Appendix F
Environmental Impact Analysis
Environmental Impact Analysis

Revised Outer Continental Shelf Lease Exploration Plan

Camden Bay, Beaufort Sea, Alaska

May 2011

Prepared by:
Shell Offshore Inc.
3601 C Street, Suite 1000
Anchorage, Alaska 99503
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ACRONYMS AND ABBREVIATIONS

µg microgram(s)
µPa micropascal(s)
°F degrees Fahrenheit
°C degrees Celsius
2D two-dimensional
3D three-dimensional
4MP Marine Mammal Monitoring and Mitigation Plan
AAC Alaska Administrative Code
AAAQS Alaska Ambient Air Quality Standards
AAQS Ambient Air Quality Standards
ac acre(s)
ACMA Alaska Coastal Management Act
ACMP Alaska Coastal Management Program
ACRT Auxiliary Contract Response Team
ACS Alaska Clean Seas
ADCA Alaska Division of Community Advocacy
ADEC Alaska Department of Environmental Conservation
ADF&G Alaska Department of Fish and Game
ADIOS2 Automated Data Inquiry for Oil Spills
ADOT&PF Alaska Department of Transportation and Public Facilities
ADNR Alaska Department of Natural Resources
AES ASRC Energy Services
AES–RO ASRC Energy Services – Response Operations, LLC
AEWC Alaska Eskimo Whaling Commission
AHRS Alaska Heritage Resource Survey
air-mi air miles
air-km air kilometers
ANCSA Alaska Native Claims Settlement Act
ANIMIDA Arctic Nearshore Impact Monitoring in Development Area
ANSER Arctic North Slope Eastern Region
ANWR Arctic National Wildlife Refuge
AO Arctic Oscillation
APD Application to Drill
APE area of potential effect
ARCO ARCO Alaska, Inc./Atlantic Richfield Company
AS Alaska Statute
ASL above sea level
ASRC Arctic Slope Regional Corporation
ATV all terrain vehicle
Avg average
BACT best available control technology
bbl barrel(s)
BO  Biological Opinion
BOD  Biochemical Oxygen Demand
BOEMRE  Bureau of Ocean Energy Management, Regulation and Enforcement
BOP  Blowout Preventer
bopd  barrels of oil per day
BPXA  BP Exploration (Alaska), Inc.
BWASP  Bowhead Whale Aerial Survey Project
CAA  Clean Air Act, Conflict Avoidance Agreement
CAH  Central Arctic Herd
Camden Bay  Camden Bay Area
CDFO  Canadian Department of Fisheries and Oceans
CEQ  Council on Environmental Quality
CFR  Code of Federal Regulations
cm  centimeter(s)
cm³  cubic centimeter(s)
CO  carbon monoxide
CO₂  carbon dioxide
COCP  Critical Operations and Curtailment Plan
Com Center  Communication and Call Center
CPUE  catch per unit effort
CWA  Clean Water Act
CZM  Coastal Zone Management
CZMA  Coastal Zone Management Act
DASARs  Directional Autonomous Seafloor Acoustic Recorders
dB  decibel(s)
DCOM  Division of Coastal and Ocean Management
DDT  dichlorodiphenyltrichloroethane
DEW  Distance Early Warning
Discoverer  Motor Vessel Noble Discoverer
DO  dissolved oxygen
DP  Dynamic Positioning
EA  Environmental Assessment
EAB  Environmental Appeals Board
EEZ  U.S. Exclusive Economic Zone
EDMS  Emissions Data Management System
EFH  Essential Fish Habitat
EIA  Environmental Impact Analysis
EIS  Environmental Impact Statement
EP  Exploration Plan
EPA  U.S. Environmental Protection Agency
ERL  Effects Range Low
ERM  Effects Range Median
ESA  Endangered Species Act
FAA  Federal Aviation Administration
<table>
<thead>
<tr>
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<tr>
<td>FEIS</td>
<td>Final Environmental Impact Statement</td>
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<tr>
<td>FMP</td>
<td>Fishery Management Plan</td>
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<td>Fuel Transfer Plan</td>
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Environmental Impact Analysis
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Camden Bay, Alaska

OCS  Outer Continental Shelf
OCSLA Outer Continental Shelf Lands Act
OD  outside diameter
ODPCP Oil Discharge Prevention and Contingency Plan
OHA Office of History and Archaeology
OPA Oil Pollution Act
OPA-90 Oil Pollution Act of 1990
OPMP Office of Project Management and Planning
OS oil storage
OSR oil spill response
OSRA Oil Spill Risk Analysis
OST Oil Storage Tanker
OSV offshore supply vessel
Pa Pascal(s)
PAH polycyclic aromatic hydrocarbons
Pb lead
PCH Porcupine Caribou Herd
PDO Pacific Decadal Oscillation
pk-pk peak-to-peak
PM particulate matter
PM$_{2.5}$ particulate matter of 2.5 micrometers or less
PM$_{10}$ particulate matter of 10 micrometers or less
POC Plan of Cooperation
POPs persistent organic pollutants
ppb parts per billion
ppg pounds per gallon
ppm parts per million
precip precipitation
PSD Prevention of Significant Deterioration
PTE potential to emit
PTS permanent threshold shift
PTVD Proposed Total Vertical Depth
Rec record
RS/FO Regional Supervisor/Field Operations
ROV remotely operated vehicle
rms root mean square
rpm revolutions per minute
RPS Response Planning Standard
R/V Research Vessel
SA Subsistence Advisor
SAR search and rescue
SCR Selective Catalytic Reduction
SHA Society for Historical Archaeology
Shell Shell Offshore Inc.
SILs Significant Impact Levels
SIWAC Shell Ice and Weather Advisory Center
SLP seal level pressures
SO$_2$ sulfur dioxide
SO$_x$ sulfur oxides
TAH total aromatic hydrocarbons
TAPS Trans Alaska Pipeline System
TCP traditional cultural property
TD total depth
TDS treatment/disposal site
TK Traditional Knowledge
TLUI Traditional Land Use Inventory
Tot total
TPAH total polycyclic aromatic hydrocarbons
TPH total petroleum hydrocarbons
TSS total suspended solids
TTS temporary threshold shift
UIC Ukpeagvik Iñupiat Corporation
ULSD Ultra Low Sulfur Diesel
U.S. United States
USACE U.S. Army Corps of Engineers
USCG U.S. Coast Guard
USCGC U.S. Coast Guard Cutter
USFWS U.S. Fish and Wildlife Service
USGS U.S. Geological Survey
VOC volatile organic compound(s)
VOSS vessel of opportunity skimming system
VRT Village Response Team(s)
VSI Vertical Seismic Imager
VSP Vertical Seismic Profile
W West
WBM water based mud
WCD Worst Case Discharge
WHOI Woods Hole Oceanographic Institute
WRAP Western Regional Air Partnership
YBP years before present
ZVSP zero-offset vertical seismic profile
PREFACE

This Environmental Impact Analysis (EIA) accompanies Shell Offshore Inc.'s (Shell) Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Beaufort Sea, Alaska, for Flaxman Island Blocks 6559, 6610 & 6658 and Beaufort Sea Lease Sales 195 & 202 (revised Camden Bay EP). This EIA is prepared pursuant to the requirements of the Outer Continental Shelf Lands Act (OCSLA), 43 U.S.C. §§ 1331-1356, and the regulations of the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), including 30 Code of Federal Regulations (CFR) §§ 250.212(o) and 250.227. This EIA is a project- and site-specific analysis of Shell's planned activities. It provides a complete description of all of the activities Shell plans to perform. The EIA identifies and describes the resources and conditions of the project area and assesses the potential environmental impacts on those resources and conditions of the planned activities. It further identifies and describes the mitigation measures Shell will implement in connection with the planned activities. The EIA presents data, analysis, and conclusions so as to assist BOEMRE in complying with the National Environmental Policy Act (NEPA), and other relevant federal laws, including the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA), as the agency considers the revised Camden Bay EP for approval.

Shell's plan, as detailed in its revised Camden Bay EP, is to use a single drilling vessel, either the conical drilling unit Kulluk (Kulluk) or potentially the Motor Vessel (M/V) Noble Discoverer (Discoverer), to conduct exploration drilling activities at four drill sites offshore in Camden Bay, Beaufort Sea, Alaska. This is a frontier exploration drilling project: the drill sites are between 16 and 23 miles (mi) (25.7 and 37.2 km) offshore in Arctic waters that are inaccessible for up to nine months of the year due to pack ice. They are remote from any infrastructure, and Shell's planned exploration operations will be the only offshore exploration drilling program taking place on federal outer continental shelf (OCS) lands in the entire Beaufort Sea (an area of approximately 71,550 square miles (mi²) 185,314 square kilometers [km²]). The activities are planned to begin on or about 10 July 2012 and end on or before 31 October 2012 (first drilling season), and then continue in subsequent drilling seasons until the end of the four-well exploration program.

Shell's Arctic Experience

Shell, through its parent and affiliate corporations, has substantial experience exploring for oil and gas in Arctic environments, including the Beaufort and Chukchi Seas. Beginning almost 50 years ago, various Shell Oil Company subsidiaries operated continuously in Alaska until 1998. Shell was one of the most prominent explorers in all of the frontier offshore basins of Alaska, as well as being an operator and major producer in Cook Inlet. During the 1980s, Shell either operated or was a partner in nine exploration wells drilled offshore in the Beaufort Sea. During the late 1980s through the early 1990s, Shell also drilled four exploration wells in the Chukchi Sea and participated in a fifth exploration well.

In addition to its activities in the Alaskan Arctic, The Shell Group (of which Shell and its subsidiaries are a part) also has extensive experience with Arctic and near-Arctic projects in Russia, Canada's Mackenzie Delta, and Norway. Shell will draw upon this experience in organizing and conducting its proposed Camden Bay exploration activities.
Project Description

Shell's revised Camden Bay EP proposes a four-well program of exploration drilling at two prospects between the months of July to October each year until complete. Shell's plans include a mid-season suspension of activities beginning 25 August to accommodate the fall subsistence bowhead whale hunts of the villages of Kaktovik and Nuiqsut (Cross Island), with a resumption of operations after the whale hunts have concluded. During the suspension for the whale hunts the drilling fleet will leave the Camden Bay project area and move to an area north of latitude 71° 25′N and west of longitude 146° 4′W. Shell proposes to drill four exploration wells on oil and gas leases Shell acquired in federal OCS lease sales in 2005 and 2007. Two wells will be drilled on each of two distinct oil and gas prospects named by Shell: “Sivulliq” (proposed drill sites G and N); and “Torpedo” (proposed drill sites H and J) (Figure 2.1-1). The Sivulliq drill sites are located approximately 16 mi (25.7 km) offshore in the Beaufort Sea in an area known as Camden Bay. The Torpedo H drill site, which is 20.8 mi (33.5 km) offshore and the Torpedo J drill site, which is 23 mi (37.2 km) offshore, are located approximately 5.5 mi (9 km) northeast of the Sivulliq drill sites. Both the Sivulliq and Torpedo drill sites are located on the near-shore shelf of the Beaufort Sea, where the sediment at both locations is predominately composed of silty sands and mud. Despite the water depth (approximately 110 feet (ft) (33.4 meters [m]) at Sivulliq G, 107 ft (32.5 m) at Sivulliq N, 120 ft (36.6 m) at Torpedo H, and 124 ft (37.8 m) at Torpedo J), the seafloor at both of these locations is gouged by ice keels each year.

Although the proposed area is remote, there is a long history of safe, environmentally sound exploration drilling activity in the Beaufort Sea, generally, and in Camden Bay, specifically. Between 1981 and 2002, 30 wells were drilled in the Beaufort Sea. Seven of those wells were drilled in the Camden Bay area, and at least two of those historic well locations were on the Sivulliq prospect (Figure 1.2-1).

