of the NOAA 2008 data to opportunistic offshore bottom-trawl surveys conducted by Frost and Lowry (1983) in 1976 and 1977, the authors suggest that there may have been a shift in fish species composition and community structure in the central Beaufort Sea over the past three decades. However, they note that without more extensive surveys, it is difficult to conclude that changes in species communities have occurred

Based on the studies described above and other studies (Fruge et al. 1989; Johnson et al., 2010; Thorsteinson, Jarvela, and Hale, 1992), Table 6 presents a list of fish species most likely to occur in the proposed drilling areas, or which could be affected by drilling activities:

Table 6 Fish Species most likely to occur in the Proposed Drilling Areas, or which could be affected by drilling activities

Common Name	Latin Name
Arctic cod	*Boreogadus saida*
Arctic flounder	*Pleuronectes glacialis*
Saffron cod	*Eleginus gracilis*
Capelin	*Mallotus villosus*
Dolly Varden	*Salvelinus malma malma*
Fourhorn sculpin	*Myoxocephalus quadricornis*
Arctic cisco	*Coregonus autumnalis*
Least cisco	*Coregonus sardinella*
Humpback whitefish	*Coregonus pidschian*
Kelp Snailfish	*Liparis tunicatus*
Ninespine Stickleback	*Pungitius pungitius*
Pink salmon	*Oncorhynchus gorbuscha*
Chum salmon	*Oncorhynchus keta*
rainbow smelt	*Osmerus mordax*

Commercial fishing has not occurred in the Beaufort region aside from a few artisanal fisheries involving village fishers in State waters. Therefore the typically published stock assessments and monitoring data associated with commercial fishing do not exist. The literature on fish in the U.S. Arctic most often addresses the general occurrence, distribution and abundance of adult fish in the open-water season. Limited published literature is available at this time regarding discrete populations, movement patterns and life history of most fish species in the U.S. Arctic. Subsistence fishing, however, has long been an integral part of life along the coasts of the Beaufort and Chukchi seas and, therefore, there is an abundance of traditional knowledge about fish that occur nearshore in the region.

The effects of ongoing climate change in the Arctic, such as warming sea temperatures and increased acidity, affect fish in many ways including changes in lower trophic food sources and changes in ice habitat extent and qualities (Hopcroft et al., 2006).

Additional information on the fish in the region of the proposed drilling is incorporated here from two earlier documents, the 2009 Camden Bay EA (USDOI, MMS, 2009a), and the 2011 Camden Bay EP.

3.2.4.2. Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 U.S.C. 1801-1884) mandated the identification of Essential Fish Habitat (EFH) for managed species as well as measures to conserve and enhance the habitat necessary to fish to carry out their lifecycles. The MSFCMA requires cooperation among the National Marine Fisheries Service (NMFS), the Fishery Management Councils, fishing participants, Federal and State agencies, and others in achieving EFH protection, conservation, and enhancement.

Fishery Management Plans in the U.S. Beaufort Sea

The Salmon Fishery Management Plan for Coastal Alaska (1990) applies to all life stages of the five Pacific salmon species in the U.S. Beaufort Sea. Pacific salmon occur in the Beaufort marine and estuarine environments, however, their numbers are low compared to the Bering Sea. Salmon, primarily pink and chum, have been captured in the Beaufort nearshore (Craig, 1984; Craig and Haldorson, 1986; Fechhelm and Griffiths, 2001; Fechhelm et al., 2009). As climate change occurs (ice reduction, warming waters) salmon are moving further north in greater numbers (Moss et al., 2009; Kondzelą et al., 2009).

The Arctic Fishery Management Plan (2009) identifies three commercial target species in the U.S. Arctic: Arctic cod, saffron cod, and snow crab (opilio crab). Adult and juvenile Arctic cod EFH are the only designated habitats that occur in the proposed Camden Bay project area (Figure 4). The Arctic Fishery Management Plan describes Arctic cod adult and late juvenile EFH as follows (NMFS has not yet determined EFH for eggs and larvae of the Arctic cod):

> Arctic Cod EFH, Adult and Late Juvenile: "the general distribution areas for this life stage is located in pelagic and epipelagic waters from the nearshore to offshore areas along the entire shelf (0-200 m [0-656 ft]) and upper slope (200-500 m [656-1,640 ft]) throughout Arctic waters and often associated with ice floes which may occur in deeper waters" (NPFMC, 2009).

The MSFCMA provides authority for an ecosystem-based approach to the management and protection of fish and fish habitat. The intent of designating Ecosystem Component Species is to understand the habitat of ecosystem component species, promote ecosystem-based management and provide sound conservation and sustainability of fish and fisheries.

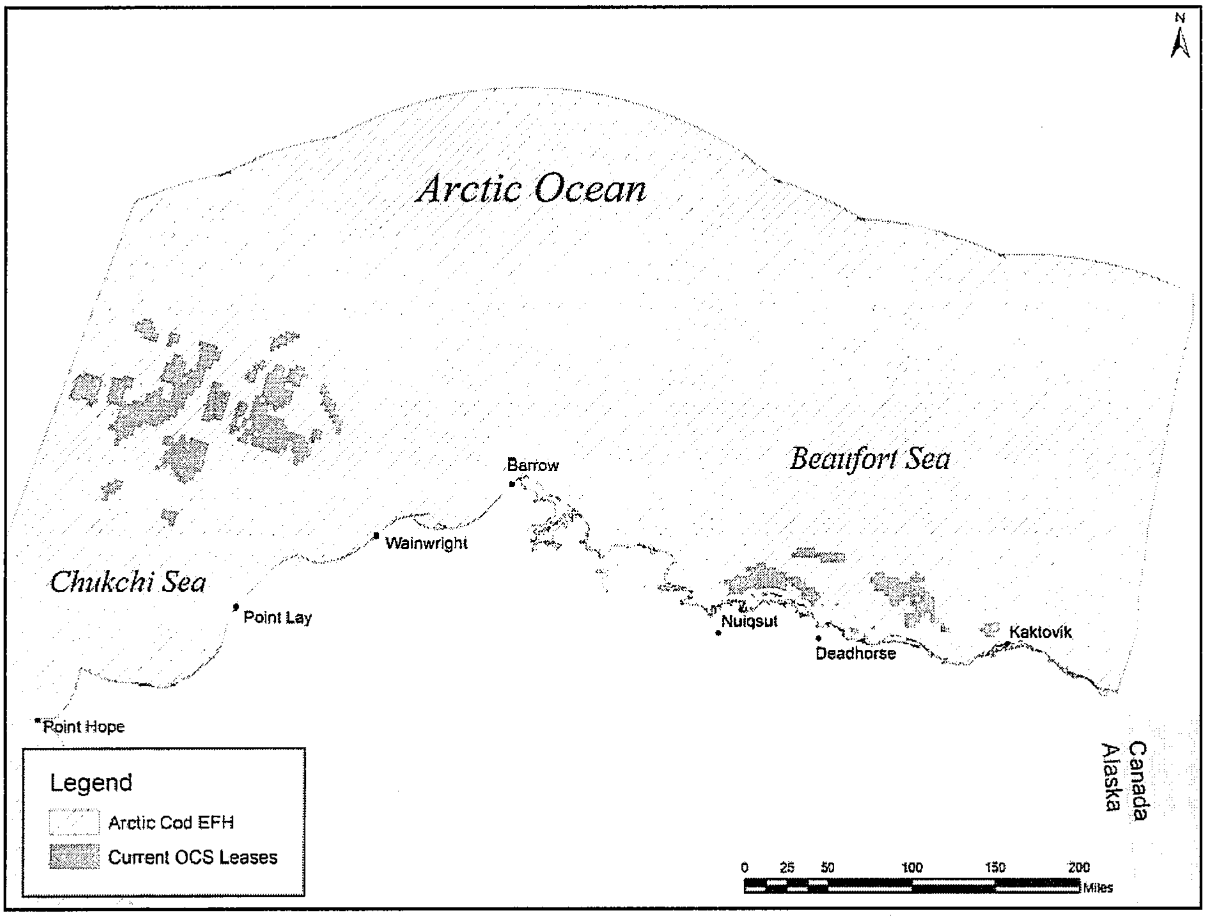

Figure 4 Arctic Cod Essential Fish Habitat

The Arctic Fishery Plan describes eight ecosystem component species that "are thought to be, should conditions allow, commercially viable". These ecosystem component species are: yellowfin sole, Alaska plaice, flathead sole, Bering Flounder, starry flounder, capelin, rainbow smelt, and blue king crab. Based on literature published on various fish surveys, it is likely that yellowfin sole, Bering flounder, starry flounder, capelin, and rainbow smelt occur in the vicinity of the Proposed Action (**Error! Reference source not found.**) (Logerwell et al., 2010, 2011; Rand and Logerwell, 2011;

Frost and Lowry, 1983; Fechhelm et al., 2009, Craig, 1984). Habitat descriptions for these ecosystem component species are available at the Arctic Fishery Management Plan web-site (NPFMC, 2011).

The policy of designating Ecosystem Component Species recognizes the "complex interactions among ecosystem components, and seeks to protect important species utilized by other ecosystem component species, potential target species, other organisms such as marine mammals and birds, and local residents and communities" (NPFMC, 2009).

Table 7 EFH target species that occur (designated in the Arctic Fishery Management Plan, 2009) and ecosystem component species that likely occur in the Camden Bay project area, Beaufort Sea, Alaska.

Fish Species	Designated EFH Species and Ecosystem Component Species in the Area of Proposed Action
Arctic cod (Boreogadus saida), Late Juvenile and Adult	EFH Species
Yellowfin sole (Limanda aspera)	Ecosystem Component Species
Bering flounder (Hippoglossoides robustus)	Ecosystem Component Species
Starry flounder (Platichthys stellatus)	Ecosystem Component Species
Capelin (Mallotus villosus)	Ecosystem Component Species
Rainbow smelt (Osmerus mordax)	Ecosystem Component Species

Arctic Cod. Arctic cod is widely distributed in the U.S. Arctic in the pelagic, demersal and nearshore environments. The absolute numbers of Arctic cod and their biomass is one of the highest of any finfish in the region (Logerwell et al., 2010, 2011; Rand and Logerwell, 2011; Frost and Lowry, 1983). The various life stages of Arctic cod occur across a broad range of habitats. Commonly they are associated with sea ice, using it as forage habitat to feed on microorganisms on the underside and as shelter. The Arctic Fishery Management Plan describes the Arctic ice forage habitat:

> All life stages of certain amphipod and copepod species are associated with perennial ice, suggesting an ice-specific community exists in addition to open-water zooplankton species feeding opportunistically on ice algae. In addition, turbellarians and nematodes are part of these perennial ice communities (Gradinger et al., 2005). Densities of these invertebrates can be locally high attracting foraging fish, most commonly the Arctic cod, Boreogadus saida (Gulliksen and Lonne, 1991). However, most observations of Arctic cod and other larger animals are associated with the extremely productive (and more easily studied) ice edge habitat. (NPFMC, 2009)

The primary foods of Arctic cod include planktonic copepods and amphipods, ice-associated amphipods and epibenthic crustaceans. (Bradstreet and Cross, 1982; Gulliksen and Lonne, 1991). Arctic cod move and feed in different groupings - dispersed, in small schools and very large schools throughout the water column (Welch, Crawford, and Hop, 1993). Frost and Lowry (1983) found smaller Arctic cod occurred more often in water less than 100 m deep.

In the summer of 2008, an Arctic fish survey was conducted by NOAA/University of Washington/University of Alaska in the western Beaufort Sea (Logerwell et al., 2010; Logerwell, Rand, and Weingartner, 2011; Rand and Logerwell, 2011). Results of this survey showed that Arctic cod were the most abundant fin-fish caught during the summer survey, both by weight and absolute numbers. Pelagic yearling-and-older Arctic cod were most abundant at the continental shelf-break (100 m). Pelagic young-of-year were most commonly found inshore. Arctic cod (of all age classes) comprised 99% by-weight of all midwater fish surveys (acoustic and trawl) and 96% by weight of demersal fish trawls. Johnson et al. (2010) describes Arctic cod as one of the most abundant species captured by beach seine and bottom trawl near Cooper Island in the western Beaufort Sea. Arctic cod captured by beach seine were mostly young-of-the-year, whereas Arctic cod captured by trawl included fish as old as age-3.

Trophic Linkages. Arctic cod are an important species in the Arctic foodweb both as prey and predator. The Arctic Fishery Management Plan (NPFMC, 2009) discusses these trophic linkages:

> Both the limited available survey data and the more comprehensive Arctic marine mammal and bird literature prominently feature Arctic cod and saffron cod as locally abundant species in the Alaskan Arctic and as critical components of pelagic food webs. In open-water and/or ice edge habitats, Arctic cod are a key link converting the production of small animals (pelagic zooplankton and ice-associated small invertebrates) into useful forage for large animals (birds and mammals. (Welch, Crawford, and Hop, 1993)

Ringed seals, ribbon seals, spotted seals, beluga whales and several seabird species depend heavily on Arctic cod. Ice seals particularly depend upon Arctic cod in the winter (Bluhm and Gradinger 2008; Dehn et al., 2007; Divoky, 1984; Frost and Lowry, 1981; Frost and Lowry 1984; Welch, Crawford, and Hop, 1993). Arctic cod feed on zooplankton, euphausiid/krill, pelagic amphipods, ice-associated amphipods and epibenthic crustaceans. Other species feed on these same organisms, placing the Arctic cod in competition during low productivity years with species such as bowhead whales and ringed seals.

The biomass of Arctic cod (as both predator and prey) transfers energy throughout the food web. The Arctic Fishery Management Plan (NPFMC, 2009) presents the results of a Beaufort Sea study by Frost and Lowry (1984):

> Frost and Lowry (1984) estimated the consumption requirements for the most common marine mammals and birds in the pelagic food web of the Alaskan Beaufort shelf, and included Arctic cod as both forage for these predators and as a predator on zooplankton. An estimated 123,000 tons of Arctic cod were required to feed the Belugas, ringed seals, marine birds, and Arctic cod themselves in the Beaufort Sea. Belugas and ringed seals in particular were dependent on Arctic cod for a majority of their consumption, and birds for half their consumption requirements. A total of 2,000,000 metric tons of forage (copepods, euphausiids, pelagic amphipods, Arctic cod, and other prey) was required for all predators including Arctic cod, of which nearly half was copepods. (NPFMC, 2009)

The abundance, wide distribution and the role in the food web of the Arctic cod in the Beaufort Sea make this species very important in the overall ecosystem of the Arctic region.

There are several factors that are currently influencing the Arctic environment EFH such as the presence and transit of cargo barges, research vessels and onshore oil and gas industrial activities. These activities could contribute noise, fuel spills, petroleum spills and nonpoint runoff to the sea. Climate change is currently having an effect on the Arctic environment EFH including warming sea surface, reduction in sea ice, and increased ocean acidification. These effects would continue during the proposed activities.

3.2.4.3. Invasive Species.

An invasive species is defined as "a species whose introduction does or is likely to cause economic or environmental harm or harm to human health where it is introduced". (Executive Order 13112 of February 3, 1999: *Invasive Species*)

An aquatic invasive species can be a plant, animal or microscopic pathogen. A variety of invasive species ranging across numerous taxa have been introduced around the world (GISP/UNEP, 2011). Potential vectors for introducing aquatic invasive species include vessel dockage to land, fouled ship hulls, ballast-water discharge, oil rigs, and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays, ocean-bottom-survey cables). In a more passive manner, floating plastic debris can also serve as a vector for transporting non-native species from one point to another.

Across all vectors and pathways, climate change can influence the dispersal of invasive species, presenting the potential for increased risk of invasion of non-native species (EPA, 2008, Rahel and Olden, 2008, Hellman et al., 2008). Ice cover, cold sea temperatures, ocean salinity and river discharge are important factors in the U.S. Arctic that may be influenced by climate change and therefore act synergistically with invasion of non-native species.

The Arctic Fishery Management Plan (NPFMC, 2009) discusses the potential introduction of invasive species into Alaska arctic waters and the potential effects. The Plan states: "Relatively few exotic, invasive species have been documented in Alaska. It is believed that this is due to a combination of factors, including geographic isolation; harsh climate conditions and cold temperatures; fewer concentrated, highly disturbed habitat areas; and the state's stringent plant and animal transportation laws. Alaska waters are, however, vulnerable to exotic species invasion. Potential introduction pathways include… the movement of large ships and ballast water from the United States West Coast and Asia" (Fay, 2002).

A non-native marine crustacean (amphipod) has been found in harbors ranging from Ketchikan in Southeast Alaska to Dutch Harbor in the Aleutian Islands. This is one of the few known cases of non-native marine organisms spread widely in Alaska (Ashton et al., 2008). An invasive colonial tunicate (*Didemnum vexillum*), which encrusts surfaces in a thick adhesive mat was found extensively in a Sitka harbor in June 2010. It is believed to have been introduced through previously used dock and pier timbers relocated to the state or through ballast water discharge or fouled hulls (ADFG, 2011). Invasive rats, although not an aquatic species, are adept swimmers and have been introduced into new regions, including Alaska, through vessel transit and groundings. Besides swimming, they can ride floating debris. Invasive rats are established in Alaska in at least three mainland communities, in three island communities in Southeast Alaska, on 11 islands in the Aleutians and on numerous smaller Aleutian islets. (Ebbert et al., 2007).

The Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) (16 U.S.C. 4701-4751) was passed in 1990 and amended by the National Invasive Species Act of 1996 (NISA). The U.S. Coast Guard developed regulations (33 CFR 151) that implement provisions of this Act and its amendment. Vessels brought into the State of Alaska or Federal waters are subject to these Coast Guard regulations which are intended to reduce the transfer of invasive species. The regulations require the "removal of fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, State, and Federal regulations," however, the regulations do not require the same removal procedures for ocean-bottom cables or seismic equipment.

3.2.5. Marine and Coastal Birds.

The general distribution and abundance of birds for the Beaufort Sea has been updated from resource information contained in the Beaufort Multi-Sale EIS (USDOI, MMS, 2003: III-49 through III-54). Most marine birds that occur in the Beaufort and Chukchi seas are there during the open-water season. Arrival times usually coincide with the formation of leads during spring migration to coastal breeding areas. Migration times vary between species, but spring migration for most species takes place between late March and late May. Those birds that are most likely to be affected by the Proposed Action are summarized in Table 8. As with other analyses incorporated by reference, BOEMRE assumes that any contact with oil by a bird will be fatal.

Some birds that breed on the North Slope migrate to or through the project area twice each year. Some marine and coastal birds may breed outside the project area, but spend time in the Beaufort Sea after breeding or during their non-breeding seasons. Departure times from the Beaufort Sea for the fall and winter vary between species and often by sex within the same species, but most marine and coastal birds will have moved out of the Beaufort Sea by late October before the formation of sea ice.

Descriptions of Species or Species Groups

Marine and coastal birds can be grouped according to certain aspects of their life-history or status: ESA-listed birds, loons and waterfowl, seabirds, shorebirds, and raptors/ravens). The timing and specific location of the proposed activities influence which birds could be affected. Birds listed as threatened or candidate (four species) or abundant in the proposed project area (five species) have the greatest potential for adverse effects and are described further (Table 8). These nine species were carried forward to the Environmental Consequences section.

Table 8 Marine and coastal birds most likely to be affected by the Proposed Action

Species	Threatened or candidate species	Abundant in offshore action area	Carried forward under effects analysis
ESA-Listed Species			
Spectacled Eider	Yes		Yes
Steller's Eider	Yes		Yes
Kittlitz's Murrelet	Yes		Yes
Yellow-billed Loon	Yes		Yes
Loons and Waterfowl			
Long-tailed Duck		Yes	Yes
Common Eider		Yes	Yes
King Eider		Yes	Yes
Seabirds			
Northern Fulmar		Yes	Yes
Short-tailed Shearwater		Yes	Yes

Note: An empty cell indicates Not Applicable.

3.2.5.1. ESA-Listed Birds

The distribution, abundance and legal status of birds designated as threatened or listed as candidate species under the ESA are most recently described in the ESA Section 7 consultation documents (USDOI, MMS, 2009a; USDOI, FWS, 2009). These include the Steller's eider (*Polysticta stelleri*; threatened), the spectacled eider (*Somateria fisheri*; threatened), the Kittlitz's murrelet (*Brachyramphus brevirostris*; candidate species), and the yellow-billed loon (*Gavia adamsii*; candidate species) and are often collectively referred to as ESA-listed birds. These four species, due to their special status, are carried forward into Environmental Consequences (Table 8). None of the Proposed Action operations will take place in the Ledyard Bay Critical Habitat Unit, which is an area of importance to spectacled eiders.

Spectacled Eider. The North Slope spectacled eider population seems to be stable, at least since the initiation of aerial surveys of the Arctic Coastal Plain (ACP) in 1992 (Larned et al., 2009). Spectacled eiders breed in low densities across the Alaskan ACP east to about the Shaviovik River. Males leave the breeding grounds along the ACP for the ocean around mid- to late June at the onset of incubation by female eiders. Males are followed by females whose nests fail, and finally by successful breeding females and young birds in August and September. Female spectacled eiders have been documented migrating west along the Alaska coast as far as 40 km offshore (TERA, 1999). Most spectacled eiders will have migrated from the Beaufort Sea by mid-October, although small numbers of spectacled eiders could be encountered in nearshore locations of the Beaufort Sea.

Steller's Eider. A small number of Steller's eiders breed on the ACP of Alaska, most conspicuously near Barrow. Steller's eiders have been observed east of Barrow to the Prudhoe Bay area where they are considered rare (TERA, 1997). They are rare east of Barrow and even rarer as the season progresses due to molt migration, failed breeding, etc. As with the more common spectacled eider, these birds move to nearshore coastal waters after their breeding season. Few if any Steller's eiders would likely be in the southern Beaufort Sea during or after the open-water season.

Yellow-billed Loon. Yellow-billed loons typically nest on low islands or narrow peninsulas on the edges of large, deep, tundra lakes (Johnson and Herter, 1989). The yellow-billed loon is relatively rare in the Arctic region (North, 1994). Dau and Larned (2005, 2006, 2007, 2008) and Dau and Bollinger (2009) observed 23, 99, 46, 18, and 59 yellow-billed loon(s), respectively, during a late-June survey of the coast and barrier islands between Omalik Lagoon and the Canadian Border. Of the approximately 3,300 yellow-billed loons present on the breeding grounds on the North Slope, primarily between the Meade and Colville rivers in the National Petroleum Reserve-Alaska (NPR-A), it is likely that there are fewer than 1,000 nesting pairs because some of the 3,300 are nonbreeders. Additionally, there are approximately 1,500 yellow-billed loons (presumably juvenile nonbreeders) that remain in nearshore marine waters or in large rivers during the breeding season. In total, there are fewer than 5,000 yellow-billed loons on the North Slope breeding grounds and nearshore marine habitat (Earnst et al., 2005).

Satellite-tagging of eight yellow-billed loons from the ACP showed that in late September most yellow-billed loons leave Arctic waters as they migrate to the Kamchatka Peninsula or the Kuril Islands (Rizzollo and Schmutz, 2008, 2009, 2010).

Kittlitz's Murrelet. This species may nest as far north as Cape Beaufort (100 km northeast of Cape Lisburne). Kittlitz's murrelets have been observed on a regular basis in the Chukchi Sea in late summer and early fall by Divoky (1987), but they have not been subsequently observed by others on similar cruises in the Chukchi Sea, suggesting that there is a great deal of annual variation in their occurrence. Murrelet foraging areas may occur near Barrow. The Kittlitz's murrelet was reported just west of Barrow in September-October 2007 (Renner, Hunt, and Kuletz, 2008). A few individual Kittlitz's murrelets could occur in close proximity to Barrow during the open-water season. The only recent notable change in the baseline information is recent documentation that individual Kittlitz's murrelets occur in the Beaufort Sea, near Kaktovik (Day, Gall, and Prichard, 2011).

3.2.5.2. Other Birds

3.2.5.2.1. Loons and Waterfowl

The Pacific loon (*Gavia pacifica*), red-throated loon (*G. stellata*), Pacific brant (*Branta bernicla nigricans*), lesser snow goose (*Chen caerulescens caerulescens*), greater white-fronted goose (*Anser albifrons frontalis*), and tundra swan (*Cygnus columbianus*) occur in nearshore coastal waters of the Beaufort and Chukchi seas (USDOI, MMS, 2003; 2008). Waterfowl species that are more abundant and occur in more offshore areas of the Beaufort and Chukchi seas include the long-tailed duck (*Clangula hyemalis*), the common eider (*Somateria mollissima*), and the king eider (*Somateria spectabilis*) and are described below.

Long-tailed Duck. The long-tailed duck population has decreased considerably since 1989, but it remains a common species in the Beaufort Sea during the open-water period (Mallek, Platte, and Stehn, 2007). Many long-tailed ducks molt in the lagoons along the Beaufort Sea coast. In late June and early July, most male and nonbreeding female long-tailed ducks migrate to coastal molting areas where they are flightless for a 3- to 4-week period. Breeding females molt on freshwater lakes during the last phases of duckling development before departing the North Slope in fall (Johnson and Herter, 1989). While most long-tailed ducks migrate within 45 km (28 mi) of shore (roughly along the 20-m [~ 66-ft] isobath), infrequent observations of long-tailed ducks in pelagic waters occur in late September (Divoky, 1987).

The molt is an energetically costly time, and long-tailed ducks have abundant food resources in the shallow water lagoons (Flint et al., 2003). During the molt, long-tailed ducks tend to stay in or near the lagoons, especially near passes between the lagoon and the sea (Johnson, Frost, and Lowry, 1992; Johnson, Wiggins, and Wainwright, 1992; Kinney, 1985). Brackney and Platte (as cited in Lysne, Mallek, and Dau, 2004) observed long-tailed ducks feeding heavily in passes between barrier islands.

Common Eider. The common eider population in the Beaufort Sea declined by 53% between 1976 and 1996 (Suydam et al., 2000). Common eiders were surveyed in marine waters within 100 km of the Beaufort Sea shoreline between Barrow and Demarcation Point by Fischer and Larned (2004) during summers in 1999-2001. In general, common eiders were concentrated in shallow waters (<10 m [<33 ft]), with the highest densities occurring in segments between Oliktok Point and Prudhoe Bay and between Tigvariak Island and Brownlow Point. Common eiders were most commonly associated with barrier islands in these segments, becoming less commonly observed up to 50 km seaward. Common eider densities were highest in areas of low ice cover.

Fischer and Larned (2004) concluded that because eider densities did not vary between summer months, the eiders they observed near barrier islands were local breeders rather than molt or fall migrants. This is consistent with Petersen and Flint (2002), who showed that satellite-tagged common eider hens remained in shallow waters close to their breeding sites through September.

Common eiders nest on barrier islands or spits along the Beaufort Sea coast. Dau and Larned (2005) observed 1,819 common eiders along the Beaufort Sea coast with 652 on barrier islands and 1,167 on the mainland. Dau and Larned (2007) observed a total of 1,936 common eiders. Of these, 871 were along the Beaufort Sea coast with 423 along the barrier islands and 448 along the mainland. The highest concentrations were on survey segments on both sides of Kaktovik. In 2007, total birds and indicated breeding pairs were down 37.6% and 44.0%, respectively, from 2006 counts of 3,102 birds and 1,207 pairs. Total birds and indicated breeding pairs in 2007 were down 30.0 and 27.8%, respectively, from the 1999-2006 averages of 2,766+885 (1 standard deviation, range 1,353-4,449) birds and 937+264 (1 standard deviation, range 572-1,340) pairs (Dau and Larned, 2007). In 2009, Dau and Bollinger (2009) reported that common eider numbers, while continuing to show considerable annual variation over the 1999-2009 time period, have declined by 1.4%/year while the number of indicated breeding pairs has showed less variability and is increasing at 3%/year.

Male common eiders begin moving out of the Beaufort Sea beginning in late June. After the molt is completed, some common eiders move offshore into pelagic waters, but most eiders remain close to shore (Divoky, 1987). When traveling along the northwest coast of Alaska, these eiders tend to stay along the 20-m isobath, approximately 45 km (28 mi) from shore. Most males are out of the Beaufort Sea by late August or early September, and most females were gone by late October or early November. Most breeding female common eiders and their young begin to migrate to molt locations in late August and September, although large numbers of female common eiders were observed molting in the eastern Beaufort Sea in Canada (Johnson and Herter, 1989).

King Eider. Most king eiders begin to arrive in the Beaufort Sea by the middle of May. Arrival times in the Beaufort Sea are dependent upon the location and timing of offshore leads along the Chukchi Sea (Barry, 1986). Most king eiders nesting on the North Slope between Icy Cape and the western boundary of ANWR nested in three general areas: between the Colville River and Prudhoe Bay, southeast of Teshekpuk Lake and a large area near Atqasuk (Larned, Stehn, and Platte, 2006). Dau and Larned (2005, 2006, 2007, 2008; Dau and Bollinger, 2009) surveyed the Chukchi Sea and Beaufort Sea mainland coastlines found 800, 3,045, and 1,621, 2,227, and 565 king eiders in 2005, 2006, and 2007, 2008, and 2009, respectively.

The king eider population in the Beaufort Sea appeared to remain stable between 1953 and 1976 but declined by 56% between 1976 and 1996 (Suydam et al., 2000). Fischer and Larned (2004) surveyed king eiders in marine waters within 100 km of the Beaufort Sea shoreline between Barrow and Demarcation Point during summers in 1999 and 2001. King eiders were the second most abundant species counted during the survey periods. King eider densities varied according to water depth, offshore distance, and percent of ice cover. Large flocks of king eiders concentrated in the mid-depth (10-20 m [33-66 ft]) zone offshore of Barrow and Oliktok Point. In 1999 and 2000, these flocks were in waters >10 m (>33 ft) deep but were found in the shallow (<10 m [<33 ft]) and mid-depth zone in July 2001. King eiders were unique among species surveyed by occurring in higher densities in low (31%) and moderate (31-60%) ice cover (Fischer and Larned, 2004).

Satellite telemetry was used to determine that most king eiders spent more than 2 weeks staging across all offshore areas of the Beaufort Sea, especially Harrison Bay and Smith Bay, but including areas off Camden Bay, prior to fall migration (Phillips, 2005; Powell et al., 2005). Female king eiders may need to remain in the Beaufort Sea longer than males to replenish fat stores depleted during egg laying and incubation (Powell et al., 2005). Prior to molt migration, king eiders in the Beaufort Sea usually were found about 13 km offshore; however, during migration to molting areas, king eiders occupied a wide area ranging from shoreline to >50 km (>31 mi) offshore (Phillips, 2005).

3.2.5.2.2. Seabirds

The common murre (*Uria aalge*), thick-billed murre (*U. lomvia*), tufted puffin (*Fratercula cirrhata*), horned puffin (*F. corniculata*), black-legged kittiwake (*Rissa tridactyla*), black guillemot (*Cepphus* *grylle*), Ross' gull (*Rhodostethia rosea*), ivory gull (*Pagophila eburnea*), Arctic tern (*Sterna paradisaea*), pomarine jaeger (*S. pomarinus*), parasitic jaeger (*S. parasiticus*), long-tailed jaeger (*S. longicaudus*), and glaucous gull (*Larus hyperboreus*) occur in the Beaufort Sea and Chukchi Sea (USDOI, MMS, 2003, 2008). Seabird species that are more abundant and occur in offshore areas include the northern fulmar (*Fulmarus glacialis*) and the short-tailed shearwater (*Puffinus tenuirostris*) and are described below.

Northern Fulmar. Fulmars do not breed in the Proposed Action area, and those observed during the summer are nonbreeders or failed breeders from southern areas. Fulmars are most numerous from late August to mid-September.

Short-Tailed Shearwater. Shearwaters do not breed in the Arctic region. These birds breed in the southern hemisphere. At northern latitudes, short-tailed shearwaters likely forage at highly productive patches of euphausiids and amphipods. Divoky (1987) reported short-tailed shearwaters north of Barrow and into Arctic Canada, depending on the presence of sea ice. In certain years, an estimated 100,000 short-tailed shearwaters passed Point Barrow in 1 day in mid-September (Divoky, 1987).

3.2.5.2.3. Shorebirds

The most common shorebird species include dunlin (*Calidris alpina*) and phalaropes (*Phalaropus spp.*) (Alaska Shorebird Working Group, 2004). Nearshore and shoreline habitats are especially important habitats where shorebirds replenish energy reserves after breeding and prior to southward migration, but these habitats are out of the project action area and these species are not evaluated further.

3.2.5.2.4. Raptors and Ravens

Raptors along nearshore and shoreline areas of the Beaufort Sea consist of small numbers of snowy owls (*Nyctea scandiaca*) and transient peregrine falcons (*Falco peregrinus*), golden eagles (*Aquila chrysaetos*), northern harriers (*Circus cyaneus*), and rough-legged hawks (*Buteo lagopus*). Ravens (*Corvus corax*) have recently expanded their distribution across portions of the North Slope. These species do not typically extend into offshore areas during the open-water season and are not evaluated further. A few snowy owls have occasionally been observed on icebergs or floes during the open-water season where they rest or scavenge carrion.

Climate Change Effects

Scientific and public interest in the Arctic is at an all-time high, attributed largely to a multitude of warming-induced changes now under way and a growing appreciation for the region's importance to the global climate system. Temperatures over Arctic land areas have risen and continue to rise at roughly twice the rate of the rest of the world (IPCC, 2007b). Some trends from climate change to coastal and marine birds are evident and are anticipated to continue. The draft Arctic Multi-Sale EIS (USDOI, MMS, 2008, section 3.3.5.1) briefly described likely ongoing effects on coastal and marine birds from changes in oceanographic processes and sea-ice distribution, duration of snow and ice cover, distribution of wetlands and lakes, and sea level rise. That section concluded that continued climate change can result in short- and long-term and beneficial or detrimental population-level effects on coastal and marine birds. Exactly how Arctic birds/bird groups are responding to climate change over time and space cannot be predicted, but, considering the short duration of this action, precise response data is not required for this analysis.

3.2.6. Marine Mammals.

There are 15 marine mammal species that can occur in the Proposed Action area (Table 9). In the following description, these are divided into two groups: 1) those afforded special protection under the Endangered Species Act (ESA) and 2) others. All marine mammals in the Proposed Action area are protected by the Marine Mammal Protection Act.. Marine mammals listed under the ESA, or are common in the Proposed Action area are analyzed further (Table 9). Rare or uncommon species are not evaluated further.

3.2.6.1. ESA-listed Marine Mammals

The general distribution, abundance and legal status of several marine mammals designated as endangered, threatened, proposed for listing, or candidate species under the ESA are most recently described in the ESA Section 7 consultation documents (USDOI, MMS, 2008b, 2009c; USDOI, FWS, 2009, USDOC, NOAA, NMFS, 2008). These include the bowhead whale (*Balaena mysticetes*, endangered), the fin whale (*Balaenoptera physalus*, endangered), the humpback whale (*Megaptera novaeangliae*, endangered), the ringed seal (*Phoca hispida*, proposed for listing), the bearded seal (*Erignathus barbatus*, proposed for listing), the polar bear (*Ursus maritimus*, threatened), and the Pacific walrus (*Odobenus rosmarus*, candidate) and are often collectively referred to as ESA-listed marine mammals. These seven species, due to their special status, are carried forward into Environmental Consequences (Section 4.2.7). Additional information on marine mammals occurring in the Beaufort and Chukchi seas is in the Arctic Multiple-Sale Draft EIS.

Bowhead Whale. The bowhead whale occurs seasonally in the Beaufort and Chukchi seas. This stock of bowhead whales is currently referred to as the Western Arctic stock. Bowhead whales are currently increasing in abundance at a rate of approximately 3.2% per year. During the spring (mid-March to approximately mid-June), bowhead whales migrate north and east through leads in the Chukchi Sea on their way to their primary summer feeding grounds in the eastern U.S. Beaufort Sea and Canadian Beaufort Sea.

Bowhead whales are present in the eastern Beaufort Sea throughout the summer (Moore, Clarke, and Ljungblad, 1989; Moore and Reeves, 1993; Moore et al., 2000; Moore et al., 2002). Some bowhead whales may remain in or return to the Chukchi Sea throughout the summer. In the autumn, bowhead whales move from the Beaufort Sea westward toward and across the Chukchi Sea as they migrate back to the Chukotka Peninsula waters and the Bering Sea wintering areas from about mid-September through November (Moore et al, 1995). Some bowhead whales killed during the late summer/fall had prey in their stomachs, indicating that a portion of bowhead whales may feed in the U.S. Beaufort Sea, including the Camden Bay area (Lowry, Sheffield, and George, 2004). Bowhead whales migrate southward through the Bering Strait in late October through early November.

Bowhead whales are often associated with heavy ice cover and remain over the shallow continental shelf waters most of the year. The Western Arctic stock of bowhead whales overwinter in the Bering Sea, where most mating probably occurs. Recent satellite telemetry data indicate use of areas in the Chukchi and Bering seas with extensive ice (Moore and DeMaster, 1997; Moore et al., 2000).

All recent available information indicates that the population has continued to increase in abundance over the past several decades and may have doubled in size since about 1978. The estimated current annual rate of increase is similar to the estimate for the 1978-1993 time series. The Western Arctic bowhead whale stock may have reached, or is approaching, the lower limit of its historic population size (Allen and Angliss, 2010).

The bowhead whale was listed as endangered under a precursor to the ESA in 1970 (35 *FR* 18319, December 2, 1970) and have remained on the list since the ESA was passed in 1973. The NMFS received a petition in February 2000, requesting that portions of the U.S. Beaufort and Chukchi Seas be designated as critical habitat for the Western Arctic stock of bowhead whales. The NMFS determined not to designate critical habitat for this stock because: (1) the population decline was due to over exploitation by commercial whaling, and habitat issues were not a factor in the decline; (2) the population is abundant and increasing; (3) there is no indication that habitat degradation is having any negative impact on the increasing population; and (4) existing laws and practices adequately protect the species and its habitat (67 *FR* 55767, August 30, 2002).

Fin Whale. The fin whale appears to be expanding into Arctic waters. Individual and small groups of fin whales are considered infrequent visitors to the U.S. Chukchi Sea during the open-water period. Observations from industry (Funk et al., 2011; Funk et al., 2007; Ireland et al., 2009) based monitoring and research programs (Clarke and Ferguson, 2010; Delarue et al., 2010) since 2006 have annually documented through observation and passive acoustic monitoring individual or small groups of fin whales in the U.S. Chukchi Sea. Fin whales have not been documented to occur in the Beaufort Sea.

Fin whales were listed as endangered under a precursor to the ESA in 1970 (35 FR 18319, December 2, 1970) and have remained on the list since the ESA was passed in 1973. A final recovery plan was completed in July 2010 (USDOC, NOAA, NMFS, 2010). No critical habitat has been designated for fin whales in the North Pacific.

Humpback Whale. The humpback whale also appears to be expanding into Arctic waters. Agency researchers and industry monitoring programs have indicated the presence of humpback whales in the U.S. Chukchi Sea since 2007. Hashagen, Green, and Adams (2009) noted a humpback adult and calf in the western Beaufort Sea in August 2007.

All stocks of humpback whales in U.S. waters were listed as endangered under the precursor to ESA in 1970 (35 *FR* 18319, December 2, 1970) and have remained on the list since the ESA was passed in 1973. A Final Recovery Plan for the humpback whale was completed in November, 1991 (USDOC, NOAA, NMFS, 1991). No critical habitat has been designated for this species.

Ringed Seal. The ringed seal is considerably more abundant than other ice seals in the Beaufort and Chukchi seas, particularly during the winter and spring, and is the ice seal most likely to be encountered in the Proposed Action area (Burns, 1970). They are closely associated with ice, and in early summer the highest densities of ringed seals are found in nearshore fast and pack ice. Ringed seals have the unique ability to maintain breathing holes in thick ice. During the open-water season, ringed seals are dispersed throughout the open-water. Ringed seals construct lairs in landfast or drifting pack ice, and give birth in mid-March through April (Smith and Stirling, 1975; Smith and Hammill, 1981).

Kelly et al. (2010) estimates that over one million ringed seals inhabit the Beaufort, Chukchi and Bering Seas based on information from existing surveys and studies. Ringed seal numbers are believed to be considerably higher in the Bering and Chukchi seas, particularly during winter and early spring (71 *FR* 9783). Bengston et al. (2005) reported an abundance estimate of 252,488 ringed seals in the eastern Chukchi Sea, while Frost and Lowry (1981) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter. Kelly et al. (2010) placed their maximum density estimate of ringed seals at Prudhoe Bay and along the coast south of Kivalina at 1.62 seals/km^2.

The NMFS initiated a status review to determine if listing the ringed seal under the ESA was warranted (73 *FR* 16617-16619, March 28, 2008). The NMFS proposed to list ringed seals in the Alaskan Arctic as threatened under the ESA (75 *FR* 77476, December 10, 2010). The listing proposal was based on the NMFS conclusion that the Arctic ringed seal population in Alaska, numbering around a million, will face a significant extinction risk due to anticipated changes in sea ice conditions and snow cover in the Arctic from climate changes (Kelly et al., 2010). Critical habitat for the ringed seal has not been designated.

Bearded Seal. Bearded seals are the largest of the northern phocids, and have a circumpolar distribution. During the open-water period, bearded seals occur mainly in relatively shallow areas, preferring areas no deeper than 200 meters. Most bearded seals are found in the Bering and Chukchi seas and are predominantly benthic feeders, feeding on a variety of invertebrates (Burns, 1970; Stirling, Kingsley and Calvert, 1982; Stirling, 1997).

Cameron et al. (2010) developed a crude estimate of 3,150 resident bearded seals in the Beaufort Sea that was uncorrected for submersed seals or seasonal migrants, and around 27,000 resident bearded seals in the Chukchi Sea. Cameron et al. (2010) estimated the maximum density of bearded seals from Prudhoe Bay to the coast south of Kivalina to be about 0.14 seals/km^2.

The Beringian Distinct Population Segment (DPS) of bearded seals, a population which includes the bearded seals located in the vicinity of the proposed exploration wells, has been proposed for listing under the ESA based on the NMFS conclusion that they will be threatened with extinction because of anticipated decoupling of sea ice cover and benthic feeding habitat, a loss in adequate molting habitat, and projected decreases in prey density and/or availability due to climate change (Cameron et al., 2010). Critical habitat for the Beringian DPS of bearded seals has not been designated.

Polar Bear. Polar bears occur on the pack and shorefast ice, along the coast, and on barrier islands. Polar bears have occasionally been observed in open-water in the Beaufort and Chukchi seas while transiting between pack ice and shore. There are two polar bear stocks recognized in Alaska: the southern Beaufort Sea and the Chukchi/Bering Seas stocks; though there is considerable overlap between the two. A third stock, the Northern Beaufort Sea stock could be encountered in offshore waters and on the pack ice in the northeastern Beaufort Sea.

The polar bear is listed as threatened throughout their range under the ESA (73 *FR* 28212, May 15, 2008). Polar bear habitat use and distribution may reflect prey availability, time allocated for hunting prey, and the use of retreat habitats (Durner et al., 2004). Modeling of polar bear ice habitat selection showed that shallow-water areas where different ice types intersected were preferred (Durner et al., 2004, 2007). The FWS designated critical habitat for the polar bear (74 *FR* 76058, December 7, 2010). Three different critical habitat units were identified: sea ice, terrestrial denning, and barrier island habitats.

Pacific Walrus. The Pacific walrus is associated with the moving pack ice year-round. Walrus winter in the Bering Sea and the majority of the population summers throughout the Chukchi Sea and the westernmost part of the Beaufort Sea. Pacific walruses are usually found in waters of 100 m or less, possibly because of higher productivity of their benthic foods in the shallower water (Fay, 1982). In recent years, climate change has caused walrus to move to terrestrial haulouts in the Chukchi Sea in summer when the sea ice retreats northward.

The following information is drawn from 76 FR 13454 (March 11, 2011). In the spring and early summer, most of the walrus population follows the retreating pack ice northward into the Chukchi Sea; however, several thousand animals, primarily adult males, remain in the Bering Sea. During the summer months, walruses are widely distributed across the shallow continental shelf waters of the Chukchi Sea. Substantial summer concentrations are normally found in the unconsolidated pack ice west of Point Barrow. Small herds of walruses occasionally range east of point Barrow into the Beaufort Sea in late summer. While typically considered uncommon in the Beaufort Sea, abundance is dependent on ice concentrations, and in some years walrus can be more abundant than is commonly believed (see Ireland et al., 2009). As the ice edge advances southward in the fall, walruses reverse their migration and re-group on the Bering Sea pack ice.

In 2006, U.S. and Russian researchers surveyed walrus groups in the pack ice of the Bering Sea using thermal imaging systems to detect walruses hauled out on sea ice and satellite transmitters to account for walruses in the water. The number of walruses within the surveyed area was estimated at 129,000 individuals (95% C.I. 55,000-507,000). Existing abundance estimates do not support an evaluation of population trend.

Walruses rely on floating pack ice as a substrate for resting and generally require ice thicknesses of 50 cm (20 in) or more to support their weight. Although walruses can break through ice up to 20 cm (8 in) thick, they usually occupy areas with natural openings. Concentrations in summer tend to be in areas of unconsolidated pack ice, usually within 100 km (30 mi) of the leading edge of the ice pack. When suitable pack ice is not available, walruses haul out to rest on land, a behavior that is becoming more common in the Chukchi Sea. Isolated sites, such as barrier islands, points, and headlands, are most frequently occupied. Social factors, learned behavior, and proximity to their prey base are also thought to influence the location of haulout sites.

Although capable of diving to deeper depths, walruses are generally found in shallow waters of 100 m (300 ft) or less, possibly because of higher productivity of their benthic foods in shallower water. They feed almost exclusively on benthic invertebrates. Prey densities are thought to vary across the continental shelf according to sediment type and structure. Preferred feeding areas are typically composed of sediments of soft, fine sands. The juxtaposition of ice over appropriate depths for feeding is especially important for females and their dependent young that are not capable of deep diving or long exposure in the water. The mobility of the pack ice is thought to help prevent walruses from overexploiting their prey resource.

The FWS completed a status review of the Pacific walrus and determined that listing the species was warranted; however listing was precluded by higher priority actions and is a candidate species (76 *FR* 7634, February 10, 2011).

Table 9 The stock, habitat, and estimated abundance of marine mammals occurring within the Proposed Action area.

Species	Stock	Habitat	Estimated Abundance	Analyzed further?
Beluga Whale	Eastern Chukchi Sea	Open leads and polynyas, coastal areas, ice edges	3,710	Yes, due to relative abundance
Beluga Whale	Beaufort Sea	Open leads and polynyas, coastal areas, ice edges	32,453	Yes, due to relative abundance
Narwhal		Offshore, ice edge, heavy pack ice, open leads	86,000, Rare in Chukchi/Beaufort	No, due to relative abundance
Killer Whale	Offshore	Open-water	Not estimated, but rare in Chukchi/Beaufort	No, due to relative abundance
Harbor Porpoise	Bering Sea	Coastal waters <100m depth, Chukchi only	40,039, Rare in Chukchi/Beaufort	No, due to relative abundance
Bowhead Whale	Western Arctic	Ice edge, polynyas and leads, open-water	9,472	Yes, endangered species
Gray Whale	Eastern North Pacific	Open and coastal waters	17,752, Rare in Chukchi/Beaufort	No, due to relative abundance
Fin Whale	Northeast Pacific	Open-water	5,700, Rare in Chukchi/Beaufort	Yes, endangered species
Minke Whale	Alaska	Open-water	Rare in Chukchi/Beaufort	No, due to relative abundance
Humpback Whale	Central North Pacific	Open-water	5,833, Rare in Chukchi/Beaufort	Yes, endangered species
Bearded Seal	Alaskan Arctic	Pack ice and open-water	30,000	Yes, proposed for listing
Spotted Seal	Alaska	Pack ice, ice edge and coastal habitat	59,214	Yes, due to relative abundance
Ringed Seal	Alaska	Shorefast and pack ice	249,000	Yes, proposed for listing
Ribbon Seal	Alaska	Open-water and pack ice	49,000, Rare in Chukchi/Beaufort	No, due to relative abundance
Pacific Walrus	Chukchi/ Bering	Pack ice and coastal haulouts	129,000, Rare in Chukchi/Beaufort	No, due to relative abundance
Polar Bear	Southern Beaufort Sea	Coastal, barrier islands, pack ice	1,526	Yes, threatened species
Polar Bear	Northern Beaufort Sea	Coastal, barrier islands, pack ice	1,200	Yes, threatened species
Polar Bear	Chukchi/ Bering	Coastal, barrier islands, pack ice	2,000	Yes, threatened species

Note: Species listed under the Endangered Species Act are analyzed further; rare or uncommon species are not analyzed further.
Source: Allen and Angliss, 2010.

3.2.6.2. Other Marine Mammals

Of the remaining species, the beluga whale and spotted seal are most widely distributed and common within the Proposed Action area. Additional information on marine mammals occurring in the Beaufort and Chukchi seas can be found in the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008).

Five cetacean species (harbor porpoise, minke whale, killer whale, narwhal, and gray whale) could occur in the project area during the open-water period. These species occur in low densities and are most likely to be within 100 km of shore and in waters less than 200m deep or along the shelf break.

Recent evidence from Funk et al. (2009) during 2006-2009 in the Chukchi and Beaufort seas suggest that harbor porpoise and minke whale are uncommon or rare in the Chukchi and Beaufort seas, but may be increasing in these areas during the open-water season. Small numbers of killer whales have also been recorded during industry surveys. The narwhal occurs in Canadian waters, but is rarely seen in the U.S. Beaufort Sea. Small numbers of gray whales occur in continental shelf waters along the Chukchi Sea coast in summer and to a lesser extent along the Beaufort Sea coast. These species are not discussed further because they are rare or uncommon in the Proposed Action area and mitigation measures would avoid or minimize any chance of adverse interaction.

One other ice seal species that could occur in the action area is the ribbon seal. The ribbon seal is uncommon in the Chukchi Sea and there are few sightings in the Beaufort Sea. This species is not discussed further because it is uncommon in the Proposed Action area and mitigation measures would avoid or minimize any chance of adverse interaction.

Beluga Whale. The Beaufort Sea and Chukchi Sea beluga whale stocks winter in the Bering Sea and summer in the Beaufort and Chukchi seas, migrating around western and northern Alaska along the spring lead system in April and May (Richard, Martin, and Orr, 2001; Angliss and Outlaw, 2005). Belugas generally are associated with ice and relatively deep water throughout the summer and autumn. During late summer and autumn, most belugas migrate westward far offshore near the continental shelf break and the pack ice (Frost, Lowry, and Burns, 1988; Hazard, 1988; Clarke, Moore, and Johnson, 1993; Miller et al., 1999). During fall aerial surveys in the U.S. Beaufort Sea, Christie, Lyons, and Koski (2009) reported the highest beluga sighting rates during the first two weeks of September and in the northern part of their survey area.

Moore (2000) and Moore, DeMaster, and Dayton (2000) suggested that beluga whales select deeper water near the continental shelf break independent of ice cover. However, during the westward migration in late summer and autumn, small numbers of belugas are sometimes seen near the Beaufort Sea coast of Alaska (e.g., Johnson, 1979). Christie, Lyons, and Koski (2009) reported higher beluga sighting rates at locations >60 km offshore than at locations nearer shore during aerial surveys in the U.S. Beaufort Sea in 2006–2008. Belugas were not recorded, however, during Arctic cruises by the Healy in 2005 or 2006 (Haley, 2006; Haley and Ireland, 2006). This could be due to avoidance of the icebreaker by beluga. Icebreakers may be audible to beluga over distances of 35 to 78 km (Erbe and Farmer, 2000). Eastern Chukchi belugas move into coastal areas along Kotzebue Sound and Kasegaluk Lagoon in late June and remain there until mid to late July (Suydam et al., 2001; Suydam, Lowry, and Frost, 2005).

Spotted Seal. The Bering Sea DPS of spotted seals inhabit the Bering and Chukchi seas as well as the more southern portion of the Beaufort Sea. Spotted seals are more abundant in the Chukchi Sea and occur in small numbers in the Beaufort Sea. Spotted seals are associated with sea ice from late fall through spring, especially during the breeding and molting seasons (April through June). During the remainder of the year, spotted seals rest on sea ice or at coastal haul outs between foraging trips. Spotted seals prey upon a wide variety of fish and invertebrate species. They typically migrate south from the Chukchi Sea and into the Bering Sea in October or November (Burns, 1970; Stirling, Kingsley, and Calvert, 1982; Stirling, 1997; Boveng et al., 2009).

3.2.7. Sociocultural Systems

Sociocultural systems encompass three concepts: (1) social organization, (2) cultural values, and (2) institutional organizations of communities. By "social organization" we mean how people are divided into social groups and networks. By "cultural values" we mean desirable values that are widely shared explicitly and implicitly by members of a social group. By "institutional organization" we refer to the government and non-government entities that provide services to the community. These three concepts are interrelated. For most Alaska Natives, subsistence (and the relationship between people, land, water, and its resources) is the expression of cultural identity, and production of subsistence foods is the activity around which social organization and generational transmission of the culture occurs. Institutional organizations, in turn, reflect and affect the social organization and cultural values. For the North Slope of Alaska, Iñupiat traditions and practices largely define social organization and cultural values, while the civil and tribal governments and ANCSA Native corporations largely define institutional organization. A detailed explanation of Sociocultural factors appears in Section 3.4.3 of the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a).

Although there have been substantial social, economic, and technological changes in Iñupiat lifestyle, subsistence continues to be the visible central organizing value of Iñupiat sociocultural systems and it is primarily through impacts to subsistence activities that impacts to sociocultural systems are assessed (USDOI, MMS, 2008a).

The Arctic is undergoing climate change, which affects subsistence hunting. For example, subsistence hunters report dispatching seals in the water rather than on ice floes (SRB&A, 2010). The Cross Island bowhead whale hunt is now typically starting earlier, by the end of August, rather than in September as in years past (Applied Sociocultural Research, 2011). Fishers are noting more salmon in streams that formerly supported primarily whitefish (Carothers, 2011). In sum, shifts in timing and regime changes are leading to adaptation on the part of subsistence harvesters.

