OCS EIS/EA
MMS 2009-061

Environmental Assessment

Shell Gulf of Mexico, Inc.
2010 Exploration Drilling Program
Burger, Crackerjack, and SW Shoebill Prospects
Chukchi Sea Outer Continental Shelf, Alaska

Chukchi Sea OCS Leases OCS-Y-2280, OCS-Y-2267, OCS-Y-2321, OCS-Y-2111, and OCS-Y-2142

Prepared by

Office of Leasing and Environment
Alaska OCS Region

MMS U.S. Department of the Interior
Minerals Management Service

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Contents

1.0 PURPOSE AND NEED

1.1 Purpose of the Proposed Action

Shell Gulf of Mexico Inc. (Shell) submitted an Exploration Plan (EP) to the Minerals Management Service (MMS), Exploration Plan, 2010 Exploration Drilling Program, Posey Blocks 6713, 6714, 6763, 6764, and 6912, Karo Blocks 6864 and 7007, Burger, Crackerjack, and SW Shoebill Prospects, OCS Lease Sale 193, Chukchi Sea, Alaska (Shell Gulf of Mexico Inc., 2009a), dated July 2009, to conduct exploration drilling to evaluate the oil and gas resource potential of three prospects on the company's Outer Continental Shelf (OCS) leases in the U.S. Chukchi Sea. The MMS requested additional information from Shell on August 7 and September 4, and the EP was deemed submitted October 20, 2009. Shell acquired these leases through OCS Lease Sale 193 in February 2008. Under OCS leasing regulations in 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 proposed exploration of their Chukchi Sea leases is 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.

Shell proposes to drill exploration wells at up to three of five possible drill sites during the July-October 2010 open-water-drilling season. Three proposed drill sites (one per block) are located on three different blocks (6714, 6764, and 6912) in the Burger Prospect; one drill site is on a single block (6864) in the Crackerjack Prospect; and one drill site is on a single block (7007) in the SW Shoebill Prospect. The total number of wells that would be drilled in 2010 would depend on ice and weather conditions, the length of time available for drilling, and other factors affecting the time that it takes to drill each well. Based on past experience and current planning, Shell anticipates drilling up to three wells during the 2010 drilling season. Each of the five drill sites would be permitted for drilling in 2010 to allow for operational flexibility in the event sea ice conditions prevent access to one or more locations. Applications for Permits to Drill must be submitted to MMS for approval prior to drilling.

The drilling operations would be conducted using the M/V *Frontier Discoverer* (*Discoverer*), a modern drillship that has been retrofitted and ice reinforced for operations in Arctic OCS waters. Given favorable conditions, it is anticipated that the initial drilling activity would begin at the Burger Prospect. If Burger is not accessible, the next preferred location to begin the exploration drilling, if favorable conditions exist, is at the SW Shoebill Prospect. If neither the Burger nor SW Shoebill Prospects are accessible, the Crackerjack Prospect, if accessible, would be the site of initial exploration drilling well. It should be noted that focus of the 2010 drilling program would be shifted immediately to the Burger Prospect as soon as it becomes safe to anchor and operate the drillship on that Prospect. Given favorable drilling performance and subsurface results at the initial Burger drill site, another of the permitted drill sites in the Burger Prospect may be the next well drilled.

Shell has submitted the EP under MMS operating regulations at 30 CFR 250 Subpart B. In support of the EP, Shell submitted an environmental impact analysis (EIA) (Shell Gulf of Mexico Inc., 2009b), a Chukchi Sea Regional oil discharge prevention and contingency plan (ODPCP) for the 2010 drilling program (Shell Gulf of Mexico Inc., 2009c), environmental monitoring information, site-specific geohazards survey data and assessment, mitigation measures, and other project-specific information pursuant to 30 CFR 250.212 and 30 CFR 250.227. Shell submitted, with the EP, a project-specific Plan of Cooperation (POC) to reduce potential conflicts with subsistence activities, a description of their Cultural Awareness and Health, Safety, Security, and Environment (HSSE) Awareness Programs, and other information required by Lease Sale 193 lease stipulations. In support of their EIA, Shell also submitted the following reports: Distribution and Abundance of Seabirds in the Northeastern Chukchi

Sea (Gall and Day, 2009); Acoustic Modeling of Underwater Noise from the *Discoverer* in the Chukchi Sea (JASCO, 2009); Bird Strike Avoidance on *Discoverer* Lighting Study Report (ASRC Energy Services, 2009); Marine Mammal Surveys at the Klondike and Burger Survey Areas in the Chukchi Sea during the 2008 Open Water Season (Brueggeman, 2009); and Draft Update: Modeled Drill Mud Impacts from an Exploratory Drilling Campaign in the Chukchi Sea and Beaufort Sea, Alaska (Shell Global Solutions, 2009).

The MMS has completed technical and environmental reviews of the EP and supporting information to ensure the proposed activities are 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 DOI Manual (DM) Chapter 15 (516 DM 15), MMS has prepared the EA to determine whether the proposed action may result in significant effects, as defined at 40 CFR 1508.27, that could trigger the need for preparation of an environmental impact statement (EIS) and to assist MMS planning and decisionmaking. In keeping with CEQ regulations at 40 CFR 1506.5(a),(b) (see below) and the intent of MMS operating regulations at 30 CFR 250.227, MMS reviewed, evaluated, and verified the information and analysis provided in Shell's EIA used in this EA. The MMS updated, revised, and supplemented the information as necessary. A list of MMS staff responsible for reviewing, evaluating, and verifying the information submitted by Shell is in Section 5 of this EA.

> **40 CFR 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 and Biological Opinions

NEPA mandates that Federal agencies conduct an environmental review of certain Federal projects. The NEPA review is required 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 MMS has completed numerous NEPA reviews of Arctic OCS activities. In recent years, NEPA reviews relevant to the proposed activities have included the following:

- Environmental Assessment – Shell Offshore, Inc., 2010 Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska. OCS EIS/EA MMS 2009-052. Anchorage, AK: USDOI, MMS, Alaska OCS Region (USDOI, MMS, 2009) (hereafter, "Camden Bay EA").

- 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. Anchorage, AK: USDOI, MMS, Alaska OCS Region (USDOI, MMS, 2008a) (hereafter "Arctic Multiple-Sale Draft EIS").
- Environmental Assessment – Shell Offshore Inc., Beaufort Sea Exploration Plan, OCS EIS/EA MMS 2007-009. Anchorage, AK: USDOI, MMS, Alaska OCS Region (USDOI, MMS, 2007a).
- Chukchi Sea Planning Area: Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea, Final Environmental Impact Statement. OCS EIS/EA MMS 2007-026. Anchorage, AK: USDOI, MMS, Alaska OCS Region. (USDOI, MMS, 2007b) (hereafter "Chukchi Sale 193 EIS").
- Outer Continental Shelf Oil & Gas Leasing Program: 2007-2012 Final Environmental Impact Statement. OCS EIS/EA MMS 2007-003. (USDOI, MMS, 2007c).

These documents can be found on the MMS website at http://www.mms.gov/alaska/ref/EIS_EA.htm or http://www.mms.gov/5-year/2007-2012FEIS.htm. Relevant sections of these documents are summarized and incorporated by reference in this EA. This EA tiers from the Chukchi Sale 193 EIS (USDOI, MMS, 2007b).

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

- Shell Gulf of Mexico Inc. Exploration Plan, 2010 Exploration Drilling Program, Posey Blocks 6713, 6714, 6763, 6764, and 6912, Karo Blocks 6864 and 7007, Burger, Crackerjack, and SW Shoebill Prospects, OCS Lease Sale 193, Chukchi Sea, Alaska (Shell Gulf of Mexico Inc., 2009a)
- Final Biological Opinion for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling (USDOI, FWS, 2009).
- Endangered Species Act – Section 7 Consultation: Biological Opinion: 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).
- Environmental Assessment and 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, 2007).
- Biological Opinion for Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Associated Seismic Surveys and Exploratory Drilling (USDOI, FWS, 2007).

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.

Outer Continental Shelf Lands Act and MMS 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 MMS conducts an appropriate NEPA review at each stage.

The MMS is responsible for regulating and monitoring the oil and gas operations on the Federal OCS. The MMS 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 at 30 CFR 250. Regulations for oil-spill prevention and response are specified at 30 CFR 254.

Prior to any exploration activities being conducted on a lease, an EP and supporting information must be submitted to MMS for review and approval. Supporting information includes environmental information, an archeological 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 MMS has completed both technical and environmental reviews of the activities proposed in Shell's EP, including evaluations for shallow geologic hazards (geohazards) and manmade hazards, archeological resources, endangered species, sensitive biological features, water and air quality, oil-spill response, and other uses of the OCS.

The MMS 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 2.3.10 of this EA.

The MMS 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 MMS' intent of requirements. A detailed listing of the Alaska OCS Region's NTLs is published on the Alaska Region website at: http://www.mms.gov/alaska/regs/NTLs.htm.

Shell is not proposing to use new or unusual technology (Shell Gulf of Mexico Inc., 2009a: Section 2c). Shell must conduct operations in accordance with MMS' comprehensive and stringent regulations for safety and pollution prevention, which, in accordance with 30 CFR 250.107(c), are generally requirements to use the best available and safest technology. 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 MMS will not approve an APD until applicable conditions of EP approval have been met.

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 the 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 MMS to ensure that measures to protect endangered and threatened species are implemented and followed.

The MMS formally consulted NMFS on the potential effects of OCS oil and gas leasing and exploration on the threatened and endangered species under NMFS jurisdiction in the Beaufort Sea and Chukchi Sea. The NMFS published a Biological Opinion (BO) in 2008 (NOAA, NMFS, 2008), concluding that the OCS oil and gas leasing program and exploration activities are not likely to jeopardize the continued existence of the fin whale, the humpback whale, and the bowhead whale.

The MMS formally consulted with the FWS on the potential effects of oil and gas leasing and exploration on the threatened and endangered species and designated critical habitats under FWS jurisdiction in the Beaufort Sea and Chukchi Sea. The FWS provided a BO for the Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling in 2009 (USDOI, FWS, 2009), concluding that the OCS oil and gas leasing program and exploration activities are not likely to jeopardize the continued existence of the spectacled eider, the Steller's eider, and the polar bear or damage or adversely modify designated critical habitat.

On October 29, 2009, FWS published a proposed rule identifying proposed Critical Habitat for the Polar Bear (74 *FR* 56058-56086). The rule identifies the physical and biological features essential to the conservation of the polar bear. The rule includes as proposed critical habitat "[s]ea-ice habitat, which is sea-ice over marine waters 300 m (984.2 ft) or less in depth that occur over the continental shelf" [74 *FR* 56081]. Shell's planned drill sites are at water depths between 43 and 46 m. The FWS has identified landfast sea ice (sea ice that is frozen to the shoreline or seafloor and is relatively immobile) and pack ice (annual and multi-year ice that is in constant motion due to winds and currents) as critical sea ice habitats [74 *FR* 56059]. All of the potential drill sites are seaward of areas over which landfast ice forms. Open water was not proposed as critical habitat [74 *FR* 56065]. The proposed rule includes marine sea-ice habitat because it serves as a platform for polar bears when hunting, feeding, traveling, resting, or denning. The MMS has determined that the proposed action will not destroy or adversely modify the proposed critical habitat as activities are not expected to appreciably reduce the conservation value of the proposed critical habitat for the polar bear. The MMS has had ongoing communications with FWS regarding the proposed action and will continue communications to ensure continued compliance with the ESA.

Because marine mammals, including the polar bear, are protected by the Marine Mammal Protection Act (MMPA), MMS approval of an APD is conditioned on the issuance of incidental take authorization to Shell under the MMPA by the FWS and NMFS. Issuance of incidental take authorization under MMPA is required before an Incidental Take Statement (ITS) under the ESA is valid.

Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) establishes Federal responsibility to conserve marine mammals. The NMFS has jurisdiction over whales and seals, including the bowhead whale, gray whale, beluga whale, minke whale, humpback whale, harbor porpoise, bearded seal, ringed seal, ribbon seal, and spotted seal. The FWS has jurisdiction over the polar bear and Pacific walrus.

The MMPA prohibits the "taking" of a marine mammal without a permit or exemption. Section 101(a)(5)(D) of the MMPA established 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, kill or collect, or attempt to harass, hunt, capture, kill or collect." 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 Service 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 the permissible methods of taking and the requirements pertaining to mitigation, monitoring, and reporting of such takings. The MMPA authorizations require that operators conduct monitoring 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 applied for an Incidental Harassment Authorization (IHA) from NMFS in a letter dated May 22, 2009 (Shell Gulf of Mexico Inc., 2009a: Appendix C), and a Letter of Authorization (LOA) from FWS dated May 22, 2009 (Shell Gulf of Mexico Inc., 2009a: Appendix E). Any approval of Shell's EP will be a conditional approval. Under a 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 2.3.11 of this EA.

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 they are conducted consistent with the State's approved plan. The Alaska Coastal Management Program (ACMP) implements the CZMA and requires 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. The ACMP's Coastal Project Questionnaire and Certification Statement (CPQ) is necessary for the Alaska Department of Natural Resources, Division of Coastal and Ocean Management coordination and review. A copy of Shell's CPQ is included as Section 15 of the EP (Shell Gulf of Mexico Inc., 2009a). As part of the MMS review process, the EP and supporting environmental information were sent to the ACMP for consistency-certification review and response. Any approval of Shell's EP will be a conditional approval. Under a 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 consistency concurrence from the State of Alaska.

Clean Air Act

The Clean Air Act (CAA) (43 U.S.C. § 7401, et seq.) governs air pollutant emissions and requires the Environmental Protection Agency (EPA) and the States to carry out programs to ensure attainment of the National Ambient Air Quality Standards (NAAQS). The CAA regulations in 40 CFR Part 50 require certain facilities that emit criteria pollutants (nitrogen dioxide, sulfur dioxide, small-diameter particulate matter, ozone, carbon monoxide, and lead) 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.

Shell submitted a Prevention of Significant Deterioration (PSD) permit application to EPA on December 11, 2008, for emissions from the *Discoverer* and support vessels. The EPA began seeking public comments on August 20, 2009, on the proposed PSD permit for Shell Chukchi Sea exploration drilling program (USEPA, 2009b). The comment period on the proposed permit ended on October 20, 2009, and EPA is currently reviewing public comments. The proposed permit would allow Shell to operate the *Discoverer* drillship and associated vessels for a multi-year exploratory oil and gas drilling program within its current OCS leases in the Chukchi Sea beyond 25 mi from Alaska's seaward boundary. Because the drillship operations are considered a "major" source, the permit must ensure that the operations meet the requirements of the PSD program (USEPA, 2009b).

According to EPA's Statement of Basis for Proposed Outer Continental Shelf Prevention of Significant Deterioration Permit No. R10OCS/PSD-AK-09-01 (USEPA, 2009c):

> The PSD rules at 40 CFR § 52.21(k) require the permit applicant to demonstrate that, for all regulated air pollutants that would be emitted in excess of the significance thresholds at 40 CFR § 52.21(b)(23)(i), the allowable emission increases (including secondary emissions)

> from a proposed new major stationary source, in conjunction with all other applicable emission increases or reductions at the source, would not cause or contribute to a violation of any NAAQS nor cause or contribute to a violation of any applicable "maximum allowable increase" over the baseline concentration in any area. The analysis must be based on air quality models, data bases, and other requirements specified in 40 CFR 51, Appendix W, Guideline on Air Quality Models. (USEPA, 2009c: p.73)
>
> In its air quality analysis, Shell used a non-guideline model called ISC3-Prime (USEPA 2004a) in order to better predict the maximum concentration immediately downwind of the hulls of the vessels. The ISC3-Prime model has been evaluated under Arctic conditions (USEPA 2003). The EPA believes ISC3-Prime is an appropriate model for determining the air quality impacts from the *Discoverer* and the Associated Fleet in Arctic conditions and approved the use of ISC3-Prime pursuant to Section 3.2 in 40 CFR Part 51, Appendix W for use in evaluating Shell's permit application and air impact analysis. As provided in 40 CFR § 52.21(l)(2), EPA is requesting public comment on the suitability of use of the ISC3-Prime model in the ambient air quality impact analysis for this permitting action. (USEPA, 2009c: p. 71)

Issuance of the EPA permit would authorize air emissions from the proposed activities and set emission limitations and other provisions to ensure that the permitted emissions will have no adverse effect on public health, and all health-based NAAQS will be met. Shell must comply with provisions of the required air quality permits. Shell must implement best available control technology (BACT) and comply with provisions of the required air quality permits.

The MMS finding on air emissions is pursuant to MMS regulatory requirements and not a finding on the EPA PSD permit. The MMS has reviewed and assessed the air emissions information submitted by Shell. The air emissions information meets MMS regulatory requirements at 30 CFR 250.218, 250.224, and 250.225, and was assessed under 30 CFR 250.218 and 250.303. 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 PSD permit.

The MMS air quality regulations at 30 CFR 250.302, 250.303, and 250.304 were promulgated as mandated by section 5(a)(8) of OCSLA. The 1990 Clean Air Act Amendments (CAAA) directed the EPA to regulate air emissions from OCS sources located offshore of States along the Pacific, Arctic, and Atlantic coasts, and along the Gulf Coast off the State of Florida to the east of longitude 87º30'W. The applicable part of the statute is Section 328 of the CAA (42 U.S.C. §7627). Section 328(a)(1) states in part: "The authority of this subsection shall supersede section 5(a)(8) of the Outer Continental Shelf Lands Act (OCSLA) but shall not repeal or modify any other Federal, State, or local authorities with respect to air quality." The EPA promulgated implementing regulations at 40 CFR 55 on September 4, 1992. Thus, EPA has jurisdiction regarding air quality permits on the Alaska OCS.

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 AKG-28-0000) 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 (USEPA, 2006).

Shell submitted Notices of Intent (NOI), dated May 22, 2009, to EPA requesting authorization for the *Discoverer* to discharge liquid wastes regulated under the NPDES General Permit at the proposed drill sites (Shell Gulf of Mexico Inc. 2009a: Appendix B). Under a 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.

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 MMS regulations in 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 Chukchi 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 that meets the response planning requirements of the State of Alaska and Federal oil-spill-planning regulations.

The Regional ODPCP includes information specific to the well sites, including worst-case oil-spill estimates, a worst-case oil-spill scenario, and modeling results. The ODPCP includes information regarding Shell's regional oil-spill organization and dedicated response assets, potential spill volumes, and sensitive environmental resources. The ODPCP 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.

Cultural Resource Regulations

Archaeological resource requirements are contained in MMS operational regulations under 30 CFR 250.194. Technical requirements for 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.

Information to Lessees (ITL) 16 *Archaeological and Geologic Hazards Reports and Surveys* in the Final Notice of Sale for the Chukchi Sea Planning Area Oil and Gas Lease Sale 193 specified the blocks for which an archaeological report would be required (USDOI, MMS, 2008b). Shell's proposed drill sites are not on blocks listed in the ITL. Section II.B.3.c(2) of the Chukchi Sale 193 EIS identified blocks having high potential for the occurrence of archaeological resources.

Potential prehistoric archaeological resources that may exist in areas where water depths are less than 60 m and that have sufficient sediment cover to have protected sites from the effects of marine erosion and ice gouging. Water depths at the proposed drill sites are 43.3-45.4 m (142-149 ft). All of the proposed drill sites have been subject to ice gouging. Prehistoric archaeological resources are not expected in areas where water depths exceed 60 m because these areas of the continental shelf would have become submerged by rising sea level prior to 13,000 years Before Present (BP). Archaeological

analysis of shallow geologic and marine geophysical survey data identifies areas of possible archaeological resources to be avoided (USDOI, MMS, 2008a).

Under Section 106 of the National Historic Preservation Act, MMS consults with the Alaska State Historic Preservation Office (SHPO) for OCS activities during the pre-lease process. A Section 106 consultation for the Chukchi Sea Planning Area was completed in conjunction with the Chukchi Sale 193 EIS (USDOI, MMS, 2007b) and again recently in conjunction with the Arctic Multiple-Sale EIS (SHPO concurrence dated September 24, 2008).

Site-specific geophysical surveys have been conducted at the proposed drill sites. The MMS' review of the site-specific geophysical data indicates that there are no historic properties at Shell's proposed drill sites. The MMS forwarded this finding to the SHPO and received concurrence from SHPO on November 17, 2009.

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)

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, ocean-bottom cables). The USCG developed regulations (33 CFR 151) that implement provisions of the NABPCA 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." Shell's proposed activities must comply with the Coast Guard 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. In addition, the Chukchi Sea poses harsh and frigid environmental conditions that are believed to impose major and difficult challenges to invasive species that might be introduced into the region's waters by vessels or equipment. Therefore, the likelihood of introducing invasive species from the proposed activities is considered to be very low, and this issue is not considered further in this EA.

2.0 PROPOSED ACTION AND ALTERNATIVE

2.1 Background

Shell proposes to drill up to three exploration wells located more than 60 mi (97 km) offshore in the Chukchi Sea, Alaska, on the Burger, Crackerjack, and SW Shoebill prospects of the Chukchi Sea OCS Planning Area (Figures 2-1, 2-2, and 2-3). The drilling activities are planned to commence on or about July 4 and would cease on or before October 31. Shell expects to drill up to three wells during the 2010 drilling season. Shell has identified five proposed drill sites. The number of wells that would be drilled in 2010 would depend on ice conditions and the length of time available for drilling.

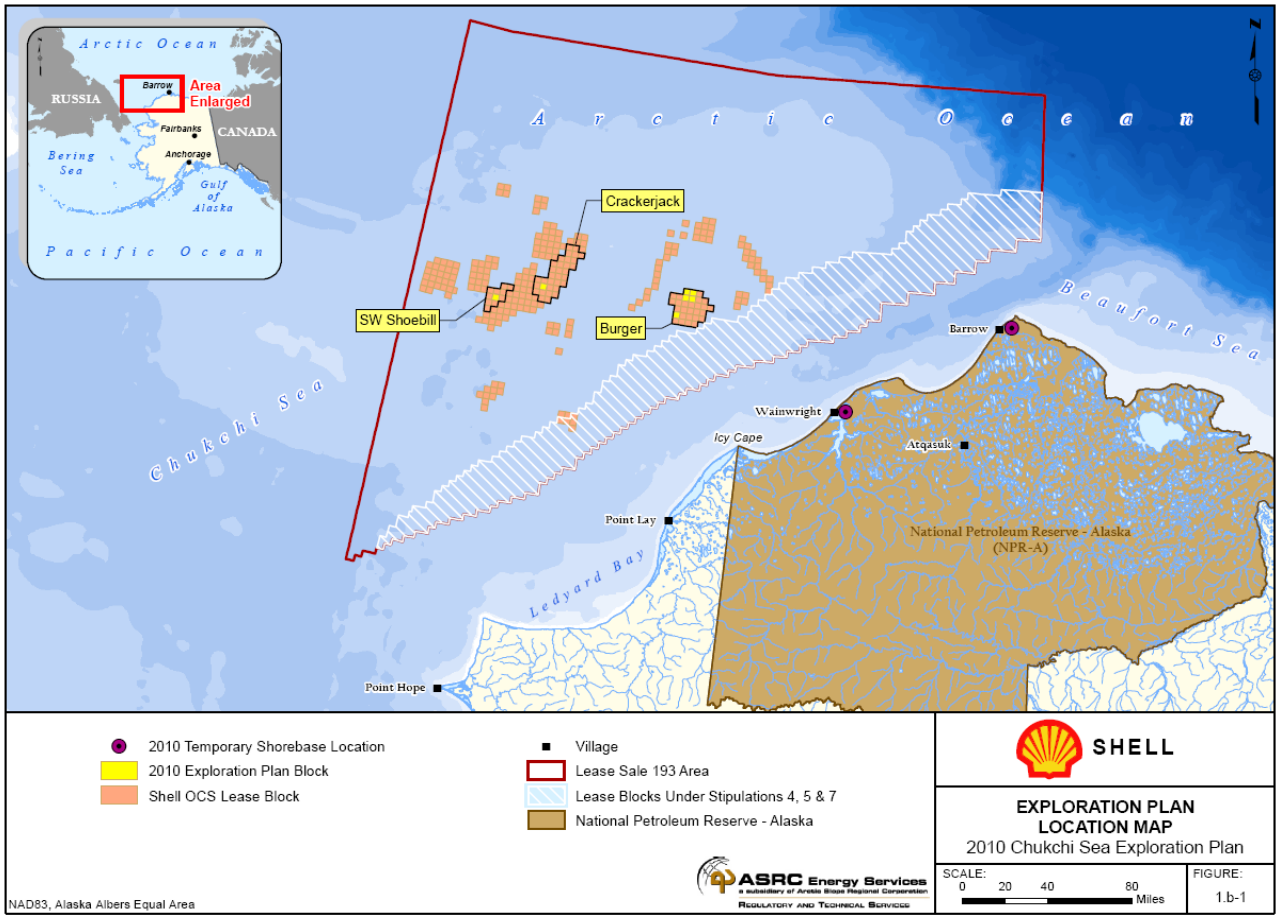

Figure 2-1. Location of 2010 Exploration Plan Blocks.

Given favorable conditions, Shell anticipates drilling activity would begin at the Burger Prospect. If Burger is not accessible, then the next preferred location to begin the exploration drilling, if favorable conditions exist, would be the SW Shoebill Prospect. If neither the Burger nor SW Shoebill Prospects are accessible, then the Crackerjack Prospect, if open, would be the site of initial exploration drilling. The focus of the 2010 drilling program would be shifted to the Burger Prospect as soon as it becomes safe to anchor and operate the drillship on that prospect. Given favorable drilling performance and subsurface results at the initial Burger drill site, another of the permitted drill sites in the Burger Prospect may be the next well drilled. The exploration wells will be plugged and abandoned in compliance with MMS regulations after drilling operations have been completed. It is likely that during the period covered by this EP, that a well may be started, temporarily abandoned due to ice conditions, and finished later in the same drilling season.

Five exploration wells have been drilled in the vicinity of Shell's proposed exploration wells. All five wells were drilled during the open-water period using floating drilling units. Two wells initiated in 1989 and 1990 were drilled on or near the Crackerjack Prospect. One well initiated in 1989 was drilled on the Burger Prospect.

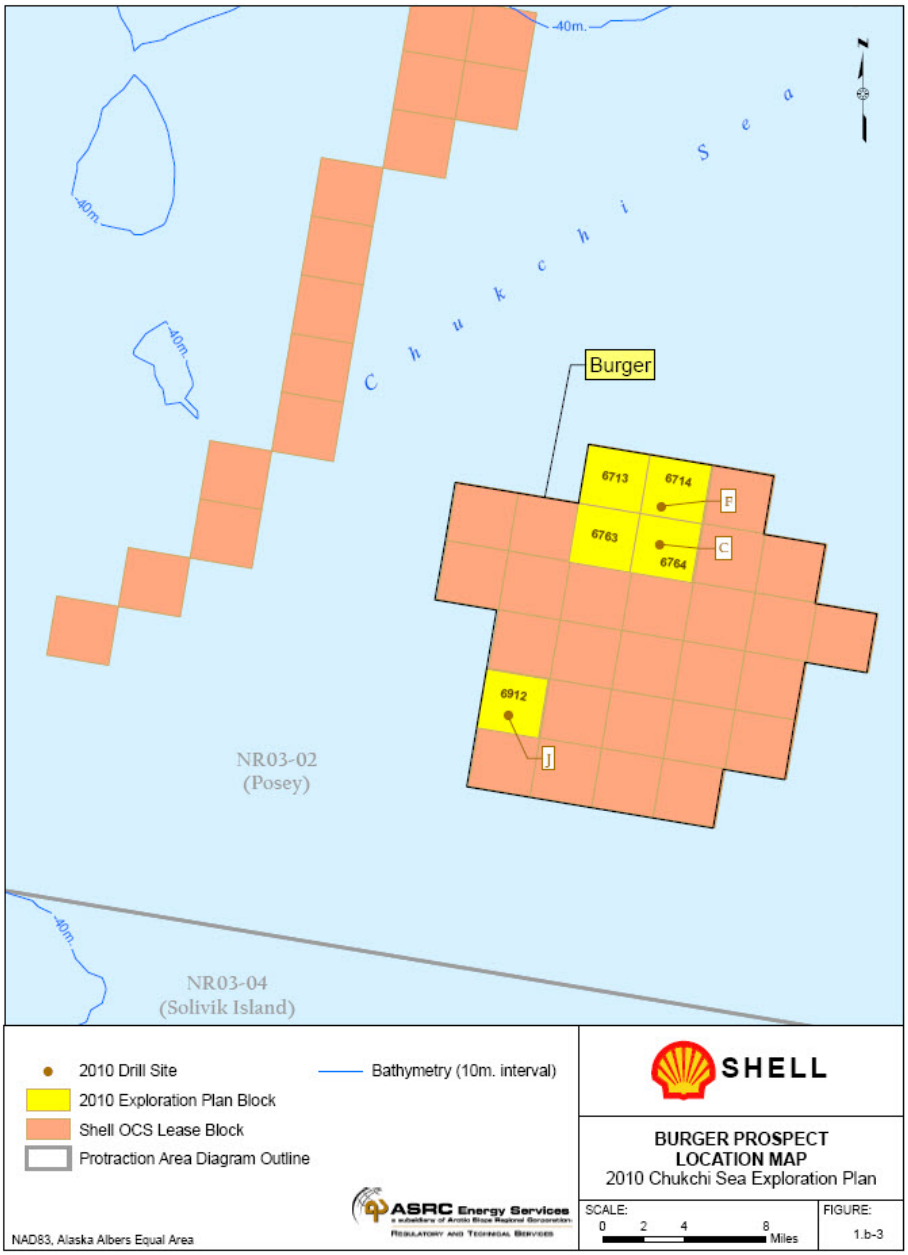

Figure 2-2. Location of Burger Prospect Wells C, F and J.

2.2 Alternatives

Alternative 1 –Proposed Action

The proposed action is to drill up to three exploration wells on oil and gas leases Shell acquired in Federal Chukchi OCS lease sale 193 in 2008. Shell has identified five potential drill sites in five of its Chukchi Sea leases. Shell proposes a single season of exploration drilling activities at up to three drill sites during the months of July through October 2010.

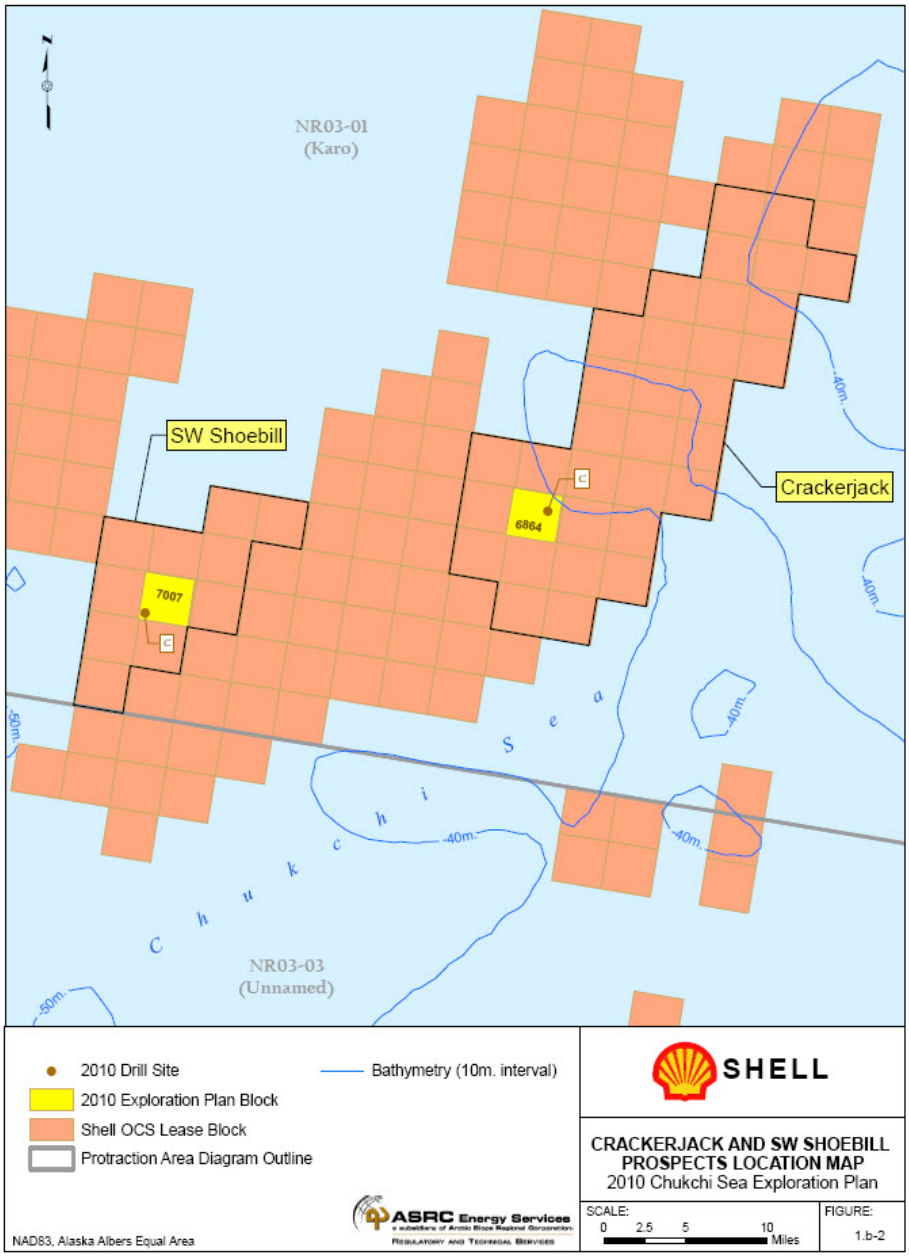

Figure 2-3. Location of Crackerjack and SW Shoebill Prospects.

Shell would drill from the *Discoverer*. The *Discoverer* has state-of-the-art drilling and well-control equipment. The *Discoverer* would be supported by additional vessels for ice management, anchor handling, crew transport and supplies, and spill response. Additional vessels would implement Shell's marine mammal monitoring and mitigation plan and support scientific research efforts. Shell states that all of the vessels are ice-class and specifically equipped for operating in Arctic waters.

Alternative 2 – No Action

Under this alternative, MMS would disapprove Shell's proposed exploration drilling activities. This alternative would delay or preclude Shell from evaluating the potential hydrocarbon resources of their leases acquired under OCS Lease Sale 193.

Other Alternatives Considered but Not Included for Further Analysis

"Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense…" (CEQ's Question 2a of NEPA's Forty Most Asked Questions). Alternatives must also meet the purpose and need of the proposal (40 CFR 1502.13). The purpose of the proposed action is evaluation of the oil and gas resource potential by Shell on the company's Outer Continental Shelf (OCS) leases in the U.S. Chukchi Sea. Shell's proposed exploration of their Chukchi Sea leases is 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. No additional alternatives that meet the purpose and need for the proposal were identified by MMS.

Some commenters on the EP stated they believed more baseline information was needed for the analysis and the decision on the EP. Some commenters stated that the activities should not be allow because they believe industry has as yet been unable to demonstrate an ability to clean-up oil spills in Arctic conditions. Some commenters stated that there should be additional opportunities to comment on the proposed activities and MMS environmental analysis (e.g., preparation of an EIS with scoping and public hearings, making the EA available for public review and comment before a decision on the EP). Aside from any consideration of the merits, accomplishing each would require substantial delay of the exploration activities. Such delay of the proposed activities would require Shell to submit a new or amended EP, which would require its own regulatory, technical, and environmental reviews. Therefore, delay of the proposed activities would be equivalent to the No Action Alternative.

The EA analysis has identified additional measures to further mitigate adverse impacts or reduce the risk of adverse impacts. The effectiveness of these measures is analyzed in the EA under the proposed action, rather than considering the measures as alternatives to the proposed action.

2.3 Description of the Proposed Action

2.3.1 Overview

Shell's proposal, as detailed in the EP (Shell Gulf of Mexico Inc., 2009a), is to use a single drillship, the *Discoverer*, to complete a single season of exploration drilling activities at up to three offshore locations in the Chukchi Sea. Up to three wells would be drilled on three distinct oil and gas prospects named by Shell as Burger, Crackerjack, and SW Shoebill within five leases. Three possible drill sites (one per block) are located on three different blocks (Posey 6714, 6764, and 6912) in the Burger Prospect, one is on a single block (Karo 6864) in the Crackerjack Prospect, and one is on a single block (Karo 7007) in the SW Shoebill Prospect. All three prospects are located on the mid-shelf region of the Chukchi Sea OCS Planning Area. Water depths at the drill sites are 142-149 ft (43.3-45.4 m). All five drill sites are evaluated in this EA.

Shell's proposed activities would be conducted during the summer open-water season. The activities are planned to begin on or about July 4, 2010, and extend through October 31, 2010, depending upon ice and weather. Each drill site has been surveyed by Shell and determined by MMS not to contain any shallow hazards or archaeological and historical resources. The prospect areas are representative of the relatively homogeneous ocean-bottom landscape in the mid-shelf region of the Chukchi Sea and contain no unique bottom habitats or relief features that would make these areas particularly attractive to fish or other biological resources.

Once the *Discoverer* is mobilized to a drill site and securely anchored to the seafloor, drilling operations would commence. Each well would take approximately 37 days to drill. Each well would be plugged and abandoned in accordance with MMS requirements upon completion of drilling.

Shell's proposed operations must comply with applicable Federal, State, and local laws, regulations, and lease and permit requirements. The MMS 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 MMS 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 AKG-28-0000 impose limitations on permissible discharges. Shell submitted Notices of Intent (NOI) dated May 22, 2009, to EPA requesting authorization for the *Discoverer* to discharge liquid wastes regulated under the NPDES General Permit at the Burger wells C, F, and J, Crackerjack well C, and SW Shoebill well C drill sites (Shell Gulf of Mexico Inc., 2009a: Appendix B).
- Air quality permit under the Clean Air Act from the EPA. The EPA's air quality permits limit and regulate air emissions to protect ambient air quality. Shell submitted an application for a Prevention of Significant Deterioration (PSD) permit for its 2010 exploration program to the EPA on December 11, 2008.
- Incidental Harassment Authorization (IHA) from NMFS regulating the incidental non-lethal harassment of protected species under the Marine Mammal Protection Act (MMPA). Shell submitted an application for an IHA dated May 22, 2009, to NMFS (Shell Gulf of Mexico Inc., 2009a: Appendix C).
- Letter of Authorization (LOA) from FWS regulating the incidental non-lethal harassment of protected species under MMPA. Shell submitted an application for an LOA dated May 22, 2009, to FWS (Shell Gulf of Mexico Inc., 2009a: Appendix E).
- 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.
- Coastal Consistency Concurrence under the CZMA from the State of Alaska, certifying that Shell's proposed activities are consistent with the enforceable standards of the Alaska Coastal Management Program (ACMP), including the enforceable standards of the North Slope Borough (NSB) Coastal Management District. A copy of Shell's Coastal Project Questionnaire and Certification Statement is in the EP (Shell Gulf of Mexico Inc., 2009a: Section 15.0 Attachment 15.1). Concurrent with the MMS review process, the EP and supporting environmental information were sent to the State for consistency-certification review and response.

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 has proposed an environmental orientation program (Shell Gulf of Mexico Inc., 2009a: Section 11.0) that informs Shell personnel and contractors regarding applicable laws and compliance obligations (Lease Stipulation 2, Sale 193);
- Marine Mammal Monitoring and Mitigation Plan (4MP) (Shell Gulf of Mexico Inc., 2009a: Appendix D) to avoid impacts to marine mammals and collect scientific data on marine mammal species (Lease Stipulation 4, Sale 193);

- Plan of Cooperation (POC) (Shell Gulf of Mexico Inc., 2009a: Appendix I) to coordinate exploration activities with Alaskan Native subsistence activities to avoid unreasonable interference with subsistence resources and activities (Lease Stipulation 5, Sale 193);
- Shell's Alaska Fuel Transfer Operating Conditions and Procedures (Shell Gulf of Mexico Inc., 2009a: Section 9.0, Attachment 9.4) (Lease Stipulation 6, Sale 193); and
- Shell's Bird Strike Avoidance and Lighting Plan Chukchi Sea Alaska (Shell Gulf of Mexico Inc., 2009a: Appendix J) (Lease Stipulation 7, Sale 193).

Under this EP, Shell would employ personnel and contractors experienced in operating in the Arctic 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.

2.3.2 Drill Sites and Operating Environment

Shell proposes exploration drilling up to three wells at five potential drill sites. The five drill sites are located on the continental shelf in the central Chukchi Sea OCS Planning Area. Sediments at all identified locations are predominately composed of silty sands and mud. Ice gouging of the seafloor is observed at all three prospects despite water depths of approximately 141-150 ft (40-46 m) (Table 2-1). The two communities in closest proximity to the proposed exploration activities are Point Lay and Wainwright.

Table 2-1 Proposed Drill Sites – Burger, Crackerjack, and SW Shoebill Prospects, Chukchi Sea

Prospect	Well	Area	Block	Lease Number	Water Depth	Days to Drill	Latitude	Longitude
Burger	C	Posey	6764	OCS-Y-2280	149'	37	N71° 18' 17.2739"	W163° 12' 45.9891"
Burger	F	Posey	6714	OCS-Y-2267	148'	37	N71° 20' 13.9640"	W163° 12' 21.7460"
Burger	J	Posey	6912	OCS-Y-2321	144'	37	N71° 10' 24.0292"	W163° 28' 18.5219"
Crackerjack	C	Karo	6864	OCS-Y-2111	142"	37	N71° 13' 58.9211"	W166° 14' 10.7889"
SW Shoebill	C	Karo	7007	OCS-Y-2142	149"	37	N71° 04' 24.4163"	W167° 13' 38.0886"

Note: Coordinate system is NAD 83 UTM Zone 3

- The Burger C drill site is located about 78 statute mi (126 km) offshore to the west-northwest of the village of Wainwright, the nearest community.
- The Burger F drill site is located about 78 statute mi (126 km) offshore to the west-northwest of the village of Wainwright, the nearest community.
- The Burger J drill site is located about 78 statute mi (126 km) offshore to the west-northwest of the village of Wainwright, the nearest community.
- The Crackerjack C drill site is located about 126 statute mi (202 km) to the west-northwest of the village of Point Lay, the nearest community.
- The SW Shoebill C drill site is located about 133 statute mi (214 km) offshore to the west-northwest of the village of Point Lay, the nearest community.

Shell plans to temporarily establish shorebase facilities at Barrow and Wainwright for the duration of the planned 2010 exploration drilling program.

Seafloor Conditions at the Drill Sites

The MMS regulations (30 CFR 250.214) require shallow hazards assessment be conducted prior to drilling or installing mobile drilling units for oil and gas activities. A summary of the shallow-hazards assessment is presented in the EIA (Shell Gulf of Mexico Inc., 2009b: Sections 1.3, 1.4, and 3.3.2). A short chronology and summary of pertinent shallow-hazards surveys and assessments are presented here.

Shallow hazards surveys were conducted in 1988 and 1989 over ten historical industry prospects in the vicinity of Shell's current proposed activities (EIA Table 3.3.2-1). The historic Tourmaline survey (Fugro, 1989) and Crackerjack survey cover portions of Shell's current Crackerjack Prospect, and the historic Burger survey (Fugro, 1990) covers portions of Shell's current Burger Prospect including four of Shell's EP Blocks (Posey 6713, 6714, 6763, and 6764). The historic shallow hazard survey data collected over the Burger Prospect was re-analyzed by Fugro for the Burger C and F drill sites. Fugro prepared an updated shallow hazards and cultural resources/archaeological assessment (Fugro, 2009).

In 1989-1990, Shell conducted shallow-hazards surveys at the Burger prospect and in the vicinity of Crackerjack C drill site. In 2008, Shell collected shallow-hazards data at the Burger J, Crackerjack C, and SW Shoebill C drill sites.

In 2008, Shell contracted Geoscience Earth & Marine Services, Inc. (GEMS) to conduct shallow-hazards surveys across the Burger, Crackerjack, and SW Shoebill prospects. The following parameters were assessed and analyzed for both shallow hazards and 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.

- Bathymetry
- Ice gouging
- Buried channels
- Seafloor obstructions
- Surficial sediments
- Sediment slides
- Permafrost
- Shallow faulting
- Seismicity
- Shallow gas
- Natural gas hydrates
- Archaeological features

The planned Burger C, F, and J drill sites were evaluated based on the re analyzed assessments of 1989-1990 and the 2008 shallow hazards survey data. The planned Crackerjack C and SW Shoebill drill sites were evaluated based on data collected during the shallow-hazards surveys conducted in 2008 by GEMS (2009a; 2009b; 2009c).

The shallow-hazards surveys identified no manmade or geologic risks at any of the proposed drill sites. Other than ice gouging, the shallow-hazards surveys did not identify any shallow hazards or constraints at any of the drill sites. The installation of a mudline cellar (MLC), or well cellar, at the drill sites would mitigate the potential operational risk from ice gouging. The MLC would be sufficiently deep (approximately 37 ft [11.2 m]) to ensure that, if a drill site were to be temporarily abandoned during an emergency, wellhead equipment would be below the maximum ice-scour depth of 7 ft (2.1 m). The wellhead equipment would thereby be protected from the maximum anticipated ice-keel scour.

The MMS has reviewed the data and reports and concurs with Shell's findings that no shallow hazards occur at the proposed Burger C, F, or J, Crackerjack C, or SW Shoebill C drill sites. The MMS concurs with Shell's finding that there are no indications of historic sites or prehistoric archaeological resources at the proposed Burger C, F, or J drill sites. The MMS also reviewed the seafloor survey data for potential seafloor habitat or communities. No unique seafloor habitat or communities were identified at the proposed Burger C, F, or J drill sites.

Expected Weather Conditions at the Drill Sites

Shell's Chukchi Sea prospects are located in the Arctic Climatic Zone, which is characterized by cold temperatures, nearly constant wind, and low precipitation. Climate summaries for weather stations near the villages of Barrow, Point Lay, and Wainwright are provided in EIA Tables 3.1.1-1, 3.1.1-2, and 3.1.1-3 (Shell Gulf of Mexico Inc., 2009b), respectively.

The lack of natural wind barriers results in unrestricted winds in the Alaskan Arctic. Gusting winds are more frequent between September and November. Along the coast, gale-force winds (greater than 39 mph [34 knots]) are frequent, and wind velocities of hurricane strength (greater than 74 mph [64 knots]) have been recorded for this region. Although rare in April, May, and June, occasional high-wind events and sudden storms have been reported (USDOI, MMS, 2007b). An analysis of high-wind events in Barrow from 1955-2000 indicates that the extreme winds in the fall have decreased slightly and the winds in the summer have increased slightly (Lynch et al., 2004).