Shell will conduct drilling operations using the latest drilling technologies and techniques. Shell will drill the wells using either the Kulluk or the Discoverer. The Kulluk is a conically shaped, ice strengthened floating drilling unit designed and constructed for extended season drilling operations in Arctic waters, and relying on an Arctic Class IV hull design. The Kulluk also includes state-of-the-art drilling and well control equipment, and accommodations for a crew of up to 108 persons. The Discoverer is a modern drillship for operating in Arctic OCS waters. The Discoverer includes state-of-the-art drilling and well control equipment, as well as accommodations for a crew of up to 140 persons. The drilling vessel will be supported by additional vessels for ice management, anchor handling, resupply, and waste storage. An oil spill response (OSR) barge will be staged near the drilling vessel, supported by its own tug vessel, with a full complement of crew and oil spill response equipment. All support vessels will be specifically equipped for operating in Arctic waters.

Each drill site has been surveyed by Shell and determined not to contain any shallow hazards that could interfere with drilling or archaeological and historical resources that might be disturbed. Once the drilling vessel is mobilized to a drill site and securely anchored to the seafloor, drilling operations will commence. The Torpedo wells will take approximately 44 days each to drill. The Sivulliq wells will take approximately 34 days each to drill. All wells will be permanently plugged and abandoned in accordance with BOEMRE requirements upon completion of drilling. No oil or gas will be produced from the wells, and no pipelines or other permanent facilities will be built.
All operations will comply with applicable federal, state and local laws, regulations, and lease and permit requirements. Shell will have trained personnel and monitoring programs in place to ensure such compliance. In addition, BOEMRE and other federal regulatory agencies will maintain continuing oversight of all of Shell's exploration activities, and BOEMRE retains the specific authority to require additional mitigation, as appropriate, to respond to actual conditions encountered, or even require the operation to shutdown altogether. Shell has committed to not discharging selected waste streams during routine drilling operations, even though the waste streams are allowable discharges under the current EPA Arctic National Pollutant Discharge Elimination System (NPDES) General Permit (AKG-28-0000). Shell will not discharge drilling mud, cuttings with adhered mud, treated sanitary waste, domestic waste, bilge water, or ballast water. These wastes will be collected and stored on an ocean-going deck barge, or waste barge and transported and disposed of onshore at an approved and licensed facility.

The following are among the permits and authorizations governing Shell's activities, which collectively impose mandatory requirements to ensure safety, protect the environment, avoid interference with subsistence resources and activities, and mitigate any potential adverse impacts:

- NPDES under the Clean Water Act (CWA) from the U.S. Environmental Protection Agency (EPA), imposing strict limits on the permissible discharges to the Beaufort Sea
- Air Quality Permit under the Clean Air Act (CAA) from the EPA, limiting and regulating air emissions to protect ambient air quality
- Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS), for Non-Lethal Taking of Whales and Seals Letter of Authorization (LOA) from the U.S. Fish and Wildlife Service (USFWS), for the Incidental Take of Polar Bears and Pacific Walrus
- Nationwide Permit No. 8 under the Rivers and Harbors Act from the U.S. Army Corps of Engineers (USACE), regulating the location and installation of the *Kulluk* or *Discoverer* on the seafloor
- Coastal Consistency Concurrence under the Coastal Zone Management Act (CZMA) from the State of Alaska, certifying that the proposed activities of Shell’s revised Camden Bay EP are consistent with the enforceable standards of the Alaska Coastal Management Program (ACMP).

Shell must also implement mandatory mitigation measures and safety programs. These include:

- Plan of Cooperation (POC) to coordinate exploration activities with Alaska Native subsistence activities to avoid unreasonable interference with subsistence resources and activities
- Oil Spill Response Plan (federal) and Oil Discharge Prevention and Contingency Plan (ODPCP) (state) to prevent oil spills from ever occurring, and requiring contingency response plans in the highly unlikely event of any spill
- Marine Mammal Monitoring and Mitigation Plan (4MP), to avoid impacts to marine mammals and collect scientific data on marine mammal species
- Bird Strike Avoidance and Lighting Plan
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- Polar bear, Pacific walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan.

The mitigation measures Shell will apply were developed over several years of Arctic exploration activities, in consultation with Alaska Native stakeholders, and have been proven effective in minimizing impacts to the environment, subsistence resources, and Alaska Native subsistence activities. Shell acknowledges that bowhead whales are a vital cultural and subsistence resource for the Inupiat. Shell's measures to protect this important resource include a Communications Plan to coordinate activities with subsistence users, employment of local Subsistence Advisors (SAs), and voluntary limitations on aircraft and vessel routes and travel. Shell will staff all vessels with trained on board marine mammal observers (MMO). Shell will commence drilling activities on or about 10 July, but will cease activities prior to the beginning of the fall whale hunts on 25 August. During the suspension for the whale hunts the drilling fleet will leave the Camden Bay project area and move to an area north of latitude 71° 25'N and west of longitude 146° 4'W. After the hunts have concluded, activities will resume and extend through 31 October, depending on ice and weather.

Shell has employed or contracted with trained personnel to conduct the exploration drilling activities. Shell is committed to local hire, local contracting and local purchasing to the maximum extent possible. All Shell personnel and contractors are experienced operating in the Arctic OCS and are well versed in all federal and state laws regulating field operations.

Environmental Analyses

BOEMRE (and its predecessor, the Minerals Management Service [MMS]) has performed numerous environmental studies of the Arctic OCS over the last 40 years. In recent years, these environmental studies have included the following:

- Draft Environmental Impact Statement - Beaufort and Chukchi Sea Planning Areas - Oil and Gas Lease Sales 209, 212, 217, and 221 (OCS EIS/EA MMS 2008-0055)
- Final Environmental Impact Statement - Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea (OCS EIS/EA MMS 2007-026)
- Environmental Assessment - Proposed Oil & Gas Lease Sale 202, Beaufort Sea Planning Area and Finding of No New Significant Impacts (OCS EIS/EA MMS 2006-001)
- Environmental Assessment - Proposed Oil & Gas Lease Sale 195, Beaufort Sea Planning Area and Finding of No Significant Impacts (OCS EIS/EA MMS 2004-028)
- Final Environmental Impact Statement - Beaufort Sea Planning Area Oil and Gas - Lease Sales 186, 195, and 202, (OCS EIS/EA MMS 2003-001)

In addition, BOEMRE and its predecessor MMS has conducted or funded numerous baseline studies of the Arctic OCS and is planning even more. Among recent publications, these baseline studies include:
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- Beaufort Sea Marine Fish Monitoring 2008: Pilot Survey and Test of Hypotheses. (OCS Study BOEMRE)
- Satellite Tracking of Western Arctic Bowhead Whales (OCS Study BOEMRE 2010-03)
- Bowhead Whale Abundance Through Photographic Analysis (Rugh 2008)
- Empirical Weathering Properties of Oil in Ice and Snow (OCS Study MMS Study 2008-033)
- Alternative Oil Spill Occurrence Estimators and Their Variability for the Alaskan OCS - Fault Tree Method: Update of GOM OCS Statistics to 2006 (OCS Study MMS Study 2008-025)

The BOEMRE website lists dozens of studies completed to-date, as well as planned studies for the future (http://www.alaska.boemre.gov/ess/index.htm). In addition, Shell has funded studies in preparation for this project including ice movement studies using buoy deployment; acoustic modeling and monitoring of drilling and support vessel sound and bowhead whale movements; vessel-based marine mammal monitoring and mitigation tracking; integrated ecosystem-based surveys of marine environment; water and sediment quality surveys, and air quality monitoring.

These studies provide many volumes of data on the Arctic OCS. Collectively, the studies analyze everything from potential impacts on the natural environment to the socioeconomic effects of exploration activities on humans. The studies also include numerous technical studies ranging from the likely trajectory of spilled oil in the ocean to the effects of drilling sound energy on threatened and endangered species. The studies provide information for agency decision-making regarding whether to lease, areas to select (or not select) for leasing, lease stipulations and mitigation measures, operational requirements, and permit restrictions. This comprehensive body of work, which in part forms the basis for the analysis presented herein, will allow BOEMRE and other regulatory agencies to evaluate Shell's revised Camden Bay EP and ensure that all oil and gas exploration activities are performed in an environmentally sound manner, with minimal impacts to the affected environment.

Among other important findings, detailed studies by BOEMRE and its predecessor MMS have repeatedly confirmed that exploration drilling activities such as those proposed in this revised Camden Bay EP:

- Have only negligible, short-term, temporary impacts on the environment, including wildlife;
- Do not threaten the continued existence of any endangered or threatened species;
- Do not cause significant or unreasonable interference with any subsistence species, particularly bowhead whales, or Alaska Native subsistence activities when appropriate mitigation measures are followed; and
- Do not pose a statistically insignificant risk of a large, catastrophic oil spill (blowout).

The large body of knowledge available to BOEMRE and other regulatory agencies continues to grow and informs agency decision-making with each new project, including this one. BOEMRE completed an environmental impact statement (EIS) in 2003 for several planned lease sales (Sales 186, 195 and 202) in the Beaufort Sea planning area (listed above). Shell
acquired the leases containing the Sivulliq and Torpedo prospects in lease sales 195 (2005) and 202 (2007), respectively. Shell's current proposed revised Camden Bay EP was scoped within the exploration alternatives analyzed in BOEMRE’s 2003 Beaufort Sea EIS (MMS 2003) and incorporates information in the other BOEMRE environmental studies listed above.

The results of Shell’s work in developing this EIA indicate the same findings as those reported by BOEMRE in their independent studies. In summary, the exploration drilling activities proposed at the Torpedo and Sivulliq prospects in Camden Bay:

- Have minimal or negligible direct or indirect environmental impacts, and impacts which do occur are expected to be ameliorated soon after drilling ceases and would be expected to be unmeasurable the following year (or sooner)
- Have negligible or minor and short-term effects on biological resources, as most effects on marine mammals, marine birds, and marine fish will be restricted to disturbance with associated momentary changes in behavioral activities, and to temporary displacement
- Do not threaten the continued existence of any endangered or threatened species
- Will not cause significant or unreasonable interference with any subsistence species, particularly bowhead whales, or Alaska Native subsistence activities, particularly for this project where Shell has voluntarily adopted a mid-season suspension during the Kaktovik and Cross Island whale hunt
- Will have negligible or non-existent impacts on water quality, particularly for this project where Shell has adopted self-imposed restrictions on discharges, agreeing to collect and transport the major NPDES-permitted discharges (e.g., drill cuttings with adhered mud, drilling mud) to an approved and licensed facility for disposal
- Does not pose a statistically realistic risk of a large, catastrophic oil spill (blowout)

In this EIA, Shell considered the cumulative impacts from other reasonably foreseeable future activities and found these impacts to be minor. Specifically, Shell is aware of limited barge traffic transiting through the area, ongoing scientific studies, and Shell’s own plans for exploration drilling in the northeastern Chukchi Sea (approximately 410 mi [660 km] west of the Camden Bay project area during the same time frame; however, Shell is not aware of any exploration seismic or site clearance survey activities planned by other operators in the vicinity of its Camden Bay exploration drilling operations.

This EIA, together with past studies, will assist BOEMRE in complying with NEPA and all other relevant federal and state laws when considering this specific project for approval.
1.0 INTRODUCTION

As required by Title 30 of the Code of Federal Regulations (CFR), Shell Offshore, Inc. (Shell) submits the following comprehensive Environmental Impact Analysis (EIA) in support of its revised Camden Bay Exploration Plan (EP) which was submitted to the United States (U.S.) Department of Ocean Energy Management, Regulation and Enforcement (BOEMRE) on this date for BOEMRE review and approval. The exploration drilling activities detailed in Shell’s Camden Bay EP that are analyzed herein are planned to begin in 2012.

Shell wants to revise its initial approved OCS Camden Bay EP. The initial Camden Bay EP was submitted to the Minerals Management Service (MMS) (now BOEMRE) in May 2009 and was conditionally approved on October 16, 2009 and found consistent with State of Alaska standard under the Alaska Coastal Management Program (ACMP) on January 22, 2010. The approved EP addressed a one-year plan using the Discoverer with two planned drill sites: one at the Sivulliq prospect (Sivulliq N – Flaxman Island Lease Block 6558) and one at the Torpedo prospect (Torpedo H – Flaxman Island Lease Block 6610). The initial Camden Bay EP was originally scheduled for the 2010 drilling season, but was subsequently postponed when BOEMRE suspended exploration drilling in the Arctic until further notice. Following the BOEMRE suspension, on October 5 Shell submitted to BOEMRE an update to the initial EP along with information in response to Notice to Lessee (NTL) No. 2010-N06, and an Application for Permit to Drill (APD) for the Sivulliq N drill site in 2011.