3.2.8. Subsistence Activities

Subsistence activities are assigned the highest cultural values by the Iñupiat Eskimo of the North Slope and provide a sense of identity in addition to being an important economic pursuit. Subsistence resources are shared between house holds, communities, kin groups, and friends in a deeply embedded prescribed network that bonds the culture in tangible and concrete ways. These sharing networks, the joyful connection the harvester feels when attuned to the environment, transmission of strategies, skills, and traditional knowledge from one generation to the next all underscore the view held by Alaska Natives that subsistence is not just as an activity that is imbedded in the culture; it is very culture itself. Unlike the Western concept of subsistence as a practice that helps one eke out a living, among Alaska Natives there is not even a term for subsistence, because it is the richness and wealth that life on this earth provides the harvester (Wheeler and Thornton, 2005).

The bowhead whale is a subsistence resource of paramount importance, and, consequently, descriptions of the social organization pertaining to the crew, the hunt, quantity, and distribution of the whale dominate subsistence discourse in North Slope Iñupiat Eskimo communities (USDOI, MMS, 2009a).

Bowhead whaling traditions underscore the central values and activities for the Iñupiat of the North Slope. Bowhead whale hunting strengthens family and community ties and the sense of a common Iñupiat heritage, culture, and way of life, and provides a strength, purpose, and unity in the face of rapid change (USDOI, MMS, 2008a; EDAW/AECOM, 2007). Although bowhead whaling traditions are unquestionably important, harvest of other wild resources, including caribou, fish, avian species, and other marine mammals are important to the local inhabitants to provide a variety in the diet and nutrition or to provide nutritional needs if few or no bowhead whales are taken (USDOI, MMS, 2009a).

Subsistence Communities

This discussion focuses on the subsistence activities, related subsistence resources, and subsistence distribution levels that generally occur during the period of Shell's proposed exploration at the Sivulliq and Torpedo prospects in Camden Bay, from about July 10 through October 31.

Kaktovik. Kaktovik's subsistence-harvest areas are depicted in detail in Figures 3.4.2-1 through 3.4.2-7 of the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a) and in the MMS OCS Study 2009-003, Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow (SRB&A, 2010: Maps 61-110). Subsistence resources used by Kaktovik are listed in Tables 3.4.2-3 through 3.4.2-5 of the Arctic Multiple-Sale Draft EIS. Kaktovik's annual harvest of bowhead whales from the 1980s to 2005 is shown in Table 3.4.2-9 of the Arctic Multiple-Sale Draft EIS.

Summer Months (July-August): During summer, the people of Kaktovik engage in a community-based subsistence fishery. Most households gillnet at beach sites on Barter Island near Kaktovik, where the primary fish harvested is sea run Dolly Varden, or char. In fact, "Kaktovik" means "place where people fish on the beach" (Leffingwell, 1919). Some Kaktovik households also fish to the east, where the primary fish harvested is Arctic cisco (SRB&A, 2010: Map 67). Some households have fished westward in the Canning River, but the main level of effort is on Barter Island. In 2002, one of two years actively censused, 79% of the households fished in summer (Pedersen and Linn, 2005; USDOI, MMS, 2009a; SRB&A, 2010, Maps 66-75).

Caribou and bearded seals are also important resources taken during the summer months. A peak harvest time for taking caribou is in July, when hunters selectively harvest fat bulls along the coast. Over a 4-year period, researchers determined that the summer hunt represented about 40% of all caribou taken on an annual basis and were hunted as far west as the Canning River (USDOI, MMS, 2009a; Pedersen and Coffing, 1984). Residents travel both inside and outside the barrier islands (SRB&A, 2010). Bearded and ringed seal hunting may coincide with caribou hunting or seals might be the sole prey. Most seals are hunted during the open water season in July, August and sometimes into September when basking on ice floes (SRB&A, 2010). Waterfowl are also taken in the summer months (Impact Assessment Inc., 1990b; SRB&A, 2010).

Late Summer to Early Autumn (August 25-end of September): The bowhead whaling effort takes precedence over any other subsistence activity, and occurs only in the fall. Although Nuiqsut's Cross Island bowhead whale hunt is well documented as part of monitoring and mitigation efforts stemming from petroleum development, less is known about the Kaktovik bowhead whale hunt. Whaling crews use Kaktovik as their home base, leaving the village and returning on a daily basis. The core whaling area is within 12 mi of the village with a periphery ranging about 8 mi farther, if necessary. This core whaling area is about 48 mi from the project area. The extreme limits of the Kaktovik whaling limit would be the middle of Camden Bay to the west. The timing of the Kaktovik bowhead whale hunt roughly parallels the Cross Island whale hunt (Impact Assessment Inc, 1990b; SRB&A, 2010: Map 64). The Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a) describes the hunting of beluga whales from Kaktovik. As best as can be ascertained, about one beluga is harvested annually in conjunction with the bowhead whale hunt, but most households obtain beluga through exchanges with other communities (USDOI, MMS, 2009a).

When people again mobilize for subsistence activities in fall after the bowhead whale hunt, they direct their subsistence efforts inland to hunt caribou, moose, Dall sheep, and avian species, and to fish if the channel separating Barter Island from the mainland has frozen deep enough to bear the weight of fourwheelers or snowmachines. In the fall/winter, the people fish inland under river ice using nets, mainly catching Dolly Varden, Arctic cisco, and lake trout (SRB&A, 2010: Map 70; Impact Assessment Inc, 1990b; Pedersen and Linn, 2005; Pedersen and Coffing, 1984; USDOI, MMS, 2009a; SRB&A 2010, Maps 72, 73, 69, and 70).

Nuiqsut. Nuiqsut's subsistence-harvest areas are depicted in detail in Figures 3.4.2-11 through 3.4.2-27 of the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a) and in MMS OCS Study 2009-003, Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow (SRB&A, 2010: Maps 111-162). Subsistence resources used by Nuiqsut are listed in Tables 3.4.2-7 through 3.4.2-8 of the Arctic Multiple-Sale Draft EIS. Nuiqsut's annual harvest of bowhead whales from the 1980s to 2005 is shown in Tables 3.4.2-9 of the Arctic Multiple-Sale Draft EIS.

Summer Months (July-August): During summer, the people of Nuiqsut catch whitefish, primarily along channels of the Colville River. They also harvest Arctic char, dog salmon, pink salmon, and the spotted seals that follow the fish upriver. Waterfowl are hunted, as are summer caribou (Research Foundation of State University of New York, 1984; SRB&A, 2010: Map 112).

People of Nuiqsut hunt ringed seal, bearded seal and eiders offshore of the Colville River eastward to the mouth west bank of the Canning River in the summer. Residents reported traveling as far as Camden Bay to the east in search seals. The most intensive use was reported offshore from the Colville River delta between Atigaru Point and Thetis Island, up to 25 miles offshore, although a few residents reported traveling as much as 40 miles offshore when hunting seals. A number of Nuiqsut hunters reported hunting seals and eiders from Thetis Island, sometimes camping there for several days. Others reported taking only day trips from the community. The distance residents travel depends primarily on the location of the ice pack, as the seals migrate with the ice pack, resting on the ice floes and feeding near the ice. July is the peak month for sealing with high numbers taken also in June and in August (SRB&A 2010: Maps 134, 132, 134, 135, and 295). Although seal is not a preferred meat for human consumption, people use the oil as a condiment, and send the bearded seal skins to Barrow for covering umiat. Seals are hunted in nearshore waters during this time. There was general agreement that the best place to harvest them is off the Colville delta (Impact Assessment Inc., 1990a; SRB&A 2010; USDOI, MMS, 2009a).

Late Summer to Early Autumn (August 25-end of September): Bowhead whaling takes precedence over any other subsistence activity, and occurs only in the fall. The 2010 Cross Island bowhead whale hunting season was the shortest known on Cross Island, lasting for a period of 5 days. The season had on early start with the arrival on Cross Island of three crews with seven boats on August 28. A fourth crew with 3 boats arrived on August 29, and the fifth and sixth crews arrived on August 20, each with two boats. Single whales were landed on August 29 and August 31, and 2 whales were landed on September 1. The whales landed on August 29 were large, and towed to Cross Island late in the day, so all crews were required for butchering on August 30. Five crews scouted on August 31 and a whale was landed early in the day. Four crews scouted on September 1, and 2 whales were landed, one in the afternoon and one in the evening. On September 2, three crews hoisted their whaling flags for the first time in memory (Applied Sociocultural Research, 2010).

Whale strikes occurred at an average distance of about 16 mi (about 27 km) from Cross Island. The shorter 2010 season compares with the 21-day season in 2006 and the 27-day season in 2005. Over the past 9 years of reported monitoring (2001-2008), the majority of the bowhead whales have been harvested in the northeast quadrant off Cross Island (Applied Sociocultural Research, 2011; USDOI, MMS, 2009a; SRB&A, 2010: Maps 113 and 114).

In recent years, the Cross Island whalers focus exclusively on taking bowhead whales. They do not hunt for belugas, and crew members must ask for permission from the whaling captain to kill a polar bear that might be in the vicinity of the harvested whale carcasses because it would entail hours away from the bowhead whale hunt (Applied Sociocultural Research, 2009). Scheduling and logistical conflicts with bowhead whaling do not mean that the people have abandoned these beluga whale and polar bear as subsistence resources, and hunts for these resources may resume in the future (SRB&A, 2010).

3.2.9. 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 from high value onshore oil and gas infrastructure, as well the Federal government, State of Alaska, and local governments. 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 OCS revenue. Under section 8(g) of the OCS Lands Act, coastal states are entitled to receive 27% of revenues from offshore leases in Federal waters that are located within 3 miles of the State's seaward jurisdictional boundary. Oil and gas activities generate revenues for the Federal government through royalties, bonus bids, and rental revenues. 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 2011 Camden Bay EP are not expected to generate economic effects at the State or Federal level, because the activities described in the Proposed Action are short term and limited in scale in terms of the 'footprint', they will generate very small economic benefits at the State or Federal level. Economic benefits at the State and Federal level would be much more noteworthy if development and production occur in the future.

Local Employment and Personal Income: Descriptions of the NSB economy in the 2011 Camden Bay EP (Shell, 2011a) and EIA (Shell, 2011b) are incorporated by reference, and salient points are summarized below. Additional information on the NSB economy is also provided below. The NSB is a mixed economy, characterized by a traditional cash economy and subsistence economy. The NSB economy is characterized by 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 employment and personal income in the oil industry. As noted in the exploration plan, only 23 NSB residents were directly employed in the oil industry in 2003. More local hire is needed to increase employment and personal income benefits from oil and gas activities within the local communities.

Revenues: The NSB government receives a large share of its revenues from property taxes levied on high value onshore oil and gas infrastructure. As the depreciable value of that infrastructure has decreased, the revenues accruing to the NSB from oil and gas activities have also declined.

3.2.10. Environmental Justice

The Environmental Justice (EJ) Executive Order requires each Federal Agency to make the consideration of EJ part of its mission. The Executive Order requires an evaluation in an EIS or EA as to whether the proposed project would have "disproportionately high adverse human health (i.e., community health) and environmental effects...on minority populations and low income populations." Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the North Slope and the Northwest Arctic Boroughs, the area potentially affected by survey activities. The ethnic composition of Kaktovik, Nuiqsut, and Barrow demonstrates that all three communities would be classed as minority communities on the basis of their proportional American Indian and Alaskan Native membership. The Statewide population is 15.4% American Indian and Alaskan Native. On this basis, an evaluation of disproportionate impacts is required. BOEMRE has found in past analyses that the best indicator of disproportionate impacts on the minority and low income populations of the North Slope are the impacts to subsistence practice and any consequent impacts on the sociocultural systems (USDOI, MMS, 2008a).

3.2.11. Public Health

The health and welfare of the residents of the NSB is a primary concern of any offshore oil and gas activity in the Beaufort Sea. Public health descriptions in the 2011 Camden Bay EP are incorporated by reference, and salient points are summarized below. The main public health issues in the NSB include:

- General health
- Accidental injuries
- Cultural stress mitigation
- Cardiovascular and cerebrovascular disease
- Cancer
- HIV
- Sanitation
- Contaminant exposure to environmental pollutants
- Psychosocial health
- Nutrition
- Noncommunicable disease
- Chronic lung disease
- Respiratory Infections
- Maternal child health
- Health services infrastructure

Indicators of general population health include life expectancy, mortality rates, infant mortality, and general health and well being surveys. North Slope communities have experienced a decline in epidemic infectious disease, with mortality rates declining and life expectancy increasing. Since the era of epidemic infectious diseases the health status of North Slope communities is now characterized by increases in diabetes, cancer, and ongoing social and psychological stress and change.

As noted in the 2011 Camden Bay EP, the project is designed to avoid any interference with public health in the communities of Kaktovik and Nuiqsut, in the following manner:

- Helicopters will be based out of Deadhorse and provide support for crew change, provision resupply, SAR operations on isolated flight paths;
- Exploration drilling activities at the Sivulliq or Torpedo drill sites are planned to begin on or about July 10 and run through October 31, with a suspension of all operations beginning August 25 for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. The drilling vessel and support vessels will leave the Camden Bay project area and will return to resume activities after the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts conclude. Activities will extend to midnight October 31, depending on ice and weather; and
- The distance from these two communities to the exploration site is sufficient to avoid any project operations from intruding on everyday community life. The project area is approximately 60 mi (96.5 km) from Kaktovik and 120 mi (193 km) from Nuiqsut.

3.2.12. Archaeological Resources

The Archaeological Resource requirements are contained in NHPA and 36 CFR 800 as well as in BOEMRE operational regulations under 30 CFR 250.194. The technical requirements for the archaeological resource surveys and reports that may be required under the regulations are detailed in the Alaska OCS Region NTL 05-02 and NTL 05-A03.

Under Section 106 of the National Historic Preservation Act, BOEMRE consults with the Alaska State Historic Preservation Office (SHPO) for OCS activities during the pre-lease process. Section 106 consultation for the Beaufort Sea Planning Area was completed in conjunction with completing the Beaufort Sea Multiple-Sale EIS and again recently in conjunction with the Arctic Mutliple-Sale Draft EIS (SHPO concurrence dated September 24, 2008).

The BOEMRE's review of the site-specific geophysical data indicates that there are no historic properties at Shell's proposed drill sites. On June 29, 2011, BOEMRE concluded Section 106 consultation with the Alaska State Historic Preservation Officer (SHPO). BOEMRE informed the SHPO of the determination that drilling of the four wells and related activities will have no effect on historic properties. The SHPO concurred with BOEMRE's determination of no historic properties affected on July 6, 2011.

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4.0 ENVIRONMENTAL CONSEQUENCES

Analytical Process. Each alternative was analyzed for direct and indirect effects to the resources identified in Section 3.0. The analysis also included the identification of mitigation, where appropriate, which could be used to limit these effects. Each alternative was then analyzed for its incremental contribution to the cumulative effect of all past, present, and reasonably foreseeable future actions for each resource. A summary of prior analyses which included the effects of a large and a very large oil spill is provided in Sections 5.6 – 5.8. A level of effect determination (negligible, minor, moderate or major), based on the definitions provided in Appendix B, is provided for each resource in the following sections.

4.1. Alternative 1 – the No Action Alternative

4.1.1. Direct and Indirect Effects

Under Alternative 1- the No Action Alternative, Shell's 2011 Camden Bay EP would not be approved, a permit to drill would not be issued, and the proposed activities would not occur. Not issuing the permit to drill the exploratory wells at the Sivulliq and Torpedo prospects could delay the evaluation of borehole data required to increase the human understanding of the geology and petrophysical characteristics of the rocks needed for the assessment of geologic origin and potential petroleum reserves. Not approving the EP and issuing a permit to drill would result in lost or delayed opportunities for discovery and production of natural resources and any associated economic benefits

Under Alternative 1 – The No Action Alternative, there would be no disturbance to any resources attributable to the proposed exploration drilling activities. There would be no effects on biological or subsistence resources.

4.1.2. Cumulative Effects

The Arctic Ocean ecosystem is rapidly changing, with melting sea ice and increasing sediment input from numerous regional river systems. Open water seasons are longer than in past years and there has been a reduction in multi-year ice. Activities which are currently ongoing in the U.S. Arctic region or which may occur in the foreseeable future which may affect OCS resources include: increased marine vessel and air traffic, fuel and petroleum spills, permitted and non-permitted discharges, long-distance aerosol-transported pollutants, pollutants, warming temperatures, melting of sea ice, ocean acidification, and risk of invasive species from ship hulls and equipment deployed. Specific activities which are reasonably foreseeable to occur during the period of the Proposed Action and which are included in the analysis of cumulative effects are summarized in Appendix C, Cumulative Effects, of this EA.

The 2006 Seismic PEA, Lease Sale 195 and 202 EAs, and the Beaufort Sea Multiple-Sale EIS provide detailed descriptions of past activities, reasonably foreseeable future activities and the environmental consequences of these activities in the Beaufort Sea. If the Proposed Action does not take place, no additional effects would be added to the effects associated with ongoing or reasonably foreseeable future activities in the Beaufort Sea that are described in Appendix C, Cumulative Effects.

4.2. Alternative 2 – The Proposed Action

4.2.1. Air Quality

The condition of local air quality could be adversely affected by the introduction of additional emissions from new pollution sources. This section evaluates the potential for adverse air quality effects due to pollutant sources required for the proposed Shell Offshore Inc. (Shell) Revised Exploration Plan (EP) (2011 Camden Bay EP). Implementation of the 2011 Camden Bay EP would require the use of a large drilling ship and support marine vessels in Camden Bay, and aircraft operating from nearby Deadhorse Airport. The air quality analysis of the emissions associated with the Proposed Action was provided by Shell in the Environmental Impact Assessment (EIA) appended to the 2011 Camden Bay EP (2011 Camden Bay EIA). Additional information was available through review of the air operating permits for the drillship *Kulluk* (Shell, 2011d; Shell, 2011e), and the drillship, *Discoverer* (Shell, 2010; Shell, 2011d). Information reviewed and incorporated into this assessment also included the air quality evaluations provided in the 2002-2007 Five-Year Program Environmental Impact Statement (EIS) (USDOI, MMS, 2002), the 2003 Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003), and the 2009 Camden Bay EA (USDOI, MMS, 2009a). The collective information was reviewed and evaluated for potential adverse air quality impacts relative to the specific federal action proposed for the 2011 Camden Bay EP. The specific action is the proposed drilling of four exploratory wells on two prospects in Camden Bay, adjacent to Alaska's North Slope Borough, in the Beaufort Sea.

Other sections in this environmental review provide information relative to regulations, meteorology and climate of the Arctic, existing air quality on the North Slope, and characteristics of the emission sources considered in the air quality assessment. A list of the relevant sections is provided in Appendix D, Air Quality. The statutory framework guiding the assessment of air quality impacts is found in the discussion of the Clean Air Act (CAA) earlier in Section 1.3.5, which includes details of the air operating permits required for operation of the 2011 Camden Bay EP. Meteorological conditions at the location of the drill sites are described earlier in Section 0., Expected Weather Conditions at the Drill Sites.

The existing character of air quality on the North Slope is discussed earlier in Section 3.2.1, which includes an overview of the regulations that guide pollution control on the Outer Continental Shelf (OCS). The characteristics of the pollutant sources associated with the Proposed Action are described earlier in Section 2.3.4, Drillship, Support Vessels, and Aircraft, and Section 2.3.6, Emissions, which includes descriptions of the emission reduction measures and Best Available Control Technology (BACT) proposed for the drillship *Kulluk* and the optional drillship, *Discoverer*. Additional information, including tables reflecting the air quality analysis results are provided in Appendix D, Air Quality.

4.2.1.1. Direct and Indirect Effects

The assessment of potential air quality impacts due to the Proposed Action is based on the air quality technical analysis provided in the 2011 Camden Bay EP. The 2011 Camden Bay EP includes the 2011 Camden Bay EIA, and references the drillships *Kulluk* and *Discoverer* air operating permit applications that were submitted to the EPA Region 10 for review and approval. The 2011 Camden Bay EIA and the permit applications, together with all subsequent supporting documentation, were reviewed and found to include all drillship emission information and emission reduction measures required for the EP, which complies with 30 CFR 250.218. In addition, the documentation provided by Shell included emission information for support vessels, aircraft, and onshore and offshore emission sources needed for support of the proposed EP, as required under 30 CFR 250.224 and 250.225. Therefore, the data provided in the 2011 Camden Bay EP was adequate for BOEMRE to make the regulatory assessment of potential air quality impacts pursuant to the OCS Air Regulations (40 CFR Part 55).

Table 10 Annual Emissions allowable under the state and federal CAA Title V air permits for the drillship *Kulluk*.

Pollutant Group	Emissions (tons per year)									
	NO_X	$PM_{2.5}$	PM_{10}	CO	SO_2	VOC	Pb	NH_3	RSC	CO_2e
Stationary OCS Source										
Kulluk Drillship	48.66	6.15	6.39	42.36	1.09	12.31	0.02	1.00	0.14	13168.61
Support Vessels	127.02	17.31	17.51	77.39	3.08	16.24	0.03	12.43	0.13	44189.30
OSR Vessels	37.93	2.84	3.06	38.35	0.37	10.23	0.02	NA	0.12	2359.01
OSR Work Boats	15.01	1.20	1.20	4.05	0.05	1.49	0.00	NA	0.00	697.07
Total Stationary OCS Source	***228.62***	***27.51***	***28.16***	***162.15***	***4.59***	***40.26***	***0.07***	***13.43***	***0.39***	***60,413.99***
Mobile Source										

Pollutant Group	Emissions (tons per year)									
	NO_X	$PM_{2.5}$	PM_{10}	CO	SO_2	VOC	Pb	NH_3	RSC	CO_2e
Aircraft	2.84		0.10	3.93	0.35	1.73	NA	NA	NA	960.28
Total Project Emissions	**231.46**	**27.51**	**28.26**	**166.08**	**4.94**	**41.99**	**0.07**	**13.43**	**0.39**	**61,374.27**
Major Source Threshold	*250*	*250*	*250*	*250*	*250*	*250*	*250*	*None*	*None*	*100,000*

Note: CO_2e is carbon dioxide equivalent, and represents greenhouse gas (GHG) emissions.
Annual refers to the drilling season, approximately 120 days.
RSC represents hydrogen sulfide (H_2S), upper limit of total reduced sulfur and reduced sulfur compound emissions.
NA is not available.

Source: Shell, May 2011, Environmental Impact Analysis – Revised Outer Continental Shelf Lease Exploration Plan, Section 2.8, Air Emissions, Table 2.8-1, *Kulluk* Annual Potentials to Emit.
Shell, April 28, 2011, Engineering Calculations [*Kulluk*_Beaufort EI 20110429.xls]

The direct and indirect emissions caused by implementation of the Proposed Action include the drillship, the support vessels, and the aircraft. Shell prepared an emission inventory of these sources in support of the air quality permits required by the Environmental Protection Agency (EPA) and the Alaska Department of Environmental Conservation (ADEC). The emission inventory included the use of Best Available Control Technology (BACT) and owner-requested restrictions (ORR) to lower emissions, particularly emissions of nitrogen oxides and carbon monoxide from drilling operations. The total projected annual emissions from the drillship, *Kulluk*, and the alternate drillship, *Discoverer*, are given in Table 10 and Table 11.

Table 11 Annual Emissions allowable under the state and federal CAA PSD air permits for the drillship *Discoverer*.

Pollutant Group	Emissions (tons per year)									
	NO_X	$PM_{2.5}$	PM_{10}	CO	SO_2	VOC	Pb	NH_3	RSC	CO_2e
Stationary OCS Source										
Discoverer Drillship	20.80	2.52	2.57	6.46	0.22	3.13	0.02	0.16	0.14	57,585.72
Support Vessels	125.68	13.74	14.10	69.58	0.55	17.74	0.03	0.36	0.13	
Offshore Management	72.51	2.14	2.51	46.11	0.26	11.05	0.00	0.00	0.00	
OSR Vessels	98.07	1.04	1.41	27.63	0.27	9.75	0.02	0.00	0.12	
OSR Work Boats	19.06	1.34	1.34	4.11	0.01	1.51	0.00	0.00	0.00	
Total Stationary OCS Source	**336.12**	**20.78**	**21.93**	**153.89**	**1.31**	**43.18**	**0.07**	**0.52**	**0.39**	**57,586.00**
Mobile Source										
Aircraft	2.84		0.10	3.93	0.35	1.73	NA	NA	NA	960.28
Total Project Emissions	**338.96**	**20.78**	**22.03**	**157.82**	**1.66**	**44.91**	**0.07**	**0.52**	**0.39**	**58,546.00**
Major Source Threshold	*250*	*250*	*250*	*250*	*250*	*250*	*250*	*None*	*None*	*100,000*

Notes: CO_2e is carbon dioxide equivalent, and represents greenhouse gas (GHG) emissions.
CO_2e emissions shown for the drillship Discoverer is the total for all the marine vessels required for the exploration plan and listed in this table.
Annual refers to the drilling season, approximately 120 days..
RSC represents hydrogen sulfide (H_2S), upper limit of total reduced sulfur and reduced sulfur compound emissions.
NA is not available.

Source: Shell, May 2011, Environmental Impact Analysis – Revised Outer Continental Shelf Lease Exploration Plan, Section 2.8, Air Emissions, Table 2.8-2, *Discoverer* Annual Potentials to Emit.
Shell, April 28, 2011, Engineering Calculations [*Discoverer*_Beaufort_EI 20110519_D.xls]

Values given in Table 10 and Table 11 represent emissions after the application of reduction strategies, such as, BACT and other owner-requested restrictions (ORR). For the drillship *Kulluk*, emissions of NO_X, and CO, and SO_2 were greater than the threshold of 250 tons per year before application of the reduction strategies but were reduced to less than 250 tons per year when the emission reduction strategies were applied, defining the *Kulluk* as a minor source. Emissions of NO_X for the *Discoverer* remained above the threshold even after emission reduction strategies were applied, defining the *Discoverer* as a major source.

In the 2011 Camden Bay EIA, the emission inventories of the OCS stationary sources (not including mobile sources) were translated into pollutant concentrations using computer modeling for comparison to the National Ambient Air Quality Standards (NAAQS) and the Alaska Ambient Air Quality Standards (AAAQS). The results of the dispersion analysis provided by Shell are included in Appendix D, Air Quality. The results show the Proposed Action, using either the drillship *Kulluk* or *Discoverer*, would not cause emissions that would result in pollutant concentrations that would equal or exceed the NAAQS or the AAAQS.

In the assessment of air quality impacts associated with the Proposed Action, Shell considered the emissions of greenhouse gases (GHG) and carbon dioxide equivalent emissions (CO_2e). In a June 2010 ruling by the EPA, referred to as the Tailoring Rule, the agency establishes a schedule for the applicability criteria that determine which new stationary sources are required to report GHG emissions from federal actions (75 *FR* 31514, 2010). The Tailoring Rule states that as of July 1, 2011, a new stationary source is not subject to GHG regulations unless the federal action emits or has the potential to emit 100,000 tons per year or more of CO_2e. The 2011 Camden Bay EP inventory shows potential emissions of CO_2e from either ship would be less than 65,000 tons per year. As such, the requirement to report GHG would not apply to the Proposed Action.

Black carbon, commonly referred to as soot, is a pollutant with high radiative forcing that supports warming trends in the Arctic. Radiative forcing is the result of the difference between the expected amount of incoming and outgoing solar energy, where radiative forcing is measured in watts per square meter. The analysis required to find the actual value of this ratio is complicated and difficult, and involves not only black carbon but other factors such as natural deforestation and volcanic activity (Chandler, 2010). Arctic haze contributes to the budget of black carbon in the Arctic, and along with soot emissions from diesel engines, black carbon has a tendency to decrease the albedo, or reflectivity, of sea ice. The decrease in albedo contributes to the warming and loss of sea ice. The drillship proposed for the exploration plan uses diesel engines for drilling and would be the largest source of black carbon attributable to the exploration plan. The loss of sea ice is not affected solely by black carbon deposits, but depends on snow cover, ice age, ice thickness, and state of melting (Dorn, Dethloff, and Rinke, 2009). Also, the magnitude of Arctic snow albedo effects is seasonal, and the effect is not measurable in the dark Arctic winter (Kopp and Mauzerall, 2010). A mitigation strategy to decrease the emissions of particulate matter (PM), the main source of black carbon from a diesel engine, is the use of low sulfur fuel. Sulfur is emitted directly as a component of burning crude oil and is found in both gasoline and diesel. Low sulfur diesel fuel (~10 to 15 parts per million) controls emissions of NO_X and PM. Particulate filters on engines using low sulfur fuel reduce PM from 50 percent to near 100%. The State of Alaska finalized a rule making the use of low-sulfur fuel (15 ppm maximum) mandatory in all highway, nonroad, locomotive, and marine diesel engines (71 FR 3250 June 6, 2006). Although the exploration plan proposed for the Beaufort Sea would occur in the summer months, the drillship and all the support marine vessels are required to use ultra-low-sulfur fuel, as required by the State of Alaska. In addition, the drillship vessel would be equipped with other emission reduction equipment, as required in the air quality permits for the Kulluk and the Discoverer. Thus, emissions of black carbon would be reduced to the greatest extent possible.

Upon reviewing and evaluating the relevant documents, BOEMRE expects the same level of effect from the Proposed Action as characterized in the 2011 Camden Bay EP. As such, the BOEMRE considers the Proposed Action to be compliant with state and federal air quality standards and without potential to cause or contribute to any violation of the NAAQS or the AAAQS that define healthful air quality. Also, the annual emissions are considered compliant with the plans and milestones included in the Alaska Air Quality Control Plan, including the Alaska State Implementation Plan (SIP). Further, the Proposed Action is considered compliant with the relevant provisions of the Clean

Air Act (CAA), including Title I, Section 176(c)(1), Limitations on Certain Federal Assistance, Title I, Part C, Prevention of Significant Deterioration of Air Quality, and Title III, Section 328, Air Pollution from Outer Continental Shelf Activities. As such, the level of effect on air quality caused by the Proposed Action is considered minor for the exploration plan using either the drillship *Kulluk* or the drillship *Discoverer*. The levels of effect relevant to air quality impacts are provided in Appendix B. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

4.2.1.2. Cumulative Effects

The Proposed Action includes the temporary use of marine vessels and aircraft, which are pollutant sources that could contribute to the emission budget within the North Slope Borough. In addition, the proposed action may impact other activities in the same region of the Beaufort Sea that could have an adverse cumulative effect on air quality. Specifically, any additional activities occurring during the same time period and in the same general area requiring the use of large marine vessels or aircraft 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, when considering prevailing wind conditions over the open sea, the few emission sources onshore, and the distance of the proposed drilling sites from the shoreline, emissions from the proposed action, when combined with other operations in the Beaufort Sea, would likely be diluted and dispersed resulting in pollutant concentrations below the air quality standards at the shoreline. A thorough description of the relevant additional activities that are recent, ongoing, or reasonably foreseeable during the period of time as the Proposed Action, and that could result in measurable adverse cumulative air quality impacts, is provided in Appendix C.

Projects that are reasonably foreseeable to occur during the same time period or in the same general area as the proposed action include, (1) the multiple-well exploration drilling in the Chukchi Sea proposed by Shell; (2) the Bowhead Whale Feeding Ecology Study (BOWFEST), sponsored by the National Oceanographic and Atmospheric Administration (NOAA) and the National Marine Mammal Laboratory since 2007, and planned to continue from August through September 2012, (3) the Chukchi Acoustics, Oceanography, and Zooplankton (CHAOZ) study, which is planned to take place from July through September 2012 in the Bering, Chukchi, and Beaufort seas; (4) the Chukchi Offshore Monitoring in Drilling Area (COMIDA) aerial cetacean survey, which is planned to take place from mid-June through October 2012, in the northeast Chukchi Sea; and (5) periodic occurrence of Arctic haze. Arctic haze is a seasonal occurrence in the winter through the summer months, and even with the past contribution of temporary marine vessel emissions in the area, the EPA considers the North Slope Borough as a clean air resource where the pollution does not violate federal clean air standards and is not a threat to human health or wildlife habitats.

Due to prevailing wind conditions over the open sea, because of the few emission sources in the onshore areas of the North Slope Borough, and due to the distance of the projects from the North Slope, the level of air quality effect when considered together with the emissions from the proposed action would be minor and would not result in adverse cumulative impacts to air quality. The reasonably foreseeable cumulative effects will occur at nearly the same level each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the impacts to air quality from the Proposed Action and from reasonably foreseeable cumulative activities would amount to a minor level of effect.

4.2.2. Water Quality

4.2.2.1. Direct and Indirect Effects

The exploratory drilling proposed in Camden Bay for the open-water seasons of 2012 and subsequently, until completion of 4 exploratory wells, would be conducted under NPDES General Permit AK280000 (Offshore Oil and Gas Exploration Facilities in Alaska) as authorized by EPA. The type and degree of effects on water quality from discharges into the marine environment are influenced by several physical factors including: rate of discharge, depth of discharge, concentration of contaminants, currents, bathymetry, density layers, oxygen concentration and water temperature. These factors would be considered by EPA under its NPDES permitting process.

Cuttings (without drilling mud) from well intervals and construction of mud cellars would be discharged to the seafloor under this General Permit. Shell estimates that a total of 36,750 bbl of cuttings from the four drill holes would be discharged or deposited to the sea floor. Discharge of these cuttings would increase turbidity and suspended sediment in the water column in the vicinity of the drill holes (Table 12).

Waste streams from desalination, treated deck drainage, cooling water, blow-out preventer fluid and cement would also be discharged according to NPDES AK280000.

Seawater withdrawn for use as non-contact cooling water would be discharged from the drillship (at a depth of 41 ft (12.5 m) or 19.6 ft (6.0 m)) at temperatures above-ambient sea temperature. These thermal wastewaters would discharge into the sea above the stratification for salinity and temperature (found at approximately 20m) and would likely mix quickly. It is estimated that the thermal discharge would affect water temperatures within an area 164 ft long and 13 ft wide at the drillship *Discoverer* and 256 ft long and 16 ft wide at the drillship *Kulluk* (Shell, 2011a). Desalination brine would be discharged as a waste stream with higher salinity and other dissolved constituents than the ambient receiving water (Table 12).

Table 12 Waste (bbls) to be discharged from four exploration wells proposed into the Beaufort Sea.

Type of Waste	Sivulliq G	Sivulliq N	Torpedo H	Torpedo J	Total Discharge from 4 Lease Blocks
Drill Cuttings without Drilling Muds - Discharged	9,035	9,041	9,337	9,337	36,750
Non-Contact Cooling Water - Discharged	1,978, 052	1,978, 052	2,559,832	2,559,832	9,075,768
Desalination Brine - Discharged	4,200	4,200	5,500	5,500	19,400
Deck Drainage - Discharged	170	170	220	220	780
Blow-Out Preventer Fluid -Discharged	56	56	56	56	224
Excess Cement - Discharged	50	50	50	50	200

Note: 1bbl = 42 gallons, 5.614 ft^3 and 0.159 m^3

A total of 15,862 bbl of seafloor material would be excavated to construct four mud cellars and those cuttings would be deposited on the seafloor (Table 13) below the temperature and salinity stratification layer. The excavation of mud cellars would increase sediment, suspended solids and turbidity in the lower water column above background levels (1.8 – 3, NTU; 0.26 – 0.73 mg/L TSS as measured over four days in August, 2008).

Table 13 Estimated surface area disturbed and volume of sediment excavated by two drill ships to construct a maximum of four mud cellars in Camden Bay during the Proposed Action.

Drill Ship (# of Mud Cellars)	Diameter of Mud Cellar	Total Surface Area Disturbed (2 mud cellars)	Depth of Mud Cellar	Total Volume Extracted (2 Mud Cellars)
Discoverer (2)	≥20 ft (6.1 m)	≥628 ft^2	41 ft (12 m)	≥6,098 bbl (969.4 m^3)
Kulluk (2)	≥24 ft (7.3 m)	≥904 ft^2	41 ft (12 m)	≥8,764 bbl (1393 m^3)

Note: 1bbl = 42 gallons, 5.614 ft^3 and 0.159 m^3

Anchoring would include setting 8 to 12 anchors at each site depending on which drill ship is in use. The seafloor area affected and the volume excavated in anchoring is presented in Table 14. Anchoring would introduce suspended sediment and turbidity into the lower water column causing concentrations above background levels.

Table 14 Seafloor scarring as a result of anchor sets at four proposed drilling sites in Camden Bay.

Drill Ship (# of Drill Sites)	# of Anchors Deployed/ Drill Site	Scar Area for Each Anchor and Chain	Total Scar Area for all Anchors at 2 Drill Sites	Seafloor Penetration of Anchor
Kulluk (2)	12	3,249 ft2(302 m^2)	77,976 ft^2 (7,244 m2)	down to 10 ft (3.06 m)
Discoverer (2)	8	2,124 ft^2 (197 m)	33,984 ft^2 (3,157 m2)	down to 11 ft (3.4 m)

Note: 1bbl = 42 gallons, 5.614 ft^3 and 0.159 m^3

Shell has proposed for 2012 and 2013 (with additional seasons as necessary until completion of four wells) to not discharge spent water-based drilling fluids; drill cuttings with adhered drilling fluids; sanitary waste; domestic waste; hazardous waste; used oil; bilge water; and ballast water (Table 15). Instead, these waste streams would be collected at the drilling site, contained and shipped via barge out of the Beaufort Sea to an approved facility in Arlington, Oregon. It is estimated that 14,902 barrels of spent water-based drilling muds and cuttings with adhered drilling muds would be generated and then shipped to the disposal facility, thus reducing the potential effects on water quality in Camden Bay. Domestic waste (92,112 bbls) would be collected, contained and shipped out of the Arctic, reducing the nutrients and contaminants.

Table 15 Waste (bbls) to be collected and transported out ("Not Discharged") from four exploration wells proposed in the Beaufort Sea.

Type of Waste	Sivulliq G	Sivulliq N	Torpedo H	Torpedo J	Total Waste Not-Discharged from 4 Lease Blocks
Water-Based Mud – Not Discharged	2,213	2,213	3,022	3,003	10,451
Drill Cuttings with Water-Based Mud – Not Discharged	713	713	1,522	1,503	4,451
Sanitary Waste – Not Discharged	5,391	5,391	6,977	6,977	24,736
Domestic Waste – Not Discharged	20,075	20.075	25,981	25,981	92,112
Ballast Water – Not Discharged	1,670	1,670	1,720	1,720	6,780
Bilge Water – Not Discharged	612	612	792	792	2,198
Used Oil – Not Discharged	50	50	50	50	200
Hazardous Waste – Not Discharged	10	10	10	10	40

Note: 1bbl = 42 gallons, 5.614 ft^3 and 0.159 m^3

Specific information is available on the water chemistry (Trefry and Trocine, 2009) and benthic habitats (Dunton, Schonberg, and McTigue, 2009) in the proposed drilling area. These studies were conducted in light of past drilling activity in the lease area (one well in 1985 and 1 well in 1986). The results from the research of Trefry and Trocine (2009) showed that levels of total metals, total petroleum hydrocarbons and total polycyclic aromatic carbons were not elevated above background at most of the 46 sites they sampled in the Sivulliq area in the summer of 2008. The exceptions to the background levels were found near the two sites drilled in the mid-1980s. This suggests that the drilling muds deposited on the seafloor showed some residual chemical signatures twenty years later. In the current drilling proposal, drilling fluids and cuttings with adhered drilling fluids would not be deposited or discharged but instead barged out of the Beaufort Sea. The elimination of this waste stream would result in a reduction of materials and chemical constituents entering the sea at the drill site and subsequently, reduced turbidity, suspended sediment and chemical residues at the drill sites (Table 16).

Table 16 Waste Streams and the Effects on Water Quality in 2012 the Proposed Action.

Activity/Waste Stream	Effects on Water Quality
Spent water-based drilling fluids and drill cuttings with adhered drilling fluids collected and shipped out by barge	No effect on water quality
Sanitary waste; domestic waste; hazardous waste; used oil; bilge water; and ballast water collected and shipped out by barge	No effect on water quality
Drill cuttings without drilling fluids discharged or deposited to seafloor	Turbidity, suspended sediments in water column as permitted under NPDES
Desalination brine waters, cooling waters treated deck drainage, excess cement and blow-out preventer fluid discharged subsurface	Warming in immediate area, increased salinity in immediate subsurface waters, fluid and cement chemical constituents into subsurface and seafloor as permitted under NPDES

There is a potential for fuel spills during fuel transfers. A fuel spill would introduce hydrocarbons and temporary toxicity effects to the surface water. The effects of a fuel spill would be limited by required deployment of booming equipment during fuel transfers and automatic shutdown of fuel lines triggered by decreased pressure.

A small oil spill of 48 barrels was estimated based on the oil spill analysis discussed in section 2.3.9. An oil spill of this size would introduce petroleum hydrocarbons to the surface water and water column. Acute hydrocarbon toxicity levels in the water column could occur initially, however, at these concentrations, the acute toxicity would be short-lived and spatially limited. The chronic hydrocarbon concentrations, however, would persist for less than three days in the immediate area of the spill.

The following are ways in which water quality effects would be mitigated:

- Barging waste streams instead of discharging or depositing at the drill site
- Booming fuel transfer activities
- Equipment for early warning of a potential well-control event
- Oil spill response vessels in the immediate vicinity of the drilling operations
- Operations conducted under NPDES permit authorized and administered by EPA
- Adherence to the following plans: Critical Operations and Curtailment Plan (in the event hazards are identified in the vicinity of the drilling operations); Ice Management Plan; Well Control Contingency Plan; and Fuel Transfer Plan

After mitigation, the effects of the proposed actions on water quality would be minor. The minor effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The direct and indirect effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

4.2.3. Cumulative Effects:

The activities described in this analysis are projected for a near future time frame of July-October, 2012, July-October 2013 and potentially July-October in following years. The cumulative effects of these activities on water quality are expected to be minor in the immediate Camden Bay area of the drilling operation and minor on the regional Beaufort Sea scale.

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. The number of cargo, tourism and research vessels in the region is increasing as the ice cover is reduced. This increases the risk of vessel accidents, groundings and potential oil and cargo spills and introduction of marine invasive species. These ongoing effects would be the background effects on which Shell's July-October, 2012 and July-October, 2013 (and potentially July-October in following years) Camden Bay operation would occur.

Over the four drilling sites and associated activities, the effects on water quality in Camden Bay would be minor. The effects of the proposed exploratory drilling, in addition to other ongoing activities in Camden Bay, would be minor. The reasonably foreseeable cumulative effects will occur at nearly the same level each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the impacts to water quality from the Proposed Action and from reasonably foreseeable cumulative activities would amount to a minor level of effect.

4.2.4. Lower Trophic Levels

4.2.4.1. Direct and Indirect Effects

Direct and indirect effects on the lower trophic resources include the sediments displaced during anchoring of drilling rigs, construction of the mud line cellar (MLC), and early drilling phases, permitted water discharges through the EPA NPDES permit, potential of invasive species introduction, and potential liquid hydrocarbon spills. Although the effects on lower trophic populations include past and future deposition of mercury, barium, and hydrogen sulfide on surface sediments due to sediment disruption, problems with the mechanical turbation of benthic environments due to ice gouging and ice melt, or a paucity of life cycle information on many invertebrate species (USDOI, USGS, 2011), these factors would not be a factor during the time period analyzed within this analysis. There are no known sensitive or unique biological communities in the vicinity of the exploration drill sites that would be affected by these activities.

The 2011 Shell Camden Bay EIA (Section 2.2) discusses two possible drilling rigs, the *Kulluk* and the *Discoverer*. The *Kulluk* will deploy a total of 12 anchors, and the *Discoverer* a total of 8 anchors. Drilling vessels and anchor handling vessels would deploy and retrieve anchors a total of 4 times at each of the proposed 4 drill sites during the 2012 and 2013 exploration periods. This will account for deployment of anchors during exploration initiation in July, retrieval of anchors during suspension of drilling activities and movement of the drill ships offsite in August to enable mitigation for the migration of Bowhead whales and subsistence hunting activities, and repeat of deployment and retrieval of anchors to proceed for the second half of the work season from August through October. At each anchor site, seafloor disturbance will occur and sediment will be displaced during the placement and setting of anchors. Embedment type anchors will be used, designed to anchor and drag through the seafloor for approximately 2-3 times the anchor length (anchor maximum length of 21.5 ft (6.5 m), depending on drill ship and anchors used). The anchor chain and any landed anchor wires will create an anchor trough while being dragged after placement of the anchor on the seafloor that will add to the anchor scar. The dimensions of these anchor scars vary with the size of the anchor, the length of the chain, and seafloor characteristics. The scars in the case of the *Kulluk* are expected to have an average surface area of 3,249 ft^2 (302 m^2) and a disturbed volume of 543 yd^3 (415 m^3) per anchor. The total scar area for all 12 anchors would be 38,988 ft^2 (3,622 m^2), with a total volume of 6,516 yd^3 (4,980 m^3) per drill site. (A detailed discussion of this process including sizes of anchors and volumes of sediment displaced can be found in Section 2.3 of the 2011 Camden Bay EP.) The known composition of the seafloor sediments in the region of the proposed drill sites, and studies of ice gouge affects of reshaping the benthic environments implying they will be disturbed by ice gouging activities as much as the anchor placements, leads to a conclusion of a negligible effect on benthic lower trophic populations caused by these activities.

A MLC will be constructed at each of the 4 drill sites as preparation for the drilling operations. The MLC is a circular working platform drilled into the hard mud under the surface of the benthic environment at the seafloor. For the *Kulluk*, the diameter will be at least 24 ft (7.3 m), with a depth of approximately 41 ft (11.3 m) below mudline. Estimated volume of displaced or disturbed sediment is approximately 4,382 bbl (696 m^3). Early drilling phases will displace sediments to the level of the first drill casing, but proposed capture of drilling discharges and muds will negate release of sediment. (A detailed discussion of MLC construction and resulting discharges can be found in

Section 2.3 of the Shell Revised OCS EP). The displaced sediments of these activities have been modeled by Shell to cover approximately 1,592 ft (0.48 km) from the discharge source. The cuttings pile would be greatest approximately 66 ft (20 m) down-current from the discharge site, with dimensions of 10 ft (3.0 m) thick and 328 ft (100 m) wide. At approximately 886 ft (270 m) down-current of the source, the cuttings were estimated to be 0.4 in. (1 cm) thick and 246 ft (75 m) wide. A total of 36,750 barrels of cuttings (without drilling mud) would be discharged to the seafloor during the drilling of four exploration wells. The effects of these sediment deposits downstream from the creation of the MLC would result in a localized and temporary loss of pelagic and benthic communities directly affected by the suspension and deposition of the displaced sediments.

Permitted NPDES discharges that are not reclaimed, stored and shipped by barge will include desalination brine waters, cooling waters, treated deck drainage, excess cement and blow-out preventer fluid. These will cause local and temporary effects to surface and pelagic environments that will be negligible.

Several factors may potentially introduce invasive species during the Proposed Action. These include the use of equipment imported from other regions that may contain internal or surface viable life stages of invertebrate organisms that potentially could be released into the environment during the normal use of the equipment for work purposes, the presence of fouling organisms on hulls or propellers, and the release of ballast waters not properly discharged in transit. At the present time, invasive marine species have not been documented in Arctic waters. Therefore, the level of effects is negligible. However, with the potential of climate change, increase in ocean acidification, and increased industry and research activity in the Arctic regions, there is a corresponding potential of greater future risks for introduction of invasive species to the Beaufort and Chukchi Sea waters.

Oil spill effects, mitigation of oil spills, and their potential of occurrence are discussed in detail in Sections 2.3.9 and 2.3.10 of this document. The effects of small (<1,000 bbl) to large (≥1,000 bbl) oil spills on lower trophic level organisms are dependent upon seasonality, duration, and weather conditions during and following the event. Spills of these magnitudes would likely have lethal, but localized, effects to limited numbers of the populations of lower trophic-level organisms by exposing them to petroleum-based compounds at, or above, acute or chronic toxicity levels and result in negligible to minor effects.

In summary, all the above listed direct and indirect effects from the Proposed Action alternative on pelagic, benthic, and epontic lower trophic organisms would be limited by the coverage area of the four proposed drill sites and the time scale of the two work seasons considered in the exploration plan. Therefore, the effects are considered to be short-term and negligible. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The negligible to minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

4.2.4.2. Cumulative Effects

Cumulative effects are discussed in detail in the Arctic Multi-Sale Draft EIS (USDOI, MMS, 2008a: pp. 4-1 – 4-13) and in Appendix C of the current document, and are summarized below. Within this section, the natural and anthropogenic cumulative effects are discussed for the surface and pelagic waters and the benthic seafloor environments within the area of the Torpedo and Sivulliq prospects and the time period of the proposed July through October exploration period.

The effects of climate change on surface and pelagic waters of the proposed drill sites include warming of the surface temperatures, changes in sea ice resulting in an increase in length of the open water season in the region, and resultant ocean acidification stemming from these changes. Anthropogenic effects include deposition of soot from air emissions, accidental spills of petroleum byproducts from vessel refueling and other vessel activities, and surface disturbance from the passage of military, research, recreation, subsistence, and industry aircraft and marine vessels. These activities present a potential for adverse environmental effects in the proposed time period of the project, but the duration of the project would make the cumulative effects negligible, localized and temporary.

Natural cumulative effects for the Proposed Action and specific to the benthic environment within the proposed drill sites include ice gouging and ice melt from glaciers and winter snow cover contributing to the seasonal influx of nutrients and sediments from the Canning, Colville, Sagavanirktok River, and other regional rivers and streams that will be deposited over benthic environments. Anticipated anthropogenic effects include anchor deployment and retrieval for drilling rigs and other associated support vessels, and MLC construction and subsequent release of sediments. Anchor deployment and retrieval will also occur for the airgun array used during vertical seismic profiling and the data collection buoys utilized during ancillary activities. Other 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 in the proposed time period of the project, but the duration of the project and the sand, silt, and mud substrate of the benthic environment would make the cumulative effects negligible. The reasonably foreseeable cumulative effects will occur at nearly the same level each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the impacts to lower benthic resources from the Proposed Action and from reasonably foreseeable cumulative activities would amount to a negligible level of effect.

4.2.5. Fish and Essential Fish Habitat

4.2.5.1. Direct and Indirect Effects

Fish and Essential Fish Habitat (EFH) in the project area would be affected by several aspects of the proposed exploration drilling activities including: vessel traffic, vessel noise, and vessel anchoring; mud cellar construction; drilling noise and drill cuttings; permitted waste stream discharges (under NPDES Permit AKG280000, expired June 2011 and expected to be re-issued in 2012 before open-water season); water withdrawals; small refueling spills; and oil spills from vessel accidental spills or well releases. These activities and potential effects are presented in (Table 17).

Table 17 Proposed Exploration Drilling Activities and Potential Effects on Fish and Essential Fish Habitat in Camden Bay, Alaska.

Exploration Activities and Accidental Discharges	Effects on Fish and EFH
Excavation of mudcellar and well-hole drilling	Loss of physical benthic habitat; sediment plume; increase in turbidity and total suspended solids (TSS); reduced visibility
Deposition of cuttings on the seafloor (with no drilling mud)	Loss of physical benthic habitat; sediment plume; increase in turbidity and TSS; loss of benthic-obligate fish, eggs, and larvae in the immediate vicinity
Anchoring of drillships (Table 18), potential for introduction of invasive species.	Loss of physical benthic habitat; localized increase in turbidity and TSS; loss of benthic-obligate fish, eggs, and larvae in the immediate vicinity
Intake and discharge of non-contact cooling water	Injury to small eggs and larval fish from withdrawal of seawater through 5 mm mesh at 6 cm/sec, exposure of pelagic eggs, larvae and juveniles in the vicinity of discharge to water temperatures above ambient
Discharge of desalination brine	Exposure of fish, eggs and larvae to increased salinity in immediate vicinity of discharge (at 41 ft/12.5m depth)
Discharge of deck drainage, blow-out preventer fluid and cement	Exposure of fish, eggs and larvae to low-level chemical constituents in immediate vicinity of discharge area
Fuel spills, small oil spills	Exposure of fish, eggs, larvae and habitat to localized petroleum hydrocarbon contaminants that could temporarily affect normal fish behavior and physiological responses.
Large oil spills, well-blowouts	Acute and chronic hydrocarbon contaminant effects on egg, larvae, juvenile and adult fish life stages and on fish prey; oil contact and covering of benthic and pelagic EFH in the marine, estuarine and freshwater environments.

Exploration Activities and Accidental Discharges	Effects on Fish and EFH
Vessel and drilling noise, Seismic surveys	Startle response and scattering of adult pelagic fish which could interupt on-going feeding or reproductive behaviors; repeated or sustained exposure of benthic-obligate fish which are unable or less able to escape noise; exposure and potential injury of pelagic and benthic eggs and larvae in the marine and estuarine environments; potential for introduction of invasive species from vessels and equipment.

Table 18 Potential benthic habitat disturbance by anchoring drill ships at a total of four drill sites in Camden Bay

Drill Ship Name	# of Drill Sites	# of Anchors Deployed/ Drill Site	Scar Area for Each Anchor and Chain	Total Scar Area for all Anchors at 2 Drill Site	Seafloor Penetration of Anchor
Kulluk	2	12	3,249 ft^2	77,976 ft^2 (7,244 m2)	down to 10 ft (3.06 m)
Discoverer	2	8	2,124 ft^2 (197 m)	33,984 ft^2 (3,157 m2)	down to 11 ft (3.4 m)

Drillship anchoring at four sites would cause a loss of a total of 111,960 ft^2 of benthic fish habitat. The areas affected and volumes excavated of each of the two drillships are presented in Table 18. Anchoring would introduce suspended sediment and turbidity into the lower water column causing decreased visibility and suspended particulate that would be drawn in over fish' gills. Arctic cod lower-water-column EFH could be affected by the increased suspended sediment.