The open-water drilling season is from the beginning of July to the end of October. Summers are characterized by a high frequency of fog and southwesterly winds; while in winter, snowstorms are accompanied by strong easterly, northeasterly, and northerly winds. Available information indicates that snowfall accumulation in October is minimal. In general, the region has 6 to 10 storm-days per month with storms typically lasting from 6 to 24 hours; however, individual storms may last up to 14 days.

Expected Ice Conditions at the Drill Sites

The sea-ice descriptions in the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a) and the Shell EIA (Shell Gulf of Mexico Inc., 2009b) are incorporated by reference and salient points are summarized as follows. There are three general forms of sea ice in the project area, including the shorebase: (1) landfast ice, which is attached to the shore, is relatively immobile, and extends to 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 arctic sea ice is undergoing rapid changes. There are reported changes in sea-ice extent, thickness, distribution, age, and melt duration. In general the sea-ice extent is becoming much less in the arctic summer and slightly less in winter, and the decline in sea-ice extent is increasing. The thickness of arctic ice is decreasing. 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.

Shell's proposed drilling activities are planned for the Arctic summer "open-water" season. The proposed drill sites are seaward of the typical extent of landfast ice during the time of operations. 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.

The start of on-site project activities would begin after July 1, which coincides with the retreat of the ice in most years (early June to late July). The duration of open water (less than 10% ice concentration) in the central Chukchi Sea has lengthened by up to four weeks over the past 30 years to a summer average of 17 weeks. However, the range of open water is variable from year to year and ice could be present at the proposed drill sites. High concentrations (>10%) of ice in early July may delay start of operations.

There can be significant differences in the timing of pack ice retreat and melting between years as evidenced by the analysis below. The MMS reviewed ten years (2000-2009) of NOAA National Ice Center ice coverage data within the date range of July 1st to July 4th. The distance from each of the proposed drill sites from the edge of the pack ice in early July 1 of each year over this period was calculated utilizing ArcGIS software. Specifically, over this period, the distance to the ice edge from the proposed SW Shoebill drill site varied from 51 km (32 mi) north of the southern pack ice edge (where the

site was under pack ice) in 2009 to 100 km (62 mi) south of the southern pack ice edge in 2005 (where the site was in open water); a difference of 151 km (94 mi) between the two years. Similarly, the ice conditions at the proposed Crackerjack well site varied extensively between 2009 and 2005. The Crackerjack well site was under pack ice 50 km (31 mi) north of the pack ice edge in 2009, whereas in 2005, the site was in open water 87 km (54 mi) south of the pack ice edge. At the proposed Burger J well site, the pack ice boundary again varied substantially between the maximum southern ice extent of the pack ice boundary in 2000 and the minimum pack ice edge extent in 2005 within the analyzed period. In 2000, the Burger J well site was under pack ice and the pack ice edge was 64 km (40 mi) to the south of the site. In 2005, the Burger J well site was in open water and the pack ice edge was 72 km (45 mi) north of the site. The proposed Burger F well site was under pack ice, approximately 87 km (54 mi) north of the pack ice edge in 2000, whereas in 2005, the site was in open water and the pack ice edge was 53 km (33 mi) north; a difference between the two years of 140 km (87 mi). The proposed Burger C well site was under pack ice approximately 84 km (52 mi) north of the pack ice edge in 2000, whereas in 2005, the site was in open water and the pack ice edge was 55 km (34 mi) to the north. In summary, during the analyzed ten-year period 2000-2009, a minimum pack ice extent in the Chukchi Sea occurred in 2005. All of the proposed well sites would have been located in open water and the pack ice would have been on average 73 km (45 mi) to the north. In comparison, during the minimum ice years within this ten-year period (2000 and 2009), all of the proposed well sites would have been under pack ice.

Floating ice could approach established drilling operations. Shell's Ice Management Plan (Shell Gulf of Mexico Inc., 2009a: Section 9.0 b) would be implemented to change the direction of approaching ice to ensure safe operations at all times. Ice-management activities would also include keeping ice from forming or piling up at the drillship's hull. Shell's proposed activities would conclude on or before the surface of the Chukchi Sea begins forming thick winter sea ice, which historically varies from late October to mid December. Additional information on Chukchi Sea ice and Arctic sea ice trends is presented in Section 3.2.3 of Shell's EIA and in Section 3.4 of Shell's ODCPC (Shell Gulf of Mexico Inc., 2009c).

2.3.3 Drillship, Support Vessels, Aircraft, and Shore-Based Support

Shell would conduct drilling operations using the *Discoverer* and the latest drilling technologies and techniques. The *Discoverer* is a modern drillship retrofitted for operating in Arctic OCS waters. The *Discoverer* has state-of-the-art drilling and well-control equipment. The drillship *Discoverer* would be attended by a minimum of six vessels that would be used for ice-management, anchor handling, oil spill response, refueling, supply, and servicing. The ice-management vessels would consist of an icebreaker and an anchor handler. The icebreaker would be located at a distance of several miles or more away from the drill site. For oil-spill response, vessels would include an oil-spill-response vessel (OSRV), a tank vessel for storage of any recovered liquids, and associated smaller workboats. The OSRV, with a full complement of crew and spill-response equipment, would be staged near the *Discoverer*. An oil-spill-response barge and a tug would be located in waters near Wainwright.

The other support vessels and aircraft would be deployed to the site as needed. A re-supply ship would travel from Wainwright to the drilling vessel as needed. There would be one flight per day by a support helicopter from the shore base to the drill site. Additional vessels would implement Shell's marine mammal monitoring program (4MP) (Shell Gulf of Mexico Inc., 2009a: Appendix D) and support scientific research efforts. Aircraft would be used for aerial marine mammal monitoring near the coast.

Tables 2.2-1, 2.2-2, and 2.2-3 in the EIA (Shell Gulf of Mexico Inc., 2009b) lists the specifications of the drilling and support vessels Shell is proposing to use. In addition, Shell provides estimates for trip frequency and duration for each vessel and aircraft (Shell Gulf of Mexico Inc., 2009a: Section 13, Table 13.a-3). Shell states that all support vessels would be ice-class and specifically equipped for operating in arctic waters.

The *Discoverer* is a true floating drilling vessel (drillship), which means it mobilizes under its own power. The *Discoverer* is a 514 ft (156 m) moored drillship with drilling equipment on a turret. The *Discoverer* is winterized for service in the arctic offshore environment. It can be moved off the drill site in a matter of hours with the help of its anchor handler. It is a self-contained drilling unit with full accommodations for a crew of up to 124 persons (quarters, galley, and sanitation facilities).

The *Discoverer* would be positioned at the proposed drill site under its own power, and then anchored using an eight anchor system. Each anchor would be placed up to 3,600 feet (1,100 m) from the drillship and is 17 ft (5.2 m) wide by 18 ft (5.5 m) long. Anchors would be embedded an estimated 11 ft (3.4 m) into the seafloor. Setting and removing the anchors would be accomplished using an anchor-handling vessel. Shell estimates that the total scar area for all eight anchors would be 16, 992 ft^2 (1,579 m^2) per well. The total volume of disturbed sediments for all eight anchors is estimated by Shell to be 4,064 yd^3 (3,107 m^3) per well.

The *Discoverer* would have approximately 111 total drilling days in the project area. Drilling days for each well is estimated at 37 days. The "days onsite" for each well includes five days for constructing the MLC, one day to set anchors, one day to remove anchors, and one day to move. Transit speed of the *Discoverer* is 8 knots.

Shell's Critical Operations and Curtailment (COCP) Plan (Shell Gulf of Mexico Inc., 2009a: Attachment 9.1) 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.

Shell has developed and will implement a Critical Operations and Curtailment Plan (COCP) (Shell Gulf of Mexico Inc., 2009a: Section 9.0 Attachment 9.1), which establishes protocols to be followed in the event potential hazards (e.g., ice floes, inclement weather) are identified in the vicinity of the drilling operations. The COCP threat classifications are based on the time available to prepare the well and safely move off the drill 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. Ice management activities are likely to include pushing and breaking up some small floes, but are unlikely to include breaking large sheets of ice or thick multi-year ice.

Most personnel transfers and some logistics support of the drilling program would be by helicopter. Helicopters would be used for crew changes. Peak helicopter trip frequency is estimated at one per day (Shell Gulf of Mexico Inc. 2009a: Table 13.a-3).

Fixed-wing aircraft would be used for marine mammal monitoring. Aerial monitoring would enhance the monitoring of onboard marine mammal observers (MMO) and acoustic monitoring. Shell's aerial monitoring program is described in the Marine Mammal Monitoring and Mitigation Plan (4MP) (Shell Gulf of Mexico Inc., 2009a: Appendix D). Aircraft travel would be controlled by Federal Aviation Administration approved flight paths and would comply with flight restrictions imposed by the Lease Sale 193 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. As indicated in the EP, Shell's flight restrictions would prohibit 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.

EA Figure 2-4 depicts vessel traffic routes to the drill sites. EA Figure 2-5 (following page) depicts the helicopter routes to the drill sites. From Wainwright, the boat and helicopter flight paths are direct to the Burger, Crackerjack, or SW Shoebill prospects.

Shell would temporarily establish shorebase facilities in Barrow and Wainwright and use these facilities for the duration of the planned 2010 exploration drilling program. Shorebase facilities for air support would be located in either Barrow, at the State-owned and operated Barrow Wiley Post Will Rogers Memorial Airport (Barrow Airport), or the airstrip located in the Village of Wainwright, which is owned and operated by the NSB. The airstrip at the Distant Early Warning (DEW line) site outside of Wainwright may also be available for emergency purposes.

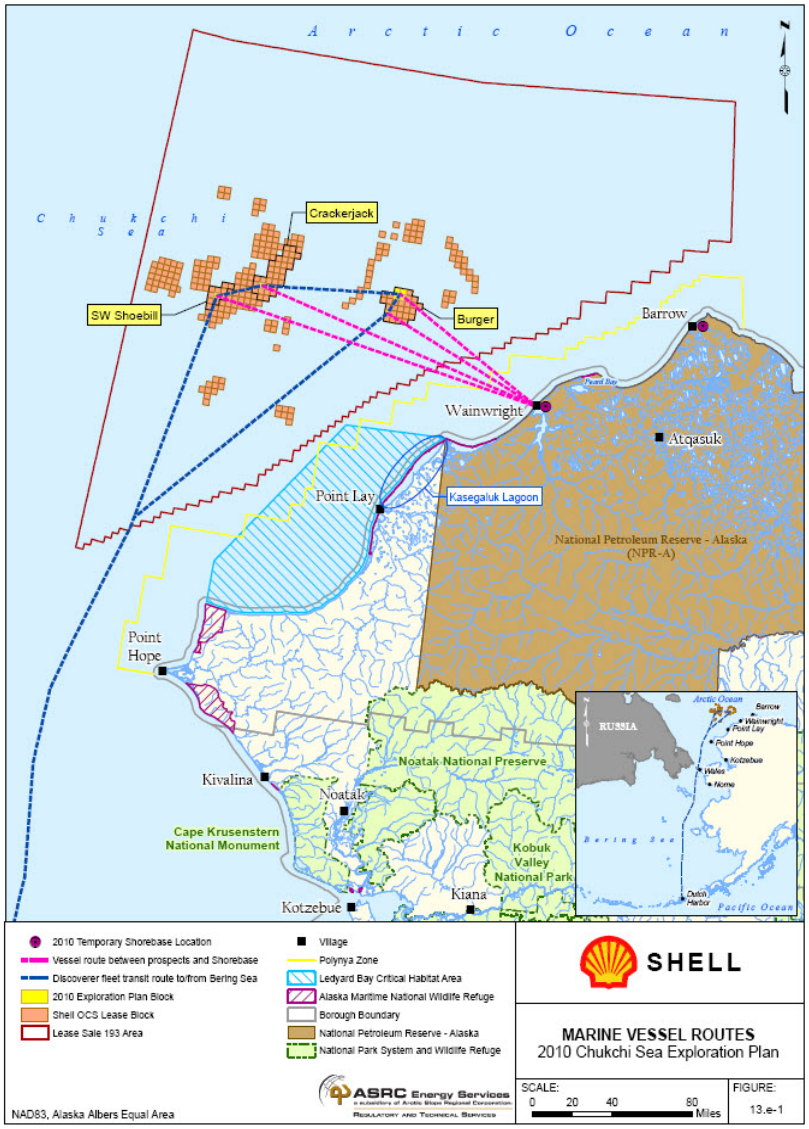

Figure 2-4. Marine Vessel Routes.

Support helicopters would be stationed and serviced in existing facilities at the Barrow airport, or possibly out of the Village of Wainwright. A hangar would be constructed on an existing pad at either location for housing the helicopter. Offshore crewmembers would be transported to shore at either Wainwright or Barrow via helicopter and then transported to Barrow or Fairbanks using a fixed wing airplane. The helicopter would relocate to Barrow each evening if stationed at Barrow, or remain in Wainwright if the hangar is constructed.

Shell currently leases office space in Barrow and would continue to use these facilities during the 2010 exploration drilling program. Additional office space may be leased during 2010, but no other development of new facilities or expansion of existing facilities in Barrow is planned for 2010. Existing accommodations such as hotels would be used for the shorebase staff, which is expected to be approximately 6-7 persons.

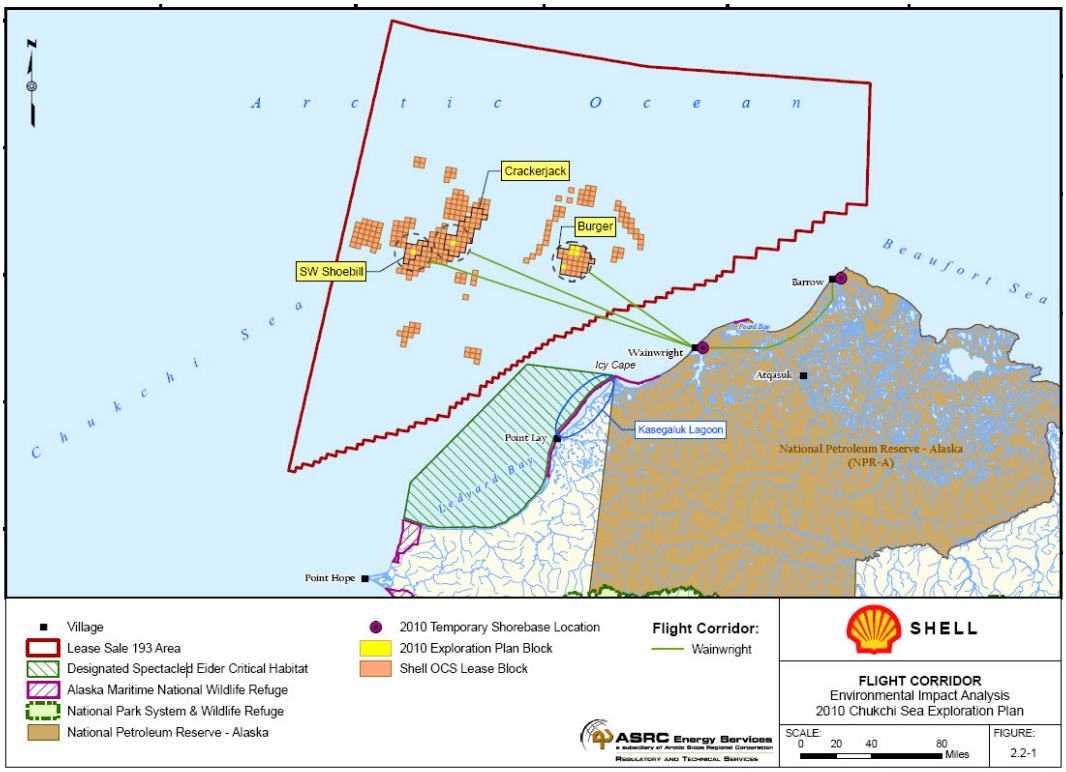

Figure 2-5. Flight Corridor.

Shorebase facilities for marine support may be temporarily established in the Village of Wainwright for the 2010 exploration drilling program. No expansions to the Village of Wainwright airstrip are planned, although Shell may improve the runway surface and conduct periodic maintenance throughout 2010.

There are currently no docks in Wainwright. The two existing earthen boat ramps (at the lagoon and at the lagoon entrance) connected to the village by gravel roads would be used for marine access and support by shallow draft vessels. The primary ramp for the exploration drilling program would be the lagoon ramp, and the primary use of the ramp would be to support oil spill response (OSR) training. No new docks are planned for the 2010 exploration drilling program. Lift and hoist equipment (crane) would be installed near the ramp if feasible. Lifting may be accomplished by forklifts and other smaller pieces of equipment. Aviation and marine fuel would be stored in Wainwright, and a secure yard would be established for storage of oil spill response equipment and load staging for the marine vessels. Shell would use an existing 30,000-gallon (113 m^3) tank for diesel and bring in three additional 50,000-gallon (189 m^3) tanks for aviation fuel. All four tanks would be inspected, certified, double-walled tanks on gravel pads, with secondary containment capable of holding 110% of the tank volume.

Existing accommodations in Wainwright would be used to the extent possible. The 20 personnel based in Wainwright would be housed in Olgoonik's existing 20-man camp for 110-150 days (Shell Offshore Gulf of Mexico Inc. letter to MMS dated August 13, 2009). Consistent with Shell's travel policy, personnel who are not residents of Wainwright would report for their shifts in Anchorage and rotate to and from

their duty stations in Wainwright on a bi-monthly basis. Shell would not have additional personnel in Wainwright except in an emergency situation.

In the event of weather problems, Shell would first attempt to stop the crew change flight in Anchorage. If the crew change flight has already landed in Barrow, Shell would house the crew in Barrow in 35 bunks provided by the Ukpeagvik Inupiat Corporation. In the event of an emergency diversion to Wainwright, personnel would either wait for weather to improve, be provided a charter flight to Anchorage, or would be transported to the drill ship to be housed until weather conditions allow safe transport to their final destination (Shell Offshore Gulf of Mexico Inc. letter to MMS dated August 13, 2009). Shell would make all reasonable efforts to move personnel out of Wainwright at the earliest possible time.

2.3.4 Discharges and Waste Management

The general NPDES permit AKG-28-0000 (EPA, 2006) for the offshore areas of Alaska, including the Chukchi Sea, authorizes discharges from oil and gas exploration facilities. The Arctic general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment. The *Discoverer* is permitted under the NPDES for the Chukchi Sea and would be the sole drilling vessel used for exploration. Under the NPDES General Permit AKG-28-0000, eleven separate effluent streams are allowed for the *Discoverer*. Each effluent stream, and the associated projected amount of discharge, is listed in Table 2.6-3 of the EIA.

Shell would use water-based drilling fluids. Shell estimates that 4,405, 4,730, and 5,005 barrels (bbl) of water-based drilling muds, respectively, would be used at the Burger F, Crackerjack, and SW Shoebill drill sites. Drilling fluid volumes and chemistry would comply with NPDES General Permit conditions.

During the 2010 drilling season, the *Discoverer* would be used to construct the MLCs, set casing, and drill up to three wells each to total depth. Shell would recycle drilling muds (e.g., use muds on multiple wells), to the extent practicable based on operational considerations (e.g., mud 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 discharged into marine waters in conformance with NPDES permit conditions. At the end of the season, excess water-based fluid, approximately 1,500 bbl (238 m^3), would be diluted to a 30:1 ratio with seawater and then discharged into marine waters in conformance with NPDES permit conditions. The NPDES Arctic General Permit allows for discharge of both drill cuttings and used drilling fluids to ambient waters of the Chukchi Sea at each drill site.

Wastes include cement slurry, drainage waters, and domestic wastewaters. Certain discharges are made through the drillship's disposal caisson (Shell Gulf of Mexico Inc., 2009b: Table 2.6-3). The base of the discharge caisson while drilling is 19.6 ft (6.0 m) below mean sea level.

Cement would be used to set the steel casing in the wellbore and to plug the well after it has been drilled to depth. Drainage waters include rainfall landing on the deck surfaces of the drillship, and wash-down water generated when cleaning portions of the deck. Domestic wastewaters include gray water, which is effluent from showers, laundry, and liquid galley wastes, and black water from treated sewage. Cement slurry, drainage waters, and black water are discharged (after sanitation treatment) according to the conditions and limitations of the NPDES General Permit.

The volumes of liquid/fluid, slurry, and cuttings expected to be generated and the rates at which they would be discharged are indicated in Tables 2.6.1-b, 2.6.2-b, and 2.6.3-b of the EIA.

A list of the components that may be added to the drilling fluid is summarized in Table 2.5-1 of the EIA. The component list and the associated volumes account for drilling needs at various depths from the MLC to total depth for each well.

The discharge produced from the water cooling unit is expected to be 2.5 ˚F (1.4 ˚C) above the ambient temperature. Seawater temperature is expected to reach ambient temperature within 450 ft (137 m) of the drillship.

Solid wastes (trash) would be segregated and disposed of or recycled at approved disposal or recycling facilities on land. Solid food wastes would be incinerated onboard. Shell would use either the Wainwright Landfill operated by the NSB or would contract the services of Phillips Service in Anchorage.

Hazardous waste and used oil would be stored onboard in approved containers, and then transferred by boat to an approved disposal site.

2.3.5 Emissions

Emissions from the *Discoverer* and support vessels would be authorized through an air quality permit issued by EPA under the Clean Air Act (CAA).

The drillship, *Discoverer,* would be attended by vessels for ice management, anchor handling, spill response, refueling, resupply, and servicing. The primary sources of the emissions by the *Discoverer* drillship and support vessels would be combustion engines including the vessel engines, generators, compressors, draw works, and pumps. Emission units on the *Discoverer* 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. All emission units on the *Discoverer* would use diesel with sulfur content at or below 15 parts per million (ppm).

The six main generator engines on the *Discoverer* would be equipped with selective catalytic reduction systems (SCR) to reduce emissions of NO_x as well as CO and VOC. The air compressor engines would meet EPA Tier 3 emission standards. The hydraulic power units, cranes, cementing, and logging units would have catalytic diesel particulate filters to reduce emissions of volatile organics, carbon monoxide, and hydrocarbon particulate matter. The compressors, hydraulic power units, and cranes are assumed to operate a maximum of 63 days for the season. The incinerator would be limited to a daily capacity of 1,525 pounds per day. The sulfur content of all engines on the *Discover*, except the propulsion engines, would be limited to 15 ppm. The sulfur content of fuel used by support vessels would be 0.19%.

Ice-management activity accounts for more than 90% of support vessels' emissions; thus, total emissions would be lower in favorable ice conditions. The remainder of emissions would be generated from the production of electricity, compressed air, and hydraulic pressure to support drilling; incineration of solid waste; and as a low-volume deliberate by-product ("ammonia" slip) from air pollution control equipment to reduce oxides of nitrogen. Emissions generated from the proposed activities would include NO_x, CO, SO_2, $PM_{10,}$ $PM_{2.5}$, and lead (Pb). The project would generate lesser quantities of VOCs, HAPs, ammonia, and CO_2.

Estimates of the total annual potential emissions for the *Discoverer* and support vessel sources are provided in Table 7.a-3 of the EP (Shell Gulf of Mexico, Inc., 2009a). Table 2.7-1 of the EIA has outdated emissions information (Shell Gulf of Mexico Inc., 2009b). Shell confirmed that the emissions inventories included in EP Section 7 are the updated numbers submitted to EPA in the May 29, 2009, Supplemental Response to EPA. Support-vessel emissions are included only when the vessel is within

25 mi (40 km) of the drillship. The project total annual HAPs are estimated at about 3.5 tons per year, which is below the EPA 25-ton per year major source threshold. Shell's modeling of project emissions are based on a maximum 168-day drilling season.

To determine whether a proposed OCS activity is exempt from further air quality review under MMS operating regulations, the highest annual total amount of emissions from the facility for each air pollutant calculated using the following formulas in Sec. 250.218(a) or 250.249(a) (below) and the results compared to the emission exemption amount "E" for each air pollutant.

> $E=3400D^{2/3}$ for CO; and E=33.3D for TSP, SO_2, NO_X, and VOC (where E is the emission exemption amount expressed in tons per year, and D is the distance of the facility from the closest onshore area of the State expressed in statute miles).

If the amount of projected emissions is less than or equal to the emission exemption amount "E" for the air pollutant, the facility is exempt for that air pollutant from further air quality review.

The exemption formulas calculations for Shell's proposed Chukchi exploration drilling program are:

> $E=3400D^{2/3}$ for CO= $3400*60^{2/3}$= 52,109 tons CO
>
> E=33.3D for TSP= 33.3 * 60= 1,998 tons TSP
>
> E=33.3D for SO_2= 33.3 * 60= 1,998 tons SO_2
>
> E=33.3D for NO_X= 33.3 * 60= 1,998 tons NO_X
>
> E=33.3D for VOC= 33.3 * 60= 1,998 tons VOC

Because the amount of projected emissions is less than or equal to the emission exemption amount "E" for each air pollutant, the proposed activities are exempt from further air quality review under MMS rules.

Shell has committed to applying emission reduction measures in their proposed activities. Shell's BACT measures are equivalent to the BACT requirements in the EPA proposed Chukchi Sea Permit Number R10OCS/PSD-AK-09-01 for the *Discoverer*. As the agency with jurisdiction over air quality on the Alaska OCS, EPA will include final BACT requirements upon promulgation of a permit for Shell's Chukchi Sea operations. The MMS will not approve an APD and commencement of activities will not be authorized until Shell's receipt of the required air quality permit. The MMS has determined that Shell's emission reduction measures achieve BACT required under MMS regulations for temporary OCS facilities. The modeling described under MMS regulations at 30 CFR 250.303(e) is to determine whether projected emissions may trigger the need for emission controls. For temporary facilities, the required emission controls are BACT (30 CFR 250.303(h)). With BACT incorporated in the proposed activities, it is not necessary for modeling to be performed to determine whether BACT is needed (30 CFR 250.303(a) states: "the lessee shall comply with the requirements of this section as necessary).

Shell's BACT and emission reduction measures (Shell Gulf of Mexico Inc., 2009b: Section 4.1.1) include:

- Limiting the drilling to 168 days.
- Primary generators on the *Discoverer* will be retrofitted with selective catalytic reduction devices to reduce nitrogen oxides (NOx) emissions to under 0.5 grams/kilowatt-hour (g/kW-hr), and catalytic oxidation devices to reduce carbon monoxide (CO) by 80%, volatile organic compounds (VOCs) by 70%, and particulate matter of 10 microns or less (PM_{10}) by at least 50%.
- All other engines on the *Discoverer* will either be Tier 3 (low emissions) or will be retrofitted with catalytic Diesel Particulate Filters devices to reduce CO, VOCs, and hazardous air pollutants (HAPs) by at least 90% and fine particulate matter of 2.5 microns or less ($PM_{2.5}$) by at least 85%.

- Ultra-low sulfur content (0.0015%) fuel will be used by the *Discoverer* and low sulfur content (0.19%) fuel will be used by support vessels to reduce sulfur dioxide (SO_2) emissions.
- Limiting combined generator usage to 71% of combined engine capacity.
- Limiting the MLC compressors to the equivalent emissions of 2 of the 3 operating at the capacity for 63 days.
- Limiting the cranes to the equivalent emissions of both cranes operating at capacity for 63 days per season.
- Limiting daily cementing and logging to the equivalent emissions of 30% of combined cementing engine capacity.
- Limiting incinerator use to 1,525 pounds per day (lb/day).

Shell also performed a cumulative impact analysis by including emissions from existing sources over a wide area. Concentrations were within the PSD Class II incremental limits and the national ambient air quality standards.

2.3.6 Sound Generation

When ice-management vessels are transiting open water, sound generated is less than when actually 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., 1995).

Sounds generated by the *Discoverer* have not yet been directly measured and noise propagation measurements are not yet available. However, measurements of sounds from a similar drillship, *Northern Explorer II*, were performed at two different times and locations in the Beaufort Sea (Miles et al., 1987; Greene, 1987). During acoustic data collection, there was a support vessel idling in the vicinity of the drill rig (Miles et al., 1987; Greene, 1987). Source levels for the *Discoverer* were estimated based on its similarity to the *Northern Explorer II.* A comparison of the key specifications for the two drillships is provided in Table 5-1 of Shell's Application to NMFS for an IHA (Shell Gulf of Mexico Inc., 2009a: Appendix C).

These measurements provide source levels for modeling noise propagation from the *Discoverer*. The *Northern Explorer II* was used as a proxy source for the *Discoverer*.

In 2009, JASCO modeled sound-level thresholds for the *Northern Explorer II* for the three Chukchi Sea locations, the Burger, Crackerjack, and SW Shoebill. Preliminary sound modeling is summarized in Shell's IHA and LOA applications (Shell Gulf of Mexico Inc., 2009a: Appendixes C and E, respectively).

At 1 km from the *Northern Explorer II*, the frequency spectrum ranges from one hertz (Hz) to more than five kilohertz (kHz) (Greene, 1987; Miles et al., 1987). There are narrowband tonal peaks near 72 Hz and 239 Hz, and broadband peaks at 920 Hz and 1640 Hz (Miles et al., 1987).

Modeled sound radii indicate that the sound from drill ship would not exceed 180 dB. The 160-dB radius for the *Discoverer* was modeled to be < 0.10 km (< 100 m; < 328 ft) from the drill ship. The area estimated to be exposed to ≥ 160 dB around the *Discoverer* operating at any of the planned drill sites is approximately 0.01 km^2. The 120-dB radius was modeled to be at 1.36 km (0.85 mi) from the drill ship in July and at 1.47 km in October for the Burger site. The 120-dB radius was modeled to be between 0.51 and 0.57 km (0.32-0.35 mi) for the SW Shoebill site and 0.38-0.59 km (0.24-0.37 mi) for the SW Shoebill site and Crackerjack site, respectively, in the July-October time periods. The varied modeling results for the sound radii at the different drill sites reflect site-specific factors including water depth, seafloor topography, and seasonal and depth variations in water temperature. The modeled sound radii would be verified through field measures soon after the drill ship is onsite.

Ice-management activities may be necessary in early July and/or near the end of operations in late October, if ice is present. Based on source levels for the icebreaker *Vladimir Ignatjuk* (reported in Brewer et al., 1993, and Hall et al., 1994), sounds produced while the vessel was actively managing ice in this area were estimated to fall below 160 dB rms at within 150 m from the vessel and to fall below 120 dB rms at about 8 km from the vessel. For the *Vladimir Ignatjuk* standing by (cruising at 2 knots), the sound level was modeled to reach 160 dB at less than 0.10 km (< 100 m, < 328 ft) from the vessel. The 120-dB radius for the *Vladimir Ignatjuk* at standby was modeled to range from 8.46 km (5.3 mi) in July to 9.58 km (6.0 mi) in October for the Burger site, 4.98 km (3.1 mi) in July to 4.69 km (2.9 mi) in October for the SW Shoebill site, and 4.87 km (3.0 mi) in July to 5.98 km (3.7 mi) in October at the Crackerjack site. For the proposed activities, the sound radii for the ice-management vessel would be verified through field measurements when the vessel is on site and actively managing ice.

Because any ice management would be an effort to preemptively manage ice away from the drillship at a safe distance, Shell estimates that any ice-management activities would occur at a distance of 6.2-9.3 mi (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*. Therefore areas exposed to sound levels of 160 dB or greater around the drillship and around ice-management activities are not expected to overlap.

Shell would verify the modeled decibel 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 as soon as possible after the *Discoverer* is onsite.

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) (Richardson et al., 1989, citing Greene, 1985).

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 airplanes engaged in marine mammal monitoring, aircraft would use a flight path that keeps the aircraft at least 5 mi (8 km) inland between Barrow and Wainwright.

2.3.7 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
- Oil Spill Response

The MMO program employs, among others, local Inupiat 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 then use that information to develop appropriate mitigation measures to address concerns related to subsistence activities and to avoid potential conflicts.

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.

2.3.8 Analysis of Accidental Oil Spills

For purposes of this EA analysis, no large spills (≥ 1,000 bbl) or very large (≥ 150,000 bbls) crude oil spills are estimated based on calculations and analyses (Appendix A) from the proposed exploration activities. (Note that MMS' definition of a large spill (≥ 1,000 bbl) used in this analysis is different from the definition of large spill (≥ 48 bbl) used in the EIA.) This estimate is based on: (1) the low rate of OCS exploratory drilling well-control incidents spilling fluids per well drilled; (2) since 1971 no large spills have occurred from exploratory drilling well-control incidents while drilling more than 14,000 wells; (3) the low number of exploration wells being drilled from this proposal; (4) no crude oil would be produced; and (5) the history of exploration spills on the Arctic OCS, all of which have been small, as documented in EA Appendix A.

Based on the points listed above, the most likely size spill that might occur would be a small (< 1,000 bbl) spill. For purposes of analysis, we chose a 48-bbl fuel-transfer spill, as identified in Shell's Chukchi Sea Regional ODPCP (Shell Gulf of Mexico Inc., 2009c) Summary of Potential Discharges, for a representative spill size in MMS' small category. A summary of the potential discharges is shown in Appendix A Table A-1 and analyzed in EA Appendix A.

To judge the effect of a 48-bbl diesel-fuel oil spill, we estimate how much oil would evaporate, how much oil would be dispersed, and how much oil would remain after a certain time period. A 48-bbl diesel-fuel spill could evaporate and disperse within approximately 48 hours (EA Appendix A Table A-4).

The SINTEF model fate and behavior 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 of fuel barges or vessels prior to transfer operations would be used in accordance with MMS lease stipulations, USCG requirements, and Shell's operating procedures. Response equipment and trained personnel deploy recovery equipment for the control and removal of product spilled into the environment mitigating the impacts of a small spill.

Should a 48-bbl diesel-fuel oil spill occur during exploration drilling, the spill would be localized and persist less than 3 days.

2.3.9 Oil Spill Prevention and Contingency Planning

As required by both Federal and State regulations, Shell has developed and would implement a comprehensive Chukchi Sea Regional ODPCP (Shell Gulf of Mexico Inc., 2009c) during its exploration drilling operations. The ODPCP presents specific information on the response program that includes a description of personnel and equipment mobilization, the incident management team organization, and the strategies and tactics used to implement effective and sustained spill containment and recovery operations. Shell would provide dedicated response vessels and equipment for the onshore, nearshore and offshore operations. Response activities would be conducted using Shell or ACS tactics as defined in Shell's *Beaufort and Chukchi Seas Regional Tactics Manual* and/or ACS's *Technical Manual*, or otherwise as defined in the ODPCP. 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 has designed its response program based on a regional capability of responding to a range of spill volumes, from small operational spills up to and including the worst case discharge (WCD) from an exploration well blowout.

A dedicated oil-spill-response vessel (OSRV) possessing sufficient onboard storage capacity to provide containment, recovery, and storage for the initial 24-hour operational period (12,690 bbl (1,951 m^3)) would be staged in the vicinity of the drillship when drilling into potential liquid hydrocarbon bearing zones. An Arctic oil storage tanker (OST) would be staged so that it will arrive at the recovery site within 24 hours of departure from its staging location. The OST will possess a minimum liquid storage capacity of 287,100 bbl (45,645 m^3), sufficient capacity to store all recovered liquids (oil and emulsified oil/water) from a 30-day blowout.

An oil-spill-response barge (OSRB) with skimming capability and an associated tug would be located in the nearshore zone. The OSRB would possess capacity to mobilize prior to earliest projected time oil could arrive in the Chukchi nearshore zone. The OSRB would have storage capacity of 18,636 bbl (2,963 m^3) for recovered liquids. It would also carry response equipment, including a 47-ft (14-m) skimming vessel, 34-ft (10-m) workboats, mini-barges, boom, and duplex skimming units for nearshore recovery and protection. The OSRB would carry designated response personnel who would mobilize to recovery areas, deploy equipment, and begin operations.

Shell's primary oil spill removal organization (OSRO) contractors are Alaska Clean Sea (ACS) and Arctic Slope Regional Corporation Energy Services - Response Operations, LLC (AES-RO). Both ACS and AES-RO 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 Chukchi Sea spill containment and recovery. The ACS and AES-RO would conduct response activities using the Shell *Beaufort and Chukchi Seas Regional Tactics Manual*, or ACS Tactics, as defined in the ACS *Technical Manual*.

Shell would implement mandatory spill prevention training programs for field operating personnel. Prevention training would include strict procedures and management practices to eliminate spills in all aspects of operations. All project personnel, including employees and contractors, involved in oil spill response would receive response training as described in the ODPCP. Training drills also would be conducted periodically to familiarize personnel with on-site equipment, proper deployment techniques, and maintenance procedures.

2.3.10 Compliance with Lease Stipulations

Shell's leases were obtained under the Chukchi Sea Oil and Gas Lease Sale 193 held February 6, 2008. A summary of the lease stipulations and Shell's planned actions to comply with each stipulation is provided below. The full text of the stipulations is on the MMS website: http://www.mms.gov/alaska/cproject/Chukchi193/FNOS193/Stips.pdf.

Stipulation No. 1 - Protection of Biological Resources

If previously unidentified biological populations or habitats that may require additional protection are identified in the lease area by the Regional Supervisor, Field Operations (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. Based on any surveys that the RS/FO may require of the lessee or on other information available to the RS/FO on special biological resources, the RS/FO may require the lessee to:

(1) Relocate the site of operations;

(2) Establish to the satisfaction of the RS/FO, on the basis of a site-specific survey, either that such operations will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist;

(3) Operate during those periods of time, as established by the RS/FO, that do not adversely affect the biological resources; and/or

(4) Modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

If any area of biological significance should be discovered during the conduct of any operations on the lease, the lessee shall immediately report such finding to the RS/FO and make every reasonable effort to preserve and protect the biological resource from damage until the RS/FO has given the lessee direction with respect to its protection. The lessee shall submit all data obtained in the course of biological surveys to the RS/FO with the locational information for drilling or other activity. The lessee may take no action that might affect the biological populations or habitats surveyed until the RS/FO provides written directions to the lessee with regard to permissible actions.

Shell Actions: As required by 30 CFR 250.214, and as specified in MMS Alaska OCS Region NTL 05-A01, Shell conducted shallow hazards surveys at the five planned drill sites. Surveys were conducted at three of the sites in 2008. Shell conducted surveys at the other two sites in 1989-1990, and Fugro reanalyzed the data at current standards in 2009 (Fugro 2009, GEMS 2009a, GEMS 2009b, GEMS 2009c). The survey data includes detailed bathymetry and identification of seafloor features through the use of subbottom profilers and side scan sonar methods.

In addition to the shallow hazard surveys, which provide detailed information on the seafloor sediments and relief, Shell conducted or participated in the funding or in the facilitation of several types of environmental studies in and near the prospects in 2008 to gather baseline data regarding resources in the project area. These studies included coastline surveys to assess the relative environmental sensitivity of Chukchi Sea coastline segments, walrus tagging and monitoring studies, seal tagging and monitoring studies, bird and marine mammal surveys, assessments of the benthic invertebrate communities, oceanographic studies, and sediment quality assessments at the planned drill sites. The results of the marine mammal and bird surveys are summarized in the EIA in Appendix F. These studies also indicated that there are no areas of special biological significance in the vicinity of the drill sites.

Underwater video reconnaissance surveys were conducted at historical drill sites at Burger and Crackerjack in 1989, and the results were submitted to MMS at that time. These surveys also found

a relatively flat and featureless seafloor with a silty substrate and a benthic fauna typical of the Sale 193 Area (Finney 1989; Boudreau 1989).

Shell identified no areas of special biological significance within or near the prospect areas. The MMS reviewed the survey data and concurs with Shell's finding. The MMS has determined that there is no indication that previously unidentified biological populations or habitats that may require additional protection occur in the lease area. Therefore, MMS does not require Shell to conduct additional biological surveys of the drill sites.

Stipulation No. 2 - Orientation Program

The lessee shall include in any exploration plan (EP) or development and production plan (DPP) submitted under 30 CFR 250.211 and 250.241 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 will 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 will be operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence activities and pertinent mitigation. The program shall be attended at least once a year by all personnel involved in onsite exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) and all supervisory and managerial personnel involved in lease activities of the lessee and its agents, contractors, and subcontractors. The lessee shall maintain a record of all personnel who attend the program onsite for so long as the site is active, not to exceed 5 years. This record shall include the name and date(s) of attendance of each attendee.

Shell Actions: Shell has developed and is currently implementing an orientation program for all Shell and contractor personnel involved in Shell's exploration activities.

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 has designed a comprehensive orientation program that 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. The orientation program provides guidance on how to avoid disturbance of these resources.

Shell's Cultural Awareness Program addresses the following:

- Alaska Native Ethnic Composition
- Brief history of land claims
- Formation of regional corporations, and region within which Shell is working
- History of the North Slope

- Cultural diversity
- Comparison of cultural values of Alaskan Natives vs. non-Natives
- Patterns of language
- Communication skills and body language
- Guidelines on cultural artifacts
- Local community values and customs
- Whaling

Shell's Health, Safety, Security, and Environment (HSSE) Awareness Program addresses the following:

- Shell's HSSE Commitment
- Intervention policy
- Journey Management requirements
- Personal Protective Equipment requirements
- General Alaska Venture Hazards, such as earthquakes and volcanoes
- Medical emergencies
- Security
- North Slope Safety requirements
- Shell Alaska Venture Standards and Procedures
  - Cold Climate Work Standard
  - Firearms Use in Wildlife Confrontations
  - Procedure for Vessel-to-Vessel Personnel Transfers
- Incident Reporting
- Environmental Awareness
  - Endangered Species Act (ESA) – Major Provisions
  - Endangered and threatened species
  - MMPA of 1972
  - Marine mammal interactions
  - Sensitive Habitats on the North Slope
  - Wildlife interactions
  - Prohibited activities of hunting, trapping, and fishing
  - Environmental requirements for air, spills, and waste
  - Environmental training

Stipulation No. 3 - Transportation of Hydrocarbons

This stipulation is not applicable to the proposed activities.

Stipulation No. 4 - Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources.

A lessee proposing to conduct exploration operations, including ancillary seismic surveys, on a lease within the blocks identified below during periods of subsistence use related to bowhead whales, beluga whales, ice seals, walruses, and polar bears will 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 appropriate agencies and co-management organizations, determines that a monitoring program is not necessary. Organizations currently recognized by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) for the co-management of the

marine mammals resources are the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, the Ice Seal Commission, and the Nanuuk Commission. The RS/FO will provide the appropriate agencies and co-management organizations a minimum of 30 calendar days, but no longer than 60 calendar days, to review and comment on a proposed monitoring program prior to Minerals Management Service (MMS) approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced.

Shell Actions: This stipulation is not applicable to activities on the leases or support activities identified in the EP.

Nonetheless, Shell submitted a copy of their Marine Mammal Monitoring and Mitigation Plan (4MP) with the EP (Shell Gulf of Mexico Inc., 2009a: Appendix D). Thus, measures of the 4MP are considered to be part of the proposed activities and would become enforceable requirements upon approval of the EP. The 4MP is also included in Shell's application for an IHA. 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 an aerial monitoring and reconnaissance program and recording of ambient sound levels and vocalization of marine mammals. 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 provide advice on mitigative 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 for advising on appropriate mitigation measures. Observations made by MMOs serve as the primary basis for estimation of take of marine mammals. The MMOs would also collect basic information on bird species.

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 2010 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.

Acoustic Recorders: 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 employed 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. Preliminary sound modeling is summarized in Shell's IHA and LOA applications (Shell Gulf of Mexico Inc. 2009a: Appendixes E and F, respectively). 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 2010 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 sound-propagation profiles of the drillship and support vessels would be conducted during operations.

Stipulation No. 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence-Harvesting Activities.

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. This stipulation applies to exploration, development, and production operations on a lease within the blocks identified below during periods of subsistence use related to bowhead whales, beluga whales, ice seals, walruses, and polar bears. The stipulation also applies to support activities, such as vessel and aircraft traffic, that traverse the blocks listed below or Federal waters landward of the sale during periods of subsistence use regardless of lease location. Transit for human safety emergency situations shall not require adherence to this stipulation.

Prior to submitting an exploration plan to the MMS for activities proposed during subsistence-use critical times and locations for bowhead whale and other marine mammals, the lessee shall consult with the North Slope Borough, and with directly affected subsistence communities and co-management organizations to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures that 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 activities are compatible with whaling and other marine mammal subsistence hunting activities and will not result in unreasonable interference with subsistence harvests.

A discussion of resolutions reached during this consultation process and plans for continued consultation shall be included in the exploration plan. In particular, the lessee shall show in the plan how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. The lessee shall also include a discussion of multiple or simultaneous operations, such as ice management and seismic activities, that can be expected to occur during operations in order to more accurately assess the potential for any cumulative affects.

Shell Actions: This stipulation is not applicable to activities on the leases identified in the EP. This stipulation does apply to the support activities, such as the vessel and aircraft traffic described in the EP, that traverse the blocks listed in the stipulation or Federal waters landward of the Sale 193 area during periods of subsistence activities indicated in the stipulation. 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, Stipulation 5 requires the operator to consult with the NSB and directly affected subsistence communities and co-management organizations prior to submitting an EP. 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." 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 and "show how its activities, in combination with others activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities." The requirements of Stipulation 5 parallel requirements for incidental take authorizations from FWS and NMFS under MMPA.

Shell's Plan of Cooperation (POC) (Shell Gulf of Mexico Inc., 2009a: Appendix I) identifies the measures Shell has developed and would implement during its proposed 2010 exploration drilling program to minimize any adverse effects on the availability of marine mammals for subsistence uses. The POC details Shell's communications and consultations with local communities concerning its

proposed 2010 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. Table 4.2-1 of the POC provides a list of public meetings attended or held by Shell as it developed its POC. 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. Attachment B of the POC also includes copies of the sign-in sheets from the meetings and the presentation materials used at the meetings. A summary of Shell's POC meetings is provided below.

In preparation for its proposed 2010 proposed Chukchi Sea exploration drilling program (and proposed 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 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 subsistence communities that were consulted regarding Shell's 2010 proposed activities include: Barrow, Wainwright, Kotzebue, Kivalina, Point Lay, and Point Hope. Additionally, Shell met with the Arctic Eskimo Whaling Commission (AEWC), Inupiat Community of the Arctic Slope (ICAS), and the Native Village of Barrow. Beginning in early January 2009, Shell held one-on-one meetings with representatives from the NSB and Northwest Arctic Borough (NWAB), subsistence-user groups leadership, and Village Whaling Captain Association representatives. Shell presented the proposed project to the NWAB Assembly on January 27, 2009; to the NSB Assembly on February 2, 2009; and to the NSB and NWAB Planning Commissions on March 25, 2009. Several one-on-one meetings were also held throughout the villages. Shell plans to conduct post-operation consultations with the various subsistence stakeholder groups.