Shell is planning to drill four wells on three OCS lease blocks in the Camden Bay area of the Beaufort Sea with a planned start in 2012. Two of the four wells in this exploration plan (Sivulliq N and Torpedo H) are included in the BOEMRE-approved (initial) 2010 Camden Bay Exploration Plan. The primary distinctions between the initial 2010 EP and the current revised EP are the addition of two drill sites, one each in the same prospects; the decision to collect and not discharge to the sea selected waste streams that would have been discharged in 2010; and latitude to use either the Kulluk or Discoverer. A comparison of the initial EP and the currently proposed EP are presented in Table 1.0-1.

The EIA is organized as follows:

- Section 1.0 – Introduction, provides an overview of the planned exploration drilling program and describes the applicable regulatory framework.
- Section 2.0 – Planned Exploration Drilling Activities, describes the planned drilling program.
- Section 3.0 – Resources and Conditions, describes the potentially affected environment.
- Section 4.0 – Environmental Impacts, provides results of analyses of the direct, indirect, and cumulative impacts that the planned exploration drilling activities may have on the environment and includes a list of mitigation measures.
- Section 5.0 – Consultation, provides a summary of the consultation efforts that Shell has undertaken and those that Shell plans to conduct with regard to the proposed drilling program.
- Section 6.0 – References, provides a list of information sources cited in this document.
Table 1.0-1  Comparison of Shell’s Approved Camden Bay EP and the Revised EP

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<td>Flaxman Island 6559, 6610, and 6658</td>
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<td>Discoverer or Kulluk</td>
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<td>• Additional OSV for offshore supply</td>
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<td>Oil Spill Response</td>
<td>Oil Spill Response (OSR) Tug and Barge; OSR Vessel, Oil Storage (OS) Tanker</td>
<td>OSR Tug and Barge; Arctic Tanker, OSR barge carrying containment equipment</td>
</tr>
<tr>
<td>Air permit</td>
<td>*Discoverer – Prevention of Significant Deterioration (PSD) permit authorization R10OCS/PSD-AK-2010-01</td>
<td>*Discoverer – PSD permit authorization R10OCS/PSD-AK-2010-01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Kulluk – Minor Source Permit application for Beaufort Sea submitted February 28, 2011</td>
</tr>
</tbody>
</table>

The Camden Bay EP and this EIA address the exploration drilling activities planned for Camden Bay in the Beaufort Sea, beginning in July 2012. The lease blocks are 6658 (Sivulliq N and G drill sites); 6610 (Torpedo H drill site); and 6559 (Torpedo J drill site) in the Flaxman Island BOEMRE protraction area. The lease blocks were acquired by Shell in 2005 under Outer Continental Shelf (OCS) Lease Sale 195 and in 2007 under OCS Lease Sale 202. Each lease block is approximately 9 square miles (mi²) (23 square kilometers [km²]).

The drill site coordinates and distances from the mainland are presented in Table 1.0-2. Locations of the lease blocks are depicted in Figure 1.0-1.

The number of wells Shell might drill and evaluate in a single season will be determined by ice and sea conditions, as well as operational issues (e.g., the time required to drill each well). The order of drilling does not affect impacts.

The two communities in closest proximity to the planned offshore exploration drilling operations are Kaktovik (aka: Barter Island) to the east and Nuiqsut to the west. Deadhorse is the logistics and support base for North Slope oil and gas operations. The existing shore-based facilities at West Dock and Deadhorse will be utilized in support the offshore exploration drilling activities.
Figure 1.0-1  Camden Bay Exploration Plan Location Map
Table 1.0-2  Shell Lease Blocks and Planned Drill Site Locations in Camden Bay

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>Surface Location (NAD 83*)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drill site</td>
<td>Lease File #</td>
<td>NR06-04 Flaxman Island Lease Block No.</td>
<td>Latitude (N)</td>
<td>Longitude (W)</td>
<td>Distance to Mainland Shore mi (km)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sivulliq G</td>
<td>OCS-Y 1805</td>
<td>6658</td>
<td>70° 23' 46.82&quot;</td>
<td>146° 01' 03.46&quot;</td>
<td>16.6 (26.7)</td>
<td></td>
</tr>
<tr>
<td>Sivulliq N</td>
<td>OCS-Y 1805</td>
<td>6658</td>
<td>70° 23' 29.58&quot;</td>
<td>145° 58' 52.53&quot;</td>
<td>16.2 (26.1)</td>
<td></td>
</tr>
<tr>
<td>Torpedo H</td>
<td>OCS-Y 1941</td>
<td>6610</td>
<td>70° 27' 01.62&quot;</td>
<td>145° 49' 32.07&quot;</td>
<td>20.8 (33.5)</td>
<td></td>
</tr>
<tr>
<td>Torpedo J</td>
<td>OCS-Y 1936</td>
<td>6559</td>
<td>70° 28' 56.94&quot;</td>
<td>145° 53' 47.15&quot;</td>
<td>23.1 (37.2)</td>
<td></td>
</tr>
</tbody>
</table>

*North American Datum 1983
N = North
W = West
mi = statute mile(s)
km = kilometer(s)

The closest drill site to Kaktovik is Torpedo H, at approximately 55 mi (89 km). The closest drill site to Nuiqsut is Sivulliq G, at approximately 117 mi (188 km).

Shell has developed and implemented a comprehensive, ongoing stakeholder engagement program to share information about its planned OCS exploration drilling activities with stakeholders and encourage their comments on the Camden Bay EP. Stakeholders include the North Slope Borough (NSB), local residents, subsistence groups, local organizations, federal and state agencies, and non-governmental organizations. Outreach and discussion with the Alaska Eskimo Whaling Commission (AEWC) along with other marine mammal co-management groups are part of Shell’s stakeholder engagement plan.

An integral part of the stakeholder engagement plan is a POC to ensure that all exploration drilling operations are conducted in a manner that prevents unreasonable conflicts between oil and gas industry activities and the subsistence activities and resources of the Inupiat residents of the North Slope. The POC supports both Shell’s Incidental Harassment Authorization (IHA) which is required by National Marine Fisheries Service (NMFS), and Letter of Authorization (LOA) which is required by the U.S. Fish and Wildlife Service (USFWS) and BOEMRE Stipulation No. 5 for leases acquired under OCS lease sales 186, 195 and 202.

1.1 Current Shell Leaseholdings and Historical Camden Bay Area Lease Sales

In September 2001, the former MMS announced a multiple sale process for oil and gas leases in Alaska’s Beaufort OCS. Three Beaufort oil and gas lease sales were proposed under the 2002 through 2007 five-year program. The Beaufort Sea multi-sale process incorporated planning and analysis for Sales 186, 195 and 202.

Shell has active leases from each of those sales. Shell currently holds 170 active leases in the Beaufort OCS. Seven leases were acquired in Sale 186 held in 2003; 82 in Sale 195 held in 2005; and 81 leases were acquired in Sale 202 held in 2007. The current Camden Bay exploration plan involves leases from Sales 195 and 202.

Lease block 6658 was acquired in Sale 195 (proposed locations of Sivulliq drill sites N and G). Lease blocks 6010 and 6559 were acquired in Sale 202 (proposed locations of Torpedo drill sites H and J, respectively).
1.2 Historic Exploration Drilling in the Beaufort Sea

The purpose of the exploration drilling activities described in Shell’s Camden Bay EP is to evaluate the oil and gas potential of its prospects in the Camden Bay area of the Beaufort Sea. There is a long history of safe, environmentally-sound exploration drilling activity in the Beaufort Sea, and specifically in Camden Bay. Over a period extending from 1981 to 2002, 30 wells were drilled in the Beaufort Sea. Seven of those wells were drilled in the Camden Bay area (Figure 1.2-1) with another five wells drilled nearby. Two of those historic well locations were on the Sivulliq prospect.

In 1985 and 1986, Union Oil Company drilled one exploration well and one appraisal well at the Hammerhead Prospect, (now designated the Sivulliq Prospect). At the time, Shell was a 33-1/3 percent working interest owner in the leases encompassing the Hammerhead wells. The leases were later relinquished in 1998. Shell regained leases for the Hammerhead prospect and several others in OCS Lease Sale 195 in 2005. BOEMRE determined that one of the legacy Hammerhead wells was producible under its regulations.

In 2008, environmental baseline studies were conducted at and around Shell’s planned drill sites. Water and sediment samples were collected and analyzed to determine the chemical and biological characteristics of the benthic environment. This benthic study helped determine background levels of naturally occurring chemicals, presence of contaminants, and abundance of lower trophic organisms at prospective drill sites. Results of the 2008 benthic study provided additional information to assess possible impacts from previous exploration drilling at the Hammerhead Prospect.

Table 1.2-1 is a summary of information excerpted from the Environmental Impact Statement (EIS) for the Alaska OCS Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202. The table presents information on the exploration wells that have been drilled to date in the Beaufort Sea (MMS 2003-1), including the OCS lease, operator, prospect, location, drilling start (spud) and end dates, water depth, and drilling unit.
Figure 1.2-1  Historic Offshore Well Locations