Each of the four mud cellars constructed would disturb between 314 and 452 ft2 of benthic fish habitat to a sub-seafloor depth of 41 ft (12 m). Between 3,049 – 4,382 bbl (484.7 – 696.7 m3) would be excavated to construct each mud cellar (a potential total of 15,862 bbl excavated for 4 mud cellars). Cuttings from mud cellar construction would be deposited on the seafloor.

Cuttings-without-drilling-mud would be discharged (a total of 36,750 bbls) to the seafloor during the drilling of four exploration wells. A model of the deposition of cuttings from the mud cellar and well holes was developed by Shell (Shell, 2011a). The model results show that the cuttings deposition would extend approximately 1,592 ft (0.48 km) down-current from discharge source. The cuttings pile would be greastest at approximately 66 ft (20 m) down-current from the discharge site where it would reach 10 ft thick (3.0 m) and 328 ft wide (100 m).

The excavation of 4 mud cellars and the drilling of 4 well holes would cause: loss of benthic fish habitat through excavation and deposition of cuttings on benthic fish habitat; and increase above background levels of suspended sediment, suspended solids and turbidity in the lower water column, which includes Arctic cod EFH. Effects of turbidity and suspended sediments on benthic habitat would vary as a function of the distnace from the distrubance; benthic habitat will be lost at teh site of the mud cellars and in the immediate area from smothering by settling sediment. The areal effects of suspended sepdiment for this project have been modeled (Shell, 2011a).

Over the 4 drill sites, 9,075,768 barrels of seawater are projected to be withdrawn across 5mm screens at a velocity of approximately 12 ft/min (6 cm/sec) for use as non-contact cooling water and for other uses. The majority of the withdrawn water would be discharged back to the sea at temperatures slightly above ambient at a depth above the salinity and temperature stratification (found at approximately 20m) and would likely mix quickly in this upper layer. It is estimated that the thermal discharge would affect water temperatures within areas 164 ft long by 13 ft wide (*Discoverer*) and 256 ft long by 16 ft wide (*Kulluk*) (Shell, 2011a).

Desalination operations at the 4 drill sites would discharge an estimated total of 19,400 bbls of brine water with greater concentrations of salinity and other dissolved constituents than the ambient receiving water.

Free-swimming life stages of some pelagic and demersal fish species, such as the ecologically important adult Arctic cod and adult capelin, are potentially capable of avoiding the turbidity, sedimentation, contaminants, brine water, warmer water, and noise and seismic sources in their immediate vicinity that are created by activities in the project area. Adult fish that can escape these effects may at first experience startle responses and disruption of ongoing behaviors before scattering from the vicinity of the effects. Weak-swimming or non-swimming developmental life stages of larvae, fry, smolt, or eggs of fishes that may be present in or pass through the area during the proposed activities, however, would be negatively affected, such as epipelagic Arctic cod eggs and larvae and capelin juveniles.

Demersal fish life stages with strong affinities to benthic habitats, such as sculpins, flounder, snailfish, saffron cod eggs, capelin eggs and Arctic cod juveniles and adults, are not expected to avoid the temporary disturbances to their immediate environment (Mecklenberg, Mecklenberg, and Thorsteinson, 2002). Individual fish mortatlities would most likely in the benthic environmnet in the area of the drilling activities as a result of benthic habitat excavation or cuttings deposition. Seismic activity has been shown to cause changes in distribution patterns and abundance of fish in a study area (Engas et al. 1996).

Noise from ships, sound from seismic surveys and other sound sources would affect fish through interference with sensory orientation and navigation, decreased feeding efficiency, scattering of fish away from a food source and redistribution of fish schools and shoals (Fay, 2009; Radford et al., 2010; Simpson, 2010; Slabbekoorn, et al., 2010; Purser and Radford, 2011). Pelagic species, such as adult Arctic cod, adult salmon and similar species would startle and scatter as noise continues and, in theory, receive reduced levels of sound. Sedentary, burrowing, territorial, benthic-obligated fish, shallower near-shore fish, fish eggs and fish larvae in the area of the rig and oil spill would be exposed to higher noise levels due to their limited swimming behaviors, obligate life history characteristics, behavioral traits or spatial limitations. Foraging and reproduction behaviors of these benthic-obligate fish could be affected negatively by seismic activities and noise.

A small oil spill of 48 barrels was estimated based on an oil spill analysis. An oil spill of this size would introduce petroleum hydrocarbons to the surface water and water column. Acute hydrocarbon levels in the water column could occur initially, however, at these concentrations, the spill effects would be short-lived and spatially limited. The effects of hydrocarbon concentrations of a small oil spill, however, could continue longer in the immediate area of the spill, depending on the size, location, season and species of fish present. A small oil spill or fuel spill could adversely affect the surface water quality; epipelagic adult fish and developmental stages (including Arctic cod eggs and adults); and surface water EFH of Arctic cod and Pacific salmon.

The most likely Pacific salmon species that would be affected are pink and chum salmon in the nearshore environment. Salmon nearshore and freshwater EFH in the Beaufort could be affected outside of Camden Bay if there was a large oil spill or well blow-out. There are 8 anadromous coastal streams and rivers in the immediate vicinity of Camden Bay known to support anadromous Dolly Varden: Katakturik River, Marsh Creek, Carter Creek, Nataroarok Creek, and four unnamed streams. Dolly Varden in the Camden Bay region could be affected by small or large oil spills or vessel accident spills that reach the inshore or nearshore environments.

Some waste streams would be collected and transported out of the Beaufort Sea to an approved facility including: 14,902 barrels of spent water-based drilling muds and cuttings-with-adhered-drilling-muds; and 92,112 bl of domestic waste, used oil and hazardous waste. The collection and transport of these waste discharges would greatly reduce potential negative effects on benthic fish habitat, benthic fish, developmental stages of pelagic fish populations, and on Arctic cod and Pacific salmon EFH in the Camden Bay region.

Mitigation measures in the Proposed Action that reduce potential effect to fish and EFH include the following:

- Barging certain waste streams instead of discharging or depositing on the seafloor
- Water quality monitoring at fixed and random locations around the drilling operations

- Booming fuel transfer activities
- Equipment for early warning of a potential well-control event
- Oil spill response vessels in the immediate vicinity of the drilling operations
- Adherance to the following plans: Critical Operations and Curtailment Plan (in the event hazards are identified in the vicinity of the drilling operations); Ice Management Plan; Well Control Contingency Plan; and Fuel Transfer Plan

Following the implementation of these mitigation measures and the analysis of effects above, BOEMRE finds the level of effects would be minor. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

4.2.5.2. Cumulative Effects:

The activities described in this analysis are projected for a near future time frame of July-October, 2012, July- October 2013 and potentially July-October in following years. Overall, the proposed activities would result in negative minor effects to fish at the individual level, primarily due to benthic habitat loss. The proposed activities, however, would have a negligible effect on fish population levels on a Beaufort Sea regional scale. The reasonably foreseeable cumulative effects will occur at nearly the same level each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the impacts to fish from the Proposed Action and from reasonably foreseeable cumulative activities would amount to a minor level of effect.

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. The number of cargo, tourism and research vessels in the region is increasing as the ice cover is reduced. This increases the risk of vessel accidents, groundings and potential oil and cargo spills and introduction of marine invasive species. These ongoing effects would be the background effects on which Shell's July-October, 2012 and July-October, 2013 (and potentially July-October in following years) Camden Bay operation would occur.

The most recent EFH consultation on Pacific salmon for OCS exploration activities in the Beaufort Sea was conducted in 2009, concurrent with the preparation and public review of the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a). The BOEMRE received NMFS' conservation recommendations in a letter dated June 26, 2009. Arctic cod EFH consultation for the drilling proposed by Shell in Camden Bay in 2012 and 2013 is being conducted in a separate EFH document. The determination of effects on EFH will be stated in that document.

4.2.6. Marine and Coastal Birds

4.2.6.1. Direct and Indirect Effects

Nine species listed as threatened or candidate (four species) or abundant in the proposed project area (five species) have the greatest potential for adverse effects and are carried forward to the effects analysis.

ESA-listed Birds

ESA-listed birds include the Steller's eider, the spectacled eider, the Kittlitz's murrelet, and the yellow-billed loon.

Spectacled Eider. The Proposed Action includes a commitment that specifically avoids any program-related vessel travel within the Ledyard Bay Critical Habitat Unit (LBCHU), an area of importance to spectacled eiders, except for emergencies for human health or navigation safety. All incursions into the LBCHU for emergencies or safety must be reported within 24 hours. Implementation of this mitigation measure would result in no adverse effects on this critical habitat unit.

Spectacled eiders would not be in areas where they could experience adverse effects from seismic airgun noise, drilling noise, icebreaking or ice management, or permitted discharges. Accidental small spills are not expected to reach areas where spectacled eiders occur. Few eiders would be migrating in offshore areas where collisions are probable and mitigation measures are expected to avoid the potential for spectacled eiders striking project facilities/vessels. Flight altitude restrictions and consistent vessel/aircraft travel routes would mitigate adverse effects to any spectacled eiders in nearshore coastal areas and a negligible level of effect is anticipated. 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.

Steller's Eider. Steller's eiders would not be in areas where they could experience adverse effects from seismic airgun noise, drilling noise, icebreaking or ice management, or permitted discharges. Accidental small spills are not expected to reach areas where Steller's eiders occur. Few Steller's eiders would be migrating in offshore areas where collisions are probable and mitigation measures are expected to avoid the potential for eiders striking project facilities/vessels. Flight altitude restrictions and consistent vessel/aircraft travel routes would mitigate adverse effects to any Steller's eiders in nearshore coastal areas and a negligible level of effect is anticipated. 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.

Kittlitz's Murrelet. There are only two reported observations of the Kittlitz's murrelet in the Beaufort Sea, both at considerable distances from the drill sites. These are just east of Barrow and offshore of Kaktovik. There is little potential for interaction between the exploration drilling activities and individual Kittlitz's murrelets. Flight altitude restrictions and consistent vessel/aircraft travel routes would mitigate adverse effects to any Kittlitz's murrelets in nearshore coastal areas and a negligible level of effect is anticipated. 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.

Yellow-billed Loon. There are fewer than 5,000 yellow-billed loons on the North Slope breeding grounds and nearshore marine habitat. Yellow-billed loons may occur in the project area; however, they begin nesting in coastal lakes around mid-June, remaining in nearshore areas and wetlands until their fall migration in late August thru mid-September. Juveniles or non-breeders may remain in nearshore marine waters or in large rivers during the breeding season.

Because of the location of the project area in relation to their lifecycle requirements, few yellow-billed loons are expected to occur in the vicinity of the proposed drilling activity. Few yellow-billed loons are expected to be affected by seismic airgun noise, drilling noise, icebreaking or ice management, permitted discharges, collisions with program facilities/vessels, or accidental oil spills. Flight altitude restrictions and consistent vessel/aircraft travel routes would mitigate adverse effects to loons in nearshore coastal areas and a negligible level of effect is anticipated. 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.

Other Marine and Coastal Birds

Marine and coastal bird species that are more abundant and occur in more offshore areas of the Beaufort Sea include the common eider, king eider, the long-tailed duck, the northern fulmar, and the short-tailed shearwater. These species are carried forward into the effects analysis.

Common Eider. Most breeding female common eiders and their young begin to migrate to molt locations in late August and September, although large numbers of female common eiders were observed molting in the eastern Beaufort Sea in Canada near Cape Parry and Cape Bathurst (Johnson and Herter, 1989). Johnson, Wiggins, and Wainwright (1992) observed between 1,125 and 2,031 common eiders in early September during aerial surveys in 1989 and 1990 during the molt period.

After the molt is completed, some common eiders move offshore into pelagic waters, but most eiders remain close to shore (Divoky, 1987).

Common eiders were surveyed in marine waters within 100 km (62 mi) of the Beaufort Sea shoreline between Barrow and Demarcation Point by Fischer and Larned (2004) during summers in 1999-2001. In general, common eiders were concentrated in shallow waters (<10 m), with the highest densities occurring in segments between Oliktok point and Prudhoe Bay and between Tigvariak Island and Brownlow Point. Common eiders were most commonly associated with barrier islands in these segments, becoming less commonly observed up to 50 km seaward. Our most recent information indicates that male common eiders begin leaving the Beaufort Sea beginning in late June and are gone by late August or early September, and most females are gone by late October to early November. When traveling west along the Beaufort Sea coast, approximately 90% of the common eiders migrate within 48 km (29.8 mi) of the coast; 7% migrate 13-16 km (8 -9.9 mi) from shore, roughly along the 17-20 m isobath (Johnson and Herter, 1989, citing Bartels, 1973).

The largest potential for the Proposed Action to affect common eiders concerns flocks of post-breeding or migrating eiders around the barrier islands. The impact-producing factors that could affect long-tailed ducks are vessel traffic and noise, aircraft traffic and noise, and oil spills. Seismic airgun noise, drilling noise, icebreaking and ice management, and permitted discharges associated with the Proposed Action are not expected to affect long-tailed ducks. Changes to vessel lighting and the location of the drilling operation are expected to avoid the potential for eiders striking project facilities/vessels.

Vessel Traffic and Noise. The Proposed Action includes predetermined vessel travel routes that avoid or minimize adverse effects to common eiders in nearshore coastal areas. A negligible level of effect is anticipated from vessel traffic. 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.

Aircraft Traffic and Noise. The Proposed Action includes flight altitude restrictions and predetermined flight routes that avoid or minimize adverse effects to common eiders in nearshore coastal areas. A negligible level of effect is anticipated from aircraft traffic. 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.

Oil Spills. Section 2.3.10 describes spill prevention and response. While there is some potential for a fuel spill during the proposed operations, few common eiders are anticipated to occur in the project area and few could be exposed to an accidental spill. Post-breeding common eiders would likely avoid spill response activities. Accidental small spills that are immediately contained would have a negligible level of effect on common eiders. 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.

If a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact many common eiders. Limited mortality from a small spill would be considered a minor level of effect. As with other analyses incorporated by reference, BOEMRE assumes that any contact with oil by a bird will be fatal.The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

King Eider. Most tagged king eiders spent more than 2 weeks staging offshore in the Beaufort Sea prior to migrating to molt locations in the Bering Sea (Phillips, 2005; Powell et al., 2005). Female king eiders may need to remain in the Beaufort Sea longer than males to replenish fat stores depleted during egg laying and incubation (Powell et al., 2005). Prior to molt migration, king eiders in the Beaufort Sea usually were found about 13 km (8 mi) offshore; however, during migration to molting areas, king eiders occupied a wide area ranging from shoreline to >50 km (31 mi) offshore (Phillips, 2005). Fischer and Larned (2004) surveyed king eiders in marine waters within 100 km (62 mi) of the Beaufort Sea shoreline between Barrow and Demarcation Point during summers in 1999 and 2001.

King eiders were the second most abundant species counted during the survey periods. King eider densities varied according to water depth, offshore distance, and% of ice cover. Large flocks of king eiders concentrated in the mid-depth (10-20 m) zone offshore of Barrow and Oliktok Point. In 1999 and 2000, these flocks were in waters >10 m (32 ft) deep but were found in the shallow (<10 m) and mid-depth zone in July 2001. King eiders were unique among species surveyed by occurring in higher densities in low (31%) and moderate (31-60%) ice cover (Fischer and Larned, 2004).

The largest potential for the Proposed Action to affect king eiders concerns flocks of migrating eiders in ice-laden areas offshore. The impact-producing factors that could affect king eiders are vessel traffic and noise, aircraft traffic and noise, ice management, and oil spills. Seismic airgun noise, drilling noise, and permitted discharges associated with the Proposed Action are not expected to affect king eiders. Changes to vessel lighting and the location of the drilling operation are expected to avoid the potential for eiders striking project facilities/vessels.

Vessel Traffic and Noise. The Proposed Action includes predetermined vessel travel routes that avoid or minimize adverse effects to king eiders in nearshore and offshore areas. A negligible level of effect is anticipated from vessel traffic. 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.

Aircraft Traffic and Noise. The Proposed Action includes flight altitude restrictions and predetermined flight routes that avoid or minimize adverse effects to king eiders in nearshore coastal areas. A negligible level of effect is anticipated from aircraft traffic. 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.

Icebreaking and Ice Management. King eiders were more commonly observed in ice-laden waters and would have a greater potential for interactions with an active icebreaker. King eiders would be expected to move away from an active icebreaker. These eiders are expected to move to other areas unharmed. A negligible level of effect is anticipated from icebreaker operations. 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.

Oil Spills. While there is some potential for a fuel spill during the proposed operations, few king eiders are anticipated to regularly occur in the project area and few could be exposed to an accidental spill. The vessel activity associated with spill response could help keep king eiders away from a spill. Based on the mitigation measures, accidental small spills will be immedieately contained and would have only a negligible level of effect on king eiders. As with other analyses incorporated by reference, BOEMRE assumes that any contact with oil by a bird will be fatal.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.

If a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact king eiders. Should a small spill escape containment, depending on location, it could contact a small number of king eiders. Limited mortality from a small spill would be considered a minor level of effect. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Long-tailed Duck. In late June and early July, most male and non-breeding female long-tailed ducks migrate to coastal molting areas. Typical migration distances offshore for long-tailed ducks occur within 45 km of shore; infrequent observations of long-tailed ducks in pelagic waters occur in late September (Divoky, 1987). Molting long-tailed ducks are flightless for a 3- to 4-week period and breeding females molt on freshwater lakes during the last phases of duckling development before departing the North Slope in fall (Johnson and Herter, 1989). The largest potential for the Proposed Action to affect long-tailed ducks concerns concentrations of molting or migrating flocks around the barrier islands.

The impact-producing factors that could affect long-tailed ducks are vessel traffic and noise, aircraft traffic and noise, and oil spills. Seismic airgun noise, drilling noise, icebreaking and ice management, and permitted discharges associated with the Proposed Action are not expected to affect long-tailed ducks. Changes to vessel lighting and the location of the drilling operation are expected to avoid the potential for long-tailed ducks striking project facilities/vessels.

Vessel Traffic and Noise. The Proposed Action includes predetermined vessel travel routes that avoid or minimize adverse effects to long-tailed ducks in nearshore coastal areas. A negligible level of effect is anticipated from vessel traffic. 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.

Aircraft Traffic and Noise. The Proposed Action includes flight altitude restrictions and predetermined flight routes that avoid or minimize adverse effects to long-tailed ducks in nearshore coastal areas. A negligible level of effect is anticipated from aircraft traffic. 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.

Oil Spills. Section 2.3.10 describes spill prevention and response. While there is some potential for a fuel spill during the proposed operations, few long-tailed ducks are anticipated to occur in the project area and few could be exposed to an accidental spill. Similarly, if a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact long-tailed ducks. The vessel activity associated with spill response would have little success in keeping keep molting ducks away from a spill because they are flightless. Furthermore, later in the open-water season, new migrants would arrive in a spill area on a regular basis, making hazing difficult. Based on the mitigation measures, accidental small spills will be immedieately contained and would have only a negligible level of effect on long-tailed ducks. 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.

Should a small spill escape containment, depending on location, it could contact molting or migrating long-tailed ducks. Limited mortality from a small spill would be considered a minor level of effect. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Northern Fulmar. Most northern fulmars in offshore areas migrate through the Bering Sea and spend most of their time in the Chukchi Sea. Divoky (1987) estimated 45,000 northern fulmars in pelagic waters of the Chukchi Sea (typically south of Cape Lisburne) during late August to mid-September, but this number is relatively small compared with an estimated 2.1 million that are present in the Bering Sea in the summer (Gould, 1983). With such a large number of fulmars in the adjacent Chukchi Sea, thousands of fulmars are anticipated to occur in offshore areas of the U.S. Beaufort Sea. Fulmars form flocks at food concentrations, which change locations throughout the open-water season.

The impact-producing factor that could affect northern fulmars is a small oil spill. Vessel traffic and noise, aircraft traffic and noise, seismic airgun noise, drilling noise, icebreaking and ice management, and permitted discharges associated with the Proposed Action are not expected to affect northern fulmars. Changes to vessel lighting and the location of the drilling operation are expected to avoid the potential for northern fulmars striking project facilities/vessels.

Oil Spills. While there is some potential for a fuel spill during the proposed operations, few northern fulmars are anticipated to regularly occur in the project area and few could be exposed to an accidental spill. Similarly, if a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact northern fulmars. The vessel activity associated with spill response could help keep fulmars away from a spill. Based on the mitigation measures, accidental small spills will be immedieately contained and would have only a negligible level of effect on northern fulmars. As with other analyses incorporated by reference, BOEMRE assumes that any contact with oil by a bird will be fatal. 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.

Should a small spill escape containment, depending on location, it could contact a flock of northern fulmars. Limited mortality from a small spill would be considered a minor level of effect. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Short-tailed Shearwater. Short-tailed shearwaters are routinely found across the entire U.S. Chukchi Sea, but are most common in the southern portion. Short-tailed shearwaters are most common from late August to late September. Divoky (1987) reported short-tailed shearwaters as far north as Barrow and into arctic Canada. In certain years, an estimated 100,000 short-tailed shearwaters passed Point Barrow in one day in mid-September (Divoky, 1987). Migrating shearwaters appear to migrate closer to shore, but these numbers indicate a substantial number also occur in offshore areas, especially during the spring and fall.

At northern latitudes, short-tailed shearwaters forage on dense patches of euphausiids and amphipods. Short-tailed shearwaters form flocks at food concentrations, which change locations throughout the open-water season.

The impact-producing factor that could affect short-tailed shearwaters is a small oil spill. Vessel traffic and noise, aircraft traffic and noise, seismic airgun noise, drilling noise, icebreaking and ice management, and permitted discharges associated with the Proposed Action are not expected to affect short-tailed shearwaters. Changes to vessel lighting and the location of the drilling operation are expected to avoid the potential for short-tailed shearwaters striking project facilities/vessels.

Oil Spills. While there is some potential for a fuel spill during the proposed operations, few short-tailed shearwaters are anticipated to regularly occur in the project area and few could be exposed to an accidental spill. Similarly, if a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact short-tailed shearwaters. The vessel activity associated with spill response could help keep shearwaters away from a spill. Based on the mitigation measures, accidental small spills will be immedieately contained and would have only a negligible level of effect on short-tailed shearwaters. As with other analyses incorporated by reference, BOEMRE assumes that any contact with oil by a bird will be fatal. 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.

Should a small spill escape containment, depending on location, it could contact a flock of short-tailed shearwaters. Limited mortality from a small spill would be considered a minor level of effect. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Summary of Direct and Indirect Effects

The Proposed Action includes mitigation measures that avoid or minimize impacts from vessel traffic and noise, aircraft traffic and noise, icebreaking and ice management, and oil spills to a negligible level of effect. Overall, no more than a minor level of effect on marine and coastal bird populations is anticipated. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

4.2.6.2. Cumulative Effects

Activities associated with the Proposed Action do not have a cause-effect relationship that would influence aspects of climate change discussed in section 3.1.1. Appendix C describes reasonably foreseeable future events that could occur in the project area that could affect bird populations. These projects include vessels and aircraft that are not subject to altitude or route restrictions and likely have greater impacts than the Proposed Action. The incremental contribution of the Proposed Action to the collective impacts on bird populations in the project area is no more than minor. The reasonably foreseeable cumulative effects will occur at nearly the same level each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the impacts to marine and coastal birds from the Proposed Action and from reasonably foreseeable cumulative activities would amount to no more than a minor level of effect.

4.2.7. Marine Mammals

4.2.7.1. Direct and Indirect Effects

Of the 15 marine mammal species that can occur in the Proposed Action area, nine were carried forward for effects analysis because of their ESA-status or relative abundance. As in Section 3.2.6, these are divided into two groups: 1) ESA-listed Marine Mammals and 2) Other Marine Mammals.

ESA-listed Marine Mammals

ESA-listed marine mammals include the bowhead whale, the fin whale, the humpback whale, the ringed seal, the bearded seal, the polar bear, and the Pacific walrus.

Bowhead Whale. The Proposed Action could affect bowhead whales through vessel traffic and noise, aircraft traffic and noise, seismic airgun noise, drilling noise, icebreaking and ice management, permitted discharges, and accidental oil spills.

Vessel traffic and noise. Bowhead whales react to the approach of vessels at greater distances than they react to most other activities. Most bowhead whales exhibit avoidance of vessel traffic, although reactions are less dramatic to slower moving vessels and vessels that are not approaching the animals directly (USDOC, NMFS, 2008a).

Bowhead whales observed in vessel-disturbance experiments in the Canadian Beaufort Sea began to orient away from an oncoming vessel at a range of 2-4 km (1.2-2.5 mi) and to move away at increased speeds when approached closer than 2 km (1.2 mi) (Richardson and Malme, 1993). Most bowhead whales began to swim rapidly away when vessels approach rapidly and directly. A few whales reacted at distances from 5-7 km (3.1-4.3 mi) and a few whales did not react until the vessel was <1 km (<0.62 mi) away. Received noise levels as low as 84 dB re 1 μPa or 6 dB above ambient elicited strong avoidance of an approaching vessel at a distance of 4 km (2.5 mi). Vessel disturbance during these experimental conditions temporarily disrupted activities and whales in social groups moved apart.

The Proposed Action and required authorizations include measures to avoid or minimize adverse effects to bowhead whales (Shell, 2011a: Appendix D). Some whales may move away from transiting vessels, but no collisions with whales are likely to occur. Vessel traffic and noise from the

Proposed Action are expected to result in a negligible level of effect on bowhead whales in the project area. 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.

Aircraft Traffic and Noise. Most routine aircraft traffic would be completed along designated routes at an altitude >460 m (1,500 ft), but dedicated low-level marine mammal survey flights provide a frequent source of disturbance. Fixed wing aircraft typically are capable of producing tones mostly in the 68 to 102 Hz range and at noise levels up to 162 dB re 1 μPa-m at the source (Greene and Moore, 1995: 102-105).

Shallenberger (1978) reported baleen whale responses appear to vary depending on flight altitude and received sound levels; some individual whales were disturbed by overflights at 1,000 ft (305 m), whereas others showed no response at 500 ft (152 m). Reactions to low-level fixed-wing aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) during studies of feeding bowhead whales sometimes caused abrupt turns and hasty dives (Richardson and Malme, 1993).

Aircraft on a direct course usually produce audible noise for only tens of seconds, and the bowhead whales were likely to resume their normal activities within minutes (Richardson and Malme, 1993). Patenaude et al. (1997) found that few bowhead whales (2.2%) during the spring migration were observed to react to Twin Otter overflights at altitudes of 60-460 m. Reaction frequency diminished with increasing lateral distance and with increasing altitude. Most observed reactions by bowhead whales occurred when the Twin Otter was at altitudes of <182 m and lateral distances of <250 m. There was little, if any, reaction by bowhead whales when the aircraft circled at an altitude of 460 m and a radius of 1 km. The effects from an encounter with aircraft were brief and the whales resumed their normal activities within minutes.

The Proposed Action and required authorizations include measures to avoid or minimize adverse effects to bowhead whales. Most routine aircraft traffic is completed along designated routes at an altitude >460 m (1,500 ft), but dedicated low-level marine mammal survey flights provide a frequent source of disturbance. Some individual whales may make an abrupt turn or hasty dive in response to low-level flight activity, but these whales should return to normal activities within minutes. Aircraft traffic and noise from the Proposed Action are expected to result in no more than a minor level of effect on bowhead whales in the project area. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Seismic Airgun Noise. Vertical seismic profiling (VSP) is conducted once some drilling has been completed. These programs use hydrophones suspended in the well at intervals which receive signals from external sound sources, usually an airgun(s) suspended from the drill rig or a nearby supply vessel. Data are used to aid in determining the structure of a particular petroleum-bearing zone. Purely defined, VSP refers to measurements made in a vertical wellbore using geophones inside the wellbore and a source at the surface near the well. The Proposed Action includes a geophysical survey referred to as zero-offset vertical seismic profile (ZVSP) at each drill site where a well is drilled.

The potential effects of seismic airgun noise on bowhead whales have been evaluated and mitigation measures to minimize these effects have been factored into these assessments (USDOI, MMS, 2006a, b, 2008a, b; USDOC, NMFS, 2006, 2008). Industry seismic survey programs have implemented mitigation measures and monitored bowhead whale behaviors and distribution (e.g., Funk et al., 2011; Haley and Ireland, 2006). The typical mitigation measures and on-site monitoring, shut- and power-down and ramp-up procedures appear effective in avoiding or minimizing adverse effects to whales to the lowest extent practicable.

The VSP could occur at each well location at the end of the drilling season. The entire VSP operation is anticipated to be completed within 24 hours. The airgun sources for the project are moderate size and would be used for a short time period for the survey. While there may be a small number of bowhead whales in the drillship vicinity, mitigation measures would avoid or minimize adverse effects to whales and it is unlikely that there would be any cases of temporary hearing impairment or non-auditory physical effects. The VSPs could result in short-term behavioral changes to a small number of whales; however, implementation of typical monitoring and mitigation measures avoid or minimize these impacts. Seismic airgun noise associated with the VSPs is anticipated to have no more than a negligible level of effect on bowhead whales in the project area. 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.

Drilling Noise. The reactions of individual bowhead whales to drillship-operation noise are variable. Individuals whose behavior appeared normal have been observed on several occasions within 10-20 km (6.2-12.4 mi) of drillships in the eastern Beaufort Sea, and there have been a number of reports of sightings within 0.2-5 km (0.12-3 mi) from drillships (Richardson et al., 1985; Richardson and Malme, 1993). On several occasions, the bowhead whales were well within the zone where drillship noise should be clearly detectable by them. In other cases, bowhead whales may avoid drillships at 20-30 km (USDOI, MMS, 2003). Richardson and Malme (1993) point out that the data suggest stationary, continuous noise sources, such as stationary drillships, elicit less dramatic reactions with bowhead whales than mobile noise sources. Most observations of bowhead whales tolerating noise from stationary operations are based on opportunistic sightings of whales near ongoing oil-industry operations.

The distance at which bowhead whales may react to drillships is variable and difficult to gauge, because some bowhead whales would be expected to respond to noise from drilling units by changing their migration speed and swimming direction to avoid closely approaching these noise sources. For example, in the study by Koski and Johnson (1987), one whale appeared to adjust its course to maintain a distance of 23-27 km (14.3-16.8 mi) from the center of the drilling operation. Migrating whales apparently avoided the area within 10 km (6.2 mi) of the drillship, passing both to the north and to the south of the drillship. The study detected no bowhead whales within 9.5 km (5.9 mi) of the drillship, and few were observed within 15 km (9.3 mi). The study concluded that bowhead whales appeared to avoid the offshore drilling operation during their fall migration in 1986.

In another study, Richardson et al. (1995) concluded:

> ...migrating bowheads tolerated exposure to high levels of continuous drilling noise if it was necessary to continue their migration. Bowhead migration was not blocked by projected drilling sounds, and there was no evidence that bowheads avoided the projector by distances exceeding 1 kilometer (0.54 nautical miles). However, local movement patterns and various aspects of the behavior of these whales were affected by the noise exposure, sometimes at distances considerably exceeding the closest points of approach of bowheads to the operating projector.

Richardson et al. (1995) also reported that bowhead whale avoidance behavior has been observed in half of the animals when exposed to 115 dB re 1 μPa rms broadband drillship noises. However, reactions vary depending on the whale activity, noise characteristics, and the physical situation (Richardson and Greene, 1995). The study concluded that the demonstrated effects were localized and temporary and that playback effects of drilling noise on distribution, movements, and behavior were not biologically important. Offshore drilling operations occurred in the Beaufort Sea over the past several decades, during which time the Western Arctic bowhead whale stock increased to about 10,545, an estimate that may approach the carrying capacity in the Beaufort and Chukchi seas (Section 3.2.6.1).

Individual bowhead whales may respond to drillship noise by making slight adjustments to their swimming path. These responses may occur whenever the drillship is active, but are not anticipated when drilling is not underway. For example, the withdrawal of the drillship from the drill site area starting August 25 would avoid disturbance impacts and any interference with the harvest of migrating bowhead whales by the villages of Kaktovik and Nuiqsut.

Underwater noise could result in small deviations in the path of some bowhead whales in the vicinity of drilling operations and bowhead whales are anticipated to experience no more that a minor level of effect. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Icebreaking and Ice Management. Whale response distances may vary, depending on icebreaker activities and sound-propagation conditions. Brewer et al. (1993) reported that in fall 1992, migrating bowhead whales avoided an icebreaker-accompanied drillship by over 25 km. The ship was icebreaking almost daily. Richardson et al. (1995) noted that in 1987, bowhead whales also avoided another drillship with little icebreaking. Based on models in earlier studies, Miles, Malme, and Richardson (1987) predicted that bowhead whales likely would respond to the sound of icebreakers that were 2-25 km (1.24-15.53 mi) away. That study predicted roughly half of the bowhead whales show avoidance responses to an icebreaker underway in open-water at a range of 2-12 km (1.25-7.46 mi) or to an icebreaker pushing ice at a range of 4.6-20 km (2.86-12.4 mi) when the sound-to-noise ratio is 30 dB.

Richardson et al. (1995) concluded that exposure to a single playback of variable icebreaker sounds can can effect movements and behavior of migrating whales in the lead system during the spring migration east of Point Barrow. The study indicated response distances for bowhead whales around an actual icebreaker could be highly variable; however, for typical traveling bowhead whales, detectable effects on movements and behavior are predicted to extend commonly out to radii of 10-30 km (6.2-18.6 mi) and sometimes to over 50 km (31.1 mi).

It should be noted that these predictions were based on reactions of whales to playbacks of icebreaker sounds in a lead system during the spring migration, and are subject to a number of qualifications that are not relevant because the Proposed Action is during the ice-free season. Richardson et al. (1995: 322) summarized:

> The predicted typical radius of responsiveness around an icebreaker like the Robert Lemeur is quite variable, because propagation conditions and ambient noise vary with time and with location. In addition, icebreakers vary widely in engine power and thus noise output, with the Robert Lemeur being a relatively low-powered icebreaker. Furthermore, the reaction thresholds of individual whales vary by at least ±10 dB around the "typical" threshold, with commensurate variability in predicted reaction radius.

Richardson et al. (1995: xxi) stated that:

> If bowheads react to an actual icebreaker at source to noise and RL values similar to those found during this study, they might commonly react at distances up to 10-50 km from the actual icebreaker, depending on many variables. Predicted reaction distances around an actual icebreaker far exceed those around an actual drillsite...because of (a) the high source levels of icebreakers and (b) the better propagation of sound from an icebreaker operating in water depths 40+ m than from a bottom-founded platform in shallower water.

Although some bowhead whales may react to icebreaking and ice-management activities, the timing of this project during the open-water season, the low likelihood of the presence of large amounts of sea ice, and the short duration of the Proposed Action, icebreaking and ice-management activities are expected to have a minor level of effect on the Western Arctic bowhead whale stock. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Permitted Discharges. Under the Proposed Action, spent drilling fluids and cuttings, sanitary wastewater, and domestic wastewater would be retained on a barge onsite for later removal and disposal at a facility in the Pacific Northwest (Shell, 2011a). Few discharges will occur on site and few benthic organisms would be exposed to drill cuttings and other materials, because of the relatively small discharge plume and the plume's proximity to the drillship. Mobile invertebrates and fishes are anticipated to avoid the area affected by the discharge plume, thereby avoiding exposure.

With implementation of measures to retain discharges to the maximum amount practicable, there are few opportunities for unauthorized discharges to enter the marine environment. The likelihood of bowhead whales ingesting organisms contaminated by discharges associated with the proposed activities is very low and a negligible level of effect from permitted discharges to bowhead whales is anticipated. 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.

Oil Spills. Section 2.3.10 describes spill prevention and response. While there is some potential for a fuel spill during the proposed operations, few bowhead whales are anticipated to occur in the project area and few could be exposed to an accidental spill. Similarly, if a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact bowhead whales. Finally, the vessel activity associated with spill response would likely keep bowhead whales out of the spill area, and individual whales would likely avoid the spill by leaving the area during spill response activities. Accidental small spills are anticipated to have no more than a negligible level of effect on bowhead whales. 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.

Summary of Direct and Indirect Effects on the Bowhead Whale. The Proposed Action includes mitigation measures that avoid or minimize impacts from vessel traffic and noise, seismic airgun noise, permitted discharges, and oil spills to a negligible level of effect. Aircraft traffic and noise, icebreaking and ice management, and drilling noise associated with the Proposed Action are anticipated to result in no more than a minor level of effect. Taken together, these activities are anticipated to result in no more than a minor level of effect on the bowhead whale population per year. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Fin Whale. Recent observations from monitoring and research programs and passive acoustic monitoring indicate individual and small groups of fin whales are infrequent visitors in the U.S. Chukchi Sea during the open-water period, but have not been documented to occur in the Beaufort Sea (Section 3.2.6.1).

The potential effects of the Proposed Action on fin whales are anticipated to be the same as those described for bowhead whales, except there are very few fin whales in the action area and no fin whales have been documented to occur in the Beaufort Sea. Because of substantial mitigation measures incorporated into the Proposed Action that would avoid or minimize adverse effects on fin whales, no more than a negligible level of effect is anticipated. 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.

Humpback Whale. Recent research and monitoring programs have indicated the presence of small numbers of humpback whales in the U.S. Chukchi Sea and Beaufort Sea (Section 3.2.6.1).

The potential effects of the Proposed Action on humpback whales are anticipated to be the same as those described for bowhead whales, except there are very few humpback whales in the action area. Because of substantial mitigation measures incorporated into the Proposed Action that would avoid or minimize adverse effects on humpback whales, no more than a negligible level of effect is anticipated. 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.

Ringed Seal and Bearded Seal. The Proposed Action includes activities that could affect ringed seals and bearded seals. The impact–producing factors include vessel traffic and noise, aircraft traffic and noise, seismic airgun noise, drilling noise, ice management, permitted discharges, and small spills. Due to the similarities in the vulnerability and responses of ringed seals and bearded seals in the Alaskan Arctic (Section 3.2.6.1), the potential effects of the Proposed Action on the two species are combined.

Vessel Traffic and Noise. Vessel traffic associated with the Proposed Action would primarily be during the open-water season, when most ringed seals have followed the receding ice edge northward away from the project area. During that time period bearded seals would have moved into shallower waters closer to shore. Given the low densities of ice seals in general, relatively few ringed seals and bearded seals would be expected to be in the project area, but those present could be affected by vessel activity.

Jansen et al. (2010) indicated that vessel presence and movement can motivate seals to alter their behavior. Richardson (1995) concluded that at least some seals may have a high tolerance to vessels and vessel noise, but it depends on vessel distance and whether seals are hauled out or not. Vessel noise did not seem to strongly affect pinnipeds already in the water, whereas hauled out seals often responded more strongly to the presence of vessels (Richardson, 1995). Jansen et al. (2006) reported that hauled out harbor seals approached by ships at 100 m were 25 times more likely to enter the water than those approached at 500 m. Brueggeman et al. (1992) observed hauled out ringed seals displaying short-term escape reactions when a ship approached within 0.25 mile. As there are no land haul-out sites for ringed near the drill site, no direct impacts to hauled out ringed seals would be expected from support vessels during drilling operations. Bearded seals do not haul out on land in the Proposed Action area.

All project vessels must reduce speed and avoid course changes within 900 ft (274 m) of a ringed or bearded seal, whether hauled out or in open-water. On-board MMOs will assist vessels in implementing this mitigation measure to avoid collisions with ice-seals.

Due to mitigation measures designed to minimize adverse effects on marine mammals, vessel traffic and noise would have a negligible level of effect on ringed seals and bearded seals in the project area. 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.

Aircraft Traffic and Noise. Aircraft are needed to support the drillship and other parts of the overall operation. There is some potential that ringed seals and bearded seals could be disturbed by low-flying aircraft.

Born et al. (1999) reported ringed seals showed a 21% probability of reacting to fixed-wing aircraft at 100 m from the aircraft, 6% between 100 and 300 m from the flight track, and 2% between 300 and 500 m from the flight track. The study also noted that the variables most likely to influence the probability of escape responses were time of day and temperature.

Calvert and Stirling (1985) reported that counts of ringed seal calls in water in an area subjected to low-flying aircraft were similar to those in less disturbed areas. The Proposed Action has incorporated mitigation measures to reduce the likelihood of impacts to ringed seals and bearded seals including restricting aircraft to above 1,500 ft (457 m), unless the aircraft is landing or taking off or conducting surveys to monitor for marine mammals, or for navigational safety. Flight paths for aircraft leaving the shorebase would remain approximately 5 mi inland until reaching a point near Pt. Thompson, where aircraft would then turn north over water to reach the drilling sites. The flight plan would only present 16 mi of possible disturbance to ringed seals or bearded seals in the flight segment between the drillship and the coast. The flight altitude restrictions along this route, however, would avoid or minimize disturbance to ice seals.

Most routine aircraft traffic is completed along designated routes at an altitude >460 m (1,500 ft), but dedicated low-level marine mammal survey flights provide a frequent source of disturbance to ice seals. Some individual ice seals could respond to low-level flight activity, but these seals should return to normal activities within minutes. Aircraft traffic and noise from the Proposed Action are expected to result in no more than a minor level of effect on ringed seals and bearded seals in the project area. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Seismic Airgun Noise. Vertical seismic profiling (VSP) is conducted once some drilling has been completed. These programs use hydrophones suspended in the well at intervals which receive signals from external sound sources, usually an airgun(s) suspended from the drill rig or a nearby supply vessel. Data are used to aid in determining the structure of a particular petroleum-bearing zone. Purely defined, VSP refers to measurements made in a vertical wellbore using geophones inside the wellbore and a source at the surface near the well. The Proposed Action includes a geophysical survey referred to as zero-offset vertical seismic profile (ZVSP) at each drill site where a well is drilled.

The pulsed sounds associated with seismic exploration have higher peak levels than most other industrial sounds to which ice seals are routinely exposed. Most ice seals spend greater than 80% of their time submerged in the water (Gordon et al., 2004); consequently, some could be exposed to sounds from seismic 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). While seismic surveys can contain energy up to 1 kHz, most of the emitted energy is less than 200 Hz (Richardson et al., 1995). Gordon et al. (2004) suggested phocids may be susceptible to the masking of biologically important signals by low frequency sounds, such as those from seismic surveys, and while brief, small-scale masking episodes might have few long-term consequences. Southall et al. (2007) proposed that PTS could occur to pinnipeds exposed to single sound pulses at 218 dB re: 1 μPa in water, however, injury from seismic surveys may occur only if animals entered the zone immediately surrounding the sound source since noise loss occurs rapidly with distance from operating airguns.

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 operating airgun arrays (Brueggeman et al., 1991; Harris, Miller, and Richardson, 2001; Miller and Davis, 2002). Brueggeman et al. (1991) reported that 96% of the seals they encountered during seismic operations in the Beaufort Sea were encountered during non-data acquisition activities, suggesting avoidance of active data acquisition operations, and Miller and Davis (2002) reported that on average seals in the Beaufort Sea were observed at 150 m from vessels when seismic surveys were inactive as opposed to 210 m when seismic surveys were being conducted, with sound levels of 190 dB re 1 μPa extended out to 210 m. Harris, Miller, and Richardson, (2001) observed sighting rates of ringed seals from a seismic vessel in the Beaufort Sea showed no difference between periods using the full airgun array, a partial array, or no airguns, although the mean distances to seals increased during full array operations, indicating some local avoidance at 190-200 dB re 1 μPa noise levels. These observations provide limited support for the Temporary Threshold Shift and Permanent Threshold Shift injury criteria as outlined in Southall et al. (2007) and localized avoidance by ringed seals (Harris, Miller, and Richardson, 2001). In contrast, telemetry work by Thompson, Duck, and McConnel (1998) suggested that avoidance and behavioral reactions to small airgun sources could be more pronounced than ocular observations indicate. 2001 tagging studies (Cott, Hanna, and Dahl, 2003) reported that seismic surveys in the Beaufort Sea had no obvious effect on the timing or route of ringed seals migrating in the fall.

Funk et al. (2010) reported the highest Marine Mammal Observer (MMO) effort was required where noise levels were <120 dB re 1 μPa during 2006-2008 Beaufort Sea and Chukchi Sea seismic survey activities. In the same report, pinniped sighting rates from monitoring vessels in the Beaufort Sea and Chukchi Sea were higher than those from seismic vessels, with the highest rates occurring in the <120 dB re 1 μPa zone, suggesting localized avoidance of active seismic vessels.

During a 2010 seismic survey in the Chukchi Sea, MMOs from the seismic vessel had the highest sighting rate in the ≥160 dB re 1 μPa zone, while MMOs on the monitoring vessels had their highest sighting rates in the 159-120 dB re 1 μPa (Blees et al., 2010). MMOs on both vessels observed roughly similar sighting rates of 12.5/1,000 km (seismic vessel) and 11.8/1,000 km (monitoring vessels) during periods of non-seismic activity or when dB levels were <120 dB re 1 μPa. Results from Blees et al. (2010) conflict with the position that seismic surveys would likely displace ringed seals from an area where received noise levels are in excess of 159 dB re 1 μPa because monitoring vessels recorded their highest seal sighting rates from monitoring vessels in the 159-120 dB re 1 μPa zone (18.8/1,000 km) as opposed to the seismic vessel where the highest seal sighting rate was in the ≥160 dB re 1 μPa zone (31.5/1,000 km). Although 146 seals were observed from the seismic vessel during airgun operations only 10 were detected in the ≥190 dB re 1 μPa zone, while 154 seals were observed by monitoring vessels where there was no ≥190 dB re 1 μPa zone.

Ultimately Blees et al. (2010) estimated 416 ringed seals may have been exposed to airgun pulses ~21 each with pulses ≥160 dB re 1 μPa, based on the assumption that ~19.1% (416/2,180 = 0.191, and 0.191 x 100% = 19.1%) of the seals observed were ringed seals. By applying this 19.1% estimate to the number of seals observed in the ≥190 dB re 1 μPa zone (652), a rough estimate (0.191 x 652 = 124.5 ≈ 125 seals) can be derived suggesting 125 ringed seals were exposed to noise levels ≥190 dB re 1 μPa for approximately 2 times each if there was no avoidance of the sound source. Caution should be used in interpreting this calculation because Blees et al. (2010) did not specify the ringed seals estimate for the ≥190 dB re 1 μPa zone and the authors stated that the actual numbers of seals exposed to Received Sound Levels (RSL) ≥190 dB re 1 μPa was likely greater than the 10 observations, but lower than the estimated 652 seal exposures.

Similarly, Blees et al. (2010) estimated 1,681 bearded seals may have been exposed to airgun pulses ~21 each with pulses ≥160 dB re 1 μPa, based on the assumption that ~77% (1,681/2,180) of the seals observed were ringed seals. By applying the 77.1% estimate to the number of seals observed in the ≥190 dB re 1 μPa zone (652), a rough estimate (0.771 x 652 = 502.75 ≈ 503 bearded seals) can be derived suggesting 503 bearded seals were exposed to noise levels ≥190 dB re 1 μPa for approximately 2 times each if there was no avoidance of the sound source. Caution should be used in interpreting this calculation since Blees et al. (2010) did not specify the bearded seals estimate for the ≥190 dB re 1 μPa zone, because the estimate of 652 exposed seals is much higher than the 10 seals that were actually witnessed in the zone, and because the author states that the actual numbers of seals exposed to RSL ≥190 dB re 1 μPa was likely greater than the 10 observations but lower than the estimated 652 seal exposures.

Seismic surveying has limited potential to affect fishes and some invertebrate species that fall within the ice seal diet (USDOI, MMS, 2006a). The primary prey species for ringed seals from the late fall into the spring are Arctic cod. Potential effects to some prey species (i.e., some teleost fishes) may include displacement from foraging, staging, or spawning areas. For some species the displacement may last for days, weeks, or longer. 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 newly weaned ringed seal pups (Gordon et al., 2004). The opposite potentially could occur because damaged or disoriented prey could attract ice seals to seismic-survey areas, providing robust short-term feeding opportunities (Gordon et al., 2004).

The VSP could occur at each well location at the end of the drilling season. The entire VSP operation is anticipated to be completed within 24 hours. The airgun sources for the project are moderate size and would be used for a short time period for the survey. While there may be a small number of ringed seals or bearded seals around the drillship, mitigation measures would avoid or minimize adverse effects to ice seals and it is unlikely that there would be any cases of temporary hearing impairment or non-auditory physical effects. The VSPs could result in short-term behavioral changes to a small number of seals; however, implementation of typical monitoring and mitigation measures avoid or minimize these impacts. Seismic airgun noise associated with the VSPs are anticipated to have no more than a negligible level of effect on ringed seals and bearded seals in the project area. 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.

Drilling Noise. Some ringed seals and bearded seals may be displaced around a drill site by active drilling operations (Richardson et al., 1995). The effects of offshore drilling on ringed seals in the Beaufort Sea were investigated in the past by Frost and Lowry (1988) and Moulton et al. (2005). Frost and Lowry (1988) concluded that local ringed seal populations were less dense within a 2 nmi buffer of man-made islands and offshore wells that were being constructed in 1985-1987. Moulton et al. (2005) found ringed seal densities on the same locations to be higher in years 2000 and 2001 after a period of habituation.

Moulton et al. (2005) reported that during spring aerial surveys for ringed seals, there was no evidence that construction, drilling, and production activities at BP's Northstar oil development in the Beaufort Sea affected local ringed seal distribution and abundance. The Northstar facility is on an artificial island. Drilling and production sounds from Northstar likely were audible to ringed seals, at least intermittently, out to approximately 1.5 km in water and 5 km in air (Blackwell et al., 2004). Underwater sounds from construction, drilling, and production reached background values at 2-4 km away (Richardson and Williams, 2004). Richardson and Williams (2004) concluded that there was little effect from the low to moderate level, low-frequency industrial sounds emanating from the Northstar facility on ringed seals during the open-water period and that the overall effects of the construction and operation of the facility were short-term and localized, with no consequences to seal populations as a whole. Adult ringed seals may habituate to drilling activities over several years, but are not assumed to do so in a single year.

Harwood, Smith, and Melling (2007) evaluated the potential impacts of exploratory drilling on ringed seals in the near shore Canadian Beaufort Sea, during February to June 2003-2006. The first three years of the study (2003-2005) were conducted prior to industry activity in the area, while a fourth year of study (2006) was conducted during the latter part of a single exploratory drilling season. The distances from industrial sites to seal breathing holes and lairs were not substantially different between the pre-activity (2003 and 2004) and industrial activity (2006) periods. The movements, behavior, and home range size of ten seals tagged in 2006 also did not vary statistically between the 19 days when industry was active (20 March to 8 April) and the following 19 days when industry operations were completed. Resting ringed seal densities did not differ among the different study years and were comparable to densities found in during surveys conducted in 1974-1979. No detectable effect on ringed seals could be discerned in the one season of drilling in the study area (Harwood, Smith, and Melling, 2007). As the Harwood study was conducted when seals were engaged in more sensitive periods of pupping, breeding, and molting, these results indicate that seals may be more tolerant of other potential disturbances after these activities are concluded. Potential effects to bearded seals are estimated to be the same as for ringed seals.

Modeled sound radii indicate that the drillship activities would generate a 120 dB re 1 μPa at 13.27 km from the *Kulluk* and 3.32 km from the *Discoverer* (Shell, 2011a, Table 10.b-1, page 10-4). The NMFS uses a 120-dB rms isopleth to indicate where Level B harassment begins for continuous acoustic sources, such as drillships. Modeling indicates there is no chance for bearded or ringed seals to encounter a noise level from the drill ship that could result in physical injury. Seals approaching the drill site would encounter increasing levels of underwater noise of their own volition. While a small number of ringed seals and bearded seals could move out of the immediate area, these movements to other nearby similar areas are anticipated to result in no more than a negligible level of effect. 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.

Icebreaking and Ice Management. Ice management activities associated with the Proposed Action are described in detail in Section 2.3.4. Project timing would alleviate harm to breeding seals, seal pups in lairs, and molting seals. The Proposed Action would occur after the ice-seal breeding season (which ends in mid June), during the open-water season.

Some ringed or bearded seals could be associated with ice that could be encountered during movement of the fleet to or from the project site in the Beaufort Sea. Strandberg, Embacher, and Sagriff (1984) concluded that ringed seals tended to remain on the ice or in their breathing holes just a few tens of meters away from a ship moving through extensive pack ice in Admiralty Inlet, Canada. After the ship had passed, seals tended to move into the ship's track, similar to their response to natural openings. Ringed or bearded seals hauled out on ice in close proximity (<1 km) to the fleet may enter the water. Extensive pack ice is not anticipated in the project area during the Proposed Action.

Limited ice breaking might be needed to assist the fleet in accessing/exiting the project area if large amounts of ice pose a navigational hazard. Ice seals have variable responses to ice management activity. Alliston (1980, 1981) reported icebreaking activities did not adversely affect ringed seal abundance in the Northwest Territories and Labrador. Brueggeman et al. (1992) reported ringed seals and bearded seals diving into the water when an icebreaker was 0.93 km away; however, Kanik, Winsby, and Tanasichuk (1980) reported that ringed seals remained on sea ice when an icebreaker was 1-2 km away.

The drill site is expected to be mostly ice-free during July, August, and September and the need for ice management should be infrequent. The presence of an icebreaker is primarily a safety precaution to protect the drill ship from damage. Ice-seals could be on isolated floes that may need to be managed for safety. Any ice seals on floes approaching the drill ship may be disturbed by ice management activities. Ringed seals and bearded seals on an ice floe are anticipated to enter the water before the icebreaker contacts the ice, remain in the water as the ice moves past the drill ship, and could reoccupy ice after it has moved safely past the drill ship. While a small number of ringed seals and bearded seals could leave ice haulouts and enter the water, these short-term disturbances to individual ice-seals are anticipated to result in no more than a negligible level of effect. 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.