The POC meets the requirements of Stipulation 5 and commits to reasonable measures to avoid conflicts with subsistence uses in the subject area. Moreover, Shell has stated that the POC may be supplemented to reflect additional engagements with local subsistence users and any additional or revised mitigation measures that are adopted as a result of those engagements.

In addition, Shell has publically stated it is committed to a Conflict Avoidance Agreement (CAA) process and has demonstrated this by making efforts to negotiate an agreement every year it has planned activities. The analysis in this EA does not, however, rely on any future CAA, but considers only the implementation of committed mitigation measures in determining potential impacts of the proposed activities.

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

Fuel transfers (excluding gasoline transfers) of 100 barrels or more will 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. The lessee's oil spill response 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 Attachment 9.0-4 of the EP (Shell Gulf of Mexico Inc., 2009a: Section 9.0). 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. Standard operating procedures during fuel transfers include conducting operations in daylight with on-site observers to shut down the pumps in the event of leak to minimize the volume of any potential spill.

Shell's fuel-transfer plan does not fully comply with the requirement of the lease stipulation to surround the fuel barge. This stipulation was developed for a specific EP using a bottom-founded facility in the Beaufort Sea. The *Discoverer* is a turret-moored vessel, which means it rotates about the axis of the turret in response to prevailing wind conditions. The *Discoverer* is not static positioned like a bottom-founded structure or a point-moored floating drilling unit. Because the *Discoverer* is not stationary, anchoring a boom around a fuel barge would be operationally difficult and increase risk to the personnel safety. The MMS has determined that the alternative boom-deployment configuration Shell has proposed provides equivalent or enhanced capabilities for downstream containment and recovery of any spill.

The MMS and U.S. Coast Guard (USCG) updated their Memorandum of Agreement (MOA) in February 2008 (http://www.mms.gov/MOU/PDFs/MOA-USCG04FloatingFacilities-Final.pdf) regarding jurisdictional responsibilities: Under the MOA, fuel transfers for floating facilities (which includes Mobile Offshore Drilling Units (MODU), such as the *Discoverer*) are under the jurisdiction of the USCG. The MMS defers to the USCG and the approved facility response plan.

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

In accordance with the Biological Opinion for the Chukchi Sea Lease Sale 193 issued by the Fish and Wildlife Service (FWS) on September 3, 2009, lessees must adhere to lighting requirements for all exploration or delineation drilling 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: In compliance with this stipulation, Shell's *Bird Strike Avoidance and Lighting Plan, Chukchi Sea, Alaska* (lighting plan) (Shell Gulf of Mexico Inc., 2009a: Appendix J) outlines Shell's bird strike avoidance strategy for drilling operations near the drillship in the central Chukchi Sea for 2010. The emphasis in Shell's lighting plan is on the prevention of bird strikes into the drillship by threatened spectacled eiders (*Somateria fischeri*) and Steller's eiders (*Polysticta stelleri*). The likelihood of bird strikes to the drillship is considered to be low and the probability of bird strikes is expected to be reduced further by Shell's implementation of the lighting modifications as specified in their lighting plan. Shell's reporting the conditions under which the bird strike occurred would help MMS and FWS in better understanding the occurrence of bird strikes associated with lighting on offshore structures.

Other measures to meet the requirements of the FWS BO and Stipulation 7 are identified as recommended additional mitigation and other measures in Section 3.2.5 of this EA.

2.3.11 Other Mitigation

Some of the additional mitigation measures Shell has adopted and would implement during its 2010 Chukchi Sea exploration drilling operations are listed below. Mitigation measures were presented to community leaders and subsistence user groups starting in January of 2009. Shell states that the measures below incorporate modifications in response to comments and concerns expressed during the consultation process.

- The drilling and OSR vessels would enter the Chukchi Sea on or about July 1 to minimize effects on subsistence hunts for bowheads, belugas, and walrus. Exploration drilling activities are planned to begin on or about July 4 and drilling in hydrocarbon bearing zones would end on or

before October 31, 2010, depending on ice and weather. The *Discoverer* and support vessels would then leave the Chukchi Sea.

- To minimize impacts on marine mammals and subsistence hunting activities, vessels that can safely travel outside of the polynya zone and the Ledyard Bay Critical Habitat Area would do so, unless it is necessary to break ice (as opposed to managing ice by pushing it out of the way) or if sea state conditions require an alternative route. Shell would notify the local communities through the Com Centers of any change in the transit route. In all cases, vessel transits would follow a route that allows for the highest degree of safety regarding ice conditions and sea states.
- Shell has developed a Communication Plan (Shell Gulf of Mexico Inc., 2009a: Appendix I Attachment C) to coordinate activities with local subsistence users as well as Village Whaling Associations. The Communication Plan includes the establishment of Com Centers in coastal villages along the U.S. Chukchi Sea during Shell's planned activities in 2010. Shell would implement the plan before initiating exploration drilling operations to minimize the risk of interfering with subsistence hunting activities, and to keep up-to-date on the timing and status of the bowhead whale migration and subsistence hunts.
- Shell would employ local Subsistence Advisors from the local communities to provide consultation and guidance regarding subsistence hunting. Nine subsistence advisor-liaison positions (one per village) would be hired to work approximately 8 hours per day and 40-hour weeks throughout Shell's 2010 proposed exploration activities. The subsistence advisor would gather data on subsistence lifestyle within the communities and advise Shell as to ways to minimize and mitigate potential impacts to subsistence resources during the drilling season. Responsibilities of the subsistence advisors would include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; and advising how to avoid subsistence conflicts. Shell is developing a subsistence advisor handbook to specify position work tasks in more detail. In the EP, Shell indicates that this handbook would be completed before commencement of operations. The MMS will direct Shell to include, in its training material and handouts, instructions for the Subsistence Advisors to call MMS is there are issues that are not being resolved to the satisfaction of the Subsistence Advisor. The MMS will also notify the communities that MMS can be contacted directly.
- Shell would recycle drilling muds (e.g., use those muds on multiple wells) to the extent practicable based on operational considerations (e.g., whether mud properties have deteriorated to the point where they cannot be used further), to reduce discharges from its operations. At the end of the season excess water base fluid, approximately 1,500 bbl (238 m^3), would be pre-diluted to a 30:1 ratio with seawater and then discharged through the disposal caisson.
- 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.
- Shell would implement the following measures as part of its marine mammal monitoring and mitigation program to further minimize the risk of impacting marine mammals and interfering with the subsistence hunt:
  - Aircraft would not operate within 500 yd (460 m) of whale groups;
  - Aircraft and vessels would not operate within 0.5 mi (800 m) of walruses or polar bears when observed on land or ice;
  - When within 300 yd (275 m) of marine mammals, vessels underway would reduce speed, avoid separating members from a group and avoid multiple course changes; and
  - For those vessels underway, vessel speed would be reduced during inclement weather conditions in order to avoid collisions with marine mammals.

- Shell would implement the following measures as part of its bird strike avoidance and lighting plan to further minimize the risk to eiders and other species of coastal and marine birds:
  - Outside lighting on the drillship would be replaced with ClearSky lighting that minimizes the disorientation and attraction of birds associated with light and reduces probability of bird strikes and circling
  - Shading and minimizing the use of high intensity lights on the drillship and support vessels to those areas that must use such lights for safety reasons (e.g., crane operations); those lights would be turned-off as soon as possible following the operation
- Shell has developed and would implement an Ice Management Plan (IMP) (Shell Gulf of Mexico Inc. 2009a: Section 9.0 Attachment 9.2) 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 Gulf of Mexico Inc. 2009a: Section 9.0 Attachment 9.1), 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 developed and would implement a Well Control Contingency Plan (WCCP) (Shell Gulf of Mexico Inc. 2009a: Section 9.0 Attachment 9.3) 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 Gulf of Mexico Inc. 2009a: Section 9.0 Attachment 9.4), 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.

3.0 DESCRIPTION OF THE ENVIRONMENT AND ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

3.1 Introduction

The area in which Shell proposes to conduct exploratory drilling operations is located northwest of Wainwright more than 60 mi (97 km) offshore in the Chukchi Sea OCS. The potential effects of exploratory drilling activities in the Chukchi Sea Planning Area were assessed in recent MMS NEPA documents. The areawide descriptions of the environment and analyses of potential effects were included in the Chukchi Sale 193 EIS for OCS Lease Sale 193 (USDOI, MMS, 2007b). This EA tiers from the Chukchi Sale 193 EIS. Relevant information and analyses in the Chukchi Sale 193 EIS are summarized and incorporated by reference in this EA, as needed. The Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a) provides MMS' most recent description of the environment and analysis of the potential effects of Arctic OCS activities. Portions of the Arctic Multiple-Sale Draft EIS are summarized and incorporated by reference.

In 2009, NMFS completed an EA and issued a Finding of No Significant Impact (FONSI) for the *Issuance of an Incidental Harassment Authorization to Shell Offshore, Inc. and Shell Gulf of Mexico, Inc. to Take Marine Mammals by Harassment Incidental to Conducting an Open-water Marine Survey Program in the Chukchi Sea, Alaska* (USDOC, NOAA, NMFS, 2009). The environmental documentation for the IHA is incorporated by reference in this EA where applicable.

The 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) provides a comprehensive description of the biology of the marine mammal species under NMFS' jurisdiction; and analysis of the potential effects of OCS leasing and exploration activities on marine mammal species under NMFS' jurisdiction.

The FWS Biological Opinion for *Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling* (USDOI, FWS, 2009) provides a comprehensive description of the biology of the ESA-listed species under FWS' jurisdiction; and analysis of the potential effects of OCS leasing and exploration activities on ESA-listed species under FWS' jurisdiction.

Additional information on the environment at the proposed drill sites and on the potential effects of the proposed activities on environmental resources is provided in the EIA (Shell Gulf of Mexico Inc. 2009a: Appendix F; also cited as Shell Gulf of Mexico Inc. 2009b), Shell's IHA application to NMFS dated May 22, 2009 (Shell Gulf of Mexico Inc. 2009a: Appendix C); and Shell's LOA application to FWS (Shell Gulf of Mexico Inc. 2009a: Appendix E).

Information from the above documents has been reviewed, summarized, updated, and incorporated, as needed and appropriate, in this EA. Relevant sections of the above documents are cited, summarized, and incorporated by reference, as appropriate.

3.2 Alternative 1: Biological Resources

The environmental conditions at the proposed drill sites as described in Shell's EIA do not deviate from the general conditions described in the Chukchi Sale 193 EIS (USDOI, MMS, 2007b). There are no indications from recent studies or site-specific information that the prospect areas differ from what was generally described in the Chukchi Sale 193 EIS. No sensitive seafloor biological communities or habitats were identified during geohazards surveys at the proposed drill sites.

3.2.1 Levels of Effects for Biological Resources

Negligible:

- No measurable impacts and no population-level effects.
- Localized, short-term disturbance or habitat effects experienced during one season are not anticipated to accumulate across multiple seasons.
- No mortality or detectable impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- No detectable population-level effects. Temporary, nonlethal adverse effects to some individuals may occur.
- Widespread annual or chronic disturbances or habitat effects are not anticipated to accumulate across 1 year, or small scale localized effects that are anticipated to persist for more than 1 year.
- For mammals or birds, mortality is not anticipated.
- For fish and invertebrates, low mortality levels may occur, measurable in terms of individuals or <1% of the population.
- 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 detectable population-level effects. Adverse impacts to listed species could occur.
- 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 are long term and localized.

Major:

- Mortalities or disturbances occur that have measureable and thus significant population-level effects. For marine mammals, mortality might occur above the estimated Potential Biological Removal (PBR).
- The action may jeopardize an endangered or threatened species or its critical habitat.
- For fish and benthic invertebrates, 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 population-level effects.
- Widespread seasonal or chronic effects 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.

Screening Analysis for Potentially Affected Biological Resources

The mechanisms of effects to biological resources from the proposed activities during the July-October operational timeframe in the vicinity of the prospect areas are expected to be the same as those analyzed in the Chukchi Sale 193 EIS (USDOI, MMS, 2007b). The analyses in the Chukchi Sale 193 EIS and Shell's EIA (Shell Gulf of Mexico Inc., 2009b) were reviewed to determine expected level of effects from the types of activities proposed in the EP and the presence or absence of biological resources during the July-October operational timeframe in the vicinity of the prospect areas. Tables 3.2.1-1, 3.2.1-2, and 3.2.1-3 below indicate the expected impact levels of the proposed activities on the biota in the vicinity of the Burger, Crackerjack, and SW Shoebill prospects based on the analyses in the Chukchi Sale 193 EIS and Shell's EIA. This first step in the screening analysis assumes that all species are present. The expected presence or absence of species is considered in the "Presence and Habitat Use Analysis" below. For more detailed analyses, refer to Chukchi Sale 193 EIS (USDOI, MMS, 2007b) and Shell EIA (Shell Gulf of Mexico Inc., 2009b). The likelihood of large hydrocarbon spills occurring was analyzed in and summarized in EA Section 2.3.8 and EA Appendix A and determined not to be a reasonably foreseeable outcome of the proposed activities.

Screening for Potential Effects on Mammals

Table 3.2.1-1. Effects analysis determinations for mammal species that may occur in the vicinity of the project area. Effects are described as NG = negligible, MN = minor, MO = moderate, MJ = major, and * = effect after mitigation. Determinations were based on existing analyses in USDOI, MMS (2007b) and Shell Gulf of Mexico, Inc. (2009b) and incorporate more recent information from other sources, as appropriate.

Species	Vessel Traffic	Vessel Noise	Aircraft Traffic	Aircraft Noise	Drilling Noise	Icebreaking/Ice Management	Vessel Mooring and MLC Construction	Drill Cuttings and Drilling Mud Discharges	Other Permitted Discharges	Small Liquid Hydrocarbon Spills	Air Pollutant Emissions	Cumulative Effects
Marine Mammals												
Bearded Seal	MN*	MN	NG	NG	MN	MN	NG	NG	NG	NG*	NG	MN*
Beluga Whale	MN*	MN	NG	NG	NG	MN	NG	NG	NG	NG	NG	MN
Bowhead Whale	MN*	MN	NG	NG	MN	MN	NG	NG	NG	NG	NG	MN
Fin Whale	MN*	MN*	NG	NG	MN	NG	NG	NG	NG	NG	NG	MN
Gray Whale	MN*	MN	NG	NG	MN	NG	NG	NG	NG	NG	NG	MN
Harbor Porpoise	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Humpback Whale	MN*	MN	NG	NG	MN	NG	NG	NG	NG	NG	NG	MN
Killer Whale	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Minke Whale	MN*	MN	NG	NG	MN	MN	NG	NG	NG	NG*	NG	MN*
Pacific Walrus	MN*	MN	MN*	MN*	MN	MN	NG	NG	NG	NG*	NG	MN*
Polar Bear	MN*	MN	MN*	MN	NG	MN	NG	NG	NG	NG*	NG	MN*
Ribbon Seal	MN*	MN	NG	NG	MN	MN	NG	NG	NG	NG*	NG	MN*
Ringed Seal	MN*	MN	NG	NG	MN	MN	NG	NG	NG	NG*	NG	MN*
Spotted Seal	MN*	MN	NG	NG	MN	MN	NG	NG	NG	NG*	NG	MN*
Terrestrial Mammals												
Western Arctic Caribou Herd	NG	NG	MN*	MN*	NG	NG	NG	NG	NG	NG*	NG	MN*
Teshekpuk Caribou Herd	NG	NG	MN*	MN*	NG	NG	NG	NG	NG	NG*	NG	MN*
Grizzly Bear	NG	NG	NG*	NG*	NG	NG	NG	NG	NG	NG	NG	NG
Other Furbearers	NG	NG	NG*	NG*	NG	NG	NG	NG	NG	NG	NG	NG

During the July-October time period, bowhead whales may be found feeding near Barrow or Wrangell Island and a few may pass through the prospect areas as they move from the Beaufort Sea toward Wrangell Island or southward toward the Bering Sea. Gray whales may be feeding in shallow nearshore waters, such as Peard Bay, or shallow offshore waters, such as Hanna Shoal. Ice seals are likely to be widely dispersed and move through the area as they forage. Orca, humpback, or fin whales may occur throughout the Chukchi Sea. Walrus and polar bear are likely to remain on the sea ice north of the drill site area, or may occur onshore later in the summer-fall period. Tagging studies indicate that walrus forage in shallow waters throughout the area during this time period.

Preliminary results from surveys conducted in the proposed Burger drill site area and in the Klondike area (southwest of Burger and southeast of Popcorn and Shoebill) during July-October, 2008, identified all four species of ice seals, walrus, harbor porpoise, gray whale, killer whale, bowhead, minke, and polar bear as present in the area. Walrus were the species most commonly encountered, with ringed, bearded, and spotted seals occurring in low numbers. Fewer than ten harbor porpoise and ten killer whales were observed, with one or two of each of the other cetacean species. Nine polar bear were observed in the Burger area, with none seen in the Klondike area (Brueggeman, 2009).

Factors from exploration drilling that may affect marine and terrestrial mammals include noise, disturbance, and the release of contaminants into the environment. The main noise-producing activities would include: (1) air traffic; (2) drilling; (3) icebreaking and ice-management noise; (4) and vessel traffic. Details on source- and received-sound levels for many of these activities can be found in the MMS Biological Evaluation of the Potential Effects of Oil and Gas Leasing and Exploration in the Alaska OCS Beaufort Sea and Chukchi Sea Planning Areas on Endangered Bowhead Whales (*Balaena mysticetus*), Fin Whales (*Balaenoptera physalus*), and Humpback Whales (*Megaptera novaeangliae*) (USDOI, MMS, 2006b; Richardson et al., 1995). Icebreaking and ice-management activities likely would elicit strong responses from cetaceans and walrus that were nearby. Air traffic and vessel traffic may elicit a flight response from mammals resulting in some small energy loss as they move away from the sound source. Polar bears may avoid vessels or move toward the sound source in some instances.

Modeled sound radii indicate that the sound associated with the proposed drilling operations from the *Discoverer* would not exceed the 180-dB level. Sounds from drilling are modeled to diminish to 160 dB at < 0.06mi (< 0.10 km) from the drillship, and the 120-dB sound level is modeled to occur at 0.9 mi (1.5 km) or less (Shell Gulf of Mexico Inc., 2009b: Section 2.8). Considering the limited size of the area potentially affected by noise associated with drilling relative to the total area of the Chukchi Sea OCS, MMS expects no measureable population-level effects from noise on marine mammals. Consequently drilling sounds in the marine environment are expected to result in a negligible or minor level of effects to marine mammals in the vicinity of the project area.

Modeled sound radii indicate that the sound associated with icebreaking operations from the *Vladimir Ignatjuk* would not exceed the 190-dB level at the source, and would diminish to 160 dB within < 0.15 km from the vessel. The sound would diminish to 120 dB in 15.5 km from the vessel at the Burger site, and in 7.5 km or less from the vessel at the Crackerjack and SW Shoebill sites. The difference in sound level radii reflects site-specific modeling factors, including water depth, seafloor topography, and water temperature. Shell estimates that ice-management activities are likely to occur up to 38% of the drilling season, with most ice management occurring in early summer (Shell EIA, Section 2.8). Ice management activities would primarily include pushing or moving ice floes away from the drilling area rather than ice breaking. Walrus are the species most likely to be disturbed during ice breaking and ice-management activities when in the Chukchi Sea prospect areas.

Vessel traffic related to the proposed activities would be limited to routes from Wainwright directly to the drill sites, and would not occur in sensitive near shore waters such as Peard Bay or Kasegaluk Lagoon. Vessels would have marine mammal observers on board and would slow down and/ or change course to

avoid marine mammals. Air flights would follow a corridor from Wainwright directly to the drill sites. Flights from Wainwright to Barrow would follow a flight corridor 5 mi inland of the coast. All flights would be at 1,500 ft AGL or higher, unless required to fly lower due to visibility and safety constraints. The primary sources of potential disturbance to terrestrial mammals would be aircraft flights.

The drillship *Discoverer* would be positioned at the proposed drill site under its own power, and then anchored using an eight anchor system. Each anchor would be placed up to 3,600 feet (1,100 m) from the drillship and is 17 ft (5.2 m) wide by 18 ft (5.5 m) long. Anchors would be embedded an estimated 11 ft (3.4 m) into the seafloor. Setting and removing the anchors would disturb seafloor sediments and leave a depression on the seafloor from the anchor and anchor chain. Shell estimates that the total scar area for all eight anchors would be 16, 992 ft^2 (1,579 m^2) per well. The total volume of disturbed sediments for all eight anchors is estimated by Shell to be 4,064 yd^3 (3,107 m^3) per well. Benthic invertebrates or sedentary fish species located at each anchor site may be crushed beneath the anchor, contacted by the anchor chain, or suffocated by disturbed sediments. These localized effects are not anticipated to have population level effects for benthic invertebrate or fish species.

Each drill site would have a mudline cellar (MLC) with a 314 ft^2 footprint. Drilling waste (mud and cuttings) would be discharged at the site. Waterborne contaminants associated with the discharge plume may affect marine mammals through ingestion. Because of the relatively small discharge plume and the plume's proximity to the drillship, MMS expects marine mammals to avoid the area affected by the discharge plume, thereby avoiding exposure. See EA Section 3.5 for a further description of discharges and contaminants. Marine mammals that feed on benthic invertebrates or sedentary fish species in the project area might ingest some organisms with very low levels of contamination, but exposures are not anticipated to be high enough to cause any health impacts. Impacts related to discharges are expected to be minor and localized. No population-level effects are expected for any marine mammal species that occur in the prospect areas. Because no marine mammal species are expected to experience measureable population-level effects from any discharges, or sediment or temperature changes related to the proposed activities, MMS concludes that there should be a negligible level of effects to marine mammal species from drilling muds and cuttings discharges, and other permitted discharges listed in EIA Tables 3.2.1-1 thru 3.2.1-3.

Screening for Potential Effects to Seabirds, Loons and Shorebirds Commonly Found in the Northeastern Chukchi Sea

Table 3.2.1-2a. Effects analysis determinations for bird species that may occur in the vicinity of the project area. Effects are described as NG = negligible, MN = minor, MO = moderate, MJ = major, and * = effect after mitigation. Determinations were based on existing analyses in USDOI, MMS (2007) and Shell Gulf of Mexico, Inc. (2009b), and incorporate more recent information from other sources, as appropriate.

Species	Vessel Traffic	Vessel Noise	Aircraft Traffic	Aircraft Noise	Drilling Noise	Icebreaking/ Ice Management	Vessel Mooring and MLC Construction	Drill Cuttings and Drilling Mud Discharges	Other Permitted Discharges	Small Liquid Hydrocarbon Spills	Air Pollutant Emissions	Bird - Ship Collisions	Cumulative Effects
Seabirds													
Common Murre	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN	MN
Thick-Billed Murre	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN	MN
Tufted Puffin	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Horned Puffin	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG

Species	Vessel Traffic	Vessel Noise	Aircraft Traffic	Aircraft Noise	Drilling Noise	Icebreaking/ Ice Management	Vessel Mooring and MLC Construction	Drill Cuttings and Drilling Mud Discharges	Other Permitted Discharges	Small Liquid Hydrocarbon Spills	Air Pollutant Emissions	Bird - Ship Collisions	Cumulative Effects
Seabirds													
Black Guillemot	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Parakeet Auklet	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Least Auklet	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Crested Auklet	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Kittlitz's Murrelet	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Black-legged Kittiwake	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Short-Tailed Shearwater	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN	MN
Northern Fulmar	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Pelagic Cormorant	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Glaucous Gull	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Ivory Gull	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Ross's Gull	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Sabine's Gull	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Arctic Tern	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Pomarine Jaeger	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Parasitic Jaeger	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Long-Tailed Jaeger	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Loons													
Pacific Loon	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Red-Throated Loon	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Yellow-Billed Loon	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Shorebirds													
Red-Necked Phalorope	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Red Phalorope	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG

Screening for Potential Effects to Waterfowl Commonly Found in the Northeastern Chukchi Sea

Table 3.2.1-2b. Effects analysis determinations for bird species that may occur in the vicinity of the project area. Effects are described as NG = negligible, MN = minor, MO = moderate, MJ = major, and * = effect after mitigation. Determinations were based on existing analyses in USDOI, MMS (2007) and Shell Gulf of Mexico Inc. (2009b), and incorporate more recent information from other sources, as appropriate.

Species	Vessel Traffic	Vessel Noise	Aircraft Traffic	Aircraft Noise	Drilling Noise	Icebreaking/ Ice Management	Vessel Mooring and MLC Construction	Drill Cuttings and Drilling Mud Discharges	Other Permitted Discharges	Small Liquid Hydrocarbon Spills	Air Pollutant Emissions	Bird - Ship Collisions	Cumulative Effects
Waterfowl													
Common Eider	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN	MN
Spectacled Eider	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN	MN
Steller's Eider	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN	MN
King Eider	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN	MN
Northern Pintail	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Red-Breasted Merganser	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Long-tailed Duck	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN	MN
Black Scoter	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
White-Winged Scoter	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Greater Scaup	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Lesser Snow Goose	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Greater White-Fronted Goose	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Canada Goose	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Pacific Black Brant	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Tundra Swan	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG

Preliminary results from surveys conducted in the proposed Burger drill site area and in the Klondike area (southwest of Burger and southeast of Popcorn and Shoebill) during July-October, 2008, identified Pacific loon, northern fulmar, short-tailed shearwater, black-legged kittiwake, glaucous gull, thick-billed murre, least auklet and crested auklet as the species most commonly encountered. Birds were more numerous in early fall, with fewer present in late summer or late fall. Short-tailed shearwaters were the most numerous at both sites with an average density of 40 birds /km^2 in the Klondike area in early fall, and 32 birds /km^2 in the Burger area in early fall (Gall and Day, 2009). Additional surveys conducted as part of the MMS-funded COMIDA (Chukchi Offshore Monitoring in Drilling Area) studies in mid-July through mid-August also found very low bird densities in the proposed drill site areas. The COMIDA transects covered 314 km^2 throughout the northeastern Chukchi Sea. A density of 4.7 birds/ km^2 was observed in the drill site areas and no listed species were observed. The highest densities occurred in the nearshore coastal waters and at Hanna Shoal, with 11.18 birds/km^2 and 11.74 birds/km^2, respectively (Grebmeier et al, 2009).

Because of the distance between the proposed drill sites and any breeding, brood rearing, or preferred foraging habitat for nearshore birds and the localized area of potential disturbance related to the proposed drilling, nearshore aggregations of birds are not expected to be affected. Because of the distance between the proposed drill sites and colonies, nesting, and brood-rearing areas the occurrence of waterfowl, seabirds, loons, and shorebirds (specifically phalaropes) in the vicinity of the proposed activities is expected to be sporadic and very low density. The effects analyses for exploratory drilling evaluated in Chukchi Sale 193 EIS (USDOI, MMS, 2007b) and Shell's EIA (Shell Gulf of Mexico Inc., 2009b) are incorporated by reference.

As noted in Table 3.2.1-2a and b, most bird species are expected to experience negligible or minor levels of direct, indirect, and cumulative effects from the proposed activities. Birds appear to be present in low densities, and most would move away from the noise and activity associated with the drill rig. Some species, including eiders, move west from the Barrow area to Russia, Japan, or other parts of Asia after breeding and could potentially migrate through the prospect areas. Few to no bird strikes or avian collisions involving the drillship or support vessels and spectacled or Steller's eider mortalities are anticipated. Bird strikes are not expected during the northward migration of spectacled and Steller's eiders because the northern migration occurs in May, before the drillship and support vessels enter the Chukchi Sea. During the months of July and August there are almost 24 hours of daylight. High intensity lights will be used only during certain critical operations for safety reasons during this time period, thus lessening the chance of disorienting birds that lead to bird strikes. However, should a spectacled or Steller's eider strike occur, this would not result in a population level effect to the species. The low probability of bird strikes occurring as well as any potential disorientation of migrating eiders will be reduced by implementation of a number of mitigation measures that are part of Shell's Bird Strike Avoidance and Lighting Plan. These measures include minimizing vessel light output, using green lighting on the drillship, and monitoring conditions to assess risk and reduce the chance of bird strikes. Bird strikes are not expected, but would result in a moderate level of effect should they occur. No population level effects are anticipated.

Bird species are likely to avoid the ongoing disturbance from the associated noise of the drilling and therefore would not be exposed to any toxicity either from the discharge plume or from ingesting organisms that had been exposed to the plume.

Screening for Potential Effects to Fish and Benthic Invertebrate Species Commonly Found in the Northeastern Chukchi Sea

Table 3.2.1-3. Effects analysis determinations for fish and invertebrate species that may occur in the vicinity of the project area. Effects are described as NG = negligible, MN = minor, MO = moderate, MJ = major, and * = effect after mitigation. Determinations were based on existing analyses in USDOI, MMS (2003) and Shell Gulf of Mexico, Inc. (2009b), and incorporate more recent information from other sources, as appropriate.

Species	Vessel Traffic	Vessel Noise	Aircraft Traffic	Aircraft Noise	Drilling Noise	Icebreaking	Vessel Mooring and MLC Construction	Drill Cuttings and Drilling Mud Discharges	Other Permitted Discharges	Small Liquid Hydrocarbon Spills	Air Pollutant Emissions	Cumulative Effects
Fish												
Arctic Cod	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Saffron Cod	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Sculpin	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Staghorn Sculpin	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN

Species	Vessel Traffic	Vessel Noise	Aircraft Traffic	Aircraft Noise	Drilling Noise	Icebreaking	Vessel Mooring and MLC Construction	Drill Cuttings and Drilling Mud Discharges	Other Permitted Discharges	Small Liquid Hydrocarbon Spills	Air Pollutant Emissions	Cumulative Effects
Fish												
Bering Flounder	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Warty Sculpin	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Hamecon	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Walleye Pollock	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Ribbed Sculpin	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Capelin	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Wattled Eelpout	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Pacific Herring	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Slender Eelblenny	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Canadian Eelpout	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Eelpout	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Sturgeon Poacher	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Pacific Cod	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Variegated Snailfish	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Butterfly Sculpin	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Hookear Sculpin	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
Invertebrates												
polychaete worm	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
brittle star	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
sipunculid - peanut worm	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
clam	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN
amphipod	NG	NG	NG	NG	NG	NG	MN	MN	MN	NG	NG	MN

Screening for Potential Effects to Fish and Lower Trophic Organisms

Shallow hazards surveys conducted by Shell at the prospects, as well as past surveys conducted at prospects in the area have not revealed any unusual or special benthic features or communities. Video reconnaissance surveys (Finney, 1989) were conducted within the Burger and Crackerjack Prospects within a few miles of Shell's current drill sites. Similar surveys were conducted at the Popcorn Prospect, which is in the same general area, and the benthic community in the Popcorn Prospect was found to be similar in composition to those at the Burger and Crackerjack Prospects, but at a lower density (Finney, 1989). About 15 species were identified. The brittle star, (*Ophiura sarsi)*, was found to be the predominant organism with densities of 9-37/ft^2 (100-400/m^2). Other abundant macro-invertebrates observed at the sites were a soft coral (*Eunephthya* spp.), the basket starfish (*Gorgonocephalus caryi),* and sea cucumbers (*Psolus* spp., *Cucumaria* spp.).

Benthic and epibenthic organisms are abundant in the Chukchi Sea and increase in numbers and diversity in the summer during open-water conditions. The northeastern quadrant of the Chukchi Sea generally supports a higher biomass of benthic organisms than other areas of the Chukchi Sea (Grebmeier and

Dunton, 2000). This may be because the pelagic fauna is incapable of consuming all of the phytoplankton; the unconsumed phytoplankton sinks to the bottom, providing food for the benthos. Areas of high benthic biomass serve as important feeding grounds for benthic grazers, such as gray whales, walrus, and some seaducks. The prospect areas are within the northeastern Chukchi Sea.

Hard-bottom communities are aggregations of macrophytic algae (large kelps), benthic microalgae, and benthic invertebrates associated with rocks and other hard substrate. Benthic fauna in hard-bottom communities include sponges, soft corals, hydroids, sea anemones, bryozoans, nudibranchs, and sea squirts (Dunton and Schonberg, 1980). No kelp beds, hard-bottom communities, or other special benthic habitats are known to occur in the prospect areas. No kelp beds or other special habitat areas were identified from the high-resolution seismic survey data gathered in the sites. All known large kelp beds in the Chukchi Sea are located south of prospect areas (USDOI, MMS, 2008a). There are also coastal kelp beds located near Skull Cliffs, northeast of Peard Bay, and 16 mi (25 km) southwest of Wainwright.

More than 66 fish species have been documented in the northeastern Chukchi Sea (Barber et al., 1997). These include marine fish (argely restricted to marine habitats) and diadromous (migratory) fish that utilize both marine and freshwater habitats. Some of the more common fish species are listed in Table 3.2.1-3. The distribution of marine fish species in the Chukchi Sea is driven by salinity, water depth, and percentage of gravel in the sediments (Barber et al., 1997) and often shifts as seasonal changes occur.

The primary potential impacts to fish or benthic invertebrate species would occur from disturbance of the seafloor. Modeling of drilling muds and cuttings discharges (Section 4.1.2, Shell Gulf of Mexico Inc., 2009b) indicates that TSS (Total Suspended Solids) concentrations drop to <100 ppm within about 328 ft (100 m) of the drillship. More than 90% of solids form a plume that settles quickly to the bottom. Neff (2005) estimated that the concentration of water-based drilling mud in the plume generally drops below the toxicity limit within two minutes of discharge and 15 m (49 ft) of the discharge location.

Highly mobile species such as cod and pollock are likely to move away from the source of disturbance. Each MLC is expected to be no more than 314 ft^2 (Table 2.3-2, Shell Gulf of Mexico Inc., 2009b). Any localized sedentary or limited range species (such as sculpin, eelpouts, and most benthic invertebrates) that occur within the MLC area or directly beneath the discharge area are likely to suffer mortality. These losses are expected to be localized (< 2,000 ft^2 for all three wells) and to have no population level effects.

All impacts related to discharges are expected to be localized. Overall, no population-level effects are expected for any species that occur in the prospect areas. A minor level of effects for some fish and invertebrate species is expected from drilling mud and cuttings discharges, and other permitted discharges listed in EIA Tables 3.2.1-1 thru 3.2.1-3.

Presence and Habitat Use Analyses

Tables 3.2.1-4, 3.2.1-5, and 3.2.1-6 below provide species population estimates, the status of each species under the ESA, the number of individuals expected to occur near the prospect areas, and habitat preferences. This section discusses species that could be present in the Chukchi Sea near the prospect areas and terrestrial mammals using the Chukchi coastal areas during Shell's 2010 proposed activities.

Marine mammals found in the Chukchi Sea are listed below in Table 3.2.1-4. The most common marine mammals in the northeastern Chukchi Sea are Pacific walrus, ringed seals, spotted seals, bearded seals, polar bears, bowhead whales, gray whales, beluga whales, and harbor porpoises. Small numbers of killer whales, minke whales, and ribbon seals may be present in the Chukchi Sea, but not necessarily in the vicinity of the planned exploration drilling operations. Typical cetacean and pinnipeds species visiting the prospect areas during the proposed time period of operations are expected to be migrating or feeding gray whales; walrus, ringed, spotted and bearded seals; small numbers of beluga, minke and ribbon seals; and the occasional bowhead or harbor porpoise.

The presence and abundance of each species of marine mammals within the prospect areas depends upon environmental factors such as water depth, time of year, and the presence of sea ice. Depth preference varies between marine mammal species. The presence of ice in the prospect areas has varied greatly in past years (see EA Section 2.3.2), and the prevalence of ice in the vicinity of the prospects during Shell's planned exploration drilling program would have bearing on the number of ice-associated marine mammals (e.g., polar bear, walrus, ringed seals, spotted seals, bearded seals) present in the vicinity of the operations. Even with reasonably foreseeable variability in ice concentrations and movement, the proposed activities are not expected to occasion more than minor effects on marine mammals.

All marine mammals are federally protected species under the MMPA. There are no state-listed marine mammal species of special concern within the northeastern Chukchi Sea area. Bowhead whale, humpback whale, and fin whale are listed as endangered under the ESA. Polar bear are listed as threatened under the ESA. The Pacific walrus has been proposed for threatened status, as have ringed and bearded seals.

Presence and Habitat Use Analyses for Mammals

Table 3.2.1-4. Population information and habitat use for marine and terrestrial mammal species that may be exposed to the effects of the proposed action. ESA Status: N = not listed, C = candidate, T = threatened, E = endangered, P = proposed for listing, and S = species of concern. Anticipated Number of Exposures: * = speculative number based on general biological assumptions.

Species	Population Size	Anticipated Number of Potential Exposures of Marine Mammals to Received Sound Levels at Project Drill Sites	ESA Status	Area Habitat Preferences During Open Water Season (information sources are USDOI, MMS (2003) and Shell EIA (2009) unless otherwise noted)
Marine Mammals				
Bearded Seal	Unreliable estimate of 250,000 - 300,000 in Bering/Chukchi/ Beaufort Seas as reported in Allen and Angliss, 2009.	64-105 at $\geq$ 120 dB and 24-39 at $\geq$ 160 dB (Shell, 2009b).	p	Over continental shelf with 70% - 90% ice cover and between 20 and 100 nautical miles offshore. May remain near ice, or in open waters.
Beluga Whale	39,258 Bering/Chukchi/Beaufort Seas as reported in Allen and Angliss, 2009.	12-48 at $\geq$ 120 dB and 6-24 at $\geq$ 160 dB (Shell, 2009b).	N	Usually follow lead systems and nearshore areas in spring migration. Summer habitat use is segregated with older males using the continental shelf break and heavy ice, while females with young prefer shallower water over the shelf. Belugas migrate westward along the shelf edge during their fall migration. Common in nearshore waters and lagoons
Bowhead Whale	10,545 Western Arctic Stock as reported in Allen and Angliss, 2009..	2-10 at $\geq$ 120 dB and 1-5 at $\geq$ 160 dB (Shell, 2009b).	E	Migrate through the Chukchi Sea in spring and fall, feeding over deep water and in shallow waters in U.S. Beaufort Sea in summer. An unknown portion of the population migrates in the vicinity of drill sites from Barrow area toward Russia in fall.
Fin Whale	Population size in the North Pacific is uncertain, the min. estimate for the Alaska population is 5700 as reported in Allen and Angliss, 2009.	0-5 at $\geq$ 120 dB and 0-5 at $\geq$ 160 dB (Shell, 2009b).	E	Deep offshore waters, the North Pacific population may be a separate subspecies,
Gray Whale	18,813 Eastern Pacific/Stock as reported in Allen and Angliss, 2009.	48-193 at $\geq$ 120 dB and18-73 at $\geq$ 160 dB (Shell, 2009b).	N	Waters over continental shelf, nearshore waters, and shallow offshore areas may be present in the drill site areas.
Harbor Porpoise	48,215 Bering/Chukchi Seas as reported in Allen and Angliss, 2009.	11-27 at $\geq$ 120 dB and 4-10 at $\geq$ 160 dB (Shell, 2009b).	N	Considered rare and extralimital.

Species	Population Size	Anticipated Number of Potential Exposures of Marine Mammals to Received Sound Levels at Project Drill Sites	ESA Status	Area Habitat Preferences During Open Water Season (information sources are USDOI, MMS (2003) and Shell EIA (2009) unless otherwise noted)
Marine Mammals				
Humpback Whale	961 Pacific/Bering Seas as reported in Allen and Angliss, 2009.	0-5 at $\geq$ 120 dB and 0-5 at $\geq$ 160 dB (Shell, 2009b).	E	Considered rare and extralimital, sightings becoming more common in recent years.
Killer Whale	<314 Bering Sea as reported in Allen and Angliss, 2009.	0-5 at $\geq$ 120 dB and 0-5 at $\geq$ 160 dB (Shell, 2009b).	N	Open water and ice front, some coastal areas. Present but not common in the Chukchi Sea.
Minke Whale	No estimates available, no min. abundance estimate available as reported in Allen and Angliss, 2009..	0-5 at $\geq$ 120 dB and 0-5 at $\geq$ 160 dB (Shell, 2009b).	N	Common but not abundant in the Bering/Chukchi Seas., may penetrate loose ice in summer, migratory.
Narwhal	Estimate of 60,000-80,000 world wide, as reported by Canada Fisheries and Oceans, 2009.	0-5 at $\geq$ 120 dB and 0-5 at $\geq$ 160 dB (Shell, 2009b).	N	A few records exist in the Chukchi Sea, rare sightings
Pacific Walrus	Unreliable Estimates as reported in Allen and Angliss, 2009.	20-15,000 present within 12 miles of drill sites in previous years, no exposure estimate currently available (Shell, 2009b).	p	Seasonally abundant in area. Usually forage over continental shelf.
Polar Bear	20,000 - 25000 worldwide (FWS 2009 Biological Opinion)	0-36 present within 12 miles of drill sites in previous years, no exposure estimate currently available (Shell, 2009b).	T	Areas of sufficient sea ice cover North of the project location from July thru October. Some may be in open water transiting between sea ice and the coast. Females with young, and sub adults may occur onshore.
Ribbon Seal	Unreliable estimate of 90,000 – 100,000 in Bering/Chukchi Seas as reported in Allen and Angliss, 2009.	0-5 at $\geq$ 120 dB and 0-5 at $\geq$ 160 dB (Shell, 2009b).	N	Pelagic waters in the Bering and Chukchi Seas. Individuals have been rarely documented in Beaufort Sea.
Ringed Seal	Unreliable estimate of 249,000 in Bering, and Chukchi Seas as reported in Allen and Angliss, 2009.	1,728-2,726 at $\geq$ 120 dB and 615-978 at $\geq$ 160 dB (Shell, 2009b).	p	Shallow waters over continental shelf.
Spotted Seal	Unreliable estimate of 59,214 Bering/Chukchi Seas as reported in Allen and Angliss, 2009.	35-138 at $\geq$ 120 dB and 12-49 at $\geq$ 160 dB (Shell, 2009b).	N	Seasonal visitor to Beaufort Sea. Shallow waters over continental shelf. Occupy terrestrial haul outs in summer, including Kasegaluk Lagoon.
Terrestrial Mammals				
Central Arctic Caribou Herd	31,857 Alaska	NA	N	Coastal areas are used for insect relief.(Griffith et al. 2002)
Teshekpuk Caribou Herd	45,166 in 2002 (most recent data available)	NA	N	Most caribou from the Teshekpuk herd calve near Teshekpuk Lake in May/June, moving back toward Wainwright in the fall in some years (Carroll and Bente, 2007).
Grizzly Bear	Estimate 900-1120 in GMU 26A (Harper, 2007)	NA	N	Ubiquitous throughout in low densities.
Other Furbearers	Variable. Populations are reported to be stable (Szepanski, 2007)	NA	N	Ubiquitous throughout in low to moderate densities (Szepanski, 2007).

Allen and Angliss (2009) characterize the population estimates for ice seals (ringed, ribbon, bearded, and spotted seals) as unreliable or tentative, but ice seal populations are known to be in the tens to hundreds of thousands for each species across the Arctic. Ice seals are associated with sea ice for all or part of the year. Although some species of ice seals tend to remain near the ice edge during the summer months, they occur regularly in open water, particularly during the summer.

Partial counts indicated a minimum of 16,000 walrus, but a population-wide estimate is currently not available. Pacific walrus remain along the ice edge for much of the year, with most males migrating to terrestrial haulout sites along the coast in summer. Females and calves remaining along the ice edge until the sea ice retreats north of the continental shelf, when females and calves move to terrestrial haul out sites along the coast of the Chukchi Sea. In recent years, the sea ice edge has retreated north of the proposed drilling area by mid to late July. Existing information available on ice seal and walrus habitat use in conjunction with the site specific information available in the exploration plan provides an adequate level of detail for this analysis.

Shell's site-specific seafloor surveys and biological studies indicate there are no unique features in this project area of special significance to marine mammals. Hanna and Herald shoals have the highest gravel concentration of surface sediments near the prospect areas. The shoals are important feeding grounds for bottom-feeding animals, such as walrus, gray whales, and some seaducks because of their high benthic biomass and shallow depth. The proposed drill sites are located more than 25 mi from either shoal, but animals moving to or from the shoals may move through the prospect areas, and this potential is specifically considered in this analysis.

Because of the limited information on marine mammal species in the Chukchi Sea Planning Area, MMS considered whether additional studies of marine mammals would be necessary to determine the potential for significant effects for this site-specific analysis. Although information on marine mammal species in the Chukchi Sea is limited compared to some other regions of Alaska, there is sufficient information to evaluate the effects on marine mammals from the proposed activities, which would include benthic habitat disturbance, noise, and temporary displacement. The area of disturbance would be limited temporally and spatially. Only minor impacts to marine mammal species are anticipated.

Presence and Habitat Use Analyses for Birds

Table 3.2.1-5. Population information and habitat use for avian species that most commonly occur in the vicinity of the proposal area, and listed species that may occur in the proposal area. ESA Status: N = not listed, P = proposed for listing, C = candidate species, T = threatened species, and E = endangered species.

Species	Population Size	Range of Estimated Densities (late summer, early fall, late fall) from Burger area, 2008 surveys	ESA Status	Area Habitat Preferences During Open Water Season (information sources are MMS (2007) and Shell EIA (2009) unless otherwise noted)
Birds				
Pacific Loon	39, 945 for the Arctic coastal plain survey area (USDOI, FWS, 2006)	0-4.9 birds/km^2	N	Breeds on freshwater tundra lakes. Rests on open ocean during migration. Winters on ocean waters near coast, and sometimes on bays or estuaries
Northern Fulmar	2.1 million breeding birds in North America, (USDOI, FWS, 2006).	0.1-1.1 birds/km^2	N	Nests on Alaska Peninsula and Bering Sea islands. Winters at sea – Bering Sea, Gulf of Alaska
Short-Tailed Sharwater	Estimate 23 million breeding birds world-wide, (USDOI, FWS, 2006).	0.0-31.6 birds/km^2	N	Most at sea in south Bering Sea, Gulf of Alaska, fewer in Chukchi & Beaufort Sea
Black-Legged Kittiwake	Estimate of 1,322,000 in Alaska, (USDOI, FWS, 2006).	0.2-17.7 birds/km^2	N	Nest southeast Alaska north to Point Hope; winters at sea Bering Sea, Gulf of Alaska

Species	Population Size	Range of Estimated Densities (late summer, early fall, late fall) from Burger area, 2008 surveys	ESA Status	Area Habitat Preferences During Open Water Season (information sources are MMS (2007) and Shell EIA (2009) unless otherwise noted)
Birds				
Glaucous Gull	Population numbers are poorly known, but estimate 100,000 in Alaska (USDOI, FWS, 2006).	0.1-4.2 birds/km^2	N	Colonial nester along most of coastline, most common gull
Thick-Billed Murre	Estimates of 2.2 million birds in Alaska (USDOI, FWS, 2006).	0.0-0.1 birds/km^2	N	Nest SE Alaska to Cape Lisburne. Winter in open water Bering Sea, Gulf of Alaska
Least Auklet	Difficult to census, estimates of 5.5-9 million in North America, (USDOI, FWS, 2006).	0.0-0.1 birds/km^2	N	Nest AK Peninsula/Aleutians - Bering Sea islands. Non-breeding in Chukchi. Winters offshore.
Crested Auklet	2.9 million in North America, (USDOI, FWS, 2006).	0.0-0.3 birds/km^2	N	Nest Aleutian / Bering Sea islands. Non-breeding in Chukchi. Winters offshore.
Steller's Eider	100-866 on Alaska's North Slope (USDOI, FWS, 2009)	uncommon	T	Coastal and offshore areas provide habitat for Steller's eiders. The Alaska-breeding population is primarily confined to the Arctic Coastal Plain of Alaska's North Slope, with a distinguished concentration around Barrow (USDOI, FWS 2002c)
Spectacled Eider	4,000-9,000 Nest on Alaska's North Slope (Larned et al, 2007)	uncommon	T	Currently breeding distribution includes the central coast of the Yukon-Kuskokwim (Y-K) Delta, the Arctic Coastal Plain of Alaska, and the Arctic Coastal Plain of Russia (USDOI, FWS 2005). After nesting, spectacled eiders move to coastal waters where they migrate to molting areas.
Kittlitz's Murrelet	20,000 in Alaska (90% of the world's population) (USDOI, FWS, 2009)	uncommon	C	Occur at sea in substantial numbers along the ice edge in late summer and fall, particularly in the central Chukchi Sea.
Yellow-Billed Loon	3,000-4,000 in Alaska (USDOI, FWS, 2009).	uncommon	C	Breeds on coastal and inland low-lying tundra in association with fish-bearing lakes, winters in coastal waters.