![Map of historic offshore well locations in Camden Bay, Alaska. The map shows various well locations and labels such as 'Seal 1 (1984)' and 'McConville 1 (2002).']
<table>
<thead>
<tr>
<th>Lease OCS-Y</th>
<th>Well No.</th>
<th>API Number</th>
<th>Operator</th>
<th>Project</th>
<th>Spud</th>
<th>End</th>
<th>Water Depth</th>
<th>Drilling Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0180 1</td>
<td>50-029-21236</td>
<td>Shell Oil Company</td>
<td>Seal</td>
<td>BF 70 29' 31.77&quot; N 148 41' 34.68&quot; W</td>
<td>2/22/85</td>
<td>7/18/85</td>
<td>39 ft</td>
<td>P.N.J.V. Rig #1 Seal Gravel Island</td>
</tr>
<tr>
<td>0181 1</td>
<td>50-029-21074</td>
<td>Shell Western E&amp;P Inc.</td>
<td>Seal</td>
<td>BF 70 29' 31.44&quot; N 148 41' 35.80&quot; W</td>
<td>2/4/84</td>
<td>6/3/84</td>
<td>39 ft</td>
<td>P.N.J.V. Rig #1 Seal Gravel Island</td>
</tr>
<tr>
<td>0191 1</td>
<td>55-201-00001</td>
<td>Exxon Corporation</td>
<td>Beachy Point</td>
<td>BF 70 23' 11.70&quot; N 147 53' 27.98&quot; W</td>
<td>1/11/81</td>
<td>3/1/82</td>
<td>18 ft</td>
<td>Nabors 27-E, BF-37 Gravel Island</td>
</tr>
<tr>
<td>0191 2</td>
<td>55-201-00002</td>
<td>Exxon Corporation</td>
<td>Beachy Point</td>
<td>BF 70 23' 11.79&quot; N</td>
<td>12/2/81</td>
<td>3/15/82</td>
<td>18 ft</td>
<td>Nabors 27-E, BF-37 Gravel Island</td>
</tr>
<tr>
<td>0195 1</td>
<td>55-201-00003</td>
<td>Shell Oil Company</td>
<td>Tem</td>
<td>BF 70 16' 46.02&quot; N 147 29' 45.61&quot; W</td>
<td>5/28/82</td>
<td>8/18/82</td>
<td>21 ft</td>
<td>Brinkhoff #4, Tem Gravel Island</td>
</tr>
<tr>
<td>0196 1</td>
<td>55-201-00004</td>
<td>Shell Oil Company</td>
<td>Tem</td>
<td>BF 70 16' 46.33&quot; N 147 29' 44.90&quot; W</td>
<td>10/16/82</td>
<td>3/3/83</td>
<td>21 ft</td>
<td>Brinkhoff #4, Tem Gravel Island</td>
</tr>
<tr>
<td>0197 1</td>
<td>55-201-00004-01</td>
<td>Shell Western E&amp;P Inc.</td>
<td>Tem</td>
<td>BF 70 16' 46.33&quot; N 147 29' 44.89&quot; W</td>
<td>2/10/87</td>
<td>5/10/87</td>
<td>22 ft</td>
<td>Pool Arctic #5, Tem Gravel Island</td>
</tr>
<tr>
<td>0267 1</td>
<td>55-232-00003</td>
<td>Arco Alaska, Inc.</td>
<td>Fireweed</td>
<td>71 71' 05&quot; 10.72&quot; N</td>
<td>10/19/80</td>
<td>12/20/80</td>
<td>50 ft</td>
<td>SSDC/MAT</td>
</tr>
<tr>
<td>0280 1</td>
<td>55-232-00001</td>
<td>Exxon Corporation</td>
<td>Antares</td>
<td>71 71' 02&quot; 10.06&quot; N</td>
<td>152 43' 25.28&quot; W</td>
<td>1/18/85</td>
<td>49 ft</td>
<td>Beaufort Sea #1, CIDS</td>
</tr>
<tr>
<td>0280 2</td>
<td>55-232-00002</td>
<td>Exxon Company USA</td>
<td>Antares</td>
<td>71 71' 02&quot; 10.06&quot; N</td>
<td>152 43' 25.46&quot; W</td>
<td>1/19/85</td>
<td>49 ft</td>
<td>Beaufort Sea #1, CIDS</td>
</tr>
<tr>
<td>0302 1</td>
<td>55-231-00004</td>
<td>Amoco</td>
<td>Mars</td>
<td>70 50' 34.83&quot; N</td>
<td>152 04' 17.98&quot; W</td>
<td>3/12/86</td>
<td>25 ft</td>
<td>Spray Ice Island</td>
</tr>
<tr>
<td>0334 1</td>
<td>55-231-00001</td>
<td>SOHIO Alaska Petroleum</td>
<td>Mukruk</td>
<td>70 41' 00.04&quot; N</td>
<td>150 55' 11.89&quot; W</td>
<td>1/12/84</td>
<td>48 ft</td>
<td>United Rig #2, Mukruk Gravel Island</td>
</tr>
<tr>
<td>0338 1</td>
<td>55-231-00005</td>
<td>Tenneco</td>
<td>Phoenix</td>
<td>70 43' 01.99&quot; N</td>
<td>150 25' 40.15&quot; W</td>
<td>9/23/86</td>
<td>60 ft</td>
<td>SSDC/MAT</td>
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<tr>
<td>0370 1</td>
<td>55-201-00007</td>
<td>Shell Oil Company</td>
<td>Harvard</td>
<td>71 70' 35&quot; 05.4&quot; N</td>
<td>149 05' 48.8&quot; W</td>
<td>9/28/85</td>
<td>50 ft</td>
<td>PAA Rig #5, Sandpiper Gravel Island</td>
</tr>
<tr>
<td>0371 1</td>
<td>55-201-00008</td>
<td>Amoco</td>
<td>Sandpiper (Harvard)</td>
<td>71 70' 35&quot; 05.4&quot; N</td>
<td>149 05' 48.4&quot; W</td>
<td>9/28/85</td>
<td>49 ft</td>
<td>PAA Rig #5, Sandpiper Gravel Island</td>
</tr>
<tr>
<td>0742 1</td>
<td>55-231-00001</td>
<td>Arco Alaska, Inc.</td>
<td>Cabot</td>
<td>78 71' 19&quot; 25.44&quot; N</td>
<td>155 12' 56.48&quot; W</td>
<td>1/11/91</td>
<td>55 ft</td>
<td>SSDC</td>
</tr>
<tr>
<td>0804 1</td>
<td>55-231-00003</td>
<td>Exxon Company USA</td>
<td>Orion</td>
<td>87 70' 57&quot; 22.3&quot; N</td>
<td>152 03' 46.6&quot; W</td>
<td>11/10/85</td>
<td>50 ft</td>
<td>GLOMAR BEAUFORT SEA #1 CIDS</td>
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<tr>
<td>0849 1</td>
<td>55-171-00006</td>
<td>Union Oil Company</td>
<td>Hammerhead</td>
<td>87 70' 21&quot; 52.6&quot; N</td>
<td>146 12&quot; 7.9&quot; W</td>
<td>6/10/85</td>
<td>103 ft</td>
<td>Canmar Explorer II</td>
</tr>
<tr>
<td>0849 2</td>
<td>55-171-00006</td>
<td>Union Oil Company</td>
<td>Hammerhead</td>
<td>87 70' 21&quot; 47.77&quot; N</td>
<td>146 01' 52.41&quot; W</td>
<td>9/27/86</td>
<td>107 ft</td>
<td>Explorer II Drillship</td>
</tr>
<tr>
<td>0865 1</td>
<td>55-171-00009</td>
<td>Arco Alaska, Inc.</td>
<td>Kuvium</td>
<td>87 70' 18&quot; 36.0&quot; N</td>
<td>145 32' 18.2&quot; W</td>
<td>7/28/93</td>
<td>96 ft</td>
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</tr>
<tr>
<td>0866 1</td>
<td>55-171-00008</td>
<td>Arco Alaska, Inc.</td>
<td>Kuvium</td>
<td>87 70' 18&quot; 36.78&quot; N</td>
<td>145 25' 10.9&quot; W</td>
<td>9/22/92</td>
<td>110 ft</td>
<td>Beaudri Kulluk</td>
</tr>
<tr>
<td>0871 1</td>
<td>55-171-00002</td>
<td>Shell Western E&amp;P Inc.</td>
<td>Corona</td>
<td>87 70' 18&quot; 52.6&quot; N</td>
<td>144 43' 32.9&quot; W</td>
<td>7/28/86</td>
<td>116 ft</td>
<td>Canmar Explorer II</td>
</tr>
<tr>
<td>0917 1</td>
<td>55-141-00005</td>
<td>Amoco Production Company</td>
<td>Betcher</td>
<td>87 70' 16&quot; 31.16&quot; N</td>
<td>141 30' 46.4&quot; W</td>
<td>9/5/88</td>
<td>167 ft</td>
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</tr>
<tr>
<td>0943 1</td>
<td>55-141-00004</td>
<td>Tenneco</td>
<td>Aurora</td>
<td>87 70' 06&quot; 33.0&quot; N</td>
<td>142 47' 05.88&quot; W</td>
<td>11/2/87</td>
<td>66 ft</td>
<td>SSDC/MAT</td>
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<tr>
<td>1002 1</td>
<td>55-171-00007</td>
<td>Amoco Production</td>
<td>Galahad</td>
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<td>144 57' 35.75&quot; W</td>
<td>9/14/91</td>
<td>166 ft</td>
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<tr>
<td>1578 1</td>
<td>55-201-00010</td>
<td>Encana Oil &amp; Gas (USA) Inc.</td>
<td>McCovey</td>
<td>124 70' 31&quot; 37.9&quot; N</td>
<td>148 10' 45.2&quot; W</td>
<td>12/6/2002</td>
<td>35 ft</td>
<td>SSDC/MAT</td>
</tr>
<tr>
<td>1597 1</td>
<td>55-171-00011</td>
<td>Arco Alaska, Inc.</td>
<td>Wild Weasel</td>
<td>124 70' 13&quot; 22.41&quot; N</td>
<td>145 29' 57.11&quot; W</td>
<td>10/1/93</td>
<td>87 ft</td>
<td>Canmar Kulluk</td>
</tr>
<tr>
<td>1650 1</td>
<td>55-201-00009</td>
<td>British Petroleum Exploration (Alaska)</td>
<td>Liberty</td>
<td>144 70' 16&quot; 45.113&quot; N</td>
<td>147 29' 47.145&quot; W</td>
<td>2/7/97</td>
<td>21 ft</td>
<td>PAA #4 Tem Gravel/ice Island</td>
</tr>
<tr>
<td>1663 1</td>
<td>55-171-00012</td>
<td>Arco Alaska, Inc.</td>
<td>Wantough</td>
<td>144 70' 02&quot; 34.3&quot; (NAD 83)</td>
<td>144 55' 02&quot; W (NAD 83)</td>
<td>11/1/97</td>
<td>35 ft</td>
<td>Glimar Beaufort Sea #1</td>
</tr>
</tbody>
</table>

Source: OCS Beaufort Sea Planning Area Oil and Gas Lease Sales 199, 195, and 202 BS (2003)
CIDS = Concrete Island Drilling Structure
1.3 Historic Shallow Hazards Surveys

Evaluations of historic shallow hazards surveys have been conducted by Geo LLC for areas covering the proposed Sivulliq and Torpedo drill sites. The analyses of the surveys are described in greater detail in Section 3 of the EP. For the studies, 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 easily mitigated by design, implementation, or procedures. In general, all sites were deemed as being favorable for exploration drilling.

The results of the shallow hazards and site clearance surveys that encompass the currently proposed drill sites were submitted to BOEMRE under separate cover and include the following reports.

The assessment of historic evaluations covering Sivulliq G and N drill sites are:

- Geo LLC 2008a. Exploration Wellsites Geohazards Assessments, Sivulliq Prospect, Beaufort Sea, Alaska. Report 12731-005-00 (drafted by Geo LLC dated March 23, 2007; submitted to BOEMRE March 30, 2007). Assessment was performed in 2007 based on synthesis of publicly available geotechnical and high-resolution geophysical data, and reprocessed 2-dimensional (2D) seismic data.


The assessment of historic evaluation covering the Torpedo H and J drill sites is:


1.4 Shell’s Shallow Hazards Surveys

BOEMRE regulations (30 CFR 250.213) require shallow hazards and site clearance surveys be conducted prior to drilling or installing mobile drilling units for oil and gas activities.

Evaluation of Shell’s shallow hazards surveys have been conducted by Fugro over the proposed drill sites. The analyses of the surveys are described in greater detail in Section 3 of the EP. Fugro has also reinterpreted the historic shallow hazards survey data covering these drill sites and they have concluded that the seafloor and shallow geologic conditions are favorable for exploratory drilling at all of the proposed drill sites.

The results of the shallow hazards and site clearance surveys that encompass the currently proposed drill sites were submitted to BOEMRE under separate cover and include the following reports.

- Fugro Geoconsulting, Inc. 2009a Shallow Hazards Assessment, Sivulliq G, V, W and Supplemental N Wellsites, Blocks 6658, 6659, 6708 and 6709, Flaxman Island Area, Beaufort Sea, Alaska. Report No. 27.2008-2266 (drafted by Fugro Geoconsulting, Inc. dated February 12, 2009; Submitted to BOEMRE February 24, 2009). This supplemental survey, which includes the Sivulliq
N drill site, was conducted during the 2008 open water season as was requested by BOEMRE to confirm the evaluation presented by Geo LLC 2008a. Bathymetric data and other information were collected using a remotely operated vehicle (ROV). This data was collected in accordance with NTL-A005.

Reinterpretation of shallow hazards surveys by Geo LLC (2008a and 2008b), in conjunction with additional supplemental data interpreted by Fugro (2009a), confirmed the possibility of shallow gas near to but not present at the Sivulliq G and N drill sites. Fugro concluded that there is a low potential for encountering shallow gas at either drill site.

No shallow hazards, man-made obstructions (historic or prehistoric) were identified by Fugro at the planned Sivulliq drill sites. Fugro concluded that both drill sites were favorable for exploration drilling.


The Fugro report confirmed the findings of the GeoLLC report, except that Fugro found no evidence of permafrost at the Torpedo H drill site. No shallow hazards, man-made obstructions (historic or prehistoric) were identified, specifically at the Torpedo H drill site. The report concludes that the seafloor and shallow geologic conditions are favorable for exploration drilling operations at the Torpedo H drill site.


Fugro’s analysis found no evidence of shallow hazards, man-made obstructions (historic or prehistoric) at the Torpedo J drill site. They conclude that the seafloor and shallow geologic conditions are favorable for exploration drilling operations at the Torpedo J drill site.

### 1.5 Regulatory Framework

Shell’s planned exploration drilling program will be conducted in compliance with an established regulatory framework that includes federal and state regulations as they relate to OCS leases and oil and gas exploration activities. Key environmental statutory and regulatory programs governing the exploration drilling program are described in this section.