Permitted Discharges. Under the Proposed Action, spent drilling fluids and cuttings, sanitary wastewater, and domestic wastewater would be retained on a barge onsite for later removal and disposal at a facility in the Pacific Northwest (Shell, 2011a). Few discharges will occur on site and few benthic organisms would be exposed to drill cuttings and other materials, because of the relatively small discharge plume and the plume's proximity to the drillship. Mobile invertebrates and fishes are anticipated to avoid the area affected by the discharge plume, thereby avoiding exposure.

With implementation of measures to retain discharges to the maximum amount practicable, there are few opportunities for unauthorized discharges to enter the marine environment. The overall effect of the proposed activities may be temporary, non-lethal effects to fish populations. As a consequence, the likelihood of ice seals ingesting benthic organisms or fishes contaminated by discharges associated with the proposed activities is very low and a negligible level of effect from permitted discharges to ringed seals or bearded seals is anticipated. 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.

Oil Spills. Oil spills are accidental events. The potential effects of small oil spills are described below. Large and very large oil spills are described in Section 5.7, and Section 5.8.

Section 2.3.10 describes spill prevention and response. While there is some potential for a fuel spill during the proposed operations, few ringed seals or bearded seals are anticipated to occur in the project area and few could be exposed to an accidental spill. Similarly, if a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact ice seals. Finally, the vessel activity associated with spill response would likely keep ice seals out of the spill area, and individual seals would likely avoid the spill by leaving the area during spill response activities. Accidental small spills are anticipated to have no more than a negligible level of effect on ringed seals and bearded seals. 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.

Polar Bear. Polar bears and critical habitat are described in Section 3.2.6.1. The Proposed Action could affect polar bears or their habitats through vessel traffic and noise, aircraft traffic and noise, icebreaking and ice management, and accidental oil spills. Permitted discharges and seismic airgun and drilling noise associated with the Proposed Action are not anticipated to affect polar bears.

Vessel Traffic and Noise. Polar bears may be stressed by energy expenditures related to avoiding or investigating vessels in the lead systems or traffic on ice. Encounters are much less likely to occur during the open-water season when the proposed activities would occur, because most polar bears remain in the active ice zone (USDOI, FWS, 2009c). The Proposed Action specifies that project vessels will not operate within 0.5 mi (800 m) of polar bears observed by the Marine Mammal Observers onboard on land or sea ice. Vessels will follow specific corridors from West Dock to and from the drill site at least 1 mi from barrier islands (except traversing the Mary Sachs Entrance, or for navigation safety). The Proposed Action also includes measures to reduce the likelihood of impacts to polar bears; specifically identified in the Polar Bear, Pacific Walrus, and Grizzly Avoidance and Human Encounter /Interaction Plan (Shell, 2011b). Vessel operations, as monitored by MMOs, are anticipated to result in no more than a negligible level of effect on polar bears. 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.

Aircraft Traffic and Noise. Most routine helicopter traffic would fly at least 1,500 ft AGL between shore facilities and the drill site (except during take-offs, landings, or for navigational safety). Helicopter traffic may travel between Deadhorse and the Beaufort Sea drill site, following a flight corridor that is 5 mi inland and then directly offshore through the Mary Sachs Entrance to the drill site (weather permitting).

Dedicated low-level marine mammal survey flights could provide a frequent source of disturbance to polar bears; however, polar bears are expected to be uncommon in open-water areas. Aircraft traffic and noise from the Proposed Action are expected to result in no more than a negligible level of effect on polar bears in the project area. 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.

Icebreaking and Ice Management. Polar bear reactions to icebreakers are variable. Polar bears are known to run from sources of noise and the sight of icebreakers, but other times polar bears have demonstrated curiosity towards icebreakers. During the open-water season, most polar bears remain offshore on the pack ice or land and are not normally present in the project area. Any encounters between a polar bear and icebreakers associated with this project are expected to elicit transitory short-term behavioral reactions in polar bears (USDOI, FWS, 2009) and a negligible level of effect is anticipated. 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.

Oil Spills. Oil spills are accidental events. The potential effects of small oil spills are described below. Large and very large oil spills are described in Section 5.7, and Section 5.8.

Section 2.3.10 describes spill prevention and response. While there is some potential for a fuel spill during the proposed operations, few polar bears are anticipated to occur in the project area and few could be exposed to an accidental spill. Similarly, if a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact polar bears. Finally, the vessel activity associated with spill response would likely keep polar bears out of the spill area, and individual polar bears would likely avoid the spill by leaving the area during spill response activities. Accidental small spills are anticipated to have no more than a negligible level of effect on polar bears. 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.

Polar Bear Critical Habitat. The Proposed Action would occur during the open-water season when sea ice is approaching its minimum. The Proposed Action includes mitigation measures that avoid or minimize close approaches to barrier islands, areas seasonally important to polar bears. Ice management activities could be needed to protect the drillship and are not anticipated to be extensive in duration or aerial extent. No long-term adverse effects to designated critical habitat are anticipated.

Activities associated with the Proposed Action do not have a cause-effect relationship that would influence aspects of climate change discussed in section 4.0, considered the largest threat to polar bear habitat. Climate change over the project timeframe are anticipated to result in a minor level of effect (short-term, widespread), but could be beneficial or adverse to sea ice depending on the vagaries of the Arctic weather. The incremental contribution of the Proposed Action to the collective impacts on polar bear habitats in the project area is negligible. 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.

Pacific Walrus. The Pacific walrus is described in Section 3.2.6.1. The Proposed Action could affect Pacific walruses through vessel traffic and noise, aircraft traffic and noise, seismic airgun noise, drilling noise, icebreaking and ice management, permitted discharges, and accidental oil spills.

Vessel Traffic and Noise. Richardson (1995) found that vessel noise does not seem to strongly affect pinnipeds (e.g., Pacific walrus) that are already in the water. Pacific walrus may avoid moving vessels, with most reactions occurring within 0.46 km (0.29 mi) (Richardson et al., 1995) or they may approach vessels out of curiosity. Mitigation measures in Shell's Polar Bear, Pacific Walrus, and Grizzly Avoidance and Human Encounter/Interaction Plan (Shell, 2011b), include a 0.5 mi (800 m) exclusion zone around observed walrus for vessels in transit, which is expected to reduce contacts with and minimize adverse effects to Pacific walrus. Vessel traffic effects on walrus are expected to be transient and localized. Because of the timing of the project, the low number of walrus expected to occur in the central Beaufort Sea, and required mitigation measures, vessel traffic and noise from the Proposed Action are expected to result in a negligible level of effect on Pacific walrus. 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.

Aircraft Traffic and Noise. Aircraft associated with the exploration activities would maintain a 1,500 ft altitude, except during take-offs and landings or when conducting marine mammals surveys. Low-level marine mammal surveys have the potential to regularly affect Pacific walrus in the drilling area. Due to the low numbers of Pacific walrus expected in the project area, however, a minor level of effect on Pacific walrus from low-level survey flights is anticipated. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Seismic Noise. Walrus use sound for communication and spend a great deal of time foraging underwater. They may be exposed to noise from seismic surveys. Temporary threshold shift (TTS) may occur after exposure to seismic pulses; however, this has not been documented in walrus. Walrus have good low-frequency hearing (Kastelein et al., 2002) and may be susceptible to masking of biologically important signals by low frequency sounds, such as airgun pulses from seismic surveys (Gordon et al., 2004). Masking of biologically important sounds by anthropogenic noise is equivalent to a temporary loss of hearing acuity. Brief, small-scale masking episodes might, in themselves, have few long-term consequences for individuals or populations of marine mammals.

The potential for direct impacts causing injury from seismic surveys would be most likely if individuals entered a 180-dB zone immediately surrounding the high-energy noise source. Direct impacts potentially causing injury from seismic surveys are unlikely because walrus avoid active airgun operations and MMOs are required to decrease the sound levels by shutting down all or some of the airguns if marine mammals enter the 180/ 190 dB zones.

The VSPs are short-duration activities that have specific monitoring requirements and mitigation measures designed to minimize adverse effects on walruses. A negligible level of effect on Pacific walrus is anticipated because VSPs would occur in areas of open-water where walrus densities are expected to be relatively low, would be of short in duration, and have safety zones that would be closely monitored. 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.

Drilling Noise. Underwater noise associated with drilling could affect walruses near an active drillship. Modeled sound radii indicate that the sound associated with the proposed drilling operations from *Discoverer* would not exceed the 180-dB level. Sounds from drilling are modeled to reach 160 dB at 172 ft (52.5 m) from the drillship (USDOI, MMS, 2009a). Modeling indicates there is no chance for walrus to encounter a noise level from the drill ship that could result in physical injury. Walruses approaching the drill site would encounter increasing levels of underwater noise of their own volition. Such approaches are not considered take. While a small number of Pacific walruses could move out of the immediate area, these movements to other nearby similar areas are anticipated to result in no more than a negligible level of effect. 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.

Icebreaking and Ice Management. Walrus near moving icebreakers exhibited avoidance behavior in a monitoring project during drilling in the Chukchi Sea (Brueggeman et al., 1991). During icebreaking, walrus moved 12-16 mi (20-25 km) from the operations to areas where sound energy levels approached ambient levels. Walrus did not show an avoidance reaction when vessels were anchored or drifting and did not appear affected by drilling sound. This was confirmed by the sightings of walrus near prospects during drilling operations (Brueggeman et al., 1991).

Icebreakers, particularly those transiting through the Beaufort Sea, could have a minor effect on walrus herds hauled out on ice or in water. Ice-management may temporarily cause a few walrus foraging or resting in the Beaufort Sea to avoid the area of operations. However icebreakers temporarily alter habitat, which could benefit walrus by opening up new areas, or cause additional stress by fragmenting large ice floes where walrus haul out to rest. Moreover, this project is planned for the open-water season and extensive icebreaking and ice-management activity is not anticipated. Because of the timing of the project, the low number of Pacific walrus using the project area, and the short duration of the Proposed Action,BOEMREexpects a negligible level of effect on Pacific walrus. 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.

Permitted Discharges. Under the Proposed Action, spent drilling fluids and cuttings, sanitary wastewater, and domestic wastewater would be retained on a barge onsite for later removal and disposal at a facility in the Pacific Northwest (Shell, 2011a). Few discharges will occur on site and few benthic organisms would be exposed to drill cuttings and other materials, because of the relatively small discharge plume and the plume's proximity to the drillship. Due to mitigation measures, there are few opportunities for unauthorized discharges to enter the marine environment. The likelihood of walruses ingesting benthic organisms contaminated by discharges associated with the Proposed Action is very low.

With implementation of measures to retain discharges to the maximum amount practicable, permitted discharges would have no more than a negligible level of effect on Pacific walruses in the project area. 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.

Oil Spills. Oil spills are accidental events. The potential effects of small oil spills are described below. Large and very large oil spills are described in Section 5.6.

Section 2.3.10 describes spill prevention and response. While there is some potential for a fuel spill during the proposed operations, few walruses are anticipated to occur in the project area and few could be exposed to an accidental spill. Similarly, if a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact walruses. Finally, the vessel activity associated with spill response would likely keep walruses out of the spill area, and individual walrus would likely avoid the spill by leaving the area during spill response activities. Accidental small spills are anticipated to have no more than a negligible level of effect on Pacific walruses. 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.

Other Marine Mammals

Of the remaining marine mammal species, the beluga whale and spotted seal are most widely distributed and common within the Proposed Action area. These species have some potential for adverse effects.

Beluga Whales. The Proposed Action could affect beluga whales through vessel traffic and noise, aircraft traffic and noise, seismic airgun noise, drilling noise, icebreaking and ice management, permitted discharges, and accidental oil spills.

Vessel Traffic and Noise. Fraker, Sergeant, and Hoek (1978) described a startle response of belugas to vessels moving through areas with a high concentration of whales. Reactions of beluga whales to vessels varies among individuals and the amount of avoidance exhibited by individuals would depend upon the amount of previous exposure to moving vessels and level of importance of the need for an individual to be in the same area of vessel traffic (Finley and Davis, 1984). In some studies, more intense reactions to large vessels were seen, but these observations were made in deep water (Finley et al., 1990; LGL and Greeneridge, 1996). Such reactions are not expected in the relatively shallow waters of the project area, because most belugas will be feeding in the deeper waters along the ice front and the continental shelf break, far to the north and away from the project area (USDOI, MMS, 2003). There are few opportunities for vessel traffic to encounter beluga whales in offshore areas and a negligible level of effect is anticipated. Should beluga whales move further inland, they could periodically encounter vessel traffic. Mitigation measures designed to avoid or minimize adverse effects from vessel noise or collisions would reduce impacts and no more than a minor level of effect would be anticipated to beluga whales moving through nearshore waters. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Aircraft Traffic and Noise. As described in the Arctic Multiple-sale Draft EIS (USDOI, MMS, 2008a), the greatest potential for helicopter or fixed-wing aircraft to cause adverse effects on beluga whales exists in areas where they are aggregated. Richardson et al. (1995) opportunistically observed the effects of helicopter overflights on migrating belugas near Point Barrow during 1989-1994. Of 760 groups observed, 24 groups reacted overtly. Turbine-powered helicopter passes at about 250 m (820 ft) lateral distance from belugas and at altitudes up to 460 m ASL (1,500 ft) and Twin Otter passes at altitudes about 182 m (600 ft) ASL and at lateral distances about 250 m (820 ft) elicited pronounced reactions (e.g., vigorous swimming, abrupt dives, or tail thrashing) from belugas.

However, most belugas observed showed no obvious reaction to single passes at altitudes >150 m ASL. Those belugas maintained their headings and continued respiring at the surface while the helicopter operated nearby (Richardson et al., 1995). In a few cases, belugas responded to direct overflights by turning away from the aircraft, but in others, belugas responded only by looking up at the aircraft (Richardson et al., 1995). The authors noted that the behavioral reactions of belugas were brief and inconsequential, and that there was no objective way to measure the biological importance of the behavioral reactions observed.

The Proposed Action includes typical flight altitude restrictions and predetermined flight routes that avoid or minimize adverse effects to beluga whales in nearshore coastal areas. Low-level marine mammal monitoring flights could have a greater level of effect on beluga whales. No more than a minor level of effect is anticipated from aircraft traffic. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Seismic Airgun Noise. Underwater sounds are important to beluga whale communication. Seismic noise has the potential to affect beluga whale communication (USDOI, MMS, 2006b). Seismic noise also has some potential to temporarily affect beluga whale hearing, most often referred to as a Temporary Threshold Shift (TTS). The Proposed Action includes a few Vertical Seismic Profiles (VSPs), once wells are drilled. Specific mitigation measures are used to avoid exposing marine mammals to seismic sounds during the brief (<24 hrs) period when the few VSPs are being conducted. These measures include direct observation of the esonified area by an MMO while the VSP is being conducted, with the requirement to shutdown the operation if a marine mammal approaches or is within the area where TTS could occur.

The VSPs are short-duration activities that have specific monitoring requirements and mitigation measures designed to minimize adverse effects on beluga whales. A negligible level of effect on beluga whales is anticipated because VSPs would occur in areas where numbers of beluga whales are expected to be relatively low, would be of short in duration, and have safety zones that would be closely monitored. 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.

Drilling Noise. Belugas are believed to have poor hearing of sounds below 1 Hz, the range of most drilling activities, but have shown some behavioral reactions to lower sounds. Brewer et al. (1993) observed belugas within 2.3 mi (3.7 km) of the drilling unit *Kulluk* during drilling. Belugas primarily use high-frequency sounds to communicate and locate prey; therefore, masking by low-frequency sounds associated with drilling activities is not expected to occur. If the distance between communicating whales does not exceed their distance from the drilling activity, the likelihood of potential impacts from masking would be low. At distances greater than 660-1,300 ft (200-400 m), recorded sounds from drilling activities did not affect behavior of beluga whales, even though the sound energy level and frequency were such that it could be heard several kilometers away (Richardson et al., 1995). This exposure resulted in whales being deflected from the sound energy and changing behavior. These brief changes are expected to be temporary and are not expected to affect whale population (Richardson et al., 1991; Richard, Martin, and Orr, 1998). Brewer et al. (1993) observed belugas within 2.3 mi (3.7 km) of the drilling unit *Kulluk* during drilling. A more detailed discussion of this information is provided in the Arctic Multiple-sale Draft EIS (USDOI, MMS, 2008a). Some beluga whales may avoid the area in the vicinity of the drilling operations because of noise; however the level of effect is expected to be minor.

Icebreaking and Ice Management. While observing the response of beluga whales to icebreakers, Finley and Davis (1984) reported avoidance behavior when icebreaker vessels approached at distances of 22-31 mi (35-50 km). Belugas are thought to have poor hearing below 1 Hz, the range of most drilling activities, but have been seen showing some behavioral reactions to the sounds (USDOI, MMS, 2008a). Beluga whales would not likely approach an active icebreaker, avoiding the noise associated with such activity. Beluga whales could alter their swimming paths to avoid the operation, which would be considered no more than a minor level of effect. The effects evaluated will occur each season that Shell conducts exploratory drilling operations under this exploration plan. The minor effects, however, are temporally limited and consecutive years of activity would not have an additive effect.

Permitted Discharges. Under the Proposed Action, spent drilling fluids and cuttings, sanitary wastewater, and domestic wastewater would be retained on a barge onsite for later removal and disposal at a facility in the Pacific Northwest (Shell, 2011a). Few discharges will occur on site and few benthic organisms would be exposed to drill cuttings and other materials, because of the relatively small discharge plume and the plume's proximity to the drillship. Mobile invertebrates and fishes are anticipated to avoid the area affected by the discharge plume, thereby avoiding exposure.

With implementation of measures to retain discharges to the maximum amount practicable, there are few opportunities for unauthorized discharges to enter the marine environment. The overall effect of the proposed activities may be temporary, non-lethal effects to fish populations. As a consequence, the likelihood of beluga whales ingesting benthic organisms or fishes contaminated by discharges associated with the proposed activities is very low and a negligible level of effect from permitted discharges to beluga whales is anticipated. 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.

Oil Spills. Section 2.3.10 describes spill prevention and response. While there is some potential for a fuel spill during the proposed operations, few beluga whales are anticipated to occur in the project area and few could be exposed to an accidental spill. Similarly, if a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact beluga whales. Finally, the vessel activity associated with spill response would likely keep beluga whales out of the spill area, and individual whales would likely avoid the spill by leaving the area during spill response activities. Accidental small spills are anticipated to have no more than a negligible level of effect on beluga whales in the project area. 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.

Spotted Seals. The Proposed Action includes activities that could affect spotted seals. The impact–producing factors include vessel traffic and noise, aircraft traffic and noise, seismic airgun noise, drilling noise, ice management, permitted discharges, and small spills. Although the spotted seal is less common than ringed seals or bearded seals, the vulnerability and responses of spotted seals to the Proposed Action would be the same as those previously described for ringed seals and bearded seals. As a consequence, the potential effects of the Proposed Action on spotted seals are anticipated to be the same as those described for ringed seals and bearded seals. Because of substantial mitigation measures incorporated into the Proposed Action that would avoid or minimize adverse effects on spotted seals, no more than a negligible level of effect is anticipated. 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.

4.2.7.2. Summary of Direct and Indirect Effects on Marine Mammals

The Proposed Action includes mitigation measures that avoid or minimize impacts from seismic airgun noise, drilling noise, permitted discharges, and oil spills to a negligible level of effect. Aircraft traffic and noise, icebreaking and ice management, and drilling noise are anticipated to result in no more than a minor level of effect. Taken together, these activities are anticipated to result in no more than a minor level of effect on the marine mammal populations and critical habitat per year.

4.2.7.3. Cumulative Effects

Activities associated with the Proposed Action do not have a cause-effect relationship that would influence aspects of climate change discussed in section 4.0. Climate change over the project timeframe are anticipated to result in a minor level of effect (short-term, widespread), but could be beneficial or adverse to sea ice depending on the vagaries of the Arctic weather. Appendix C describes reasonably foreseeable future events that could occur in the project area that could affect marine mammals and critical habitat in the project area. These projects include vessels and aircraft that are not subject to altitude or route restrictions and likely have greater impacts than the Proposed Action. For example:

- Marine mammal research flights often fly at low altitudes that result in direct impacts to marine mammals, especially when they circle for counts or photographs.
- Research projects have deviated from designated transect routes to investigate reports of beluga whale concentrations.
- Ice conditions and subsistence hunting are expected to have a greater impact on migration and survival of walrus than vessel traffic.

The incremental contribution of the Proposed Action to the collective impacts on marine mammals in the project area is no more than minor. The reasonably foreseeable cumulative effects will occur at nearly the same level each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the impacts to marine mammals from the Proposed Action and from reasonably foreseeable cumulative activities would amount to a minor level of effect.

4.2.8. Sociocultural Systems

Sociocultural systems encompass three concepts: (1) social organization, (2) cultural values, and (3) institutional organizations of communities. By "social organization" we mean how people are divided into social groups and networks. By "cultural values" we mean desirable values that are widely shared explicitly and implicitly by members of a social group. By "institutional organization" we refer to the government and quasi- government entities that provide services to the community. For the Proposed Action and communities described in the affected environment section, sociocultural systems effects are directly linked to the effects subsistence resources.

4.2.8.1. Direct and Indirect Effects

The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) is committed to protecting subsistence activities. The BOEMRE Alaska Region has adopted through regulatory practice, a position on significance in the context of NEPA that supports the goal of protecting subsistence activities. This position is clearly aligned with the way BOEMRE regulates offshore oil and gas geophysical and geological surveys and exploratory drilling activities for several decades. The predominate attribute of this regulatory policy makes clear that BOEMRE will only permit offshore oil and gas activities when the disruption to subsistence harvest of resource can be minimized in such a manner that the disruption is short term and as a result of incidental or accidental encounters. Under the Proposed Action, these encounters will come primarily from vessel traffic and aircraft traffic associated with the project. As such, because of the negligible effects to subsistence described in Section 4.2.9 effects to sociocultural systems, such as social organization and institutional arrangement are not expected to occur. 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.

The BOEMRE views oil spills as having the potential to cause long term significant effects that would disrupt or nearly eliminate subsistence harvests. Oil spills are never permitted and are always in violation of the law. Operators would be held accountable and responsible for mitigation and monitoring loss or reduction of subsistence species on the local subsistence harvesters and the linked social organizations and institutions.

4.2.8.2. Cumulative Effects

This analysis considers that cumulative effects on subsistence and local economic opportunities from the activities listed in Appendix C, Cumulative Effects, which would most affect sociocultural systems. As described above under direct and indirect effects, BOEMRE permitted activities are only allowed when the disruption to subsistence harvest of resource can be minimized in such a manner that the disruption is short term and as a result of incidental or accidental encounters. Activities permitted or authorized by other government agencies have policies that are similar to those required by BOEMRE to reduce effects to subsistence to a negligible level. As such, cumulative effects to sociocultural systems are not expected to occur. The reasonably foreseeable cumulative effects will occur at nearly the same level each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the impacts to sociocultural systems from the Proposed Action and from reasonably foreseeable cumulative activities would amount to a non-existent or negligible level of effect.

4.2.9. Subsistence Activities

The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) is committed to protecting subsistence activities. The BOEMRE Alaska Region has adopted through regulatory practice, a position on significance in the context of NEPA that supports the goal of protecting subsistence activities. This position is clearly aligned with the way BOEMRE regulates offshore oil and gas geophysical and geological surveys and exploratory drilling activities for several decades. The predominate attribute of this regulatory policy makes clear that BOEMRE will only permit offshore oil and gas activities when the disruption to subsistence harvest of resource can be minimized in such a manner that the disruption is short term and as a result of incidental or accidental encounters. Under the Proposed Action, these encounters will come primarily from vessel traffic and aircraft traffic associated with the project. As such, effects to sociocultural system are described in term of subsistence other components of sociocultural systems, such as social organization and institutional arrangement are not expected to occur.

Incidental or accidental short term encounters from associated vessel and aircraft traffic can be further eliminated through effective communication between the communities and the BOEMRE and/or industry such as those identified in Section 2.3.11, Stipulation 5, Plan of Cooperation, and 2.3.12, Other Mitigation, Protection of Subsistence Activities.

The BOEMRE views oil spills as having the potential to cause long term significant effects that would disrupt or nearly eliminate subsistence harvests. Oil spills are never permitted and are always in violation of the law. Operators would be held accountable and responsible for mitigation and monitoring loss or reduction of subsistence species on the local subsistence harvesters.

This discussion is limited to subsistence harvest of resources taken in the summer from July 10-August 25 and autumn in September and October when Shell may be actively working the Camden Bay prospects.

Shell's proposed Camden Bay activities at Sivulliq and Torpedo prospects present the potential for affecting subsistence harvesters at two Iñupiat communities: Nuiqsut, which lies 118 miles southwest of the leases, and Kaktovik, which lies 60 miles southeast of the prospects. Barrow lies 298 mi west of the proposed project area. Cross Island, from which Nuiqsut whalers launch their bowhead whale hunt, is 47 mi southwest of the proposed project area.

As described in greater detail above, the Proposed Action will drill 4 exploration wells, 2 in Sivulluq leases and 2 in Torpedo leases. The leases are located 16 – 20 mi north of Cape Thompson, on the north coast of Alaska, in Camden Bay, Beaufort Sea. Actual drilling is proposed during the open water season. Work would mobilize by July 10 during the open water season, when sea ice is not as extensive as in the spring, reducing the likelihood of requiring the use of any icebreaker and after most bowhead whales have migrated eastward to their summer localities. Regular crew support and rotation and ancillary support would be provided by helicopters flown from Deadhorse, Prudhoe Bay.

Shell's helicopters would fly a prescribed route previously agreed to during Government-to-Government meetings in 2007 with local residents of Nuiqsut and Kaktovik to lessen effects on subsistence activities. This route crosses the coast over State lands about 10 mi west of the mouth of the Canning River, just off the west tip of Flaxman Island (Shell, 2011a: Figure 2-2). Helicopters would be required to fly at an altitude of between 1,500 and 1,000 ft, weather permitting, to reduce or eliminate effects to land and sea mammals and the people who hunt them for subsistence purposes.

An ice-management vessel would be present to be used, if necessary, when the drill rig travels to the proposed drill sites. The drilling would occur for a relatively short duration (approximately 6 weeks at each drill site).

Shell would suspend all activity and withdraw from the prospects during the Nuiqsut and Kaktovik bowhead whale hunt, out of consideration of the importance of the resource to the Iñupiat of Kaktovik and Nuiqsut. Shell would suspend all activity by August 25 and move offsite. Exploratory work would resume only after Kaktovik and Nuiqsut completed fall bowhead whaling. Shell may continue until October 31.

When drilling is suspended on August 25, the borehole would be plugged and abandoned per BOEMRE requirements. All vessels, including the drillship, would withdraw from the area until whaling crews from both Nuiqsut, at Cross Island, and Kaktovik have completed fall bowhead whaling. There would be no overflights or industrial marine traffic during the bowhead whale hunt, and no subsidiary effects that might affect subsistence harvest, such as wastewater discharge in the migratory bowhead route during this time. Work may resume after completion of the Cross Island and Kaktovik bowhead whale hunts for up to another 6 weeks, or until October 31, depending on ice and weather.

4.2.9.1. Direct and Indirect Effects

No documented subsistence activities have occurred at the proposed offshore drill sites (SRB&A, 2010). The proposed overland helicopter route crosses an area that is recognized as being subsistence territory occasionally used by the Iñupiat of Kaktovik and Nuiqsut. Past use has been prolonged and consistent, as evidenced by the numerous house sites, camps, and other cultural features that dot the landscape (Impact Assessment Inc., 1990a and 1990b; Pedersen and Coffing, 1984).

An important consideration in assessing potential direct and indirect effects on subsistence activities is that most of Shell's activities would occur in the summer from mid-July until late August. This is the time during which the Iñupiat from Kaktovik and Nuiqsut fish. Most Kaktovik residents fish the beaches at or east of the village; in the past, some have fished the Canning River. The people of Nuiqsut fish the Colville River.

Summer fishing would not be affected by drilling and associated vessel or helicopter traffic. Drilling would occur out of range of fishers, about 20 mi offshore, and helicopter traffic would transect a prescribed route about 10 mi west of the Canning River. The proposed exploration would have either no effect or a negligible effect on the summer fishery as long as Shell adheres to the plan for overland flights, deployment from Deadhorse, and drilling about 20 mi offshore and works from 6-12-weeks. Short- and long-term effects on Nuiqsut and Kaktovik fisheries are considered to be non-existent to negligible.

Hunting caribou or seals during summer would be unaffected by drilling or associated vessel traffic. Helicopter traffic would pass overland on a prescribed route about 10 mi west of the mouth of the

Canning River at an altitude of between 1,000 and 1,500 ft. This would have a negligible effect on hunting bull caribou or seals. The only possible effect would be if a hunter takes aim at a caribou or seal immediately below the prescribed helicopter route, and a flight passed overhead below 1,000 ft in altitude due to weather. In that case, the prey might become skittish and flee. The chance of this occurring is remote, because the area under consideration for the helicopter route was established by industry through discussions as it receives little use by Kaktovik or Nuiqsut subsistence harvesters. Current hunting localities based on (a) the distance from either community and the high cost of fuel; and (b) the proximity of on-shore petroleum development (Impact Assessment Inc., 1990a and 1990b; Pedersen and Coffing, 1984). Thus, the helicopter flight, deployment from Deadhorse, and drilling about 20 mi offshore also would have a negligible effect on subsistence users from Kaktovik and Nuiqsut. Short- and long-term effects on Nuiqsut and Kaktovik subsistence hunting of caribou or seals are considered to be non-existent to negligible since the proposed project is estimated to last from 6-12-weeks.

All air and vessel traffic and drilling associated with the proposed exploration would be suspended for the duration of the Nuiqsut and Kaktovik bowhead whale hunt from August 25 until both communities reach their quotas and/or stop the hunt. There would be no auditory disturbance, refueling, or wastewater discharge at Sivulliq or Torpedo, no effect on the whale hunt harvest, or any other subsistence activity that would occur during this period. Short- and long-term effects on hunting for bowhead whales, beluga whales, or other any other subsistence resources are considered to be non-existent as long as Shell withdraws north or west of the migratory path of bowhead whales during the Nuiqsut and Kaktovik whale hunts.

Bowhead whaling at Barrow (about 300 mi west of the proposed drill sites) may continue through October. It is unlikely any disturbance or deflection of bowhead whales by the proposed activities would affect whales as they migrated past Barrow. Short- and long-term effects on the Barrow subsistence hunt is expected to be non-existent to negligible because of the distance of the project area from Barrow.

After the Nuiqsut and Kaktovik bowhead whale hunts, subsistence activities at both communities move away from the coast to the interior. During this time, people net fish under the river ice; shoot migratory waterfowl on the wing; hunt for moose, caribou, and mountain sheep (the latter by Kaktovik hunters); and trap furbearers. Kaktovik hunters and furbearer trappers use the foothills of the Brooks Range (SRB&A, 2010; Impact Assessment Inc., 1990b; Pedersen and Coffing, 1984). Short- and long-term effects on late fall to early winter subsistence activities are considered to be negligible, since Shell will alter the flight path from the interior to closer to the coast and maintain an altitude of 1,000-1,500 ft, will deploy from Deadhorse, and drills only the 4 prospects about 20 mi offshore. This brief analysis of subsistence activities discloses that in all likelihood, with mitigation measures in place, direct and indirect effects on subsistence would be negligible at the most. 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.

4.2.9.2. Cumulative Effects

This environmental analysis has identified vessel traffic, specifically marine vessel traffic, as the greatest impact source of anthropogenic sound introduced to the Beaufort Sea during the timeframe of the proposed activities. Marine vessel traffic would not be associated with the proposed exploration drilling, since no support vessels or aircraft would overfly the area during the shutdown period Shell would suspend all activity and withdraw from the prospects during the Nuiqsut and Kaktovik bowhead whale hunt, out of consideration of the importance of the resource to the Iñupiat of Kaktovik and Nuiqsut. Shell would suspend all activity by August 25 and depart the area. Exploratory work would resume only after Kaktovik and Nuiqsut completed fall bowhead whaling. Shell may continue until October 31.

Other vessel traffic is not controlled by the proposed project, and should be assumed to continue through the whale hunt. These vessels could be icebreakers, Coast Guard vessels, other supply ships and tugs and barges, and vessels associated with scientific endeavors. Cross Island whalers have reported that anthropogenic noise related to vessel traffic makes bowhead whales "skittish," more alert to sound and more difficult to approach (Applied Sociocultural Research, 2009).

Air traffic not associated with the proposed project may involve flight patterns at a lower altitude than the 1,500 ft level that will be industry's standard for this project. Airtraffic associated with the proposed project will also be suspended when Shell withdraws from the prospects during the Nuiqsut and Kaktovik bowhead whale hunts, but other air traffic associated with basic village transportation, freight and mail, and scientific endeavors would continue unabated. The air traffic noise has the potential to disrupt and disturb subsistence hunters from Nuiqsut and Kaktovik. Thus, it is possible that negligible cumulative effects will be experienced by subsistence hunters. The reasonably foreseeable cumulative effects will occur at nearly the same level each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the impacts to subsistence from the Proposed Action and from reasonably foreseeable cumulative activities would amount to a minor level of effect.

4.2.10. Economy

4.2.10.1. Direct and Indirect Effects

Descriptions of the NSB economy in the Shell Offshore Inc. 2011 Outer Continental Shelf Lease Exploration Plan, Camden Bay Alaska 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 offshore exploration plan promises to provide specific benefits to some local residents in and around Barrow, Nuiqsut, and Kaktovik. Shell's proposed exploration drilling would offer employment to a small number of local NSB residents. The MMO 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 one or two individuals from each of the Beaufort and Chukchi Sea villages. The activities described in the Exploration Plan would also support employment of oil spill response personnel. A more detailed discussion of local hire can be found in section 2.3.8.

Even with the potential employment associated with the proposed activities, it appears that employment opportunities for local residents, especially Alaskan Natives, would remain comparatively low in oil industry- related jobs on the North Slope. 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 Kaktovik, Nuiqsut, and Barrow. These effects do not constitute an important change in the impacts previously identified and evaluated in the conditionally approved 2010 Camden Bay EP (USDOI, MMS, 2009a).

Revenues: The proposed exploration activities will not result in additional onshore oil and gas infrastructure that the NSB and State of Alaska would receive property tax revenues from, and so the direct and indirect effect on revenues are expected to be negligible. 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.

4.2.10.2. Cumulative Effects

The sources of cumulative impacts affecting the 2011 Camden Bay EP and known activities planned for 2012 are listed in Appendix C – Cumulative Effects. The proposed activities are short term and temporary, involving low levels of new employment and no generation of property tax revenues accruing to the NSB or State of Alaska, and are therefore expected to have a negligible cumulative effect on employment, income, and revenue levels of the NSB and the communities of Kaktovik, Nuiqsut, and Barrow. The reasonably foreseeable cumulative effects will occur at nearly the same level each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the economic impacts from the Proposed Action and from reasonably foreseeable cumulative activities would amount to a negligible level of effect.

4.2.11. Environmental Justice

4.2.11.1. Direct and Indirect Effects

This analysis considers that proposed project direct and indirect effects on subsistence and public health as factors that would most affect environmental justice. Because the subsistence analysis concludes that the proposed project will have non-existent to very low direct and indirect effects on subsistence, it would follow that the proposed project will have non-existent to negligible 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.

4.2.11.2. Cumulative Effects

Incidental or accidental short term encounters can be further eliminated through effective communication between the communities and the BOEMRE and/or industry. Stipulation 5, the Conflict Avoidance Mechanism to Protect Subsistence Whaling and Other Subsistence Harvesting Activities applied to sales 195 and 202 (USDOI MMS, 1995; USDOI MMS, 2006) and is an example of a remedy for these types of disruptions.

The BOEMRE views oil spills as having the potential to cause long term significant effects that would disrupt or nearly eliminate subsistence harvests. Oil spills are never permitted and are always in violation of the law. Operators would be held accountable and responsible for mitigation and monitoring loss or reduction of subsistence species on the local subsistence harvesters.

This analysis considers that cumulative effects on subsistence and local economic opportunities are factors that would most affect environmental justice. Because the analysis concludes reasonably foreseeable activities will have cumulative effects on subsistence will be negligible, it would follow that there will be negligible cumulative effects on environmental justice. A different conclusion about the level of cumulative effects on economics will lead to a different outcome herein. The reasonably foreseeable cumulative effects will occur at nearly the same level 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.

4.2.12. Public Health

4.2.12.1. Direct and Indirect Effects

The activities associated with the EP would be staged out of Deadhorse, Prudhoe Bay, and the West Dock areas. 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. Findings regarding air quality and emissions remain the same and are incorporated by reference. However, water quality will have an even smaller effect on public health than originally described. Shell's 2011 EP proposes to reduce discharges into the marine environment by not discharging water based drilling fluids, drilling cuttings with adhered drilling fluids, treated sanitary waste, bilge water, and ballast water to the ocean. Instead, a tug and barge would be added to the fleet of vessels to provide temporary storage for these wastes as needed. The wastes would be transported out of the Arctic for disposal in approved facilities in accordance with all applicable laws and regulations. The tug and barge would enter the Sivulliq drill site area at about the same time as the drillship and other vessels, and would remain with the fleet until the end of the drilling season. In public testimony about offshore oil and gas exploration and development, the Iñupiat have long expressed concern over the introduction of contaminants into the marine environment that could affect subsistence resources. Storage of waste water and waste products such drilling cuttings and fluids and proper disposal beyond the arctic will go far to address persistent concerns held by the local community. The direct and indirect effects of the 2011 Camden Bay EP on public health 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 conditionally approved 2010 Camden Bay EP (USDOI, MMS, 2009a). 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.

4.2.12.2. Cumulative Effects

Other reasonably foreseeable activities which may affect public health are listed in Appendix C. With the implementation of the mitigation described in sections 3.1.13 and 4.2.11., the cumulative effects from the Proposed Action in combination with other reasonably foreseeable activities are considered to be negligible. These effects do not constitute a substantive change in the impacts to public health previously identified and evaluated in the conditionally approved 2010 Camden Bay EP (USDOI, MMS, 2009a). The reasonably foreseeable cumulative effects will occur at nearly the same level each season that Shell conducts exploratory drilling operations under this exploration plan. For the life of the project, the impacts to public health from the Proposed Action and from reasonably foreseeable cumulative activities would amount to a negligible level of effect.

5.0 POST DEEPWATER HORIZON EVENT ENVIRONMENTAL REVIEW

The *Deepwater Horizon* (DWH) event and oil spill in the Gulf of Mexico is addressed in this analysis. This section provides a summary of the germane investigations, reports, and recommendations that followed the 2010 event. This section also includes a description of changes that were made to regulations governing OCS activities and a review of prior NEPA analyses to determine the continued adequacy of those analyses.

5.1. *Deepwater Horizon* Oil Spill.

The *Deepwater Horizon* was a semi-submersible mobile offshore drilling unit (MODU) operated by British Petroleum Exploration & Production, Inc. engaged in drilling the Macondo well on Mississippi Canyon Block 252 (MC252) in federal Outer Continental Shelf (OCS) waters located in the Gulf of Mexico, about 41 miles offshore of Louisiana.

On April 20, 2010, the *Deepwater Horizon* caught fire and exploded while the vessel was in the process of capping the Macondo well prior to temporary abandonment. The blowout resulted in the release of oil in the Gulf of Mexico, 11 deaths, and numerous injuries. Response teams were not able to control the fire and the vessel sank on April 22, 2010 in about 5,000 feet of water approximately 1,500 feet from the well center. Attempts to activate the blowout preventer failed, and an estimated 4.9 million barrels of oil and an unknown quantity of natural gas was released before the well was capped on July 15, 2010. A relief well was completed On August 19, 2010, and the well was permanently plugged and abandoned.

The BOEMRE and the U.S. Coast Guard (USCG) are conducting a joint investigation to identify the factors which led up to the event, and developing conclusions and recommendations for future procedural and/or policy changes. On April 22, 2011, the Deepwater Horizon Joint Investigation Team (JIT) released a preliminary report covering issues under Coast Guard jurisdiction including the explosions on the Mobile Offshore Drilling Unit (MODU) *Deepwater Horizon*; the resulting fire; evacuations; the flooding and sinking of the *Deepwater Horizon*; and the safety systems of the MODU and its owner, Transocean. The findings released do not include an analysis of what led to the loss of well control or other aspects of the investigation that fall under BOEMRE jurisdiction. The JIT has been granted an extension of the deadline for its final report and it was not available at the date of publication of this EA. This approval was provided by the USCG and BOEMRE. The DWH event also precipitated several changes to BOEMRE's regulation of oil and gas activities on the OCS; these are addressed in the subsections below. This analysis assesses the relevance of the DWH event for the regulation of the Proposed Action, and incorporates into the present decision-making process the lessons learned.

5.2. Government Reports and Recommendations

Since the Deepwater Horizon event, several reviews from within or commissioned by the Federal government have offered formal recommendations regarding review and regulation of OCS oil and gas activities.

Council on Environmental Quality (CEQ). As a direct result of the *Deepwater Horizon* accident and the Macondo oil and gas spill, the CEQ reviewed MMS NEPA policies, practices and procedures relating to OCS oil and gas exploration and development and issued a report on August 16, 2010 (CEQ 2010). Contained in the report were recommendations made to BOEMRE to be used as "guideposts" to provide a consistent, rigorous, and transparent approach in NEPA reviews and other environmental analyses. Two of these recommendations apply to this EA:

> **Transparency, Public Accountability, and Sound Decisionmaking**
>
> Ensure that NEPA analyses fully inform and align with substantive decisions at all relevant decision points; that subsequent analyses accurately reflect and carry forward relevant underlying data; and that those analyses will be fully available to the public.

> Ensure that NEPA documents provide decisionmakers with a robust analysis of reasonably foreseeable impacts, including an analysis of reasonably foreseeable impacts associated with low probability catastrophic spills for oil and gas activities on the Outer Continental Shelf.
>
> **Changed Circumstances**
>
> Consider supplementing existing NEPA practices, procedures, and analyses to reflect changed assumptions and environmental conditions, due to circumstances surrounding the [Macondo] Oil Spill.

Section 0 below places the very large oil spill analysis for the Beaufort Sea in the context of the Torpedo H drill site worst case discharge information; incorporats of the information emerging from the DWH event investigations into the environmental assessment; and presents summary information to the decision-maker on the prevention, response and environmental consequences of a very large oil spill although the risk that the proposed wells will result in such a spill is very low.

The National Commission on the BP *Deepwater Horizon* Oil Spill and Offshore Drilling (The National Commission). The National Commission issued its final report (PCR, 2011) on January 11, 2011. This report described the causes of the incident and recommended "reforms to make offshore energy production safer." Some of these recommendations are specific to the Arctic. The recommendations relate to:

- How the NEPA process and related environmental analyses are conducted by BOEMRE.
- Oil spill prevention and response.
- Public administration and management of offshore resources, including specific recommendations for changes in legislation, conducting scientific studies, financing of bureau operations, and permitting and response by BOEMRE and other agencies such as the EPA.

Recommendations regarding the NEPA process and environmental analyses were addressed by insuring early consultation by BOEMRE with other agencies. Consultations with the National Marine Fisheries Service (NMFS), the Fish and Wildlife Service (FWS) and others are enumerated in the consultation and coordination sections of this EA and related NEPA documents listed in Section 6, Consultation and Coordination.

Most of the oil spill prevention and response recommendations are related to systems safety and reliability and additional mechanisms and processes for preventing pollution, specifically the loss of well control. This EA addresses compliance with operating regulations, describes inspections and other spill prevention actions the Bureau undertakes, including pollution prevention measures and oil spill prevention and response.

U.S. Coast Guard Incident Specific Preparedness Review. Following major (≥2,381 bbls) oil spills, Coast Guard internal regulations call for an Incident Specific Preparedness Review (ISPR) to conduct a thorough examination of the Coast Guard preparedness process and to critically evaluate this process in conjunction with the implementation, integration, and effectiveness of national, regional, and local oil spill response plans. An ISPR provides an assessment of a major response along with recommendations for improvement. On March 18, 2011, the United States Coast Guard distributed the Final Action Memorandum for the *Deepwater Horizon* Oil Spill ISPR.

The DWH ISPR contains a number of "lessons learned" and recommendations for many circumstances including the content of area contingency plans, identification of environmentally sensitive areas, worst case discharge scenarios in oil spill response plans, in-situ burning operations, spill containment, sustainability of offshore and nearshore response efforts, and use of vessels of opportunity. The review included recommendations that the Coast Guard request BOEMRE to take specific actions regarding the integration of oil spill contingency plans for regional response, review requirements for in-situ burning equipment, and take a number of actions regarding subsea containment.

United States Geological Survey Circular 1370. In April 2010, the Secretary of the Interior requested that USGS complete a special review of the state of information known about the Beaufort and Chukchi seas. On June 23, 2011, USGS released its report as USGS Circular 1370: "An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas, Alaska" (USDOI, USGS, 2011). The report summarizes key existing scientific information, develops a rapid process to identify where knowledge gaps exist, and provides initial guidance for what research is needed to improve decision making.

Special consideration is given in the report to four identified "Issue Topics":

- Effects of climate change on physical, biological and social conditions as well as resource management strategies in the Arctic.
- Developing foundational geospatial data on the Arctic OCS.
- Synthesis of existing scientific information on a wide range of topics.
- Spill-risk evaluation and response, and improving environmental data inputs for spill models.

Independent of development of the USGS report, BOEMRE had begun or planned a large number of studies to address the knowledge "gaps" in the four topics subsequently identified by USGS. The report is generally consistent with the strategic planning undertaken by the BOEMRE Environmental Studies Program (ESP) and serves to validate the annual cycle of review of available data and knowledge gaps which identifies studies for funding undertaken by the BOEMRE ESP at the National and Regional levels. Alaska Region ESP information is available at: http://alaska.boemre.gov/ess/index.HTM.

The BOEMRE reviewed the USGS report during the preparation of this EA. The review was focused in areas where the USGS identified information needs to determine whether these needs were critical for the decisionmaking process at the exploration stage of the OCS Lands Act four-stage process.

Information Needs. The scope of the USGS report is the entire US Arctic and, therefore, many of the information needs or "data gaps" identified are of a regional nature, cover a broad category (e.g. anthropogenic noise), or are presented in the context of a long time period (e.g. climate change). For example, the USGS report found:

> Little work has been done as of yet projecting how circulation patterns in the Beaufort and Chukchi Seas may change during the next 50 years. Because those patterns are critical in shaping both the physical and biological environments of the Arctic OCS, and are an important element of spill response models, support for research aimed at better understanding how these patterns may change in the future is important.

Exploration in this EA is anticipated to occur within 2-3 years from 2012. The extent to which the surface circulation pattern changes by midcentury (2050) is not relevant to this analysis, but the collection of the information is a good long-term goal.

The scope of the EA is also much more focused and limited than the review completed by USGS. The EA addresses a discrete activity at a discrete location at a discrete time with a relatively short duration. For example, the USGS report found:

> Recent at-sea information on marine birds for most of the study area is lacking or unpublished. Similarly, with the exception of information from Cooper Island and Cape Lisburne, much of the seabird colony information is out-of-date. Filling these data gaps would enhance our ability to measure the effects of climate change and assess the impacts of development and transportation.

While BOEMRE agrees this is a good goal for developing science on the Arctic, the information is not necessary to inform the decision-maker regarding the potential level of effects of the Proposed Action. BOEMRE has sufficient site specific information to complete a robust analysis of the impacts of the Proposed Action on marine birds. The BOEMRE requires an applicant to provide a variety of site-specific environmental, geological and geophysical detail within their proposed exploration plans which is then reviewed and independently verified. General information needs for the Arctic may not, therefore be relevant to specific exploration plans for which adequate information may exist.

The BOEMRE has also taken a cautious approach where more information would be beneficial to this project. For example, the USGS report (USGS, 2011) found that there is a lack of information on the response of ice seals to aircraft. The Proposed Action has incorporated mitigation measures to reduce the likelihood of impacts to ringed seals and bearded seals by restricting flights to above 1,500 ft (457m). Based on Born et al. (1999), the BOEMRE has found that despite the general lack of information on the response of ice seals to the noise of aircraft, the mitigation measure will remove the possibility of impacting ice seals.

Oil Spill Response Gap. The USGS report made several recommendations on oil spill prevention and response, recognizing that "effective Arctic technologies are the first step in oil spill minimization." The report also examined the efficacy of oil spill counter measures and the oil spill "response gap." A "response gap" occurs when activities that may produce an oil spill are conducted during times when an effective response cannot be achieved, either because available countermeasures will not be effective or their deployment is precluded by environmental conditions or safety issues.

The Proposed Action incorporates several features, described in Section 2.3.12 - Pollution Prevention Measures, which use Arctic-specific technologies and incorporates several measures to increase response capabilities and minimize the response gap. These measures include stationing and maintaining spill response vessels in the immediate vicinity of drilling operations, the use of containment equipment designed for Arctic conditions, and the staging of capping stack equipment aboard an ice management vessel so it will be available for immediate deployment. Section 5.6.1 - Overview of Oil Spill Effects and Response Analysis, provides specific information on oil spill response in the Beaufort Sea.

5.3. Transparency, Public Accountability, and Sound Decisionmaking

The April 2010 Macondo well control incident and subsequent oil and gas spill occurred following the completion of the oil spill analysis for the Shell 2010 EPs (USDOI, MMS, 2009a, USDOI, MMS, 2009b). An examination of OCS well control through 2010 is included below to update the data provided in the 2009 Camden Bay EA.

5.3.1. OCS Well Control Incident Rates.

This section updates information in the 2009 Camden Bay EA Appendix A, Section 1.3.2 which discussed OCS well control incidents from 1971-2007. The year 1971 is considered reflective of the modern regulatory environment. 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.

Three relevant data sets are considered: (1) all well control incidents from 1971-2009 prior to the DWH event, then (2) well control incident rates from exploration and development drilling including the DWH event, and finally (3) spills associated with well control incidents from exploration drilling including the DWH event (USDOI, BOEMRE, AIB, 2011).

Exploratory and Development/Production Operations From 1971-2009. There were 249 well control incidents during exploratory and development /production operations on the OCS from 1971-2009 (this includes incidents associated with exploratory and development drilling, completion, workover, plug and abandon, and production operations). During this period, 41,514 wells were drilled on the OCS and 15.978 billion barrels (Bbbl) of oil were produced. Of the 249 well control incidents that occurred during this period, 50 (20%) resulted in the spillage of condensate/crude oil ranging from <1 bbl to 450 bbls. The total spilled from these 50 incidents was 1,829 bbls. This volume spilled was approximately 0.000011447% of the volume produced during this period.

In 2010, four well control incidents occurred, including the DWH event. Although a final spillage volume from the DWH event has not been determined by BOEMRE, the current estimate from Lubchenco et al. (2010) is 4.9 million bbls. The three other well control incidents that occurred in 2010 did not result in the spillage of condensate/crude oil.

Development and Exploration Well Drilling From 1971-2010. From 1971 through 2010 there were a total of 41,781 wells drilled in the OCS comprising of 40,565 wells in the Gulf of Mexico, 1,086 wells in the Pacific Region, 46 wells in the Atlantic Region and 84 wells in the Alaska Region. Of these, 26,245 were development wells, 15,491 were exploration wells and 43 were core tests or relief wells. The overall drilling well control incident rate is 1 well control incident per 292 wells drilled, compared to 1 well control incident per 410 development wells drilled, and 1 well control incident per 201exploration wells drilled. These well control incident rates include all well control incidents related to drilling operations whether they spilled oil or not.

Exploration Well Drilling From 1971-2010. From 1971 through 2010 industry drilled 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. During this period, there were 77 well control incidents associated with exploration drilling. Of those 77 well control incidents, 14 (18%) resulted in crude, condensate or oil in drilling mud spills ranging from 0.5 bbl to 200 bbls, for a total 354 bbls, excluding the estimated volume from the DWH event. From 1971-2010 one well control incident resulted in a spill volume of 1,000 bbls or more and that was the DWH event.

The 2009 Camden Bay EA stated that no large (greater than or equal to 1,000 bbl) oil spills from exploration and development well control incidents occurred from 1971-2007 while drilling approximately 38,000 wells. With the inclusion of the Macondo incident, one large spill occurred from 1971-2010 while drilling approximately 38,000 wells. The BOEMRE analyzed the effects of a low probability very large oil spill in the Beaufort Sea Lease Sale 186, 195 and 202 Environmental Impact Statement (Beaufort Sea Multiple Sale EIS, Section IV.J) (USDOI, MMS, 2003) and tiered to that analysis in the 2009 Camden Bay EA.

The BOEMRE reviewed the oil spill elements analyzed in the Beaufort Sea Multiple Sale EIS (summarized in Table 19, column 2) to determine if the estimates are within the scope of the very large oil spill analysis in light of information provided by Shell in the Exploration Plan. In calculating the flow rate, length of flow, and volume, the Beaufort Sea Multiple-Sale EIS analysis did not consider a reduced volume that may be achieved through the use of oil spill countermeasures.

The Torpedo H well was selected as the basis for comparison as it has the highest calculated worst case discharge (WCD) of the four wells proposed in the EP (Shell, 2011, p. 2-5). BOEMRE analysis (Table 19, column 3) establishes a flow rate of 2,498 bopd which differs from that provided by Shell's estimate of 9,468 bopd (Table 19, column 4). This EA considers mitigation measures incorporated into Shell's 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 Torpedo H is within the range analyzed in the Beaufort Sea Multiple Sale EIS for both BOEMRE's and Shell's WCD scenario.

Table 19 Comparison of Very Large Oil Spill Scenario Elements to Worst Case Discharge Information.