The most extensive surveys of bird use in the northeastern Chukchi Sea were those reported by Divoky (1987). These surveys were conducted throughout the Chukchi Sea from mid-July through mid-October in multiple years in the 1970's and 1980's. These historic open water surveys have found that all three species of jaegers (pomarine, parasitic and long-tailed) were common in the Chukchi Sea until late September. Jaegers were well dispersed over all areas surveyed, including the area of Shell's prospects. Encounters with gulls varied by species and time throughout the July-October time frame of the surveys. Glaucous gulls were found to be present in all areas of the pelagic Chukchi Sea, including the area of Shell's prospects. Single ivory gulls were observed as early as July 18 and were considered rare until September 22. They were common to abundant in areas where ice was present, including the area of Shell's prospects from late September till the end of the observations on October 12. The lack of ice during the surveys likely had an effect on the number of ivory gull sightings. Ross's gulls were not found to be common until late September. Most were found at the ice edge although small numbers were seen well south of the ice, but they were found over most of the survey area and would be expected in the area of Shell's prospects. Black-legged kittiwakes were common throughout most of the survey area, including the area of Shell's prospects, from mid-July until late September. Densities increased from 1 to more than 2 birds/sq mi from late August to early September and decreased after as they left the Chukchi Sea. Sabine's gulls and arctic terns were rarely found in the pelagic Chukchi Sea; most observations were within 29 mi (46 km) from shore. The lack of sightings well offshore indicates that migration likely occurs landward of the 66 ft (20 m) isobath.

Divoky (1987) reports that alcids (murres, auklets, murrelets, and puffins) were commonly encountered throughout the July-October period of the survey, but that densities varied by species and time throughout

the period. Murres were most abundant in the southern and south central areas of the Chukchi, south of the prospect areas. Sightings decreased after August 20. Murres began to depart the Chukchi Sea as early as late August. Black guillemots were regularly found in low densities in the central and northern Chukchi Sea when ice was present. Both murres and black guillemots were common in offshore areas, including the area of Shell's prospects, during July and August. Parakeet auklets were found to be uncommon in the Chukchi Sea until late August when they became common in the southern Chukchi Sea. By late September, they were again uncommon. Small numbers of least auklets were found in the central Chukchi Sea after late September and few were found after October 1. Crested auklets move from the Bering Sea into the central Chukchi Sea in late August and early September; they were regularly encountered from August 27 into the first half of October. However, crested auklets were encountered in patches, likely reflecting the availability of zooplankton. Least and crested auklets were observed in the area of Shell's prospects. Small numbers of tufted puffins were found in the central and southern Chukchi Sea. They were only regularly found in the southern Chukchi Sea. Few horned puffins were found in the central Chukchi Sea in August and numbers increased in September after the breeding season. Most horned puffins found in the central Chukchi Sea were observed near the Cape Lisburne area. Puffins were not observed in the area of Shell's prospects.

Northern fulmars were (Divoky, 1987; Gall and Day, 2009) present in the central Chukchi Sea before late August, and become more common from late August to mid-September and absent after late September. Shearwaters were found to be common to abundant in the Chukchi Sea during periods of maximum ice retreat from late August to late September and their distribution can be expected to follow zooplankton prey abundance. Both the northern fulmar and shearwater were observed in the area of Shell's prospects (Divoky, 1987; Gall and Day, 2009).

Based on the available literature, northern fulmars; short-tailed shearwaters; red and red-necked phalaropes, glaucous, ivory, and Ross's gulls;, kittiwakes; pomarine, parasitic, and long-tailed jaegers; common and thick-billed murres; black guillemots; and least and crested auklets would be expected to occur in the vicinity of the Shell's prospects during the July-October time frame when Shell's exploration drilling would take place. These groups of species are often found foraging in the pelagic Chukchi Sea. Loons and sea ducks are typically found in nearshore waters where depths are shallower for foraging, but they might occasionally be found in the prospect areas. Overall, bird use (densities) of the offshore waters in the northeastern Chukchi Sea is lower than in the nearshore waters where high bird densities have been observed (Divoky, 1987, Gall and Day, 2009).

Shell funded and supported bird surveys along transects within a 35 x 35 mi (56 x 56 km) study area surrounding the Burger prospect and Klondike area (roughly 15 miles southwest of Burger). Data was collected by ABR, Inc. from July 23 to October 12, 2008, with a total of 3,751 mi (6,037 km) of transects during 417 hours of observation (Gall and Day, 2009). Comparisons from the data collected by ABR, Inc. to data collected by Divoky (1987) are difficult. The ABR, Inc. data collection was from only one year, both studies do not have good spatial overlap, and survey designs and sample sizes differed (Gall and Day, 2009). Nonetheless, both studies found that shearwaters, crested auklets, black-legged kittiwakes, northern fulmars, and thick-billed murres were the most abundant species representing a total of 65% of the birds observed overall.

Of the 31 bird species recorded during Shell's surveys in mid-July through mid-October 2008, eight were detected commonly enough to generate reliable estimates of density (Table 3.2.1-5). Densities of each of the eight most-abundant species differed substantially among seasons; however, seasonal patterns of abundance differed by species. Thick-billed murres were most numerous in late summer and early fall, whereas short-tailed shearwaters, northern fulmars, black-legged kittiwakes, and Pacific loons were most numerous in early fall; glaucous-gulls and least auklets were most numerous in both early and late fall; and crested auklets were most numerous only in late fall (Gall and Day, 2009).

Some areas along the Chukchi Sea coast are particularly important habitat for a number of species. These include nesting colony sites and locations where large numbers of birds congregate for staging, foraging, or molting, as well as migration routes. Kasegaluk Lagoon contains important avian habitats. The richness and diversity of birds in the Kasegaluk Lagoon system are distinctly greater than in other arctic Alaska lagoons (Johnson et al., 1992). Pacific Black Brant was the most abundant species of bird recorded during aerial surveys of the Kasegaluk Lagoon by Johnson et al. (1992). Large quantities of green algae are believed to have attracted brant to feed in the area. Shorebirds also extensively use lagoons such as Kasegaluk Lagoon during fall migration (Alaska Shorebird Working Group, 2004). In spring, loons migrate along the coast and use inland routes (Johnson and Herter, 1989). In fall, loons migrate along the coast and then out to sea once they reach the Lisburne Peninsula (Divoky, 1987). The proposed drill sites are more than 60 statute miles from the coastline. Vessels associated with the project would travel directly from Wainwright to the drill sites, and would not be moving parallel to the coast or entering Peard Bay, Kasegaluk Lagoon, Ledyard Bay, or other areas identified as sensitive habitats in Shell's EIA.

In the Chukchi Sea, common eiders molt in areas near Point Lay, Icy Cape, and Cape Lisburne (Johnson and Herter, 1989). Peard Bay may be particularly important to molting common eiders (Kinney, 1985). After molting, most common eiders stay close to shore, but some move offshore into pelagic waters (Divoky, 1987). Most males move out of the Chukchi Sea by late August and early September, and most females move out by late October or early November. Most common eiders winter near the Bering Sea pack ice or near the Aleutian Islands, but some remain within open leads in the Chukchi Sea until early winter (Johnson and Herter, 1989).

Other species of sea ducks also use the Chukchi Sea extensively, particularly close to shore. King eiders have been found close to shore two weeks prior to and during wing molt, suggesting that the sea is an important migration flyway and staging area (Phillips, 2005; Powell et al., 2005). By late June, flocks of long-tailed ducks begin to move westward toward protected coastal areas such as lagoons, leeward beaches within barrier islands, and large lakes where they gather to form massive molting flocks (Johnson and Herter, 1989). While molting, they take advantage of abundant supplies of invertebrate foods (Johnson and Herter, 1989).

Shorebirds extensively use the shorelines, particularly during fall migration (Johnson and Herter, 1989). Kasegaluk Lagoon and Peard Bay have been identified as important shorebird sites (Brown et al., 2001).

Bird strikes are the most likely threat to avian species from the proposed activities. However, seabirds are the species most likely to be in the drill site areas. Seabirds, such as gulls, terns, and jaegers, fly at higher altitudes than do sea ducks; moreover, they are gliders, usually flying at slower speeds than do sea ducks, which fly quickly and at low altitudes. The slower speeds and higher altitudes used by seabirds are expected to provide more reaction time, allowing seabirds to avoid striking the drill ship and other vessels under most conditions.

Presence and Habitat Use Analyses for Fish and Invertebrates

There are no ESA-listed fish or invertebrate species present in the prospect areas. Species known to be present in the area, and abundance information, where available, are provided below.

Shallow hazards surveys conducted by Shell at the prospects, as well as surveys conducted at historical prospects in the area have not revealed any unusual or special benthic features or communities. Video reconnaissance surveys (Finney, 1989) were conducted within the historical Burger and Crackerjack Prospects within a few miles of Shell's current drill sites. The benthic communities were considered by MMS to be consistent with Cluster Group VI in Table 3.2.1-6 (Boudreau, 1989).

Table 3.2.1-6 Common Benthic Species Found in the Chukchi Sea.

Dominant Species	Common Name
Cluster Group VI	
Maldane sarsi	polychaete worm
Ophiura sarsi	brittle star
Golfingia margariticea	sipunculid - peanut worm
Astarte borealis	clam
Cluster Group VIII	
Macoma calcarea	clam
Nucula tenuis	clam
Yoldia hyperborea	clam
Ponteporeia femorata	amphipod

Barber et al. (1994) surveyed demersal marine fish in the northeastern Chukchi Sea in 1990 and 1991 and identified six different fish assemblages through statistical analysis. The distributions of these marine fish species assemblages are indicated in Table 3.2.1-7.

Table 3.2.1-7 Estimated Mean Abundance Fish per Square Kilometer of the Twenty-One Most Abundant Demersal Fish Species in Each of the Six Demersal Fish Assemblages in the Northeastern Chukchi Sea.

Common Name	Assemblage					
	I	II	III	IV	V	VI
Arctic cod	43,733	16,419	5,280	8,172	16,096	6,100
Saffron cod	684	2	170	19	10,956	0
Sculpin	3,391	49	44	2	4,492	0
Arctic Staghorn sculpin	1,005	87	889	156	2,618	7
Bering flounder	1,599	72	0	61	15	3
Warty sculpin	178	0	429	177	773	9
Hamecon	20	0	0	11	1,061	4
Walleye pollock	69	0	0	26	861	0
Ribbed sculpin	70	3	120	59	722	0
Capelin	437	0	0	40	0	0
Wattled eelpout	453	0	0	139	323	0
Pacific herring	195	0	0	139	323	0
Slender eelblenny	235	18	2	14	141	0
Canadian eelpout	260	64	2	0	6	0
Marbled eelpout	76	7	4	284	13	5
Sturgeon poacher	60	0	18	5	280	0
Pacifc cod	21	0	1	6	273	0
Variegated snailfish	129	2	0	15	29	0
Rainbow smelt	0	0	0	0	258	0
Butterfly sculpin	89	0	0	13	0	0
Hookear sculpin	80	0	0	0	20	0

The abundance of each of the 21 most common species found in these assemblages is indicated in EIA Table 3.5.1-2. Shell's Burger Prospect is an area where Assemblage VI is predominant; Assemblages II and VI are predominant in the areas of the Crackerjack and SW Shoebill Prospects (EIA Figure 3.5.1-2). The most abundant demersal fish species in the assemblages found in Shell's prospects were arctic cod, arctic staghorn sculpin, and Bering flounder; most other species were found in very low numbers. Abundant pelagic species in the northeastern Chukchi include Pacific herring and capelin (Craig, 1984). Although capelin are most abundant in nearshore waters (Craig, 1984) it is included here due to its importance as a forage species.

Because of the limited information on fish and benthic invertebrate species in the Chukchi Sea Planning Area, MMS considered whether additional studies of fish and benthic invertebrates would be necessary to determine the potential for significant effects for this site-specific analysis. Although information on continental-shelf fish species in the Arctic is limited compared to other regions of Alaska, there is sufficient information to evaluate the effects on fish and benthic invertebrates from the proposed activities. Effects would include benthic habitat disturbance, noise, toxicity, and turbidity. The area of disturbance would be limited temporally and spatially. Fish species that are highly mobile would be able to avoid the disturbance in the prospect areas and the associated temporary effects of turbidity, toxicity, and noise.

Some more sedentary fish species and some benthic invertebrates would likely be impacted by the site disturbance and discharges associated with drilling, however these impacts are anticipated to be localized and of short duration with no population level effects. Shell conducted extensive seafloor and shallow geologic surveys and collected shallow cores for geochemical and geotechnical studies. None of the site studies indicated that the seafloor environment at the proposed drill sites is unique in the area. If during the exploration, unique benthic habitats, species, or communities were found, the occurrence would be reported to MMS and per the requirements of Lease Stipulation 1, Shell's activities would be modified as necessary to protect those resources. Based on this information, MMS believes that additional fish studies are not needed at this time for adequate site-specific analysis prior to the proposed activities.

The EIA (Shell Gulf of Mexico Inc.. 2009b) summarized the effects of noise on fish in Section 4.1.12, explaining fish may react to sound levels $\geq$ 120 dB and that drillship noise typically falls between 90 dB and 138 dB, depending on distance from the noise source. The EIA states that the ice-management vessels can produce sounds ranging from 174-184 dB, or 10-15 dB higher if actively breaking/moving ice. Such sound levels could motivate fish to temporarily avoid these areas; however, no measurable population-level effects on fish are anticipated from the proposed activities. The overall effect of the proposed activities on fish and invertebrates is expected to be negligible or minor, depending upon the mobility of the individual species, with lethal take of small numbers of some fish and invertebrate species, and no population level effects within the northeastern Chukchi Sea.

The Department of Commerce approved the Fishery Management Plan for Fish Resources of the Arctic Management Area in August 2009 (NPFMC, 2009). The Salmon Fishery Management Plan for Coastal Alaska, approved in 1990 (NPFMC and NOAA, NMFS, 1990) applies to the five Pacific salmon species in the Alaska Chukchi and Beaufort Seas. The Arctic Fishery Management Plan (2009) identifies three commercial target species: Arctic cod, saffron cod, and snow crab (*opilio* crab). The Arctic Fishery Plan also 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. The general distribution for adult and late juvenile Arctic cod essential fish habitat (EFH) covers the entire Arctic Fishery Plan Area, which includes both the Chukchi and Beaufort seas. MMS consulted with NMFS on EFH during the Sale 193 prelease process in 2007. Considering the limited areal extent of disturbance associated with the proposed activities and broad area of the EFH defined to date, MMS has determined the proposed activities would have negligible effects on EFH.

Identification of Biological Resources Requiring Further Evaluation

The data from EA Tables 3.2.1-1 thru 3.2.1-6 were analyzed for level of effects, the anticipated population density of individuals at the project site, and habitat preferences. This information was then evaluated in relation to the impact levels specified in EA Section 3.2.1. All ESA and MMPA listed species that occur within the project area, and species that could experience more than negligible effects from the proposed activities are analyzed further, and those that would experience negligible impacts have been excluded from further consideration and analysis.

3.2.2 Proposed Action Mitigation for Biological Resources

Shell incorporated extensive mitigation in their proposed activities to lessen or alleviate the impacts associated with exploratory drilling on wildlife species. These measures are summarized in EA Sections 2.3.9 and 2.3.10. Shell describes its proposed mitigation measures in EP Appendix C (IHA application to NMFS); EP Appendix E (LOA application to FWS including Shell's Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Encounter Interaction Plan); EP Appendix J (Bird Strike Avoidance and Lighting Plan); and EP Appendix D (Marine Mammal Monitoring and Mitigation Plan). These proposed mitigations are in addition to, or may be amended by, measures required under MMPA authorizations and the ESA consultations administered by NMFS and the FWS. Shell's mitigation measures related to discharges, emissions, and spills are summarized in EA Section 2.3.4, EA Section 2.3.11, and Shell's ODPCP (Shell Gulf of Mexico Inc. 2009c). The mitigation measures from the EP listed below are pertinent to species protection and are assumed in the analyses.

Vessel Traffic and Noise

- Shell will not operate vessels within 0.5 mi (800 m) of polar bears.
- The drill ship and associated support vessels will not enter the Chukchi Sea before July 1unless authorized by the USFWS based upon a review of seasonal ice conditions and other factors (50 CFR 18.118 (a)(3)(i)) to minimize effects on marine mammals and birds that frequent open leads and to minimize effects on spring bowhead whale or beluga hunting.
- To minimize impacts on marine mammals and subsistence-hunting activities, the drillship and support vessels traversing north through the Bering Strait will transit through the Chukchi Sea along a route that avoids the spring lead system while allowing for the highest degree of safety regarding ice conditions and sea states.
- Marine Mammal Observers (MMOs) shall be posted on ships to ensure that support vessel activities do not disturb marine mammal resources or the subsistence hunt of those resources.
- The MMOs will 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.
- For vessels in transit, if a marine mammal is sighted from a vessel within its relative safety radius, the Shell vessel will reduce activity (e.g., reduce speed and/or change course) and sound energy level to ensure the animal is not exposed to sound above the safety level for that species (180 dB for cetaceans and walrus, 190 dB for polar bears and ice seals). Full activity will 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.
- When within 900 ft (274 m) of marine mammals, vessels will reduce speed, avoid separating members from a group, and avoid multiple course changes.
- Vessels will not operate within 0.5 mi (800 m) of walrus.
- Vessel speed to be reduced during inclement weather conditions to avoid collisions with marine mammals.

- When within 1,000 ft (300 m) of walrus in water, vessels will reduce speed and avoid multiple changes of direction.

Aircraft Traffic and Noise

- Shell will implement flight restrictions prohibiting aircraft from flying within 1,000 ft (330 m) (horizontal distance) 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.
- Aircraft shall not operate below 1,500 ft (457 m), unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, or unless engaged in providing assistance to a whaler or in poor weather (low ceilings) or any other emergency situations.
- Aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft (457 m) in areas of active whaling; such areas to be identified through communications with the Com Centers. Aircraft will not operate within 1500 ft (457 m) of whale groups.
- 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 directly south of its offshore destination, at which point it shall fly directly north to its destination.
- Helicopters primarily will fly direct routes (except to avoid severe weather), which will reduce the spatial area potentially disturbed. Planned routes also avoid areas of known polar bear dens.
- Aircraft and vessels will not operate within 0.5 mi (800 m) of walrus or polar bears when observed on land or ice. When polar bears are seen by aircraft, the aircraft will change route to avoid disturbing the bear.
- Regular overflight surveys and support vessel surveys for marine mammals will be conducted to monitor prospect areas.
- Mitigation to reduce bird disturbances will include flight path selection, flight altitudes, and flight timing to avoid those times that large concentrations of birds are present in the vicinity of the airport or the drillship.
- The helicopter flight path will be along the coastline at 1,500 ft (457 m) altitude approximately 5 mi (8 km) inland from the coastline between Wainwright and Barrow, or directly from Wainwright perpendicular to the coast to the drill site, reducing disturbances to nearshore birds and overflights of any barrier island.

Drilling Noise

- Anchored vessels, including the drilling vessel, will remain at anchor and continue ongoing operations if approached by a marine mammal. An approaching animal not exhibiting avoidance behavior is assumed to be curious and not harassed. The anchored vessel will remain in place and continue ongoing operations to avoid a flight or alarm response from the animal elicited by suddenly changing sound-energy conditions.

Bird-Ship Collisions

- Installing shading and directing light inward and downward to living and work structures to minimize light radiating from the drillship. Shell is planning to reduce or shade light output from:
  - Derrick lights, deck lighting, doorway and stairway lighting, and pipe rack lighting – lights will be shaded to direct light downward and inward and/or the wattage reduced.
  - Crane boom lights – lights will remain unshielded for safety during crane operations.
  - Heliport lighting – lights will be dimmed or shut off when not in use.
  - Escape pod lighting – lights will be dimmed when not in use.
  - Navigation and clearance lights – no changes will be made due to safety concerns.
  - Lights from windows – shades will be used during darkness.
- Where applicable, replacing some lights with “ClearSky” light technology to reduce the amount of red light output. ClearSky lighting emits fluorescent light with a unique light spectrum without

the long-wavelength (red) components. This technology is produced by Philips Lighting. Studies indicate that removing the long wavelength components of the spectrum reduces the visual and orientation impact on birds (Marquenie, 2007).

- Conducting an assessment of the movements of bird flocks in the proximity of the drillship using the radar equipment available onboard the drillship. One aspect of the assessment will be to monitor and compare bird movements during periods of good and poor visibility. Radar will be used to perform bird-movement monitoring, because visual observations may not be possible during periods of poor visibility, such as at night or during foggy conditions.
- Shell has committed to a bird-strike monitoring program that record and report bird strikes and conditions under which they occur (e.g., vessel lighting configuration), providing the FWS with data for risk assessment of bird strikes related to operational activities, weather conditions, and response of eiders and other migratory birds to drillship lighting.

Operations

- Solid food wastes will be incinerated onboard the drillship, eliminating the wastes as a potential attractant for polar bears.

3.2.3 Effects Analysis for Biological Resources

This EA tiers from the Chukchi Sale 193 EIS (USDOI, MMS, 2007b), and applies the results of those analyses to the site specific information from Shell's EP and EIA. More in-depth analyses can be found in Chukchi Sale 193 EIS (USDOI, MMS, 2007b) and the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a). Additional information can also be found in the Shell EP and EIA (Shell Gulf of Mexico Inc., 2009a and 2009b). Shell has determined that no unique or noteworthy resources or seafloor habitats occur in the vicinity of the proposed drill sites. Thus, the anticipated effects of this proposed action discussions are consistent with those in the 193 EIS with regard to effects on Chukchi Sea resources.

Aircraft Traffic and Noise

Aircraft traffic associated with the exploration drilling program is not expected to have direct or indirect effects on fish. No reported instances of impacts to fish from overflights of helicopter or fixed wind aircraft were found during a review of the scientific literature documenting previous studies.

Aircraft traffic has been found under some circumstances to impact birds. Aircraft traffic associated with Shell's planned exploration drilling program would probably cause some disturbances to birds, including Steller's and spectacled eiders, in both onshore and offshore areas but the impact would be short term and minor consisting of behavioral reactions, such as alert responses or flushing, with no measurable impact on populations. Aircraft that Shell would use and the frequency of flights are described in Section 2.2. The highest potential for any impact occurring is during sensitive life stages of the birds such as nesting, molting (when birds are flightless), and staging (when birds are assembled in large numbers prior to migration). Repeated disturbance could prevent staging birds from maintaining or acquiring sufficient nutrients for subsequent migration (Taylor, 1993 cited in Miller, 1994). Of most concern regarding bird populations in the northeastern Chukchi Sea are potential disturbances of colonial-nesting marine birds and the disturbance of large numbers of waterfowl that utilize coastal waters such as Kasegaluk Lagoon, Peard Bay, and Ledyard Bay for molting or staging. Since air traffic associated with Shell's activities would not fly over these areas, disturbances are not expected.

For whales, the most common reaction to aircraft traffic is avoidance behavior, such as diving. Richardson et al. (1985) monitored the responses of summering bowhead to overflights with both fixed wing (Islander) aircraft and helicopter (Sikorsky S-76) in a set of planned experiments. Overflights of fixed-wing aircraft sometimes evoked responses at altitudes of less than 1,000 ft (305 m), infrequently at altitude of 1,500 ft (457 m), and virtually never at altitudes greater than 2,000 ft (610 m). The researchers

concluded that bowhead whale behavior is generally not disturbed by aircraft if an altitude of 1,500 ft (> 457 m) is maintained. The most common bowhead reactions to overflights were sudden or hasty dives, and changes in orientation, and dispersal or movement out of the area. Changes in activity were sometimes noted. Bowheads that were engaged in social activities or feeding or were less sensitive than those that were not. Whales in shallow water < 33 ft (< 10 m) were often very sensitive. No overt responses were observed to helicopter overflights at an altitude of 500 ft (153 m); however, others (Richardson et al., 1995a) have reported disturbances such as hasty dives in response to low-level helicopter overflights. Richardson and Malme (1993) reported that most bowhead whales in their study did not show a response to helicopters flying at altitudes above 500 ft (150 m).

Gray whales may show avoidance behavior in response to air traffic sound energy. The Scientific Research Association (1988) reported that gray whales usually exhibit avoidance behavior when helicopters flew lower than 1,198 ft (365 m). Mothers with calves appear to be more sensitive to air traffic (Clarke et al., 1989). Some gray whales have been observed reacting to sound energy generated by helicopters flying within 328 ft (100 m) of the whales (Richardson, 1998). As a mitigation measure Shell helicopters will be prohibited from flying at altitudes below 1,500 ft (457 m) except during take-offs and landings and when weather conditions force an altitude reduction for safety reasons. Shell helicopter flights should therefore have little or no effect on gray or bowhead whales. Any changes in gray whale behavior due to aircraft traffic associated with Shell's exploration drilling program will be minor and temporary lasting only minutes or hours at the most.

Richardson (1995) observed some belugas exhibiting avoidance behaviors in reaction to aircraft flying at altitudes less than or equal to 820 ft (250 m), most, however, showed no reaction to aircraft flying at altitudes greater than or equal 492 ft (150 m). The amount of time that belugas may be affected by low-flying aircraft is usually only seconds (Stewart et al., 1982). Some beluga whales have been observed (Richard, 1998) reacting to helicopter sound via deflection when exposed to helicopters within 328 ft (100 m). These brief encounters with aircraft are not expected to have any more than a brief effect on belugas (Richardson et al., 1991; Richard, 1998), and any potential deflection or displacement would likely be temporary. Shell's mitigation measure of requiring an altitude of 1,500 ft (457 m) or more for all helicopter flights will avoid most or all effect on belugas.

Spotted seals showed immediate reaction to the presence of aircraft during surveys by Rugh et al. (1997). Rugh et al. observed disturbances of spotted seals at terrestrial haul outs by aircraft at altitudes up to 4,500 ft (1,370 m) and up to 2 km away. In summer, spotted seals haul out in large numbers on the sand bars near Kasegaluk Bay. Concentrations of animals hauled out on land seem to react more severely than the scattered small groups found on the sea ice in spring. Since Shell's flight routes would be directly from Wainwright out to sea, or 5 mi inland, disturbances of spotted seals at terrestrial haul outs are not expected. Disturbances of seals by Shell's aircraft would be temporary and localized to small numbers of seals hauled out on remnant ice floes. Potential impacts on seals from aircraft traffic will be mitigated by Shell's selection of a flight corridor (Figure 2.2-1) that minimizes the portion of flights that would be over coastal waters. Flights between Barrow and Wainwright will be along a corridor that is more than 5.0 mi inland to minimize effects on subsistence and subsistence resources including marine mammals.

Walrus may stampede into the water when disturbed from haul out sites. Calves are particularly vulnerable during stampedes, and several scientists have reported numerous mortalities following stampedes caused by disturbance events (Kochnev, 2007; GarlichMiller, pers. comm., 2009; Loughrey, 1959). Scientists evaluated walrus reactions to survey aircraft flying at an altitude of 305 m (1,000 ft) over the pack ice and 152 m (500 ft) over land. It appeared that walrus hauled out on land or ice were more sensitive to overflights (Bruggeman et al., 1990). Bruggeman et al observed 17% of the walrus groups on ice and none on land react to the aircraft. Walrus reacted to flights between 197 and 492 ft (60 and 150 m) above sea level (within 0.62 mi [1 km] lateral distance) by either orienting towards the aircraft or escaping into the water (Bruggeman et al., 1990). Salter (1979) found that at horizontal

distances beyond 2.5 km, the only responses elicited by aircraft were head raises by some animals in the herd. Shell's flight route traveling 5 mi inland is expected minimize the possibility of disturbing walruses at terrestrial haul outs.

Polar bears exposed to aircraft are anticipated to move away and quickly resume their natural habits. Helicopters will fly along a direct pre-determined flight corridor, which will reduce the spatial area potentially disturbed. Aircraft will maintain a 1,500 ft (450 m) minimum altitude and 0.5 mi (800 m) lateral distance from bears hauled out onto land or ice, unless weather does not permit this altitude. With these mitigation measures in place, the aircraft traffic associated with the planned exploration drilling program will have a minor, if any, effect on polar bears.

Aircraft traffic associated with the planned exploration drilling program may cause some temporary behavioral disturbance, and possibly deflection away from the sound source. The intensity of the sound energy level perceived by terrestrial or marine mammals would depend on size of the aircraft and power output. A take-off would produce a more intense sound than cruising speed, which would in turn produce a more intense sound than the landing approach (Richardson and Malme, 1993). A marine mammal under water would typically only hear an aircraft at low altitude when it is within the area 13 degrees on either side of the vertical from where the animal is located (Richardson and Malme, 1993). According to Shell, aircraft other than marine mammal monitoring flights will not fly below an altitude of 1,500 ft (300 m), within 0.5 mi (800 m) of walrus or polar bear observed on land or ice, or within 500 yd (460 m) of whale groups. These flight restrictions are standard mitigation measures which are usually required by FWS and NMFS as part of the LOA and IHA process. Aircraft would follow flight corridors directly from shore at Wainwright to the drill site, and 5 mi inland when traveling from Wainwright to Barrow. Given these mitigation measures, aircraft impacts associated with the drilling program are expected to be negligible and consist of brief behavioral responses.

Vessel Traffic and Noise

Vessel traffic will have little or no impact on fish. Sound energy produced by the vessels when under way would cause some avoidance of the area near the vessel but any such effects would be minor as they would affect only a small number of individuals, a tiny proportion of the total fish population. Sound impacts are discussed in detail below in sections concerning the effects of sound from drilling and ice management. Any impact will consist of temporary behavioral responses lasting only as long as the vessel was operating at the location.

Vessel traffic will disturb some birds and temporarily displace foraging and resting birds. Disturbance will be largely limited to the flushing of birds away from vessel pathways. Larger bird species generally have greater flushing distances and different types of vessels have different flushing distances; flushing distances for some waterbird species have been shown to be 66-164 ft (20-50 m) for personal watercraft and 75-190 ft (23-58 m) for an outboard-powered boat (Rodgers and Schwikert, 2002). Flushing distances not only vary between species, but between individuals (Rodgers and Schwikert, 2002). Some species such as some of the gulls are attracted to vessels. Potential for effects due to vessel incursion(s) is greater in nearshore waters adjacent to bird nesting colonies, where disturbance could result in lowered productivity due to nest abandonment, direct loss of eggs or chicks, increases in predation rates on eggs and chicks, and in important habitats where birds are concentrated for feeding, molting, or staging. In these situations there is concern that birds could move to less suitable habitats, expend more energy, or eat less, thereby negatively affecting their energetics and possibly fitness for migration.

Steller's eiders exhibit tolerance to vessel traffic and readily habituate to vessels and human activity. USACE (2000d) reported that vessels moving through flocks of Steller's eider during arrival to or departure from the Trident Seafood plant dock in the Aleutians do not flush the eiders unless there is direct competition for space. In those cases, the eiders typically fly only a short distance before landing.

Not including Ledyard Bay during the molt period, the density of eiders in areas of the Chukchi Sea is expected to be relatively low, where vessels would operate beyond the coastal areas occupied by most eiders (USDOI, MMS, 2007b). With drilling activity and most vessel activity occurring more than 60 mi (97 km) offshore, and any prospect-to-shore vessel traffic being along an identified corridor that avoids important habitats, any disturbances to eiders would be brief behavioral responses and temporary displacement confined to very small areas of the available habitat (Chukchi Sea), all such impacts will be short term and negligible. There will be no effect on the populations of spectacled or Steller's eiders.

Agness et al. (2008) studied the effects of various types of vessels with lengths of 20-1,000 ft (6-305 m) on Kittlitz's murrelets. Murrelet group size was not affected by vessel activity. Near-shore densities were suppressed temporarily by vessel passage but recovered within hours, the effects were not apparent over 24 hours or multiple days, and did not result in persistent loss of foraging habitat for Kittlitz's murrelets. Murrelets spent about 30% more time flying and less time loafing when vessels were in the vicinity; diving behavior was not altered. The energy budgets of the birds were not compromised. Large and fast-moving vessels caused the greatest disturbance to Kittlitz's murrelets. Shell's 2010 exploration drilling program in the Chukchi involves support vessels, a drillship, an OSR fleet, and vessels for transporting supplies. These vessels would be operating at slow speeds of 10 knots or less (<19 km/hr). As vessels pass an area, birds would likely move some distance away and then soon after, continue on with foraging and resting. Most vessel traffic would take place offshore in the vicinity of the leases, which are more than 60 mi (97 km) from shore where bird densities are relatively low. Disturbances from offshore vessel traffic should be short term lasting only as long as the activity, and would occur at a relatively small geographic scale. Therefore, disturbances from vessel traffic are not anticipated to result in bird mortality and should not affect birds on a population scale. Offshore drilling and therefore most vessel traffic will be occurring more than 155 mi (250 km) from the large cliff nesting colonies in the Cape Lisburne area. As birds from these colonies are known to forage as far as 75 mi (120 km) from the colony, no disturbance of these birds would be expected. Any vessel traffic between the prospects and shorebase would probably not bring the vessel within 20 mi (32 km), depending on hazardous ice in the immediate area, of any known nesting colonies and should therefore have no effect on nesting birds. Transit routes outside of the polynya zone and well away from bird nesting areas will be selected.

Bowhead whales have exhibited avoidance of marine vessels. When a vessel approaches a bowhead whale, the most likely response is to swim away from the vessel (Richardson and Malme, 1993). Hobbs and Goebel (1982) reported that bowheads react more strongly to boats with outboard motors than to diesel ships. Richardson and Finely (1989) noted that bowheads tend to react most strongly to vessels when the vessels were moving quickly and directly toward the whale than if the vessel was moving more slowly or in any other direction than at the whale.

Richardson et al. (1985b) found that bowheads react more strongly to vessel traffic than other industrial disturbances such as aircraft overflights and drilling. Most bowheads began to turn away when vessels approached within 0.6-2.5 mi (1-4 km) of the whale. The whales typically tried to outrun the boat; when the vessel was within a few hundred yards (meters); the whales turned away from the vessel path or dove. Groups of whales scattered, fleeing generally stopped a few minutes after the vessel passed but the scattering was evident for a longer period of time – perhaps an hour or more. Additional behavioral responses to vessel traffic included changes in respiration rates. Similar responses to vessels have been observed in fin (Ray et al., 1978 in Richardson et al., 1985) and humpback whales (Baker et al., 1983 in Richardson et al., 1985b).

Koski and Johnson (1987) made similar observations of bowheads in the Alaskan Beaufort where strong responses by feeding bowheads to large icebreakers and supply vessels were observed. Changes in whale behavior were temporary, with feeding often resuming while the moving vessel was still within 3.7-6.0 mi (6.0-10.0 km). At least some of the whales were observed back at the same area the next day indicating there was little if any effect on use of the area by whales.

Wartzok et al. (1989) reported that bowheads generally ignored a small ship at distances greater than 547 yd (500 m). Over 180 whales voluntarily approached within 547 yd (500 m) of the vessel. Little response was noted unless there was a sudden change in sound level due to ship acceleration. These studies indicate that some bowheads will react more strongly than others to vessel traffic associated with Shell's exploration drilling program. Bowheads may alter their behavior and avoid the area within 0.6-2.5 mi (1-4 km) of the vessel. Any changes in behavior such as swimming speed and orientation, respiration rate, surface-dive cycles will be temporary and lasting only minutes or hours. Similarly, any consequent displacement of bowheads will be of a similar length of time and be restricted to a distance of a few miles (kilometers) from the vessel. The drillship and support vessels will not enter the Chukchi Sea until after July 1 when most of the spring bowhead migration is complete. Few bowheads are expected to be encountered during the drilling operations, minimizing any effects. As a mitigation measures, vessels associated with the drilling program that are underway will reduce speed, avoid separating members from a group of whales and avoid multiple course changes when within 300 yd (275 m) of marine mammals. Vessel speed will be reduced during inclement weather conditions in order to avoid collisions with marine mammals. With these mitigation measures in place, any effects on bowheads from vessel traffic will be minor and temporary, lasting only minutes or hours after the vessel has passed.

Bogoslovskaya et al. (1981) observed avoidance behaviors by gray whales when vessels came within 980 ft (300 m), but saw no reaction to vessels further away. During a study by Schulberg et al. (1989), many gray whales showed no deflection or change of behavior until vessels came within 98 ft (30 m). Underwater sound may also elicit a response in whales to avoid vessels moving within their immediate area. Any avoidance responses due to vessel traffic are expected to be minimal and temporary.

It is expected that vessel traffic will result in temporary deflection of beluga whales. The main factor affecting their migration route, however, is the extent and location of sea ice (USDOI, MMS, 2003). Fraker, Sergeant, and Hoeck (1978) observed startle responses in belugas when vessels moved through areas with a high concentration of whales. Reactions of beluga whales to vessels will likely vary between individuals. The amount of avoidance exhibited by an individual beluga would depend upon the amount of previous exposure to moving vessels, and the level of need for the beluga to be in the same area as 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). Any behavioral reactions of belugas to vessels are expected to be temporary in nature and localized. No belugas were observed within Chukchi Sea prospects in most years during historical drilling programs in this area of the Chukchi Sea, and no belugas were observed in the Burger Prospect by Shell in 2008. Small numbers may be encountered during Shell's planned 2010 drilling program, if pack ice is in the area. Any resulting effects would be minor.

Ringed, bearded, and spotted seals appear to be fairly tolerant of vessel traffic. Brewer et al. (1993) reported observations of ringed seals following ice management vessels in the Beaufort Sea, apparently feeding on fish and plankton in the disturbed waters. Documented reactions of walrus to vessels include waking up, head raising, and entering the water (Richardson et al., 1995). Brueggeman et al. (1990, 1991) monitored the behavior of walrus in response to vessels associated with exploration drilling near Shell's prospects in 1989 and 1990. They reported that none of the observed groups of walrus exhibited avoidance behavior in response to anchored or drifting vessels. Responses of walrus to moving vessels varied with distance, ranging from no response to approaching the vessel to avoidance behavior. Most walrus reacted when the vessel came within about 550 yd (500 m) of the walrus. Mitigation measures as described in Section 2.1 and in Shell's Polar Bear and Pacific Walrus Interaction and Avoidance Plan include a 0.5 mi (800 m) exclusion zone around observed walrus for vessels in transit, this mitigation measure will reduce the potential for disturbance and incidental takes of walrus.

It is likely that some marine mammals will be present in the prospect area when the exploration drilling operations are ongoing. The most common marine mammal occurrences will likely be ringed, spotted,

and bearded seals, walrus, and gray whales. Small numbers of beluga whales, minke whales, and ribbon seals may also be present.

Impacts of vessel traffic on any of these marine mammals would be minor and short term, consisting only of temporary displacement. Seals and walrus may leave the ice, make hasty dives, or move off. Brueggeman et al. (1991) noted that the behavioral effect on walrus was of a very brief duration, with displaced walrus occasionally re-occupying ice floes as soon as the vessel passed. Potential effects of vessel traffic on marine mammals would be reduced with implementation of Shell's mitigation measures that prohibit vessels from operating within 0.5 mi (800 m) of walrus when observed on land or ice. Vessels underway will reduce speed and avoid multiple course changes when within 300 yd (275 m) of marine mammals in the water to avoid separating members from a group. Vessel speed will also be reduced during inclement weather conditions in order to avoid accidental collisions with marine mammals. No Shell vessels will intentionally approach any marine mammal. Vessel traffic may temporarily displace marine mammals from preferred feeding areas or temporarily deflect them from migration routes. This may cause some small immeasurable energetic effects.

Vessel traffic is expected to have a negligible impact on terrestrial mammals due to the distance the project area is from the coast. Vessel traffic will only come into contact with a small coastal area when loading and offloading personnel and equipment. Caribou are known to swim to barrier islands or linger in shallow waters to avoid insect harassment from late June to mid-August (Cameron and Smith, 1992; Lawhead, 1997). Noise from vessel traffic near the coast and barrier islands can potentially impact caribou by causing them to avoid or flee these areas. However, the onshore areas that will be disturbed by vessel traffic will mostly be near the village of Wainwright and disturbances from vessel traffic are expected to negligible.

Drilling and Ice-Management Activities and Noise

Sound pressure levels expected to be generated by drilling and ice management during Shell's planned drilling program are described in EIA Section 2.8 (Shell Gulf of Mexico Inc., 2009b). Drilling from the *Discoverer* is expected to generate sound energy levels of about 175 dB at the source, diminishing to less than 160 dB within a distance of less than 110 yd (100 m) of the drillship, and to 120 dB within 400-1,600 yd (380-1,470 m). Ice-management activities are expected to generate sound energy levels of about 181 dB at the source, diminishing to less than 160 dB within a distance of less than 110 yd (100 m) of the drillship and to 120 dB within 2.9-4.7 m (4.6-7.5 km). Shell has estimated the number of marine mammals that might be exposed to sound levels of greater than 120 dB and 160 dB.

Investigations of fish behavior in relation to vessel sound energy (Olsen et al., 1983; Ona, 1988; Ona and Godo, 1990) have shown that fish react when the sound from the engines and propellers exceeds a certain level. Avoidance reactions have been observed in fish such as cod and herring when vessels approached close enough that received sound levels were 110-130 dB (Nakken, 1992; Olsen, 1979; Ona and Godo, 1990; Ona and Toresen, 1988). However, other researchers have found that fish such as polar cod, herring, and capelin are often attracted to vessels (apparently by the sound) and swim toward the vessel (Rostad et al., 2006). Typical sound source levels of vessel sound in the audible range for fish are 150-170 dB re 1 µPa/Hz (Richardson et al., 1995). In calm weather, ambient sound levels in audible parts of the spectrum lie between 60-100 dB re 1 µPa.

Ice management would be expected to produce the most intense sounds associated with exploration drilling. Reported source levels for vessels during ice management have ranged from 175 dB to 185 dB (Brewer et al., 1993; Hall et al., 1994). Based on reported source levels and ambient sound levels of 80-100 dB, there may be some avoidance by fish of the area near the drillship while drilling, around the anchor handler and ice-management vessel in transit and during ice management, and around other support and supply vessels when underway. Any avoidance reactions will last only minutes longer

than the vessel is operating at that location or the unit is drilling, and would be limited to a relatively small area within a few mi of the vessel (Mitson and Knudsen, 2003; Ona et al., 2007). There are no commercial, recreation, or subsistence fisheries in the area that could be disrupted by such effects. No important spawning habitats are known to occur at or near the drilling locations. The impacts of sound from drilling operations and ice management on fish will therefore be negligible. Effects would be the same at all three prospects.

No studies investigating the impacts of sound levels produced by drilling and ice management on birds were found in the literature. Such studies may not have been supported due to the expected low impacts to bird populations and viability due to the effects of sound energy produced by drilling and ice management on birds.

Studies on the effects of seismic surveys on birds present some indication of how drilling and ice management sounds could affect birds. Seismic surveys produce underwater sound that is generally much stronger (220-250 dB) than what is produced from drilling and ice management. The results of modeling the propagation and loss of sound energy that will be generated by Shell's drilling program are presented in Section 2.8. Source levels for drilling are expected to be about 175 dB, and about 181 dB for ice management, reducing to 160 dB within less than 328 ft (100m). Evans et al. (1993) evaluated marine birds from operating seismic vessels in the North Sea and found no observable difference in bird behavior. Birds did not show differences in behavior when close or far from the survey vessels and the birds were neither repelled nor attracted to the vessels. Similarly, studies in the Canadian Arctic (Webb and Kempf, 1998) and Wadden Sea (Stemp, 1985) found no statistical differences in bird distribution between with and without on-going seismic surveys. Lacroix et al. (2003) investigated the effects of a marine seismic survey on molting long-tailed ducks in the Beaufort Sea and found that the survey program had no effect on the movements, diving behavior or site fidelity of the ducks. These studies indicate that vessels the size of Shell's ice-management vessel, in combination with sound sources (seismic airguns) that generate sound levels in excess of that expected for ice management result in no long term effects on birds. Any effects would consist of temporary and minor behavior responses such as the flushing of birds from the vicinity of the vessel. Any such effects would likely last only minutes to a few hours at the most.

Eiders that are exposed to sound energy from drilling and ice management are anticipated to either move from the area or show little effect. Studies on the effects of seismic surveys, which generate more intense sound than drilling and ice management, have revealed little effect on marine birds supporting this conclusion (Evans et al., 1993; Stemp, 1985; Webb and Kempf, 1998). Sound energy generated by drilling and ice management is expected to have no impact on Steller's and spectacled eiders; drilling activities would not start until July, after the spring migration, and the activities would take place outside areas regularly used by these species. Any effects that might occur would be minor and temporary.