#### 1.5.1 Outer Continental Shelf Lands Act

The Outer Continental Shelf Lands Act (OCSLA) established federal jurisdiction over the OCS and granted authority to the Secretary of the Interior to manage OCS resources. The Secretary has delegated the authority to promulgate regulations, conduct leasing, and issue permits in the OCS to the BOEMRE. Section 18 of OCSLA also directs the BOEMRE to periodically revise its oil and gas leasing programs, which the BOEMRE does on a five-year basis. These five-year leasing plans are national in scope and
provide a schedule for all lease sales within the five-year period. These programs are developed through a comprehensive National Environmental Policy Act (NEPA) process that includes resource analyses, public input, and environmental analyses. Chukchi Sale 193 was conducted under the BOEMRE’s OCS Oil & Gas Five Year Leasing Program: 2007-2012 (MMS 2007c).

The BOEMRE has issued regulations pertaining to oil and gas exploration in 30 CFR 250. Exploration drilling activities must follow these regulations as well as lease stipulations and any conditions applied to the required EP. Shell’s compliance with the Lease Sale 193 lease stipulations is discussed in Section 4.3 of this document. BOEMRE also issues NTLs for specific OCS regions and activities, and requires several interagency and government-to-government consultations to demonstrate compliance with applicable federal laws. Shell must also submit and obtain approval of an APD for each drill site, after approval of the EP and before conducting the drilling program. APDs contain detailed information about the drilling program that allows BOEMRE to evaluate the operational safety and pollution prevention measures.

In accordance with the OCSLA, in February 2003, BOEMRE issued the Final Environmental Impact Statement (FEIS) for the Alaska OCS Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202. In addition, BOEMRE has issued Environmental Assessments (EAs) in support of each of these lease sales.

### 1.5.2 National Environmental Policy Act

The NEPA mandates federal agencies conduct an environmental review of their actions or projects that require federal funding, federal authorizations or permits, or the involvement of federal lands. NEPA is a coordinated review process that includes resource impact analyses. NEPA reviews are conducted at various levels of detail and scope depending on the nature of the proposed action. Routine activities with well known environmental effects may qualify for a Categorical Exclusion from further NEPA analysis, while other activities trigger an EA or the most rigorous level of review, an EIS.

BOEMRE prepares EISs for their five-year leasing plans, including the 2007 to 2012 plan (MMS 2007c), which contained Lease Sale 193. These NEPA reviews are conducted by BOEMRE headquarters. BOEMRE’s Alaska OCS Region subsequently prepared a more detailed EIS (MMS 2007b) specifically for Lease Sale 193, including analyses of anticipated levels of exploration drilling by multiple operators before holding the sale. Under their NEPA-implementing rules, BOEMRE will prepare a NEPA document specifically evaluating the effects of Shell’s planned exploration drilling program as presented in the revised Camden Bay EP. The environmental analysis presented in this EIA tiers off of, and incorporates by reference, many of the analyses presented in these two EISs.

### 1.5.3 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) established a federal responsibility to protect marine mammals. Under the MMPA, NMFS is responsible for the management and protection of the bowhead whale, gray whale, fin whale, humpback whale, minke whale, beluga whale, harbor porpoise, bearded seal, ringed seal, and spotted seal. The USFWS has jurisdiction over polar bear and Pacific walrus. The MMPA prohibits industry from taking of marine mammals in U.S. waters without NMFS authorization and defines the term “take” as harassing, hunting, capturing, killing, or collecting, or attempting to harass, capture, kill, or collect marine mammals. Harassment is statutorily defined as “any act of pursuit, torment, or annoyance.” This is further categorized and defined as Level A Harassment – which has the potential to injure a marine mammal; and Level B Harassment – which has the potential to disturb a marine mammal stock by causing disruption of behavioral patterns.
Sound, vessels, and aircraft traffic associated with the planned exploration drilling program possibly could result in incidental disturbance of marine mammals. An IHA is required for potential disturbances to NMFS jurisdiction marine mammals that represent “takes” under the MMPA, while a LOA from the USFWS authorizes similar non-lethal takes of polar bears and Pacific walrus. Shell is applying for, and must receive, both an IHA and an LOA for the planned exploration drilling activities. Copies of the applications being submitted for the drilling program are attached in Appendix C, D, and E of Shell’s revised Camden Bay EP.

1.5.4 Endangered Species Act

The Endangered Species Act (ESA) of 1973 provides a process by which animal or plant populations that are in jeopardy can be listed as threatened or endangered in order to protect the species or its critical habitat. An endangered species is an animal or plant species in danger of extinction throughout all or a significant portion of its range. A threatened species is an animal or plant species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Critical habitat must be designated for a species concurrently with listing it as a threatened or endangered species. Although some like the bowhead whale have been listed as endangered for years, but have no critical habitat designated.

Under the ESA, the taking of a listed species is prohibited without an LOA. To take is defined as: to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. This may include significant habitat modification or degradation if it kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Shell would be required to obtain an LOA for any potential incidental takes of threatened and endangered species during the planned exploration drilling program.

Section 7 of the ESA mandates consultation by federal agencies to ensure that their activities are not likely to jeopardize the continued existence of listed species or adversely modify designated critical habitats. Section 7 consultation is triggered by the application for a federal approval. Under this section of the ESA, the BOEMRE must consult with USFWS and NMFS before issuing approval of Shell’s EP. BOEMRE previously consulted with the NMFS and USFWS regarding potential effects on threatened and endangered species from the exploration drilling that could occur as a result of leasing activities in the Beaufort Sea. NMFS (2008) published a Biological Opinion (BO) in 2008 concluding that the exploration drilling activities resulting from the lease sale would not likely jeopardize the continued existence of the fin whale, humpback whale, and bowhead whale. USFWS (2009) similarly provided a BO for planned lease sales in the Chukchi and Beaufort Seas, finding that the resulting exploration drilling activities would not likely jeopardize the continued existence of the Steller’s or spectacled eiders. The USFWS (2008c) also issued a BO on incidental take regulations, and concluded that the levels of oil and gas exploration expected to be conducted in the Beaufort Sea in 2007-2012 would not likely jeopardize the continued existence of polar bears. The bearded seal and ringed seal are proposed for listing as endangered. Also, the Pacific walrus and yellow-billed loon are considered a candidate species for listing under the ESA by USFWS.

1.5.5 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA), 16 USC 1451 et seq. (Section 307), mandates that a state with an approved CZMA plan reviews certain OCS activities to ensure they are conducted in a manner consistent with the state’s approved plan. The review authority applies to exploration drilling activities of an area leased under the OCSLA that affect resources within a state’s coastal zone. BOEMRE may issue an approval for activities in an exploration plan only when the State has concurred that the activities are consistent with its CZMA plan.
The 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 (CPQ) and Certification Statement are necessary for agency coordination and review. Shell’s CZMA submission is included as Section 15 of the EP.

1.5.6 Clean Air Act

The federal Clean Air Act (CAA), as revised in 1990, governs air pollutant emissions and requires the EPA and the states to carry out programs to assure attainment of the National Ambient Air Quality Standards (NAAQS). The CAA established two types of national air quality standards. Primary standards set limits to protect human public health, including the health of “sensitive” populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings (EPA 2009a). The Primary and Secondary NAAQS are identical for four of the six criteria pollutants (nitrogen dioxide, small-diameter particulate matter, ozone, and lead). The sulfur dioxide Secondary NAAQS is less strict than the primary standard, and there is no Secondary NAAQS for carbon monoxide.

The CAA regulations require certain facilities that emit criteria pollutants or hazardous substances to obtain a permit establishing limits on the types and amounts of emissions, governing operating parameters for pollution control and monitoring devices, and monitoring and record-keeping requirements. In this case, EPA Region 10 will issue the air permit for the Kulluk and Discoverer.

Shell has received OCS PSD Permit to Construct No. R10CS/PSD-AK-0901 for the Discoverer, which would cover the planned exploration in Camden Bay if Shell selects the Discoverer for drilling. The PSD Permit is available online at: http://yosemite.epa.gov/R10/airpage.nsf/Permits/beaufortap/$FILE/Shel%20Beaufort%20Permit%20Final%20WebV%2004-09-10.pdf.

Shell has applied for a Minor Source permit for the Kulluk in the Beaufort Sea to operate in the Beaufort Sea on indefinite number of future drilling seasons. Shell's OCS Permit Application for a Minor Source permit for the Kulluk is available online at: http://www.epa.gov/region10/pdf/permits/shell/kulluk/revised-air-permit-app-0311.pdf.

This permit will regulate air emissions from the Kulluk and from the support vessels when within 25 mi (40 km) of the anchored Kulluk. The implementation of best available control technology (BACT) and compliance with other provisions of the permit will ensure that air emissions are minimized. Results of modeling the air emissions and dispersion show that there will be no adverse effect on public health. All health-based NAAQS will be met.

1.5.7 Clean Water Act

The Clean Water Act (CWA) has several sections or programs applicable to exploration drilling activities in offshore waters. Section 402 of the CWA established the NPDES as carried out by the EPA. The CWA and accompanying regulations made it unlawful to discharge any pollutant from a point source into navigable waters, including the OCS, without an NPDES permit.

In addition, as regulated under applicable sections of the CWA and the U.S. Coast Guard (USCG) regulations (33 CFR Part 151), the EPA reissued the NPDES Arctic GP AKG-28-0000 (GP AKG-28-0000) for Offshore Oil and Gas Operations on the OCS and Contiguous State Waters. This permit authorizes certain discharges from oil and gas exploration facilities located in or adjacent to the Beaufort Sea (and other locations offshore of Alaska) according to effluent limitations, monitoring requirements, and other conditions set forth within the general permit. Permitted discharges related to exploration
drilling and logistics include drilling fluids and cuttings, deck drainage, sanitary waste, BOP fluid, uncontaminated ballast water, and bilge water (EPA 2006), among other discharges.

Shell has committed to not discharging selected waste streams in the Beaufort Sea during routine drilling operations, even though the waste streams are allowable discharges under the current EPA Arctic NPDES GP AKG-28-0000. Shell will not discharge drilling mud, cuttings with adhered mud, treated sanitary waste, domestic waste, bilge water, or ballast water. These wastes will be collected and stored on a cargo barge and transported and disposed of at an approved and licensed facility.

Shell’s EIA for the EP supplements the review already completed during the EIS for the Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 and NPDES renewal processes. Shell has submitted a Notice of Intent (NOI) to discharge under the Arctic NPDES GP. Separate NOIs were filed for each lease block and authorization will be received prior to drilling with either the Kulluk or Discoverer.

**1.5.8 Oil Pollution Act of 1990**

The Oil Pollution Act of 1990 (OPA) establishes a program governing removal of spilled oil and requiring planning for and responding to oil spills. In compliance with OPA-90, Shell has prepared the Beaufort Sea Regional Exploration Oil Discharge Prevention Contingency Plan (ODPCP) as a fundamental component of the proposed exploration drilling program (submitted to the BOEMRE as a separate document). A revised (January 2010) ODPCP was approved by the BOEMRE on 11 March 2010.

Shell's Beaufort Sea ODPCP is a regional oil spill response plan that demonstrates Shell’s capabilities to entirely 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 event occurring during exploration, Shell has designed its response program based upon 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) from an exploration well blowout. Shell has revised the regional ODPCP approved by BOEMRE in March 2010, with a submittal to BOEMRE in May 2011 that addresses a new calculated WCD for the wells included in this revised Camden Bay EP. Shell’s program is based on a WCD flowrate planning scenario that exceeds the calculated WCD and response planning requirements of the State of Alaska and the federal oil spill planning regulations.

The ODPCP includes information regarding Shell’s regional oil spill organization and dedicated response assets, potential spill risks, and local environmental sensitivities. The plan also details Shell’s spill prevention programs, including personnel training and the procedures and management practices to prevent discharges. The ODPCP response information addresses personnel and equipment mobilization from various locations, equipment operating characteristics, and the availability of additional response resources both on- and off site.