Description	Beaufort Multiple-sale EIS	Torpedo H (BOEMRE)	Torpedo H (Shell)	Relative Change (BOEMRE)
Flow Rate	15,000 bopd	2,498 bopd	9,468 bopd[1]	One sixth the size
Length of Flow	15 days	15 days	15 days	Same
Volume	225,000 barrels[2]	37,470 barrels	142, 020 barrels	One sixth the size

Description	Beaufort Multiple-sale EIS	Torpedo H (BOEMRE)	Torpedo H (Shell)	Relative Change (BOEMRE)
Oil Type	38 °API	35 °API	35 °API	Similar oil quality
Location	Surface	Surface or Subsurface (subsurface modeled for WCD)	Surface or Subsurface (subsurface modeled for WCD)	Subsurface likely will surface within 1000 m of the location of loss of well control
Mitigation	Cleanup	Potential for oil to be collected within 15 days with the capping and containment system prior to reaching the sea surface and spreading		

Source: Shell Offshore Inc. (2010) and BOEMRE (2010).
Key: °API = American Petroleum Institute gravity (API)
Bopd = barrels of oil per day
[1]Provided as required by 30 CFR 250.213 and 250.219
[2]Approximately 180,000 barrels estimated to reach the marine environment

Information in Table 19 examines the same scenario elements as the previous analyses:

- The information provides an estimated flow rate, a length of time, a total volume and oil property information. The estimated flow rate is approximately 6 times less than previously analyzed;
- The final estimated volume is approximately one fifth of the volume reaching the gravel pad and water analyzed in the Beaufort Sea Multiple-Sale EIS (180,000 barrels), Section IV.I Low-Probability, Very Large Oil Spill (USDOI, MMS, 2003); and
- The oil type is similar in composition, physical properties, and evaporation rate.

BOEMRE determined that the low-probability, very large oil spill effects conclusions in the Beaufort Sea Multiple Sale EIS, Section IV.I remain valid for informing the decision maker of the effects of a, low-probability, very large oil spill in the vicinity of the Proposed Action. In addition to the original cleanup mitigation analyzed, the use of a capping stack and containment system could limit further the amount of oil reaching the sea surface and spreading should a loss of well control occur.

The BOEMRE analyzed the potential impacts of a very large spill from a well-control incident (USDOI, MMS, 2003: IV-228 to IV-247), including mitigation of spill response, and the conclusions of that analysis are found in section 0 of this EA. There are no site-specific anomalies that differentiate a very large spill release at Launch Area (LA) 12 analyzed and from LA15 where Shell's leases occur, and the oil-spill contacts are statistically similar.

5.4. Rule Changes Following the Deepwater Horizon Event

The aftermath of the DWH event provided new information about drilling on the OCS; in particular, it provided new information about (1) safety issues, (2) deficiencies of blowout containment technologies and strategies, and (3) shortcomings in oil spill response strategies and resources relative to spills in deepwater. The BOEMRE has addressed these issues by strengthening its regulations of OCS activities. A listing, followed by a summary, of new rules and rulemaking procedures are provided below:

- The Drilling Safety Rule, Interim Final Rule to Enhance Safety Measures for Energy Development on the Outer Continental Shelf (Drilling Safety Rule). This rule strengthens requirements for safety equipment, well control systems, and blowout prevention practices on offshore oil and gas regulations.
- The Workplace Safety Rule on Safety and Environmental Management Systems (SEMS Rule). This rule requires operators to develop and implement a comprehensive SEMS for identifying, addressing, and managing operational safety hazards and impacts; promoting both human safety and environmental protection; and improving workplace safety by reducing risk of human error.
- NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS," effective June 18, 2010 (Plans NTL).

- NTL-2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," effective November 9, 2010 (Certification NTL).

The Drilling Safety Rule. On October 14, 2010, BOEMRE issued an interim final rule entitled "Increased Safety Measures for Energy Development on the Outer Continental Shelf" (75 FR 63346). The interim rulemaking revises selected sections of 30 CFR 250 Subparts D, E, F, O, and Q. The Drilling Safety Rule includes new standards and requirements related to the design of wells and testing of the integrity of wellbores; the use of drilling fluids; and the functionality and testing of well control equipment including blowout preventers. To these ends, the rule is expected to promulgate OCS-wide provisions that will:

- Establish new casing installation requirements;
- Establish new cementing requirements;
- Require independent third party verification of blind-shear ram capability;
- Require independent third party verification of subsea BOP stack compatibility;
- Require new casing and cementing integrity tests;
- Establish new requirements for subsea secondary BOP intervention;
- Require function testing for subsea secondary BOP intervention;
- Require documentation for BOP inspections and maintenance;
- Require a Registered Professional Engineer to certify casing and cementing requirements;
- Establish new requirements for specific well control training to include deepwater operations.

Safety and Environmental Management Systems Rule. A new subpart to 30 CFR Part 250: Subpart S – Safety and Environmental Management Systems (SEMS) is designed to reduce the hazards associated with drilling operations and further reduce the likelihood of a blowout scenario such as described for this VLOS analysis. The SEMS Rule requires all OCS operators to develop and implement a comprehensive management program for identifying, addressing, and managing operational safety hazards and impacts, with the goal of promoting both human safety and environmental protection. The interim final rule was published on October 14, 2010 (75 FR 63345), requiring full implementation of a SEMS program as recommended by the rule's effective date of November 15, 2011. The 13 elements of the industry standard (American Petroleum Institute, Recommended Practice 75) that 30 CFR 250 Subpart S now makes mandatory are as follows:

- defining the general provisions for implementation, planning and management review, and approval of the SEMS program;
- identifying safety and environmental information needed for any facility such as design data, facility process such as flow diagrams, and mechanical components such as piping and instrument diagrams;
- requiring a facility-level risk assessment;
- addressing any facility or operational changes including management changes, shift changes, contractor changes;
- evaluating operations and written procedures;
- specifying safe work practices, manuals, standards, and rules of conduct;
- training, safe work practices, and technical training, including contractors;
- defining preventative maintenance programs and quality control requirements;
- requiring a pre-startup review of all systems;
- responding to and controlling emergencies, evacuation planning, and oil-spill contingency plans in place and validated by drills;

- investigating incidents, procedures, corrective action, and follow-up;
- requiring audits every 4 years, to an initial 2-year reevaluation and then subsequent 3-year audit intervals; and
- specifying records and documentation that describe all elements of the SEMS program.

NTL (Notice to Lessees) 2010-N06. Effective November 8, 2010, NTL No. 2010-NO6 requires that blowout intervention information be submitted with future Exploration or Development and Production Plans. The blowout scenarios required by 30 CFR 250.213(g) and 250.243(h) must include supporting information for any assertion that well bridging will constrain or terminate the flow or that surface intervention will stop the blowout. The availability of a rig to drill a relief well and rig package constraints must also be addressed. These scenarios must also specify as accurately as possible the time it would take to contract for a rig, move it on site, and drill a relief well, including the possibility of drilling a relief well from a neighboring platform or an onshore location.

NTL (Notice to Lessees) 2010-N10. Also released on November 8, 2010 was NTL 2010-N10. This NTL explains that applications for well permits must include a statement that all authorized activities will be conducted in compliance with all applicable regulations, to include the new measures discussed above. For operations using subsea BOPs or surface BOPs on floating facilities, BOEMRE will evaluate whether each operator has submitted adequate information demonstrating that it has access to and can deploy subsea containment resources that can adequately and promptly respond to a blowout or other loss of well control. The BOEMRE will also evaluate whether each operator has adequately described the types and quantities of surface and subsea containment equipment that the operator can access in the event of a spill or threat of a spill.

Joint Industry Task Forces. In response to the DWH event, several entities within the oil and gas industry cooperatively formed Joint Industry Task Forces. The stated purpose of each Task Force is "to review and evaluate current capacities, and to develop and implement a strategy to address future needs and requirements in equipment, practices or industry standards" applicable to the studied activity. Where possible, information developed by these Tasks Forces will be augmented with input from regulatory agencies, oil spill response and well control specialists, investigation panels, and other public sector and non-governmental organizations. To date, Task Forces on "Oil Spill Preparedness and Response" and "Subsea Well Control and Containment" have submitted draft recommendations. Joint Industry Task Force recommendations will not have the force of regulation, but may provide the basis for enhanced industry standards or future rulemaking processes.

BOEMRE Inspection Program. Under the direction of the OCS Regional Office in Anchorage, Alaska, BOEMRE inspection program for Alaska provides review and inspection of oil and gas operations. BOEMRE conducts on-site inspections to ensure compliance with lease terms, Notices to Lessees, and approved plans, and to ensure that safety and pollution-prevention requirements of regulations are met. These inspections involve items of safety and environmental concern. Further information on the baseline for the inspection of lessee operations and facilities can be found in the National Office Potential Incident of Noncompliance List (USDOI, MMS, 2005).

BOEMRE has taken steps to further strengthen its inspection program in light of the DWH event. BOEMRE is hiring additional inspectors. Also, the bureau is creating for the first time a National Offshore Training Center led by a training director dedicated to training inspectors on how to do their jobs. In the past, BOEMRE inspectors learned how to do their jobs through a combination of on-the-job training and industry-sponsored courses aimed at teaching how certain types of equipment functioned. Inspectors also received training from academia and third-party vendors. The Director of the National Offshore Training Center will develop national training strategies and programs to maintain and improve the technical capabilities of offshore inspections and compliance personnel throughout the bureau.

5.5. Site Specific Differences from Macondo

While BOEMRE responded to the Macondo well control incident with new nationwide regulations, it is important to note that there are important differences between the geological and physical conditions and the regulatory spill prevention requirements at the Macondo site in the Gulf of Mexico and the Sivulliq and Torpedo drill sites in the Beaufort Sea. The BOEMRE has compared the substantive differences and similarities between the Macondo and the proposed exploration drilling and concluded that the Macondo incident does not foreshadow any reasonably foreseeable events at the Sivulliq or Torpedo drill sites. The comparison data, summarized in Table 20, illustrates that the Macondo incident can not be directly correlated to reasonably foreseeable events in the Beaufort Sea as is described in detail in the following paragraphs.

5.5.1. Geological and Physical Conditions.

The Macondo well was drilled in approximately 5,000 ft of water, whereas the wells proposed by Shell will be drilled in approximately 107 to 124 ft of water among the 4 wells (EA tbl. 2). The shallower water depth allows for direct (non-acoustic) and faster communication with the blowout preventer (BOP) system allowing an operator to quickly activate the BOP. This translates to a much faster response time in the event of a well control incident with a well at the Sivulliq or Torpedo sites.

The Macondo well was drilled to 18,000 ft and had a reservoir pressure reported to be approximately 12,000 pounds per square inch (psi). The proposed Torpedo H well is expected to be drilled to a much shallower total depth (10,000 ft) and encounter an expected reservoir pressure of ~3,600 psi (BOEMRE model). The lower formation pressure results in a higher margin of safety. It also allows operators to change the weight of the drilling mud by several pounds per gallon to balance formation pressures.

The discharge rates observed at the Macondo well are much higher than the estimates for the Torpedo H well. These higher rates are due primarily to very high formation pore pressures at Macondo compared with much lower pore pressures anticipated at Torpedo H and the very low viscosity oil at Macondo compared to the higher (by a factor of 3.5) viscosity oil predicted at Torpedo H.

Table 20 Comparison of *Deepwater Horizon* / Macondo and Torpedo H Wells.

Geologic Information and Flow Parameters[1]	*Deepwater Horizon* / Macondo	Torpedo H (BOEMRE Model)
Water Depth (ft)	5,000	~120
Distance From Shore (mi)	41	21
Reservoir Depth (ft)	18,150	<10,000
Reservoir Thickness (ft)	95.5	Proprietary
Reservoir Age	12-16 mybp[2]	23-34 mybp[2]
Reservoir Porosity (%)	21.7	33
Reservoir Permeability	223.7	141
Reservoir Temperature (°F)	243	134
Reservoir Pressure (psi)	11,856	~3,600
Oil Gravity (°API)	38.2	35
Oil Viscosity (centipose)	0.168	0.58
Oil Volume Factor (rbbl/stbbl)[3]	2.367	1.54
Estimated Maximum Discharge Rate (bopd[3])	53,000 – 62,000	2,498-9,468[5]

Note: [1]*Deepwater Horizon* / Macondo geologic properties from PIV Study (2010, file pages 20-23; estimated maximum discharge rates from McNutt et al., 2011, p. 1))
[2]mybp = millions of years before present
[3]rbbl/stbbl = Reservoir Barrels per Stock-Tank Barrel. A stock-tank barrel is a barrel of oil at 60°F and 1 atmosphere pressure (14.73 psia)
[4]bopd = barrels of oil per day
[5]Worst case discharge calculation (BOEMRE, 2,498 bopd, Shell 9,468 bopd)

5.5.2. Arctic Specific Measures to Prevent Oil Spills

Exploratory drilling activities conducted on the OCS must be conducted in accordance with BOEMRE regulations at 30 CFR 250. These regulations set comprehensive requirements for well design based on site specific shallow geohazards, site clearance information, and deep seismic data. They also mandate the staging of redundant pollution prevention equipment, testing and verification that equipment is working properly, and training and testing of personnel in well control procedures. These regulations also establish the technical specifications for the specific drilling rig and the drilling unit. The 30 CFR 250 regulations include specific requirements for conducting operations in the Arctic. These include:

- Locating the blowout preventer (BOP) in a well cellar (a hole constructed in the sea bed) to position the top of the BOP below the maximum potential ice gouge depth. This protects the BOP and assures the well can be safely shut in, in the event the drilling unit has to move off location.
- Using special cements in areas where permafrost is present. These special cements create less heat than normal cements when curing so that permafrost does not thaw.
- Enclosing or protecting equipment to assure it will function under sub-freezing conditions.
- Developing critical operations and curtailment procedures which detail the criteria and process through which the drilling program would be stopped, the well shut in and secured and the drilling unit moved off location before environmental conditions (such as ice) exceed the operating limits of the drilling vessel.

In addition to the maintenance and implementation of its ODPCP, Shell would implement the following additional measures to further minimize the chance of an oil spill that might impact marine mammals and interfere with the subsistence hunt:

- Shell has established and would follow transit routes that avoid known fragile ecosystems and critical habitat areas to reduce the possibility of impacting those resources in the unlikely event of a vessel accident that resulted in a diesel spill.
- Shell has developed and would implement an Ice Management Plan (IMP) (Shell, 2011a: Section 9.0 and Appendix K) to ensure real-time ice and weather forecasting to identify conditions that might put operations at risk and modify its activities accordingly. The IMP also contains ice-threat classification levels depending on the time available to suspend drilling operations, secure the well, and escape from advancing hazardous ice.
- Shell has developed and would implement a Critical Operations and Curtailment Plan (COCP) (Shell, 2011a: Section 9.0 and Appendix J), which establishes protocols to be followed in the event potential hazards, including ice, are identified in the vicinity of the drilling operations (e.g., ice floes, inclement weather, etc.). Like the IMP, the COCP threat classifications are based on the time available to prepare the well and escape the location. The COCP also contains provisions for not initiating certain critical operations, if there is insufficient time available before the arrival of the hazard at the drill site.
- Shell has engineered each of its exploration wells (hole sizing, mud program, casing design, casing cementing depth, wellhead equipment, etc.) specifically to minimize the risk of uncontrolled flows from the wellbore due to casing or other equipment failures.
- Shell requires its drilling supervisors, toolpushers, drillers, and assistant drillers to hold an International Association of Drilling Contractors (IADC) WellCap (or equivalent) certificate showing mastery of well-control procedures and principles, and its crews must participate in regular training and drills in kick control to minimize the risk of a well-control event that might lead to a spill.
- Shell would use state-of-the-art automatic kick-detection equipment, including pit-volume totalizers, a flow detector, and various gas detectors placed about the rig, to provide early warning of a potential well-control event.

- The blowout preventer Shell would install on the high-pressure wellhead housing on the 20-in conductor casing on each exploration well includes redundant mechanical barriers to provide multiple means of closing in the well to prevent an oil flow to the surface.
- Shell would install multiple barriers, including manual and automated valves, on the drilling rig to prevent flows from coming up the drill string.
- Shell has developed and would implement a Well Control Contingency Plan (WCCP) (Shell, 2011a: Section 9.0 and Appendix L) in the extremely unlikely event of a well-control event to minimize the risk of oil coming in contact with the water. As part of the WCCP, Shell would prepare a Relief Well Drilling Plan for each location in advance of spudding the well to ensure that a relief well can be started quickly to kill the well.
- Shell has developed and would implement a Fuel Transfer Plan (FTP) (Shell, 2011a: Section 9.0 and Appendix M), which requires, among other things, the deployment of containment boom prior to any refueling operation.
- Shell would station and maintain its OSRVs in the immediate vicinity of its drilling operations to ensure timely response to any spill event.
- In addition to the OSR fleet, oil spill containment equipment will be available for use in the unlikely event of a blowout. The barge will be centrally located in the Beaufort Sea and supported by an Invader Class Tug and possibly an anchor handler. The containment equipment will be designed for conditions found in the Arctic including ice and cold temperatures. This equipment will also be designed for maximum reliability, ease of operation, flexibility and robustness so it could be used for a variety of blowout situations.
- Capping Stack equipment will be stored aboard one of the ice management vessels and will be available for immediate deployment 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 to the well to affect a seal capable of withstanding the maximum anticipated wellhead pressure (MAWP) and closing the assembly to completely seal the well against further flows (commonly called "capping and killing")
  - Attaching a device or series of devices to the well and diverting flow to surface vessel(s) equipped for separation and disposal of hydrocarbons (commonly called "capping and diverting")
- Pre-booming for all fuel transfers between vessels.

No drilling activity can be conducted until BOEMRE has approved an application for permit to drill (APD). The BOEMRE engineers and geoscientists review each APD for proper engineering considerations, site specific engineering and geologic conditions, and compliance with BOEMRE regulations. Any changes to an approved APD must be submitted, reviewed, and approved by BOEMRE.

The BOEMRE Alaska OCS Region plans to continue its policy of maintaining a continuous inspection presence during exploratory drilling operations in the Arctic. This is in recognition of the high level of public concern, some of the unique operating conditions, and logistical considerations in rotating personnel between onshore staging locations and remote drill sites. The BOEMRE inspector witnesses all critical operations, including BOP tests, running casing, and cementing activities. While on site, BOEMRE conducts unannounced well control drills and written and verbal tests of industry personnel's knowledge of well control procedures and processes. The BOEMRE inspectors have the authority to shut down drilling activity in the event of non-compliance with BOEMRE regulations.

The BOEMRE Alaska OCS Region receives daily reports of on-going drilling activity. The BOEMRE engineering and geosciences staff independently review and compare ongoing drilling activities with the APD and the observed engineering and geological conditions encountered while drilling. BOEMRE staff work closely with the drilling vessel operators throughout the project to make modifications to the well design or drilling procedures when appropriate.

Wells are drilled in sections, with casings (or pipe) placed and cemented in each section before another section is drilled. The BOEMRE policy is to review the drilling prognosis and projected environmental conditions prior to drilling out each casing shoe (section of well and pipe). This ensures that no new drilling occurs and no open hole is exposed until BOEMRE is confident that there is sufficient time to drill to the next casing point, set casing, cement the casing, and secure the well with out interruption due to adverse weather conditions or ice.

5.6. Oil Spill Effects and Response

As previously explained, the effects of an oil spill on the human environment and the effects of response activities associated with an oil spill were analyzed at each stage of the NEPA process. This analysis began, as an area-wide analysis in the 2002-2007 Five Year Program EIS and became progressively more geographically focused through the Beaufort Sea Multiple-Sale EIS, Sale 195 EA, Sale 202 EA and finally addressed site-specific effects in the 2009 Camden Bay EA. A summary of the analysis at each level is provided below. Following the summary is a brief description of the effects of a very large oil spill on each resource.

5.6.1. Overview of Oil Spill Effects and Response Analysis

Five Year Program EIS. Outer Continental Shelf oil and Gas Leasing Program: 2002 to 2007, Final Environmental Impact Statement, April 2002, OCS EIS/EA MMS 2002-006, Volume II, Appendix C, Oil Spill Response Capabilities for Offshore Oil and Gas Operations, describes BOEMRE regulatory authority over a Oil Spill Response Plan (OSRP) and includes the BOEMRE review and approval process. The EIS analysis describes regional conditions affecting OCS oil-spill planning and response including:

- The effects on response time in Alaska because of the remoteness of the area and other factors (page C-12 through C-14).
- A description of the technology and techniques of oil spill containment and clean-up and effectiveness of each (various mechanical containment and cleanup equipment, in-situ burning, dispersants, bioremediation, various coastal clean up techniques, page C-17 through C-28).
- The effectiveness of oil spill response technology in Arctic environments including in-situ burning, oil spill response in broken ice conditions and its effectiveness, spilled oil trapped in or under ice (page C-28 through C-32).

Beaufort Sea Multiple Sale EIS. Beaufort Sea Planning Area Oil and Gas Lease Sale 186, 195, and 202 Final Environmental Impact Statement OCS EIS/EA MMS 2003-001, February 2003 continues the discussion of spill prevention and response to include:

- Oil spill prevention and response regime and the technology and techniques of oil spill response (mechanical, in-situ burning, freezing oil) and factors that affect recovery effectiveness for Beaufort Sea conditions (Section IV.5, Spill Prevention and Response and Section IV.A. 6, page 4-16 to 4-18).
- Effect of a large oil spill and response on physical, biological, and social resources (Section IV.C). (Note: while the analysis of large oil spills estimated that no large spills would occur during exploration or development, the effects analysis does analyze a 1,500 barrel spill from a production facility and a 4,600 barrel spill from pipelines).
- Effect of a very large oil spill (225,000 barrel spill) and clean up on the physical, biological and social resources of the Beaufort Sea (Section IV.I, page IV-227 through IV-247).

Specific Lease Sale EA. Environmental Assessment (EA/EIS MMS 2004-028) Proposed Oil and Gas Lease Sale 195, Beaufort Sea Planning Area considered information applicable to Lease Sale 195 that had become available since the multiple sale FEIS. The EA briefly reviewed the oil-spill analysis from the multiple sale EIS, provided new information on oil spills and oil-spill response, and, in-light of new information, updated the analysis of effects of a large oil spill on various resources.

Exploration Plan EA—2010. Shell Offshore Inc. 2010 Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska, OCS EIS/EA MMS 2009-052 June 2009 examined site specific conditions, including:

- A list of specific proposed measures for oil spill prevention and response (Section 2.3.9, page 21).
- A discussion of pollution prevention measures (p. 30)
- The effects analysis does not address effects from an oil spill as no large (≥1,000 bbl) or very large (≥150,000 bbls) crude oil spills are estimated to occur from the proposed activities (see EA Section 2.3.8 and Appendix A).
- The EA (Appendix A) concludes, for a very large oil spill, that there are no site-specific anomalies that differentiate a very large spill release at Launch Area (LA) 12 from LA15, and the oil-spill contacts are statistically similar. BOEMRE, therefore, analyzed the potential impacts from a very large well-control incident where fluids are released into the Beaufort Sea in the Multiple-Sale EIS and incorporated the analysis in the EA by reference. The Multiple-Sale EIS also considered the mitigation of spill response.
- Shell's ODPCP response scenario addressed the potential immediate release of crude oil to the environment by a loss of well control during drilling.

5.7. Large Oil Spill Effects

This section addresses the adequacy of the Beaufort Sea Multiple-Sale EIS large oil spill analysis for the purposes of analyzing this site-specific proposal. A large oil spill, as defined by BOEMRE, is an oil spill with a total volume that is greater than or equal to 1,000 bbls. The chance of one or more large spills occurring is low; however, BOEMRE comprehensively analyzed the potential consequences of a hypothetical large spill in the Beaufort Sea Multiple-Sale EIS (Section IV.C.), Sale 202 EA, and the Arctic Multiple-Sale Draft EIS, (Section 4.4) for likely consequences to all resources. Based on OCS median spill sizes, the BOEMRE estimated a 1,500-bbl diesel or crude oil spill from a facility or a 4,600 -bbl crude oil spill from a pipeline for purposes of analyzing a large spill size (Anderson and LaBelle, 2000). 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 (LA1-18) and pipeline segments (P1-11) assuming a spill occurs are discussed in USDOI, MMS (2003, 2004, 2006, 2008). In the unlikely event of a large accidental oil spill within LA15, the location of Shell's leases, the potential for major impacts exist from a large accidental oil spill as identified in previous analyses (USDOI, MMS, 2003, 2008).

The following paragraphs describe the effects of a large oil spill on the identified resources.

Air Quality.

A large oil spill would cause an increase in the concentrations of gaseous hydrocarbons (volatile organic compounds) which could affect onshore air quality (USDOI, MMS, 2003, p. IV-245). Although effects would be localized and temporary, concentrations of criteria pollutants may exceed the federal and Alaska ambient air quality standards during the initial phases, particularly in the vicinity of the event. Major impacts at the spill-site may cause only minor impacts onshore, depending on how far from shore the spill occurs. The prospects under consideration in the 2012 Camden Bay EP are 16 miles from the nearest onshore area (Point Thompson) and as far away as 125 miles from Nuiqsut. Impact in the vicinity of Nuiqsut would be expected to be much lower as compared to Point Thompson. As surface oil evaporates or is removed, as any fires are extinguished, and as the use of additional clean-up equipment lessens, impacts will eventually decrease to a minor level. Thus, while initial impacts are estimated to be major at the spill site, the emissions from the oil spill at most onshore locations would be minor to moderate.

Emissions from the occurrence and clean-up of a large oil spill on the outer continental shelf would consist primarily of hydrocarbons (volatile organic compounds) created from oil on the surface of the water. However, in the event of an initial explosion of gas and oil, the result would be a large black plume of smoke causing short-term emissions of particulate matter (PM) and the other products of combustion, such as NO_X, SO_X, CO, VOC, and CO_2. The fire could also produce polycyclic aromatic hydrocarbons (PAHs), which are known to be hazardous to human health. The severity of impacts would decrease following the initial event and emissions would be limited to mostly VOC from the surface oil and emissions associated with engines from vessels and other equipment used for the clean-up process (USDOI, MMS, 2003, p. IV-245). By the time the oil reaches the shoreline, emissions from the surface oil would decrease due to weathering and decreased thickness of the oil layer. During the clean-up process, the impact to onshore air quality may increase slightly due to the combination of in situ burning, use of dispersants, and the use of vessels, surface vehicles, and aircraft to support the clean up. Eventually, the continuing decrease in surface oil (USDOI, MMS, 2004, Sec. IV.A.1), less use of clean-up equipment, and the effect of Arctic winds would be expected to decrease any onshore air quality impacts to minor levels of effect.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

Water Quality.

Water quality would be adversely affected by hydrocarbons from a large oil spill, resulting in acute and chronic hydrocarbon contamination of the water. Hydrocarbons could exceed the 1.5 parts per million acute toxic criterion for water quality during the first day of a spill and the 0.015 parts per million chronic criterion for about a month thereafter. A broad-scale increase in dissolved petroleum in the surface water and water column would cause chronic toxicity conditions for organisms. Over the long-term, contamination of aquatic environments from oil leaching would continue from oil breakdown products such as polycyclic aromatic hydrocarbons (PAHs). Sunlight (UV radiation) increases the toxicity of PAHs so summer sunlight in arctic Alaska could exacerbate the amount and degree of toxicity.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

Lower Trophic Organisms.

The effects of a large oil spill on phytoplankton vary widely, depending on the concentration and type of oil or compounds used in the experiments and on the species being tested. Nevertheless, general patterns do exist, and both laboratory and field studies have shown that hydrocarbons typically inhibit phytoplankton growth at higher concentrations (USDOI, MMS, 2003: p. IV-30). In cases where studies have been conducted following small and large oil spills, there was found to be a lack of effect on phytoplankton populations at this level of a large oil spill. This is thought to be due to the relatively rapid turnaround rate of phytoplankton generations (9-12 hrs) and the influx of phytoplankton from unaffected areas that replace the population levels. Effects on phytoplankton populations would be highest in the summer during periods of bloom concentrations that are most likely to occur in early July and late August. It is likely that the effects of a large spill on phytoplankton are negligible due to the levels of oil released to the environment.

The effects of petroleum based hydrocarbons on invertebrates have been observed by both field based observations and laboratory testing. Effects are highly varied and depend upon species tested and levels of exposure. When considering zooplankton, it is known that exposure to sunlight increases toxicity of petroleum by the enhanced creation of polcyclic aromatic hydrocarbons from raw crude. A study by Shirley and Duesterloh (2002) noted increased toxicity in copepods with exposure to these products, with copepods being considered as important components of zooplanktonic masses. In general, the effect of the oil associated with a large oil spill would depend on the amount of sunlight, wind speed and duration, air and water temperature, and the composition of the oil. However, based on the assumptions associated with weathering of Prudhoe Bay crude oil, within 10 days of a spill occurring during the summer season, 26% of the oil would have evaporated, 58% would remain on the surface, and 16% would be dispersed through the water column (Table IV.A-6a). Dispersed and dissolved oil in the water column has the greatest potential of adversely affecting zooplankton and benthic or pelagic invertebrates. Effects of a large oil spill on these organisms would likely be negligible to minor due to the levels of oil released to the environment, with these effects being highly dependent upon the physical forcing mechanisms that move and break down the oil within the environment.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

Fish and EFH.

Effects of a large oil or diesel fuel spill on arctic fishes, including Pacific salmon, would depend on the season of the spill, the location of the spill; the lifestage of the fishes (adult, juvenile, larval, or egg) affected; and the duration of the exposure. A large oil spill would cause acute and chronic toxicity effects to individual fish and local fish populations that could take multiple generations to recover to their former status.

A large oil spill that contacted estuarine and riverine waters and EFH could affect the year's salmon smolts and eggs. If the oil contacted nearshore Beaufort Seafish spawning and feeding habitat, fish such as capelin and arctic cod would be affected. Depending on the location, timing and duration of a large oil spill, EFH and regional fish populations would be affected.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

Marine and Coastal Birds

Spectacled Eiders. Previous analyses in the multiple-sale EIS (USDOI, MMS, 2003: IV-91) found that spectacled eiders experiencing moderate or heavy oil contact would not survive; most lightly oiled birds also are not likely to survive at arctic water temperatures. Swallowed oil may cause reduced physiological function and production of fewer young.

With any substantial mortality, the potential exists for a significant adverse effect on the spectacled eider population. Mortality of eiders from a large oil spill was expected to be fewer than 100 individuals; however, any substantial losses (25+ individuals) would represent a considerable effect. Recovery from substantial mortality would not occur while the population exhibited a declining trend. The relatively small loss of spectacled eiders likely to result in the unlikely event of an oil or fuel spill in the Beaufort Sea, where so far there is little indication of large numbers gathering in offshore waters, may be difficult to separate from natural variation in population numbers.

The Lease Sale 195 EA updated the conclusion that the potential level of effect on the spectacled eider population was still expected to be substantial and recovery from such mortality would not occur while the population exhibited a declining trend (USDOI, MMS, 2004: 31). Similarly, the Lease Sale 202 EA reached the same conclusion, but added that while an oil spill, under certain conditions, would result in a potentially significant effect to spectacled eiders, the coincidence of all the factors that would have to occur simultaneously to result in such an impact to spectacled eiders is highly improbable, and large impacts to spectacled eiders were not anticipated (USDOI, MMS, 2006a: 34).

Steller's Eiders. Previous analyses in the multiple-sale EIS (USDOI, MMS, 2003: IV-98) concluded that in the unlikely event a large oil spill occurs, Steller's eiders experiencing moderate to heavy contact oil contact would not survive; most lightly oiled birds also are not likely to survive at arctic water temperatures. A minor proportion of the small Alaskan breeding population is likely to be vulnerable to an oil spill, because staging and migrating individuals generally are scattered in relatively few flocks along the coast during the brief summer/fall period of breeding and migration. Small numbers of spring migrant Steller's eiders typically are observed during migration counts of eiders past Point Barrow, suggesting that many of the small population nesting in northwestern Alaska may arrive at the nesting areas via overland routes from the Chukchi Sea. If this is the case, relatively few eiders are likely to occupy leads offshore the northern coastline east of Point Barrow where they would be vulnerable to oil entering such habitat. Given the apparently small population seasonally occupying northwestern Alaska, low Steller's eider mortality is likely from an oil spill; however, recovery of the Alaska population from spill-related losses is not likely to occur, if numbers on the breeding ground continue to decline and the reproductive rate remains relatively low.

The Lease Sale 195 EA updated the conclusion that the potential level of effect on the Steller's eider population was expected to be the same as stated in the multiple-sale EIS (USDOI, MMS, 2004: 32). Similarly, the Lease Sale 202 EA reached the same conclusion, but added that while an oil spill under certain conditions would result in a potentially significant effect to Steller's eiders, the coincidence of all the factors that would have to occur simultaneously to result in such an impact to Steller's eiders is improbable, and that considerable impacts to Steller's eiders were not anticipated (USDOI, MMS, 2006a: 34).

Kittlitz's Murrelet. Previous analysis in the multiple-sale EIS (USDOI, MMS, 2003) and subsequent EAs (USDOI, MMS, 2004, 2006) did not consider the Kittlitz's murrelet to be present in the Beaufort Sea.

Yellow-billed Loon. Previous analysis in the multiple-sale EIS (USDOI, MMS, 2003: 107) considered adverse effects from a large spill on the yellow-billed loon in general terms. No remarkable effects were identified because the species occurs in low densities across nearshore coastal areas of the Beaufort Sea.

The Lease Sale 195 EA updated information on the yellow-billed loon (USDOI, MMS, 2004: 14). Yellow-billed loons had been observed in small numbers on the Colville River delta. This species had a small estimated Alaska population of 3,650. Fewer than 200 yellow-billed loons were observed during nearshore aerial surveys along the Arctic coast in late July – early August 2002 and 2003. The EA concluded there was no indication that species characterized as having a lower potential for noteworthy effects from oil and gas development were more susceptible than was concluded in the multiple-sale EIS. Most have exhibited relatively stable populations in recent surveys, although the yellow-billed loon was of some concern.

The Lease Sale 202 EA updated conclusions regarding the potential for a large spill to affect the yellow-billed loon (USDOI, MMS, 2006a: 46). The EA concluded that studies involving population trends and distribution of yellow-billed loons indicated they had a higher potential for potentially significant effects from activities following Sale 202 than was stated in the multiple-sale EIS. However, the coincidence of factors that would have to occur simultaneously to have a considerable effect was improbable, and non-trivial impacts were not reasonably certain to occur.

Common Eiders. Previous analysis in the multiple-sale EIS (USDOI, MMS, 2003: 106) considered adverse effects from a large spill on the common eider and concluded that most species with low reproductive rates or population effects (i.e., common eider) were not likely to suffer high mortality as a result of an oil spill, because they are not abundant in most of the proposed lease sale areas and do not occur in large feeding flocks, although any losses would be recovered slowly due to relatively low reproductive rates. In the case of common eiders, because they have experienced substantial losses over the past several decades, mortality at the higher levels was expected to represent a significant effect. With any substantial mortality, which could occur if substantial proportions of migrants from nesting areas outside a contacted spill area were to be affected, the potential exists for a substantial adverse effect on Beaufort Sea common eider populations.

The Sale 195 EA (USDOI, MMS, 2004: 32) updated the potential level of effect on the common eider population and expected them to be the same as stated in the multiple-sale EIS. However, the EA added that available research information indicated that fall-migrant individuals stop at least once while crossing the Beaufort Sea and potentially were more vulnerable to contact by a spill than previously considered. The Sale 202 EA updated the potential level of effect on the common eider population and expected them to be the same as stated in the multiple-sale EIS (USDOI, MMS, 2006a: 46).

King Eiders. Previous analysis in the multiple-sale EIS (USDOI, MMS, 2003: 106) considered adverse effects from a large spill on king eiders and concluded that species with or population effects (i.e., king eider) were not likely to suffer high mortality as a result of an oil spill, because they are not abundant in most of the proposed lease sale areas and do not occur in large feeding flocks, although any losses would be recovered slowly due to relatively low reproductive rates. In the case of king eiders, because they have experienced substantial losses over the past several decades, mortality at the higher levels was expected to represent a significant effect. With any substantial mortality, which could occur if substantial proportions of migrants from nesting areas outside a contacted spill area were to be affected, the potential exists for a notable adverse effect on Beaufort Sea king eider populations.

The Lease Sale 195 and 202 EAs (USDOI, MMS, 2004: 32, 2006: 46) updated the potential level of effect on the king eider population and expected them to be the same as stated in the multiple-sale EIS. The latter EA added that available research information indicated that king eiders concentrated in deeper offshore waters and were potentially more vulnerable than previously considered.

Long-tailed Ducks. Previous analysis in the multiple-sale EIS (USDOI, MMS, 2003: 106) considered adverse effects from a large spill on long-tailed ducks and concluded that high levels of mortality were expected to result in a significant long-term adverse effect on the regional population. Depending on population trend, the loss of several thousand long-tailed ducks could be recovered within several generations or not recover until the population experiences an increasing trend. With any substantial mortality, which could occur if substantial proportions of migrants from nesting areas outside a contacted spill area were to be affected, the potential exists for a substantial adverse effect on Beaufort Sea long-tailed ducks.

The Lease Sale 195 and 202 EAs (USDOI, MMS, 2004: 32, 2006: 46) updated the potential level of effect on the long-tailed duck population and expected them to be the same as stated in the multiple-sale EIS.

Marine and Coastal Birds Summary. BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

Marine Mammals

Bowhead Whales. In the unlikely event of a large oil spill, the probability of oil contacting whales is likely to be considerably less than the probability of oil contacting bowhead habitat. If a spill occurred and contacted bowhead habitat during the fall migration, it is likely that some whales would be contacted by oil (USDOI, MMS, 2003: IV-79). The number of whales contacting spilled oil would depend on the location, size, timing, and duration of the spill and the whales' ability or inclination to avoid contact. The extent of the effects would depend on how many whales contacted oil, the duration of contact, and the age/degree of weathering of the spilled oil. It is likely that some whales would experience temporary, nonlethal effects. Prolonged exposure to freshly spilled oil could kill some whales, but the number likely would be small.

Reanalysis for the Sale 195 EA (USDOI, MMS, 2004: 40) concluded that whales exposed to spilled oil likely would experience temporary, nonlethal effects, although prolonged exposure to freshly spilled oil could kill some whales. There are, in some years and in some locations, relatively large aggregations of feeding bowhead whales within the proposed lease-sale area. If a large amount of fresh oil contacted a substantial portion of such an aggregation, effects potentially could be greater than typically would be assumed. However, based on available information about the effects of oil on large cetaceans, there was no evidence that any impact on this population from an oil spill would be likely to result in a considerable effect. The population is robust, and the population is, as evidenced by its continued increase despite a documented lethal removal in the subsistence hunt, resilient to relatively small removals. Based on published information, the amount of mortality, if any, due to an unlikely large oil spill, is not likely to be large. A reanalysis for the Lease Sale 202 EA (USDOI, MMS, 2006a: 35) also concluded that no noteworthy impacts to the bowhead whale were expected due to activities associated with proposed Sale 202, including the effects of an assumed oil spill.

Fin Whales. Previous analysis in the multiple-sale EIS (USDOI, MMS, 2003) and subsequent EAs (USDOI, MMS, 2004, 2006) did not consider the fin whale to be present in the Beaufort Sea.

Humpback Whales. Previous analysis in the multiple-sale EIS (USDOI, MMS, 2003) and subsequent EAs (USDOI, MMS, 2004, 2006) did not consider the humpback whale to be present in the Beaufort Sea.

Ringed Seals. Previous analyses in the multiple-sale EIS (USDOI, MMS, 2003: IV-120) and two subsequent EAs (USDOI, MMS, 2004: 41, 2006: 35) concluded that a large spill could affect perhaps 100-200 ringed seals, with the population recovering within about 1 year. In the context of new information that has become available since publication of the multiple-sale EIS, those NEPA conclusions remained consistent; thus the updated potential level of effect on pinnipeds was expected to be about the same as stated in the multiple-sale EIS.

Bearded Seals. Previous analyses in the multiple-sale EIS (USDOI, MMS, 2003: IV-120) and two subsequent EAs (USDOI, MMS, 2004: 41, 2006: 35) concluded that a large spill could affect 30-50 bearded seals, with the population recovering within about 1 year. In the context of new information that had become available since publication of the multiple-sale EIS, those NEPA conclusions remained consistent; thus the updated potential level of effect on pinnipeds was expected to be about the same as stated in the multiple-sale EIS.

Polar Bears. Previous analysis in the multiple-sale EIS (USDOI, MMS, 2003: IV-120) concluded that polar bears were most likely to be oiled or eat oiled prey at a whale carcass on either Cross or Barter Island or at a concentration of seals in the sale area. The EIS concluded an estimated 5-30 bears could be harmed. This estimate was based on the number of polar bears sometimes observed by the bowhead whale aerial surveys conducted in the Cross Island and Barter Island areas during the fall bowhead whale harvest. An estimated 5-30 bears could be lost to a spill, if the spill contacted Cross or Barter Island when and where that many polar bears may be concentrated during the subsistence-whale harvest. This represents a severe event. However, the probability of this occurrence is low.

The multiple-sale EIS and two subsequent EAs (USDOI, MMS, 2004: 41, 2006: 35) concluded the more likely loss would be no more than 6-10 bears (5.7-10 bears, assuming a bear density of 1 bear per 25 km2 divided into 143-252 km2, the area swept by the large spill as a discontinuous slick in broken ice or meltout. The polar bear population was expected to recover individuals killed by the spill within 1 year and there would be no effect on the population. The new information did not change the conclusion of no significant population-level effects.

Pacific Walrus. Previous analyses in the multiple-sale EIS (USDOI, MMS, 2003: IV-120) and two subsequent EAs (USDOI, MMS, 2004: 41, 2006: 35) concluded that a large spill could affect fewer than 100 walruses, with the population recovering within about 1 year. The net westward movement of spills and the chance of spill contact to offshore primary feeding habitats of walruses during the summer open-water season (July 1 through October 1) are low, less than 0.5-6%, assuming a spill occurred in the Beaufort Sea Planning Area and contacted Ice/Sea Segments 46-51 within 180 days or less. Oil contamination of walruses probably would not result in direct mortality of healthy individuals. However, contamination could seriously stress diseased or injured animals and stress young calves, causing some deaths. Perhaps a small number of walrus calves (fewer than 100) and some adults could die from oil contamination, but such a loss is likely to be replaced within 1 year by natural recruitment in the population.

Beluga Whales. Previous analyses in the multiple-sale EIS (USDOI, MMS, 2003: IV-121) and two subsequent EAs (USDOI, MMS, 2004: 41, 2006: 35) concluded that a large spill could affect fewer than 10 beluga whales, with the population recovering within about 1 year. Beluga whales would be most vulnerable to oil contact during the spring migration off Point Barrow. Contamination of the ice-lead system from an oil slick during spring migration (April-June) could directly expose several whales to some oil-spill contact. However, such contact is expected to be brief or intermittent and probably would not result in any deaths of healthy whales or have long-lasting sublethal effects after short exposure. The probability of oil-spill occurrence and contact to the lead system during the spring (May-June) period is very low (less than 0.5%). The likely physical reaction between oil, ice, water temperature, and wind off Point Barrow appreciably would reduce the chance of an oil slick persisting in the lead system. Therefore, belugas of the western Beaufort population may have some contact with an oil spill that would temporarily contaminate the lead system off Point Barrow; however, few, if any, beluga whales are likely to be seriously affected, even in a severe situation, with no long-term effect on the population. In the context of new information that had become available since publication of the multiple-sale EIS, subsequent NEPA conclusions remained consistent; thus the updated potential level of effect on beluga whales was expected to be about the same as stated in the multiple-sale EIS.

Spotted Seals. Previous analyses in the multiple-sale EIS (USDOI, MMS, 2003: IV-120) and two subsequent EAs (USDOI, MMS, 2004: 41, 2006: 35) concluded that a large spill could affect 10-20 spotted seals, with the population recovering within about 1 year. In the context of new information that had become available since publication of the multiple-sale EIS, those NEPA conclusions remained consistent; thus the updated potential level of effect on pinnipeds was expected to be about the same as stated in the multiple-sale EIS.

Marine Mammals Summary. BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

Sociocultural Systems.

The BOEMRE views oil spills as having the potential to cause long term significant effects that would disrupt or nearly eliminate subsistence harvests. Oil spills are never permitted and are always in violation of the law. Operators would be held accountable and responsible for mitigation and monitoring loss or reduction of subsistence species on the local subsistence harvesters.

Effects on the sociocultural systems of the communities of Barrow, Nuiqsut, and Kaktovik would come from changes in population, employment and the effects of the oil spill and clean-up activities on subsistence harvests. Community activities and traditional practices for harvesting, sharing, and processing subsistence resources could be seriously disrupted in the short term, if there are concerns over the tainting of bowhead whales from an oil spill.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

Subsistence.

A good source of information on spill effects is the Social Indicators Study of Alaskan Coastal Villages, Volume VI: Analysis of the Exxon Valdez Spill Area, 1988-1992 (Human Relations Area Files, Inc., 1994). The summary of findings section affirmed that, immediately after the spill and continuing into early 1990, Native people decreased their harvests of wild resources and relied on preserved foods harvested before the spill (USDOI, MMS, 2003, p. 153). By the winter of 1991, the Natives' normal harvesting activities had begun to resume, but the proportions of wild foods in their diets remained below those of 1989. The study also demonstrated in its analysis that non-Natives and Natives "define the environment and resources within the environment very differently. Commodity valuation takes precedence" for non-Natives and "instrumental use and cultural and spiritual valuation take precedence" for Native people (Human Relations Area Files, Inc., 1994).

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

Economy.

A large oil spill could adversely impact the subsistence lifestyle of the North Slope Borough (USDOI, MMS, 2003, p. IV-239). An important segment of the Borough's economy depends on subsistence resources, and a loss of those resources would translate into a substantial decline in noncash household income. This would be offset to some degree by employment opportunities associated with oil spill response activities. Approximately hundreds of cleanup jobs and associated personal income could be created for 1-2 years following a large oil spill.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

Public Health.

Because development and production activities would be enclave based, adverse impacts to the local village infrastructure, health care, and emergency response systems are expected to be minimal. Demands on local village infrastructure from construction, operation, maintenance, and abandonment activities would not be expected, because all these activities would be staged out of Prudhoe Bay. Stress created by the fear of a large oil spill is also a distinct predevelopment impact-producing factor within the human environment (USDOI, MMS, 2003, IV-C p. 168). Stress from this general fear can be broken down to the particular fears of:

- being inundated during cleanup with outsiders who could disrupt local cultural continuity
- the damage that spills would do to the present and future natural environment
- drawn out oil-spill litigation
- contamination of subsistence foods
- lack of local resources to mobilize for advocacy and activism with regional, State, and Federal agencies
- lack of personal and professional time to interact with regional, State, and Federal agencies
- retracing the steps (and the frustrations involved) taken to oppose offshore development
- responding repeatedly to questions and information requests posed by researchers and regional, State, and Federal outreach staff
- having to employ and work with lawyers to draft litigation in attempts to stop proposed development.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

Archaeological Resources.

Cleanup and support activities, such as mobilizing equipment and personnel, removing soil, washing, etc., would have the greatest potential for damaging or destroying archaeological resources (USDOI, MMS, 2003, p. 175). Exposure of undocumented sites increases the possibility of vandalism. Increased human presence and activity increases the potential for archaeological sites to be recognized, resulting in the site having a higher chance of being vandalized. The discovery and reporting of archaeological sites during cleanup activities also would result in their being documented and protected.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical large oil spill associated with the Proposed Action as was characterized in these documents.

5.8. Very Large Oil Spill Effects

This section addresses the adequacy of the Beaufort Sea Multiple-Sale EIS very large oil spill analysis for the purposes of analyzing this site-specific proposal. A very large oil spill, as defined by BOEMRE, is an oil spill with a total volume that is greater than or equal to 150,000 bbls. As described in Appendix A, The chance of a very large spill (≥150,000) occurring is very low; however, BOEMRE comprehensively analyzed the potential effects of such a spill in the Beaufort Sea Multiple-Sale EIS Section IV.I Low-Probability, Very Large Oil Spill. The spill scenario was based on a 15,000-bbl flow-rate for 15 days totaling 225,000 bbl. In the unlikely event of a very large accidental oil spill, the potential for major impacts exist, as identified in USDOI, MMS (2003). The Beafort Sea Multiple Sale EIS spill scenario was based on a 15,000 bbl flow rate for 15 days totalling 225,000 bbl which is much higher than the WCD for the site-specific scenario analyzed in this EA. The following paragraphs describe the effects of a very large oil spill on the identified resources.

Air Quality.

A very large oil spill could cause an increase in the concentrations of gaseous hydrocarbons (volatile organic compounds) which could affect onshore air quality (USDOI, MMS, 2003, p. IV-245). Any effects would be localized and temporary. Concentrations of criteria pollutants would likely remain well within Federal and Alaska ambient air quality standards.

Typical emissions from outer continental shelf accidents consist of hydrocarbons (volatile organic compounds); only fires associated with blowouts or oil spill cleanup efforts (in situ burning) produce other pollutants, such as nitrogen oxides, carbon monoxide, sulfur dioxide, and particulate matter. The cleanup of a very large oil spill would require the operation of some equipment, such as boats and vehicles. Emissions from their operation would include nitrogen oxides, carbon monoxide, and sulfur dioxide.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

Water Quality.

A very large crude oil spill would cause elevated hydrocarbon concentrations on the ocean water surface, in the water column and in coastal riverine waters covering a very large area. These concentrations would exceed state and Federal water quality standards and present acute and chronic toxic conditions to aquatic organisms (USDOI, MMS, 2003, p. IV-230). Oil would be removed from the environment during clean-up processes, however, the amount of oil removed would be affected by several factors including weather and sea conditions during the clean-up. As oil was removed during the clean-up process, there would be less volume available to become dispersed or entrained in the environment.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

Lower Trophic Levels.

The spill would adversely affect some lower trophic-level organisms by exposing them to petroleum-based compounds at, or above, acute or chronic toxicity levels (USDOI, MMS, 2003, p. IV-231). An oil spill of 225,000 bbls is not expected to have a measurable effect on sub-tidal marine plants (e.g. Boulder Patch kelp habitat), which exist at depths lower in the water column than toxic concentrations of oil would generally appear. The nearshore area does support mobile benthic and epibenthic invertebrates (amphipods, mysids, copepods, euphasiids, clams, snails, crab, and shrimp), which are fed on by vertebrate consumers during the summer. If contacted by surface oil, these invertebrates are likely to die or be affected at a sub-lethal level.

Oil that becomes incorporated into shoreline bottom sediments by wave action is expected to remain entrained in the sediment for several years. In areas where bottom sediments are heavily oiled, some lethal and sub-lethal effects could occur each summer, when seasonal benthic invertebrates return to those areas. Other lower trophic-level organisms likely to be contacted by oil in the water column are plankton. Because of similarities in habitat use and distribution, the percentage of other marine-invertebrate larva contacted by floating or dispersed oil is likely to be similar to that expected for plankton. Some lower trophic-level organisms on the shorelines would be adversely affected by use of shore based oil containment booms and other response tactics.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

Fish.

Effects to fishes would be more likely to occur from an oil spill moving into nearshore waters in summer, where fishes concentrate to feed and migrate (USDOI, MMS, 2003, p. IV-232). There may be sub-lethal or lethal effects on some marine and migratory fish. The number affected would depend on the size of the area affected, the concentration of petroleum present, the time and duration of exposure, and the stage of fish development involved (eggs, larva, and juveniles are most sensitive). While a very large oil spill would be expected to affect about 300 km of nearshore waters, particularly in shallow-water lagoons associated with barrier islands, and coastline, it would likely have mostly sub-lethal effects (e.g. changes in growth, feeding, fecundity, and temporary displacement) on marine and migratory fish. Juvenile fish (e.g. arctic cod), which are common in the nearshore area during summer, or nearshore spawners (e.g. capelin) are among the most likely candidates to be adversely affected.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

Marine and Coastal Birds.

A very large oil spill could result in marine and coastal bird mortality exceeding a few thousand individuals, if brood-rearing waterfowl or shorebirds contact stranded oil along a substantial proportion of affected shoreline (USDOI, MMS, 2003, p. IV-236). In lagoon habitats, long-tailed duck densities suggest that when large concentrations of molting individuals are present, tens of thousands could be contacted by spilled oil. This would constitute a substantial loss to the regional population. Notable losses would also be experienced by post-breeding common eiders concentrated near barrier islands and in lagoons. A spill from Sivulliq N would be expected to contact several other species present in substantial numbers, including the king eider, scoters, northern pintail, Pacific loon, and glaucous gull. Any mortality, decreased fitness or productivity from indirect effects such as decreased availability of food a source or physiological effects caused by the ingestion of oil would be additive to the losses of oiled individuals. Effects of oil spill clean-up activities would be similar to that described for spectacled and Steller's eiders (below).

The very large oil spill is expected to cause spectacled and Steller's eider mortality, if females with recently fledged young contact stranded oil in coastal habitats, or flocks of adult eiders or females with young feeding in lagoons and offshore waters are contacted by a spill sweeping over thousands of square kilometers (USDOI, MMS, 2003, p. IV-234). Any mortality, decreased fitness or productivity from indirect effects, such as decreased availability of food sources or physiological effects caused by the ingestion of oil, would be additive to the loss of oiled individuals. Mortality of a few spectacled and Steller's eiders also would represent a substantial loss to the small regional populations.

Containment, recovery, and cleanup activities associated with a very large oil spill are expected to involve hundreds of workers and numerous boats, aircraft, and onshore vehicles operating over an extensive area for more than 1 year. The presence of such a workforce is likely to act as a general hazing factor, displacing eiders from the immediate area of activity, perhaps within a few kilometers, which potentially might be viewed as a positive result, given the birds' extreme vulnerability to oil in the environment. If a reliable system of locating eiders in a specific area can be devised, specific birds or groups in danger of oil contact could be targeted with specific hazing tactics.