Sounds are important to marine mammals because they use sound to navigate, communicate, find open water, avoid predators, and find food. Ambient or background sound levels in the Chukchi Sea have been measured at 80-100 dB under relatively calm seas (Brueggeman et al., 1990). Concern has focused on the intensity of impacts to marine mammals from sound, and these concerns have been focused primarily on the potential for deflection of whales from hunting and migration areas, masking of environmental sounds and intra-species communication, and physiological damage to marine mammal hearing. Avoidance behavior by marine mammals in response to sound energy, such as temporary deflection from feeding and migration areas, is the most likely behavioral response expected as a result of Shell's exploration activities in the Chukchi Sea. Any such effects are expected to be similar among the three prospects. Ringed seals have been found to have very limited response to drilling activities. While monitoring marine mammal distribution and reaction to drilling in the Beaufort Sea with the *Kulluk*, Brewer et al. (1993) observed ringed seals approaching within 33 ft (10 m) of the drilling vessel and concluded that seals were not disturbed by drilling activity. The same conclusion was reached for bearded seals that

approached within 656 ft (200 m) of ice breakers (Brewer et al., 1993.) While monitoring marine mammals at a historical Beaufort Sea drill site, Gallagher et al. (1992) observed seals within 115 ft (35 m) of the drillship *Northern Explorer II* indicating a high level of tolerance to such sounds and activities.

Avoidance behavior in response to sound energy noise by marine mammals such as temporary deflection from feeding areas or migration corridors is the most likely behavioral response expected as a result of Shell's exploration drilling activities in the Chukchi Sea. The location of the proposed drill sites, more than 60 mi offshore and more than 25 mi from either Herald Shoal or Hanna Shoal, and the timing of the proposed activities (during the open-water period) decreases the likelihood of disturbance to large numbers of marine mammals from drilling noise. Bowhead whales, likely due to their hearing range, have been reported to react more to low frequency sounds than higher frequency sounds (Richardson et al., 1995b). Monitoring of the distribution and behavior of bowhead whales has been conducted at several historic exploration wells drilled in the Beaufort (Davis, 1987; Gallagher et al., 1992; Brewer et al., 1993; Hall et al., 1994). These studies and play-back (recorded drilling sounds) studies (Richardson et al., 1985a,b; Wartzok et al., 1989) provide a wealth of information and a strong indication of what the effect of Shell's drilling program may be.

Davis (1987) monitored the responses of bowhead whales to drilling operations at the Corona and Hammerhead wells in the U.S. Beaufort. The only response he saw was avoidance behavior in some whales. Davis (1987) concluded that avoidance behavior was temporary and sound generated by the drilling operations did not impede migration of the whales.

Richardson et al. (1985) projected recordings of the drillship *Explorer II* at summering bowheads in the Canadian Beaufort Sea. Changes in behavior in response to the sounds were observed. Some whales showed avoidance behavior, but the deflection away from the sound was considered weak (Richardson et al. 1985). During the same study, Richardson et al. (1985) observed whales between 2.5 mi and 12.4 mi (4 km and 20 km) from the drillship while drilling activity was occurring, and he concluded that the whales were undisturbed. In a similar study, Wartzok et al. (1989) projected recordings of the drilling vessel *Kulluk*, no deflection was seen until sound pressure levels reached 120 dB or higher.

Gallagher et al. (1992a) monitored bowhead distribution during the drilling of the Galahad No. 1 well with the *Explorer II* in the Alaska Beaufort. They observed 96 bowheads during the monitoring effort, with the closest observed bowhead to the drillship being 10.3 mi (16.5 km), and the average distance being 22 mi (34.8 km). Observed whales were farther offshore than expected based on historical trends, and they had primarily a more northerly bearing than would be expected as they approached the drill site and then turned west as they passed the drill site. These observations indicated a possible diversion effect due to the drilling; however, the authors pointed out that it was a heavy ice year and that the whales were therefore forced to migrate further offshore along a path that was in alignment with the ice edge.

Brewer et al. (1993) monitored bowhead distribution during the drilling of the Kuvlum No. 1 well with the *Kulluk*. They observed 49 bowheads within the survey area. The closest observed whale to any industrial activity was 14 mi (23 km) from the ship with an average of 25 mi (40.3 km). They reported that, although not definitive, it appeared the drilling operations (drilling unit, icebreakers, and supply vessels) may have caused migrating bowheads to become more clumped and then shift their distribution northward around the activity. The diversion was thought to begin at a distance of about 19 mi (30 km) east of the drill site, but stated that it was temporary as the whale distribution appeared to revert back (uniform distribution and closer to shore) by the time they had reached points 19 mi (30 km) to the west of the drill site. The investigators thought it unlikely that ice conditions were solely responsible for the observed changes in whale distribution.

Hall et al. (1994) monitored bowhead distribution around the Kuvlum No. 2 and No. 3 wells, which were also drilled with the *Kulluk*. They observed 373 bowhead whales in their survey area. Bowheads were

observed as close as 4.5 mi (7.2 km) from the drilling unit. They reported that migrating bowheads were much closer to shore than those at a control area to the east. Review of their plotted sightings appears to indicate an almost complete avoidance for the area within 6.2 mi (10 km) of the drilling unit (Richardson et al., 1995a), although the authors concluded that the spatial pattern of observed bowheads may have been due to the location of ice, and that the distribution fell within previously recorded fall distributions.

Extremely loud sounds could cause temporary or permanent damage to hearing ability (Kryter, 1985). Since bowhead whales have been shown to exhibit avoidance behaviors in the presence of loud sound energy, it is unlikely that they would approach such sound sources closely enough to be injured (Richardson and Malme, 1993).

Concerns that sound energy introduced into the environment of marine mammals could cause masking (the covering of sound that would otherwise have been heard) are present. Masking can interfere with the detection of important natural sounds. Underwater sound energy could possibly mask environmental sounds (Terhune, 1981) or communication between marine mammals (Perry and Renouf, 1987). Effects from sound energy will be temporary and localized.

While onsite, the drillship would remain at anchor and continue ongoing operations if approached by a marine mammals. Current NMFS practice regarding exposure of marine mammals to anthropogenic noise is that in order to avoid Level A (i.e., injurious) harassment of marine mammals, cetaceans and pinnipeds should not be exposed to impulsive sounds of 180 dB and 190 dB rms or above, respectively (USDOC, NOAA, NMFS, 2008). Modeled sound radii indicate that the drillship would not exceed the 180 dB or 190 dB "safety" radii for cetaceans or pinnipeds, respectively, specified by NMFS (USDOC, NOAA, NMFS, 2007a).

For pulsed sounds, such as seismic airguns, NMFS uses the 160-dB rms isopleth to indicate where Level B harassment begins. For continuous (non-pulse) sound sources, such as those produced by drilling operations, NMFS uses the 120-dB rms isopleth to indicate the onset of Level B harassment (USDOC, NOAA, NMFS, 2008). The 160-dB radius for the *Discoverer* was modeled to be < 0.10 km (< 100 m; < 328 ft) from the drill ship. The 120-dB radius was modeled to be at 1.36 km (0.85 mi) from the drill ship in July and at 1.47 km in October for the Burger site. The 120-dB radius was modeled to be between 0.51-0.57 km (0.32 - 0.35 mi) for the SW Shoebill site and 0.38- 0.59 km (0.24 - 0.37 mi) for the SW Shoebill site and Crackerjack site, respectively, in the July-October time periods. In the past, NMFS has not required mitigation for Level B harassment authorized under an IHA.

Shell does not propose power-down or shut-down of drilling operations for the approach of marine mammals. Under Shell's 4MP, MMOs would be stationed on the drill ship and would monitor the surrounding area drilling operations. The MMO reports would be provided to MMS, NMFS, and FWS. The agencies have the authority to modify or halt operations, if necessary, to address observed impacts to marine mammals.

In order to limit the close contact between the whales and ice-management vessels and support-vessel operations, MMOs would be stationed on all support vessels to survey inside the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals. If a marine mammal is sighted from a vessel within its relative safety radius, the Shell vessel would reduce activity (reduce ice-management activities or speed if in transit) and sound level to ensure that the animal is not exposed to sound energy above their relative safety levels. Full activity would not be resumed until all marine mammals are outside of the exclusion zone.

Few bowhead, humpback, and fin whales are expected to be in the prospect areas when Shell would conduct the drilling operations in 2010 based on known densities of these whales, experience with historical drilling programs in the same area of the Chukchi Sea (EIA Table 3.7-2), and surveys

conducted for Shell in the Burger Prospect (Table 3.7-3). The estimated number of threatened or endangered whales that might be exposed to sound levels of greater than 120 dB and 160 dB are presented in Table 4.1.8-1 of the Shell EIA. Very few bowheads would be exposed, and no humpback whales or fin whales would be expected to be exposed. Based on these numbers and the above analysis of impacts, the effects of sound energy generated by drilling and ice management on threatened and endangered whales would be minor and temporary, affecting few if any whales, and consisting of temporary behavioral responses.

Previous studies have indicated that bowhead may react to drilling operations by avoiding the immediate area (Davis, 1987; Gallagher et al., 1992), in some instances by an average of 25 mi (40.3 km) with deflection around the drill site beginning 19 mi (30 km) east of the drill site and ending 19 mi west of the drill site (Brewer et al, 1993). Other studies have observed bowhead within 4.5 mi (7.2 km) of active drilling (Hall et al, 1994).

Reactions to play backs of recorded drilling sounds have been noted in migrating gray whales off the California coast (Malme et al., 1983, 1984), summering gray whales in the Bering Sea, and wintering whales offshore of Mexico (Dahlheim, 1987). The most commonly observed reactions included reduced swimming speeds and slight avoidance by diverting course seaward or shoreward of the sound source. After passing the sound source, the whales returned to the same course. Similar reactions would be expected in response to exploration drilling and ice-management activities associated with Shell's proposed activities. Any effects are expected to be limited to behavioral responses, and would be considered minor and temporary, lasting only as long as the drilling operations continued.

Because belugas primarily use high-frequency sounds to communicate and locate prey, masking by low-frequency sounds associated with drilling activities is not expected to be a substantive issue (Gales, 1982). If the distance between communicating whales does not exceed their distance from the sound sources the likelihood of potential impacts due to masking would be low (Gales, 1982). At distances greater than 656 to 1,312 ft (200 to 400 m), recorded sound energy from drilling activities did not affect behavior of beluga whales, even though the sound level and frequency were such that it could be heard several miles away (Richardson et al., 1995b). This exposure resulted in belugas being deflected from the sound energy and changing behavior. These changes are expected to be temporary and will not affect beluga populations (Richardson et al., 1991; Richard et al., 1998).

Reactions of beluga whales to vessels will likely vary between individuals. The level of avoidance exhibited by individuals would depend upon the amount of previous exposure to moving vessels and level of need for an individual to be in the same area as vessel traffic (Finley and Davis, 1984). Belugas are thought to have poor hearing below one Hz, the range of most drilling and vessel sounds, but have been seen showing some behavioral reactions to these sounds. Brewer et al. (1993) observed belugas within 2.3 mi (3.7 km) of the drilling vessel *Kulluk* while drilling in the Beaufort Sea. Ice conditions will likely have a greater impact on migration of the whales than vessel traffic would (USDOI, MMS, 2003). Startle responses were observed in belugas by Finley and Davis (1984). Erbe and Farmer (2000) described two types of noise associated with ice breaking, bubbler system noise and propeller cavitation noise, and reported that ice breaking activities may be audible to beluga from 35 to 78 km away, depending upon conditions. Temporary hearing damage can occur if beluga remain within 1-4 km of active ice breaking operations for 20 minutes or more (Erbe and Farmer, 2000). While observing the response of beluga whales to icebreakers, Finley and Davis (1984) reported avoidance behavior when ice breakers approached within 22 to 31 mi (35 to 50 km) of the animal. Beluga whales are unlikely to occur or remain near the drill site areas in summer. Shell intends to deflect ice floes in its ice management plan rather than break them if possible. Vessel and personnel safety cannot be compromised, however. Any behavioral reactions of belugas to sound energy generated by drilling and ice management are expected to be temporary in nature, lasting only as long as drilling operations continue.

Responses by seals to sounds produced during exploration activities are not well documented, yet seals are not likely to be impacted by sound from Shell vessel traffic. Concerns have been expressed that sound energy introduced into the environment of marine mammals could cause masking (the covering of sounds that would otherwise have been heard) of other sounds that are present in the environment. Masking can interfere with the detection of important natural sound sources. Underwater drilling sounds could possibly mask environmental sounds (Terhune, 1981) or communication between marine mammals (Perry and Renouf, 1987). However, in a study conducted by Cummings et al. (1984) in which breeding ringed seals were subjected to recordings of industrial sounds, there were no documented effects on ringed seal vocalizations.

Walrus commonly react to sounds from moving vessels, but most do not react to sound energy from drilling (Richardson et al., 1995a). While monitoring marine mammals during exploration drilling in the Chukchi Sea in 1989-1991, Brueggeman et al. (1990) noted that walrus near moving ice breakers exhibited some avoidance behavior. Most reactions of walrus to moving vessels occurred when the vessels approached to within 0.3 mi (0.5 km) of the walrus. During ice-breaking activities, walrus moved 12.4 to 15.5 mi (20 to 25 km) from the operations where sound energy levels were 11%-19% above ambient sound level. Thus, walrus were simply displaced away from vessels to areas where sound levels approached ambient levels temporarily.

Walrus did not exhibit an avoidance reaction when vessels were anchored or drifting and did not appear to be affected by drilling sounds. Many walrus moved through the prospect areas during the previous drilling campaign with the pack ice, and low numbers of walrus summered within the prospect area. With the retreat of the pack ice, walrus inhabited the drilling areas for only a short period of time. Walrus density, mean group size, association with ice cover, distance from the ice edge, and distance from the prospect were compared before and after drilling to evaluate responses of walrus to the drilling operations (Brueggeman et al., 1990). Walrus density and group size before and during drilling were found not to differ but distribution did change. Walrus showed no preference for a particular amount of ice cover before operations but preferred areas of moderate ice cover during operations, particularly operations involving ice-breaking activities. The walrus were fairly evenly distributed across the pack ice and from the ice edge and prospect before operations, but they became more distant and clumped during ice-breaking operations. Once ice-breaking activities stopped, walrus once again became more evenly distributed, indicating that any effects were brief and that walrus may adjust to drilling, ice-management, and other operational sounds.

The probability of encountering walrus during drilling or ice management operations is highly dependent on the presence of ice in the area. The presence or absence of pack ice in the proposed drilling area during the operational period cannot be predicted at this time. During historic drilling in the Chukchi, ice was present in some years and not in others, with many more walrus being found in the prospect when ice was near. Shell will not conduct drilling operations if there is heavy ice near the drillship. If pack ice is located within 10-20 mi (16-32 km) of the drillship, walrus would likely be affected. Effects would probably be limited to slight changes in distribution with some walrus avoiding the area or retreating to the center of the ice floe. All such effects would be minor and temporary, lasting only as long as the ice and walrus, which are moving with wind and current, are in the area.

Drilling and ice management sound energy will have little effect on polar bears. At most, bears have demonstrated curiosity when encountering vessels and will approach them on ice or in water on occasion (Harwood et al., 2005). Although polar bears can be drawn to areas of human activity, the drilling operations would take place during the open water season, so few encounters with polar bears are anticipated. Shell's avoidance and interaction plan follows established FWS guidelines and is expected to further minimize the likelihood of polar bear encounters with the proposed activities. The effects of ice-management activities, should sea ice approach the drilling operations, and drilling operations are

expected to extend to only a very small portion, if any, of the sea ice in the more than 200,000 mi^2 proposed for designation as Polar Bear Critical Habitat.

Drilling activities would occur at least 78 mi (126 km) offshore from Wainwright. Noise from drilling and ice management would not affect terrestrial mammals.

Bird-Strikes (Collisions)

Marine birds risk collisions with vessels at night due to attraction and subsequent disorientation from high-intensity lights. Sea ducks are particularly vulnerable to collisions with vessels, primarily because they tend to fly quickly and low over the water. Johnson and Richardson (1982) documented that 88% of eiders migrating to molting areas along the Beaufort Sea coast flew below an estimated 10 m (32 ft), and over 50% flew below 5 m (16 ft). Eiders leaving the North Slope travel day or night. Movement rates (birds/hour) did not differ between night and day, but movement rates and velocities were higher on nights with good visibility (Day et al., 2004). A number of factors may reduce the height at which eiders migrate, including wind speed and direction, weather (i.e., fog or rain), and lighting (day vs. night) conditions (Day et al., 2005).

Day, Prichard, and Rose (2005) completed a 4-year study of bird migration and collision avoidance at Northstar Island. The authors used bird radar to assess the reaction of migrating eiders and other birds to collision-avoidance lights located on the production structure. The authors reported that the lights were not so strong that they disrupted eider migration, but the eiders did slow down and diverted their flight paths from the island.

Thirty common eiders, 6 king eiders, and 13 long-tailed ducks were killed due to collisions with Northstar and Endicott islands in the Alaskan Beaufort Sea during fall migrations in 2001-2004 (Day et al., 2005). This total was collected over a relatively narrow window (80 days total spread over 4 years) of the fall migration and, thus, probably underestimates total collision loss during fall migration. The greatest potential for collision impacts occurs where structures are in nearshore or coastal areas where birds, particularly eiders and long-tailed ducks, are known to migrate.

Few to no bird strikes or avian collisions involving the drillship or support vessels and spectacled or Steller's eider mortalities are anticipated. The low probability of such events occurring due to potential disorientation of migrating eiders by ship lights would be reduced by implementation of a number of mitigation measures that are part of Shell's Bird Strike Avoidance and Lighting Plan. These measures include minimizing vessel light output, using green lighting on the drillship, and monitoring conditions to assess risk and reduce the chance of bird strikes. No collisions of listed eider species with ships have been documented.

Bird strikes are not expected during the northward migration of spectacled and Steller's eiders because the northern migration occurs in May, before the drillship and support vessels enter the Chukchi Sea. During the months of July and August when drilling would occur, there are almost 24 hours of daylight. High intensity lights will be used only during certain critical operations for safety reasons during this time period, thus lessening the chance of disorienting birds that lead to bird strikes.

After August, drilling would remain at least 60 mi (97 km) offshore. During this time, in Ledyard Bay, spectacled eiders tend to concentrate in waters from 12 to 30 mi offshore (19 to 48 km) (Petersen, Larned, and Douglas, 1999). Few threatened eiders are expected to use the offshore areas where drilling will occur. None were observed near the Burger Prospect during intensive bird surveys carried out in July through October 2008.

Shell's plans for exploration in the Chukchi Sea are not expected to result in threatened eider strikes because exploration activities would take place in July-October at least 60 mi (97 km) offshore in areas

where use by spectacled and Steller's eiders is low and where eiders are scarce. The low probability of such events occurring would be further reduced by mitigation measures. Any strike would likely result in injury or mortality to the bird, but would have no effect on the population.

Some seabirds, such as shearwaters and murres, may become disoriented by strong lights and fly into or land on vessels at night or in inclement weather. Directing light sources inward and downward, and turning off work lights when possible decreases the likelihood of these effects.

Long-tailed ducks are prone to collisions with structures and vessels, and they frequently venture farther from shore. The diving capacity of long-tailed ducks would allow them to forage on the seafloor on both project locations so that vessels conducting exploratory drilling could pose a threat to long-tailed ducks, especially if the vessels were using high-intensity work lights while operating during darkness or inclement weather. Bird strikes are not anticipated due to the location of the drill sites and the lighting mitigation in place. A bird strike leading to mortality would result in a moderate effect, but would not have a population level effect.

3.2.4 Overall Conclusion on Effects to Biological Resources

Shell's proposed exploration drilling activities are expected to have negligible or minor and short term effects on biological resources. Effects on marine mammals, marine birds, and most marine fish would be restricted to disturbance and temporary displacement. Disturbance factors include drilling sound, vessel and aircraft traffic, MLC construction, and drilling waste discharges. As described in detail in Section 4.1.7 of the Shell EIA, studies have shown that most such effects from such factors on marine mammals are ephemeral, lasting minutes or hours after the disturbance has ceased. Past exploration activities in the analysis area have not been shown to have any lasting deleterious effects on biological resources.

Discharges, MLC construction, and mooring may have lasting effects on directly impacted communities of benthic organisms. Discharges have been found to alter the species composition of benthic communities, with these changes lasting up to eight years or more. However, for the specific proposed activities, these effects would be limited to a relatively small area and are considered to be minor.

Threatened and endangered species in the area include humpback, fin, and bowhead whales, polar bear, and Steller's and spectacled eiders. Effects on bowhead whales and polar bear from the proposed activities are expected to be minor and limited to disturbance and potentially some avoidance of the area surrounding the drillship and support vessels. Impacts to humpback and fin whales are unlikely, as these species are extralimital in the proposed action area. Effects are expected to be limited to disturbance or avoidance and would therefore be minor and temporary. Effects would be further reduced by the mitigation measures required of by Shell. Eiders could be disturbed or displaced by vessel traffic associated with Shell's activities, but the effects are expected to be minor and temporary. Past exploration drilling in the area has not been shown to have any lasting deleterious effects on these species.

3.2.5 Additional Mitigation for Biological Resources

Recommended Additional Mitigation and Other Measures

- The Marine Mammal Observers on vessels underway in the Chukchi Sea should monitor the ocean waters near the ship for surfacing whales. If a surfacing whale is observed within 300 ft (100 m) of the ship, the ship should disengage propellers to avoid potential propeller injury to the whale (prop strike) and, to a lesser degree, collision. Propellers should remain disengaged until the whale moves beyond 300 ft (100 m) from the ship. Safety of the vessel and its personnel shall take precedence over this measure.

- Routine deck searches for dead or injured birds should be performed, especially during or following periods of darkness or inclement weather. Most avian collisions occur during periods of darkness and/or inclement weather such as rain or fog.
- If a bird strikes and remains on the vessel, leave it to recover and depart on its own. If necessary to take it out of harm's way, move it to a dry place where it can depart if it wants to. If the bird is still alive and has not departed after about 12 hours, gently return it to the sea surface.
- Birds perching on ship structures (such as antennas or rigging) should be allowed to rest and depart on their own.
- All bird collisions shall be documented and reported within 3 days to MMS. Minimum information will include species, date/time, location, weather, identification of the vessel involved and its operational status when the strike occurred. Carcasses should be returned to the sea.
- The FWS requests a couple of photos of any birds killed by collision: wings spread if possible, top and bottom views, and head. Photographs are not required, but would be very helpful in verifying species as part of the collision report.

Mitigation Considered and Not Recommended

- If the aerial monitoring detects 12 or more bowhead whales or 4 bowhead whale cow/calf pairs within an acoustically-verified 120-dB monitoring zone, Shell must reduce sound pressure levels in the drilling area.

The MMS considered this mitigation measure, because NMFS required a similar measure in the 2007 IHA for Shell's 2007-2009 Beaufort Sea EP. Subsequently, in their Federal Register Notice on issuance of Shell's IHA for seismic surveying in 2009 (USDOC, NOAA, NMFS, 2009), NMFS states "monitoring of a 120-dB radius in the Chukchi Sea is not practicable and due to safety concerns, NMFS would not require this level of monitoring in the Chukchi Sea."

- Implement and monitor bubble curtain technology to greatly alleviate the propagation of noise in the water column, greatly lessening the impacts of drilling noise on cetaceans and pinnipeds.

The MMS does not believe that the low levels of potential effects of the drilling activities, as planned, would justify a need for such mitigation.

Additional Background: The sound-reduction potential of a bubble train curtain is supported by some research and bubble curtains may have promise in relation to attenuation of seismic airgun sound propagation. A recent paper (Ayers, Jones, and Hannay, 2009) estimated transmission loss of airgun array sounds by about 21 dB for plane sound waves incident perpendicular to a bubble curtain. Since airguns are not part of the proposed activities, the degree of effectiveness such mitigation would bring to the proposed activities is unknown. Introducing such mitigation for this project could potentially impart noise variability and effects that would otherwise not occur.

3.3 Alternative 1: Subsistence Activities, Employment, and Community Health

Subsistence activities are the central element in the NSB socioeconomic system. The socioeconomic composition of the NSB is a blend of traditional subsistence activities and State, Federal, and Native corporation services and jurisdictions that provide unique benefits and pressures that are collectively a part Arctic indigenous life. The following sections of the EA address specific components of these socioeconomic resources that are most relevant to the communities of Barrow, Wainwright, Point Lay, and Point Hope: subsistence, employment, and community health. The coastal communities of Barrow,

Wainwright, Point Lay, and Point Hope are 140, 78, 92, and 180 mi, respectively from the prospect areas. Concerns regarding short- or long-term effects of the proposed project on the biological species upon which the local residents depend for subsistence can be found in the appropriate sections describing the biological resources, water quality, and air quality in this EA. For example, concerns about bowhead whale deflection, effects on coastal fish habitat, sensitivity of beluga whales to noise, effects of air emissions on human health are beyond the specific scope of the subsistence analysis are found in their appropriate EA sections.

3.3.1 Levels of Effects and Existing Environment for Subsistence Activities

Subsistence activities are assigned the highest cultural values by the Iñupiaq Eskimo of the North Slope and provide a sense of identity, in addition to being a pivotal economic pursuit. Subsistence is viewed by Alaskan Natives not just as an activity that is imbedded in the culture; it is viewed as the very culture itself (Wheeler and Thornton, 2005). The bowhead whale is a subsistence resource of paramount importance, and, consequently, the social organization pertaining to the crew, the hunt, quantity, and distribution of the whale dominate when discussing North Slope Iñupiaq Eskimo subsistence.

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, 2007). Although bowhead whaling traditions are unquestionably significant, harvest of other wild resources, including other marine mammals, caribou, fish, and avian species are important to the local inhabitants in providing a variety to the diet and needed nutrition, as well as satisfying basic nutritional needs when few or no bowhead whales are taken.

Shell proposes to begin operations on its Chukchi prospects on or after July 4, 2010. This would be after the spring bowhead whale hunts in Point Hope, Point Lay, Wainwright, and Barrow are completed. The discussion below is limited to the subsistence harvest of resources taken in the summer from the beginning of July to the end of October when Shell would move the drill rig south to Dutch Harbor.

Shell's proposed Chukchi Sea drilling and associated activities at the Burger, Crackerjack, and SW Shoebill prospects present the potential to affect subsistence resources and users in two Iñupiat communities: Wainwright, which lies 78 mi southeast of the leases, and Point Lay, which lies 92 mi southeast of the leases. Barrow, which lies 140 mi east of the prospect areas, and Point Hope, which lies 180 mi to the south of the prospect areas, are considered to be well away from any potential disturbance effects that could occur from the proposed activities.

Shell has identified five potential drill sites on the Burger, Crackerjack, and SW Shoebill prospects from which it proposes to drill three wells. The proposed exploration drill sites are located more than 60 mi offshore. Shell proposes to mobilize by July 4, 2010, after whales and other marine mammals have completed their spring migration north through the polynya zone. This start-up date would serve to reduce icebreaker and drilling noise disturbance on bowhead whales as they migrate north.

Regular crew rotation and ancillary support would be provided by ship and helicopter from Wainwright. Shell's helicopters would fly a prescribed inland route 5 mi from the coast from Barrow to Wainwright to lessen effects on subsistence activities. This route crosses the coast over the National Petroleum Reserve-Alaska (Figure 2-5). Helicopters would be required to fly at a minimum altitude of 1,500 ft to reduce or eliminate effects to land and sea mammals and local subsistence hunters pursuing these resources for subsistence purposes. Shell's support vessel would be required to reduce speed upon siting of marine mammals within 300 yd (275 m) of the vessel as well as other specified measures to avoid harassing or harming marine mammals.

During drilling activity, ice-management and oil-spill response vessels would be on-site. The drilling could occur from July 4 through October 31. When drilling is suspended, boreholes would be plugged and abandoned per MMS requirements.

Levels of Effects for Subsistence

In evaluating the potential adverse effects from OCS activities, MMS examines both the magnitude and duration of disruption. For the site-specific analysis in this EA, we used the following four categories of impact levels ranging from negligible to high:

Negligible: Periodic, short-term effects that have no consequent effects to subsistence resources or harvests.

Minor: One or more subsistence resources would be affected for up to 1 year (1 harvest season), but none of these resources would become unavailable, undesirable for use, or experience population reductions and, therefore, would not alter subsistence harvests.

Moderate: Although one of more subsistence resources would be unavailable, undesirable for use, or experience population reductions for a period up to 1 year (1 harvest season), with subsistence harvests being affected for that period, the affected subsistence resources and harvests would be expected to recover completely if proper mitigation is applied or proper remedial action is taken once mitigation is implemented.

Major: Major is the highest level of effect and is similar to the *moderat*e definition, except affected subsistence resources and harvests would not be expected to fully recover within 1 year, even if proper mitigation is applied during the life of the proposed action, or even if proper remedial action is taken once the impacting agent is eliminated.

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 operation in the Chukchi Sea, from July through October 31.

Barrow

Barrow's subsistence-harvest areas are depicted in detail in Figures 3.4.2-53, 3.4.2-56, 3.4.2-57 and 3.4.2-58 of the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a). Subsistence resources used by Barrow are listed in Tables 3.3.2-1, 3.3.2-2, 3.3.2-8, and 3.3.2-10 of the Arctic Multiple-Sale Draft EIS. Barrow's annual harvest of bowhead and beluga whales, walrus, and polar bear from the 1980s to 2005 are shown in Tables 3.4.2-9 (bowhead), 3.4.2-10 (beluga), 3.4.2-11 (walrus), and 3.4.2-6 (polar bear) of the Arctic Multiple-Sale Draft EIS. (See also EA Table 3.3.1-1 below).

Barrow residents hunt the bowhead whale during both spring and fall; in the past, more whales were harvested during the spring whale hunt, but with changing ice conditions the fall has increased in importance as the major whaling season. Hunters use aluminum skiffs with outboard motors to chase the whales during the fall migration, which takes place in open water up to 30 mi offshore. No other marine mammal is harvested with the intensity and concentration of effort that is expended on the bowhead whale. Subsistence studies conducted in the early 1990s indicated that 58.2% of Barrow's total subsistence harvest was marine mammals, and 43.3% of the total harvest was bowhead whales (USDOI, MMS 2008).

Beluga whales are available from the beginning of the spring whaling season through June and occasionally in July and August in ice-free waters. Belugas are harvested in the leads between Point Barrow and Skull Cliff; these activities would generally take place in the period before the proposed

start of Shell's activities. Later in summer, belugas occasionally are harvested on both sides of the barrier islands of Elson Lagoon, which is more than 80 mi from the nearest of Shell's prospects. Caribou, the primary terrestrial source of meat for Barrow residents, is available throughout the year, with peak-harvest periods from February through early April and from late June through late October. Hair seals are harvested primarily during the winter months, especially from February through March; no harvesting of hair seals is expected to occur during the period of the proposed activities (USDOI, MMS, 2008a).

The hunting of bearded seals (*ugruk*) is an important subsistence activity in Barrow, because the bearded seal is a preferred food and because bearded seal skins are the preferred covering material for the skin boats used in whaling. Most bearded seals are harvested during the spring and summer months and from open water during the pursuit of other marine mammals in both the Chukchi and Beaufort seas, but harvest areas do not extend into the area of Shell's proposed activities. Barrow residents harvest marine and freshwater fishes, but their dependency on fish varies according to the availability of other resources. Capelin, char, cod, grayling, salmon, sculpin, trout, and whitefish are harvested. Fishing occurs primarily in the summer and fall months and peaks in September and October. Most fishing occurs at inland fish camps, particularly in lakes and rivers that flow into the southern end of Dease Inlet over 150 mi from Shell's proposed activities in the Chukchi Sea (USDOI, MMS, 2008a).

Walrus are harvested during the summer marine-mammal hunt west of Point Barrow and southwest to Peard Bay. Most hunters travel no more than 15-20 mi to hunt walruses, although more recent interviews indicated hunters are traveling as far as 100 mi north from Point Barrow in pursuit of walrus. The major walrus-hunting effort occurs from late June through mid-September, with the peak season in August. Although traditional harvest areas do extend into the sale area they are still at least 90 mi eastward of proposed activities. Barrow residents hunt polar bears from October to June; no hunting of polar bears is expected to occur in the prospect areas during the period of Shell's proposed activities. Migratory birds, particularly eider ducks and geese, provide an important food source for Barrow residents because of the dietary importance of birds as the first source of fresh meat in the spring. Most spring bird hunting takes place between April and June), before the proposed start of Shell's activities. In late August and early September, with peak movement in the first 2 weeks of September, ducks and geese migrate south and are again hunted by Barrow residents. Birds, primarily eiders and other ducks, are hunted along the coast from Point Franklin to Admiralty Bay and Dease Inlet (USDOI, MMS, 2008a).

Wainwright

Wainwright's subsistence-harvest areas are depicted in detail in Maps 69, 70, and 71 in the Northwest National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement (USDOI, BLM and MMS, 2003). A summary of Wainwright's preferred subsistence resources appears in Tables 3.4.2-1, 3.4.2-16 and 3.4.2-17 in the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008). Wainwright's annual harvest of bowhead and beluga whales, walrus, and polar bear from the 1980s to 2005 are shown in Tables 3.4.2-9 (bowhead), 3.4.2-10 (beluga), 3.4.2-11 (walrus), and 3.4.2-6 (polar bear) of the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008; see also EA Table 3.3.1-1 below).

Bowhead whales are Wainwright's most important marine resource and are available in the Wainwright area beginning in late April. Bowhead-harvest areas vary from year to year, depending on where the open leads form, and the distance of the leads from shore also varies from year to year, but generally the hunt has concluded by mid-June before the startup of proposed drilling activities (USDOI, MMS, 2008). In Braund's subsistence study conducted in Wainwright from 1988-1989, bowhead whales (4 whales harvested) accounted for 42.3% of total edible pounds harvested, while marine mammals made up 70% of the total edible pounds harvested (USDOI, MMS, 2008).

In its study *Traditional Knowledge Regarding Bowhead Whales in the Chukchi Sea*, MMS is funding satellite telemetry work to document bowhead whale movements, important habitats, and interactions

with industrial activities. The purpose is to collect traditional knowledge regarding bowhead whales so that it can be combined with data from the satellite telemetry study for a more complete understanding of the migrations and local movements of bowhead whales. Seven whaling captains from the community of Wainwright shared their knowledge of ice conditions, timing of migration, feeding and mating behavior, conditions necessary for whaling, and their concerns about oil and gas activities. Information from this study (Huntington and Quakenbush, 2009) that is relevant to the current analysis is summarized below.

Near Wainwright, bowhead whales have occasionally been observed after the shorefast ice has broken up and also in fall. Whalers recognize three runs of bowhead whales, all of which occur before the proposed commencement of Shell's exploration activities. The first run occurs when the leads first open. In the past, this run would occur in late April, but in recent years it has taken place earlier so that bowhead whales now appear in early April and sometimes even in March. The second run of whales also requires open leads or ponds. The third run of whales takes place in the second half of May and early June. After the whaling season, when hunters pursue bearded seals in the pack ice, they may see bowhead whales still migrating. On a few occasions, whales have been seen even later in July near Wainwright and Icy Cape. In October, whales have been seen a few times near Wainwright, but they do not generally follow the coast southward from Barrow.

Beluga whales are available to Wainwright hunters during the spring bowhead-whaling season (late April to early June); however, pursuing belugas during this time jeopardizes the bowhead whale so the beluga hunt occurs only if no bowheads are in the area. There are two pulses of beluga whales that go by Wainwright, one in early May and another in late June. Because people are focusing on the bowhead whale harvest in May, they only hunt belugas from the late June migration. The hunt occurs nearshore and would be completed before the startup of drilling activities. Since 1990, the beluga harvest has ranged from 0-38 animals in 1998 while in 2001, 23 whales were taken (USDOI, MMS, 2008a).

Caribou is the primary source of meat for Wainwright residents. Before freezeup, caribou hunting is conducted along the inland waterways, particularly along the Kuk River system. During spring, the herd returns and concentrates near the Utukok and Colville River headwaters. In June, the herd follows major stream and river drainages toward the coast. Late summer and fall hunting could occur in the area of Shell's Barrow-Wainwright flight corridor.

Wainwright residents hunt four seal species: ringed, spotted, ribbon (all hair seals), and bearded seals. Most seal hunting occurs within 20 mi from shore or in seasons when drilling activities would not be present.

Walrus are present seasonally in Wainwright, with the exception of a few that overwinter in the area. The peak hunting period occurs from July to August as the southern edge of the pack ice retreats. Hunters prefer to harvest walruses south of their communities, so northward-moving pack ice can carry the hunters toward home while they butcher their catch on the ice. Walrus hunting during August can occur up 40 mi from shore, still 20 mi or more from Shell's proposed drilling activities. In late August and early September, Wainwright hunters occasionally harvest walruses that are hauled out on beaches. Walrus present within the supply/flight corridor potentially could be disrupted by these activities but IHA and LOA monitoring requirements, flight elevations at 1,500 feet, and coordination with community Com Centers and SAs would likely mitigate potential disturbance to walrus.

Wainwright residents hunt polar bears primarily in the fall and winter, less frequently in the spring, and rarely in the summer.

Wainwright residents harvest a variety of fish in most marine and freshwater habitats along the coast and in lagoons, estuaries, and rivers. The most important local fish harvest occurs from September through November in the freshwater areas of the Kuk, Kugrua, Utukok, and other river drainages. Marine fishing

is conducted from Peard Bay to Icy Cape and in Kuk Lagoon. Fishing occurs exclusively in nearshore coastal areas that are not expected to experience impacts from Shell's drilling and support activities.

The migration of ducks, murres, geese, and cranes begins in May and continues through June. The waterfowl harvest is initiated in May at whaling camps and continues through June. During the fall migration south, hunting success is limited. No bird hunting would occur in the areas where drilling activities would occur.

Point Lay

Point Lay's subsistence-harvest areas are depicted in detail in Figures 3.4.2-77 through, 3.4.2-86 of the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a). A summary of Point Lay's annual harvest of beluga whales, walruses, and polar bears from the 1980s-2007 are shown in Tables 3.4.2-10 (beluga), 3.4.2-11 (walrus), and 3.4.2-6 (polar bear) are shown in the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a; see also EA Table 3.3.1-1 below).

Point Lay's most important subsistence marine resource is the beluga whale, and the community depends on this species more than any other Native community in Alaska. Beluga whale makes up more than 60% of the community's total annual subsistence harvest. A major community activity is a single cooperative hunt in the summer, principally in the first 2 weeks of July, on the outer coast of the barrier islands. Hunting is done in a few key passes between these islands, where schools of belugas migrating north are known to feed, and within Kasegaluk Lagoon. Most hunting is concentrated south of the village in Kukpowruk and Naokok passes. The estimated annual harvest is approximately 40 whales (USDOI, MMS, 2008a).

According to hunters in Point Lay, belugas move slowly along the coast from Omalik Lagoon to Icy Cape while they feed. They move up the coast in two or three pulses and enter the passes in Kasegaluk Lagoon when the tide and current are going out. Hunters say that the migration path taken by the belugas is determined by the first group to pass by. If the first group is disturbed, succeeding groups of whales may not come within hunting range. Hunters believe that this first pulse of belugas should not be interfered with. It must be left alone to establish the migration path which succeeding pulses of whales will follow, regardless of hunting activity. Point Lay's crucial beluga whale hunt traditionally occurs from mid-June to mid-July. Although Shell's proposed drilling activities would have begun in the Chukchi Sea, the beluga hunt takes place nearshore, more than 60 mi from drilling activity and the supply/flight corridor (USDOI, MMS, 2008a).

Point Lay recently gained a bowhead quota and resumed spring bowhead whaling. The community took one whale in the spring 2009 hunt. It is likely that future whaling seasons in the community would likely be concluded by early June (USDOI, MMS, 2008a).

In the early 1970s when resettlement occurred, caribou was Point Lay's single most important subsistence food source, but, in the intervening years, beluga whale has supplied the greater amount of food. Hunters prefer hunting in late summer and fall, during the months of August, September, and October (USDOI, MMS, 2008a).

Bearded seals (*ugruk*) and ringed seals are taken in the spring when they can be found sunning on the northward-moving ice. Point Lay hunters begin the spring seal hunt south of the community, because the first broken ice holding sea mammals appears there, usually in April. The seal-harvest area ranges from Cape Beaufort in the south to Icy Cape in the north. Seal hunting is usually concluded by June, although spotted sealing runs through September. Sealing generally occurs no more than 25-30 mi offshore keeping it at least 70 mi from proposed drilling activities (USDOI, MMS, 2008a).

Fishing and time spent at fish camps is an important community activity for Point Lay residents. The most intense marine fishing with set gill nets starts in July and peaks in August. Chum, pink, and king salmon (rarely) are caught, as well as herring, smelt, flounder, arctic char, grayling, and broad whitefish. In fall, people move up the Kukpowruk and Utukok rivers in family groups to fish camps where they net fish. Marine fishing takes place in late fall and winter (USDOI, MMS, 2008a).

Walrus are hunted from Icy Cape to the southern end of Kasegaluk Lagoon and as much as 20 mi offshore. In years with favorable ice conditions, walrus are harvested from the end of June until the end of July on ice floes 15 mi offshore moving northward with the prevailing coastal currents. If hunting is unsuccessful near the village, hunters travel to Icy Cape and continue the hunt into August. In years with good ice conditions, the harvest averages 10-15 animals. From 1988-1997, 10 walruses were harvested, from a low of 0 for the years 1988-1992, to a high of 4 in 1995 and 1996. The walrus hunt occurs 20-25 mi offshore but would still be nearly 70 mi away from drilling activities and transportation routes and is unlikely to experience any disturbance (USDOI, MMS, 2008a).

In the short days of winter when the sea ice is solid, polar bears are sometimes taken although they are hunted less actively than in the past when it was still legal to sell their skins; no harvesting of polar bears is expected to occur during the period of the proposed activities (USDOI, MMS, 2008a).

Migratory birds (and their eggs) are an important food source for Point Lay residents, supplying them with their first source of fresh meat when ducks and geese migrate north in the spring. Hunting usually is done from the edge of the spring ice leads during May when hunters are looking for seals. In late August and early September, geese are again hunted as they fly south. The subsistence bird hunt would occur in nearshore coastal areas or onshore at least 90 mi from Shell's proposed activities (USDOI, MMS, 2008a).

Point Hope

The primary subsistence-harvest areas for Point Hope are shown in Figures 3.4.2-95 through 3.4.2-99 of the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a). See Tables 3.4.2-19 and 3.4.2-20 for a summary of Point Hope's subsistence harvest resources for 1992 of the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a; see also EA Table 3.3.1-1 below).

Beginning in late March or early April, the bowhead whale is available in the Point Hope area. No other marine mammal is harvested with the intensity and concentration of effort that is focused on the bowhead whale. The traditional whaling season runs from mid-April to late May (USDOI, MMS, 2008a) and would be concluded before drilling activities begin.

Point Hope hunters actively harvest the beluga whale during the offshore spring bowhead whaling season (late March-early June) and along the coast later in summer (July-late August/early September) (USDOI, MMS, 2008a). The proposed drilling activities and associated vessel or helicopter traffic would be over 180 mi away from Point Hope and the late summer and fall subsistence hunt for beluga whales would be out of range of any potential disturbance or disruption from Shell's activities.

Caribou is the primary source of meat for Point Hope residents. Although caribou are available throughout the year, peak harvest times occur from February to March and from late June through mid-November (USDOI, MMS, 2008a).

Seals are available to Point Hope residents from October through June; however, because of the availability of bowhead, bearded seal, and caribou during various times of the year, seals are harvested primarily during the winter months, from November through March (USDOI, MMS, 2008a). Most bearded seals are harvested during May and June, sometimes as late as mid-July, as the landfast ice breaks up into floes. Drilling and associated activities would be over 180 mi way from seal hunts.

Point Hope residents harvest a variety of fish during the entire year. Fishing occurs from coastal fish camps (often converted from spring camps for hunting bearded seals and walruses) located along the shore from Cape Thompson north to Kilkralik Point. In the fall, residents harvest grayling and whitefish on the Kukpuk River during the October upriver fishing period. Fishing occurs exclusively in nearshore or onshore coastal areas (USDOI, MMS, 2008a) that are not expected to experience impacts from Shell's drilling and support activities.

Point Hope Iñupiat traditionally have used walrus; however, the increasing importance of the walrus as a subsistence resource is been directly tied to its fluctuating population. Walrus are harvested during the spring marine mammal hunt. Although the walrus is hunted primarily during late May and early June, it also is hunted by boat during the rest of the summer along the northern shore, especially along the rocky capes and other points where they tend to haul out (USDOI, MMS, 2008a). Drilling and associated vessel or helicopter traffic would be over 180 mi way and the late spring to mid-summer subsistence hunt for walrus would be out of range of any potential disturbance or disruption from Shell's activities.

Polar bears comprise a small portion of the Point Hope subsistence harvest. Point Hope residents hunt polar bear primarily from January to April concurrently with the winter seal hunting season, and occasionally from late October to January (USDOI, MMS, 2008a). No harvesting of polar is expected to occur during the period of the proposed activities.

Throughout the year, waterfowl and other migratory birds provide are a preferred source of food for Point Hope residents. Most bird hunting occurs in spring in nearshore coastal areas (USDOI, MMS, 2008a) before drilling activities would commence and 180 mi from proposed activities.