**1.5.9 National Historic Preservation Act and Other Cultural Resource Regulations**

Cultural resources are physical resources associated with people, a society, or multiple societies. They are both built and natural parts of the physical environment and have some cultural value to one or more socio cultural groups (King 1998). They include historic sites, archaeological sites, cultural landscapes, historic documents, spiritual places, Native cultural items, historic and archaeological artifacts, and community values. They may be remnants of a past society, such as a prehistoric village, or resources of a current society, such as a fish camp a family uses every summer.
Cultural resource management and protection regulations focus on historical cultural resources that people have used or valued continually for the last 50 years or more. These regulations include federal and state laws and policies, and NSB ordinances as summarized in Table 1.5-1.

### Table 1.5-1 Agencies and Governments Managing and Protecting Historic Resources

<table>
<thead>
<tr>
<th>Agency or Government</th>
<th>Scope</th>
<th>Dataset</th>
<th>Primary Associated Applicable Laws and Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal government</td>
<td>national, state, regional,</td>
<td>National Register of Historic Places</td>
<td>Abandoned Shipwreck Act, Antiquities Act of 1906, Archaeological and Historic Preservation Act, Archaeological</td>
</tr>
<tr>
<td></td>
<td>and local</td>
<td></td>
<td>Resource Protection Act, Coastal Zone Management Act, National Historic Preservation Act</td>
</tr>
<tr>
<td>Office of History and Archaeology, ADNR</td>
<td>state, local</td>
<td>Alaska Heritage Resource Survey (AHRS)</td>
<td>Alaska Historic Preservation Act (AS 41.35), Alaska Administrative Code (AAC) (11 AAC 16)</td>
</tr>
<tr>
<td>NSB</td>
<td>borough</td>
<td>Traditional Land Use Inventory (TLUI)</td>
<td>NSB Comprehensive Plan, North Slope Code of Ordinances</td>
</tr>
</tbody>
</table>

AAC = Alaska Administrative Code
ADNR = Alaska Department of Natural Resources
AS = Alaska Statute
NSB = North Slope Borough

The National Register of Historic Places (National Register) recognizes properties of exceptional historical importance. The importance may be local, regional, or national. Historic preservationists evaluate a property’s historical significance using four key criteria:

- **Criterion A** – The property illustrates important historical event(s) or broad pattern(s).
- **Criterion B** – The property demonstrates an association with a person/people who was/were significant in the past.
- **Criterion C** – The property embodies distinctive characteristics of a type, period, or method of construction, style, or high artistic value.
- **Criterion D** – The property yields or has potential to yield important information about prehistory or history.

The Office of History and Archaeology (OHA) in Anchorage maintains data on historic and archaeological properties in the state. The AHRS database, a collection of archaeological and historic properties reports, and National Historic Preservation Act (NHPA) compliance-related letters comprise these data. The NSB maintains its own database entitled the Traditional Land Use Inventory (TLUI) of cultural resources. The TLUI includes information on archaeological and historic sites, as well as places people continue to use for traditional activities. Public agencies usually maintain their own cultural resource databases that serve their management needs.

Compliance with Section 106 of the NHPA can be satisfied under the NEPA process. Section 106 work for this exploration project will be initiated along with the NEPA process. Section 106 (36 CFR 800) requires the lead agency (the BOEMRE) and the Operator (Shell) to engage other regulatory agencies, landowners, Alaska Native tribes, communities, the public, and, as necessary, the Advisory Council for Historic Preservation. These consulting parties are to be engaged during the planning process and involved in the identification, evaluation, and mitigation of adverse effects on cultural resources.

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1 Contemporary cultural resources are addressed elsewhere in this document.
1.6 Baseline Studies

BOEMRE has conducted numerous baseline studies in the Beaufort Sea in the nearshore and in the vicinity of the project area. BOEMRE developed the continuation of Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) program. BOEMRE initiated the ANIMIDA monitoring program to assess the impacts of production facilities of Northstar and other oil and gas projects in the nearshore. (This includes monitoring and establishing background levels of several chemicals, including potential contaminants.) Through the ANIMIDA monitoring efforts, BOEMRE continues to gather long-term monitoring data, providing consistency in evaluating potential effects from site-specific, recently initiated exploration activities in the Beaufort Sea OCS (MMS 2008a). BOEMRE ongoing studies include:

- Continuation of ANIMIDA
- Beaufort nearshore currents
- Sea ice modeling
- Impact assessment for Nuiqsut (Cross Island) whaling activities
- Bowhead Whale Aerial Survey Project (BWASP)

In addition to the topics listed above, BOEMRE recently released (February 2011) a fish population study for a portion of the western Beaufort Sea titled: *Beaufort Sea Marine Fish Monitoring 2008: Pilot Survey and Test of Hypotheses*. The eastern extent of the survey area was approximately longitude 152 degrees west, near the Cape Halkett area west of Nuiqsut, well outside the proposed drilling program area. The prospects are situated approximately 140 miles (mi) (224 kilometers [km]) east of the fish survey area. A similar study of the central Beaufort Sea is scheduled to begin summer 2011.

Shell commissioned, and plans to continue, baseline studies in advance of the currently proposed exploration drilling program. Environmental conditions in the vicinity of the planned Camden Bay drill sites have been documented through the collective work of BOEMRE and industry studies. Shell plans to continue to commission these studies including coastline surveys to assess relative environmental sensitivity of Beaufort Sea coastline segments, and baseline water and sediment quality assessment surveys at planned drill sites.

The following baseline studies have been conducted and will continue during Shell’s currently proposed exploration drilling program for Camden Bay:

- ice movement studies using buoy deployment
• coastal environmental sensitivity surveys
  o Shell conducted additional baseline studies in Camden Bay in 2010 in the form of an integrated ecosystem evaluation including physical oceanography, plankton, benthos, fish, marine mammals, and marine birds. The data from these investigations will be available third quarter of 2011.
• Acoustic monitoring of drilling and support vessel sound measurements and bowhead whale movements
• vessel-based marine mammal monitoring and migration tracking
• Integrated ecosystem-based surveys of the marine environment
Channel View Drive, Port Aransas, TX 78373.


- Air monitoring stations
  - Badami monitoring station collected Air Quality (NOx, PM2.5) and meteorological data from August 2009 through January 2011.
  - Reindeer Island collects offshore meteorological data. Installed April 2009 and still operating.

- Subsistence Advisor Reports (AES 2009; AES 2010; UIC UMIAQ 2011).
2.0 PLANNED EXPLORATION DRILLING ACTIVITIES

This section describes:

- planned exploration drilling program
- proposed drill sites and the project area
- descriptions of the Kulluk and Discoverer (drilling vessels), support vessels, and aircraft
- discharges and waste management
- project-associated air emissions
- Shell’s oil discharge prevention and contingency planning

Resupply of the Kulluk or Discoverer using marine vessels will be from both Dutch Harbor (ocean-going OSV) and West Dock (coastwise qualified vessel). An ice-capable OSR barge, with an associated tug will be located nearby during the planned drilling program. The OSR barge will be the main OSR vessel and will be supported by a vessel of opportunity skimming system (VOSS) and the berthing vessel for the OSR crew, which is a second VOSS if needed. An oil spill tanker (OST) will also be located in the area for its storage capability of recovered liquids and will also serve as a refuel supply for the drilling vessel and other support vessels.

The Kulluk or Discoverer and associated support vessels will transit through the Bering Strait into the Chukchi Sea on or after 1 July, arriving on location near Camden Bay approximately 10 July. Exploration drilling activities are planned to begin on or about 10 July and run through 31 October, with a suspension of operations beginning 25 August for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. During the suspension for the whale hunts the drilling fleet will leave the Camden Bay project area and move to an area north of latitude 71° 25’ N and west of longitude 146° 4’ W and will return to resume activities after the subsistence bowhead whale hunts conclude. Exploration drilling activities may extend to midnight 31 October, or earlier, depending on ice and weather conditions.

At the end of the drilling season, the Kulluk or Discoverer, and associated support vessels will transit west into and then south through the Chukchi Sea.

2.1 Prospects and Proposed Drill Sites

The leases under this exploration plan were acquired during the Beaufort Sea Oil and Gas Lease Sales 195 (March 2005) and 202 (April 2007). In the current (revised from the approved Camden Bay EP, 2010), Shell is submitting four potential drill site locations as listed in Table 2.1-1.

<table>
<thead>
<tr>
<th>Drill Site</th>
<th>Lease File #</th>
<th>NR06-04 Flaxman Island Lease Block No.</th>
<th>Surface Location (NAD 83)</th>
<th>Distance to Mainland Shore in mi (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Latitude (N)</td>
<td>Longitude (W)</td>
<td></td>
</tr>
<tr>
<td>Sivulliq G</td>
<td>OCS-Y 1805</td>
<td>6658</td>
<td>70° 23' 46.82&quot; 146° 01' 03.46&quot;</td>
<td>16.6 (26.7)</td>
</tr>
<tr>
<td>Sivulliq N</td>
<td>OCS-Y 1805</td>
<td>6658</td>
<td>70° 23' 29.58&quot; 145° 58' 52.53&quot;</td>
<td>16.2 (26.1)</td>
</tr>
<tr>
<td>Torpedo H</td>
<td>OCS-Y 1941</td>
<td>6610</td>
<td>70° 27' 01.62&quot; 145° 49' 32.07&quot;</td>
<td>20.8 (33.5)</td>
</tr>
<tr>
<td>Torpedo J</td>
<td>OCS-Y 1936</td>
<td>6559</td>
<td>70° 28' 56.94&quot; 145° 53' 47.15&quot;</td>
<td>23.1 (37.2)</td>
</tr>
</tbody>
</table>
Shell plans to drill four wells (Table 2.1-2) to objective depth over the course of this revised exploration plan intended to start in 2012. As with any Arctic exploration drilling program, weather and ice conditions, among other factors, will dictate the actual sequence in which the wells are drilled. All wells are planned to be vertical. Bottom hole locations will have the same latitude and longitude as surface locations. The order of drilling of the wells has no affect on project impacts.

This plan also takes into account contemplates a situation where a well that is started must be temporarily suspended due to ice, weather, or other conditions, and finished at a later date. Any well on which drilling is suspended will be secured in compliance with BOEMRE regulations and with the approval of the Regional Supervisor/Field Operations (RS/FO), whether it is permanently abandoned (30 CFR 250.1710 through 1717) or temporarily abandoned (30 CFR 250.1721-1723).

Shell plans to conduct a geophysical survey referred to as zero offset vertical seismic profile (ZVSP) at each drill site where a well is drilled. Once the objective intervals are fully evaluated, each exploration well will be plugged and abandoned in compliance with BOEMRE regulation.

<table>
<thead>
<tr>
<th>Drill Site</th>
<th>Lease File Number</th>
<th>NR06-04 Lease Block Number</th>
<th>Surface Location (NAD 83)</th>
<th>PTVD</th>
<th>Water Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Latitude (N)</td>
<td></td>
<td>Longitude (W)</td>
</tr>
<tr>
<td>Sivulliq G</td>
<td>OCS-Y 1805</td>
<td>6658</td>
<td>70° 23’ 46.82”</td>
<td>7,000</td>
<td>146° 01’ 03.46”</td>
</tr>
<tr>
<td>Sivulliq N</td>
<td>OCS-Y-1805</td>
<td>6658</td>
<td>70° 23’ 29.58”</td>
<td>7,000</td>
<td>145° 58’ 52.53”</td>
</tr>
<tr>
<td>Torpedo H</td>
<td>OCS-Y-1941</td>
<td>6610</td>
<td>70° 27’ 01.62”</td>
<td>10,000</td>
<td>145° 49’ 32.07”</td>
</tr>
<tr>
<td>Torpedo J</td>
<td>OCS-Y-1936</td>
<td>6559</td>
<td>70° 28’ 56.94”</td>
<td>9,800</td>
<td>145° 53’ 47.15”</td>
</tr>
</tbody>
</table>

PTVD = proposed total vertical depth

The two communities in closest proximity to the proposed exploration drilling activities are Kaktovik (aka Barter Island) and Nuiqsut. The existing shore-based facilities at West Dock and industrial facilities at Deadhorse/Prudhoe Bay will support the offshore exploration drilling activities.