The nest disturbance of spectacled eiders caused by these activities is not expected to result in large increases in nest abandonment, loss of eggs through predation or exposure, or overall decrease in productivity. The primary reason for this level of effect is the low density of spectacled eiders nesting and the low frequency of nesting which occurs near the coast. Displacement by cleanup activity of females with broods from coastal habitats may have a negative effect if it prematurely forces them into the offshore marine environment where the high salinity could increase stress on the ducklings, which have a relatively low tolerance to salt (USDOI, MMS, 2003, p. IV-235).

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

Marine Mammals.

The probability of oil contacting bowhead whales is likely to be considerably less than the probability of oil contacting bowhead whale habitat (USDOI, MMS, 2003, p. IV-233). It is unlikely that a spill would cause an impediment to the fall migration. The migrating whales could come in contact with oil, but such contact likely would be brief. If bowheads feed in an area when spilled oil is present, some oil could be ingested. Most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects from oiling of the skin, inhaling hydrocarbon vapors, ingesting contaminated prey, fouling of their baleen, a reduction in food sources, and a displacement from feeding areas. Exposure of bowhead whales to spilled oil could result in lethal effects to some individuals.

The effect of a very large oil spill on other marine mammals is expected to be fairly long term (1-2 generations, about 15 years) on pinnipeds and short term (about 1 year) on beluga whales (USDOI, MMS, 2003, p. IV-238). Assuming that all young ringed and bearded seals exposed to the oil died because of absorption (through the skin), inhalation, and/or ingestion of toxic hydrocarbons in the oil, this loss could take these marine mammal populations more than one to two generations to recover (up to about 15 years). Although some beluga whales might encounter spilled oil during the spring migration and summer few, if any, are likely to be adversely affected (loss of fewer than 20 whales with population recovery in 1 year).

Polar bears exposed to petroleum hydrocarbons through direct contact or by ingesting oiled prey would probably not survive (Neff, 1990; St. Aubin, 1990). The density of polar bears in the Sivulliq N drilling area is low, if a spill reaches the environment there is a correspondingly low likelihood that polar bears would be exposed. Polar bears generally move offshore with the retreating pack ice while the exploratory drilling will take place in open-water. In the event of oil reaching the environment, it is likely that polar bears would be intentionally deterred to keep them away from the area, further reducing the likelihood of bears contacting the oil. Impacts associated with a very large oil spill would depend upon the time of year, weather conditions, clean up efforts and the efficiency of hazing bears away from the spill. Exposure would likely be limited to a small number of polar bears, resulting in the death of some bears that come into contact with oil. Large aggregations of bears periodically gather on shore during August through October near Point Barrow, Cross Island and Kaktovik. If a very large oil spill occurred during this time as many as 60-100 polar bears may be at risk of exposure.

Terrestrial Mammals. The potential effect of a very large oil spill on terrestrial mammals including caribou, muskoxen, grizzly bear, and arctic fox is likely to be limited to caribou groups during the insect relief periods in coastal waters near shorelines with extensive oil contamination (USDOI, MMS, 2003, p. IV-239). Heavily oiled caribou might die from skin absorption and/or inhalation of toxic hydrocarbons. Small numbers of muskoxen, grizzly bear, and arctic fox may encounter oil and be adversely affected. Potential losses would represent a short-term effect, with populations recovering within 1 year.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

Vegetation.

Coastal wetlands and coastal salt marshes would comprise the vegetation habitats most likely to be affected by a very large oil spill (USDOI, MMS, 2003, p. IV-239). Marshy wetland habitats could be partially rehabilitated by using fertilizers to aid in biological weathering-breakdown of the oil, but recovery would be slow due to cool temperatures in summer and the short growing season. Complete recovery of oiled coastal wetlands could take several decades.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

Sociocultural Systems.

A very large oil spill would affect sociocultural systems in a number of ways including associated effects from significant effects to subsistence harvest resources which could lead to a breakdown of kinship networks and sharing patterns and increased social stress in the community (USDOI, MMS, 2003, p. IV-243). A disruption of the kinship networks (i.e., social organization) could lead to a decreased emphasis on the importance of the family, cooperation, and sharing. Other effects might be a decreasing emphasis on subsistence as a livelihood, with an increased emphasis on wage employment, individualism, and entrepreneurism. Effects on the sociocultural system, such as increased drug and alcohol abuse, breakdown in family ties, and a weakening of social well-being, could lead to additional stresses on the health and social services available. Employment for oil-spill response and cleanup could disrupt subsistence harvest activities and disrupt some institutions and sociocultural systems. Employment opportunity increases associated with oil spill response activities could have sudden and negative effects, including inflation and displacement of Native residents from their normal subsistence-harvest activities. Impacts could alter normal subsistence practices and put stresses on local village infrastructures by drawing workers away from village service jobs.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

Subsistence Activities.

Subsistence-harvest activities such as bird hunting, sealing, whaling, and the ocean netting of fish could be affected by a spill during the open-water season (USDOI, MMS, 2003, p. IV-240). A very large oil spill could threaten subsistence-harvest patterns, if the spilled oil contacts subsistence-resource and harvest areas. It is possible, although not likely, that the bowhead whale harvest might not be curtailed, but that the quota could be reduced for possibly 2 years, resulting in significant effects on the bowhead whale harvests for affected communities, making the bowhead less available for use or undesirable for an extended period. Lethal and sub-lethal effects on seals, polar bears, and fish would also result from a very large oil spill.

The harvest of many subsistence species would require up to one or two generations for recovery due to population changes in abundance and/or distribution. Bearded seal harvests are not likely to occur during the season in which a spill occurred. In following years, harvests would be expected to occur in greatly reduced numbers. Marine and coastal bird harvests could also be reduced. Fish harvest, particularly in river delta areas and along the coast, would be expected to be available but in reduced numbers for 1 year before it returned to normal levels. It also is likely that for all subsistence resources, there could be reluctance to harvest any marine resources due to a perceived tainting from oil. Tainting could affect a wider area than the actual area of contact, as seals and whales move among resource areas; an animal oiled in one location potentially could be harvested in another area, well outside of the spill area.

Disturbance to bowhead whales, seals, polar bears, caribou, fish, and birds potentially could increase from oil spill cleanup activities. In the offshore environment, cleanup vessels, workboats, barges, aircraft over flights, and in situ burning could cause whales to temporarily alter their migratory route. This displacement could cause some animals, including seals in ice-covered or broken-ice conditions, to avoid areas where they are normally harvested or to become more wary and difficult to harvest. In the nearshore and onshore environments, workers, boats, support vehicles, heavy equipment, and the intentional hazing and capture of animals could disturb coastal resource habitat, displace subsistence species, alter or reduce subsistence hunter access to these species, and alter or extend the normal subsistence hunt.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

Economy.

A very large oil spill could adversely impact the subsistence lifestyle of the North Slope Borough (USDOI, MMS, 2003, p. IV-239). A substantial segment of the Borough's economy depends on subsistence resources, and a loss of those resources would translate into a substantial decline in noncash household income. This would be offset to some degree by employment opportunities associated with oil spill response activities. Approximately 3,000 cleanup jobs could be created for 1-2 years following a very large oil spill.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

Archaeological Resources.

Offshore archaeological resources would likely not be disturbed by an offshore oil spill or from cleanup activities associated with an offshore oil spill (USDOI, MMS, 2003, p. IV 244). Known and previously undiscovered archaeological sites onshore would be vulnerable to inadvertent direct or indirect disturbance and increased vandalism.

5.9. Oil Spill Response

The BOEMRE reviewed Shell's Beaufort Sea Regional Exploration Oil Discharge Prevention and Contingency Plan (ODPCP) to ensure that the plan adequately addressed lessons learned from the Macondo / Deepwater Horizon incident and subsequent oil spill. The review also included additional prevention and response measures proposed by Shell. A summary of this review and the effectiveness of various response methods is provided in the paragraphs 5.6.1 through 1.5.3.

BOEMRE has analyzed and incorporated in this EA the best available science published since the Beaufort Sea Multiple-Sale EIS, the Sale 195 and Sale 202 EA's and the 2009 Camden Bay EA and expects the same level of effects from a hypothetical very large oil spill associated with the Proposed Action as was characterized in these documents.

5.9.1. Oil Spill Discharge Prevention and Contingency Plan (ODPCP)

As required by both Federal and State regulations, Shell has developed and would implement a comprehensive Oil Discharge Prevention and Contingency Plan (ODPCP) (Shell, 2011) during its exploration drilling operations. The ODPCP must be reviewed and approved by both Federal and State regulators to ensure that Shell has the spill-response resources necessary to respond to any spill that might occur.

Shell's Beaufort Sea Regional Exploration ODPCP is a regional oil-spill-response plan that demonstrates Shell's capabilities to prevent, or rapidly and effectively manage, oil spills that may result from exploratory drilling operations. Despite the extremely low likelihood of a large oil-spill occurring during exploration, Shell has designed its response program for a regional capability of responding to a range of spill volumes that increase from small operational spills up to and including a Worst Case Discharge (WCD) scenario from an exploration well blowout, as required under 30 CFR 254.47. Shell's program is based on a WCD scenario that meets the response planning requirements of the State of Alaska and Federal oil-spill-planning regulations.

Shell has designed its response program based on a regional capability of responding to a worst case discharge (WCD) from an exploration well blowout. A dedicated Oil-Spill Response Barge (OSRB) would be staged in the vicinity of the drilling vessel when critical drilling operations into hydrocarbon-bearing zones are underway and possess sufficient capacity to provided containment, recovery, and storage for the initial operational period. Two vessel of opportunity skimming systems (VOSS) would also be employed to assist with containment and recovery operations. Shell also will mobilize an OSRB from operations in the Chukchi Sea to be on-site within 42 hours following notification to further support containment and recovery operation. An arctic oil storage tanker (OST) would arrive at the recovery site to provide interim storage of recovered fluids. The OST would possess sufficient capacity to store all recovered petroleum hydrocarbons from a 30-day blowout. Skimming and lightering operations would be conducted on a 24-hour basis ensuring uninterrupted recovery operations as skimming vessels transfer recovered fluids to the OST on a rotational basis.

Shell's primary response action contractors are Alaska Clean Sea (ACS) and Arctic Slope Regional Corporation Energy Services - Response Operations, LLC (AES-RO). The AES-RO's response personnel and oil-spill-response equipment would be maintained on standby while critical drilling operations into hydrocarbon-bearing zones are underway; and provide offshore response operations in the unlikely event of an oil-spill incident. The ACS provides manpower and equipment resources from Deadhorse for Beaufort Sea spill containment and recovery. The ACS and AES-RO would conduct response activities in both open ocean and near shore environments using the ACS Technical Manual and the Shell Beaufort and Chukchi Seas Regional Tactics Manual.

5.9.2. Additional Pollution Prevention and Response Measures

In addition to the maintenance and implementation of its ODPCP, Shell committed to implement the measures described under Pollution Prevention Measures in the 2009 Camden Bay EA (USDOI, MMS, 2009a, p. 29-30) to further minimize the chance of an oil spill that might impact marine mammals and interfere with the subsistence hunt.

In a letter to Shell on May 6, 2010, MMS requested that Shell identify additional measures that it would take to prevent or respond to a loss of well control event. Shell's response to MMS, dated May 14, 2010, which was reaffirmed in its response to Notice-to-Lessees (NTL) 2010-N06, included a number of mitigation measures listed above in Section 2.3.12, Other Mitigation and Section 5.5.2, Measures to Prevent Oil Spills. Many of these measures address mechanical and operations aspects of prevention and response. One technique, the development and deployment of a prefabricated sub-sea collection system with surface separation capability to capture and dispose of oil from a flowing well before it reaches the surface, is examined below.

Sub-sea Containment System. BOEMRE issued NTL 2010 - N10 on November 8, 2010 that encouraged, but did not require, operators to revise their oil spill contingency plans to provide information on sub-sea containment and capture equipment to meet the requirements of 30 CFR 250.254.23 and 30 CFR 250.26(d)(2). A sub-sea containment system is not required or necessary for Shell to comply with the existing 30 CFR 254 regulations for its proposed 2011 exploratory drilling program. Although the NTL does not require that operators submit revised Oil Spill Response Plans that include this containment information at this time, operators were notified of BOEMRE's intention to evaluate the adequacy of each operator to comply in the operator's current OSRP..

Shell has committed to having a pre-fabricated sub-sea collection system with surface capability to capture and dispose of oil. Shell has indicated that this system is in final design. Following construction, it will be staged on and OSRB. The selection of a final staging location will be dependent on logistics, permit considerations, local community interest and support, and infrastructure best suited for deployment. BOEMRE will require Shell to revise their ODPCP to document the staging location and deployment schedule for this system. BOEMRE will also require Shell to deploy and function-test the system prior to commencement of drilling activities.

The use of a sub-sea containment device (containment dome) is not technically complicated. USDOI, MMS (1985) concluded that; 1) such a system is viable within existing technology and 2) most major components for such a system are available and have been field tested in various offshore oil and gas procedures and applications.

Sub-sea containment technology has been successfully used in the past. Shell has prior experience with containment domes in the Gulf of Mexico. Shell used a containment dome in 20 ft of water to capture oil leaking from the damaged "Nakika" line while repairs were being performed (Coyne et al. 2005, p.3). Shell also used a containment dome to capture oil from the Mars pipeline in 2,700 feet of water after it was damaged during Hurricane Katrina (Povloski , 2008). Taylor Energy used a containment dome to collect leaking oil from wellheads buried in a mudslide during Hurricane Ivan (AP, 2010). These examples are not directly comparable to a loss of well control event where large volumes of fluids and gas flow, but represent successful deployment and use of this technology.

An oil spill containment structure was unsuccessfully deployed during the 1979 Ixtoc blowout. The dome used for the Ixtoc well was undersized and did not cover the well completely, allowing oil to leak out around the bottom of the containment structure (USDOI, MMS, 1999, p. 28-29).

A containment dome was also used during the 2010 Macondo blowout. In the first attempt, methane hydrates crystallized and blocked flow through the riser to the surface. Following a redesign of the dome, a second system was successfully deployed and resulted in a collection rate of 15,000 barrels per day (PCR, 2011).

There are substantial differences between the Ixtoc and Macondo incidents and Shell's (2011) proposed Sivulliq and Torpedo exploratory program. These include:

- New regulatory requirements for estimating worst case discharge volumes provide a better understanding of potential well control dynamics (flow rates and fluid properties) that can be factored into designing a containment system.
- Constructing and pre-staging the containment system shortens response times and allows for pre-testing of the operability and functionality of the system.
- The Sivulliq and Torpedo drill sites are in 107-124 feet of water where deployment and operation of the system would be less complicated than were experienced in the deep water Macondo well.
- Shell will have dedicated support vessels on site to assist in deployment of the system, and will not need to identify and mobilize new assets.
- Hydrates are not expected to occur from the Sivulliq or Torpedo wells: hydrate formation during the Macondo blowout was a result of high pressures and associated low temperatures found at water depths greater than 300 meters. Water temperatures at Sivulliq or Torpedo drill sites will be approximately 0° C. At this temperature, a water depth of nearly 1000 ft would be required to enable hydrates to form.

In summary, Shell's proposed subsurface collection system will be an added tool for responding to a potential well control incident where fluids flow and will increase response preparedness, but is not necessary or required to comply with 30 CFR 254.23 and 30 CFR 354.26(b)(2). Shell has the equipment and resources to contain and clean up the worst case discharge volume calculated for the Torpedo H exploratory well without a subsea containment system.

5.9.3. Effectiveness of Oil Spill Response.

Oil spill response capabilities are continually being improved as technological advances are applied to detection, containment, recovery and removal of spilled oil. There are many different types of countermeasures available to contain and remove or mitigate oil that has entered the environment. Response options can be grouped in four major categories: oil booms (for excluding, containing and directing floating oil); skimmers (for collecting oil); dispersants (for breaking down the molecular structure of the oil to increase dissolution and biodegradation) and in situ burning (for rapidly removing large quantities of oil from surface waters).

The effectiveness of each countermeasure varies widely as a function of the environmental conditions, type of oil spilled, and the weathered state of the oil. In general, the effectiveness of the most common oil spill countermeasures is shown in Table 21 (USDOI, MMS, 2002).

Table 21 Effectiveness of oil spill countermeasures

Countermeasure Method	Effectiveness (%)
Booms and skimmers	10 – 20
Dispersants	30 - 40
In Situ Burning[1]	90 - 98

Notes: [1] Assumes that burning is initiated soon after the spill before the oil emulsifies

6.0 CONSULTATION AND COORDINATION

The BOEMRE considered the resources and species that could potentially be affected by Shell's proposed activities and three consultations were required for:

- Federally listed or proposed threatened/endangered species (or those species' designated proposed critical habitat) as defined by the Endangered Species Act (ESA).
- Essential Fish Habitat as defined by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).
- The protection of historic properties as defined by the National Historic Preservation Act (NHPA).

6.1. Endangered Species Act Consultation

Section 7(a)(2) of the ESA requires each Federal agency to ensure that any action 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. The BOEMRE consults with FWS and NMFS for listed species under each Service's jurisdiction.

The BOEMRE completed formal consultation with NMFS, Alaska Region, on the potential effects of OCS oil and gas leasing and exploration on the Beaufort Sea and Chukchi Sea. NMFS provided a Biological Opinion (BO) for Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska and Authorization of Small Takes Under the Marine Mammal Protection Act (USDOC, NOAA, NMFS, 2008). The BO considers the effects of oil and gas leasing and exploration on threatened and endangered species under the jurisdiction of NMFS. The NMFS concluded the described actions are not likely to jeopardize the continued existence of the fin, humpback, or bowhead whale.

The December 2010, NMFS proposal (75 FR 77476) to list ringed seals and the Beringia DPS of bearded seals as threatened under the ESA requires BOEMRE to evaluate the likelihood that the proposed action would jeopardize the continued existence of these ice seals. BOEMRE has concluded that the proposed action would not jeopardize the continued existence of these ice seals and further consultation is not required under the ESA.

The BOEMRE completed formal consultation with FWS, Alaska Region, on the potential effects of OCS oil and gas leasing and exploration in the Beaufort and Chukchi Seas to affect listed species under FWS jurisdiction. The FWS provided a BO for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling dated September 3, 2009 (USDOI, FWS, 2009). The FWS concluded that it is unlikely that seismic survey and exploratory drilling activities will violate section 7(a)(2) of the ESA. The FWS determined that adverse effects on listed species are anticipated. In the BO, FWS provided incidental take authorization for listed eiders and requires incidental take of polar bears to be authorized under the MMPA.

The FWS designated polar bear critical habitat in December 2010 (75 FR 76086) and the BOEMRE has reinitiated formal consultation regarding the potential for the proposed action to destroy or adversely modify designated polar bear critical habitat. Based on the analysis in this EA, BOEMRE has preliminarily concluded that the proposed action would not destroy or adversely modify designated polar bear critical habitat. These findings are part of a new draft Biological Evaluation being prepared by BOEMRE for conveyance to FWS in the near future.

The Pacific walrus was designated a candidate species under the ESA on 10 February 2011 (76 FR 7634). While not required by the ESA, BOEMRE has initiated conferencing with the FWS regarding the potential for the proposed action to affect the Pacific walrus. Based on the analysis in this EA, BOEMRE has preliminarily concluded that the proposed action would not jeopardize the continued existence of the Pacific walrus. These findings are part of a new draft Biological Evaluation being prepared by BOEMRE for conveyance to FWS in the near future.

Under the ESA, no incidental take of a protected species is authorized unless an Incidental Take Statement (ITS) is issued by the NMFS or FWS for the proposed activity. Any approval of Shell's EP will be a conditional approval. Under the conditional approval, an APD will not be approved and commencement of activities will not be authorized until appropriate ITSs from both NMFS and FWS have been issued. Conditional approval of the APD will also include any relevant Reasonable and Prudent Measures and associated Terms and Conditions required through the ESA consultation process and does not foreclose the formulation or implementation of any Reasonable and Prudent Alternatives.

6.2. Essential Fish Habitat Consultation

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 U.S.C. 1801-1884) mandated the identification of Essential Fish Habitat (EFH) for managed species as well as measures to conserve and enhance the habitat necessary to fish to carry out their lifecycles. The MSFCMA requires cooperation among the National Marine Fisheries Service (NMFS), the Fishery Management Councils, fishing participants, Federal and State agencies, and others in achieving EFH protection, conservation, and enhancement.

BOEMRE conducted its most recent EFH consultation on Pacific salmon species for OCS exploration activities in the Beaufort Sea in 2009, concurrent with the preparation and public review of the Arctic Beaufort and Chukchi Sea Planning Areas Draft EIS (MMS, 2008). The BOEMRE received NMFS' conservation recommendations in a letter dated June 26, 2009. Arctic cod EFH consultation for the drilling proposed by Shell in Camden Bay in 2012 and 2013 (and possibly subsequent open-water seasons) is currently being conducted in a separate EFH document. The determination of effects on EFH will be stated in that consultation document.

6.3. Marine Mammal Protection Act

Shell has applied for an Incidental Harassment Authorization (IHA) from the NMFS (dated May 2011) and a Letter of Authorization from the USFWS (dated May 2011) as a component of the 2011 Camden Bay Exploration Plan (Appendix C and E, respectively). Shell proposed to incorporate mitigation measures specifically designed to prevent or minimize any incidental harm to marine mammals. Those measures are summarized in Section 2.3.11 of this EA.

To ensure compliance with the Marine Mammal Protection Act (MMPA), BOEMRE is requiring Shell to obtain an incidental take authorization (ITA) from NMFS and FWS —which could be in the form of an incidental harassment authorization (IHA) or letter of authorization (LOA)—before Shell commences BOEMRE-permitted exploration activities. Mitigation measures are included in the ITA to ensure the least practicable adverse impact on marine mammal species or stocks, and their habitat, and to ensure that potential impacts to marine mammals will be negligible and have no unmitigable adverse impacts on the availability of marine mammals for subsistence uses.

6.4. National Historic Preservation Act

Section 106 consultation, as required by the National Historic Preservation Act, is ongoing with the preparation of this EA. On June 29, 2011, BOEMRE concluded Section 106 consultation with the Alaska State Historic Preservation Officer (SHPO). BOEMRE informed the SHPO of the determination that drilling of the four wells and related activities will have no effect on historic properties. The SHPO concurred with this finding on June 6, 2011.

6.5. Reviewers and Preparers

As required by 40 CFR 1506.5(a)(b), the persons responsible for the review of Shell's EP, supporting information and analysis, and the preparation of this EA are listed below:

Name	Title
Jerry Brian	Socioeconomic Specialist
Chris Campbell	Sociocultural Specialist

Nancy Deschu	Fisheries Biologist
Dan Holiday	Biological Oceanographer
James Lima	Supervisory Environmental Protection Specialist
Virginia Raps	Meteorologist
Mark Schroeder	Wildlife Biologist
Kirk Sherwood	Geologist
Caryn Smith	Oceanographer
Bill Swears	Technical Editor
Joseph Talbott	NEPA Coordinator

6.6. Public Involvement

On Wednesday, May 11, 2011 BOEMRE posted the Shell Offshore Inc. Camden Bay Revised Exploration Plan at: http://alaska.boemre.gov/ref/ProjectHistory/2012Shell_BF/2012x.HTM. This project is similar in detail to the previously approved Shell Offshore Inc. 2010 Exploration Plan for Camden Bay at: http://alaska.boemre.gov/ref/ProjectHistory/Shell_CamdenBF/2009_final_EP_camden_bay.pdf.

On Tuesday, July 5, 2011 BOEMRE posted the Notice of Preparation of an Environmental Assessment for a 2012 Shell Camden Bay Revised Exploration Plan to the BOEMRE/Alaska website at: http://www.alaska.boemre.gov/ref/ProjectHistory/2012Shell_BF/2012x.HTM. Copies of the notice were distributed to stakeholders concurrently with this posting. Comments on the Notice of Preparation were received through midnight July 15, 2011.

The BOEMRE received comments on the Notice of Preparation from the North Slope Borough, the Northwest Arctic Borough, The Marine Mammal Commission, and a consortium of environmental advocacy organizations. The comments were then aggregated and summarized for use in the EA analyses and by the decision-maker.

Public participation relating to Shell's proposed 2012 activities has been provided through a combination of notification of the receipt of an application and a notice of the preparation of an EA. Opportunities for public input on exploratory drilling in the Arctic OCS and related issues have also been provided during several prior NEPA processes.

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APPENDIX A

ANALYSIS OF ACCIDENTAL OIL SPILLS

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Appendix A
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A. OIL-SPILL ANALYSIS AND SCENARIO FRAMEWORK OF ACCIDENTAL OIL SPILLS IN THIS ENVIRONMENTAL ASSESSMENT.

This Appendix describes the results of the oil-spill analysis and the supporting documentation for those results. The-oil-spill analysis considers the potential accidental oil spill discharges, their likelihood of occurrence, and then outlines the accidental oil spill scenario framework for the impact analysis of the alternatives in this EA. The vessel, drilling, and fuel-transfer activities described in the Exploration Plan (EP) for the proposed action were evaluated for both routine operations and accident conditions. It is not anticipated that oil spills occur as a routine activity, and, therefore are not a routine impact-producing factor. Oil spills are considered an accidental activity and are treated as an accidental impact-producing factor. An accident is an unplanned event or sequence of events that results in an undesirable consequence.

The BOEMRE 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 Beaufort Sea Multiple-Sale EIS, from which this EA tiers. The BOEMRE updated those oil spill and impact analyses in the Sale 195 EA, the Sale 202 EA, the Arctic Multiple Sale Draft EIS (especially the Beaufort Sea fault-tree information) and the 2007 and 2009 Camden Bay EAs, which this EA incorporates by reference. This Appendix also incorporates by reference the most recent information on OCS well-control incidents from the Revised LS 193 SEIS, and the 2011 Camden Bay EIA. Brief summaries, where relevant, are provided below; the information is updated and augmented by new material as needed.

Section 1.1 below begins with the summary of estimated oil spill factors (size, source, oil type, duration, likelihood of occurrence, weathering characteristics) used in the accidental oil spill scenario for the no action and proposed action alternatives in this EA. The remainder of this Appendix provides the information supporting the estimated oil spill factors used for accidental oil-spill analysis in this EA.

A-1.1. Summary: Estimated Accidental Spills by BOEMRE Size Categories.

For purposes of the no action alternative oil spill analysis, no small, large, or very large spills are estimated to occur in the proposed action area because no exploration activities occur.

For purposes of the proposed action alternative oil spill analysis, it is likely that a small spill could occur and is reasonably foreseeable. For purposes of analysis, BOEMRE estimates a 48-bbl diesel fuel-transfer spill for the volume and type of a small spill, as identified in Shell's Beaufort Sea Oil Discharge Prevention and Contingency Plan Revision 1 (ODPCP) summary of potential discharges (Shell Offshore Inc. 2011c, Table 2-1).

For purposes of the proposed action alternative oil spill analysis, no large or very large crude or diesel oil spills are estimated from exploration activities based on a review of potential discharges, historical oil spill and modeling data, and likelihood of 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 and very large) has occurred during temporary abandonment while drilling more than 15,000 exploratory wells;(3) the low number (four) 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, and (6) pollution prevention and oil spill response regulations and methods, implemented by USDOI, BOEMRE and Shell Offshore Inc. respectively, since the Deepwater Horizon event discussed in Section 5.0 of this EA.

A-1.1.1. Summary: Small Spills (<1,000 bbl) from Exploration Operations.

Historical Beaufort Sea and Chukchi Sea OCS exploration spill data suggest a small spill is likely. Thirty five exploration wells were drilled in the Arctic OCS; 35 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 hose rupture, and the spill could be relatively small. The largest Arctic OCS exploration spill was approximately 20 bbl (Section 1.3.1). For purposes of analysis, a 48-bbl diesel fuel-transfer spill was estimated as the small spill volume and oil type, and it is estimated to last less than 3 days on the surface of the water, based on oil weathering model calculations. Section 4.0 of this EA analyzes the impacts of such a small spill in each of the EA sections on oil spill impacts to specific resources. Lease Stipulation 6 and Shell's operating procedures require pre-booming during fuel transfers, which would reduce or negate adverse effects from a small 48-bbl diesel fuel-transfer spill.

A-1.1.2. Summary: Large Spills (≥1,000 bbl) from Exploration Operations.

For purposes of Shell's proposed exploration drilling program starting during the 2012 open-water season, OCS historical crude and condensate spill data demonstrates that a large spill is an unlikely occurrence of Shell's proposed exploration project. No oil will be produced. All wells will be permanently plugged and abandoned in accordance with BOEMRE requirements on completion of drilling. Since 1971, one OCS spill (large and 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 drillship or Mobile Offshore Drilling Unit, and should an internal storage tank rupture internally, it is unlikely a large diesel fuel spill would reach water. A large spill from internal diesel fuel tanks or a well-control incident is unlikely in connection with the exploration activities set forth in Shell's EP, and therefore, this EA does not analyze the impacts of such a scenario, but tiers to previous analysis of large spills as discussed in Section 5.0 of this EA.

A-1.1.3. Summary: Very Large Spills (≥150,000 bbl) from Exploration Operations.

A very large oil spill from a well-control incident during OCS exploratory drilling is a similarly unlikely occurrence. There is no absence of reliable scientific data on the chance of an exploration well-control incident occurring, 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 Shell's EP, and therefore, this EA does not analyze the impacts of such a scenario, but tiers to previous analysis of very large spills as discussed in Section 5.0 of this EA.

The BOEMRE analyzed the potential impacts of a very large spill from a well-control incident (OCS EIS/EA MMS 2003-001 at IV-228 to IV-247) and the conclusions of that analysis are found in section 5.0 of this EA. There are no site-specific anomalies that differentiate a very large spill release at Launch Area (LA) 12 analyzed and from LA15 where Shell's leases occur, and the oil-spill contacts are statistically similar. Thus, BOEMRE has analyzed the potential impacts from a very large well-control incident where fluids are released into the Beaufort Sea and incorporates that analysis by reference (see Section 5.0 of this EA). This impact analysis in USDOI, MMS (2003) considers the mitigation of spill response. Shell's ODPCP response scenario addresses the potential immediate release of crude oil to the environment by a loss of well-control during drilling. Shell's ODPCP demonstrates that access to sufficient equipment and personnel needed to respond to a well blowout flow rate of 16,000 barrels of oil per day (bopd) for 30 days.

A-1.2. Oil-Spill Volume and Type Estimates.

Oil spills are an issue of great public concern in relation to the offshore oil and gas industry. Etkin (2009) estimates that petroleum industry spillage has decreased over the last 40 years; 70 percent less oil is spilling since the 1970s and 54 percent less in the decade 1998-2007 from the previous. Although oil spill volumes are decreasing, even with consumption of oil increasing, the Deepwater Horizon Event has heightened the public's awareness to the potential impacts of very large oil spill events.

Using information from Shell's Beaufort Sea ODPCP, the BOEMRE 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, to determine a reasonably foreseeable spill analysis. The analysts used the reasonably foreseeable spill analysis to evaluate the potential oil spill impacts on their resources for this EA.

A-1.2.1. Oil Spill Potential Discharge Volume.

The BOEMRE used Shell's potential discharge volumes, summarized below in Table A-1, as the likely spill volume and oil type for each of BOEMRE's small (<1,000 bbl), large (≥1,000 bbl), and very large (≥150,000 bbls) spill size categories (Shell Offshore Inc., 2011c, Table 2-1). Within each of BOEMRE'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-bbl diesel-transfer spill is the estimated volume 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 of 480,000 bbl is in the estimated volume of very large spill without pollution prevention and oil spill response measures. The paragraph below describes why and how Shell calculated the worst-case discharge (WCD) and BOEMRE's verification of the WCD.

Table A-1 Summary of Potential Discharge Volumes and Relation to BOEMRE Spill Size Categories for Oil-Spill Analysis.

BOEMRE Spill-Size Categories	Type	Cause	Product	Size	Duration	Prevent Potential Discharge
Small <1,000 bbl	Transfer from fuel barge to drill vessel	Hose rupture	Diesel	Approximately 2,000 gallons 48 bbl (Section 1.6)	5.5 minutes (ODPCP Section 1.6)	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	Diesel	1,555 bbl	Minutes to hours	The diesel tanks are internal to each drilling vessel 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.
Very Large ≥150,000 bbl	Blowout	Uncontrolled flow at the mudline	Crude oil	480,000 bbl	30 days (ODPCP Section 1)	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. Shell (2011c): ODPCP Section 2.1.8

Source: USDOI, BOEMRE, 2011.

A-1.2.2. Worst-Case Discharge Calculation for the Oil Spill Response Plan.

The BOEMRE regulations set forth how the volume for a WCD calculation is determined for an oil-spill-response planning scenario (30 CFR and 254.47(b) and 250.213(g)). The WCD volume and storage capacities are calculated to address BOEMRE'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 WCD Volume by Citation and Source.

Citation	Source	Type and Location	Product	Size (bbl)	Duration
30 CFR 254.47(b)	Shell Offshore Inc. 2011c	Uncontrolled flow at the mudline	Crude oil	480,000	30 days (ODPCP Section 1)
30 CFR 250.213(g) and NTL 2010-N06	Shell Offshore Inc. 2011c	Uncontrolled flow at the mudline	Crude oil	198,016-407,124	Torpedo H or J well 34-43 days to drill relief well
BOEMRE Verification	USDOI, BOEMRE, 2011	Uncontrolled flow at the mudline	Crude oil	74,940 – 107,414	Torpedo H well 30-43 days to drill relief well

Note: The size in bbls range is estimated from the lowest bopd rate multiplied by the shortest number of days to drill a relief well to the highest bopd rate multiplied by the longest number of days to drill a relief well.

The BOEMRE 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 16,000 bbl of crude oil for 30 days (480,000 bbl total). This volume exceeds Shell's WCD calculated for the Sivulliq and Torpedo wells (Section 2 of the revised Camden Bay EP). Shell's Beaufort Sea ODPCP (Revision 1) demonstrates access to sufficient equipment and personnel needed to respond to a well blowout with this flow rate and total volume.

Other BOEMRE regulations 250.213(g) require a scenario for a potential blowout that will have the highest volume and maximum duration. Shell's blowout scenario provides for transiting and drilling a relief well for Sivulliq G or N in up to 29-38 days (with a resulting estimated total spill volume of 17,226-34, 884 bbl). Shell's blowout scenario provides for transiting and drilling a relief well for Torpedo H or J in up to 34-43 days (with a resulting estimated total spill volume of 198,016-407,124 bbl). Again these oil spill volumes are calculated without factoring in any intervention or response.

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 BOEMRE (USDOI, BOEMRE, 2011b). The WCD estimate does not include any intervention or response. The BOEMRE, Resource Evaluation conducted a verification of the WCD model submitted by Shell and concurs that the Torpedo H well has the highest potential discharge volume in both daily rate and cumulative flow. The BOEMRE WCD results find that the cumulative discharges are all considerably less than the cumulative discharges forecast by the Shell's WCD model (USDOI, BOEMRE, 2011b). The BOEMRE estimates the cumulative oil discharge at 30 and 43 days for the Torpedo H well is 74,940 and 107,414 bbl, respectively.

A-1.2.3. Pollution Prevention and Response

A detailed description of pollution prevention and response is provided in Section 5.0. This section also details how the WCD is modified in terms of the very large oil spill scenario analysis.

A-1.3. 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 to have a large or very large oil spill from a well-control incident during drilling or other exploration operations. The Arctic OCS historical oil spill data indicate it is likely to have a small refined spill during exploration operations.

A-1.3.1. Historical Refined and Crude Spills from Exploration Operations on the Beaufort and Chukchi Outer Continental Shelf and Canadian Beaufort.

The BOEMRE 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. During the time of this drilling, industry has had 35 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. Table A-3 shows the exploration spills on the Beaufort Sea and Chukchi Sea OCS. All the explorations spills on the Beaufort Sea and Chukchi Sea OCS have been small, with the largest spill approximately 20 bbl. OCS spill data shows that 99% of all spills on the OCS are < 50 bbl in size (Anderson and LaBelle 2000, Table 13). 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 bbl for a transfer of diesel fuel during refueling operations in their potential discharge estimates. The BOEMRE estimates a small spill is a reasonably forseeable scenario during exploratory drilling in the Beaufort Sea. The historical data shows small spills often are onto containment on vessels, platforms, facilities, or gravel islands, or onto ice, and may be cleaned up.

Table A-3 shows no large exploration spills occurred on the Beaufort Sea and Chukchi Sea OCS. 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 in the proposed action are internal to the drillship and erosion would not be a causal factor for a large oil spill. If the internal diesel fuel tanks on the ship failed or leaked, it is unlikely a large spill would reach water.

A-1.3.2. Historical Crude and Condensate Oil Spills from Well-Control Incidents on the OCS and Alaska North Slope.

The Gulf of Mexico and Pacific and Alaska OCS data show that a large spill likely would not be from a well-control incident. We consider well-control incidents that result in pollution to the environment to be very unlikely events. Well-control-incident events often are equated with catastrophic spills; however, in the last 40 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 Macondo Well 252 (hereafter called the Deepwater Horizon (DWH) event) occurred in 2010 in the Gulf of Mexico (Table A-4). Following the Santa Barbara well-control incident in 1969 and two large well control incidents in 1970 in the Gulf of Mexico, 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, and subsurface safety devices are among the provisions that were adopted in the regulatory program (Visser, 2011). The year 1971 is considered reflective of the modern regulatory environment. For 39 years no OCS well control incidents resulted in a large 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 regulations are discussed in section 5.0 of this EA.

A-1.3.2.1. OCS Well Control Incident Rates

This section updates information in the 2009 Camden Bay EA Appendix A, Section A.1.c which discussed OCS well control incidents from 1971-2007 (USDOI, MMS, 2009). The year 1971 is considered reflective of the modern regulatory environment. 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. Three relevant data sets are considered: (1) all well control incidents from 1971-2009 prior to the DWH event to update the 2009 Camden Bay

Table A-3 Exploration Spills on the Beaufort Sea and Chukchi Sea OCS.

Lease No.	Sale Area	Operator	Date	Facility	Oil	Amt. (Gal)	Cause of Spill	Response Action	Rec. (gal)
0344	71	Sohio	7/22/1981	Mukluk Island	Diesel	0.50	Leaking line on portable fuel trailer	Sorbents used to remove spill. Contaminated gravel removed.	0.05
0344	71	Sohio	7/22/1981	Mukluk Island	Diesel	1.00	Overfilled fuel tank on equipment	Sorbents used to remove spill. Contaminated gravel removed.	1.00
0280	71	Exxon	8/7/1981	Beaufort Sea I	Hydraulic Fluid	1.00	Broken hydraulic line on ditch witch.	Fluid picked up with shovels.	1.00
0280	71	Exxon	8/8/1981	Beaufort Sea I	Trans. Fluid	0.25	Overfilling of transmission fluid.	Fluid picked up and placed in plastic bags.	0.25
0280	71	Exxon	1/11/1982	Beaufort Sea I	Hydraulic Fluid	0.50	Broken hydraulic line.	Fluid picked up and stored in plastic bags.	0.50

Lease No.	Sale Area	Operator	Date	Facility	Oil	Amt. (Gal)	Cause of Spill	Response Action	Rec. (gal)
0280	71	Exxon	1/11/1982	Alaska Beaufort Sea I	Diesel	3.00	Overfilled catco 90-3 tank.	Fluid picked up.	3.00
0280	71	Exxon	1/17/1982	Beaufort Sea I	Diesel	1.00	Tank on catco 90-14 overfilled.	Fluid picked up and stored in plastic bags.	1.00
0280	71	Exxon	1/21/1982	Beaufort Sea I	Hydraulic Fluid	0.25	Broken hydraulic line on ditch witch.	Fluid picked up.	0.25
0371	71	Amoco	3/16/1982	Sandpiper Gravel Island	Unknown	1.00	Seeping from Gravel Island.	Sorbent pads.	Unknown
0849	87	Union Oil	9/4/1982	Canmar Explorer II	Unknown	1.00	Transfer of test tank from drillship to barge.	None	None
0871	87	Shell Western	9/5/1982	Canmar Explorer II	Light Oil	0.50	Washing down cement unit, drains not plumbed to oil/water seperator.	None	None
N/A	87	Shell	9/14/1982	Canmar II Drillship	Diesel	30.00	Tank vent overflowed during fuel transfer.	Deployed sorbent pads and pump.	30.00
0191	BF	Exxon	11/11/1982	Beechey Pt. Gravel Is.	Lube Oil	1.00	Loader tipped over lube oil drum	Oil cleaned up with sorbents. Contaminated gravel removed	1.00
0191	BF	Exxon	1/15/1983	Beechey Pt. Gravel Is.	Diesel	0.12	Fuel truck spilled diesel as it climbed a 40 degree ramp to island	Sorbents used and contaminated gravel removed	0.12
0191	BF	Exxon	1/23/1983	Beechey Pt. Gravel Is.	Hydraulic Fluid	2.50	Hydraulic line on backhoe broke	1 gallon in water. Boom deployed with sorbents, Contaminated gravel removed	2.50
0191	BF	Exxon	8/29/1983	Beechey Pt. Gravel Is.	Hydraulic Fluid	0.20	Hydraulic line on backhoe broke	Spill contained on island surface. Sorbents used and contaminated gravel removed.	0.25
0196	BF	Shell	8/30/1983	Ice Road to Tern Island	Hydraulic Fluid	10.0	Broken hydraulic line on rollogon	Unknown	Unknown
0191	BF	Exxon	2/26/1985	Beechey Pt. Gravel Is.	Hydraulic Fluid	0.37	Hydraulic line broke	Contaminated Snow Removed	0.37
0196	BF	Shell	3/1/1985	Ice Road to Tern Island	Hydraulic Fluid	3.00	Hydraulic line broke	Unknown	3.00
0191	BF	Exxon	3/2/1985	Beechey Pt. Gravel Is.	Gasoline	0.01	Operational Spill	Snow shoved into plastic bag.	0.01
0191	BF	Exxon	3/4/1985	Beechey Pt. Gravel Is.	Waste Oil	2.00	Drum of waste oil punctured	Snow recovered	2.00
0196	BF	Shell	3/4/1985	Tern Gravel Island	Crude Oil	1.00	Well Separator overflowed, crude oil escaped	Line boom deployed	Unknown
0196	BF	Shell	3/6/1985	Tern Gravel Island	Crude Oil	15.00	Test burner was operating poorly	Containment Boom deployed	Unknown
0196	BF	Shell	9/24/1985	Tern Gravel Island	Crude Oil	2.00	Oil released from steam heat coil when Halliburton tank moved	Sorbents and hand shovel used	2.00
0191	BF	Shell	10/4/1985	Enroute to Tern Gravel Island	Jet fuel B	800.00	Wire sling broke during helicopter transport of fuel blivits	Contaminated Snow Removed. Test holes drilled with no fuel below snow.	Unknown
0196	BF	Shell	10/29/1985	Tern Gravel Island	Crude Oil	2.00	Test oil burner malfunction	Contaminated snow removed	2.00
0196	BF	Shell	6/27/1986	Tern Gravel Island	Crude Oil	3.00	Test oil burner malfunction	Spray picked up with sorbents. Bladed up dirty snow.	2.00
0943	87	Tenneco	1/24/1988	SSDC/MAT	Gear oil	220.0	Helicopter sling failure during transfer of drums to SSDC	Scooped up contaminated snow and ice	220.0
1482	109	SWEPI	7/7/1989	Explorer III Drillship	Hydraulic fluid	10.0	Hydraulic line connector	Sorbent pads	0.84
1092	97	AMOCO	10/1/1991	CANMAR Explorer	Hydraulic fluid	2.00	Hydraulic line rupture	None	None
0865	87	ARCO	7/24/1993	Beaudril Kulluk	Diesel	0.06	Residual fuel in bilge water	None	None
0866	87	ARCO	9/8/1993	CANMAR Kulluk	Hydraulic fluid	1.26	Seal on shale shaker failed	None	None
0866	87	ARCO	9/24/1993	CANMAR Kulluk	Fuel	4.00	Fuel transfer in rough weather	3 gallons on deck of barge recovered, none in sea	3.00
1597	124	ARCO	10/31/1993	CANMAR Kulluk	Fuel	0.50	Released during emptying of disposal caisson	None	None
1585	124	BP Alaska	1/20/1997	Ice Road to Tern Island	Diesel, Hydraulic Fluid	10.5	Truck went through ice; fuel line ruptured	Scooped up contaminated snow and ice. Some product entered water	Unknown

Source: USDOI, BOEMRE 2011.

Table A-4 Number of well control incidents with pollution per year in the Gulf of Mexico and Pacific OCS Regions and total OCS wells.

			Condensate/Crude Oil Spilled (Barrels)			Product -ion	Drilling				Workover/ Completion	Well Type	Well Type	Wells Drilled
Year	Total Number of Incidents	Incidents with Condensate/ Crude Oil	Production, Workover, Completion, P&A	Drilling	Total Exploration and Development	Total	Total	Exploration	Development	Unknown	Total	Development	Exploration	Total
1956	1	0	—	—	0	—	1	—	1	0	—	204	46	258
1957	1	0	—	—	0	—	1	—	1	0	—	333	58	391
1958	2	1	0.9	—	0.9	—	1	1	—	0	1	210	65	275
1959	1	0	—	—	0	—	1	—	1	0	—	229	96	325
1960	2	0	—	—	0	1	1	1	—	0	—	290	138	428
1961	0	0	—	—	0	—	—	—	—	0	—	351	133	484
1962	1	0	—	—	0	—	1	—	1	0	—	385	159	544
1963	1	0	—	—	0	—	1	1	—	0	—	400	209	609
1964	7	3	10,280	100	10,380	4	3	2	1	0	—	507	234	742
1965	5	2	0.9	1688	1,688.9	1	4	1	3	0	—	648	194	842
1966	2	2	0.9	0.9	1.8	—	1	—	1	0	1	628	299	973
1967	2	1	0.9	—	0.9	0	—	—	—	—	2	638	321	988
1968	8	0	—	—	0	1	6	2	4	—	1	735	358	1094
1969	3	3	—	82,500.9	82,500.9	0	3	1	2	0	—	731	254	993
1970	3	2	118,000.0	—	118,000.0	1	1	—	1	0	1	756	248	1006
1956-1970	39	14	128,283.60	84,289.80	212,573.40	8	25	9	16	0	6	7,045	2,812	9,952
Major Regulatory Changes to Outer Continental Shelf Lands Act														
1971	6	2	460	—	460	2	2	1	1	0	2	620	285	909
1972	6	2	2	0.9	2.9	1	4	2	2	—	1	608	309	917
1973	3	1		0.9	0.9	0	3	2	1	—	—	569	321	890
1974	6	2	275	—	275	2	2	1	1	—	2	512	355	869
1975	7	1	0.9	—	0.9	—	5	4	1	—	2	569	334	904
1976	6	0	—	—	0	1	5	1	4	—	—	851	317	1169
1977	10	1	2	—	2	1	4	3	1	—	5	975	398	1373
1978	12	1	0.9	—	0.9	—	8	4	4	—	4	935	361	1298
1979	5	2		1.8	1.8	—	5	4	1	—	—	895	420	1316
1980	8	1	1	—	1	2	4	3	1	—	2	943	412	1356
1981	10	5	66.7	0.9	67.6	1	3	1	2	—	6	1012	400	1412
1982	9	2	1.8	—	1.8	—	5	1	4	—	4	970	457	1427
1983	12	1	—	2	2	—	10	5	5	—	2	872	458	1330
1984	5	0	—	—	0	—	4	3	1	—	1	862	663	1525
1985	6	1	50	—	50	0	4	3	1	—	2	783	574	1361
1986	2	0	—	—	0	—	1	—	1	—	1	517	296	813
1987	8	2	61	—	61	3	2	2	—	—	3	534	439	973
1988	4	1	4.5	—	4.5	1	2	1	1	—	1	510	584	1094
1989	12	0	—	—	0	3	7	4	3	0	2	572	489	1061
1990	7	3	17.5	—	17.5	0	3	1	1	1	4	638	521	1159
1991	8	1	—	0.8	0.8	—	6	3	3	0	2	483	350	833
1992	3	1	—	100	100	—	3	3	—	—	—	376	229	605
1993	4	0	—	—	0	—	4	1	3	—	—	645	365	1010
1994	1	0	—	—	0	—	—	—	—	—	1	686	438	1124
1995	1	0	—	—	0	—	1	0	1	—	—	784	395	1179
1996	4	0	—	—	0	—	2	1	1	—	2	805	462	1267
1997	5	0	—	—	0	—	4	1	3	—	1	932	549	1481
1998	9	3	2.6	1.62	4.22	3	3	2	1	—	3	665	495	1161
1999	5	1	125	—	125	—	3	1	2	—	2	676	371	1048
2000	9	3	0.02	200.5	200.52	—	8	6	2	—	1	950	443	1396
2001	10	1	1	—	1	2	5	2	3	—	3	867	411	1278
2002	6	3	350.505	—	350.505	2	3	1	2		1	654	310	964
2003	5	1	10	—	10	2	2	0	1	1	1	557	354	911
2004	6	4	2.5	22.06	24.56	1	3	3	—	—	2	569	363	932
2005	4	0	—	—	0	—	4	1	3	—	—	482	355	841
2006	2	2	10	24.5	34.5	—	1	1	—	—	1	375	414	789
2007	8	—	—	—	—	2	2	2			4	328	300	630
2008	9	0	—	—	0	3	4	1	3		2	304	267	571

Year	Total Number of Incidents	Incidents with Condensate/ Crude Oil	Condensate/Crude Oil Spilled (Barrels)			Product -ion	Drilling				Workover/ Completion	Well Type	Well Type	Wells Drilled
			Production, Workover, Completion, P&A	Drilling	Total Exploration and Development	Total	Total	Exploration	Development	Unknown	Total	Development	Exploration	Total
2009	6	2	27.94	—	27.94	1	1	1			4	179	147	338
2010	4	1	—	TBD	TBD	3	1	1			0	181	80	267
1971-2010*	**253**	**51**	**1,472.87**	**355.98**	**1,828.85**	**36**	**143**	**77**	**64**	**2**	**74**	**26,245**	**15,491**	**41,781**

Notes: Wells drilled columns include hydrocarbon, sulfur and salt wells. The total column includes core tests and relief wells in addition to exploration and development wells; therefore the total column may be slightly higher than the sum of the development and exploration wells columns for some years.

TBD - the final volume for the Deepwater Horizon that occurred on 4/20/2010 has not been determined by BOEMRE.

The 1971-2010 spill volume totals for the columns showing Drilling and Total Exploration and Development do not include the volume for the Deepwater Horizon incident that occurred on 4/20/2010.

EA baseline, then (2) well control incident rates from exploration and development drilling including the DWH event, and finally (3) oil spills associated with well control incidents from exploration drilling including the DWH event (USDOI, BOEMRE, AIB, 2011).

Exploratory and Development/Production Operations From 1971-2009. There were 249 well control incidents during exploratory and development/production operations on the OCS (this includes incidents associated with exploratory and development drilling, completion, workover, plug and abandon, and production operations). During this period, 41,514 wells were drilled on the OCS and 15.978 billion barrels (Bbbl) of oil were produced. Of the 249 well control incidents that occurred during this period, 50 resulted in the spillage of condensate/crude oil ranging from <1 bbl to 450 bbls. The total spilled from these 50 incidents was 1,829 bbls. This volume spilled was approximately 0.000011447% of the volume produced during this period.

In 2010, four well control incidents occurred, including the DWH event. Although a final spillage volume from the DWH event has not been determined by BOEMRE, the current estimate from Lubchenco et al. (2010) is 4.9 million bbls. The three other well control incidents that occurred in 2010 did not result in the spillage of condensate/crude oil.

Development and Exploration Well Drilling From 1971-2010. There were a total of 41,781 wells drilled in the OCS comprising of 40,565 wells in the Gulf of Mexico, 1,086 wells in the Pacific Region, 46 wells in the Atlantic Region and 84 wells in the Alaska Region. Of these, 26,245 were development wells, 15,491 were exploration wells and 43 were core tests or relief wells. The overall drilling well control incident rate is 1 well control incident per 292 wells drilled, compared to 1 well control incident per 410 development wells drilled, and 1 well control incident per 201exploration wells drilled. These well control incident rates include all well control incidents related to drilling operations whether they spilled oil or not.

Exploration Well Drilling From 1971-2010. Industry has drilled 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. During this period, there were 77 well control incidents associated with exploration drilling. Of those 77 well control incidents, 14 resulted in crude, condensate and oil in drilling mud spills ranging from 0.5 bbl to 200 bbls, for a total 354 bbls, excluding the estimated volume from the DWH event. From 1971-2010 one well control incident resulted in a spill volume of 1,000 bbls or more and that was the DWH event.

A-1.3.2.2. 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 1980-2003. Ninety-six percent of offshore blowouts were 30 days or less in duration and 84% were 5 days or less in duration (Shell Offshore Inc. 2011c).

A-1.3.2.3. Alaska North Slope Well Control Incident Information

The blowout record for the Alaska North Slope remains the same as reported previously in USDOI, MMS (2003) and summarized herein. Of the 10 blowouts, 9 were gas and 1 was oil. The oil blowout in 1950 resulted from drilling practices that are no longer used. A third study confirmed that no crude oil spills ≥100 bbl from blowouts occurred from 1985-1999 (Hart Crowser, Inc., 2000). The remaining blowouts released dry gas or gas condensate only, resulting in minimum environmental impact (NRC, 2003).

Scandpower (2001) used statistical blowout frequencies modified to reflect specific field conditions and operative systems at Northstar in the Beaufort Sea. This report concludes that the blowout frequency for drilling the oil-bearing zone is 1.5 x 10–5 per well drilled (all wells). This compares to a statistical blowout frequency of 7.4 x 10–5 per well (for an average development well). This same report estimates that the frequency of oil quantities per well drilled for Northstar for a spill >130,000 bbl is 9.4 x 10-7 per well.

A-1.3.3. Historical Exploration Well-Control Incidents on the OCS and Canadian Beaufort.