Table 3.3.1-1. Subsistence Whaling and Marine Mammal Hunting Activities by Community

Barrow			
	Management	**Location**	**Season**
Bowhead Whale	--NMFS (IHA) --Alaska Eskimo Whaling Commission	Spring Whaling: Ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area.	April to June: 91% of 140 whales landed from 1995 to 2008 were landed between April 25th and May 25th; 82% were landed between May 1st and May 25th.
Bowhead Whale	--NMFS (IHA) --Alaska Eskimo Whaling Commission	Fall Whaling: An area circumscribed by a western boundary extending approximately 10 mi west of Barrow, a northern boundary 30 mi north of Barrow, then southeastward to a point about 30 mi off Cooper Island, with an eastern boundary on the east side of Dease Inlet. Occasional use may extend eastward as far as Smith Bay and Cape Halkett.	September to October: 93% of 184 whales landed from 1995 to 2008 were landed between September 10th and October 20th; 82% were landed between September 19th and October 19th.
Beluga Whale	--NMFS (IHA) --Beluga Whale Committee	Spring leads between Point Barrow and Skull Cliff; later in the season, belugas are hunted in open water around the barrier islands off Elson Lagoon.	April to June
Pacific Walrus	--FWS (LOA) --Eskimo Walrus Commission	From Point Franklin on the Chukchi Sea coast to Pitt Point on the Beaufort Sea coast and up to 60 mi offshore; nearshore from Pitt Point to Prudhoe Bay.	June to August
Polar Bear	--FWS (LOA) --Nanuuq Commission	Generally in the same vicinity used to hunt walrus.	January to March May to June

Barrow			
	Management	**Location**	**Season**
Bearded Seal (Ugruk)	--NMFS (IHA) --Ice Sea Commission	From 35 mi southwest of Wainwright on the Chukchi Sea coast to Dease Inlet on the Beaufort Sea coast and up to 90 mi offshore.	November to January; some open-water sealing
Ringed Seal	--NMFS (IHA) --Ice Seal Commission	From Point Franklin on the Chukchi Sea coast to Pitt Point on the Beaufort Sea coast and up to 60 mi offshore. Open water nearshore.	November to January April to July
Spotted Seal	--NMFS (IHA) --Ice Sea Commission	Nearshore Chukchi coastline east as far as Dease Inlet and Admiralty Bay in the Beaufort Sea.	November to January July to September
Ribbon Seal	--NMFS (IHA) --Ice Seal Commission	Nearshore/offshore Chukchi coastline east as far as Dease Inlet and Admiralty Bay in the Beaufort Sea.	Some open-water sealing

Wainwright			
	Management	**Location**	**Season**
Bowhead Whale	--NMFS (IHA) --Alaska Eskimo Whaling Commission	Spring Whaling: Leads offshore of Wainwright; with whaling camps from 15 mi southwest to 30 mi northeast of Wainwright sometimes and up to 15 mi offshore; also some whaling has occurred 6 mi southwest and 6 mi northeast of Icy Cape and 6 mi offshore	April to June, primarily May: 92% of 51 whales landed from 1995 and 2008 were landed between April 24th and May 29th; 84% were landed between April 24th and May 24th
Beluga Whale	--NMFS (IHA) --Beluga Whale Committee	Along the coastal lagoon systems.	July to August
Pacific Walrus	--FWS (LOA) --Eskimo Walrus Commission	At the southern edge of the retreating pack ice. Walrus hunted at local haulouts with the focal area from Milliktagvik north to Point Franklin.	July to August August to September
Polar Bear	--FWS (LOA) --Nanuuq Commission	Around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.	August to March
Bearded Seal	--NMFS (IHA) --Ice Sea Commission	Nearshore directly offshore of Wainwright to the mouth of Kuk Lagoon.	May to August
Ringed Seals	--NMFS (IHA) --Ice Sea Commission	Nearshore from Point Lay to Point Franklin. Not commonly harvested. Nearshore from Point Lay to Point Franklin. Not commonly harvested.	May to August December to January
Spotted Seal	--NMFS (IHA) --Ice Sea Commission	At Icy Cape and nearshore Point Lay to Point Franklin, with most taken in Kuk Lagoon.	June to August
Ribbon Seal	--NMFS (IHA) --Ice Sea Commission	Nearshore/offshore Point Lay to Point Franklin.	April to August

Point Lay			
	Management	**Location**	**Season**
Bowhead Whale	--NMFS (IHA) --Alaska Eskimo Whaling Commission	Leads offshore Point Lay. Point Lay took its first whales since 1941 on May 5, 2009 at a lead 10 mi northwest of the community.	April to June: first whale taken since 1941 was a single bowhead in May 2009.
Beluga Whale	--NMFS (IHA) --Beluga Whale Committee	Hunt concentrated in Naokak and Kukpowruk Passes south of Point Lay where hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon. If the July hunt is unsuccessful, hunters can travel as far north as Icy Cape, as far south as Cape Beaufort in search of whales and up to 20 mi offshore.	mid-June to mid-July
Pacific Walrus	--FWS (LOA) --Eskimo Walrus Commission	From Cape Beaufort to Icy Cape and up to 25 mi offshore.	June to August
Polar Bear	--FWS (LOA) --Nanuuq Commission	From Cape Beaufort to Icy Cape and up to 10 mi offshore.	January to April
Bearded Seal (Ugruk)	--NMFS (IHA) --Ice Sea Commission	From Cape Beaufort to Icy Cape and up to 25 mi offshore.	June
Ringed Seals	--NMFS (IHA) --Ice Sea Commission	From Cape Beaufort to Icy Cape and up to 20 mi offshore.	March to May
Spotted Seal	--NMFS (IHA) --Ice Sea Commission	From 10 mi east of Cape Lisburne to Icy Cape and up to 25 mi offshore.	July to September
Ribbon Seal	--NMFS (IHA) --Ice Sea Commission	From Cape Beaufort to Icy Cape and up to 25 mi offshore.	March to May

Point Hope			
	Management	**Location**	**Season**
Bowhead Whale	--NMFS (IHA) --Alaska Eskimo Whaling Commission	Along the ice edge south and southeast of the point as far as Point Thompson. The pack-ice lead is rarely more than 6-7 mi offshore but hunting can range up to 15 mi offshore.	April to June: 95% of 39 whales landed from 1995 and 2008 were landed between April 16th and June 4th; 85% were landed between April 20th and May 25th
Beluga Whale	--NMFS (IHA) --Beluga Whale Committee	Same area used for the bowhead whale hunt In open water near the southern shore of Point Hope close to the beaches, as well as areas north of the point as far as Cape Dyer.	March to June July to August
Pacific Walrus	--FWS (LOA) --Eskimo Walrus Commission	From Cape Thompson to Cape Lisburne and 15 mi east to Ayugatak Lagoon and up to 20 mi offshore	May to July
Polar Bear	--FWS (LOA) --Nanuuq Commission	Area south of the point and as far out as 10 mi from shore.	January to April October to January

Point Hope			
	Management	**Location**	**Season**
Bearded Seal (Ugruk)	--NMFS (IHA) --Ice Sea Commission	From Cape Thompson to Cape Lisburne and 15 miles east to Ayugatak Lagoon and up to 20 mi offshore.	January to June
Ringed Seals	--NMFS (IHA) --Ice Sea Commission	From Cape Thompson to Cape Lisburne and 15 mi east to Ayugatak Lagoon and up to 20 mi offshore.	January to June November to December
Spotted Seal	--NMFS (IHA) --Ice Sea Commission	From Cape Thompson to Cape Lisburne and 15 mi east to Ayugatak Lagoon and up to 20 mi offshore.	January to June November to December
Ribbon Seal	--NMFS (IHA) --Ice Sea Commission	From Cape Thompson to Cape Lisburne and 15 mi east to Ayugatak Lagoon and up to 20 mi offshore.	January to June November to December

3.3.2 Proposed Action Mitigation Measures for Subsistence Activities

Shell describes their proposed migration measures in the EP in Appendix C (IHA application to NMFS), Appendix D (Marine Mammal Monitoring and Mitigation Plan), Appendix E (LOA application to FWS), Appendix I (Plan of Cooperation), and Appendix K (Subsistence advisor Program). Shell's mitigation measures related to discharges, emissions, and spills are summarized in EA Section 2.3.4, EA Section 2.3.11, and Shell's ODPCP (Shell Gulf of Mexico Inc. 2009c).

The most important mitigation proposed for minimizing impacts to subsistence activities, especially those to subsistence beluga whaling and walrus hunting is Shell's assurance that activities from its operations and exploration drilling activities would not take place in the Chukchi Sea until July 4, 2010, or later. In addition, Shell would implement the following measures to ensure coordination of its activities with local subsistence users and to minimize further risk of impacting marine mammals and interfering with the subsistence hunt:

(1) There is a transition between the open water polynya and the first year ice pack. The "edge" of the polynya is composed of broken ice pieces. Shell can transit through this broken ice area beyond the polynya "open water" without actively breaking ice by pushing through the ice pieces. To minimize impacts on marine mammals and subsistence hunting activities, vessels that can safely travel outside of the polynya zone will do so, unless it is necessary to break ice (as opposed to managing ice by pushing it out of the way) or if sea state conditions require an alternative route. Shell will notify the local communities of any change in the transit route through the Communication and Call Centers (Com Centers);

(2) Shell has developed a Communication Plan and will implement it before initiating exploration drilling operations to coordinate activities with local subsistence users as well as Village Whaling Associations in order to minimize the risk of interfering with subsistence hunting activities, and keep current as to the timing and status of the bowhead whale migration, as well as the timing and status of other subsistence hunts. The Communication Plan includes procedures for coordination with Communication and Call Centers (Com Centers) to be located in coastal villages along the Chukchi and Beaufort Seas during Shell's proposed activities in 2010;

(3) Shell will employ local Subsistence Advisors (SA) from the Chukchi Sea villages to provide consultation and guidance regarding the whale migration and subsistence hunt. A SA liaison positions will be hired to work approximately 8-hours per day and 40-hour weeks through 2010. The SA will use Traditional Knowledge (TK) to gather data on subsistence lifestyle within the community and to provide advice on 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; and advising how to avoid subsistence conflicts. A SA handbook will be developed prior to the operational season to specify position work tasks in more detail;

(4) Shell will recycle drilling muds (e.g., use muds on multiple wells), to the extent practicable based on operational considerations) (e.g., until mud properties have deteriorated to the point where they cannot be used further), to reduce discharges from its operations. At the end of the season, excess water base fluid, approximately 1,500 bbl will be diluted to a 30:1 ratio with seawater and then discharged;

(5) Shell will 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, in emergency situations or for MMO overflights) while over land or sea.

By adhering to lease-specific Stipulations No. 2 –Orientation Program, No. 4 -Industry Site-Specific Monitoring for Marine Mammal Subsistence Resources, and Stipulation No. 5 -Conflict Avoidance Mechanisms to Protect Subsistence Whaling and other Subsistence-Harvesting Activities, Shell has incorporated the following mitigation protocols in their proposed activities to lessen or alleviate the impacts associated with exploratory drilling on subsistence activities:

(1) A Cultural Awareness Program required of all employees to address environmental, social, and cultural concerns related to the project area;

(2) Shell has submitted to MMS a site-specific marine mammal monitoring program in support of its application for an IHA;

(3) Shell plans to be an active participant in future NMFS Open Water meetings and an active participant in the independent review of the monitoring plan and reports generated for future activities;

(4) Shell intends to use contractors based in the North Slope Borough (NSB), who will in turn provide job opportunities to local residents, including recruitment and training of Subsistence Advisors (SAs) and Marine Mammal Observers (MMO) from local Inupiat communities;

(5) Conducting an Aerial Survey Program with agreement from hunters in Chukchi coastal villages to collect data on the distribution, abundance, orientation, and behavior of marine mammals in coastal areas of the eastern Chukchi Sea;

(6) Participation in, and funding of, walrus and ringed seal tagging studies; and

(7) Shell's Plan of Cooperation (POC) that it developed in consultation with affected subsistence communities, stakeholders and federal, state, and local agencies in 2006 for Chukchi Sea open water activities (3D seismic activities and vessel transit) in November 2007. Shell has continued with these consultations through 2008 and into 2009 and has committed to implement the resulting POC for subsistence mitigation as part of its proposal. Shell will continue to engage with subsistence stakeholders to build on its past efforts to inform and engage the communities that could be affected by exploration activities in the Chukchi Sea. Beside those mentioned above, the POC also identifies the following mitigation measures that Shell prepared in response to community concerns: (1) Community Liaisons in Barrow and Point Hope; (2) Inupiat Communicators will be aboard the drilling and key support vessels to provide communication with subsistence hunters; (3) the Oil-Spill-Response (OSR) Fleet will be on standby 24/7 near drilling locations; and (4) Collaboration with local subsistence hunters on routes to and from the drill rig and shore.

3.3.3 Effects Analysis for Subsistence Activities

Drilling activities are not expected to disturb or disrupt subsistence activities as Shell would not begin drilling activity until the spring bowhead whale hunt is completed in the Chukchi Sea. The areas of subsistence use by the communities of Barrow, Wainwright, Point Lay, and Point Hope are discussed in Section 3.3.1 above. No documented subsistence activities have occurred at the proposed offshore drill sites. The proposed overland helicopter route crosses an area that is recognized as being subsistence territory used by the Iñupiat of Barrow, Atqasuk, and Wainwright. Past use has been prolonged and consistent, as evidenced by the numerous house sites, camps, and other cultural features that dot the landscape (S.R. Braund and Assocs., 1989a and 1989b).

An important consideration in assessing potential effects on subsistence activities is that most of Shell's activities would occur in the late summer and fall from early July to late October. This is the time during which the Iñupiat from Barrow, Wainwright, Point Lay, and Point Hope have completed the spring bowhead whale hunt. For Barrow and Point Hope, drilling and associated vessel or helicopter traffic would be more than 100 and 180 mi away, respectively, and summer and fall subsistence resource populations and harvests would be out of range of any potential disturbance or disruption from Shell's activities.

Wainwright and Point Lay would be 78 and 92 mi away from drilling activities, respectively, and most summer and fall subsistence resource populations and harvests would be out of range of any potential disturbance from drilling activities. Wainwright's bowhead and beluga whale hunts that occur in June would be completed. Subsistence hunts for polar bear, bearded seal (*ugruk*), hair seals, fish, and birds would occur either in nearshore coastal areas at least 40 mi from activities or in the spring and winter seasons when drilling and vessel and helicopter traffic would not be present. In Wainwright, walrus hunting during August can occur up 40 mi from shore, still 20 mi from proposed activities. Walrus present within the supply/flight corridor potentially could be disrupted by these activities, but IHA and LOA monitoring requirements, minimum flight elevations of 1,500 ft, and coordination with community Com Centers and SAs would likely mitigate potential disturbance to walrus so that the resulting impacts would be no more than negligible.. Caribou hunting occurs in late summer and fall and caribou congregate nearshore between Barrow and Wainwright at this time. It is expected that the inland flight corridor and maintaining 1,500 ft while transiting between the two communities would not disrupt caribou movements or the subsistence hunt. Impacts to Wainwright's subsistence resources and its subsistence hunts are expected to be negligible.

Point Lay's summer and fall subsistence resource populations and harvests would be out of range of any potential disturbance from drilling activities. Its newly instituted bowhead hunt would likely be completed by June—before the startup of drilling activities, and supply/flight corridors to Shell's prospects offshore would be approximately 80-90 mi northeast of Point Lay's traditional subsistence harvest areas. Subsistence hunts for polar bear, bearded seal (*ugruk*), most hair seals, fish, birds, and caribou would occur either in nearshore coastal areas or onshore at least 90 mi from activities or in the spring and winter seasons when drilling and vessel and helicopter traffic would not be present. Point Lay's crucial beluga whale hunt occurs from mid-June to mid-July when drilling activities would have begun in the Chukchi Sea but the hunt takes place nearshore, over 60 mi from drilling activity and the supply/flight corridor. Additionally, belugas would be migrating toward the community from the south at this time, well away from any noise or aircraft disturbance.

Tagging studies conducted from 1998-2002 clearly show that beluga whales could be in the vicinity of Shell's planned drilling activities in July through October during their spring and fall migrations. Beluga whales in the prospect areas during their spring migration tend to move north and northeastward.

According to Suydam, Lowry, and Frost (2005), movements of belugas tagged at Point Lay showed that, "Almost all of the tagged whales moved northeastward from the capture location near Point Lay toward Point Barrow. Their study results showed that "belugas generally moved from the south to the north and that only a single whale was observed deviating from this trend: one tagged whale moved south from Point Lay and then traveled a considerable distance to the north and west before returning to the east to near Barrow Canyon. No other tagged whales traveled so far to the west…"

Only those whales that have already migrated past the community and that remained 60 mi seaward and north of the community would be subject to noise and possible deflection from proposed drilling activities. Beluga whales hunted by Point Lay would be not approaching the community from the north or subject to disturbance for the proposed activities.

The walrus and spotted seal hunt occurs 20-25 mi offshore but would still be nearly 70 mi away from drilling activities and transportation routes and is unlikely to experience any disturbance. Impacts to Point Lay's subsistence resources and its subsistence hunts are expected to be negligible.

With Shell's adherence to proposed mitigation, monitoring, communication, and response plans, short- and long-term effects from drilling and air and vessel traffic on subsistence resources and hunts in Barrow and Point Hope are expected to be non-existent and negligible in Wainwright and Point Lay.

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 oil-spill analysis has determined that there is a low chance for an accidental small oil spill that likely would be operational in nature. For the purpose of this analysis, a 48-bbl fuel transfer spill was chosen. A 48-bbl diesel spill would evaporate and disperse in less than 3 days before contacting critical nearshore subsistence areas. As required by Lease Stipulation 6, oil-spill containment booms would be deployed during any refueling activity, and would contain a small oil spill if one should occur.

The perception that oil-spill contamination of subsistence foods, particularly marine mammals or fish, might be of concern to the Iñupiat at Barrow, Wainwright, Point Lay, and Point Hope and in terms of potential effects on health. Because subsistence activities do not occur in the vicinity of proposed drilling and any associated spill source and because no fuel transfer is expected during transit between the Beaufort and Chukchi seas, the short- and long-term effects of the analyzed small spill on subsistence activities are expected to be negligible to minor.

3.3.4 Overall Conclusion on Effects to Subsistence Resources

With the mitigation incorporated by Shell, effects on subsistence undertaken by Barrow, Wainwright, Point Lay, and Point Hope are expected to be negligible. Mitigation measures include:

- Drilling operations would begin well after the completion of the spring bowhead whale hunt and the spring migration of marine mammals through the polynya zone; coordination and consultation with a single point of contact, the Subsistence Advisor hired in each community.
- Adherence to communication protocols; use of marine mammal observers on-board vessels;
- Helicopter flights from Wainwright to the proposed drill sites at an altitude of 1,500 ft in altitude except landing, take-off, and during poor weather;
- An air corridor between Barrow and Wainwright running eastward and inland away from the coast;
- Consulting with local subsistence hunters on routes to and from the drill rig and shore;
- Oil-spill-response vessels on standby "24/7" near drilling locations; and
- Deploying booms during refueling to contain any small fuel spills.

Mitigation measures may not alleviate the perception that a small oil spill or regulated wastewater discharge might contaminate subsistence resources, particularly marine mammals or fish that could concern the Iñupiat of Barrow, Wainwright, Point Lay, and Point Hope in terms of potential effects on health (EA Section 3.7, below). However, this analysis demonstrates that due to the short duration of the proposed activity, which would last 16 weeks, the proposed project poses no more than a negligible effect to subsistence activities, as long as the above mitigation measures are followed. Moreover, the exploration activities and impacts expected as a result of this proposal do not present substantially different circumstances from those anticipated in the prior EIS to which this EA tiers.

3.3.5 Employment

This analysis focuses on the sociocultural effects of local employment associated with the proposed activities on Barrow, Wainwright, Point Lay, and Point Hope.

Changes in local employment may affect community sociocultural systems. The levels of effects for impacts to sociocultural systems are defined below.

Negligible: Periodic, short-term effects with no measurable effects on normal or routine community functions.

Minor: Sociocultural systems being affected for a period up to 1 year, but effects would not disrupt routine community functions and could be avoided with proper mitigation.

Moderate: Effects on sociocultural systems would be unavoidable for a period longer than 1 year. Affected normal or routine community functions would have to adjust somewhat to account for impact disruptions, but they would be expected to 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: Effects on sociocultural systems would be unavoidable, and normal or routine community functions would experience disruptions to a degree beyond what is normally acceptable. Once the impacting agent is eliminated, affected community functions may retain measurable effects, even if proper remedial action is taken.

Shell's proposed exploration drilling would offer employment to a small number of local NSB residents. The Marine Mammal Observer (MMO) program would employ local Inupiat residents to monitor and document marine mammals in the project area. The Subsistence Advisor (SA) 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 Chukchi Sea villages. Additionally, up to 10 oil-spill-response (OSR) workers would be recruited in Wainwright. Although the number of local residents employed for the proposed activities is expected to be relatively small and the effect to be negligible at the community level, qualitatively the loss of employment due to delay or deferral of exploration during the 2010 season would be significant to an individual at risk of losing his or her job.

Shell would temporarily establish shorebase facilities in Barrow and Wainwright and use these facilities for the duration of the planned 2010 exploration drilling program. Shell currently leases office space in Barrow and would continue to use these facilities during the 2010 exploration drilling program. Additional office space may be leased during 2010. Existing accommodations in Wainwright would be used to the extent possible. The 20 personnel based in Wainwright would be housed in Olgoonik's existing 20-man camp for 110-150 days. Goods and services would be obtained from local village contractors, when available, during the duration of the project.

Support for Shell's Chukchi Sea exploration drilling program was expressed in a November 11, 2009, letter from John Hopson, Jr., Director of Operations for the Olgoonik Corporation (Wainwright's village corporation). Hopson acknowledged that while the waters of the Chukchi Sea "provide our basic food sources, it is important to consider the fact that we also rely on jobs to support subsistence." Hopson stated that the community is keenly aware of the value of economic development in the community. The letter states that the community views oil operations in the Chukchi Sea as one of the most important opportunity they have for creating jobs. Hopson also stressed that Wainwright had a community development plan that located oil support activities away from the community and that this plan controlled worker access to the community. It is his belief that a realistic balance can be achieved between preserving a subsistence lifestyle and creating sustainable income earning jobs (J. Hopson, letter to the Regional Supervisor, Field Operations, MMS, Anchorage, AK, 2009).

The number of local residents employed for the proposed activities is expected to be small and the effect to be negligible at the community level. The proposed activities are short term and temporary, and are expected to have a minor effect on the economy of Wainwright and a negligible effect on the economies of Barrow, Point Lay, and Point Hope.

3.3.6 Community Health

The health and welfare of the residents of the NSB is a primary concern in any activity, and Shell's commitment to the review and analysis of project activities affirms this is a priority. The proposed activities are offshore more than 78 mi from the nearest coastal community, of limited duration, and would be performed according to all applicable statutes and regulations from a number of Federal, State, and local jurisdictions and agencies.

The following analysis addresses the factors most likely to affect community health.

All activities associated with the EP would be staged from existing infrastructure located in Barrow and Wainwright with an additional temporary marine support shorebase facility established in Wainwright and an air support shorebase facility established in Barrow/Wainwright. Goods and services would be obtained from local village contractors, when available, during the duration of the project. All personnel travelling in support of Shell's field operations must receive a "fitness to work" determination following a complete medical review prior to travel. The purpose of the medical review is to prevent the spread of communicable diseases among Shell personnel who work in close quarters during their shifts, as well as to any local residents with whom Shell personnel might come in contact. These business interactions are not expected to adversely affect community health. Please refer to EA Section 3.3.6 above for an additional discussion on local hire.

The air quality for the Chukchi Sea Planning Area is considered to be relatively pristine with concentrations of regulated air pollutants well within the National Ambient Air Quality Standards (NAAQS) and State of Alaska ambient air quality standards (18 AAC 50). The EPA air permit requirements are intended to ensure that Shell's emission levels remain low enough to prevent harm to human health and the environment at all operating scenarios, including the worst-case highest hourly, enforceable emission rate from the *Discoverer* and its support vessels. By demonstrating compliance with the applicable NAAQS, AAAQS, and PSD increment standards at the edge of the *Discoverer*, in the immediate vicinity of its support vessels, and at the Chukchi Sea shoreline, the air quality impact analysis prepared for Shell's EPA permit application shows that Shell would not have a significant adverse impact at the nearest villages along the Chukchi Sea coast, Wainwright and Point Lay. Please refer to EA Section 3.4 on air quality for additional discussion.

Emissions from the proposed Shell exploration activities are not expected to significantly deteriorate the existing good air quality of the Chukchi Sea and adjacent coastal areas of the North Slope. Air quality

impacts from the proposed activities are expected to be negligible to minor and short term. Therefore, emissions from the proposed activities are not expected to have any effect on the health of the nearest coastal villages.

Existing water quality of the OCS is good due to the remoteness, active ecological system, and the limited presence of human (anthropogenic) inputs. Existing contaminants occur at very low levels in arctic waters and sediments and do not pose an ecological risk to marine organisms in the OCS (USDOI, MMS, 2008a). Anthropogenic water discharges potentially can effect changes in local marine water quality, such as impeding or changing existing natural properties and processes, increasing sedimentation, higher water temperature, lower dissolved oxygen, degradation of aquatic habitat structure, and loss of fish and other aquatic populations. Please refer to Section 3.5 on water quality for additional discussion.

The impact of NPDES-permitted discharges associated with Shell's project is expected to be negligible and temporary. Main discharges include sanitary and domestic wastes. Minor discharges include non-contact cooling water, ballast water, desalination wastes, and deck drainage. Increases in turbidity and biological and chemical oxygen demand are expected near the discharge site, but the effects are expected to be temporary and minor, and have no effect on marine mammals and fishes or associated subsistence harvests. These effects would be limited to within 330 ft (100 m) of the discharge location. Therefore, discharges from the proposed activities are not expected to have any effect on the health of the nearest coastal villages.

The proposed activities are offshore more than 78 mi from the nearest coastal community, of limited duration, and would be performed according to all applicable statutes and regulations from a number of Federal, State, and local jurisdictions and agencies. Shell personnel must receive a "fitness to work" determination following a complete medical review. Emissions from the proposed activities are not expected to have any effect on the health of the nearest coastal villages. Discharges from the proposed activities are not expected to have any effect on the health of the nearest coastal villages. The proposed activities are expected to have no adverse impact on the health of North Slope Borough and Northwest Arctic Borough residents. The proposed activities are expected to have no adverse impact on the health of residents of the communities of Barrow, Wainwright, Point Lay, and Point Hope.

3.4 Alternative 1: Air Quality

Air quality in the Chukchi Sea Planning Area and corresponding onshore area on the North Slope is considered to be good with concentrations of regulated air pollutants within the National Ambient Air Quality Standards (NAAQS) and State of Alaska ambient air quality standards (AAAQS)(18 AAC 50). The North Slope and adjacent offshore area are classified as attainment areas under the Clean Air Act because concentrations of criteria pollutants are far less than Federal and State standards.

Air quality at the proposed drill sites is within the NAQQS. The applicable NAAQS and Prevention of Significant Deterioration (PSD) increment standards are presented in EP Table 7.f-1 (Shell Gulf of Mexico Inc., 2009a). Emissions associated with the proposed exploration drilling program would be in compliance with EPA annual and short-term standards during the drilling program, and the emissions would occur only as long as the drillship and support vessels are in the Chukchi Sea. The EPA-acceptable screening dispersion modeling indicates that air quality standards (NAAQS) (and PSD increment) would be met at the edge of the drillship and beyond even using the maximum projected emissions from all sources. Actual emissions are expected to be much lower.

The primary sources of the emissions by the *Discoverer* drillship and support vessels would be combustion engines including the vessel engines, generators, compressors, draw works, and pumps. Emissions generated from the proposed exploration activities would include nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter less then 10 microns (PM_{10}), fine

particulate matter less then 2.5 microns ($PM_{2.5}$), and lead (Pb). The project would also generate lesser quantities of volatile organic compounds (VOCs), hazardous air pollutants (HAPs), ammonia, and carbon dioxide (CO_2).

Most of the emissions would be generated from the combustion of diesel fuel for power production from the movement of the ice-management and OSR vessels. Ice-management vessel activity would account for more than 90% of support vessels' emissions; thus, total emissions would be lower in favorable ice conditions.

By demonstrating compliance with the applicable NAAQS and PSD increment standards at the edge of the *Discoverer*, in the immediate vicinity of its support vessels, and at the Chukchi Sea shoreline, the preliminary air quality impact analysis prepared for Shell's EPA permit application shows that emissions of air pollutants associated with the drilling program would have an insignificant impact on air quality at coastal villages or elsewhere on the North Slope as the planned drill sites are located more than 60 mi (97 km) from the coast.

The EPA air permit requires that allowable emission increases (including secondary emissions) from a proposed new major stationary source, in conjunction with all other applicable emission increases or reductions at the source, would not cause or contribute to a violation of any NAAQS nor cause or contribute to a violation of any applicable "maximum allowable increase" over the baseline concentration in any area. Emissions from the proposed Shell exploration activities are not expected to significantly deteriorate the existing good air quality of the Chukchi Sea and adjacent coastal areas of the North Slope. Air quality impacts from the proposed activities are expected to be negligible to minor and short term.

The onshore area adjacent to the Chukchi Sea is the Northern Alaska Intrastate Air Quality Control Region (AQCR) 9. The EPA has designated this region as Class II and in attainment or unclassifiable for all criteria air contaminants pursuant to 40 CFR 81.302. The closest existing nonattainment area to the project area is a portion of the Fairbanks North Star Borough approximately 590 mi (950 km) south-southeast of the project area. The nearest Prevention of Significant Deterioration (PSD) Class I area is Denali National Park, which includes the Denali Wilderness and excludes the Denali National Preserve. These areas are not expected to be affected by the proposed activities.

Although EPA has not established regulations for greenhouse gases/carbon dioxide (GHG/CO_2) emissions control, EPA recently proposed a regulation for large sources of >25,000 tons CO_2 equivalent per year to report annual GHG emissions beginning in the 2010 reporting year (Federal Register, 2009). The proposed exploration activities may exceed the 25,000-ton CO_2-equivalent reporting threshold, depending on the required level of ice-management activity to keep the *Discoverer* and its crew safe from hazardous sea-ice conditions. Shell's preliminary CO_2 emissions inventory indicates the *Discoverer* CO_2 emissions would be less than the 25,000 tons per year threshold with the combined *Discoverer* and support vessels CO_2 emissions approaching almost 55,000 tons per year. The projected CO_2 emissions for *Discoverer* and its support vessels combined would account for approximately 0.1% of the Alaska 2005 total statewide estimated GHG of 53 million tons and 0.4% of the Alaska 2005 Statewide oil and gas industry estimated GHG of 15 million tons. The projected CO_2 emissions from the proposed exploration activities would be negligible in comparison to the Alaska 2005 total statewide and Alaska oil and gas industry GHG/CO_2 emissions.

3.5 Alternative 1: Water Quality

Water quality is a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose. Several factors at the time of discharge can play a role in how water quality is affected: hydrological conditions, depth at which the discharge is made, rate of the discharge, composition of the discharge, and concentration of contaminants.

Shell's proposed Chukchi Sea drilling and associated activities present the potential to affect water quality. Possible impacts to water quality may occur as a result of the permitted discharges from vessels and drillships. The impact analyses provided in EIA Section 4.1.2 (Shell Gulf of Mexico Inc., 2009b) are based on the NPDES General Permit requirement that drilling waste discharges must meet toxicity requirements. The toxicity of discharges must be tested and monitored during the discharges per conditions of the NPDES General Permit.

The general NPDES permit AKG280000 (USEPA, 2006) for the offshore areas of Alaska, including the Chukchi Sea, authorizes discharges from oil and gas exploration facilities. The Arctic general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. The EPA regulations (40 CFR 125.122) require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment. Unreasonable degradation of the marine environment means: (1) significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities; (2) threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; or (3) loss of aesthetic, recreational, scientific, or economic values, which is unreasonable in relation to the benefit derived from the discharge.

The discharges listed in Shell EIA Table 2.6-3 (Shell Gulf of Mexico Inc., 2009b) have associated stipulations and effluent limitations that are defined within the general NPDES Permit. The stipulations and effluent limitations are designed to ensure that water-quality standards and criteria are not exceeded and that wastewater treatment processes used are the best available, allowing for technology and economic limits. Although the general permit requires that commingled discharges are subject to "the most stringent effluent limitations for each individual discharge," aggregate effects from the combination of multiple types of discharge could be more severe than for the individual discharges.

The release of existing sediments and drilling muds has the potential to temporarily increase total suspended solids (TSS) in the water column, which can decrease the amount of light penetrating the water column. Shell conducted modeling of the primary discharges. The results of these modeling efforts (Shell Global Solutions, 2009) are summarized EIA Section 4.1.2. A discussion of the sediment plume created by drilling activities is discussed in Shell EIA Section 4.1.2. Shell EIA Table 4.1.2-2 (Shell Gulf of Mexico Inc., 2009b) shows modeled TSS in the water column around the discharge point.

Both modeling and field studies have shown that discharged drilling fluids are diluted rapidly in receiving waters. Vertical density stratification could inhibit vertical mixing in the water column, possibly retaining discharges in the upper 20 m of water. Deeper, colder strata could resist mixing with the warmer discharge from the disposal caisson, forcing the discharged water to disperse in the upper layers of the water column over a much larger area than predicted. The area of potential disturbance is expected to remain small, however. Strong winds and storm events can disrupt such stratification, facilitating mixing. Stratification would be quickly reestablished when winds relax. Overall, the thermal, chemical, and particulate disturbances are expected to reflect the small spatial area of the modeled discharge plume.

More than 90% of solids form a plume that settles quickly to the bottom, while the remainder forms another plume in the upper water column consisting of fine-grained particles and soluble components (Ayers, Sauer, and Steubner, 1980; Ayers et al., 1980; Brandsma et al., 1980; NRC, 1983; Houghton et al., 1984; Nedwed, Smith, and Brandsma, 2004; Smith, Brandsma, and Nedwed, 2004; Neff, 2005). The dilution rate is strongly affected by the discharge rate; the NPDES General Permit limits the discharge of cuttings and fluids in water depths >40 m (131 ft.) to 1,000 bbl/hr (159 m3/hr). Neff (2005) estimated that the concentration of water-based drilling mud in the plume generally drops below the toxicity limit within two minutes of discharge and 15 m (49 ft) of the discharge location.

Other permitted discharges associated with the drilling program include treated sanitary waste, domestic wastewaters, oil-free deck drainage, cooling water, desalination wastewater, bilge water, and ballast water. All of these discharges would be conducted under the limitations and conditions of the NPDES General Permit. Localized effects on temperature, salinity, biological and chemical oxygen demand, and pH are possible, especially under certain conditions. Heavy metals are not a major concern in the water column because, although they may accumulate in sediments over time, many of the elements of concern (e.g., chromium, mercury, barium) are present in insoluble forms and are unlikely to migrate from sediments into the water column.

The discharge from the water-cooling unit is expected to be 2.5 ˚F (1.4 ˚C) above the ambient temperature and is expected to reach an ambient temperature within 450 ft (137 m) of the drillship. The temperature effect is expected to be localized and temporary.

Diesel and free oil would cause mostly surface impacts; detectable quantities of oil on the water surface would be a violation of the general NPDES permit and a result of an unintentional release. Total aromatic hydrocarbons (TAH) are soluble in the water column, and would be present in detectable concentrations only if a violation (unintentional release) of the general NPDES permit occurred. Localized impacts from biochemical oxygen demand, fecal coliform, and TSS (total suspended solids; turbidity) also may be realized if the general NPDES permit is violated.

A small fuel spill (48 bbl or less), such as a spill during a refueling operation, is the most likely spill scenario during the proposed activities (EA Section 2.3.8 and Appendix A). Nearly 100% of such a fuel spill is estimated to disperse or evaporate within 48 hours. Light refined products, such as diesel, are narrow-cut fractions that have low viscosity and spread rapidly into thin sheens (NRC, 2003). Based on the viscosity of the diesel fuel to be used, Shell estimates the maximum area of the sea with diesel on the surface in an uncontained 48-bbl spill (i.e., no pre-booming) would be about 20-200 acres (0.1-0.8 km^2), depending on sea state and weather conditions (Shell Gulf of Mexico Inc., 2009b).

The constituents of these oils are light to intermediate in molecular weight and can be readily degraded by aerobic microbial oxidation. Diesel is much lighter than water, and it is not possible for the oil to sink and pool on the seafloor. Diesel dispersed in the water column can adhere to suspended sediments, but this generally only occurs in coastal areas with high suspended sediment loads (NRC, 2003), and would not be expected to occur at the drill sites to any appreciable degree. Diesel oil in the water column is readily and completely degraded by naturally occurring microbes, generally in 1-2 months (USDOC, NOAA, NOS, 2006).

Discharges from the proposed activities would occur over relatively short periods of time (weeks to a few months at individual locations). Impacts to water quality from permitted discharges are expected to be localized and short term. Because the discharges would be regulated through Section 402 of the CWA, impacts to water quality are expected to be temporary and minor.

Water column effects from a small spill likely would be restricted to a small area and have a duration of less than 1 week. Effects would be minimized by booming during refueling, which would reduce the surface area of a spill and allow for recovery. Therefore, effects of a small spill on water quality would be expected to be minor and short term.

3.6 Alternative 2: No Action

Under the No Action Alternative, Shell's EP would be disapproved, and the proposed exploration activities would not occur. Disapproval of the EP could result in the delay or elimination of activities and potential impacts. Disapproval of the EP could result in lost opportunities for discovery and production of oil and gas resources and any associated economic benefits.

Under Alternative 2, no impacts to the physical environment or biological resources would occur from the proposed activities. No impacts to the subsistence activities would occur from the proposed activities. The potential economic benefits for local North Slope residents described in EA Section 3.3.4 above would not be realized.

3.7 Cumulative Effects

3.7.1 Background

Cumulative impacts can result from individually minor but collectively significant actions taking place over time. The scope of the cumulative impacts for this analysis is the incremental impact from the proposed exploration activities plus the aggregate effects of other activities that are known or reasonably expected to occur in the same timeframe (July-October 2010) and in the vicinity of the proposed activities, and to have potential effects on the same environmental resources.

The cumulative effects from OCS activities plus past, current, and reasonable foreseeable activities in the Arctic OCS and adjacent areas have been assessed in several recent MMS NEPA documents. Cumulative effects analyses were included the Chukchi Sale 193 EIS (USDOI, MMS, 2007b). The Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008a) provides MMS's most recent cumulative analysis of the potential effects of Arctic OCS activities. The level and types of activities proposed in Shell's EP (Shell Gulf of Mexico Inc., 2009a) are within the range of activities described and evaluated in the Chukchi Sale 193 EIS and the Arctic Multiple-Sale Draft EIS.

The analysis below incorporates information from the documents cited by reference, and updates information as needed.

The main sources of cumulative impacts associated with this EP are: (1) vessel traffic; (2) aircraft traffic; (3) oil and gas activities in federal and state waters; and (4) miscellaneous associated activities.

Shell does not intend to conduct exploratory seismic surveys in the Chukchi Sea OCS during the 2010 open-water season.

3.7.2 Cumulative Effects under Shell's Chukchi Sea and Beaufort Sea EPs

Shell has proposed exploration drilling in 2010 on their leases in both the Chukchi and Beaufort Seas. Shell proposes using the same drillship and support vessels for both operations. Weather and/or ice conditions in the Chukchi and Beaufort seas, as well as conditions at the specific proposed drilling locations, would ultimately dictate Shell's operations. Given (1) the short open-water-drilling season for Arctic operations, even assuming Shell encounters no adverse weather and/or ice conditions or other unanticipated delays; (2) Shell's commitment to cease activities by October 31 in both the Chukchi and Beaufort seas; (3) Shell's commitment to suspend exploratory drilling activity in the Beaufort Sea during the Kaktovik and Nuiqsut bowhead whale subsistence hunts; and the time required to transit between the Beaufort Sea and Chukchi Sea project areas, Shell could not drill more than three of the proposed wells in the Chukchi and Beaufort seas combined (Shell, Letter to Secretary of the Interior Salazar dated June 24, 2009).

The proposed Chukchi Sea and Beaufort Sea project areas are more than 400 mi apart. The MMS estimates a minimum of 48 hours (2 days) to plug and abandon a well. Shell estimates 1 day to retrieve the anchors prior to the drillship moving off site. The transit speed of the *Discoverer* is 8 knots (9.2 mph); therefore, about 2 days would be required to transit between the Beaufort Sea project area and the Chukchi Sea project area. Shell estimates 5 days for construction of the MLC at a drill site, and

1 day to set anchor before drilling could begin. Based on this information, there would be at least 11 days between the end of drilling operations in one project area and the commencement of drilling operations in the other project area.

Discharges and emissions associated with drilling at the two project areas would not overlap in time or space. Sound generated during transition from the Beaufort Sea to the Chukchi Sea (site-abandonment operations, transit, MLC constructing, setting anchors, and drilling) would be continuous at varying sound levels but the sound from various stages would not overlap in time or space.

Sound generated from Shell's proposed 2010 exploration drilling activities in the Chukchi Sea could not occur simultaneously with sound from the proposed Camden Bay EP because the same vessels, including the drillship, would be used for both drilling operations. Sound from the two exploration drilling operations would be separated in time and space and would not cumulatively affect the same resources. Because of the time required for transition of the drillship from one project area to the other, which is longer than the travel time for migrating species, the same animals would not be expected to be exposed to sound from both drilling operations and individual animals would not be expected to be exposed to long periods of sound from the vessels in transit.

The fall bowhead whaling season at Barrow is unlikely to experience adverse impacts from the movement of Shell's drilling vessel *Discoverer* past Barrow if it has moved offsite from its Beaufort Sea prospects after August 25 and moves westward to the Chukchi Sea to drill. Because the fall whaling season does not begin until the first week in September, the *Discoverer* would have 7-10 days to make the trip from the Beaufort Sea project area to the Chukchi Sea project.

If Shell transits to the Chukchi Sea from the Beaufort Sea during the fall bowhead whale migration and before or during Barrow's fall bowhead whale subsistence hunt, Shell should meet with the Barrow Whaling Captains to coordinate the *Discoverer's* transit route westward through the Beaufort Sea to prevent any deflection of the bowhead whale migration and any conflicts with Barrow's fall whaling season.

Effects related to proposed activities under the two EPs would not be cumulative because of the distance between the proposed Chukchi Sea and Beaufort Sea project areas and the limited areal and temporal extent of impacting factors associated with the proposed activities. Because of time required for transition between drilling operations and associated sound, discharges, and emissions at one project area and those beginning in the other project area, individual migrating animals are not expected to sequentially encounter operations in both seas.

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.

The oil-spill analysis has determined that there is a low chance for an accidental small oil spill from Shell's proposed activities in both the Chukchi and Beaufort seas. If, however, a small spill occurred in both seas, they would be separated by time and space. A small oil spill likely would be operational in nature, such as a hose rupture. For the purpose of this analysis, a 48-bbl fuel-transfer spill was chosen, and it is anticipated that it would last less than 3 days on the surface of the water. Booms would be on site and pre-deployed for fuel transfers, if a small oil spill should occur, to contain the spill in a localized area to facilitate cleanup. A 48-bbl diesel spill would evaporate and disperse in less than 3 days. The short- and long-term effects on subsistence activities are considered to be low to insignificant because subsistence activities are not performed in the vicinity of the proposed drilling, or any associated spill; however, the perception that oil-spill contamination of subsistence foods, particularly marine mammals

or fish, might be of concern to the local communities in terms of potential effects on health. As described in the oil-spill analysis section, there is no likelihood of fuel-transfer spills occurring during vessel transit from the Beaufort to the Chukchi seas because there would be no refueling during transit.

3.7.3 Other Cumulative Activities and Effects

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, and those underway with a full load, or those pushing or towing a load, are noisier than unladen vessels. The primary sources of sounds are engines, propellers, bearings, and other mechanical parts. The sound from these sources reaches the water through the vessel hull. Other than during icebreaking activities, the loudest sounds from vessels are made by the spinning propellers. Navigation and other vessel-operation equipment also generate subsurface sounds.

Other than vessels associated with the proposed activities, vessel traffic in the project area is expected to include vessels used for fishing and hunting, icebreakers, Coast Guard vessels, and supply ships and barges. Vessel traffic in the project area is expected to be limited. With the exception of research vessels, most vessels are expected to transit through the Chukchi Sea area within 12.5 mi (20 km) of the coast. During ice-free months (June-October), barges are used for supplying the local communities, Alaskan Native villages, and the North Slope oil-industry complex at Prudhoe Bay with larger items that cannot be flown in on commercial air carriers. Usually, one large fuel barge and one supply barge visit the villages per year and one barge per year traverses through the Arctic Ocean to the Canadian Beaufort Sea.

Vessel strikes with marine mammals in the Arctic Ocean are rare, in part because overall vessel traffic in the Alaska Chukchi Sea is very limited. The potential transit of the vessels, including the drillship, from Dutch Harbor to a proposed Chukchi Sea drill site or vice versa would not substantially increase the chance of vessel strikes to marine mammals or birds because of the slow speed of the vessels, mitigation measures in Shell's 4MP (Shell Gulf of Mexico Inc., 2009a: Appendix D), and mitigation measures in Shell's Lighting Plan (Shell Gulf of Mexico Inc., 2009a: Appendix J).

Most effects on marine mammals, marine birds, and most marine fish from Shell's proposed activities would be restricted to disturbance with associated changes in behavioral activities, and to temporary displacement. Disturbance factors include drilling sound, vessel and aircraft traffic, MLC construction, and drilling waste discharges. As described in detail in Section 4.1.7 of the Shell EIA, studies have shown that most such effects on marine mammals are ephemeral, lasting minutes or hours after the disturbance has ceased. Past exploration activities in the analysis area have not been shown to have any lasting deleterious effects on biological resources and would therefore not be additive to those associated with Shell's program. Other shipping and barge traffic in the area would be expected to have similar disturbance type effects to those attributed to Shell's vessels. These effects would be additive to those associated with Shell's exploration drilling program but would occur at low levels such that the cumulative effect would be negligible relative to the size of the Chukchi Sea.

Because of the limited geographic and temporal nature of the proposed exploration activities, impacts to marine mammals from related support traffic are expected to be short term and negligible to minor. Other shipping/barging traffic in the analysis area is expected to have similar disturbance effects. Eiders could be disturbed or displaced by vessel traffic associated with Shell's activities and these effects would be additive to any disturbance from other shipping or barge traffic, but the combined effects would be minor and temporary. Past exploration drilling in the analysis area would have had similar effects and has not been shown to have any lasting deleterious effects on these species.

Statoil USA E&P, Inc. (Statoil) has contracted for the acquisition of 2,400 km^2 of high-energy marine seismic survey data around Statoil's OCS leases in the Chukchi Sea. Statoil's leases are about 20 mi north of Burger. The survey is tentatively planned for August-October 2010. The Chukchi Sale 193 EIS

evaluated the potential effects of a peak level of activity of up to two drill rigs drilling up to 4 wells each (a total of 8 wells) and up to 6 seismic surveys begin conducted during any one open-water season in the Chukchi Sea OCS. The Arctic Multiple-Sale Draft EIS updates the analysis of this level of activity. The 2008 NMFS BO and the FWS 2009 BO also evaluate this level of activity.

As of November 19, 2009, MMS has received no geophysical permit applications for 2010. If Statoil submits an application to conduct exploration seismic surveys in the Chukchi Sea during the 2010 open-water season, MMS will complete a NEPA analysis, including a cumulative analysis, before any permit would be issued. The MMS would develop and require mitigation measures to ensure that any effects from proposed surveying do not rise to a level of significance when considered cumulatively with any approved exploration drilling operations. For example, mitigation measures might include required timing and distance separation to ensure that sound level thresholds associated with Shell's proposed activities and any other authorized OCS activities do not overlap. To develop appropriate mitigation, MMS would need the specific information that would be provided in the geophysical permit applications, such as the vessel information, the size and power output of the proposed seismic sound source, the location of the proposed surveys, and the sequencing of surveys if there are multiple areas proposed to be surveyed.

In addition, Statoil would need MMPA authorizations from NMFS and FWS before survey operations could begin. The FWS anticipates receiving an application for an LOA from Statoil in early 2010.