The closest drill site to Kaktovik is Torpedo H, at approximately 55 mi (89 km). The closest drill site to Nuiqsut is Sivulliq G, at approximately 117 mi (188 km).
Figure 2.1-1  Proposed Camden Bay Drill Sites

Environmental Impact Analysis
Revised Outer Continental Shelf Lease Exploration Plan
Camden Bay, Alaska
2.2 Drilling Vessel, Support Vessels, and Aircraft

Shell plans to conduct its Camden Bay exploration drilling program using the *Kulluk*. However, to preserve operational flexibility, Shell has included the *Discoverer* in its revised Camden Bay EP as an alternative to the *Kulluk* and, in addition to analyzing the potential impacts of using the *Kulluk* at the planned drill sites, herein has completed an evaluation of the potential impacts of using the *Discoverer*. Shell will use various additional vessels (e.g., ice management, anchor handling, resupply, waste containment and management and OSR) in support of its exploration drilling operations. Helicopters will be used for crew changes and some resupply and fixed-wing aircraft will be used for marine mammal monitoring. A flight altitude of 1,500 ft (457 m) above sea level (ASL) will be maintained, excluding marine mammal monitoring flights, to minimize impact on marine mammals, unless the aircraft is approaching, landing, taking off, or in an emergency (including poor visibility [e.g., fog, low ceiling]).

**Kulluk**

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

The *Kulluk*’s mooring system consists of 12 Hepburn winches located on the outboard side of the main deck. Anchor wires lead off the bottom of each winch drum inboard for approximately 55 ft (16.8 m). The wire is then redirected by a sheave, down through a hawse pipe to an underwater, ice protected, swivel fairlead. The wire travels from the fairlead directly under the hull to the anchor system on the seafloor. More information regarding anchoring is presented in Section 2.3.2.

Specifications and equipment for the *Kulluk* are presented in Table 2.2-3.

**Discoverer**

The *Discoverer* is a true floating drilling vessel (drillship), which means it has the shape of a ship and mobilizes under its own power. It is also a largely self-contained drilling vessel in that it offers full accommodations for a crew of up to 140 persons, with quarters, galley, and sanitation facilities. Specifications for the *Discoverer* are provided in Table 2.2-4.
The *Discoverer* is a 514 ft (156 m) moored drilling vessel with drilling equipment on a turret amidship. 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.

The mooring, or anchoring, system that would be used to hold the *Discoverer* in place while on site consists of eight, seven-metric-ton, wedge-block anchors with combination chain/cable anchor lines.

**Support Vessels**

During each drilling season, the *Kulluk* or *Discoverer* will be attended by a minimum of 11 vessels that will be used for ice management, anchor handling/ice management, OSR, refueling, resupply, waste removal, and servicing of the drilling operations (see Table 2.2-1). If the specific vessels listed in Table 2.2-1 are not available, vessels of similar size and/or rating will be used.

<table>
<thead>
<tr>
<th>Support Vessel (or similar)</th>
<th>Kulluk or Discoverer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Ice Management</td>
<td><em>Nordica</em></td>
</tr>
<tr>
<td>Secondary Ice Management / Anchor Handling</td>
<td><em>Hull 247</em> (also acts as tow vessel for the <em>Kulluk</em> and a berthing vessel for OSR)</td>
</tr>
<tr>
<td>Shallow water resupply</td>
<td><em>Arctic Seal</em></td>
</tr>
<tr>
<td>Offshore Resupply Vessel (OSV)</td>
<td><em>Harvey Spirit</em></td>
</tr>
<tr>
<td>Waste Streams Transfer Vessel</td>
<td><em>Carol Chouest</em></td>
</tr>
<tr>
<td>Waste Streams Temporary Storage and Transit to Disposal Facility (deck barge and tug; [deck barge])</td>
<td><em>Southeast Provider</em> and <em>Ocean Ranger</em></td>
</tr>
<tr>
<td>Waste storage barge and tug (waste barge)</td>
<td>TBD</td>
</tr>
<tr>
<td>Primary Oil Spill Response (OSR)</td>
<td><em>Point Oliktok</em> Tug and <em>Endeavor Barge</em></td>
</tr>
<tr>
<td>OSR Liquid Storage and Refuel Supply Vessel</td>
<td><em>Mikhail Ulyanov</em></td>
</tr>
<tr>
<td>OSR Containment System</td>
<td><em>Invader Class tug</em> and barge</td>
</tr>
<tr>
<td>Anchor Handler – support for the Containment System Barge</td>
<td>TBD</td>
</tr>
</tbody>
</table>

General descriptions and use of proposed support vessels is presented in Table 2.2-2.
Table 2.2-2 Specifications of Support Vessels (Not Including OSR Vessels, see Table 2.2-3)

<table>
<thead>
<tr>
<th>Spec.</th>
<th>Nordica¹</th>
<th>Hull 247¹</th>
<th>Carol Chouest¹,²</th>
<th>Harvey Spirit¹,³</th>
<th>Arctic Seal¹,⁴</th>
<th>Southeast Provider Barge &amp; Ocean Ranger Tug¹,⁵</th>
<th>Waste Storage Barge¹,⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>380.5 ft (116 m)</td>
<td>360.6 ft (110 m)</td>
<td>280 ft (85.34 m)</td>
<td>280 ft (85.4 m)</td>
<td>134 ft (50.3 m)</td>
<td>360 ft (110 m)</td>
<td>117 ft (35.7 m)</td>
</tr>
<tr>
<td>Width</td>
<td>85 ft (26 m)</td>
<td>80 ft (24.4 m)</td>
<td>60 ft (18.29)</td>
<td>60 ft (18.3 m)</td>
<td>32 ft (11.6 m)</td>
<td>100 ft (30.5 m)</td>
<td>32 ft (8.8 m)</td>
</tr>
<tr>
<td>Draft</td>
<td>27.5 ft (8.4 m)</td>
<td>24 ft (7.3 m)</td>
<td>19.24 ft (5.87 m)</td>
<td>16.5 ft (5.0 m)</td>
<td>7 ft (2.1 m)</td>
<td>14 ft</td>
<td>-</td>
</tr>
<tr>
<td>Berths</td>
<td>82</td>
<td>64</td>
<td>29</td>
<td>26</td>
<td>17</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>16 knots (30 km/hr)</td>
<td>15 knots (27.8 km/hr)</td>
<td>15 knots (27.8 km/hr)</td>
<td>13.5 knots (25 km/hr)</td>
<td>10 knots (18.5 km/hr)</td>
<td>-</td>
<td>10 knots (18.5 km/hr)</td>
</tr>
<tr>
<td>Fuel Capacity</td>
<td>11,070 bbl</td>
<td>12,575 bbl</td>
<td>8,411 bbl (normal) 11,905 bbl (max)</td>
<td>6,235 bbl (normal)</td>
<td>667 bbl</td>
<td>-</td>
<td>2,381 bbl</td>
</tr>
</tbody>
</table>

¹ or similar vessel
²Dutch Harbor supply vessel
³Dutch Harbor supply vessel/Waste removal
⁴West Dock supply vessel
⁵if necessary, will be mobilized for storage for drilling vessel resupply and waste streams removed from the drilling vessel
Ice Management

The M/V Nordica (Nordica) or a similar vessel, will serve as the primary ice management vessel in support of the Kulluk or Discoverer. Hull 247 will provide anchor handling duties, serve as the berthing (accommodations) vessel and will also serve as a secondary ice management vessel. When managing ice, the Nordica (or similar vessel) and Hull 247 will generally be confined to a 40° arc up to 3.1 mi (5 km) upwind originating at the drilling vessel (Figure 2.2-1).

It is anticipated that the ice management vessels will be managing ice for 38 percent of the time when within 25 mi (40 km) of the Kulluk or Discoverer. Active ice
management involves using the ice management vessel to steer larger floes so that their path does not intersect with the drilling vessel. In some instances, the ice management vessel may have to break ice that is an immediate safety hazard for the drilling vessel. Around-the-clock ice forecasting using real-time satellite coverage (available through Shell Ice and Weather Advisory Center [SIWAC]) will support the ice management duties. When the Nordica is not needed for ice management, it will reside outside the 25 mi (40 km) radius from the Kulluk or Discoverer if it is safe to do so. The vessel will enter and exit the Beaufort Sea with the Kulluk or Discoverer.

As anchor handler, Hull 247’s duties include setting and removing anchors, berthing (accommodations) vessel, providing supplemental oil recovery capability (VOSS) and managing smaller ice floes that may pose a potential safety issue to the Kulluk or Discoverer and the support vessels that will service the drilling vessel.

**Figure 2.2-1 Ice Management Vessels Configuration for the Kulluk or Discoverer**

![Ice Management Vessels Configuration](image)

**Resupply and Waste Removal**

The drilling operations will require the transfer of supplies between the Deadhorse/Westdock shorebase and Dutch Harbor with the Kulluk or Discoverer. While the Kulluk or Discoverer is anchored at a drill site as an OCS-source under the EPA air permit, Shell has allowed for 24 visits/tie-ups (if the Kulluk is the drilling vessel being used) or 8 visits/tie-ups (if the Discoverer is being used) throughout the drilling season from support vessels. The Harvey Spirit (or similar vessel), a 280 ft (85.4 m) supply vessel with Dynamic Positioning (DP), will shuttle supplies from the Arctic Seal (or similar vessel) and/or the Southeast Provider to the Kulluk or Discoverer.
During the resupply trips, the *Harvey Spirit*, or similar vessel, will be used to remove the mud/cuttings and other waste streams. The mud/cuttings will be transported to the *Southeast Provider* (aka deck barge; or similar vessel) or the waste barge for storage. Other waste streams (sanitary waste, domestic waste, bilge water, ballast water) will also be transferred to the *Southeast Provider* (deck barge; or similar vessel), or the waste barge for temporary storage. All waste streams will be barged south for disposal at the end of the drilling season.

While the *Kulluk* or *Discoverer* leaves Camden Bay temporarily during the Kaktovik and Nuiqsut (Cross Island) subsistence whale hunt, Shell will resupply the *Kulluk* or *Discoverer* with drilling supplies and equipment brought in from Dutch Harbor and stored on the *Carol Chouest* (or similar vessel) or the *Harvey Spirit* (or similar vessel).

Approximately 10 resupply trips from Dutch Harbor to the resupply barge will be needed during each drilling season. The *Carol Chouest* (or similar vessel), will be used as a backup supply vessel and shuttle between Camden Bay and Dutch Harbor. When drilling starts up again after the bowhead whaling harvest has concluded, additional resupply may be required from West Dock via the *Arctic Seal* (or similar vessel) via transfer to the *Harvey Spirit* (or similar vessel) to the drilling vessel. Each support vessel will require refueling 4-6 times during the drilling season, depending on fuel consumption based on utilization.

Removal of waste and resupply to the drilling vessel will be conducted the same way regardless of drilling vessel.

**Oil Spill Response**

The OSR vessels will include a primary OSR barge (the *Arctic Endeavor* and Point Class Tug, or similar vessel), *Hull 247* will act as a berthing (quartering) vessel and an oil storage tanker (OST - M/V *Mikhail Ulyanov* or a similar vessel). The *Harvey Spirit* (or similar vessel) will also act as a VOSS.

The OSR barge will have associated smaller workboats called Kvichaks. There are three 34-ft (10.4 m) Kvichaks that will support the OSR barge by laying out booms. One 47-ft (14.3 m) Rozema will provide skimming services. The berthing vessel (*Hull 247*) will be dedicated to the Camden Bay drilling program and remain in the vicinity of the *Kulluk* or *Discoverer*, with the OSR barge and the OST being staged to respond as needed to a discharge. Specifications for these vessels are provided below in Table 2.2-4 and 2.2-5.