Thirty-five (35) exploration wells were drilled between 1982 and 2003 in the U.S. Chukchi and Beaufort seas. Historically, no exploration drilling blowouts occurred as a result of the Chukchi Sea and Beaufort Sea OCS exploration drilling, nor have any occurred from the approximately 84 exploration and 14 deep stratigraphic test wells drilled within the Alaska OCS.

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. A second incident was not included at the Amaluligak wellsite with the Molikpaq drill platform. This resulted in a gas flow through the diverter, with some leakage around the flange. The incident does not qualify as a blowout by the definition used in other databases and, therefore, was excluded (Devon Canada Corporation, 2004).

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 drilling mud with oil or synthetic oil, crude or condensate oil spills. With the exception of the DWH event of 4.9 million barrels, spill sizes ranged from 0.5 bbl to 200 bbl. (Table A-3). One OCS spill (large and very large) has occurred from 1971-2010 during temporary abandonment of an exploration well. Therefore, approximately 15,000 exploration wells have been drilled, one crude oil spill (large and 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 (Table A-3).

A-1.3.4. Fault Tree Modeled Exploration Well-Control Incident Frequencies.

Bercha (2006, 2008) 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 (2006, 2008) was used in the USDOI MMS (2006, 2008) oil-spill analyses in the

Beaufort Sea which concluded approximately 1/3 of a large spill (≥1,000 bbl) was estimated to occur over the exploration and development life of the lease sale which included drilling 12 exploration and delineation wells .

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 (2008) used historical oil well blowout statistics derived from Holand (1997) for non-Arctic drilling operations and Scandpower's (2001) blowout frequency assessment for Northstar to estimate the expected size and frequency distribution of spills. Bercha reported the historical spill frequency for non-Arctic exploration well drilling as 3.42×10^{-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 1.5×10^{-4} per well to a high of 6.97×10^{-4} per well. The expected value for a blowout of this size was computed to be 3.94×10^{-4} per well (Bercha 2008). To address causal factors associated with blowouts, Bercha applied adjustments for improvements to logistics support and drilling contractor qualifications that resulted in 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 Beaufort Sea wells (30-60 m), Bercha (2008) the estimated, adjusted expected value frequency is 6.12 per 10^{-4} per well for a blowout sized between 10,000 bbl (1,590 m^3) and 149,000 bbl (23,689 m^3) and 3.54×10^{-4} per well for a blowout >150,000 bbl (23,848 m^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. Using the spill rates derived from the fault tree analysis the BOEMRE estimated approximately 1/3 of a large spill over exploration and development life of a lease sale.

A-1.3.5. Historical Worldwide Well Control Incident Spills Greater than or Equal to 150,000 Barrels.

Very large spills happen very infrequently, and there are limited data for use in our 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 (Table A-3). The sixth OCS well control incident resulting in a large spill was the DWH event. Although no official volume has been determined by BOEMRE it is clear from the spill volume estimates that the Deepwater Horizon exceeds the threshold of a VLOS; the current estimate is 4.9 million bbls and is greater than 150,000 barrel threshold for a VLOS (Lubchenco et al. 2010; McNutt et al. 2011).

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-5). 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). The BOEMRE compares numbers of spills to overall production because the number of exploration wells worldwide is not readily available. Using the 6 spills which were not a result of war, these data provide an approximate rate of about 1 very large oil spill worldwide for every 533 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; but this is not likely to be the case (especially in cases of military action).

Table A- 5 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 Abandon-ment	U.S. OCS, Gulf of Mexico	Crude	4/20/ 2010	7/15 / 201 0	87	4,900,000	McNutt et al. 2011. National Oil Spill Commission 2011.
Ixtoc	PEMEX	Expl. Well	Drilling	Mexico, Gulf of Mexico	Crude	6/3/ 1979	3/23 /198 0	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
Nowruz Oil Field No. 3 Well*	Iranian Offshore Oil	Platform	Production	Iran, Persian Gulf	Crude	2/4/ 1983	9/18 /198 3	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		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/ 1977	4/30 /197 7	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/ 1980	2/1/ 198 0	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, BOEMRE, (2011) compiled from cited references

A-1.4. Oil-Spill Analysis Framework.

There are three potential size categories of oil spills in connection with exploratory operations in this proposed action: (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 probability of a large spill occurring during exploration is low and, therefore, this EA does not analyze the impacts of large spills from exploration operations. The occurrence of a very large spill resulting from a well-control incident is similarly very low. Nonetheless, this EA incorporates by reference the BOEMRE's prior analyses of the impacts of a large and very large oil spill. See discussion in Section 5.0 of this EA. It is likely a small spill could occur during exploration operations and oil spill analysis scenario further includes small oil spill factors.

A-1.4.1. Small Oil Spills.

This section provides the analysis framework of a small oil spill used for the determination of impacts in this EA. Historical Beaufort Sea and Chukchi Sea OCS exploration spill data 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, a 48-bbl fuel-transfer spill was chosen as the size spill in the small category, based on historical experience in the Beaufort and Chukchi OCS and OCS oil-spill analysis. It is estimated to last less than 3 days on the surface of the water, based on the SINTEF Oil Weathering Model calculations. In terms of timing, a small spill from the operations could happen at any time from July to October during exploration operations. Conservatively, we assume that the vessel would not retain any of the 48 bbl of diesel fuel and depending on the time of year, a small spill reaches the following environments:

- vessel and then the water
- open water or open water and ice

The analysis of a small spill examines the weathering of the estimated small spill. In our weathering analysis, we estimate the following fate of the diesel fuel without cleanup. Table A- 6 summarizes the results we estimate for the fate and behavior of diesel fuel in our analysis of the effects of oil on environmental and social resources.

We outline our assumptions for a small spill to provide a consistent analysis of small oil spill impacts by resource. We base the analysis of effects from small oil spills on the following assumptions:

- One small spill occurs.
- The spill size is 48 bbl.
- The oil type is diesel fuel.
- All the oil reaches the environment; the vessel or facility absorbs no oil.
- The spill starts within Launch Area 15.
- There is no cleanup or containment. Pollution prevention, containment and cleanup is analyzed separately as mitigation.
- The spill could occur at any time of the exploration operations (July–October).
- The spill weathering is as we show in Table A- 5, and the spill lasts less than 3 days on the water.
- 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.

Modeling Simulations of Oil Weathering.

To judge the effect of a small oil spill, we estimate information regarding how much oil evaporates, how much oil is dispersed, and how much oil remains after a certain time period. We derive the weathering estimates of diesel fuel oil from modeling results from the SINTEF Oil Weathering Model Version 3.0 (Reed et al., 2005) for up to 30 days. Table A-6 summarizes the results we estimate for the fate and behavior of a 48-bbl diesel fuel spill. This estimate is slightly more conservative than the estimate in the EIA Table 2.10-2 which used the ADIOS 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 response experience, a small, 48-bbl diesel fuel oil spill will be localized and short term.

Table A- 6 Fate and Behavior of a Hypothetical 48-Barrel Diesel Fuel Oil Spill.

	Summer Spill[1]						
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

Notes: Calculated with the SIINTEF oil-weathering model Version3.0 of Reed et al. (2005) and assuming diesel fuel no 2.
[1] Summer (July through September), 12-knot wind speed, 2 degrees Celsius, 0.4-meter wave height.

A-1.4.2. This EA tiers to Previous Analysis of Very Large and Large Accidental Oil Spills.

After the Exxon Valdez oil spill in 1989, the BOEMRE, Alaska OCS Region analyzed very large spills in several OCS locations; five of which were in the Beaufort Sea (USDOI MMS, 1990a, b, 1991, 1995a, b, 1996, 1998, 2002, 2003a, b; USDOI, BLM and MMS, 1998, 2003; USDOI, BLM, 2005). The chance of a very large spill (≥150,000) is very low, but its potential effects were analyzed in Beaufort Sea Multiple-Sale EIS, Section IV.I Low-Probability, Very Large Oil Spill to which this

EA tiers. The spill scenario was based on a 15,000-bbl daily flow-rate for 15 days totaling 225,000 bbl. In the unlikely event of a very large accidental oil spill, the potential for major impacts exist as was identified. There are no site-specific anomalies that differentiate the trajectory analysis results of a very large spill release in LA12, previously analyzed, from one in LA15, and the oil spill contacts are statistically similar.

The chance of a large (≥1,000 bbl) spill is low, but the potential consequences were analyzed in USDOI, MMS (2003) section IV.C.; USDOI, MMS (2006); and section 4.4 USDOI, MMS (2008). Based on OCS median spill sizes, the MMS estimated a 1,500-bbl diesel or crude oil spill from a facility or a 4,600 -bbl crude oil spill from a pipeline for purposes of analyzing a large spill size (Anderson and LaBelle, 2000). 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 (LA1-18) and pipeline segments (P1-11) assuming a spill occurs are discussed in USDOI, MMS (2003, 2004, 2006). In the unlikely event of a large accidental oil spill, there is potential for major impacts as identified in previous analyses (USDOI, MMS, 2003, 2008) and discussed in Section 5.0 of this EA.

A-1.4.3. 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 moderate water depths (<100m) in a short period of time and within 1000-2000m of the release site (Daling et al., 2003). The proposed action area water depths are relatively shallow (<40m). A subsurface release or a surface release would be represented by LA15 for Shell Offshore Inc.'s proposed action.

Launch Area 15 Conditional Probabilities. The conditional probabilities to environmental resource areas and land segments (expressed as percent chance) from a spill originating in LA 15 (USDOI, MMS, 2003a: Tables A2-1-A2-54 and A2-73-A2-90) are statistically representative of the lease blocks cited in the Shell EP. The chance of a large spill contacting, assuming a large spill occurs, is summarized specifically for the LA15 and is inclusive in the conditional probability discussions in USDOI, MMS (2003a, 2004, 2006) cited above. The estimated conditional probabilities do not factor in 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.

Probabilities in the following discussion, unless otherwise noted, are summer or winter conditional probabilities estimated by the OSRA model (expressed as percent chance) of a spill ≥1,000 bbl contacting environmental resource areas (ERAs) or land segments (LSs) within a given timeframe from LA15 assuming a spill occurs (USDOI, MMS, 2003a: herein summarized as Tables A-7 and A-8).

Summer 3 Days. The OSRA model estimates a <0.5-28% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of bowhead whale migration corridor). The chance of contacting ERAs 56-58, 80, and 84 (ice/sea segments) is <0.5-55%. The chance of contacting ERA6 (Cross and No Name Islands) is <0.5 %. The chance of contacting ERA 4 (Cross Island ERA) is 1%. The chance of contacting ERA43 (Nuiqsut Subsistence Area) is 1%. The chance of contacting ERAs 9, 11, or 12 (Stockton, Maguire, Flaxman Islands) is<0.5-1%. The chance of contacting individual LSs is <0.5 except for LS42 (Point Hopson & Sweeney, Staines River) and 43 (Brownlow Point, Canning River), which have a 1% chance of contact. The chance of contacting grouped land segment (GLS) 138 (Arctic National Wildlife Refuge LSs 43-51) is 1%.

Summer 10 Days. The OSRA model estimates a <0.5-32% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of migration corridor). The chance of contacting ERA6 (Cross and No Name Islands) is 1%. The chance of contacting barrier islands ERAs 3-16 is <0.5-2%. The chance of contacting ERA43 (Nuiqsut Subsistence Area) is 4%. The chance of contacting individual LSs 39-46 is 1-2%. The chance of contacting GLS 138 (Arctic National Wildlife Refuge) is 6%.

Summer 30 Days. The OSRA model estimates a <0.5-34% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of migration corridor). The chance of contacting barrier islands ERAs 3-16 is 1-5%. The chance of contacting ERA44 (Kaktovik Subsistence Area) is 12%. The chance of contacting ERA69 (Harrison Bay/Colville Delta) is <0.5-16%. The chance of contacting ERA3 (Thetis and Jones Islands) is <0.5-23%. The chance of contacting individual LSs 37-49 is <0.5-4%. The chance of contacting GLS 138 (Arctic National Wildlife Refuge) is 15%.

Winter 3 Days. The OSRA model estimates a <0.5-7% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of migration corridor). The chance of contacting ERAs 56-58, 80, and 84 (ice/sea segments) is <0.5-51%. The chance of contacting ERA79 is 2%. The chance of contacting barrier islands (ERAs 3-16) is <0.5%. The chance of contacting ERAs 43-44 (Nuiqsut or Kaktovik Subsistence Area) is <0.5%. The chance of contacting all individual LSs is <0.5. The chance of contacting GLS 138 (Arctic National Wildlife Refuge) is <0.5%.

Winter 10 Days. The OSRA model estimates a <0.5-7% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of migration corridor). The chance of contacting barrier islands (ERAs 3-16) is <0.5%. The chance of contacting ERA43 (Nuiqsut Subsistence Area) is <0.5% and ERA44 (Kaktovik Subsistence Area) is <0.5-3%. The chance of contacting ERA69 (Harrison Bay/Colville Delta) is <0.5-1%. The chance of contacting ERA3 (Thetis and Jones Islands) is <0.5-3%. The chance of contacting individual LSs 46 (Arey Island, Barter Island), 47 (Kaktovik), or 48 (Griffin Point, Oruktalik Lagoon) is <0.5-1%. The chance of contacting GLS 138 (Arctic National Wildlife Refuge) is <0.5-7%.

Winter 30 Days. The OSRA model estimates a <0.5-8% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of migration corridor). The chance of contacting ERA6 (Cross and No Name Islands) is <0.5%. The chance of contacting ERAs 15-16 (Arey and Barter Islands, Bernard, Jago and Tapkaurak Spits) is <0.5-3%. The chance of contacting ERA43 (Nuiqsut Subsistence Area) is <0.5-1%. The chance of contacting ERA44 (Kaktovik Subsistence Area) is <0.5-4%. The chance of contacting ERA69 (Harrison Bay/Colville Delta) is <0.5-2%. The chance of contacting ERA3 (Thetis and Jones Islands) is <0.5-3%. The chance of contacting individual LSs 46 (Arey Island, Barter Island), 47 (Kaktovik), or 48 (Griffin Point, Oruktalik Lagoon) is <0.5-2%. The chance of contacting GLS 138 (Arctic National Wildlife Refuge) is <0.5-11%.

Table A- 7 Annual, Summer, and Winter Conditional Probabilities (Expressed as Percent Chance) that an Oil Spill Starting at LA15 Will Contact a Certain Land Segment or Group of Land Segments Within 3, 10 or 30 Days Assuming a Spill Occurs, Beaufort Sea Sales 186, 1

		Annual			Summer			Winter		
ID	**Land Segment Name**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**
37	Milne Point, Simpson Lagoon	:	:	:	:	:	2	:	:	:
38	Kuparuk River	:	:	:	:	:	1	:	:	:
39	Point Brower, Prudhoe Bay	:	:	:	:	1	1	:	:	:
41	Bullen Point, Point Gordon, Reliance Pt	:	:	:	:	1	1	:	:	:
42	Point Hopson, & Sweeney, Staines River	:	1	1	1	2	2	:	:	1
43	Brownlow Point, Canning River	:	1	1	1	2	3	:	:	1
44	Collinson Point Konganevik Point	:	:	:	:	1	1	:	:	:
45	Anderson Point, Sadlerochit River	:	:	1	:	1	2	:	:	:
46	Arey Island, Barter Island,	:	:	1	:	1	2	:	:	:
47	Kaktovik	:	:	1	:	1	4	:	:	:
48	Griffin Point, Oruktalik Lagoon	:	:	1	:	:	2	:	:	:
49	Angun Pt., Beaufort Lagoon	:	:	:	:	:	1	:	:	:
ID	**Grouped Land Segment Name**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**
	Teshekpuk Lake Special Area (NPR-A)	:	:		:	:	1	:	:	1
	Arctic National Wildlife Refuge	:	2	5	1	6	15	:	1	2

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 Annual, Summer, and Winter Conditional Probabilities (Expressed as Percent Chance) that an Oil Spill Starting at LA15 Will Contact a Certain Environmental Resource Area Within 3, 10, and 30 Days, Beaufort Sea Sales 186, 195, and 202.

ID	Environmental Resource Area Name	Annual			Summer			Winter		
		3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days
—	Land	1	3	8	2	10	23	:	1	3
3	Thetis and Jones Islands	:	:	1	:	1	3	:	:	:
4	Cottle & Return Islands, West Dock	:	:	1	:	1	3	:	:	:
5	Midway Islands	:	:	1	:	1	2	:	:	:
6	Cross and No Name Islands	:	:	1	:	1	3	:	:	:
7	Endicott Causeway	:	:	:	:	1	1	:	:	:
8	McClure Islands	:	1	1	:	2	3	:	:	1
9	Stockton Islands	:	1	1	1	2	3	:	:	1
11	Maguire Islands	:	1	1	1	2	2	:	:	:
12	Flaxman Island	:	1	1	1	2	3	:	:	:
13	Barrier Islands	:	:	1	:	1	2	:	:	:
14	Anderson Point Barrier Island	:	:	:	:	1	1	:	:	:
15	Arey and Barter Islands, Bernard Spit	:	1	2	:	2	5	:	:	:
16	Jago and Tapkaurak Spits	:	:	1	:	1	5	:	:	:
17	Angun and Beaufort Lagoons	:	:	:	:	:	1	:	:	:
28	Beaufort Spring Lead 10	:	:	1	:	:	:	:	:	2
31	Ice/Sea Segment 3	:	:	:	:	:	1	:	:	:
32	Ice/Sea Segment 4	:	1	2	:	1	5	:	:	1
33	Ice/Sea Segment 5	2	4	5	5	9	13	1	2	2
34	Ice/Sea Segment 6	12	14	14	28	32	34	7	7	8
35	Ice/Sea Segment 7	:	1	3	1	5	10	:	:	1
36	Ice/Sea Segment 8	:	:	1	:	1	5	:	:	:
37	Ice/Sea Segment 9	:	:	:	:	:	1	:	:	:
43	Nuiqsut Subsistence Area	:	1	3	1	4	8	:	1	1
44	Kaktovik Subsistence Area	:	1	3		5	12	:	:	:
54	Ice/Sea Segment 16a	:	:	3	:	:	2	:	:	3
55	Ice/Sea Segment 17	:	3	11		2	7	:	3	12
56	Ice/Sea Segment 18a	14	29	34	12	22	27	14	32	37
57	Ice/Sea Segment 19	52	59	61	55	63	66	51	58	60
58	Ice/Sea Segment 20a	:	6	15	1	10	21	:	5	12
59	Ice/Sea Segment 21	:	:	3	:	:	6	:	:	2
61	Ice/Sea Segment 23	:	:	:	:	:	1	:	:	:
67	Ice/Sea Segment 16b	:	:	2	:	:	2	:	:	2
69	Harrison Bay/Colville Delta	:	:	:	:	:	1	:	:	:
70	ERA 3	:	:	2	:	:	2	:	:	2
71	Simpson Lagoon	:	:	1	:	1	3	:	:	:
72	Gwyder Bay	:	:	:	:	:	1	:	:	:
74	Cross Island ERA	1	2	4	1	4	8	:	2	2
75	Water over Boulder Patch 1	:	1	1	:	1	2	:	:	1
76	Water over Boulder Patch 2	:	1	1	:	2	3	:	:	1
77	Foggy Island Bay	:	:	:	:	1	1	:	:	:
78	Mikelson Bay	:	:	:	:	:	1	:	:	:
79	ERA 4	3	5	6	5	9	11	2	3	4
80	Ice/Sea Segment 18b	7	14	16	12	22	27	5	11	12
81	Simpson Cover	:	:	:	:	1	1	:	:	:
82	ERA 5	1	3	5	2	9	14	:	1	2
83	Kaktovik ERA	:	2	5	1	5	13	:	1	2
84	Ice/Sea Segment 20b	:	4	8	:	10	21	:	2	4
85	ERA 6	:	:	:	:	:	1	:	:	:

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.

Assuming a spill occurs, the chance of a large spill contacting the group of land segments representing Arctic National Wildlife Refuge ranges from 1 percent during summer to <0.5 percent during winter within 3 days from LA15. The SINTEF Oil Weathering Model estimates that within approximately 48 hours a small 48-bbl diesel fuel spill will evaporate and disperse. Based on the weathering characteristics it is likely 48-bbl diesel fuel spill would dissipate before reaching the land segments representing Arctic National Wildlife Refuge. Lease Stipulation 6, pre-booming requirements for fuel transfers, provides further mitigation to reduce the chance of an oil spill contacting the land segments representing Arctic National Wildlife Refuge. This stipulation provides for booming during fuel transfers ensuring a 48-bbl diesel fuel spill would be contained, localized and cleaned up. Shell's, Alaska fuel transfer - operating condition and procedure, also addresses weather conditions permissive for fuel transfer and spill response, so not to prevent the deployment of spill containment boom and oil recovery vessels from carrying out an effective response in the event of a spill.

Given the: (1) low chance of a large spill contacting land segments within ANWR, assuming one occurs; (2) the low chance of a 48-bbl diesel fuel spill persisting for 3 days; and (3) the likely containment and cleanup of a 48-bbl diesel fuel spill (because of the requirements of Lease Stipulation 6 and Shell's Alaska fuel-transfer operating conditions and procedures), the grouped land segments, representing the Arctic National Wildlife Refuge, are not estimated to be contacted from a 48-bbl diesel fuel spill occurring at the Torpedo or Sivulliq drill sites.

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APPENDIX B

LEVEL OF EFFECTS DEFINITIONS AND ABBREVIATIONS

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Appendix B

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B. LEVEL OF EFFECT DEFINITIONS

The terms negligible, minor, moderate, and major are used to describe the relative degree or anticipated level of effect of an action on a specific resource. Following each term listed below for a specified resource are the general characteristics used to determine the anticipated level of effect. For each term, best professional judgment was used to evaluate the best available data concerning the affected resource.

The absence of a significant effect does not equate to "no effect." As shown in the four-category scale, and in the numerous analyses that BOEMRE has undertaken, effects from activities can be adverse and noticeable before they reach the significance threshold. Furthermore, in the cumulative effects analysis, BOEMRE analyzes the combined effects of projected activities with other actions, because BOEMRE recognizes that effects that individually do not reach this significance threshold may exceed that significance threshold when considered collectively.

B-1. Air Quality

The levels of effect applied to the air quality analysis are based on the results of two levels of analyses, the emission inventory, and if required, the more rigorous ambient air analysis based on computer dispersion modeling. A thorough investigation of the applicable federal and state regulations upon which these levels of effect are based is provided in Appendix D, Air Quality.

Significance Threshold

Emissions cause an increase in pollutants over an area of at least a few tens of square kilometers that exceeds half the increase permitted under the Prevention of Significant Deterioration criteria or the National Ambient Air Quality Standards for nitrogen dioxide, sulfur dioxide, or particulate matter less than 10 microns in diameter; or exceeds half the increase permitted under the National Ambient Air Quality Standards for carbon monoxide or ozone.

Level of Effects

Negligible

- Emissions are shown to be *de minimis*; and
- All provisions of the CAA are met and the Proposed Action is compliant to the Alaska State Implementation Plan (SIP); and
- No potential exists for adverse air quality effects.

Minor

- Emissions constitute either a minor or a major source; and
- If a major source, an ambient air analysis was conducted for comparison to the appropriate Significant Impact Levels (SILs); and
- SILs are not exceeded; and
- No further analysis is required; and
- All provisions of the Clean Air Act (CAA) are met and the Proposed Action is compliant to the Alaska SIP; and
- No potential exists for adverse air quality effects.

Moderate

- Emissions constitute a major source; and
- An ambient air analysis was conducted for comparison to the appropriate SILs; and
- At least one of the SILs is exceeded; and
- Further analysis was conducted to show compliance to the air quality standards; and

- None of the National Ambient Air Quality Standards (NAAQS) or the Alaska Ambient Air Quality Standards (AAQS) is equaled or exceeded; and
- All provisions of the CAA are met and the Proposed Action is compliant to the Alaska SIP; and
- No potential exists for adverse air quality effects.

Major

- Emissions constitute a major source; and
- An ambient air analysis was conducted for comparison to the appropriate SILs; and
- At least one of the SILs is exceeded; and
- Further analysis was conducted to show compliance to the air quality standards; and
- At least one of the NAAQS or the Alaska AAQS is equaled or exceeded; and
- Provisions of the CAA are not met and the Proposed Action is not compliant to the Alaska SIP; and
- Potential for adverse air quality effects exist.

B-2. Water Quality

The impact levels used throughout this analysis are based on the four-level classification scheme for biological and physical resources outlined in the Cape Wind Energy Project Draft EIS (USDOI, MMS, 2008).

Level of Effects

Negligible

- No measurable impacts.

Minor

- Most impacts to water quality could be avoided with proper mitigation.
- If impacts occur, the water quality would recover completely without any mitigation once the impacting agent is eliminated.

Moderate

- Impacts to water quality are unavoidable.
- The viability of the water quality is not threatened although some impacts may be irreversible
- The water quality would recover completely if proper mitigation is applied during the life of the proposed action or proper remedial action is taken once the impacting agent is eliminated.

Major

- Impacts to water quality are unavoidable.
- The viability of the water quality may be threatened.
- The water quality would not fully recover even if proper mitigation is applied during the life of the proposed action or remedial action is taken once the impacting agent is eliminated.

B-3. Lower Trophics

Significance Threshold

An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

Level of Effects

Negligible:

- No measurable impacts. Population-level effects are not detectable.
- Localized, short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across multiple seasons.
- No population level impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- Population-level effects are not detectable.
- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across 1 year, or localized effects that are anticipated to persist for more than 1 year.
- Mitigation measures may be implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate:

- Disturbances could occur, but not on a scale resulting in population-level effects.
- Widespread annual or chronic disturbances or habitat effects could persist for more than 1 year and up to a decade.
- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short term and widespread, or long term and localized.

Major

- Disturbances occur that result in measurable population-level effects.
- Widespread seasonal, chronic, or effects from subsequent seasons are cumulative and are likely to persist for more than 1 decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

B-4. Fish

Significance Threshold

An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

Level of Effects

Negligible:

- No measurable impacts. Population-level effects are not detectable.

- Localized, short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across multiple seasons.
- No mortality or impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- Population-level effects are not detectable. Temporary, nonlethal adverse effects to some individuals.
- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across 1 year, or localized effects that are anticipated to persist for more than 1 year.
- Low mortality levels may occur, measurable in terms of individuals or <1% of the local post-breeding fish populations.
- Mitigation measures may be implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate:

- Mortalities or disturbances could occur, but not on a scale resulting in population-level effects.
- Widespread annual or chronic disturbances or habitat effects could persist for more than 1 year and up to a decade.
- Some mortality could occur but remains limited to a number of individuals insufficient to produce population-level effects.
- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short term and widespread, or long term and localized.

Major

- Mortalities or disturbances occur that have measureable and thus significant population-level effects.
- The action may adversely affect an endangered or threatened species or its habitat in a way that has been deemed to be critical under the Endangered Species Act of 1973.
- For fishes, the anticipated mortality is estimated or measured in terms of tens of thousands of individuals or >20% of a local breeding population and/or >5% of a regional population, which may produce short-term, localized, population-level effects.
- Widespread seasonal, chronic, or effects from subsequent seasons are cumulative and are likely to persist for more than 1 decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

B-5. Marine and Coastal Birds

Significance Threshold

Threatened and Endangered Species: An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status.

All other Marine and Coastal Birds: An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

Level of Effects

Negligible

- Localized short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across one year.
- No mortality is anticipated.
- Mitigation measures implemented fully and effectively or are not necessary.

Minor

- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across one year, or localized effects that are anticipated to persist for more than 1 year.
- Anticipated or potential mortality is estimated or measured in terms of individuals or <1% of the local post-breeding population.
- Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short-term and localized.

Moderate

- Widespread annual or chronic disturbances or habitat effects anticipated to persist for more than one year, but less than a decade.
- Anticipated or potential mortality is estimated or measured in terms of tens or low hundreds of individuals or <5% of the local post-breeding population, which may produce a short-term population-level effect.
- Mitigation measures are implemented for a small proportion of similar impacting activities, but more widespread implementation for similar activities likely would be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short-term but more widespread.

Major

- Widespread annual or chronic disturbance or habitat effect experienced during one season that would be anticipated to persist for a decade or longer.
- Anticipated or potential mortality is estimated or measured in terms of hundreds or thousands of individuals or <10% of the local post-breeding population, which could produce a long-term population-level effect.
- Mitigation measures are implemented for limited activities, but more widespread implementation for similar activities would be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

B-6. Marine Mammals

Significance Threshold

Threatened and Endangered Species: An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status.

All other Marine Mammals: An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

Level of Effects

Negligible:

- Localized, short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across multiple seasons. Temporary, nonlethal adverse effects to a few individuals are possible.
- May cause brief behavioral reactions such as temporary avoidances of or deflections around an area. No mortality or population-level effects are anticipated.
- The action is not anticipated to affect an endangered or threatened species or critical habitat under the Endangered Species Act of 1973.
- Mitigation measures are implemented fully and effectively or are not necessary.
- Unmitigatable or unavoidable adverse effects are difficult to measure or observe.

Minor:

- Localized, disturbance or habitat effects experienced during one season may accumulate across subsequent seasons, but not over one year.
- Temporary, nonlethal adverse effects to some individuals. May cause behavioral reactions such as avoidances of or deflections around a localized area. Mortality or population-level effects are not anticipated.
- The action may adversely affect an endangered or threatened species or critical habitat under the Endangered Species Act of 1973.
- Mitigation measures are fully implemented or are not necessary.
- Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate:

- Widespread annual or chronic disturbances or habitat effects could persist for more than 1 year and up to a decade.
- Mortalities or disturbances could occur, but would be below the estimated Potential Biological Removal[1] (PBR). Population-level effects are not anticipated.
- The action is likely to adversely affect an endangered or threatened species or modify critical habitat under the Endangered Species Act of 1973.
- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short term and widespread, or long term and localized.

Major

- Widespread seasonal or chronic effects from subsequent seasons are cumulative and are likely to persist for more than 1 decade.

- Mortalities or disturbances could occur at or above the estimated Potential Biological Removal (PBR), which could be a population-level effect.
- The action may adversely affect an endangered or threatened species or critical habitat under the Endangered Species Act of 1973, but would not necessarily jeopardize the continued existence of an ESA-listed species.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

B-7. Sociocultural Systems

Sociocultural systems include social organization, cultural values, and institutional arrangements. The level of significance effect would be reached at the high level. The level of effects used for sociocultural systems is as follows:

Significance Threshold

Chronic disruption of sociocultural systems occurs for a period of more than two years, with a tendency toward the displacement of existing social patterns.

Level of Effects

Negligible

- Periodic disruption of social organization, cultural values, and institutional arrangements occurs without displacement of existing social patterns.

Minor

- Disruption of social organization, cultural values, and institutional arrangements occurs for a period of less than one year without a tendency toward displacement of existing social patterns.

Moderate

- Chronic disruption of social organization, cultural values, and institutional arrangements occurs for a period of one to two years without a tendency toward displacement of existing social patterns.

Major

- Chronic disruption of social organization, cultural values, and institutional arrangements occurs for a period of more than two years with a tendency toward displacement of existing social patterns.

B-8. Subsistence

Significance Threshold

Adverse impacts which disrupt subsistence activities, or make subsistence resources unavailable, undesirable for use, or only available in greatly reduced numbers, for a substantial portion of a subsistence season for any community.

Level of Effects

Negligible

- Subsistence resources could be periodically affected with no apparent effect on subsistence harvests.

Minor

- Adverse impacts to subsistence activities are of an accidental and/or incidental nature and limited to a short-term.

Moderate

- Adverse impacts which disrupt subsistence activities, or make subsistence resources unavailable, undesirable for use, or only available in greatly reduced numbers, for a substantial portion of a subsistence season for any community.

Major

- Adverse impacts resulting in one or more important subsistence resources becoming unavailable, undesirable for use, or available only in greatly reduced numbers for any community.

B-9. Economy

The effects levels used for this analysis focus of the impacts associated with the proposed activities on socioeconomic systems, including employment, personal income, and revenues accruing to the local, state, and federal government.

Significance Threshold

Economic effects that would cause important and sweeping changes in the economic well-being of the residents or the area or region. Local employment is increased by 20% or more for at least 5 years.

Level of Effects

Negligible

- No measurable effects beyond short term, periodic impacts.

Minor

- Adverse impacts to the affected activity or community are unavoidable without proper mitigation.
- Impacts would not disrupt the normal or routine functions of the affected activity or community. Economic systems would be impacted for a period of up to 1 year.
- Once the impacting agent is eliminated, the affected activity or community will return to a condition with no measurable effects from the proposed action without any mitigation.

Moderate

- Impacts to the affected activity or community are unavoidable. Proper mitigation would reduce impacts substantially during the life of the project.

- Effects on economic systems would be unavoidable for a period longer than 1 year.
- The affected activity or community would have to adjust somewhat to account for disruptions due to impacts of the project.
- Once the impacting agent is eliminated, the affected activity or community will return to a condition with no measurable effects from the proposed action if proper remedial action is taken.

Major

- Impacts to affected community are unavoidable.
- Proper mitigation would reduce impacts somewhat during the life of the project.
- The affected activity or community would experience unavoidable disruptions to a degree beyond what is normal.
- Once the effect producing agent is eliminated, the affected activity or community may retain measurable effects of the proposed action indefinitely, even if remedial action is taken.

B-10. Public Health

Level of Effects

Negligible

- Infrequent minor acute health problems, not requiring medical attention.
- No measurable effects on normal or routine community functions.
- No long-term consequences for Public Health or well being.

Minor

- Public Health affected, but the effects would not disrupt normal or routine community functions for more than one week.
- Effects would not occur frequently.
- Effects would not affect large numbers of individuals.
- Effects could be avoided with proper mitigation.

Moderate

- Adverse effects on Public Health occurring for brief periods of time that do not result in or incrementally contribute to deaths or long-term disabilities.
- Effects can be prevented, minimized, or reversed with proper mitigation.
- Effects could occur more frequently than minor events, but would not be frequent.

Major

- Effects on Public Health would be unavoidable and would contribute to the development of disabilities, chronic health problems, or deaths.
- Alternatively, occurrence of minor health problems with epidemic frequency.
- Effective mitigation might minimize the adverse health outcomes but would not be expected to reverse or eliminate the problem.

B-11. Archaeology

Level of Effects

Negligible

- This category equates to No Historic Properties Affected as defined by 36 CFR 800.4(d)(1), the Code of Federal Regulations that promulgates Section 106 of the National Historic Preservation Act of 1966 as amended.

Minor

- This category equates to a finding of No Historic Properties Affected when the Agency identifies a potential conflict within an Area of Potential Effect due to the presence of a geomorphological feature and revises the plan to avoid it prior to consultation with the State Historic Preservation Officer.

Moderate

- This category equates to a finding of No Adverse Effect as defined by 36 CFR 800.5(b) when the SHPO identifies a conflict that requires a change in plan to avoid effects on an Historic Property as defined by 36 CFR 800.16(l)(1&2).

Major

- This category equates to a finding of Adverse Effect as defined by 36 CFR 800.5(C) requiring mitigation and a Memorandum of Agreement.

B-12. Reference

USDOI, MMS. 2008. Cape Wind Energy Project Draft Environmental Impact Statement. OCS EIS/EA MMS 2007-024. Herndon, VA: USDOI, MMS.

Notes:

[1] Marine mammal stock management is often based on a theoretical concept called Potential Biological Removal (PBR). The PBR is defined as the maximum number of animals, not including natural mortalities, which may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustained population. An optimum sustained population is defined as the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem. For example, as the bowhead whale population continues to grow, it continues to approach its carrying capacity. Contemporary population ecology suggests that at carrying capacity, a stable population is achieved when mortality equals productivity.
The PBR is calculated as the product of the minimum population estimate, one-half the theoretical productivity rate, and a "recovery factor". For example, the current estimate for the rate of increase for the bowhead whale stock (3.3%) should not be used as an estimate of maximum productivity because the population is currently being harvested and because the population has recovered to population levels where the growth is expected to be significantly less than maximum productivity. For the Western Arctic bowhead whale stock, the population size is estimated to be 9,472 (estimated in 2001), the theoretical productivity rate is 0.2, and the recovery factor is 0.5. The PBR is generally only used by the NMFS to guide decisions regarding the allowable removal of individual animals from a stock.
The conceptual PBR is used in the level of effects to identify a threshold whereby maximum population growth is sustained or not. If an anticipated effect could result in a loss of whales that exceeded the PBR, this would be inferred to be a population-level effect. In reality, given the conservative values used to derive the PBR, the loss of marine mammals that exceeded calculated PBR could be entirely consistent with a stable population.

APPENDIX C

2012 BEAUFORT SEA CUMULATIVE EFFECTS

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Appendix C

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C. CUMULATIVE EFFECTS

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.

The cumulative effects from biotic and abiotic factors that include past OCS activities plus current and reasonable foreseeable future activities in the Arctic OCS and adjacent areas were analyzed in the 2008 Arctic Multiple Sale Draft EIS (USDOI, MMS, 2008, pgs. 4-1 – 4-13). That analysis is incorporated by reference, summarized below, updated to consider the years 2012 through 2015 and reflect the anticipated activities which would occur during the period of the proposed action.

C-1. Cumulative Effects Defined

The Council on Environmental Quality (CEQ) Regulations defines cumulative effects at 40 CFR 1508:

> **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.
>
> **Sec. 1508.8 Effects.**
>
> "Effects" include:
>
> (a) Direct effects, which are caused by the action and occur at the same time and place.
>
> (b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.
>
> Effects and impacts as used in these regulations are synonymous. Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.

C-2. Impact Sources

The main sources of introduced activities contributing to cumulative impacts affecting the Alaska OCS during the duration of the proposed activity are: (1) marine vessel traffic; (2) aircraft traffic; (3) oil and gas activities in federal and state waters; and (4) miscellaneous associated activities.

C-2.1. Marine Vessel Traffic

Marine vessels are expected to be the greatest contributors of anthropogenic sound introduced to the Beaufort Sea during the timeframe of the proposed activities. Sound levels and frequency characteristics of vessel sound energy underwater generally are related to vessel size and speed. Larger vessels generally emit more sound than smaller vessels. Vessels underway with a full load, or vessels pushing or towing loaded non-powered vessels, generate more sound than unladen vessels. While the primary sources of marine vessel sounds are propulsion engines, generators, bearings, and other mechanical components which transmit sound into the water through the vessel hull, the highest level of sound pressure introduced into the water from an underway marine vessel originates from cavitation associated with spinning propellers. Fathometers and other vessel navigation and operations equipment also generate underwater sounds.

Marine vessel traffic in the project area, other than that associated with the proposed activities, is expected to include vessels used for fishing and hunting, icebreakers, Coast Guard vessels, supply ships and barges with their associated towing vessels. During ice-free months (June- October), barges are used for supplying local communities, Alaskan Native villages, and the North Slope oil-industry complex at Prudhoe Bay with larger items that cannot be transported by commercial air carriers. Usually, one large fuel barge and one supply barge visit the coastal villages each year during the ice-free period.

C-2.2. Aircraft Traffic

Air traffic has increased in recent years, mostly in response to increased activity in academic and commercial ventures. These activities will continue to be an aspect of anthropogenic effects to the Arctic environment. Categories of aircraft traffic in the Arctic include both fixed wing and helicopter flights for the pursuit of various research programs and marine mammal monitoring, cargo flights for supplies to villages and commercial ventures including oil and gas related activities, regional and inter-village transport of passengers, air-ambulance and search and rescue emergency flights, general aviation for purpose of sport hunting and fishing or flightseeing activities, and multi-governmental military flights.

Specific activities that could affect an increase in air traffic and air emissions and lead to increased effects on native subsistence hunting activities and marine mammal and bird behavior over the proposed project area include the helicopter flights for transport of crews and supplies to and from the rigs and support vessels for oil and gas related activities, and flights conducted for marine mammal observations such as those required by BOWFEST, COMIDA, and other reasonably foreseeable research activities.

C-2.3. Oil and Gas Related Activities

Reasonably foreseeable future activities associated with current and ongoing oil and gas projects, including marine sea lifts and activities at West Dock in Prudhoe Bay are expected to remain at the current level for the duration of the proposed action. Recent trends of development-related vessel traffic indicate that traffic begins in July, peaks in August, and rapidly declines to a sporadic level by October (Shell, 2011b: Table 4.2-2.)

C-3. Miscellaneous Associated Activities

C-3.1. Other Vessel Traffic

Overall vessel traffic within the proposed exploration drilling area is expected to be limited and consistent with the level of traffic observed in recent years. Most vessel traffic is expected to consist of barges, with their associated towing / pushing vessels, transiting through the area within 12.5 mi (20 km) off the coast, during open water conditions (Shell, 2011b: 4-131). 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, 2005)

C-3.2. Scientific Research

A sizable scientific research effort conducted by governmental, non-governmental and educational organizations operating from marine vessels and aircraft occurs every year in the Beaufort Sea. The programs conducted by these organizations are expected to continue through the period of the proposed action. Marine environmental baseline studies include deployment of oceanographic equipment for collecting water and sediment samples, and use of nets and trawls for collection of phytoplankton, zooplankton, benthic invertebrate, pelagic invertebrate, and fish sampling. Also continuing will be observations of marine and coastal birds and marine mammals using standardized survey transect methods and passive acoustic monitoring. Metocean buoy and acoustic wave and current meters will continue to be deployed for studies of physical oceanography and climate studies. Previous environmental assessments, such as the environmental assessment for Shell's Beaufort Sea marine research program, describe techniques used and the effects of these programs in detail (BOEMRE, 2010, OCS EIS/EA MMS 2010-022).

Ongoing activities in the general Beaufort and Chukchi Sea regions also include the multinational efforts carried out by the Pacific Arctic Group (PAG). The PAG is a group of institutes having a Pacific perspective on Arctic science. 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, but not all, of these activities could coincide in time and space with the proposed exploration plan activities. The Diversified Biological Observatory is is a multi-national cooperative effort coordinated by the PAG, with the USA, Canada, Russia, Japan, China, and Korea contributing cruise data from past, ongoing, and planned research programs. Programmatical sampling includes continuation of collections from prior and existing research stations, including BOEMRE and MMS funded projects. Focus is on four geographical research areas within the Bering Sea, Bering Strait, Chukchi Sea, and Beaufort Sea. Science includes synthesis of multi-disciplinary studies 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 observations. (http://pag.arcticportal.org/)

C-3.3. Reasonable and Foreseeable Planned Activities

Shell Chukchi Sea Proposed Exploration Plan beginning in 2012

Shell has proposed multiple-well exploration drilling on leases in the Chukchi Sea during the period of the proposed activities in the Beaufort Sea. Shell proposes using dedicated and independent drilling and support vessels for the Chukchi Sea and Beaufort Sea operations (with some commonly shared secondary oil spill response resources). Weather, ice, and other environmental conditions at the specific locations would ultimately dictate the sequence of Shell's operations. The proposed Chukchi Sea exploration program envisions "drilling up to six exploration wells in one prospect located 64 miles (103km) offshore and 410 (600 km) west of the Torpedo and Sivulliq prospects in the Beaufort Sea" (Shell, 2011b: pp. 4-128).

The proposed Beaufort Sea and Chukchi Sea project areas are more than 400 mi apart. Discharges and emissions associated with drilling at the two project areas would not overlap in space. Sound generated during transition from the Beaufort Sea to the Chukchi Sea (site-abandonment operations, transit, MLC construction, setting anchors, and drilling) would be continuous at varying sound levels but the sound generated from the various project stages would not overlap in space. Because of the travel time for migrating species between the locations of the two operations, some individual animals could be exposed to sound from both drilling operations.

Bowhead Whale Feeding Ecology Study (BOWFEST). August – September 2012. NOAA Fisheries and National Marine Mammal Laboratory. The BOWFEST (NMML, 2011a) is a multiyear BOEMRE-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. Aerial surveys conducted by the National Marine Mammal Laboratory (NMML), acoustic monitoring, and boat-based surveys provide information on the spatial and temporal distribution of bowhead whales in the study area. Oceanographic sampling helps identify sources of zooplankton prey available to whales on the shelf and the association of this prey with physical characteristics (hydrography, currents) which may affect mechanisms of plankton aggregation. Results of this research program may help explain summer occurrences of bowheads in the Western Beaufort Sea (U.S. waters), well west of the typical summer feeding aggregations in the Canadian Beaufort Sea. Increased understanding of bowhead behavior and distribution is needed to minimize potential impacts from petroleum development activities.

Chukchi Sea Acoustic Oceonographic Zooplankton (CHAOZ). July – September, 2012. 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 three field seasons, 2010-2012. The objective of the research is to conduct passive acoustic monitoring studies and oceanographic sampling to determine abundance, migratory patterns, acoustic ecology, and foraging ecology of cetaceans and their prey. 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. Research transects are to be carried out from Wainwright, Icy Cape, Point Lay, Cape Lisburne, and Point Hope into the Chukchi and Bering Seas for deployment of accoustic and ice buoys, CTD casts, zooplankton sampling, and collection of marine mammal observation data.

Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA). Mid-June - October, 2012. NOAA Fisheries and National Marine Mammal Laboratory. NE Chukchi Sea aerial cetacean survey. COMIDA (NMML, 2011b) is a project in the northeastern Chukchi Sea designed to understand the distribution and relative abundance of cetaceans using aerial surveys during the open-water (ice-free) months, from mid-June to the end of October. Surveys follow standard line-transect protocols. Flights begin and end in Barrow, AK. The science team flies in either a De Havilland Twin Otter Series 300 or Aero Commander 690A fixed wing aircraft at altitudes between 1000-1500' and 100-110kts speed. Surveys are flown every day, weather permitting.

C-3.4. Climate Change and Ocean Acidification

Climate change is an ongoing factor in the consideration of cumulative environmental effects on the Arctic region (NOAA, 2011). It has been implicated in changing weather patterns, changes in the classification and seasonality of ice cover, and the timing and duration of phytoplankton blooms in the Beaufort 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, 2007). This phenomena is often called a sister problem to climate change, because they are both attributed to human activities that have resulted in increased CO_2 levels in the atmosphere. Ocean acidification in high latitude seas is happening at a more advanced rate compared to other areas of the ocean. The capacity of the Arctic Ocean to uptake CO_2 is expected to increase in response to increased levels as a result of climate change (Bates and Mathis, 2009). This is due to the loss of sea ice that increases the open water surface area of the Arctic seas. Exposure of cooler surface water lowers the solubility, or saturation of calcium carbonate within the water, which in turn leads to lower available levels of the minerals needed by shell-producing organisms (Fabry et al., 2009).

C-4. References

Arctic Marine Shipping Assessment. 2005. http://www.arctic.gov/publications/AMSA/current_marine_use.pdf

Bates, N.R., and Mathis, J.T., 2009, The Arctic Ocean marine carbon cycle; evaluation of air-sea CO2 exchanges, ocean acidification impacts and potential feedbacks, *Biogeosciences Discussions 6.* pp. 6695-6747. http://www.biogeosciences-discuss.net/6/6695/2009/bgd-6-6695-2009-print.pdf

BOEMRE 2012 Shell Revised Exploration Plan for the Chukchi Sea http://alaska.boemre.gov/ref/ProjectHistory/2012_Shell_CK/2012x_.HTM

CHAOZ (Chukchi Sea Acoustic Oceanographic Zooplankton) http://alaska.boemre.gov/ess/ongoingStudies/Ongoing_studies.pdf

COMIDA. 2011. (Chukchi Offshore Monitoring in Drilling Area) http://alaska.boemre.gov/ess/ongoingStudies/Ongoing_studies.pdf

Fabry, V.J.; McClintock, J.B.; Mathis, J.T.; Grebmeier, J.M., 2009, Ocean acidification at high latitudes: the bellwether. *Oceanography, 22*(4) 160-171.

Intergovernmental Panel on Climate Change (IPCC) 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp. http://www.ipcc.ch/

NMML (National Marine Mammal Laboratory). 2011a. Cetacean Assessment & Ecology Program BOWFEST Survey Project: Preliminary Data. http://www.afsc.noaa.gov/NMML/cetacean/bwasp/flights_BOWFEST.php

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APPENDIX D
AIR QUALITY

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Appendix D

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D. AIR QUALITY

The information provided in this appendix supplements the discussion of air quality conditions and impacts contained in the Environmental Assessment (EA) of the Shell Offshore Inc. (Shell) Revised Exploration Plan (EP) Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska, (2011 Camden Bay EP). Information provided in several sections of the EA contributes to the overall assessment of air quality, including discussions of climate, meteorology, and the impact of oil spills on local air quality. The location and content of the relevant sections are summarized in Table D-1.

Table D-1 Summary of sections in the EA providing information relevant to the overall assessment of air quality conditions and impacts.

EA Section, Title, and Summary
1.3 Statutory Framework *1.3.5 Clean Air Act (1990 CAA)* History of the CAA and an overview of air operating permits required for stationary pollutant sources, particularly for sources on the OCS.
2.3 Description of Alternative 2 – The Proposed Action *2.3.1 Overview*
Status of the air quality permits required for the *Kulluk* and *Discoverer* along with the other major permits required before the Proposed Action can proceed.
2.3.4 Drillship, Support Vessels, and Aircraft Physical description of the drillships and marine vessels proposed for the EP; includes aircraft.
2.3.6 Emissions Description of the types of emissions expected from the drillships, *Kulluk* and *Discoverer*, and the role of the support vessels; description of the emission reduction measures proposed for each of the drillships, including BACT and ORR.
3.0 Affected Environment *3.1.1 Climate Change* Overview of past, current, and future changes in the climate over the Arctic that could impact several local natural resources, including air quality.
3.1.2 Expected Weather Conditions at the Drill Sites
Description of the seasonal weather conditions expected at the proposed drill sites; includes wind, precipitation, and temperature information.
3.2.1 Air Quality Description of the existing local air quality conditions, including the adjacent onshore area; description of the OCS air regulations relevant to the Proposed Action
4.2 Alternative 2 – The Proposed Action *4.2.1 Air Quality*
Evaluation of the direct and indirect effects of the Proposed Action on air quality conditions; includes the emission inventories for the *Kulluk* and the *Discoverer*; includes a discussion of GHG and the evaluation of potential cumulative impacts.
5.7 Large Oil Spill Effects Air Quality section describes the potential air quality impacts from a large oil spill.
5.8 Very Large Oil Spill Effects
Air Quality section briefly describes the potential air quality impacts from a very large oil spill.

Notes: 1990 CAA is the Clean Air Act Amendments of 1990.
OCS refers to the Alaskan Outer Continental Shelf.
EP refers to the Shell Offshore Inc. (Shell) Revised Exploration Plan (EP) Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska
BACT is Best Available Control Technology
ORR is owner-requested restrictions to emissions
GHG refers to greenhouse gases.

In addition to the information provided in this EA, the Shell Offshore Inc. (Shell) *Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska*, (2011 Camden Bay EP) provides an examination of air quality conditions and impacts. The analysis is supplemented by information in the *Environmental Impact Analysis (EIA)* (2011 Camden Bay EIA), attached to the EP as Appendix F, and provides a thorough air quality analysis. Further, information regarding the inventory of emissions, computer modeling, and results of the ambient air analysis is included in the air operating permits submitted by Shell to Environmental Protection Agency (EPA) Region 10 in Seattle. The review of air quality impacts in this EA examined and relied on the information in the Shell documents, which are summarized below in Table D-2 through Table D-4. Table D-2 summarizes Shell documentation that is relevant to the air quality assessment.

Table D-2 Summary of Shell documents providing information relevant to the overall assessment of air quality conditions and impacts.

Shell Exploratory Plan and EIA Documents and Relevant Sections	
Shell Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Beaufort Sea, Alaska, May 2011 (2011 Camden Bay EP)	
The main body of the 2011 Camden Bay EP provides air quality information in two sections, Section 7.0 and Section 13. In Section 7.0, Shell presents the physical characteristics of the sources proposed for the EP, provides the emission limitation measures, discloses the annual emission inventories, and provides the results of the ambient air analysis for both the *Kulluk* and the *Discoverer*. Section 13.0 provides the same type of emission information as given in Section 7.0, but for the support vessels and aircraft.	
Section 7.0	Air Emissions Information, including distance to shore
Section 13.0	Support Vessels and Aircraft Information
Table 7.a-2	Projected Hourly Emissions from the *Kulluk* (Individual Source) and Support Vessels (Source Groups)
Table 7.a-3	Vessel Source Group Annual Maximum Emissions [*Kulluk*]
Table 7.a-8	Annual Potentials to Emit for the *Discoverer* Emission Units and Associated Fleet
Table 7.e-1	BOEMRE Exemption Results
Table 7.f-1	Summary of Maximum Estimated Concentrations
Table 7.f-2	Summary of Maximum Impacts at the Nearest Villages on the Beaufort Sea Coast
Table 7.f-3	Summary of Impacts on Air Quality
Table 7.f-4	Summary of Maximum Modeled Impacts – Beaufort Sea
Table 13.a-3	Aircraft Flights and Frequency
Table 13.b-1	*Kulluk* Support Vessel Source Group Annual Maximum Emissions
Table 13.b-2	*Discoverer* Support Vessel Source Group Annual Maximum Emissions
Appendix F	Environmental Impact Analysis (EIA) (see below)
Shell Environmental Impact Analysis (EIA) Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Beaufort Sea, Alaska, May 2011 (2011 Camden Bay EIA)	
In addition to the sections listed below, an evaluation of air emissions on other natural resource categories, such as sea ice, water quality, fish, birds, mammals, whales, and lower trophic organisms, are included in the EIA:	
Section 1.5.6	Clean Air Act
Section 2.8	Air Emissions
Section 3.1	Climate and Meteorology, including Section 3.1.7, Air Quality
Section 4.1.2	Air Quality
Section 4.2.3	Cumulative Impacts, Air Quality
Section 4.4	Analysis of the Probability of a Large or Very large Oil Spill and Potential Impacts; subsection, Impacts of a Very Large Oil Spill (discusses air quality)
Table 2.2-6	Aircraft Flights and Frequency
Table 2.8-1	*Kulluk* Annual Potentials to Emit
Table 2.8-2	*Discoverer* Annual Potentials to Emit
Table 3.1.7-1	National and Alaska AAQS and Representative Shoreline Baseline Concentrations
Table 3.1.7-2	Reported Air Quality Values – Badami Monitoring Station

Shell proposes two potential drill platforms for the EP, each with differing emissions signatures. Table D-3 summarizes the Drill Vessel *Kulluk*'s air quality documentation. *Kulluk* is not self propelled.