The proposed exploration drilling activities are short term, and potential effects are expected to be short-term and highly localized. Ice management is expected to be the greatest sound energy source during the proposed activities. The proposed activities would occur only during the open-water season and ice-management activities would occur only as necessary. Noise associated with the proposed activities is expected to have some adverse impacts on marine mammals. With mitigation measures incorporated in the activities proposed in Shell's EP, no effects or negligible to minor adverse effects to coastal and marine birds, marine mammals, and fish are expected. The incremental contribution to cumulative impacts from the proposed activities on biological resources is expected negligible.

With the mitigation incorporated by Shell, subsistence activities undertaken by Chukchi Sea coastal communities are expected to receive at most negligible effects, and the incremental contribution to cumulative impacts from the proposed activities on subsistence for these communities is expected to be negligible.

Sources of emissions in the area are generators in villages, transportation, and industrial sources at existing oil production facilities onshore and in State waters. During spring and winter, winds transport pollutants from industrial Europe and Asia across the Arctic Ocean to arctic Alaska (Rahn and Glen, 1982). These pollutants cause a phenomenon called arctic haze.

Shell anticipates operating a single drillship with associated support vessels in the Chukchi Sea in 2010. The applicable NAAQS and PSD increment standards are presented in Shell EIA Table 4.1.1-1 (Shell Gulf of Mexico Inc., 2009b). The EPA requires Shell to demonstrate compliance with these standards near the single drillship and not at the shoreline. Shell performed cumulative emissions modeling by including emissions from existing sources over a wide area. The modeling results indicate that concentrations of emissions from the cumulative sources would be within the PSD Class II incremental limits and the national ambient air quality standards.

Any emissions generated from Shell's proposed 2010 exploration drilling activities in the Chukchi Sea could not occur simultaneously with emissions from the proposed Beaufort Sea exploration activities (the same vessels, including the drillship, would be used for both drilling operations if both EP's were to

be approved). Emissions from the two exploration drilling operations would be separated in time and space and would not cumulatively affect the same resources. The anticipated emissions are expected to be well below NAAQS and AAAQS at the shoreline as a result of distance from shore, permit restrictions, and dispersion. Air quality impacts from the proposed activities are expected to be negligible to minor and short term. The incremental contribution to cumulative impacts on air quality from the proposed EP activities is expected to be negligible.

Naturally occurring substances derived from the atmospheric, terrestrial, and freshwater environments are in the water in the marine environment. Man-made substances are also found in marine waters. A few naturally occurring constituents and some manmade substances occur at toxic concentrations; these are considered pollutants. In general, the principal sources of pollutants entering the marine environment include discharges from municipalities and industrial activities, and accidental spills or discharges of crude oil, refined petroleum products, and other substances. Because of limited municipal and industrial activity around the Arctic Ocean coast, most pollutants occur at low levels in the Arctic.

Water quality in the Chukchi Sea is affected through many different mechanisms. Currents from the Bering Sea transport contaminants to the Chukchi Sea. Stream flow and runoff, along with natural erosion and flooding, transport contaminants and cause increased turbidity levels. These processes are exacerbated by climate change through loss of sea ice, altered circulation and increased storm activity. Higher water temperatures result in increased biological production and decomposition, potentially causing reduced dissolved oxygen levels and increased uptake of excess carbon dioxide by the ocean, which can reduce pH. In particular, the average pH of the ocean surface is projected to decrease by as much as 0.5 pH units by 2100 (Royal Society, 2005). Climate modeling indicates that the largest pH changes worldwide will occur in the Arctic (Steinacher et al., 2009).

Any discharges generated from Shell's proposed 2010 exploration drilling activities in the Chukchi Sea could not occur simultaneously with emissions from the proposed Beaufort Sea exploration activities (the same vessels, including the drillship, would be used for both drilling operations if both EP's were to be approved). Discharges from the two exploration drilling operations would be separated in time and space and would not cumulatively affect the same resources. Discharges from the proposed activities are expected to be localized and short term. Because the discharges would be regulated through Section 402 of the CWA, to ensure compliance with State water quality standards, impacts on water quality are expected to be temporary and minor. The incremental contribution to cumulative impacts to water quality from the proposed activities is expected to be negligible.

Climate change (Arctic warming) is an observable phenomenon in the Beaufort Sea area. Many scientists attribute this climate change, at least partly, to emissions of greenhouse gases (GHG). The exploration drilling and support activities proposed in Shell's EP are sources of GHG emissions. The projected GHG emissions from the proposed exploration activities would be insignificant in comparison to the Alaska total Statewide and Alaska oil and gas industry GHG emissions. The proposed activities would contribute a negligible amount to overall GHG emissions into the planet's atmosphere.

3.7.4 Overall Conclusion Cumulative Effects

In conclusion, negligible to minor incremental contributions to cumulative effects are expected from the exploration drilling activities as proposed in Shell's 2010 Chukchi Sea EP.

4.0 Consultation and Coordination

4.1 Public Review of the Exploration Plan

Pursuant to 30 CFR 250.232, MMS is required to submit a copy of the EP to the Governor of Alaska and the State coastal management agency for review and comment. On October 22, 2009, copies of the EP were sent to the Governor of Alaska and to the Office of Project Management and Permitting, which is the State's coastal management agency. The Governor of Alaska submitted comments on the EP, dated November 10, 2009, acknowledging the State's full support of Shell's 2010 exploration drilling plan in the Chukchi Sea. The Governor stated, "Shell's Chukchi plan represents environmentally responsible development in the OCS."

Interest by stakeholders in Shell's proposal is high. Even before the EP was deemed submitted, MMS received requests for the preliminary draft proposal. The MMS provided copies of the preliminary draft EP and received comments on the document.

It is MMS policy and practice to distribute the EP to other Federal and State agencies, local and Tribal governments and the AEWC. On October 22, 2009, MMS distributed copies of the EP to the Mayors of the NSB and NWAB; the NSB Wildlife and Planning Departments; the communities of Wainwright, Point Hope, and Barrow; the Native Villages of Wainwright, Point Lay, Point Hope, and Barrow; ICAS; the Alaska Beluga Whale Committee; the Alaska Nanuuq Commission; the Eskimo Walrus Commission; and the AEWC. Copies of the EP were provided to FWS, NMFS, EPA, the Army Corps of Engineers, the U.S. Coast Guard, and the National Park Service. Copies of the EP were sent to Alaska State agencies, including the Department of Natural Resources, the Department of Environmental Conservation, and the Alaska Oil and Gas Conservation Commission. A notification letter on the availability of the EP for review was sent to third parties who previously had expressed interest in the project. Comments were requested by November 10, 2009, based on the 21-calendar-day comment period established by 30 CFR 250.232.

On October 20, 2009, MMS posted the EP to the MMS Alaska website at http://www.mms.gov/alaska/ref/ProjectHistory/2009_Chukchi_Shell/2009_1020_Chukchi_EP/EP_2010_Chukchi.HTM. The MMS provided e-mail notification about the posting of the EP to the MMS website to NSB, communities, tribes, and AEWC to facilitate the review process.

The MMS received written comment on the EP from the Governor of Alaska, NSB, NWAB, ICAS, AEWC, and Earthjustice. The comments were reviewed by MMS and considered in the completing the regulatory, technical, and environmental reviews of the EP.

The MMS arranged Government-to-Government meetings in November with the federally recognized Native Alaskan tribal governments (see also EA Section 4.3 below). These meetings were held to provide an opportunity for the local Alaskan Native tribal governments to discuss their comments and concerns about Shell's proposed exploration drilling activities with MMS.

The MMS held additional meetings with local governments and communities to provide them an opportunity to discuss their comments and concerns about Shell's proposed exploration drilling activities with MMS. The MMS held a telephone meeting with the NWAB on November 4. The MMS held a community meeting in Wainwright on November 13.

4.2 Government-to-Government Consultation

Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*, requires Federal Agencies to consult with Tribal governments on Federal matters that significantly or uniquely affect their

communities. In January 2001, a USDOI Alaska Regional Government-to-Government policy was signed by all the USDOI Alaska Regional Directors, including the MMS Alaska Regional Director.

The MMS has held multiple Government-to-Government consultation meetings with the Federally recognized Alaskan Native tribal governments of the North Slope to discuss the OCS program, leasing, and potential OCS activities. These meeting provide an opportunity for the tribes to provide Traditional Knowledge to MMS and to discuss concerns and questions with MMS. The meetings also provide MMS an opportunity to inform the local tribal governments about MMS activities and processes. Government-to-Government consultation meetings were held in conjunction with the Chukchi Sea Sale 193 and Arctic Multiple-Sale prelease and NEPA processes.

On October 22, 2009, MMS sent copies of the EP by Federal Express to ICAS and the tribal governments of the Native Villages of Wainwright, Point Lay, Point Hope, and Barrow; and offered to conduct Government-to-Government consultation, if requested. In addition, in an October 21, 2009, e-mail, MMS informed the parties that the EP was being sent and specifically offered to conduct Government-to-Government meetings on the EP. The MMS contacted the tribal governments and ICAS by e-mail and phone to arrange for Government-to-Government meetings. Government-to-Government meetings were held the Native Village of Point Hope (teleconference) on November 9 and the Native Village of Wainwright on November 13. No other Government-to-Government consultations were requested.

4.3 Endangered Species Act Consultation

Section 7(a)(2) of the Endangered Species Act (ESA) requires each Federal Agency to ensure that any action that they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the adverse modification of designated critical habitat. The MMS consults with FWS and NMFS for listed species under each Service's jurisdiction. For ESA consultation on proposed lease sales, MMS specifically requests incremental Section 7 consultation. Regulations at 50 CFR 402.14 (k) allow consultation on part of the entire action as long as that step does not violate section 7(a)(2), there is a reasonable likelihood that the entire action will not violate section 7(a)(2), and the agency continues consultation with respect to the entire action, obtaining a biological opinion (BO) for each step. Thus, at the lease sale stage, MMS consults on the early lease activities (seismic surveying, ancillary activities, and exploration drilling) to ensure that activities under any leases issued will not result in jeopardy to a listed species or cause adverse modification of designated critical habitat.

Consultation with NMFS for the Shell's proposed exploration activities is covered by the July 17, 2008, 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).

Consultation with FWS for the Shell's proposed exploration activities is covered by the September 3, 2009, BO for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling (USDOI, FWS, 2009).

On October 29, 2009, FWS published a proposed rule in the *Federal Register* identifying proposed Critical Habitat for the Polar Bear (74 *FR* 56058-56086). The proposed rule identifies the physical and biological features essential to the conservation of the polar bear. The FWS has identified land-fast sea ice (sea ice that is frozen to the shoreline or to the seafloor and is relatively immobile) and pack ice (annual and multi-year ice that is in constant motion due to winds and currents) as critical sea ice habitats [74 *FR* 56059]. Open water is not considered an essential feature for polar bears [74 *FR* 56065]. The MMS has determined that the proposed action will not destroy or adversely modify the proposed critical habitat as activities are not expected to appreciably reduce the conservation value of the proposed critical

habitat for the polar bear. The MMS has had ongoing communications with FWS regarding the proposed action and will continue communications to ensure continued compliance with the ESA.

4.4 Marine Mammal Protection Act

Shell has applied for an Incidental Harassment Authorization (IHA) from NMFS (May 22, 2009; Shell Gulf of Mexico Inc., 2009a: Appendix C) and a Letter of Authorization from FWS (dated May 22, 2009; Shell Gulf of Mexico Inc., 2009: Appendix E) as part of their exploration program. For this EP, Shell has incorporated the mitigation measures from their 2007 Beaufort Sea exploration drilling IHA from NMFS, as well as other 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.

4.5 Essential Fish Habitat Consultation

The MMS consults on essential fish habitat (EFH) with NMFS at the lease sale stage. The most recent EFH consultation for OCS exploration activities in the Chukchi Sea was conducted concurrently with the preparation and public review of the Arctic Multiple-Sale Draft EIS. The MMS received NMFS' conservation recommendations in a letter dated June 26, 2009; and MMS completed the consultation by acknowledging the recommendations in a letter dated July 21, 2009.

5.0 Reviewers and Preparers

In keeping with the intent of CEQ regulations (40 CFR 1506.5(a),(b)) that acceptable work by an applicant not be redone but it be verified by the agency, we have reviewed, evaluated, and verified the information and analysis provided in Shell's EIA, which we used to prepare this EA. Further as required by 40 CFR 1506.5(a),(b), we have provided the names of the MMS staff responsible for the review of Shell's EP and supporting information and analysis, and preparation of this EA.

Christy Bohl	Oil Spill Program Administrator
Mike Burwell	Sociocultural Specialist
Chris Campbell	Sociocultural Specialist
Douglas Choromanski	Geologist, Office of Field Operations
Mary Cody	Wildlife Biologist
Cleve Cowles	Regional Supervisor, Office of Leasing and Environment
Deborah Cranswick	Supervisory Environmental Specialist
Christopher Crews	Wildlife Biologist
Heather Crowley	Oceanographer/Water Quality
Kathleen Crumrine	Petroleum Engineer
John Goll	Regional Director, Alaska OCS Region
Thomas Gleave	Physical Scientist/Air Quality
Daniel Hartung	Regulatory Analyst
Dirk Herkhof	Air Quality Specialist
Randy Howell	Industry Specialist
James Lusher	Engineer
Kyle Monkelien	Petroleum Engineer
Caryn Smith	Oceanographer/Oil spill Risk Analysis
Jeffrey Walker	Regional Supervisor, Field Operations

6.0 Acronyms & Abbreviations

µg	Microgram	**µPa**	micro-Pascal
4MP	Marine Mammal Monitoring and Mitigation Plan	**AAC**	Alaska Administrative Code
ACMP	Alaska Coastal Management Program	**ACS**	Alaska Clean Seas
ADEC	Alaska Department of Environmental Conservation	**ADNR**	Alaska Department of Natural Resources
AEWC	Alaska Eskimo Whaling Commission	**AES-RO**	Arctic Slope Regional Corporation Energy Services – Response Operations, LLC
APD	Application for Permit to Drill	**AQCR**	Air Quality Control Region
ASRC	Arctic Slope Regional Corporation	**BACT**	Best Available Control Technology
bbl	Barrel(s)	**Bbbl**	Billion barrel(s)
BO	Biological Opinion	**BOP**	Blowout preventer
CAA	Clean Air Act	**CAA**	Conflict Avoidance Agreement
CAAA	Clean Air Act Amendments	**CEQ**	Council on Environmental Quality
CFR	Code of Federal Regulations	**CH**	Critical Habitat
cm	Centimeter(s)	**CO**	Carbon monoxide
COCP	Critical Operations and Curtailment Plan	**COMIDA**	Chukchi Offshore Monitoring in Drilling Area
CPQ	ACMP Coastal Project Questionnaire and Certification Statement	**CWA**	Clean Water Act
CZMA	Coastal Zone Management Act	**dB**	Decibel(s)
Discoverer	Drillship M/V *Frontier Discoverer*	**DM**	U.S. Department of the Interior Manual
DOI	U.S. Department of the Interior	**DPP**	development and production plan
E	East	**EA**	Environmental Assessment
EFH	Essential Fish Habitat	**EIA**	Environmental Impact Analysis
EIS	Environmental Impact Statement	**ENE**	East-northeast
EP	Exploration Plan	**EPA**	U.S. Environmental Protection Agency
ERA	Environmental Resource Area	**ESA**	Endangered Species Act
ft	Foot/feet	**ft^2**	Square feet
ft^3	Cubic feet	**FTP**	Fuel Transfer Plan
FONSI	Finding of No Significant Impact	**FWS**	U.S. Department of the Interior, Fish and Wildlife Service

g	Grams	**gal**	Gallon(s)
GHG	Greenhouse gas	**GLS**	Grouped Land Segments
H_2S	Hydrogen sulfide	**HAPs**	Hazardous air pollutants
HC	Hydrocarbon	**Hp**	Horsepower
HSE	Health, Safety, and Environment	**HSSE**	Health, Safety, Security and Environment
ICAS	Iñupiat Community of the Arctic Slope	**IHA**	Incidental Harassment Authorization
IMP	Ice Management Plan	**in**	Inch(es)
ITL	Information to Lessees	**ITS**	Incidental Take Statement
km	Kilometer(s)	**kW**	Kilowatt(s)
lb	Pound(s)	**LOA**	Letter of Authorization
m	Meter(s), also million	**M/V**	Motor vessel
m^2	Square meter(s)	**m^3**	Cubic meter(s)
mi	Statute mile(s)	**MLC**	Mudline cellar
MMO	Marine Mammal Observer	**MMPA**	Marine Mammal Protection Act
MMS	U.S. Department of the Interior, Minerals Management Service	**MOA**	Memorandum of Agreement
MODU	Mobil Offshore Drilling Unit	**NAAQS**	National Ambient Air Quality Standards
NAD 83	North American Datum 1983	**NANPCA**	Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990
NE	Northeast	**NEPA**	National Environmental Policy Act
NISA	National Invasive Species Act of 1996	**nm**	Nautical miles
NMFS	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service	**NNE**	North-northeast
No.	Number	**NOI**	Notice of Intent
NO_x	Nitrogen oxides	**NPDES**	National Pollutant Discharge Elimination System
NSB	North Slope Borough	**NSSRT**	North Slope Spill Response Team
NTL	Notice to Lessees and Operators	**NWAB**	Northwest Arctic Borough
OCS	Outer Continental Shelf	**OCSLA**	Outer Continental Shelf Lands Act
ODPCP	Oil Discharge Prevention and Contingency Plan	**OPA**	Oil Pollution Act of 1990

OSR	Oil spill response	**OSRB**	Oil spill response barge
OSRO	Oil spill removal organization	**OSRV**	Oil spill response vessel
OST	Oil storage tanker	**Pb**	Lead
PBR	Potential Biological Removal	**PM_{10}**	Particulate matter less than 10 microns
$PM_{2.5}$	Particulate matter less than 2.5 microns	**POC**	Plan of Cooperation
ppb	Parts per billion	**ppm**	Parts per million
PSD	Prevention of Significant Deterioration	**PTE**	Potentials to emit
rms	Root mean square	**RPS**	Response Planning Standard
RS/FO	Regional Supervisor, Field Operations	**SA**	Subsistence Advisor
SCR	Selective catalytic reduction	**Shell**	Shell Gulf of Mexico Inc.
SHPO	Alaska State Historic Preservation Office	**SO_2**	Sulfur dioxide
SOPEP	Shipboard Oil Pollution Emergency Plan	**SW**	Southwest
TAH	Total Aromatic Hydrocarbons	**TBD**	To be determined
TD	Total Depth	**TK**	Traditional Knowledge
TSS	Total Suspended Solids	**T-Time**	Total time
USACE	U.S. Army Corps of Engineers	**USCG**	U.S. Coast Guard
USDOI	U.S. Department of the Interior	**USEPA**	U.S. Environmental Protection Agency
USFWS	U.S. Department of the Interior, Fish and Wildlife Service	**VOC**	Volatile Organic Compound(s)
WCD	Worst-case Discharge	**WCCP**	Well Control Contingency Plan

7.0 References

Agness, A.M., J.F. Piatt, J.C. Ha, and G.R. Vanblaricom. 2008. Effects of Vessel Activity on the Near-shore Ecology of Kittlitz's Murrelets (Brachyramphus Brevirostris) in Glacier Bay, Alaska. *The Auk* (125):346-353.

Allen, B.M. and R.P Angliss. 2009. Alaska Marine Mammal Stock Assessments, 2008. NOAA TM NMFS-AFSC-193. Seattle, WA. USDOC, NOAA, NMFS, Alaska Fisheries Science Center.

ASRC Energy Services. 2009. Subsistence Advisor Program Summary, North Slope, Alaska. Houston, TX: Shell Exploration and Production Company

Ayers, R. R., W.T. Jones, and D. Hannay. 2009. Methods to Reduce Lateral Noise Propagation from Seismic Exploration Vessels. Herndon, VA: USDOI, MMS

Ayers, R., T., Sauer, Jr., and D. Steubner. 1980. An Environmental Study to Assess the Effect of Drilling Fluids on Water Quality Parameters during High Rate, High Volume Discharge to the Ocean. Proceedings of a Symposium, Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Vol. I, Lake Buena Vista, Fla., Jan. 21-24, 1980. Washington, DC: American Petroleum Institute, pp. 351-381.

Ayers, R., Jr., T. Sauer, Jr., R. Meek, and G. Bowers. 1980. An Environmental Study to Assess the Impact of Drilling Discharges in the Mid-Atlantic. Vol. I. Quantity and Fate of Discharges. Symposium on Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Lake Buena Vista, Fla., Jan. 21-24, 1980. Washington, DC: American Petroleum Institute, pp. 382-416.

Barber, W., R. Smith, and R. Meyer. 1997. Demersal Fish Assemblages of the Northeastern Chukchi Sea, Alaska. *Fishery Bulletin* 95:195-209.

Bogoslovskaya, L., L. Votrogov, and T. Semenova. 1981. Feeding Habits of the Gray Whale Off Chukotka. *Rep. Int. Whal. Commn.* 31:507-510.

Boudreau, B. 1989. Biological Clearance for Burger and Crackerjack Prospects. U.S. Govt. Memorandum, from Regional Supervisor, Field Operations, Minerals Management Service, Alaska OCS Region to District Office Supervisor.

Brandsma, M., L. Davis, R. Ayers, Jr., and T. Sauer, Jr. 1980. A Computer Model to Predict the Short-Term Fate of Drilling Discharges in the Marine Environment. *In*: Proceedings of Symposium, Research on Environmental Impact Analysis on Environmental Fate and Effects of Drilling Fluids and Cuttings, Vol. I. Lake Buena Vista, Fla., Jan. 21-24, 1980. Washington, DC: American Petroleum Institute, pp. 588-608.

Brewer, K., M. Gallagher, P. Regos, P. Isert, and J. Hall. 1993. ARCO Alaska, Inc. Kuvlum #1 Exploration Prospect Site Specific Monitoring Program Final Report. Report to ARCO Alaska Inc., Anchorage, Alaska. Walnut Creek, CA: Coastal & Offshore Pacific Corporation

Brueggeman, J. 2009. Marine Mammal Research Program. PowerPoint document prepared for ConocoPhillips Alaska, Inc. and Shell Offshore, Inc. by Canyon Creek Consulting. Seattle, WA: Canyon Creek Consulting

Brueggeman, J. J. 2009b. Marine Mammal surveys at the Klondike and Burger Survey Areas in the Chukchi Sea during the 2008 Open Water Season. Anchorage, AK: ConocoPhillips Alaska, Inc. and Shell Exploration and Production. 45 pp.

Brueggeman, J. J., R.A. Grotefendt, M.A. Smultea, G.A. Green, R.A. Rowlett, C.C. Swanson, D.P. Volsen, C.E. Bowlby, C.I. Malme, R. Mlawski, and J.J. Burns. 1992. Final Report, Chukchi Sea 1991, Marine Mammal Monitoring Program (Walrus and Polar Bear) Crackerjack and Diamond Prospects. Anchorage, AK: Shell Western E&P Inc. and Chevron U.S.A., Inc.

Brueggeman, J.J., C.I. Malme, R.A. Grotefendt, D.P. Volsen, J.J. Burns, D.G. Chapman, D.K. Ljungblad, and G.A. Green. 1990. 1989 Walrus Monitoring Program: The Klondike, Burger, and Popcorn Prospects in the Chukchi Sea. Houston, TX: Shell Western E&P, Inc.

Brueggeman, J.J., D.P. Volsen, R.A. Grotefendt, G.A. Green, J.J. Burns, and D.K. Ljungblad. 1991. 1990 Walrus Monitoring Program/The Popcorn, Burger and Crackerjack Prospects in the Chukchi Sea. Houston, TX: Shell Western E&P, Inc.

Cameron, R. D. and W.T. Smith. 1992. Distribution and Productivity of the Central Arctic Herd in Relation to Petroleum Development: Case History Studies with a Nutritional Perspective. Research Progress Report. Juneau, AK: Alaska Department of Fish and Game

Clarke, J., S. Moore, and D. Ljungblad. 1989. Observations on the Gray Whale (Eschrichtius Robustus) Utilization and patterns in the Northeast Chukchi Sea, July-October 1982-1987. *Canadian Journal of Zoology.* 67:2646-2653.

Craig, P. C. 1984. Fish Use of Coastal Waters of the Alaskan Beaufort Sea: A Review. *Transactions of the American Fisheries Society*. 113:265-282.

Cummings, W. C.; D.V. Holliday, and B.J. Lee. Potential Impacts of Man-Made Noise on Ringed Seals: Vocalizations and Reactions. Anchorage, AK: USDOI, MMS, Alaska OCS Region; 1984; OCS Study MMS 86-0021. pp. 95-230.

Dahlheim, M. E. 1987. Bio-Acoustics of the Gray Whale (*Eschrichtius robustus).* [Ph.D. Dissertation.]. Vancouver, B.C.: University of British Columbia. 315 pp

Davis, R. A. 1987. Responses of Bowhead Whales to an Offshore Drilling Operation in the Alaskan Beaufort Sea, Autumn 1986. Anchorage, AK: Shell Western E&P, Inc. 51 pp.

Day, R. H.; A.K. Prichard, and J.R. Rose. 2005. Migration and Collision Avoidance of Eiders and other Birds at Northstar Island, Alaska, 2001-2004: Final Report. Fairbanks, AK; BP Exploration (Alaska) Inc.

Day, R. H., J.R. Rose, A.K. Prichard, R.J. Blaha, and B.A. Cooper. 2004. Environmental Effects on the Fall Migration of Eiders at Barrow, Alaska. *Marine Ornithology* 32:13-24.

Divoky, G.J. 1987. The Distribution and Abundance of Birds in the Eastern Chukchi Sea in Late Summer and Early Fall. Unpublished final report. Anchorage, AK: USDOC, NOAA and USDOI, MMS, 96 pp.

EDAW, 2007. Quantitative Description of Potential Impacts of OCS Activities on Bowhead Whale Hunting Activities in the Beaufort Sea. MMS OCS Study 2007-062. Anchorage, AK: USDOI, MMS, Alaska Region

Evans, P., E. Lewis, and P. Fisher. 1993. A Study of the Possible Effects of Seismic Testing Upon Cetaceans in the Irish Sea. Report to Marathon Oil UK. Oxford, England: Sea Watch Foundation. 35 pp.

Finley, K. J. and R.A. Davis. 1984. Reactions of Beluga Whales and Narwhals to Ship Traffic and Ice-Breaking along Ice Edges in the Eastern Canadian High Arctic, 1982-1984: An Overview. Ottawa, Ontario, Canada: Canadian Dept. of Indian Affairs and Northern Development, Northern Environmental Protection Branch, Northern Affairs Program. Environmental Studies No. 37. 329 pp.

Finley, K. J.; G.W. Miller; R.A. Davis, and C.R. Greene. 1990. Reactions of Belugas (Delphinapterus Leucas) and Narwhals (Monodon Monoceros) to Ice-Breaking Ships in the Canadian High Arctic. *Can. Bull. Fish. Aquat. Sci.* 224:97-117.

Finney, H. and Fugro-McClelland Marine GeoSciences. 1989. Summary Biological Reconnaissance Burger Prospect, Sale 109, Chukchi Sea, Alaska. Houston, TX: Shell Western E&P, Inc.

Fraker, M. A.; D.A. Sergeant, and W. Hoek. 1978. Bowhead and White Whales in the Southern Beaufort Sea. Sidney, B.C., Canada: Beaufort Sea Project, Dept. of Fisheries and the Environment. Beaufort Sea Technical Report No. 4. 114 pp.

Fugro. 1989. High-Resolution Geophysical Survey and Assessment of Potential Shallow Drilling Hazards, Tourmaline Prospect, Chukchi Sea, Alaska. Houston, TX: Shell Western E & P

Fugro. 1990. High-Resolution Geophysical Survey and Assessment of Potential Shallow Drilling Hazards, Burger Prospect, Chukchi Sea, Alaska. Houston, TX: Shell Western E & P

Fugro Geoconsulting, Inc. 2009. Drill Site Clearance Letters, Proposed Drill Sites C & F Blocks 6764 OCS-Y-2280 & 6714 OCS-Y-2267, Chukchi Sea, Alaska. Houston, TX: Shell Gulf of Mexico, Inc.

Gales, R. S. 1982. Effects of Noise of Offshore Oil and Gas Operations on Marine Mammals: An Introductory Assessment. San Diego, CA: U.S. Naval Ocean Systems Center. 1982. 79 pp. NOSC Technical Report 844

Gall, A. and R. Day. 2009. Distribution and Abundance of Seabirds in the Northeastern Chukchi Sea, 2008. Anchorage, AK: ConocoPhillips Alaska, Inc. and Shell Exploration & Production Company. 46 pp.

Gallagher, M.; K. Brewer, and J. Hall. 1992. Site Specific Monitoring Plan: Galahad Exploration Prospect. Walnut Creek, CA: Amoco Production Co. 50pp.

Geoscience Earth & Marine Services, Inc. 2009a. Shallow Hazard and Archaeological Assessment, Burger J Drill Site, Posey Block NR3-02 6912, Chukchi Sea, Alaska. Houston, TX: Shell Gulf of Mexico, Inc.

——— 2009b. Shallow Hazard and Archaeological Assessment, Crackerjack C Drill Site, Karo Block NR03-01 6864, Chukchi Sea, Alaska. Houston, TX: Shell Gulf of Mexico, Inc.

——— 2009c. Shallow Hazard and Archaeological Assessment, Shoebill Drill Site, Karo Block NR3-01 7007, Chukchi Sea, Alaska. Houston, TX: Shell Gulf of Mexico, Inc.

Grebmeier, J. and K. Dunton. 2000. Benthic Processes in the Northern Bering/Chukchi Seas: Status and Global Change. *In*. Impacts of Change in Sea Ice and Other Environmental Parameters in the Arctic. Marine Mammal Workshop, Girdwood, Ak. Bethesda, MD: Marine Mammal Commission. pp. 61-71.

Greene, C. R. 1985. Characteristics of Waterborne Industrial Noise, 1980-1984. *In*: Behavior, Disturbance Responses, and Feeding of Bowhead Whales, *Balaena mysticetus*, in the Eastern Beaufort Sea, 1980-1984, W.J. Richardson, ed. OCS Study MMS 86-0034. Reston, VA: USDOI, MMS. pp. 197-254.

——— 1987. Characteristics of Oil Industry Dredge and Drilling Sounds in the Beaufort Sea. *Journal of the Acoustical Society of America* 82(4):1315-1324.

Hall, J. D.; M.L. Gallagher; K.D. Brewer; P.R. Regos, and P.E. Isert. 1994. ARCO Alaska, Inc. 1993 Kuvlum Exploration Area Site Specific Monitoring Program Final Report. Anchorage, AK: ARCO Alaska, Inc. 218pp.

Harwood, L. A., F. McLaughlin, R.M. Allen, J. Illasiak, Jr., and J. Alikamik. 2005. First-Ever Marine Mammal and Bird Observation in the Deep Canada Basin and Beaufort/Chukchi Seas: Expeditions during 2002. *Polar Biology.* 283:250-253.

Houghton, J. P., K. R. Critchlow, D. C. Lees, and R. D. Czlapinski. 1984. Fate and Effects of Drilling Fluids and Cutting Discharges in Lower Cook Inlet, Alaska, and on Georges Bank [1981], Final Reports 27:1-388 RU 0602.

Hobbs, L. and M. Goebel. 1982. Bowhead Whale Radio-Tagging Feasibility Study and Review of Large Cetacean Tagging. NOAA Technical Memorandum. NMFS F/NWC-21. Seattle, WA: US National Marine Mammal Laboratory. 68 pp.

Huntington, H.P., and L.T. Quakenbush. 2009. Traditional Knowledge Regarding Bowhead Whales in the Chukchi Sea. OCS Study MMS 2009- 063. Anchorage, AK: MMS, Alaska OCS Region.

Jasco Applied Sciences. 2009. Acoustic Modeling of Underwater Noise from the Frontier Discoverer in the Chukchi Sea. Version 2.0. Houston, TX: Shell Exploration & Production Company

Johnson, S.R. and D.R. Herter. 1989. The Birds of the Beaufort Sea. Anchorage, AK: BP Exploration (Alaska).

Johnson, S.R., D.A. Wiggins, and P.F. Wainwright. 1992. Use of Kasegaluk Lagoon, Chukchi Sea, Alaska, by Marine Birds and Mammals, II: Marine Birds. Unpublished report. Herndon, VA: USDOI, MMS, pp. 57-510.

Johnson, S. R. and W.J. Richardson. 1982. Waterbird Migration Near the Yukon and Alaskan Coast of the Beaufort Sea: Moult Migration of Sea Ducks in Summer. *Arctic* 35:291-301.

Koski, W. R. and S.R. Johnson. 1987. Behavioral Studies and Aerial Photogrammetry. *In*: Responses of Bowhead Whales to an Offshore Drilling Operation in the Alaskan Beaufort Sea, Autumn 1986. Anchorage, AK: Shell Western E&P, Inc. 371 pp.

Kryter, K. D. 1985. The Effects of Noise on Man. Orlando, FL: Academic Press, 688 pp.

Lacroix, D. I., R.B. Lanctot, J.A. Reed, and T.L. McDonald. 2003. Effect of Underwater Seismic Surveys on Molting Male Long-Tailed Ducks in the Beaufort Sea, Alaska. *Can. J. Zool.* 81:1862-1875.

Lawhead, B. E. 1997. Caribou and Oil Development in Northern Alaska: Lessons from the Central Arctic Herd. *In*: NPR-A Symposium Proceedings, Science, Traditional Knowledge, and the Resources of the Northeast Planning Area of the National Petroleum Reserve-Alaska, D. Yokel, comp. Anchorage, Ak., Anchorage, AK: USDOI, MMS and BLM, pp. 7-5 to 7-7.

LGL Alaska Research Assocs., Inc. and Greeneridge Sciences, Inc. 1996. Northstar Marine Mammal Monitoring Program, 1995: Baseline Surveys and Retrospective Analyses of Marine Mammal and Ambient Noise Data from the Central Alaskan Beaufort Sea. Anchorage, AK: BP Exploration (Alaska) Inc.

Lynch, A.H., J.A. Curry, R.D. Brunner, and J.A. Maslanik. 2004. Toward and Integrated Assessment of the Impacts of Extreme Wind Events on Barrow, Alaska. *Bulletin of the American Meteorological Society* 85(2):209-221.

Malme, C. I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1983. Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. MMS/AK-ESU-84-025. BBN Report No 5366. Anchorage, AK: USDOI, MMS, Alaska OCS Region, 377 pp.

Malme, C. I., P.R. Miles, C.W. Clark, P. Tyack, J. Tyack, and J.E. Bird. 1984. Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior, Phase II: January 1984 Migration. Report No. 5586. Anchorage, AK: USDOI, MMS, Alaska OCS Region

Marquenie, J.M. 2007. Green light To Birds – Investigation into the Effect of Bird-Friendly Lighting. *Netherlandse Aardolie Maatschappij*. The Netherlands. 23 pp. http://www.waddenzee.nl/fileadmin/content/Dossiers/Energie/pdf/green_light_to_birdsNAM.pdf

Miles, P.R., C.I. Malme, and W.J. Richardson. 1987. Prediction of Drilling Site-Specific Interaction of Industrial Acoustic Stimuli and Endangered Whales in the Alaskan Beaufort Sea. OCS Study MMS 87-0084. Anchorage, AK: USDOI, MMS, Alaska OCS Region, 341 pp.

Mitson, R. B. and H.P. Knudsen. 2003. Causes and Effects of Underwater Noise on Fish Abundance Estimation. *Aquatic Living Resources.* 16:255-263.

Nakken, O. 1992. Scientific Basis for Management of Fish Resources with Regard to Seismic Exploration. Fisheries and Offshore Petroleum Exploitation 2nd International Conference, Bergen Norway, 6-8 April 1992. Bergen, Norway: Conference Proceedings.

National Research Council. 1983. Drilling Discharges in the Marine Environment. Washington, DC: The National Academy Press. 180 pp

National Research Council. 2003. Oil and the Sea III, Inputs, Fates and Effects. Washington, DC: The National Academies Press, 265 pp

Nedwed, T.J., J.P. Smith, and M.G. Brandsma. 2004. Verification of the OOC Mud and Produced Water Discharge Model Using Lab-Scale Plume Behavior Experiments. *Environ. Model. & Software* 19(7-8):655-670.

Neff, J. 2005. Composition, Environmental Fates, and Biological Effect of Water Based Drilling Muds and Cuttings Discharged to the Marine Environment: A Synthesis and Annotated Bibliography. Duxbury, MA: Battelle, Petroleum Environmental Research Forum, and American Petroleum Institute.

North Pacific Fishery Management Council. 2009. Fishery Management Plan for Fish Resources of the Arctic Management Area. Anchorage, AK: NPFMC. 147 pp.

North Pacific Fishery Management Council and USDOC, NOAA NMFS. 1990. Fishery Management Plan for the Salmon Fisheries in the EEZ off the Coast of Alaska. Anchorage, AK: NPFMC. 210 pp.

Olsen, K. 1979. Observed Avoidance Behavior in Herring in Relation to Passage of an Echo Survey Vessel. *ICES Journal of Marine Science.* 18:21 pp.

Olsen, K., J. Angell, F. Pettersen, and A. Lovik. 1983. Observed Fish Reactions to a Surveying Vessel with Special Reference to Herring, Codcapelin and Polar Cod. *FAO Fisheries Report.* 300:131-138.

Ona, E and O.R. Godø. 1988. Fish Reaction to Trawling Noise; the Significance for Trawl Sampling. *Rapports et Proces-Verbaux Des Reunions Conseil International Pour l'Exploration de la Mer.* 189:159-166.

Ona, E., O.R. Godo, N.O. Handegard, V. Hjellvik, R. Patel, and G. Pedersen. 2007. Silent Research Vessels are Not Quiet. *The Journal of the Acoustical Society of America.* 121:145-150.

Ona, E. and R. Torensen. 1988. Reaction of Herring to Trawl Noise. Copenhagen, Denmark: ICES CM. B-36:1-8

Perry, J. A. and D. Renouf. 1987. Further Studies of the Role of Harbor Seal (*Phoca vitulina*) Pup Vocalizations in Preventing Separation of Mother-Pup Pairs. *Canadian Journal of Zoology.* 66:934-938.

Petersen, M. R., W.W. Larned, and D.C. Douglas. 1999. At-Sea Distribution of Spectacled Eiders: A 120-Year-Old Mystery Resolved. *The Auk.* 1164:1009-1020.

Petersen, M. R., W.W. Larned, and D.C. Douglas. 1999. At-Sea Distribution of Spectacled Eiders: A 120-Year-Old Mystery Resolved. *The* Auk 1164:1009-1020.

Phillips, L. 2005. Migration Ecology and Distribution of King Eiders. M.S. Thesis. Fairbanks, AK: University of Alaska, Fairbanks.

Powell, A., N.L. Phillips, E.A. Rexstad, and E. J. Taylor. 2005. Importance of the Alaskan Beaufort Sea to King, Eiders (*Somateria spectabilis)*. OCS Study MMS 2005-057. Fairbanks, AK: University of Alaska, Fairbanks, Coastal Marine Institute.

Richard, P.R., A.R. Martin, and J.R. Orr. 1998. Study of Late Summer and Fall Movements and Dive Behavior of Beaufort Sea Belugas, using Satellite Telemetry: 1997. OCS STUDY MMS 98-0016. Anchorage, AK: USDOI, MMS, Alaska OCS Region, 25 pp.

Richardson, W.J. 1995. Documented Disturbance Reactions. In: *Marine Mammals and Noise*, W.J. Richardson, C.R. Greene, Jr., C.I. Malme, and D.H. Thomson, eds. San Diego, CA: Academic Press, Inc. pp. 241-324.

Richardson, W.J. and C.I. Malme. 1993. Man-Made Noise and Behavioral Responses. *In*: *The Bowhead Whale*, J.J. Burns, J.J. Montague, and C.J. Cowles, eds. Special Publication of The Society for Marine Mammalogy, 2. Lawrence, KS: The Society for Marine Mammalogy, pp. 631-700.

Richardson, W. J., C.R. Greene, Jr., J.S. Hanna, W.R. Koski, G.W. Miller, N.J. Patenaude, and M.A. Smultea. 1995a. Acoustic Effects of Oil Production Activities on Bowhead and White Whales Visible During Spring Migration Near Pt. Barrow, Alaska-1991 and 1994 Phases: Sound Propagation and Whale Responses to Playbacks of Icebreaker Noise. OCS Study MMS 95-0051. Anchorage, AK: USDOI, MMS, Alaska OCS Region. pp. 1-392.

Richardson, W.J. and K. Finley. 1989. Comparison of Behavior of Bowhead Whales of the Davis Strait and Bering/Beaufort Stocks. OCS Study MMS 88-0056. Herndon, VA: USDOI, MMS. 131 pp.

Richardson, W.J., R.S. Wells, and B. Wursig. 1985. Disturbance Responses of Bowheads, 1980-1984. *In*: Behavior, Disturbance Responses, and Distribution of Bowhead Whales, *Balaena mysticetus*, in the Eastern Beaufort Sea, 1980-84, W.J. Richardson, ed. OCS Study MMS 85-0034. Anchorage, AK: USDOI, MMS, Alaska OCS Region, pp. 255-306.

Richardson, W.J., J.P. Hickie, R.A. Davis, D.H. Thomson, and C.R. Greene. 1989. Effects of Offshore Petroleum operations on Cold Water Marine Mammals: A Literature Review. Washington, DC: American Petroleum Institute. 385 pp.

Richardson, W.J., C.R. Greene, Jr., W.R. Koski, and M.A. Smultea. 1991. Acoustic Effects of Oil Production Activities on Bowhead and White Whales Visible during Spring Migration near Pt. Barrow, Alaska-1990 Phase: Sound Propagation and Whale Responses to Playbacks of Continuous Drilling Noise from an Ice Platform, as Studied in Pack Ice Conditions. OCS Study MMS 95-0037. Anchorage, AK: USDOI, MMS, Alaska OCS Region, pp. 1-311.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995b. *Marine Mammals and Noise.* San Diego, CA: Academic Press, Inc.

Rodgers, J. and S. Schwikert. 2002. Buffer Zone Distances to Protect Foraging and Loafing Waterbirds from Disturbances from Personal Watercraft and Outboard-Powered Boats. *Conservation Biology.* 16:216-224.

Rostad, A., S. Kaartvedt, T.A. Klevjer, and W. Melle. 2006. Fish are Attracted to Vessels. *ICES Journal of Marine Science.* 63:1431-1437.

The Royal Society. 2005. Ocean acidification due to increasing atmospheric carbon dioxide. ISBN 0 85403 617 2. http://royalsociety.org/displaypagedoc.asp?id=13539. The Royal Society

Rugh, D. J. K. W. Shelden D. E. Withrow. 1997. Spotted Seals (*Phoca largha*) in Alaska. *Marine Fisheries Review.* 591:1-18.

Schulberg, S., I. Show, and d. Van Schoik. 1989. Results of the 1986-1987 Gray Whale Migration and Landing Craft Air Cushion Interaction Study Program. USN Contract: N62474-86-M-0942. San Bruno, CA: Naval Facilities Engineering Command. 31 pp.

Scientific Research Association. 1988. Results of the 1987-1988 Gray Whale Migration and Landing Craft Air Cushion Interaction Study Program. USN Contract: N62474-87-C-8669. San Bruno, CA: Naval Facilities Engineering Command. 45 pp.

Shell Global Solutions. 2009. Draft Update: Modeled Drill Mud Impacts from an Exploratory Drilling Campaign in the Chukchi Sea and Beaufort Sea, Alaska. Anchorage, AK: Shell Exploration and Production. 68 pp.

Shell Gulf of Mexico Inc. 2009a. Exploration Plan, 2010 Exploration Drilling Program, Posey Blocks 6713, 6714, 6763, 6764 and 6912, Karo Blocks 6864 and 7007, Burger, Crackerjack, and SW Shoebill Prospects, OCS Lease Sale 193, Chukchi Sea, Alaska. Anchorage, AK: Shell Gulf of Mexico Inc. http://www.mms.gov/alaska/ref/ProjectHistory/2009_Chukchi_Shell/2009_1020_Chukchi_EP/EP_2010_Chukchi.HTM

Shell Gulf of Mexico Inc. 2009b. Environmental Impact Analysis, Appendix F. *In*: Exploration Plan 2010 Exploration Drilling Program Posey Blocks 6713, 6714, 6763, 6764 and 6912 Karo Blocks 6864 and 7007 Burger, Crackerjack, and Shoebill Prospects OCS Lease Sale 193 Chukchi Sea. Alaska, Anchorage, AK: Shell Gulf of Mexico Inc.

——— 2009c Chukchi Sea Regional Exploration Oil Discharge Prevention and Contingency Plan. *In*: Exploration Plan 2010 Exploration Drilling Program Posey Blocks 6713, 6714, 6763, 6764 and 6912 Karo Blocks 6864 and 7007 Burger, Crackerjack, and Shoebill Prospects OCS Lease Sale 193 Chukchi Sea, Alaska. Anchorage, AK: Shell Gulf of Mexico Inc.

Shell Offshore Inc. 2009. 2010 Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska. Anchorage, AK: Shell Offshore Inc.

Smith, J.P., M.G. Brandsma, and T.J. Nedwed. 2004. Field Verification of the Offshore Operators Committee (OOC) Mud and Produced Water Discharge Model. *Environmental Modelling and Software* 19:739-749.

S.R. Braund and Assocs. 1989a. North Slope Subsistence Study, Barrow, 1988. OCS Study MMS 89-0077. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 1989b. North Slope Subsistence Study, Wainwright 1988. OCS Study MMS 89-0078. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

Steinacher, M., F. Joos, T. L. Frölicher, G. K. Plattner, and S. C. Doney. 2009. Imminent ocean acidification in the Arctic projected with the NCAR global coupled carbon cycle-climate model. *Biogeosciences* 6(4):515-533.

Stemp, R. 1985. Observations on the Effects of Seismic Exploration on Seabirds. *In*: Proceedings of the Workshop on Effects of Explosives Use in the Marine Environment, G.D. Greene, F. R. Engelhardt and R. J. Paterson, eds. Halifax, NS, Canada, Energy, Mines and Resources Canada and Indian and Northern Affairs: pp. 217-233.

Stewart, B. S., W.E. Evans, and F.T. Awbrey. 1982. Effects of Man-Made Water-Borne Noise on the Behavior of Beluga Whales (*Delphinapterus Leucas*) in Bristol Bay, Alaska. HSWRI Technical Report 82-145. Juneau, AK: USDOC, NOAA. 29 pp.