Table D-3 Kulluk Air Operating Permit Application and Associated Documents

Air Sciences Inc., *Shell Alaska Outer Continental Shelf (OCS) Beaufort and Chukchi Seas Exploratory Drilling Program: Kulluk Floating Drilling Platform – Air Quality Impact Modeling Protocol*, January 20, 2010; including Appendix A, the emission calculations. This document is the air operating permit modeling protocol for the emission inventory and ambient air analysis for the *Kulluk* in both the Chukchi and Beaufort seas. Also provided is a photograph of the floating platform. None of the tables from this document were used because the data was later updated.
Air Sciences Inc., *Supplement to EPA OCS Operating Permit Application – Shell Beaufort Sea, Alaska Exploratory Drilling Program: Conical Drilling Unit Kulluk*, February 28, 2011 Tables from this permit were not used because the data was updated. See below.
Air Sciences Inc., *OCS Permit Applications Conical Drilling Unit Kulluk Beaufort Sea*, March 29, 2011 The original permit, dated February 28, 2011, was declared incomplete by U.S. Environmental Protection Agency (EPA) and this supplement was submitted. Shell is awaiting a reply to this submittal. The permit must be approved as a condition of the approval of the EA.
Air Sciences Inc., *Engineering Calculations,* April 28, 2011 This is an EXCEL spreadsheet provided to BOEMRE, see tab [BOEMRE_Tables], [GHGTable], [SCR-NH_3 emis]

The drill ship M/V *Discoverer* may be used in lieu of the *Kulluck*. Table D-4 summarizes the Drill Ship *Discoverer*'s air quality documentation.

Table D-4 *Discoverer* Permit and Associated Documents

ENVIRON, *Outer Continental Shelf Pre-Construction Air Permit Application, Frontier Discoverer Beaufort Sea Exploration Drilling Program*, prepared for Shell Offshore, Inc., Revised January 2010		
This is the revised permit. Emissions of at least one pollutant were shown to be greater than 250 tons per year, requiring a Prevention of Significant Deterioration (PSD) permit application.		
EPA, *Statement of Basis for Proposed OCS PSD Permit No. R10OCS/PSD-AK-2010-01*, February 17, 2010		
EPA, *OCS PSD Permit to Construct*, Permit Nbr: R10OCS/PSD-AK-2010-01, Issuance Date: April 9, 2010; this permit is for the *Discoverer* in the Beaufort Sea.		
Air Sciences Inc., *Discoverer Drillship Impact Evaluation for SO_2 and NO_2 using AERMOD – Chukchi and Beaufort Seas, Shell Alaska Exploratory Drilling Program*, March 18, 2011; including Attachment A, the emission calculations; this would be considered the modeling protocol for the *Discoverer* air quality analysis.		
Based on comments on the previous air operating permit submitted for the *Discoverer*, Shell prepared a supplemental analysis of the new one-hour SO_2 and NO_2 standards.		
	Table 2-6	Annual Maximum Emissions for Each Source Group
	Table 3-9	Summary of maximum Modeled Impacts – Beaufort Sea [1-hour NO_2 and 1-hour SO_2 only]
Air Sciences Inc., Technical Memorandum to Shell, *AERMOD Air Quality Impact Analysis for NO_2, SO_2, $PM_{2.5}$, PM_{10}, CO, and NH_3 – Discoverer Drillship*, May 19, 2011; including Attachment A, the emission calculations		
This technical memorandum is a supplement to the March 18 and April 29, 2011, AERMOD Impact Reports. The memorandum provides updated ambient air analysis data for the *Discoverer* for both the Chukchi and Beaufort seas. The permit application was under remand at the time of the preparation of this EA. The permit must be approved as a condition of the approval of the EA.		
	Table 2-6 (Revised)	Annual Maximum Emissions for Each Source Group (*Discoverer*)
	Table 1	Beaufort Sea Background Data Sources and use of Background Data
	Table 3	Summary of Maximum Modeled Impacts – Beaufort Sea
	Table 5	Summary of maximum Impacts at the Nearest Villages on the Beaufort Coast

D-1. Regulatory Overview

The outside air, referred to in the regulations as ambient air, becomes polluted when harmful gases and particles build up in concentrations sufficient to directly or in indirectly cause measurable damage to human health, wildlife, or property (Monks, Granier, & Stohl et al., 2009). Thus, emissions of pollutants and the buildup of pollutant concentrations are regulated under local, state, and federal regulations.

This assessment of air quality is prepared pursuant to the National Environmental Policy Act (NEPA, 1969) and is regulated primarily by the requirements of the Clean Air Act (CAA, 1990). The ambient air in Alaska is further regulated through the state's Air Quality Management Program contained in the State Implementation Plan (ADEC, 2010c). When a proposed federal action is expected to cause emissions of any of the pollutants regulated under the CAA, the environmental review must contain an assessment of air quality. The assessment should include a description of existing conditions of sufficient scope and depth to discern the baseline characteristics of air quality over the project area. The assessment should also include an analytical evaluation of the projected emissions under each alternative considered in the environmental assessment. The project in the Beaufort Sea proposes the operation of a drillship and various support vessels, which require burning of fossil fuels to operate. Operation of the ships' engines will create emissions of regulated pollutants, thus this environmental review requires consideration of emissions from the proposed project.

The condition of air quality is measured and reported in the environmental review relative to established criteria, or standards, that define the normal concentration of specific pollutants in the ambient air. Under the CAA, the Environmental Protection Agency (EPA) is responsible for establishing and maintaining the National Ambient Air Quality Standards (NAAQS) (National Primary and Secondary Ambient Air Quality Standards, 2010), which limit concentrations of the following potentially harmful air pollutants, known as the criteria pollutants:

- Carbon monoxide (CO)
- Lead (Pb)
- Nitrogen dioxide (NO_2)

- Ozone
- Particulate matter ($PM_{2.5}$ and PM_{10})
- Sulfur dioxide (SO_2)

For each of these pollutants, the EPA establishes primary standards intended to protect public health, and secondary standards for the protection of other aspects of public welfare, such as preventing materials damage, preventing crop and vegetation damage, and assuring good visibility. Each state establishes standards similar to the NAAQS and publishes the standards in the State Implementation Plan (SIP). State standards may be more stringent than the NAAQS and could include additional pollutants. The Alaska Department of Environmental Conservation (ADEC) established ambient air quality standards for Alaska, which are published in the Alaska SIP (ADEC State Implementation Plan, 2010). A summary of the Alaska AAQS and the NAAQS is provided in Table D-5. The table defines the standards in terms of pollutant concentrations, stated either in parts per million (ppm), micrograms per cubic meter ($\mu g/m^3$), or in milligrams per cubic meter (mg/m^3).

Table D-5 Alaska and National Ambient Air Quality Standards.

Pollutant	Averaging Period	Alaska AAQS	National NAAQS (Primary and/or Secondary Standards)	
Carbon Monoxide (CO)	8-hour	10 mg/m^3	10 mg/m^3	Primary Only
	1-hour	40 mg/m^3	40 mg/m^3	Primary Only
Lead	Rolling 3-month	0.15 $\mu g/m^3$	0.15 $\mu g/m^3$ (2008 Standard)	Both
	Calendar Quarter	Not Applicable	1.5 $\mu g/m^3$ (1978 Standard)	Both
Nitrogen Dioxide (NO_2)	Annual	100 $\mu g/m^3$	100 $\mu g/m^3$	Both
	1-hour	NA	0.1 ppm (2010 Standard)	Primary Only
Ozone	8-hour (2008 Standard)	0.075 ppm	0.075 ppm	Both
	8-hour (1997 Standard)	Not Applicable	0.08 ppm	Both
	1-hour	Not Applicable	0.12 ppm	Both
Particulate Matter ($PM_{2.5}$)	Annual	15.0 $\mu g/m^3$	15.0 $\mu g/m^3$	Both
	24-hour	35 $\mu g/m^3$	35 $\mu g/m^3$ (2006 Standard)	Both
Particulate Matter (PM_{10})	24-hour	150 $\mu g/m^3$	150 $\mu g/m^3$	Both
Sulfur Dioxide (SO_2)	Annual	80 $\mu g/m^3$	80 $\mu g/m^3$	Primary Only
	24-hr	365 $\mu g/m^3$	365 $\mu g/m^3$	Primary Only
	30-minute	50 $\mu g/m^3$	Not Applicable	
	3-hour	1300 $\mu g/m^3$	1300 $\mu g/m^3$	Secondary Only
	1-hour	Not Applicable	0.075 ppm (2010 Standard)	Primary Only
Ammonia (NH_3)	8-hour	2.1 mg/m^3	Not Applicable	

Sources: Alaska Department of Environmental Conservation (ADEC). Ambient Air Quality Standards. 18 ACC §50.010, 2010.
EPA. National Primary and Secondary Ambient Air Quality Standards. 40 CFR Part 50.4 – 50.13.

Each air quality standard is subject to limitations, such as restrictions on how many times during a calendar year a standard may be violated and still comply with the standard. These limitations are provided in the federal regulations at 40 CFR Part 50.4-50.13, *National Ambient Air Quality Standards*; for the State of Alaska, the limitations are stated in the Alaska Administrative Code (AAC), Title 18, Chapter 50, *Air Quality Control*. Several of the NAAQS have been recently established or revised. The relevant EPA code revisions are listed in the following sections that include explanations of the revisions and implications to the Proposed Action.

D-1.1. Lead

The EPA updated the lead standard in 2008 to add a rolling three-month average of 0.15µg/m^3 (73 *FR* 66964, 11/12/2008). The existing 1978 standard, 1.5 µg/m^3 as a quarterly average, remains in effect for some areas previously designated nonattainment for the older standard, and until the appropriate SIPS to attain or maintain the 2008 standard are approved. The 1978 quarterly average is not listed in the Alaska SIP as a standard; however, ADEC submitted a request in April 2010 to amend Alaska's State Air Quality Control Plan, as part of the SIP, to adopt the NAAQS for lead (ozone, and $PM_{2.5}$ are also included); approval of the Alaska amendment by EPA is pending (ADEC, 2010c).

Lead is not a pollutant considered in the air quality impacts analysis for this EA because lead is not a pollutant resulting from burning diesel fuel. The criteria pollutants of concern for the Proposed Action are CO, PM, NO_X, and SO_X.

D-1.2. Nitrogen Dioxide (NO_2)

The EPA final rule for the new one-hour standard was published in February 2010 (75 *FR* 6474, 2/9/2010). The annual average concentration standard for nitrogen dioxide is sometimes stated as 0.053 ppm (40 CFR Part 50.22(c)). For the purpose of the emission inventory in this analysis, emissions of nitrogen oxides (NO_X) are conservatively considered to be entirely composed of NO_2. Shell demonstrated in the ambient air analysis included the operating permits that emissions from the Proposed Action would comply with this new standard (Shell, 2011b).

D-1.3. Ozone

The EPA has made several adjustments in recent years to the standard for ozone. The EPA proposed a revision to the 2008 eight-hour standard and has delayed the final rule until July 29, 2011. The final rule is proposed to be an annual standard within the range of 0.060 to 0.070 ppm (73 *FR* 16436, 3/28/2008; 75 *FR* 2938, 1/19/2010; Kelly, 2010). The ADEC submitted a request in April 2010 to amend Alaska's State Air Quality Control Plan, as part of the SIP, to adopt the NAAQS for ozone (lead and $PM_{2.5}$ are also included). Approval by EPA is pending. Ozone is not specifically addressed in the air quality assessment because ozone is not a pollutant emitted directly from any source. Rather, ozone is formed in the atmosphere in the presence of precursor pollutants, nitrogen oxides (NO_X) and volatile organic compounds (VOC) and sunlight. Thus the levels of NO_X and VOC are an indication of potential ozone development. The air quality analysis for the Proposed Action includes the projected emissions of NO_X and VOC (Shell, 2011a; Shell, 2011d).

D-1.4. Particulate Matter (PM_{10} and $PM_{2.5}$)

The newest standard for $PM_{2.5}$ is the 24-hour average concentration set at 35 µg/m^3 (71 *FR* 61144, 10/17/2006). The ADEC submitted a request in April 2010 to amend Alaska's State Air Quality Control Plan, as part of the SIP, to adopt the NAAQS for $PM_{2.5}$ (lead and ozone are also included). Approval by EPA is pending. Shell demonstrated in the ambient air analysis included the operating permits that emissions from the Proposed Action would comply with this new standard (Shell, 2011a; Shell, 2011d).

D-1.5. Sulfur Dioxide (SO_2)

The EPA updated the SO_2 standards to include a primary one-hour average of 0.75 ppm; at the same time EPA revoked both the primary annual and 24-hour standards, effective August 23, 2010 (75 *FR* 35520, 6/22/2010). However, the two revoked standards will stay in effect for an interim time until the required SIPs are approved, and also for one year after the new designations are made. This will serve the anti-backsliding goals of the CAA. The three-hour standard for SO_2 is sometimes stated as 0.5 ppm (40 CFR Part 50.59a). For the purpose of the emission inventory in this analysis, emissions of sulfur oxides (SO_X) are conservatively considered to be entirely composed of SO_2. Shell demonstrated in the ambient air analysis included the operating permits that emissions from the Proposed Action would comply with this new standard (Shell, 2011a; Shell, 2011d).

D-1.6. OCS Air Regulations

Sources of emission on the Alaskan OCS must be evaluated against the requirements of 40 CFR Part 55, referred to as the OCS Air Regulations. The OCS Air Regulations establish the air pollution control requirements for OCS sources and procedures for implementation and enforcement of the requirement, consistent with Section 328(a)(1) of the CAA.

For OCS facilities located within 25 miles (40 km) of the state seaward boundary, the air quality regulations would be the same as if the facility was located onshore and thus subject to the ADEC air quality regulations, published at 18 AAC 50. The extent of the 25-mile boundary is illustrated in Figure D-1, showing the proposed drill sites are well within the 25-mile boundary.

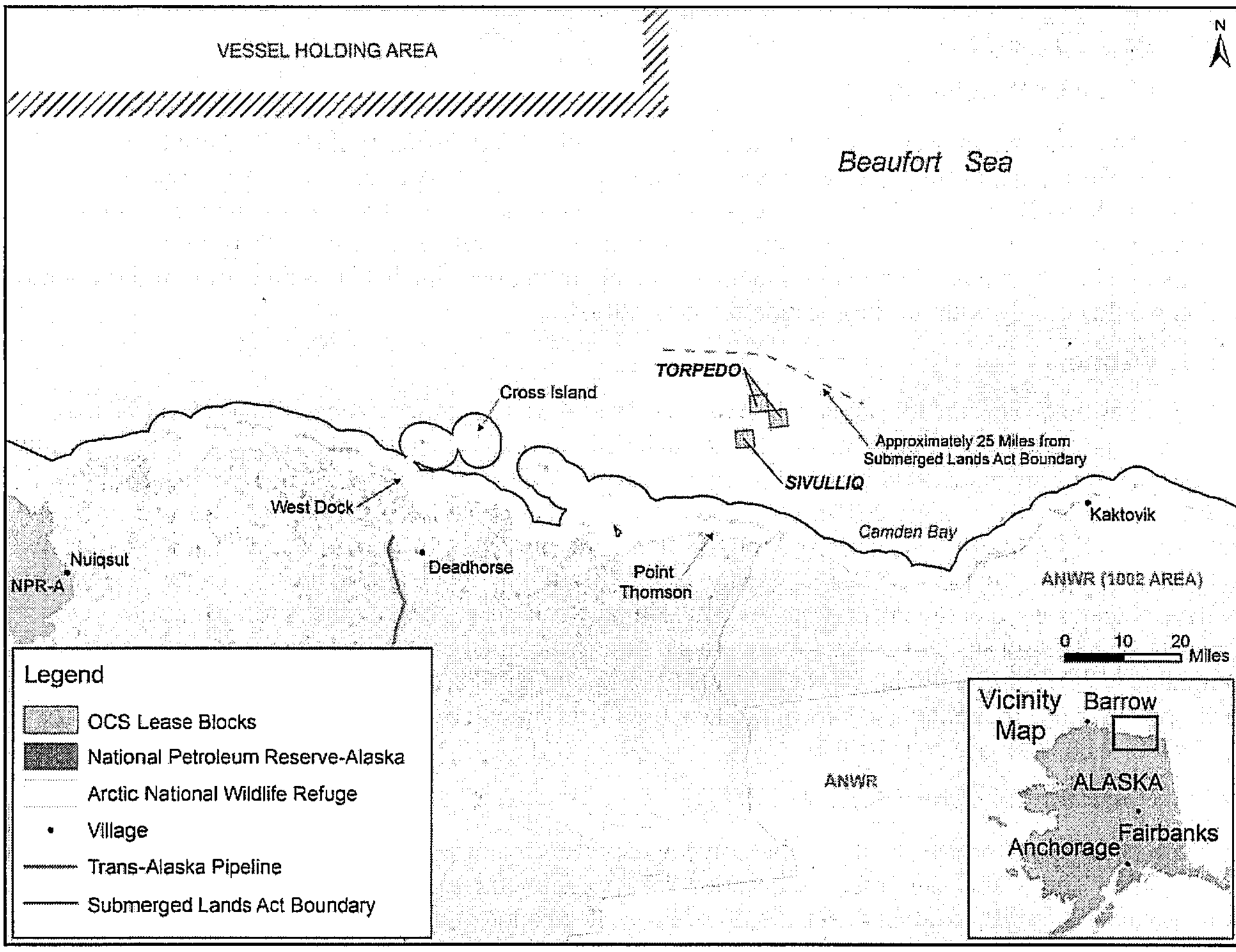

Figure D-1 Map of the project area showing the extent of the 25-mile boundary for 40 CFR Part 55 Air Regulations.

D-1.7. Definitions

The following definitions are developed from 40 CFR Part 55.2, and are modified as they would apply directly to the Alaskan OCS in the Beaufort and Chukchi seas. The definitions are helpful in describing the methods and procedures of the air quality assessment.

Attainment area – a geographical area where EPA defines the air quality as a clean resource, and pollutant concentrations are as good as or better than the NAAQS or the Alaska AAQS. An area may be an attainment area for one pollutant and a nonattainment area for others.

BACT – Best Available Control Technology; any Prevention of Significant Deterioration (PSD) permit would be required to use BACT to reduce emissions.

Corresponding Onshore Area (COA) – the onshore area that is geographically closest to the OCS source, and applies when the proposed location of the source would be located within 25 miles of Alaska's three-mile seaward boundary.

De minimis – being so small as to be negligible, as when defined relative to the CAA General Conformity Rule (40 CFR part 93.153(c)). A Latin expression meaning "little things."

Design concentration – the translation of the emission inventory to pollutant concentrations, with the background concentrations added to the project-related concentration values to disclose total maximum concentrations.

Exploratory OCS source – a temporary source on the Alaskan OCS conducted for the sole purpose of gathering information. This includes an EP intended to determine the characteristics of the reservoir and may involve the extraction of oil and gas.

Federal waters – those waters located outside the three-mile Submerged Lands Act boundary.

Major stationary source is defined distinctly depending on the location of the source and the attainment status of the associated COA.

1. PSD rules apply on the state and federal level, only in an attainment area for sources with the potential to emit (PTE) of 250 tons per year or more, and only for emissions of NO_2, PM_{10}, and SO_2 (40 CFR Part 52.21(b)(1)(a)). A source that is major for VOC or NO_X shall be considered major for ozone.
2. Title V rules for the OCS apply regardless of the attainment status, and apply on the state and federal level. Fugitive emissions are not subject to Title V for OCS sources. A major source under Title V has the PTE 100 tons per year of any regulated pollutant. Regulated pollutants include all the criteria pollutants regulated under the NAAQS; and the Alaska AAQS adds reduced sulfur compounds and ammonia. Precursor emissions of VOC are also included because VOC is regulated under the general conformity rule (40 CFR Part 93), and VOC are related to the definition for a major source of ozone in 40 CFR Part 52.21.

New OCS source – an Alaskan OCS source not already existing and does not include an action proposing modifications for an existing source. The following regulations apply to new OCS stationary sources:

1. Prevention of Significant Deterioration (PSD) rules apply under 40 CFR 52.21, when the source is located beyond 25 miles of Alaska's three-mile seaward boundary, and applies inside the boundary when PSD rules already apply on the COA. The PSD rules apply when the COA is designated as attainment; otherwise NSR rules would apply to nonattainment and maintenance areas. The North Slope Borough of Alaska is designated as attainment and is subject to the PSD rules when the source has the PTE 250 tons per year or more. Alaska adopts the rules in 40 CFR Part 52, Subpart C, Air Programs, according to Class designation; and the North Slope Borough is a Class II area. Any PSD permits must be approved and issued before construction may begin on the project; thus PSD permits are also referred to as pre-construction air permits.
2. Title V of the CAA for the OCS: The federal Title V rule applies to the OCS under 40 CFR 71 (outside the OCS Part 70 applies for Title V permits), whether or not the source is located beyond 25 miles of Alaska's three-mile seaward boundary, and applies inside the boundary where the Title V rule already applies on the COA. Title V air permits are issued by states under 40 CFR Part 70 and EPA regional offices issue Title V permits under 40 CFR Part 71 in Indian country and in other situations, such as for the OCS.

Nonattainment area – a geographic area identified by the EPA as not meeting either the NAAQS or the Alaska AAQS for one or more of the regulated pollutants.

OCS source – any equipment, activity, or facility which:

1. Emits or has the PTE any air pollutant;
2. Is regulated or authorized under the Outer Continental Shelf Lands Act ("OCSLA") (43 U.S.C. §1331 et seq.); and
3. Is located on the OCS or in or on waters above the OCS. This definition shall include marine vessels only when they are:
   a. Permanently or temporarily attached to the seabed, erected on the seabed, and used for the purpose of exploring, developing or producing resources from the seabed (Section 4(a)(1) of OCSLA (43 U.S.C. §1331 et seq.)); or
   b. Physically attached to an OCS facility, in which case only the stationary sources aspects of the vessels will be regulated.

ORR – owner-requested restrictions to emissions applied to operational use and mechanical devices.

Potential emissions – the maximum emissions of a pollutant from an OCS source operating at its design capacity. Any physical or operational limitation on the capacity of a source to emit a pollutant, including air pollution control equipment (such as BACT) and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed (such as ORR), shall be treated as a limit on the design capacity of the source if the limitation is federally enforceable. Emissions from vessels servicing or associated with an OCS source shall be considered direct emissions from such a source while at the source, and while en-route to or from the source when within 25 miles of the source, and is referred to as the PTE for an OCS source.

Significant Impact Levels (SILs) – ambient air increments caused by a major stationary source, in areas designated as Class I, II, or III; increase in pollutant concentration over the baseline concentration; the SILs are the maximum allowable increase, measured in micrograms per cubic meter.

D-1.8. Air Operating Permits

Air operating permits issued by EPA and ADEC will ensure that emission levels caused by the 2011 Camden Bay EP will remain low enough to prevent harm to human health and the environment under all operating scenarios. Shell's permit applications include an emission inventory and ambient air analysis (dispersion modeling) that include the worst-case highest hourly, enforceable emission rates from the *Kulluk* or *Discoverer* and its support vessels. (2011 Camden Bay EIA, p 4-5). The CAA regulations require certain facilities that emit criteria pollutants or hazardous substances to obtain a permit establishing limits on the types and amounts of emissions, governing operating parameters for pollution control and monitoring devices, and monitoring and record-keeping requirements. Refer to the definitions in this appendix for a major stationary source, new OCS sources, and potential emissions. In this case, EPA Region 10 will issue the air permits for the *Kulluk* and *Discoverer*. Refer to EA Section 1.3.5, Clean Air Act, for more information about air operating permits.

D-1.8.1. *Kulluk* Permits

Shell applied for three air operating permits in the revised application submitted to EPA Region 10 on March 29, 2011. The permit application requests a federal Title V permit and two Alaska state permits, one a state Title V permit, and second, a state minor source permit. A federal or state PSD permit is not necessary because the *Kulluk* would not have the PTE 250 tons per year of any PSD-related pollutant; the *Kulluk*, therefore, is not considered a major source under the PSD rule on either the federal or state level (18 AAC 50.306). Shell has requested concurrent review and consolidation of the permits so that just one permit is issued, if approved. The issuance of the permit is required before construction, and is a condition of approval of this EA, because the permit includes the Alaska minor permit, which is a pre-construction permit. The implementation of BACT strategies and compliance with other provisions of each permit are intended to ensure that air emissions are minimized. In the permit application, results of computer modeling of the *Kulluk* operation indicate none of the NAAQS or Alaska AAQS would be equaled or exceeded.

CAA Title V Permit. A Title V air operating permit is required for a stationary source with actual or limited PTE 100 tons per year or more of any of the regulated pollutants. The projected emissions inventory of *Kulluk* operations, given in Section 4.2.1.1 Table 10, shows annual emissions would exceed the 100-tons-per-year threshold for NO_X, and CO. As such, Shell is required to obtain a Part 71 permit from EPA Region 10 (40 CFR Part 71). The requirement for a CAA Title V permit includes the requirement to conduct an ambient air analysis (dispersion modeling) to compare results to the NAAQS and the Alaska AAQS (40 CFR Part 71.2, Definitions, Applicable Requirement (13)).

Alaska Title V Permit. Shell must obtain a Title V permit from the State of Alaska consistent with the federal requirements under 40 CFR Part 71(18 AAC 50.326); essentially the same as a federal Title V permit. In essence, the State of Alaska does not have a "Title V" program. Rather, the rules of the federal Title V program under Part 71 are adopted into the Alaska Administrative Code (18 AAC 50.40(j)). The agency with jurisdiction depends on the location of the source on the OCS. Sources located outside the three-mile Submerged Lands Act boundary are considered to be in federal waters. The Proposed Action is located, at the least, 16 miles from shore. Thus, the Alaska Title V permit is subject to the approval of EPA Region 10 (18 AAC 50.326(k)) rather than ADEC. Shell has requested in the permit application that EPA Region 10 consolidate the federal Part 71 permit and the Alaska Title V permit into a single permit to facilitate the notice, and the comment process.

Alaska Minor Permit. The need for an Alaska Title V permit does not exempt a stationary source from the requirement for a minor pre-construction permit under 18 AAC 50.502. Alaska requires a pre-construction minor permit when a stationary source exceeds the thresholds given in 18 AAC 50.502(c)(1) (see also 18 AAC 50.502(a)(2)). Projected emissions caused by operation of the *Kulluk* would exceed the limits for emissions of PM_{10} and NO_X. As such, a minor permit is required; and because the *Kulluk* would be located in federal waters, the jurisdiction for the approval and issuance of the minor permit rests with EPA Region 10. Shell has requested in the permit application that EPA process the Alaska minor permit and the Alaska Title V permit concurrently. The Alaska pre-construction minor permit is driving the requirement for issuance of the permit prior to construction. Any approval of the 2011 Camden Bay EP by the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) will be conditional until all air operating permits for the *Kulluk* are issued, as required. Under the conditional approval, the Application for Permit to Drill (APD) cannot be approved by BOEMRE, and commencement of activities will not be authorized, until receipt of all necessary permits and authorizations. The permit application and all associated documentation related to the *Kulluk* air operating permit are available online at: yosemite.epa.gov/r10/airpage.nsf/Permits/Kullukap/

D-1.8.2. Discoverer Permit

The EPA Region 10 provided Shell with a PSD Permit to Construct No. R10CS/PSD-AK-0901 for the *Discoverer*, which would cover the planned exploration in Camden Bay, should Shell decide to use the *Discoverer* for drilling. The permit was remanded to the EPA in December 2010 for revision. The EPA has revised the permit based on additional information provided by Shell. The draft permit is subject to a 30-day public comment period, as well as a public hearing, before EPA can issue the final permit. The EPA began accepting public comments on July 6, 2011, and will accept public comments through August 5, 2011. The final permit, if approved, will be issued after comments from the pubic and key stakeholders are reviewed and considered. Any approval of the 2011 Camden Bay EP by the BOEMRE will be conditional until all air operating permits for the *Discoverer* are issued, as required. Under the conditional approval, the APD cannot be approved by BOEMRE, and commencement of activities will not be authorized, until receipt of all necessary permits and authorizations. The permit application and all associated documentation related to the *Discoverer* air operating permit are available online at: www.epa.gov/region10/pdf/permits/shell/discoverer_beaufort_draft_revised_2011_permit_070111.pdf.

D-2. NEPA Air Quality Analysis

In the course of preparing the air operating permits, Shell conducted an analysis of emissions for the *Kulluk* and for the *Discoverer*, which includes all the marine support vessels associated with each drillship. The analysis included computer modeling, which was conducted according to the protocols submitted to EPA by Shell for the *Kulluk* (Shell, 2010) and for the *Discoverer* (Shell, 2011b). The analysis and air quality modeling conducted by Shell was required for the application of a PSD permit for the *Discoverer*, and for the Title V and pre-construction permits for the *Kulluk*. The air quality assessment required for this NEPA environmental review by the BOEMRE is distinct from the requirements for an air permit application and relies, in part, on the emission inventory and the ambient air analysis (dispersion analysis) conducted by Shell for the permit applications. However, the finding by BOEMRE for air quality impacts in this EA is a finding based on the BOEMRE independent review of air quality impacts and not a finding on the permits. The emission inventory includes the following pollutants for compliance with the NEPA guidelines, Alaska regulations, and includes greenhouse gases:

- Nitrogen oxides (NO_X)
- Fine particulate matter ($PM_{2.5}$)
- Coarse particulate matter (PM_{10})
- Carbon monoxide (CO)
- Sulfur oxides (SO_X)
- Volatile organic compounds (VOC)
- Lead (Pb)
- Ammonia (NH_3)
- Reduced sulfur compounds (RSC)
- Carbon dioxide equivalent emissions (CO_2e)

The emission inventories for both the drillships *Kulluk* and *Discoverer* are provided in EA Section 4.2.1.1, Table 10 and Table 11. The emission inventory was translated into an ambient air analysis through computer dispersion modeling using the EPA AERMOD model. The dispersion analysis was conducted for the NAAQS and Alaska AAQS, and includes:

- Nitrogen dioxide (NO_2)
- Fine particulate matter ($PM_{2.5}$)
- Coarse particulate matter (PM_{10})
- Carbon monoxide (CO)
- Sulfur dioxide (SO_2)
- Ammonia (NH_3)

The results of the dispersion analysis are provided in the application documents for the air operating permits for the *Kulluk* (Shell, 2011d), and for the *Discoverer*, (Shell, 2011a). Two analyses were conducted, one to initially compare the project-only emissions to the federal and Alaska PSD SILs (incremental increase thresholds), and one to compare the design concentrations to the NAAQS and the Alaska AAQS should any of the SILs be exceeded. The results of the analyses are provided in Table D-6 and Table D-7.

Table D-6 Prevention of Significant Deterioration (PSD) Analysis. Comparison of pollutant concentrations, associated only with the Proposed Action, to the PSD SILS for the COA Class II area.

Pollutant and Averaging Period			Project Pollutant Concentrations ($\mu g/m^3$)					
Pollutant and Averaging Period		PSD Increments	*Kulluk*			*Discoverer*		
			Nuiqsut	Deadhorse	Kaktovik	Other[1/]	Deadhorse	Kaktovik
Nitrogen Dioxide (NO_2)	Annual	*25*	0.1	0.2	0.2	0.1	0.03	0.1
Coarse Particulate Matter (PM_{10})[2/]	24-hour	*30*	0.3	0.6	1.5	0.1	0.1	0.3
Sulfur Dioxide (SO_2)	3-hour	512	4.8	5.2	8.1	1.0	0.7	2.0
	24-hour	91	2.7	2.9	4.2	0.6	0.4	1.3
	Annual	20	0.5	0.6	0.9	0.1	0.1	0.3

Note: SILs are Significant Impact Levels, or maximum allowable increases (40 CFR 55.21(c), for Class II areas.
COA is Corresponding Onshore Area (40 CFR Part 55.2).

Sources: Shell Offshore Inc., February 28, 2011, Supplement to EPA Outer Continental Shelf (OCS) Operating Permit Application [*Kulluk*], prepared by Air Sciences Inc., Table 3-11, Summary of Maximum Impacts at the Nearest Villages on the Beaufort Coast, p. 64.
Shell Offshore Inc., May 19, 2011, AERMOD Air Quality Impact Analysis of NO2, SO2, PM2.5, PM10, CO, and NH3 – *Discoverer* Drillship: Supplement to March 18 and April 29, 2011, AERMOD Impact Reports, Technical Memorandum prepared by Tim Martin, Air Sciences Inc., Table 5, Summary of Maximum Modeled Impacts at the Nearest Villages on the Beaufort Coast, p.17.
Shell Offshore Inc., March 18, 2011. Discoverer Drillship Impact Evaluation for SO2 and NO2 Using AERMOD, Table 3-9 Summary of Maximum Modeled Impacts – Beaufort Sea, p. 60.
40 CFR Part 52.21(c) Prevention of Significant Deterioration of Air Quality, for Class II areas.

1/ As represented by 50 km from nearest leases, defined in Shell Offshore Inc., March 18, 2011.
2/ 40 CFR Part 52.21(c) includes a threshold for PM_{10} annual arithmetic mean. This standard has been revoked by EPA on December 18, 2006 (71 FR 61144, dated 10/17/2006); as such, ambient air computer modeling was not conducted for this standard.

Shell prepared an emission inventory and conducted a dispersion analysis for operations using the drillship *Kulluk*, and alternately, for the drillship *Discoverer*. Both analyses were folded into the application documents for the air operating permits. The BOEMRE thoroughly reviewed and evaluated the methods and results of the analyses prepared by Shell to ensure the accuracy and credibility of the results. Refer to Section 1.3.5, Clean Air Act, for further information about the air operating permits.

The results of the PSD analysis show concentrations of pollutants associated solely with the Proposed Action would be less than, and therefore compliant with, the maximum incremental increases allowed under the PSD rules under 40 CFR Part 52.21(d). The incremental increases reflect pollutant concentrations without regard or inclusion of the existing background concentrations.

Table D-7 Ambient Air Analysis. Comparison of pollutant concentrations associated with the Proposed Action, together with the background concentrations onshore, to the NAAQS and Alaska AAQS.

Pollutant and Averaging Period		Pollutant Concentrations ($\mu g/m^3$)		
		NAAQS and Alaska AAQS	Design Concentrations	
			Kulluk	*Discoverer*
Nitrogen Dioxide (NO_2)	1-hour	188	108.7	81.6
	Annual	100	4.0	4.8
Fine Particulate Matter ($PM_{2.5}$)	24-hour	35	14.0	19.2
	Annual	15	2.4	3.5
Coarse Particulate Matter (PM_{10})	24-hour	150	75.7	65.8
Sulfur Dioxide (SO_2)	1-hour	196	36.5	35.0

Pollutant and Averaging Period		Pollutant Concentrations (μg/m³)		
		NAAQS and Alaska AAQS	Design Concentrations	
			Kulluk	*Discoverer*
	3-hour	1300	27.4	24.8
	24-hour	365	15.0	10.1
	Annual	80	4.0	3.8
Carbon Monoxide (CO)	1-hour	40000	3,019.0	2,240.0
	8-hour	10000	1,576.0	1,215.0
Ammonia (NH_3)	8-hour	2100	6.6	1.0

Sources: Shell Offshore Inc., February 28, 2011, Supplement to EPA Outer Continental Shelf (OCS) Operating Permit Application [*Kulluk*], prepared by Air Sciences Inc., Table 3-9, Summary of Maximum Modeled Impacts, p. 61.
Shell Offshore Inc., May 19, 2011, AERMOD Air Quality Impact Analysis of NO_2, SO_2, $PM_{2.5}$, PM_{10}, CO, and NH3 – *Discoverer* Drillship: Supplement to March 18 and April 29, 2011, AERMOD Impact Reports, Technical Memorandum prepared by Tim Martin, Air Sciences Inc., Table 3, Summary of Maximum Modeled Impacts – Beaufort Sea, p.15.

The results of the ambient air analysis for both drillships show concentrations of pollutants, including background emissions (design concentrations), would be less than the maximum ceiling allowed by the NAAQS and the Alaska AAQS, defined under 40 CFR Part 50 and 18 AAC 50.010, required under the Clean Air Act Section 176(c)(1), and compliant with provisions of the NEPA and the Alaska SIP.

D-3. Air Quality Levels of Effect

The levels of effect applied to the air quality analysis are based on the results of two levels of analyses, the emission inventory, and if required, the more rigorous ambient air analysis based on computer dispersion modeling. Further, the levels of effect consider whether the Proposed Action is:

- Temporary or permanent;
- Located within or beyond 25 miles from the Alaska seaward boundary (25-mile threshold);
- Adjacent to a COA that is designated attainment or nonattainment; and
- Associated with a COA that is designated as a Class I, Class II, or Class III area.

The levels of effect are first defined by applying threshold values to the emission inventory. The emission inventory is the first step in assessing the potential for adverse impacts to air quality due to a proposed federal action. While the inventory is not intended to define the severity of the impact, the character of the emission inventory can provide insight to the potential for future impacts. An inventory that demonstrates emissions that equal or exceed established thresholds can initiate further more rigorous analyses that will provide the 'hard look' required under NEPA (Robertson v. Methow Valley Citizens Council, 1989). Inherent in the hard look provision is the necessity to consider and investigate the relevant issues using the most appropriate expertise and methodology available. Thus, BOEMRE applied thresholds provided in the long-established EPA guidelines for air operating permits, the PSD permit and the Title V permit. The OCS Air Regulations require air operating permits under 40 CFR Part 55.6, Permit Requirements, and include Clean Air Act (CAA) Title V permits and PSD permits.

D-3.1. CAA Title V Requirements

The requirement for a Title V permit for an OCS source is found at 40 CFR Part 55.6(c)(3), which invokes the rules under 40 Part 71. The Part 71 Title V permit program is intended to document a state's major sources of stationary emissions regardless of the attainment status of the geographical area. A Part 71 permit is required for projects with stationary sources proposed on the OCS regardless of whether the project is located within or beyond the 25-mile threshold. The Part 71 permit is an enforceable permit issued by the EPA after the source has begun to operate. Under Part 71, a permit is required when a stationary source has the PTE 100 tons or more of any regulated pollutant, including VOCs

(42 USC 7602(j); 42 USC 7661a(b)(3)(B)(ii)(I, II, & III)). Thus, for the purpose of the BOEMRE air quality levels of effect, a proposed action that has the PTE less than 100 tons per year of any regulated pollutant would be considered a negligible source. In summary, a Title V Part 71 air operating permit on the Alaska OCS applies under the following conditions:

- Attainment or nonattainment area
- Obtain after construction
- Within or beyond the 25-mile boundary on the OCS adjacent to the North Slope Borough
- Federal EPA authority (EPA has authority on the OCS, whereas the Part 70 Title V is authorized by the state agency; Part 70 is nearly identical to Part 71)
- Major stationary source has emissions equal to or greater than 100 tons per year
- Applies to all regulated criteria and precursor pollutants

D-3.2. PSD Requirements

The EPA requires operating permits for new and modified stationary sources, referred to as pre-construction permits. A pre-construction permit is enforceable and must be obtained before construction on the federal action commences. This permit program is promulgated under the New Source Review rules (NSR), where NSR applies to areas of nonattainment and PSD rules apply to the attainment areas. The PSD permit program is intended to limit the amount of pollution emitted from a major stationary source to the best extent possible and reasonable in an area with otherwise clean air. On the OCS, a PSD permit may be required when the location of the proposed action is either within or beyond the 25-mile threshold (40 CFR Part 55.13(d)).

A project sponsor will apply for a PSD permit when a stationary source on the OCS has the PTE 250 tons or more of any regulated pollutant, including VOCs, even after BACT and ORR are applied (40 CFR 52.21(b)(1)(i)(b)). Thus, an action proposed on the OCS that creates a new stationary source with the PTE 250 tons per year or more of any criteria or precursor pollutant is defined as a major source. Under the rules for a PSD major source, an ambient air analysis is necessary to compare results to SILs defined in the PSD rule.

The EPA establishes SILs for pollutant concentrations under the 40 CFR Part 52.21 PSD rule. The SILs apply in much the same way as the emission thresholds apply to the emission inventory, except SILs are expressed in pollutant concentrations, such as parts per million (ppm) or micrograms per cubic meters ($\mu g/m^3$), and are the result of computer dispersion modeling. Referred to as ambient air incremental increases, the SILs are applied according to the classification of the Proposed Action's COA, such as Class I, Class II, or Class III. Alaska's North Slope Borough is a Class II area (i.e. not a wildlife refuge) (40 CFR Part 52.21(c)Class II). The SILs applicable to the Alaskan OCS adjacent to the Beaufort and Chukchi seas are provided in Table D-6.

Should the PSD dispersion analysis show that the maximum concentration of these pollutants, attributable solely to the Proposed Action, is greater than the SILs, additional analysis is necessary to determine if design concentrations would equal or exceed the NAAQS or the Alaska AAQS. The NAAQS and Alaska AAQS are given earlier in Table D-7.

For the purpose of the BOEMRE air quality levels of effect, a proposed action that has the PTE 250 tons per year or more of any regulated pollutant would be considered a major source, as under the PSD rules. In summary, a Part 52.21 PSD air pre-construction permit for stationary sources on the Alaska OCS applies under the following conditions:

- Attainment or unclassified area
- Obtain before construction begins (pre-construction)
- Within or beyond the 25-mile threshold on the OCS adjacent to the North Slope Borough

- Federal EPA authority
- Major stationary source has emissions equal to or greater than 250 tons per year
- Requires BACT and/or owner-requested restrictions (ORR)
- Applies to all New Source Review (NSR) regulated pollutants, which are NO_2, PM_{10}, and SO_2
- Incorporates the Alaska air quality control rules, which adds emissions of ammonia (NH_3) and reduced sulfur compounds (RSC)
- Public comment procedures are required

D-3.3. Defining the Four Levels of Effect

Assigning levels of effect to impacts from air emissions on the OCS is limited to four categories, negligible, minor, moderate, and major. Generally with air quality assessments, the objective is to determine whether or not the proposed action would have the potential to violate federal and state air quality standards, meaning the NAAQS and the State AAQS, and thereby demonstrate noncompliance with the CAA. Such an action could not be approved by a federal agency. Therefore, assigning parameters to the levels of effect first considered two scenarios, compliant and noncompliant federal actions.

Assigning more than one level of effect to a noncompliant outcome would be redundant, as a noncompliant action cannot go forward. There are no levels of noncompliance severity, the action simply is or is not compliant to the CAA. Consequently, BOEMRE considers only the major level of effect to reflect a noncompliant action. A major effect would be defined as a federal action that causes emissions that would increase pollutant concentrations to a level that would equal or exceed the NAAQS or the Alaska AAQS, which would also be noncompliant to the CAA Section 176(c)(1). By setting the major level of effect as a non-complying federal action, there are three remaining levels available to define the severity of actions that have an impact, but are ultimately compliant actions.

To define and assign compliant levels of effect, applicability parameters of the well-established federal and Alaska OCS permitting programs were used. When reviewing the various air-permitting programs, the potential for adverse air quality impacts are first assessed relative to the emission inventory. Where the Title V threshold of potential significance is 100 tons per year, the threshold is 250 tons per year under the PSD rules. In both cases, when the action has the PTE less than 100 tons per year, the source is not considered a major source. A sensitivity analysis of NO_X emissions was conducted to discern the effect of limiting emissions to just 100 tons for a season of operations on the Alaska OCS, which is approximately 120 days per year. Emissions of NO_X were used in the analysis because NO_X is the limiting pollutant from the operation of drillships and marine vessels, NO_X is a pollutant regulated by the NAAQS and the Alaska AAQS, and NO_X is a PSD regulated pollutant. The highest level of emissions resulting from marine vessels operating on the OCS is usually NO_X. The sensitivity analysis showed that if the vessels proposed for the *Discoverer* EP (Shell, 2011c) were to operate until the emissions of NO_X reached 100 tons, the operation could continue for only 35 days. This is about 30 percent of the time needed to complete the 2011 Camden Bay EP, when drilling only one well would require 34 to 44 days. Therefore, a threshold of 100 tons (uncontrolled) is considered by BOEMRE to be a reasonable threshold to define a small project. Generally, a negligible level of effect would imply an impact of little importance and of so little consequence as to warrant the slightest amount of attention. Indeed, the CAA defines *de minimis* emissions as a project that causes emissions that are less than 100 tons per year in the 40 CFR Part 93 General Conformity Rule (40 CFR 93.153). As such, the BOEMRE will consider *de minimis* emissions to be negligible for purposes of air quality levels of effect for operations on the OCS. Although no ambient air analysis would likely be conducted for such a small project, the emissions would be presumed to conform to the Alaska SIP and comply with the NAAQS and the Alaska AAQS. The action would be considered compliant to the CAA Section 176(c)(1).

The PSD rule considers federal actions to be major stationary sources only when the action causes controlled emissions that would exceed 250 tons per year. Therefore, a minor source should capture projects with the maximum PTE 100 tons per year or more, but less than 250 tons per year, with or without the application of BACT or ORR. It follows that a major source would capture all remaining possibilities, which would be projects with the maximum PTE more than 250 tons per year, even with the application of BACT and ORR. However, there are scenarios where regardless of whether the action has the PTE greater than 250 tons per year of any regulated pollutant, the ambient air analysis (dispersion modeling) shows the NAAQS and the Alaska AAQS would be met, ultimately resulting in a compliant action. At the same time, there could be instances where actions with emissions below 250 tons per year would not meet the air quality standards. Therefore, a second level of analysis was used as a threshold, which is the ambient air analysis.

Depending on the type of air operating permit required under the regulations, the air operating permit may include an ambient air analysis, which requires computer dispersion modeling. The results of the ambient air analysis can be used to compare project impacts to thresholds that may indicate the potential for adverse air quality impacts. The PSD permit program provides Significant Incremental Levels (SIL) for three pollutants, which are presented in Table D-6. The SILs depend on the EPA-designated class-level of the COA. When the ambient air analysis for these three pollutants shows concentrations below these levels, no further analysis is required under PSD; the action is presumed to comply with all the NAAQS and the Alaska AAQS. However, should the action exceed these thresholds, further analysis is necessary to model all the criteria pollutants to ensure compliance to the full set of air quality standards. Thus, actions that exceed the SILs, regardless of the emission inventory, would require additional analysis, and would be considered the more severe scenario. In all cases and levels of effect, there would be measurable emissions that are unavoidable. Based on this methodology, the following levels of effect are defined for air quality impacts and are summarized in Appendix B, Level of Effects Definitions and Abbreviations.

D-3.3.1. Negligible Level of Effect

The negligible level of effect reflects a proposed action with *de minimis* emissions. The proposed action is considered a negligible emission source and no further analysis is required. The proposed action is presumed to conform to all provisions of the CAA.

- New sources of air emissions are unavoidable; the proposed action would have maximum uncontrolled potential to emit (PTE) emissions that are less than 100 tons per year for any regulated criteria or precursor pollutant; as such, the Proposed Action is defined as a negligible emission source, and the emissions are *de minimis*, and
- Maximum PTE emissions might reflect an inventory reduced by the application of BACT, proposed ORR, and other additional controls, if required under state and federal air operating and pre-construction permit regulations, and
- If dispersion modeling was conducted, projected maximum pollutant concentrations attributable solely to the proposed action would be less than the PSD SILs, which reflect the maximum allowable incremental increase for NO_2, PM_{10}, and SO_2 for the class level designated for the COA; further, the design concentrations (total maximum concentrations including background concentrations) are less than any applicable NAAQS or AAAQS, and
- Annual emissions are presumed compliant with the plans and milestones included in the Alaska Air Quality Control Plan, including the Alaska SIP, and
- Project emissions are presumed to not have the potential to cause or contribute to a violation of any NAAQS or AAAQS that defines healthful air quality, and
- The federal action is considered compliant with the relevant provisions of the Clean Air Act 1990 Amendments, including Title I, Section 176(c)(1), Limitations on Certain Federal Assistance, Title I, Part C, Prevention of Significant Deterioration of Air Quality, and Title III, Section 328, Air Pollution from Outer Continental Shelf Activities.

D-3.3.2. Minor Level of Effect

The minor level of effect reflects a proposed action with emissions that could define a minor or a major source of emissions. If the emissions constitute a major source, an ambient air analysis was conducted for comparison to the appropriate SILs. The proposed action does not exceed the SILs and no further analysis is required. The proposed action is presumed to conform to all provisions of the CAA.

- New sources of air emissions are unavoidable and either:
  1) The proposed action would have maximum uncontrolled PTE emissions that are more than 100 tons per year, but less than 250 tons per year, for any regulated criteria or precursor pollutant; as such, the proposed action is defined as a minor emission source, or
  2) The uncontrolled PTE emissions equal or exceed 250 tons per year for any criteria or precursor pollutant, and maximum controlled PTE emissions are reduced for all pollutants to less than 250 tons per year through the application of BACT, ORR, and/or other additional controls, as may be required under state and federal air operating and pre-construction permit requirements, and the proposed action is defined as a minor emission source, or
  3) The maximum controlled PTE emissions exceed 250 tons per year even with the application of BACT, ORR, and/or other additional controls, as may be required under state and federal air operating and pre-construction permit requirements, and the proposed action is defined as a major emission source, and
- An ambient air analysis (dispersion modeling) was conducted to project maximum pollutant concentrations attributable solely to the proposed action; the pollutant concentrations would be less than the PSD SILs, which reflect the maximum allowable incremental increase for NO_2, PM_{10}, and SO_2 for the class level designated for the COA; no further analysis is required, and
- Annual emissions are presumed compliant with the plans and milestones included in the Alaska Air Quality Control Plan, including the Alaska SIP, and
- Project emissions are presumed to not have the potential to cause or contribute to a violation of any NAAQS or Alaska AAQS that defines healthful air quality, and
- The federal action is considered compliant with the relevant provisions of the Clean Air Act 1990 Amendments, including Title I, Section 176(c)(1), Limitations on Certain Federal Assistance, Title I, Part C, Prevention of Significant Deterioration of Air Quality, and Title III, Section 328, Air Pollution from Outer Continental Shelf Activities.

D-3.3.3. Moderate Level of Effect

The moderate level of effect reflects a proposed action with emissions that define a major source of emissions. An ambient air analysis was conducted for comparison to the appropriate SILs. The proposed action exceeds at least one of the SILs and further analysis was required to show compliance to the air quality standards. The additional analysis shows none of the air quality standards are exceeded. As such, the proposed action is shown to conform to all provisions of the CAA.

- New sources of air emissions are unavoidable; the proposed action would have maximum controlled PTE emissions that equal or exceed 250 tons per year for at least one of the regulated criteria or precursor pollutants; as such, the proposed action is defined as a major source, and
- The application of BACT, proposed ORR, and other additional controls, as may be required under state and federal air operating and pre-construction permit requirements, would not successfully reduce all pollutants to a level below 250 tons per year, and
- An ambient air analysis (dispersion modeling) was conducted to project maximum pollutant concentrations attributable solely to the proposed action; the pollutant concentrations would

equal or exceed at least one of the PSD SILs for NO_2, PM_{10}, or SO_2 for the class designation of the COA, and

- Further analysis shows the design concentrations would not exceed any of the applicable NAAQS or Alaska AAQS, and
- Annual emissions are compliant with the plans and milestones included in the Alaska Air Quality Control Plan, including the Alaska SIP, and
- Project emissions were shown to not have the potential to cause pollutant concentrations that would equal or exceed any of the NAAQS or the Alaska AAQS that define healthful air quality, and
- The federal action is shown to be compliant with the relevant provisions of the CAA, including Title I, Section 176(c)(1), Limitations on Certain Federal Assistance, Title I, Part C, Prevention of Significant Deterioration of Air Quality, and Title III, Section 328, Air Pollution from Outer Continental Shelf Activities.

D-3.3.4. Major Level of Effect

The major level of effect reflects a proposed action with emissions that define a major source of emissions. An ambient air analysis was conducted for comparison to the appropriate SILs. The proposed action exceeds at least one of the SILs and further analysis was required to show compliance to the air quality standards. The additional analysis shows at least one of the air quality standards is exceeded. As such, the proposed action does not conform to the provisions of the CAA. A project such as this cannot be approved by a federal agency.

- New sources of air emissions are unavoidable; the proposed action would have maximum PTE emissions that equal or exceed 250 tons per year for at least one of the regulated criteria or precursor pollutants; as such, the proposed action is defined as a major source, and
- The application of BACT, proposed ORR, and other additional controls, as may be required under state and federal air operating and pre-construction permit requirements, would not successfully reduce all pollutants to a level below 250 tons per year, and
- An ambient air analysis (dispersion modeling) was conducted to project maximum pollutant concentrations attributable solely to the proposed action; the pollutant concentrations would equal or exceed at least one of the PSD SILs for NO_2, PM_{10}, or SO_2 for the class designation of the COA; and
- Additional analysis shows the design concentrations would exceed at least one of the applicable NAAQS or Alaska AAQS, and
- Annual emissions are not compliant with the plans and milestones included in the Alaska Air Quality Control Plan, including the Alaska SIP, and
- Project emissions were shown to have the potential to cause pollutant concentrations that would equal or exceed one or more of the NAAQS and/or one of the Alaska AAQS that define healthful air quality, and
- The federal action is shown to be non-compliant with the relevant provisions of the CAA, including Title I, Section 176(c)(1), *Limitations on Certain Federal Assistance, Title I, Part C, Prevention of Significant Deterioration of Air Quality, and Title III, Section 328, Air Pollution from Outer Continental Shelf Activities.*

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