Suydam, R. S., L. F. Lowry, K. J. Frost 2005. Distribution and Movement of Beluga Whales from the Eastern Chukchi Sea Stock During Summer and Early Autumn. OCS Study MMS 2005-035. Anchorage, AK: USDOI, MMS, Alaska OCS Region. http://www.mms.gov/alaska/reports/2005rpts/2005_035.pdf

Terhune, J. M. 1981. Influence of Loud Vessel Noises on Marine Mammal Hearing and Vocal Communication. *In*: The Question of Sound from Icebreaker Operations. Proceedings of a Workshop, N.M. Peterson, ed. Toronto, Ont., Canada, Toronto, Ont., Canada: Arctic Pilot Project, Petro-Canada

USACE. 2000. Biological Assessment of Steller's Eider (*Polysticta Stelleri (Pallas)*) for harbor Construction at Sand Point, Alaska. Unpublished Memorandum for the Record. CEPOA-EN-CW-PF. Anchorage, AK: Alaska District

USDOC, NOAA, NMFS. 2007. Environmental Assessment and 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. Seattle, WA: USDOC, NOAA, NMFS, 39 pp.

——— 2008. Endangered Species Act, Section 7 Consultation: Biological Opinion: 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. Seattle, WA: USDOC, NOAA, 140 pp. http://www.mms.gov/alaska/ref/BioOpinions/2008_0717_bo.pdf

USDOC, NOAA, NMFS 2009. Small Takes of marine Mammals Incidental to Specified Activities; Open-water marine Survey Program in the Chukchi Sea, Alaska, During 2009-2010. *Federal Register* 74(206):55368.

USDOC, NOAA, NOS. 2006. Fact Sheet: Small Diesel Spills (500-5000 gallons). Seattle, WA: NOAA, NOS, Office of Response and Restoration. http://response.restoration.noaa.gov/book_shelf/974_diesel.pdf

USDOI, BLM and MMS. 2003. Northwest National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement. Anchorage, AK: USDOI, BLM and MMS, 3 Vols.

USDOI, FWS. 2007. Biological Opinion for Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Associated Seismic Surveys and Exploratory Drilling. Anchorage, AK: USDOI, FWS Region 10. 109 pp. http://www.mms.gov/alaska/ref/BioOpinions/BO193/bo_193.pdf

——— 2009. Final Biological Opinion for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling. Fairbanks, AK: USDOI, FWS Field Office. http://www.mms.gov/alaska/ref/BioOpinions/2009_0903_BO4BFCK.pdf

USDOI, MMS. 2007a. Environmental Assessment: Shell Offshore, Inc., Beaufort Sea Exploration Plan. OCS EIS/EA MMS 2007-009. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 2007b. Chukchi Sea Planning Area Oil and Gas Lease Sale 193, and Seismic Surveying Activities in the Chukchi Sea Final Environmental Impact Statement. OCS EIS/EA MMS 2007-026. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 2007c. Outer Continental Shelf Oil & Gas Leasing Program: 2007-2012 Final Environmental Impact Statement, OCS EIS/EA MMS 2007-003, Herndon, VA: USDOI, MMS.

——— 2008a. Beaufort Sea and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217 and 221 Draft Environmental Impact Statement. OCS EIS/EA MMS 2008-055. Anchorage, AK: USDOI, MMS, Alaska OCS Region. p. 11

——— 2008b. Information to Lessees. *In*: Final Notice of Sale Package: Chukchi Sea Oil and Gas Lease Sale 193. Anchorage, AK: USDOI, MMS, Alaska OCS Region. http://www.mms.gov/alaska/cproject/Chukchi193/FNOS193/ITL.pdf p. 11

USDOI, MMS. 2009. Environmental Assessment – Shell Offshore Inc. 2010 Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska. OCS EIS/EA MMS 2009-052. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

USEPA. 2006. Authorization to Discharge Under the National Pollutant Discharge Elimination System (NPDES) for Oil and Gas Exploration Facilities on the Outer Continental Shelf and Contiguous State Waters. Permit No. AKG280000. Seattle, WA: USEPA, Region 10

USEPA. 2009a. Fact Sheet - Final Area Designations for the 24-hour Fine Particle Standard Established in 2006. http://www.epa.gov/pmdesignations/2006standards/documents/2009-10-08/factsheet.htm.

——— 2009b. Outer Continental Shelf Prevention of Significant Deterioration Permit to Construct. Draft R10/CS/PSD-AK-09-01. http://yosemite.epa.gov/R10/airpage.nsf/Permits/chukchiap/$FILE/chukchi_proposed_permit.pdf

——— 2009c. Statement of Basis for Proposed Outer Continental Shelf Prevention of Significant Deterioration Permit No. R10OCS/PSD-AK-09-01. Seattle, WA: USEPA, Region 10. http://yosemite.epa.gov/R10/airpage.nsf/Permits/chukchiap/$FILE/chukchi_statement_of_basis.pdf

——— 2009d. Mandatory Reporting of Greenhouse Gases; Proposed Rule. *Federal Register* 74(68):16448.

Wartzok, D., W.A. Watkins, B. Wursig, and C.I. Malme. 1989. Movements and Behavior of Bowhead Whales in Response to Repeated Exposures to Noises Associated with Industrial Activities in the Beaufort Sea. Anchorage, AK: AMOCO Production Company. 228 pp.

Webb, C. and N. Kempf. 1998. Technical Paper: The Impact of Shallow-Water Seismic in Sensitive Areas. SPE 46722. Caracas, Venezuela: Society of Petroleum Engineers

Wheeler, P. and T. Thornton. 2005. Subsistence Research in Alaska: A Thirty Year Retrospective. *Alaska Journal of Anthropology* 3(1):69-103.

Appendix A
Analysis of Accidental Oil Spills

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1.0 Oil-Spill Analysis and Scenario Framework of Accidental Oil Spills in this Environmental Assessment.

This section describes the results of the oil-spill analysis. It analyzes the potential discharges, their likelihood, and the outlines the scenario framework chosen for the impact analysis of accidental oil spills. The vessel, drilling, and fuel-transfer activities in the Exploration Plan (EP) were evaluated for 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. This document tiers from the oil-spill analysis in the Chukchi Sale 193 EIS (USDOI, MMS, 2007). This document incorporates by reference the most recent information for Chukchi Sea Oil and Gas Lease Sales (Sales 212 and 221) in the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008) and Shell's Environmental Impact Analysis (Shell Gulf of Mexico, Inc., 2009b). Brief summaries, where relevant, are provided below; the information is updated and augmented by new material as needed.

The section below starts with the summary of estimated impact-producing factors (size, source, duration, and weathering characteristics) from accidental oil spills used in this Environmental Assessment (EA) analysis. The remainder of this Appendix provides the supporting information for the estimated impact-producing factors used for accidental oil-spill analysis in this EA.

1.1 Summary: Estimated Accidental Spills by Size Categories.

For purposes of this EA analysis, no large or very large crude or diesel oil spills are estimated from exploration activities based on a review of potential discharges, historical spill and modeling data, and likelihood of occurrence. This estimate is based on the low rate of exploratory drilling well-control incidents per well drilled spilling fluids, modeled exploratory drilling well-control incidents, and the history of exploration spills on the Arctic OCS and Canadian Beaufort Sea discussed below. It is possible that a small spill could occur and is reasonably foreseeable. For purposes of analysis, we chose a 48-bbl fuel-transfer spill for the small spill size, as identified in Shell's summary of potential discharges (Shell Gulf of Mexico, Inc., 2009b: Table 2.9-1).

1.1.1 Summary: Small Spills (<1,000 bbl) from Exploration Operations.

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. The largest OCS exploration spill was approximately 20 bbl (Section 1.3.1). For purposes of analysis, a 48-bbl fuel-transfer spill was chosen as the small spill size, and it is estimated to last less than 3 days on the surface of the water, based on weathering calculations. This EA analyzes the impacts of such a small spill in each of the EA sections on 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 fuel-transfer spill.

1.1.2 Summary: Large Spills (≥1,000 bbl) from Exploration Operations.

For purposes of Shell's proposed exploration drilling program during the 2010 open-water season, OCS historical crude and condensate spill data demonstrates that a large spill is too remote and speculative an occurrence to be considered a reasonably foreseeable occurrence of Shell's proposed exploration project. No oil will be produced. All wells will be permanently plugged and abandoned in accordance with MMS requirements on completion of drilling. Since 1971, no large crude or condensate spills have occurred from well-control incidents while drilling approximately 14,000 OCS exploration wells. All fuel-storage tanks will be internal to the drillship, and should an internal storage tank rupture internally, it is unlikely a

large diesel fuel spill would reach water. All fuel storage tanks onshore would be double walled and have containment capacity of 110% of the volume of a Worst Case Discharge (WCD).

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 not a reasonably foreseeable event in connection with the OCS exploration activities set forth in Shell's EP, and therefore, this EA does not analyze the impacts of such a worst-case scenario.

The MMS most recently 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). There are no site-specific anomalies that differentiate a very large spill release at Launch Area (LA) 5 and 11. Thus, MMS 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 1.4.2 below). This impact analysis in USDOI, MMS (2003a) considers the mitigation of spill response. Shell's Oil Discharge Prevention and Containment Plan (ODPCP) (Shell Gulf of Mexico, 2009c) response scenario addresses the potential immediate release of crude oil to the environment by a loss of well-control during drilling operations. Shell's ODPCP demonstrates access to sufficient equipment and personnel needed to respond to a well blowout flow rate of 5,500 barrels of oil per day (bopd) for 30-37 days.

1.2 Oil-Spill Potential Discharge Review.

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% less oil is spilling since the 1970s and 54% less in the decade 1998-2007 from the previous.

Using information from the potential discharges, the MMS reviewed and considered available information regarding the small, large, and very large spill-size estimates and the likelihood of the potential discharges, to determine a reasonably foreseeable spill analysis to evaluate the potential impact producing factors of an accidental oil spill for this EA.

Table A-1 shows the Shell's summary of potential discharges (Shell Gulf of Mexico, Inc., 2009b: Table 2.9-1) with the MMS spill-size categories listed in the left-hand column. The summary of potential discharges was divided into MMS's three spill-size categories: (1) small (≤1,000 barrels (bbl); (2) large (≥ 1,000 bbl); and (3) very large (≥150,000 bbl). Within each spill-size category, the estimated potential discharge size is considered the representative size for that size category. A 48-bbl diesel-transfer spill is in the small spill category, a 1,555-bbl diesel-fuel tank-rupture spill is in the large spill category, and the blowout worst-case discharge of 287,100 bbl is in the very large spill category. The paragraphs below describe why and how Shell and MMS calculated the worst-case discharge.

1.2.1 Worst-Case Discharge Calculation for the Oil Discharge Prevention and Contingency Plan.

The MMS and State of Alaska regulations set forth how the volume for a Worst Case Discharge (WCD) calculation is determined for oil-spill-response planning. The WCD volume and storage capacities are calculated to address MMS and Alaska Department of Environmental Conservation (ADEC) need to determine the adequacy of the company's spill-response capabilities. The MMS requires (30 CFR 254.47(b) Determining the volume of oil of your worst case discharge scenario) the WCD to be based upon the daily volume possible from an uncontrolled blowout flowing for 30 days. The ADEC

regulations (18 AAC 75.434) establish the Response Planning Standard (RPS) of 5,500 bbl (874 cubic meters [m^3]) of oil per day for the duration of 15 days for an exploration facility. The daily flow rate for a blowout is based on the ADEC response planning standard of 5,500 bbl per day. The MMS reviewed results from wells drilled in the area and concluded that the 5,500 bbl/day standard is appropriate; therefore, MMS concurs with using this standard for this EP. To meet both agencies' response-planning requirements, the WCD volume was calculated using ADEC's volume requirement of 5,500 bopd (874 m^3) and MMS's duration requirement of 30 days (30 CFR 254.47(b)) totaling 165,000 bbl (26,233 m^3). To determine the storage capacity requirements based on ADEC guidance, an emulsion factor of 1.54 and a percentage of free water (20%) have been added to the initial RPS of 165,000 bbl (26,233 m^3) for a total storage volume of 287,100 bbl (45,645 m^3).

Table A-1. Summary of Potential Discharges and Relation to MMS Spill Size Categories for Oil-Spill Analysis.

MMS Spill-Size Categories	Type	Cause	Product	Size	Duration	Prevent Potential Discharge
Small	Transfer from fuel barge to drill rig	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	Shipboard or Onshore Storage Tank	Tank rupture	Diesel or Jet Fuel	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. Onshore tanks would be double walled with 110% containment.
Very Large	Blowout	Uncontrolled flow at the mudline	Crude oil	287,100 – 354,090 bbl including emulsion and free water	30-37days	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.

Other MMS regulations at 30 CFR 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 drilling a relief well in up to 37 days. The MMS calculated a value based on drilling a relief well in 37 days. The total is 203,500 bbl (32,354 m^3). To determine the storage capacity requirements based on ADEC guidance, an emulsion factor of 1.54 and a percentage of free water (20%) have been added to the initial RPS of 203,500 bbl (32,354 m^3) for a total storage volume of 354,090 bbl (56,296 m^3).

1.3 Historical and Modeled Oil Spills.

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 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.

1.3.1 Historical Refined and Crude Spills from Exploration Operations on the Beaufort and Chukchi Outer Continental Shelf and Canadian Beaufort.

The MMS estimates the chance of a large (≥1,000 bbl) oil spill from 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-2 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. Based on the historical 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 MMS estimates a small spill is a reasonably forseeable scenario during exploratory drilling in the Chukchi Sea. These small spills often are onto containment on vessels, platforms, facilities, or gravel islands, or onto ice, and may be cleaned up.

Table A-2 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 this proposal 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. The storage tanks onshore would be double walled and would have 100% containment.

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 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 recent years very few well-control-incident events have resulted in spilled oil, and the volumes spilled often are small. All five of the well-control-incident events ≥1,000 bbl in the OCS database occurred between 1964 and 1970 (Table A-3). Following the Santa Barbara well-control incident in 1969, 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.

Table A-2. Exploration Spills on the Beaufort Sea and Chukchi Sea OCS.

Lease No.	Sale Area	Operator	Date	Time 24 Hr	Facility	Substance	Amt. (Gal)	Cause of Spill	Response Action	Amount Recovered (gal)
0344	71	Sohio	7/22/1981	11:00	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	14:00	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
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	N/A	Sandpiper Gravel Island	Unknown	1.00	Seeping from Gravel Island.	Sorbent pads.	Unknown
0849	87	Union Oil	9/4/1982	14:00	Canmar Explorer II	Unknown	1.00	Transfer of test tank from drillship to barge.	None	None
0871	87	Shell Western	9/5/1982	18:55	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	19:00	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	10:00	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	10:00	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	9:00	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	6:30	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	17:30	Beechey Pt. Gravel Is.	Hydraulic Fluid	0.37	Hydraulic line broke	Contaminated Snow Removed	0.37
0196	BF	Shell	3/1/1985	1:30	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	15:30	Tern Gravel Island	Crude Oil	1.00	Well Separator overflowed, crude oil escaped	Line boom deployed	Unknown
0196	BF	Shell	3/6/1985	16:30	Tern Gravel Island	Crude Oil	15.00	Test burner was operating poorly	Containment Boom deployed	Unknown
0196	BF	Shell	9/24/1985	16:00	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	8:45	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	14:00	Tern Gravel Island	Crude Oil	2.00	Test oil burner malfunction	Contaminated snow removed	2.00
0196	BF	Shell	6/27/1986	13:30	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	13:00	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	3:00	Explorer III Drillship	Hydraulic fluid	10.0	Hydraulic line connector	Sorbent pads	0.84
1092	97	AMOCO	10/1/1991	2:00	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	18:30	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

Table A-3. Number of Well-Control Incidents with Pollution per Year in the Gulf of Mexico and Pacific OCS Regions.

			Condensate/Crude Oil Spilled (Barrels)			Production	Drilling				Workover/ Completion	Well Type	Well Type	Wells Drilled
Year	Total Number of Incidents	Incidentswith 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	—	198	44	242
1957	1	0	—	—	0	—	1	—	—	1	—	311	55	366
1958	2	1	Minimal	—	Minimal	—	1	—	—	1	1	198	62	260
1959	1	0	—	—	0	—	1	—	—	1	—	225	95	320
1960	2	0	—	—	0	1	1	—	—	1	—	285	134	419
1961	0	0	—	—	0	—	—	—	—	0	—	340	127	467
1962	1	0	—	—	0	—	1	—	—	1	—	368	156	524
1963	1	0	—	—	0	—	1	—	—	1	—	379	202	581
1964	8	3	10,280#	100	10,380	5	3	—	—	3	—	493	218	711
1965	5	2		1.688	1,688	1	4	—	—	4	—	637	178	815
1966	2	2	Minimal	Minimal	Minimal	—	1	—	—	1	1	604	280	884
1967	2	1	Minimal	—	Minimal	0	—	—	—	—	2	611	297	908
1968	8	0	—	—	0	1	6	—	—	—	1	679	310	989
1969	3	3	—	82,500	82,500	1	2	—	1	1	—	630	233	863
1970	3	3	83,000	—	83,000	1	1	—	—	1	1	652	217	869
56-70	**40**	**15**	**93,280**	**84,288**	**177,568**	**10**	**24**	**0**	**1**	**17**	**6**	**6,610**	**2,608**	**9,218**
Major Regulatory Changes to Outer Continental Shelf Lands Act														
1971	6	2	460	—	460	2	2	1	1	—	2	573	264	837
1972	6	1	2	—	2	1	4	2	2	—	1	577	301	878
1973	3	0	0	—	0	—	3	2	1	—	—	550	308	858
1974	6	2	275	—	275	3	2	1	1	—	1	494	344	838
1975	7	0	0	—	0	—	5	4	1	—	2	541	326	867
1976	6	0	—	—	0	1	5	1	4	—	—	810	295	1105
1977	9	1	2	—	2	1	4	3	1	—	4	888	352	1240
1978	11	0	0	—	0	—	7	3	4	—	4	864	324	1188
1979	5	0	0	—	0	—	5	4	1	—	—	811	351	1162
1980	8	1	1	—	1	2	4	3	1	—	2	835	367	1202
1981	10	4	64	—	64	1	3	1	2	—	6	907	354	1261
1982	9	0	0	—	0	—	5	1	4	—	4	862	412	1274
1983	12	1	—	2	2	—	10	5	5	—	2	781	399	1180
1984	5	0	—	—	0	—	4	3	1	—	1	773	598	1371
1985	6	1	50	—	50	0	4	3	1	—	2	682	536	1218
1986	2	0	—	—	0	—	1	—	1	—	1	460	272	732
1987	8	2	61	—	61	3	2	2	—	—	3	464	420	884
1988	4	1	5	—	5	1	2	1	1	—	1	460	571	1031
1989	12	0	—	—	0	3	7	2	3	2 *	2	524	471	995
1990	7	3	18	—	18	0	3	1	2	—	4	580	504	1084

			Condensate/Crude Oil Spilled (Barrels)			Production	Drilling				Workover/ Completion	Well Type	Well Type	Wells Drilled
Year	Total Number of Incidents	Incidentswith Condensate/ Crude Oil	Production, Workover, Completion, P&A	Drilling	Total Exploration and Development	Total	Total	Exploration	Development	Unknown	Total	Development	Exploration	Total
1991	8	1	—	0.8	0.8	—	6	2	2	2*	2	457	334	791
1992	3	1	—	100	100	—	3	3	—	—	—	347	223	570
1993	4	0	—	—	0	—	4	1	3	—	—	593	357	950
1994	1	0	—	—	0	—	—	—	—	—	1	621	427	1048
1995	1	0	—	—	0	—	1	1	—	—	—	710	388	1098
1996	4	0	—	—	0	—	2	1	1	—	2	726	453	1179
1997	5	0	—	—	0	—	4	1	3	—	1	859	540	1399
1998	7	3	1.5	—	4.2	2	2	1	1	—	3	643	497	1140
1999	5	1	125	—	125	—	3	1	2	—	2	664	371	1035
2000	9	3	—	200.5	200.5	—	8	5	3	—	1	936	443	1379
2001	10	1	1	—	1	2	5	1	4	—	3	853	411	1264
2002	6	2	350 .5#	—	350.5	2	3	1	2	—	1	633	309	942
2003	5	2	10	—	10	2	2	1	1	—	1	539	354	893
2004	5	3	2.5	16.4	18.9	—	2	2	—	—	3	554	362	916
2005	4	0	—	—	0	—	4	3	1	—	—	457	355	812
2006	2	0	10	—	10	—	1	1	—	—	1	350	414	764
2007	7	—	—	—	—	1	2	2			4	316	300	616
2008	8	1	—	—	4	3	3		3		1	299	267	566
2009	3	0	—	—	0	2	0				1	146	116	262
71-09	**239**	**36**	**1,438.5**	**320**	**1758.20**	**32**	**137**	**70**	**63**	**0**	**69**	**24,139**	**14,690**	**38,829**

Source: USDOI, MMS, Accident Investigation Board (2009).

Notes: 1. Databases and incident reports frozen as of November 3, 2009; 2009 data not finalized, 2. # = hurricane-related; * sulphur blowouts.

From 1971-2009, 239 exploration and development well-control incidents occurred, on the OCS while drilling approximately 38,000 wells and producing 15 billion barrels (Bbbl) of oil (Table A-3). This includes all well-control incidents, whether they caused pollution or not. From 1971-2009, 36 of those 239 well-control incidents from exploration and development wells resulted in spills of crude or condensate, with the amount of oil spilled ranging from <1 bbl to 350 bbl in any one individual spill. The total volume spilled from the 36 well-control incidents is approximately 1,800 bbl. The crude and condensate volume spilled from well-control incidents was approximately 0.00001% of the volume produced. There were no crude or condensate spills ≥1,000 bbl from exploration and development well-control incidents in the last 37 years on the OCS.

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. This information is compared with the previous study conducted for drilling well-control incidents that occurred from 1971 through 1991 (Izon, Danenberger, and Mayes, 2007). This information shows a downward trend in the number of drilling well-control incidents per well drilled from 1992-2006 compared to 1971-1991.

The data analyzed was incident reports submitted by OCS oil and gas operators and from MMS accident investigation reports. Between 1992 and 2006, 39 well-control incidents occurred, compared with 87

during the time period of the previous study (1971-1991). Overall, the rate of drilling well-control incidents per well drilled improved during the period. The current 15-year study period had a drilling well-control incident rate of one for every 387 wells drilled, compared with a rate of one well-control incident for every 246 wells drilled during the previous study period.

Overall, the current period saw an improvement (decrease) in well-control-incident duration. Like the previous study, 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 U.S. Gulf of Mexico OCS blowout frequencies, as reported by Holand (1997), range from 5.9×10^{-3} blowouts per well drilled for exploratory drilling to 3.9×10^{-3} blowouts per well for development. As Holand's exploration blowout frequencies included blowouts of all types, the frequencies for a blowout resulting in oil reaching the environment are significantly less. Of the total blowouts reported by Holand (1997), gas releases accounted for 77% of the total of blowouts, gas/liquid mixtures 14%, and uncontrolled liquid flows involved 3%.

Izon, Danenberger, and Mayes (2007) report a well-control-incident rate for exploration well drilling of one for every 297 wells drilled, for a frequency of 3.4×10^{-3}. The development well drilling rate is one for every 470 wells drilled, for a frequency of 2.1×10^{-3} (Izon, Danenberger, and Mayes, 2007). Both the exploration and development well-control incident drilling frequencies reflect a decline in well-control incidents over recent years. Again, these blowout frequencies included blowouts of all kinds and frequencies for a blowout resulting in oil reaching the environment are significantly less.

The blowout record for the Alaska North Slope remains the same as reported previously in USDOI, MMS (2007) 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 not relevant today. 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 either 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 1.5×10^{-5} per well drilled. This compares to a statistical blowout frequency of 7.4×10^{-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 9.4×10^{-7} per well.

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 98 exploration and 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 1971-2007, industry has drilled approximately 172 exploration wells in the Pacific OCS, 51 in the Atlantic OCS, 14,006 in the Gulf of Mexico OCS, and 98 in the Alaska OCS, for a total of 14,307 exploration wells. From 1971-2007, there were 70 well-control incidents during exploration drilling. Of those 70 well-control incidents, four resulted in crude or condensate oil spills of 200, 100, 11, and 0.8 bbl, respectively (Table A-3). No large spills (≥1,000 bbl) have occurred from 1971-2007 during exploration drilling. Therefore, approximately 14,000 exploration wells have been drilled, and four small spills resulted in crude or condensate reaching the environment from well-control incidents during exploration drilling (Table A-3).

1.3.4 Modeled Exploration Well-Control Incident Frequencies.

Bercha (2006) developed an oil-spill occurrence fault-tree model to estimate the oil-spill rates associated with oil and gas operations for Arctic OCS locations. The information from Bercha (2006) was used in the USDOI, MMS (2007) oil-spill analyses in the Chukchi Sea.

Because limited historical spill data for the Arctic exist, Bercha 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 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).

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 2006). 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 Chukchi Sea wells (30-60 m), Bercha (2006) the estimated, adjusted frequency is 6.8 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 3.9×10^{-4} per well for a blowout >150,000 bbl (23,848 m^3).

1.3.5 Historical Worldwide Very Large Spills from Well-Control Incidents.

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. The largest spill from a well-control incident in Federal OCS waters is 80,000 bbl, approximately half the size of the starting value of the very large category, and it occurred in 1969. One other spill >50,000 bbl has happened since offshore drilling began in the United States. All five of the well-control-incident events ≥1,000 bbl in the OCS database occurred between 1964 and 1970 (Table A-3). Following the Santa Barbara well-control incident in 1969, 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. Since 1970, no OCS well-control incidents ≥1,000 bbl have occurred.

Because there have been no spills greater than 150,000 bbl in U.S. waters, the MMS looked elsewhere for data on spills of that size or larger. Therefore, we evaluated worldwide data to estimate the chance of very large spills occurring (USDOI, MMS, 2002). The spill information used was based on spills from other countries that do not have the regulatory standards that are enforced on the U.S. OCS. In addition, some drilling practices used elsewhere either are not practiced here or are against outer continental shelf regulations. An exploration well called IXTOC is in Mexican waters and not on the Gulf of Mexico

OCS. For IXTOC, the blowout came about because the operator lost circulation in the well and decided to remove the drill pipe from the well prior to re-establishing circulation and not keeping the well full as the drill pipe was removed. Under MMS regulations, an operator would not be allowed to remove the drill string without ensuring that the well is under control and sufficient mud volume is kept in the well.

Internationally from 1979 through 1996, five oil-well blowouts greater than or equal to 10 million gal. (238,000 bbl) have occurred (Cutter Information Corp., 1997; DeCola, 2000). Five of the blowouts >10 million gal. mostly were the result of either war or drilling practices that oil companies do not now use and may not use under MMS regulations in the United States. During this same time period, there were roughly 470 Bbbl of oil produced worldwide (British Petroleum, 2001). These data provide a rate of about 0.01 blowouts ≥10 million gal. per billion barrels produced.

1.4 Oil-Spill Analysis Framework.

There are three potential size categories of oil spills in connection with exploratory work in this proposed action: (1) a large spill (≥1,000 bbl) from operations; (2) a very large spill (≥150,000 bbl) from a well-control incident; and (3) a small spill (<1,000 bbl). Historical and modeling data demonstrates that the probability of a large spill occurring during exploration is insignificant 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 improbable. Nonetheless, this EA incorporates by reference the MMS's prior analyses of the impacts of a large and very large oil spill. See discussion in Section 1.4.2 below. It is likely a small spill could occur during exploration activities.

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 and potential discharge analysis. It is estimated to last less than 3 days on the surface of the water, based on weathering calculations. In terms of timing, a small spill from the operations could happen at any time from July to October during exploration operations. We assume that the vessel would not retain any oil. We assume that, 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 spill. In our weathering analysis, we estimate the following fate of the diesel fuel without cleanup. Tables A-4 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 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.
- All the oil reaches the environment; the vessel or facility absorbs no oil.
- The spill starts within Launch Area (LA) 5 or 11.
- There is no cleanup or containment. Containment and cleanup is analyzed separately as mitigation.
- The spill could occur at any time of the operations (July–October).
- The spill weathering is as we show in Table A-4, 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-4 summarizes the results we estimate for the fate and behavior of a 48-bbl diesel fuel spill. This estimate is similar to the estimate in the EP Table 2.9.5 which used the ADIOS model and a water temperature 2 degrees higher and a slightly lower wind speed. 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 oil spill will be localized and short term (<3 days).

Table A-4. 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 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

Note: For the EA the small spill size is a 48-bbl diesel spill

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 October), 12-knot wind speed, 2 degrees Celsius, 0.4-meter wave height.

1.4.2 Previous Analysis of Very Large and Large Accidental Oil Spills.

After the Exxon Valdez oil spill, the MMS analyzed very large spills in several OCS locations (USDOI MMS, 1990a, b, 1991, 1995a, b, 1996, 1998, 2002, 2003a, b; USDOI, BLM and MMS, 1998, 2003; USDOI, BLM, 2005). Very large oil spill analysis, from various locations (National Petroleum Reserve – Alaska, Beaufort Sea, Chukchi Sea, Navarin Basin, Cook Inlet and Gulf of Alaska), estimates that major impacts would occur from very large spills depending upon the timing, location, and weather conditions at the time of the very large spill. The chance of a very large spill (≥150,000) is very low, but its potential effects were analyzed most recently in USDOI, MMS (2003a) 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 was identified in USDOI, MMS (2003a). The conclusion that major impacts would occur from a low probability very large spill does not change for this site specific proposal.

The chance of a large (≥1,000) spill is low, but the potential consequences were analyzed in USDOI, MMS (2007) section IV.C. 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, grouped land segments or land segments within a given time frame from launch areas (LA1-13) and pipeline segments (P1-11) assuming a spill occurs are discussed in USDOI, MMS (2007). In the unlikely event of a large accidental oil spill, the potential for major impacts exist from a large accidental oil spill as identified in previous analyses (USDOI, MMS, 2007). No new major impacts from a large spill are identified from this proposal.

Conditional Probabilities. The summer conditional probabilities (expressed as percent chance) from LA 5 and 11 (USDOI, MMS, 2007: Tables A2-25-A2-27. A.2-30- A.2-33 and A.2-37 – A.2-39) were compared to the Shell lease blocks. The conditional probabilities from LA5 and 11 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 LA5 and 11 and compared to the Shell lease blocks

and is inclusive in the conditional probability discussions in USDOI, MMS (2007) 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.

Figures 2.9-1 through 2.9-3 in Shell Gulf of Mexico (2009b) show the locations of Environmental Resource Areas (ERA) and Land Segments (LS) in the nearshore region with a chance of contact from LA 5 or 11 greater than or equal to 1% during summer. Tables A.5 and A.6 summarize the chances of contact below for all land segments, grouped land segments and environmental resource areas from Sale 193 LA5 and 11 and Shell's lease blocks with a chance of contact greater than or equal to 1%. Figures A.1-2 through 3, in the Chukchi Sale 193 EIS Appendix A (USDOI, MMS, 2007), show the locations of ERAs, land segments, and grouped land segments.

Launch Area 5 and 11

Summer 3 Days. The OSRA model estimates the chance of a spill ≥1,000 bbl contacting ERAs 47-51 (ice/sea segments) is <0.5-14%. The chance of contacting ERA10 (Ledyard Bay Spectacled Eider Critical Habitat) is 1-8 %. The chance of contacting ERAs 39 and 40 (Point Lay and Wainwright Subsistence Area) is <0.5-1%. The chance of contacting ERA56 (ERA 56) is <0.5-3%. The chance of contacting Land or individual LSs is <0.5%. The chance of contacting any grouped land segment (GLS) is <0.5%.

Summer 10 Days. The OSRA model estimates the chance of a spill ≥1,000 bbl contacting ERAs 46-51 (ice/sea segments) is <0.5-22%. The chance of contacting ERA10 (Ledyard Bay Spectacled Eider Critical Habitat) is 1-14 %. The chance of contacting ERAs 39 and 40 (Point Lay and Wainwright Subsistence Area) is <0.5-7%. The chance of contacting ERA56 (ERA 56) is 2-8%. The chance of contacting Land is <0.5-5%. The chance of contacting individual LSs is <0.5% except 73, 74 or 75 which is 1%. The chance of contacting a GLS is <0.5% except NPRA which is <0.5-1% and the United States Chukchi Coast which is <0.5-5%.

Summer 30 Days. The OSRA model estimates the chance of a spill ≥1,000 bbl contacting ERAs 46-51 (ice/sea segments) is 1-29%. The chance of contacting ERA10 (Ledyard Bay Spectacled Eider Critical Habitat) is 6-21 %. The chance of contacting ERAs 38, 39 and 40 (Point Hope, Point Lay and Wainwright Subsistence Area) is 6-15%. The chance of contacting ERA56 (ERA 56) is 6-15%. The chance of contacting Land is 6-19%. The chance of contacting individual LSs is <0.5% except 71-81 which is 1-3%. The chance of contacting a GLS is <0.5-4% except the United States Chukchi Coast, which is 4-19%.

Comparison to Shell Blocks.

In general, conditional probabilities from the Shell blocks are lower for nearshore areas and higher for ERAs directly adjacent to the blocks. Launch Areas 5 and 11 are representative of the conditional probabilities for these blocks.

Table A-5. Summer Conditional Probabilities (Expressed as Percent Chance) that an Oil Spill Starting at LA 55 or 11 Chukchi Sea Sale 193 or Lease Blocks 2111, 2142, 2267, 2280 and 2321 Will Contact a Certain Land Segment or Group of Land Segments Within 3, 10 or 30 Days Assuming a Spill Occurs.

		LA5			LA11			2111 Crackerjack			2142 SW Shoebill			2267 Burger F			2280 Burger C			2321 Burger J		
ID	**Land Segment Name**	3 Days	10 Days	30 Days	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**
65	Buckland, Cape Lisburne	:	:	:	:	:	:			1	:	:	:	:	:	1	:	:	1	:	:	1
71	Kukpowruk River, Sitkok Point	:	:	:	:	:	1	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
72	Point Lay, Siksrikpak Point	:	:	:	:	:	1	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
73	Tungaich Point, Tungak Creek	:	:	:	:	1	2	:	:	:	:	:	:	:	:	:	:	:	:	:	:	1
74	Kasegaluk Lagoon, Solivik Isl.	:	:	1	:	1	3	:	:	1	:	:	1	:	:	:	:	:	:	:	:	:
75	Akeonik, Icy Cape	:	:	1	:	1	3	:	:	1	:	:	1	:	:	:	:	:	:	:	:	2
76	Avak Inlet, Tunalik River	:	:	:	:	:	1	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
77	Nivat Point, Nokotlek Point	:	:	:	:	:	1	:	:	1	:	:	1	:	:	:	:	:	:	:	:	2
78	Point Collie, Sigeakruk Point	:	:	:	:	:	2	:	:	2	:	:	1	:	:	2	:	:	3	:	1	3
79	Point Belcher, Wainwright	:	:	:	:	:	2			1	:	:	:	:	:	4	:	:	4	:	:	3
80	Eluksingiak Point, Kugrua Bay	:	:	:	:	:	1	:	:	:	:	:	:	:	:	3	:	:	3	:	:	2
81	Peard Bay, Point Franklin	:	:	:	:	:	1	:	:	:	:	:	:	:	:	2	:	:	2	:	:	1
82	Skull Cliff	:	:	:	:	:	:	:	:	:	:	:	:	:	:	1	:	:	:	:	:	:
ID	**Grouped Land Segment Name**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**
84	Wrangel Isl Nat Res Natural World Heritage Site	:	:	1	:	:	:	:	:	:	na	na	na	na	na	na	na	na	na	na	na	na
88	Alaska Maritime National Wildlife Refuge	:	:	:	:	:	:	:	:	1	:	:	:	:	:	:	:	:	:	:	:	1
89	National Petroleum Reserve Alaska	:	:	1	:	1	4	:	:	1	:	:	1	:	:	6	:	:	6	:	:	7
90	Kasegaluk Lagoon Special Use Area	:	:	1	:	:	2	:	:	1	:	:	1	:	:	1	:	:	1	:	:	3
95	Russia Chukchi Coast	:	:	1	:	:		:	:	1	:	:	3	:	:		:	:		:	:	
96	United States Chukchi Coast	:	:	4	:	5	19	:	:	6	:	:	6	:	1	14	:	1	16	:	2	18

Notes: ** = Greater than 99.5 percent; : = less than 0.5 percent; LA = Launch Area, na =GLS spatial location changed. Rows with all values less than 0.5 percent are not shown.

Table A-6. Summer Conditional Probabilities (Expressed as Percent Chance) that an Oil Spill Starting at LA 5 or 11 Chukchi Sea Sale 193 or Lease Blocks 2111, 2142, 2267, 2280 and 2321 Will Contact a Certain Environmental Resource Area Within 3, 10 or 30 Days Assuming a Spill Occurs.

ID	Environmental Resource Area Name	LA5			LA11			2111 Crackerjack			2142 SW Shoebill			2267 Burger F			2280 Burger C			2321 Burger J		
		3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days
—	LAND	:	:	6	:	5	19	:	:	8	:	:	9	:	1	14	:	1	16	:	2	18
1	Kasegaluk Lagoon	:	:	3	1	5	13	:	:	4	:	:	5	:	:	2	:	:	3	:	1	8
3	ERA 3	:	:	:	:	:	:	:	:	:	:	:	1	:	:	:	:	:	:	:	:	:
6	ERA 6	:	:	3	:	3	12	:	:	5	:	:	4	:	2	19	:	3	20	:	4	19
10	Ledyard Bay Spectacled Eider Critical Habitat	:	1	6	8	14	21		1	7	:	1	7	:	1	4	:	1	5	:	2	7
11	Wrangel Island 12 nmi Buffer	:	:	1	:	:	:	:	:	1	:	:	2	:	:	:	:	:	:	:	:	:
14	Cape Thompson Seabird Colony Area	:	:	1	:	:	1	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
15	Cape Lisburne Seabird Colony Area	:	:	2	:	1	3	:	:	3	:	:	4	:	:	1	:	:	1	:	:	2
18	ERA 18	:	:	7	:	:	5	:	:	8	:	:	12	:	:	4	:	:	4	:	:	5
20	Chukchi Spring Lead 2	:	:	:	:	:	1	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
21	Chukchi Spring Lead 3	:	:	:	:	2	3	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
22	Chukchi Spring Lead 4	:	:	:	1	2	3	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
35	ERA 35	:	1	4	6	12	18	:	2	7	:	:	4	8	21	36	10	22	37	5	15	27
36	ERA 36	6	13	22	34	40	46	3	17	34	3	16	32	11	23	35	17	29	40	67	71	76
38	Pt. Hope Subsistence Area	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1	:	:	1
39	Point Lay Subsistence Area	:	:	3	1	7	13	:	:	3	:	:	4	:	:	2	:	:	3	:	1	5
40	Wainwright Subsistence Area	:	:	4	1	6	18	:	:	7	:	:	7	:	2	17	:	2	20	:	4	20
45	ERA 45	:	:	1	:	:	2	:	:	2	:	:	2	:	:	1	:	:	1	:	:	1
46	Herald Shoal Polynya	:	2	9	:	:	3	:	3	13	:	7	17	:	:	5	:	:	5	:	:	6
47	Ice/Sea Segment 10	14	22	29	:	3	9	66	71	74	25	36	43	:	5	13	:	5	12	:	7	16
48	Ice/Sea Segment 11	1	6	13	1	6	13	:	2	8	:	:	4	2	12	20	1	9	17	:	5	14
49	Hanna's Shoal Polynya	:	1	3	:	:	2	:	:	1	:	:	1	:	:	3	:	:	2	:	:	2
50	Ice/Sea Segment 12	:	:	3	3	6	10	:	:	2	:	:	1	:	6	14	:	5	12	:	2	7
51	Ice/Sea Segment 13	:	:	1	:	:	3	:	:		:	:		1	1	8	1	1	8	:	:	4
56	ERA 56	:	2	6	3	8	15	:	:	5	:	:	3	3	14	30	1	12	27	:	7	19
64	Peard Bay	:	:	:	:	:	2	:	:	:	:	:	:	:	:	4	:	:	4	:	:	3
70	ERA 70	:	:	1	:	:	:	:	:	:	:	:	:	:	:	1	:	:	1	:	:	:
82	ERA 82	:	:	:	:	:	:	:	:	:	:	:	1	:	:	:	:	:	:	:	:	:

Notes: ** = Greater than 99.5 percent; : = less than 0.5 percent; LA = Launch Area, na =ERA spatial location changed. Rows with all values less than 0.5 percent are not shown.

1.6 References

Anderson, C.M. and R.P. LaBelle. 2000. Update of Comparative Occurrence Rates for Offshore Oil Spill. Spill Science and Technology 65/6:303-321.

Bercha Group, Inc. 2006. Alternative Oil Spill Occurrence Estimators and their Variability for the Chukchi Sea - Fault Tree Method. OCS Study MMS 2006-033. Anchorage, AK: USDOI, MMS, Alaska OCS Region, 128 pp. plus appendices.

British Petroleum. BP Statistical Review of World Energy 2001. London: BP; 2001; http//www.bp.com/centres/energy2002/2001inreview.asp.

Cutter Information Corp. International Oil Spill Statistics. Oil Spill Intelligence Report. 1997.

DeCola, E. International Oil Spill Statistics 2000. Arlington, MA: Cutter Information Corp.; 2001, 70 pp.

Devon Canada Corporation. 2004. Devon Beaufort Sea Exploration Drilling Program. Devon Canada Corporation, Calgary Alberta, Canada.

Etkin, D.S. 2009. Analysis of U.S. Oil Spillage. API Publication 356, Washington, D.C. American Petroleum Institute.

Hart Crowser Inc. 2000. Estimation of Oil Spill Risk from Alaska North Slope, Trans Alaska Pipeline and Arctic Canada Oil Spill Data Sets. OCS Study, MMS 2000-007. Anchorage Alaska: USDOI, MMS, Alaska OCS.

Holand, P. 1997. Offshore Blowouts Causes and Control. Houston, TX: Gulf Publishing Company.

Izon, D., E.P. Danenberger, and M. Mayes. 2007. Absence of Fatalities in Blowouts Encouraging in MMS Study of OCS Incidents 1992-2006. *Drilling Contractor* July/August: 84-89.

National Research Council (NRC). 2003. Oil and the Sea III, Inputs, Fates and Effects. Washington, DC: The National Academies Press, 265 pp.

Reed, M., Ekrol, N., Daling, P., Johansen, O., and Ditlevsen, M. K. 2005. SINTEF Oil Weathering Model User's Manual Version 3.0. Trondheim, Norway: SINTEF Applied Chemistry, 39 pp.

Scandpower. 2001. Blowout Frequency Assessment of Northstar. 27.83.01/R1. Prepared for BP Exploration (Alaska). Kjeller, Norway: Scandpower, 40 pp. plus appendices.

Shell Gulf of Mexico Inc., 2009a. Exploration Plan, 2010 Exploration Drilling Program, Posey Blocks 6713, 6714, 6763, 6764 and 6912, Karo Blocks 6864 and 7007, Burger, Crackerjack, and SW Shoebill Prospects, OCS Lease Sale 193, Chukchi Sea, Alaska. Anchorage, AK: Shell Gulf of Mexico Inc.

——— 2009b. Environmental Impact Analysis, Appendix F. In: Exploration Plan 2010 Exploration Drilling Program Posey Blocks 6713, 6714, 6763, 6764 and 6912 Karo Blocks 6864 and 7007 Burger, Crackerjack, and Shoebill Prospects OCS Lease Sale 193 Chukchi Sea. Alaska, Anchorage, AK: Shell Gulf of Mexico Inc.

——— 2009c. Chukchi Sea Regional Exploration Oil Discharge Prevention and Contingency Plan. In: Exploration Plan 2010 Exploration Drilling Program Posey Blocks 6713, 6714, 6763, 6764 and 6912, Karo Blocks 6864, and 7007, Burger, Crackerjack, and Shoebill Prospects OCS Lease Sale 193 Chukchi Sea, Alaska. Anchorage, AK: Shell Gulf of Mexico Inc.

USDOI, BLM. 2005. Northeast NPR-A final Amended Integrated Activity Plan/EIS. BLM/AK/PL-05/006+1610+930. Anchorage, AK: USDOI, BLM

USDOI, BLM and MMS. 1998. Northeast National Petroleum Reserve-Alaska Final Integrated Activity Plan/ Final Environmental Impact Statement. BLM/AK/PL-98/016+3130+930. Anchorage AK: USDOI, BLM and MMS.

USDOI, BLM and MMS. 2003. Northwest National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement. BLM/AK/PL-04/002+3130+930. Anchorage, AK: USDOI, BLM and MMS, 3 Vols.

USDOI, MMS. 1990a. Beaufort Sea Planning Area Oil and Gas Lease Sale 124, Final Environmental Impact Statement. OCS EIS/EA, MMS 90-0063. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 1990b. Chukchi Sea Oil and Gas Lease Sale 126 Final Environmental Impact Statement. OCS EIS/EA, MMS 90-0095. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 1991. Navarin Basin Oil and Gas Lease Sale 107 Final Environmental Impact Statement. OCS EIS/EA, MMS 91-0008. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 1995a. Cook Inlet Planning Area Oil and Gas Lease Sale 149 Final Environmental Impact Statement. OCS EIS/EA, MMS 95-0066. Anchorage, AK: USDOI, MMS, Alaska OCS Region., 2 Vols.

——— 1995b. Gulf of Alaska/Yakutat Planning Area Oil and Gas Lease Sale 158 Draft Environmental Impact Statement. 1 Volume. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 1996. Beaufort Sea Planning Area Oil and Gas Lease Sale 144 Final Environmental Impact Statement. OCS EIS/EA, MMS 96-0012. 2 Volumes. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 1998. Beaufort Sea Planning Area Oil and Gas Leas Sale 170 Final EIS. OCS EIS/EA, MMS 98-0007. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 2002. Liberty Development and Production Plan, Final Environmental Impact Statement. OCS EIS/EA, MMS 2002-019. Anchorage, AK: USDOI, MMS, Alaska OCS Region, 3 Vols.

——— 2003a. Beaufort Sea Planning Area Sales 186, 195, and 202 Oil and Gas Lease Sale Final EIS. OCS EIS/EA, MMS 2003-001. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 2003b. Cook Inlet Planning Area Oil and Gas Lease Sales 191 and 199 Final EIS. OCS EIS/EA, MMS 2003-055. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

——— 2007. Chukchi Sea Planning Area Oil and Gas Lease Sale 193, and Seismic Surveying Activities in the Chukchi Sea Final EIS. OCS EIS/EA MMS 2007-026. Anchorage, AK: USDOI, MMS, ——— 2008. Beaufort Sea and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 Draft EIS. OCS EIS/EA, MMS 2008-0055. Anchorage, AK: USDOI, MMS, Alaska OCS Region.

USDOI, MMS, Accident Investigation Board. 2009. Email from David Izon, Petroleum Engineer to Caryn Smith, Oceanographer on November 3, 2009. Subject: Blowout Data for Alaska.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.