An additional barge housing well containment equipment will be centrally located in the Beaufort Sea. The barge will be supported by an Invader Class Tug and possibly an anchor handler.
Table 2.2-3 Specifications of the Major Oil Spill Response Vessels

<table>
<thead>
<tr>
<th>Specification</th>
<th>OSR Barge and Tug</th>
<th>OST (Mikhail Ulyanov)</th>
<th>OSR Containment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Arctic Endeavor Barge¹</td>
<td>Point Class Tug¹</td>
<td>Barge¹</td>
</tr>
<tr>
<td>Length (ft)</td>
<td>205 ft (62.5 m)</td>
<td>90 ft (27.4 m)</td>
<td>853 ft (260 m)</td>
</tr>
<tr>
<td>Width (ft)</td>
<td>90 ft (27.4 m)</td>
<td>32 ft (9.8 m)</td>
<td>112 ft (34 m)</td>
</tr>
<tr>
<td>Draft (ft)</td>
<td>NA</td>
<td>8.5 ft (2.6 m)</td>
<td>44.6 ft (13.6 m)</td>
</tr>
<tr>
<td>Berths</td>
<td>NA</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>NA</td>
<td>7 knots (13 km/hr)</td>
<td>16 knots (30 km/hr)</td>
</tr>
<tr>
<td>Fuel Capacity</td>
<td>NA</td>
<td>1,428 bbl (227 m³)</td>
<td>440,000 bbl (69,952 m³)</td>
</tr>
<tr>
<td>Liquid Storage</td>
<td>18,636 bbl</td>
<td>NA</td>
<td>543,000 bbl (86,328 m³)</td>
</tr>
<tr>
<td>Workboats</td>
<td>(1) 47 ft (14 m) skim boat</td>
<td>(3) 34 ft (10 m) work boats</td>
<td>(4) mini-barges</td>
</tr>
</tbody>
</table>

Notes:
¹ or similar vessel
NA – not applicable
1m³ = 6.29 bbl

The *Mikhail Ulyanov* or similar vessel with similar liquid storage capacity will be the OST and will be staged such that it would arrive at a recovery site, if needed, within 24 hours of departure from its staging location.

The purpose of the OST would be to provide a place to store large volumes of recovered crude oil, emulsion and free water and to store captured liquid waste streams (treated sanitary waste, domestic waste, bilge water, ballast water). Surplus storage capacity aboard the OST beyond what is required for response at a recovery site may be allocated to store other liquid commodities consumed by the drilling vessel and support vessels, including diesel fuel. Refueling will be done per the fuel transfer plan in Appendix M of the revised Camden Bay EP. Each vessel will require refueling four to six times during the season, depending on fuel consumption based on utilization.

Photo - M/V *Mikhail Ulyanov*

Photo – Arctic Endeavor and Point Class Tug
Table 2.2-4  

**Kulluk Specifications**

**Key Features**
- Unique, purpose-built conical Arctic Class IV hull design
- Operating water depth 60 to 600 ft (18.3 to 183 m), drilling depth up to 20,000 ft (6 096 m)
- Electrically driven Varco top drive drilling system
- 24 ft (7.3 m) diameter glory hole bit capable of drilling and setting a steel casson 40 ft (12.2 m) into the seabed for ice scour protection
- Partially enclosed derrick
- 18 1/8 in (476 mm), 10,000 & 15,000 psi (69 & 103 MPa) BOP stacks
- High-performance 12 point mooring system

Kulluk is the first floating drilling vessel designed and constructed for extended season drilling operations in deep Arctic waters.

An improvement on the floating drillship concept, Kulluk is a conically shaped, ice strengthened floating drilling unit with a 24-faceted double-walled hull.
Environmental Impact Analysis
Revised Outer Continental Shelf Lease Exploration Plan

**Classification**
The unit has been designated as Arctic Class IV (by the Canadian Coast Guard) under Canadian Arctic Shipping Pollution Prevention Regulations, and as Ice Class 1A by the American Bureau of Shipping.

**Specifications**
- **Owner:** BeauDrill Limited
- **Flag:** Canadian
- **Rig Type:** Conical Drilling Unit (CMU)
- **Delivered:** 1983
- **Rig Design:** Earl & Wright - Lavalin
- **Built By:** Mitsubishi Engineering and Shipbuilding, Japan

**Dimensions**
- Diameter at main deck: 296 ft (81.0 m)
- Diameter at pump deck: 196 ft (59.7 m)
- Hull Depth: 61 ft (18.5 m)

**Operations**
- **Draft:**
  - (max. operating): 41 ft (12.5 m)
  - (min. operating): 33 ft (10.0 m)
- **Drill (light ship):** 26 ft (8.0 m)
- **Light Ship Displacement:** 19,300 tons (17,510 tonnes)
- **Maximum Drilling Depth:** 20,000 ft (6,096 m)
- **Operating Water Depth:** 60 to 600 ft (18.3 to 183 m)

**Variable Load**
- **Barite & cement bulk:** 21,471 cu ft (608 m³)
- **Liquid mud:** 2,605 bbl (414 m³)
- **Drill water:** 4,227 bbl (672 m³)
- **Fuel:** 10,085 bbl (1,625 m³)
- **Potable water:** 1,961 bbl (312 m³)
- **Ballast:** 35,928 bbl (5,942 m³)
- **Pipe & casing (pipe deck):** 1,543 tons (1,400 tonnes)
- **Brine:** 2,616 bbl (520 m³)

**Operational Limits**
**Stationkeeping Conditions**
Kulluk was built to operate in the ice infested waters of the Arctic offshore. The unit was developed to extend the drilling season available to more conventional floating vessels by enabling operations to be carried out through spring breakup conditions, the summer months, and well into the early winter period.

Kulluk was designed to maintain location in a drilling mode in moving first-year ice of 4 ft (1.2 m) thickness. With ice management support provided by BeauDrill's Arctic Class IV Icebreakers, the unit can maintain location in more severe conditions as shown below.

In terms of Kulluk's open water performance, the drilling unit was designed to maintain location in storm conditions associated with maximum wave heights of 18 ft (5.5 m) while drilling and 40 ft (12.2 m) while disconnected (assumed storm duration of 24 hrs).

If ice or open water storm conditions become more severe than those indicated, the unit's mooring system, which incorporates acoustic release devices, is disconnected from the anchors and the unit moves off location.
Environmental Impact Analysis
Revised Outer Continental Shelf Lease Exploration Plan
Camden Bay, Alaska

**Equipment**

**Drilling Equipment**

- **Derrick**
  - 160 ft (44.8 m) Deco dynamic with a 40 ft x 40 ft (12.2 m x 12.2 m) base, rated at 1,400,000 lb (633,000 daN) with 14 lines.
  - Racking platform has capacity to hold 23,340 ft (7.15 m) of 5 in (127 mm) drill pipe plus bottom hole assembly.

- **Drawworks**
  - Electro-E-3000 electric drawworks complete with sand reel, Elimago model 7838 Baylor auxiliary brake, spinning and breakout catheads and three GE model 752 motors each rated at 1,000 hp (746 kW) continuous.

- **Travelling Block**
  - McKissick model 666, 650 ton (590 tonne) capacity with 7 sheaves grooved for 1 1/4 in (31.7 mm) drilling line.

- **Swivel**
  - Idecno TL-500, 500 ton (454 tonne) capacity.

- **Drill Pipe**
  - 2000 ft (909.6 m) x 5 in (127 mm), 19.5 lb/ft (29 kg/m) with 4 1/4 IF connections.

- **Top Drive**
  - Varco TD-3 with one GE model 752 motor rated at 1,000 hp (746 kW) continuous and a 500 ton (454 tonne) hoisting capacity.

- **Rotary Table**
  - Idecno LR-515, 45.5 in (1,160 mm) driven by one GE model 752 motor, rated at 1,000 hp (746 kW) continuous, coupled to a two-speed transmission.

- **Drill String Compensator**
  - NL Shaffer 10 ft (3.05 m) stroke, 400,000 lb (178,000 daN) compensating capacity or a 1,000,000 lb (444,000 daN) locked capacity.

- **Tensioner System**
  - 4 x 90,000 lb (360,000 daN) Western Gear wiper tensioners, 48 ft (14.6 m) wireline travel with 1 3/4 in (44.5 mm) wire rope.

- **Mud Pumps**
  - 2 x Idecno T-1600 triplets, each driven by two GE model 752 motors rated at 1,000 hp (746 kW) continuous.

**Consenting Unit**

- **Dewell owned RT17 twin triplex**
  - powered by two GE model 752 motors each rated at 1,000 hp (746 kW) continuous, with 7,500 psi (52 MPa) and 10,500 psi (72 MPa) fluid ends.

**Rig Floor Pipe Handling System**

- Varco Iron Roughneck model IR-2000 Range: 2.5 to 8 in (73 to 203 mm).

**Mud Logging Room**

- Designed to accommodate equipment from any of the major mud logging companies. This room is an integral part of the rig and contains complete lab facilities.

**Testing Equipment**

- Complete testing system with a 10,000 BOPD (1,570 m³/day) capacity consisting of: header, choke manifold, steam heater, 3-phase separator, surge tank, valves/gauges, transfer pumps, and flare booms.

**Mud Conditioning Equipment**

- 4 x Thistle United VSM-120 shale shakers.
  - 1 x Braxton S8-3 desander.
  - 1 x Braxton SE-24 desilter.
  - 1 x Thistle VSM-200 mud cleaner.
  - 1 x Wagner Sigma-10W centrifuge.
  - 1 x Sharkey DM 400 centrifuge.
  - 2 x Burgess Magna-Vac vacuum degassers.
  - 2 x Alfa Laval AX-30 mud coolers.

**Subsea Equipment**

- **BOP System**
  - 1 x NL Shaffer 18 1/2 in (476 mm), 10,000 psi (69 MPa) BOP stack with annular, 4 ram type preventers, and Veeco H-4 E connector.

- **Cranes**
  - 3 x Liebherr, BSS 65/650, rated at 72 ton (65 tonnes) at 30 ft (9.1 m).

**Safety Equipment**

- **Bunkers**
  - For 108 people, recreation room, sauna, galley with seating for 30, offices, and hospital.

**Accommodation**

- **Beds**
  - For 108 people, recreation room, sauna, galley with seating for 30, offices, and hospital.

- **Power Generation**
  - **Prime Movers**
    - 3 x Electro-Motive Diesel rated at 2,817 hp (2,100 kW) each.
  - **Emergency Power**
    - 1 x GM Detroit diesel rated 873 hp (651 kW).

**Cranes**

- 3 x Liebherr, BSS 65/650, rated at 72 ton (65 tonnes) at 30 ft (9.1 m).

- **BOP Cranes**
  - 2 x Heubach main bridge cranes, 85 ton (77 tonne) capacity each with 19 ton (9.1 tonne) auxiliary hoists.

- **30 in (762 mm) Marine Riser System**
  - 3 x hydraulic pin connectors, 2 x 36 in (914 mm) Cameron, and 1 x 30 in (762 mm) Drill-Quip.

- **2 x BFD Inflatable Escape Slides**

**Heldock**

- Capacity for 108 people, recreation room, sauna, galley with seating for 30, offices, and hospital.
**Kulluk Mooring System**

The Kulluk's mooring system consists of twelve Hewburn winches located on the outboard side of the main deck. Anchor wires lead off the bottom of each winch drum inboard for approximately 35 ft (17 m). The wire is then redirected by a sheave, down through a hawse pipe to an underwater, ice protected, swivel fairlead. The wire travels from the fairlead directly under the hull to the anchor system on the seafloor.

**Specifications**

**Anchor Winch**
12 x Hewburn single-drum winches with a 287 ton (260 tonne) operating tension

**Mooring Wires and Anchors**

**Anchors**
Various sizes & quantities of anchors are available for use. Exact anchor configuration to be provided once location and seafloor conditions are specified

**Wire ropes**
Each winch drum has capacity for 3,763 ft (1,147 m) of 3½ in (88.9 mm), 5/3 ton (520 tonne) breaking strength wireline

**Anchor Release**
Each anchor wire contains a remote acoustic release (RAR) unit
### DISCOVERER SPECIFICATIONS

<table>
<thead>
<tr>
<th>TYPE-DESIGN</th>
<th>Drillship - Sonat Offshore Drilling Discoverer Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHAPE</td>
<td>Monohull with sponsons added for ice-resistance¹</td>
</tr>
<tr>
<td>SHIP BUILDERS &amp; YEAR</td>
<td>Namura Zonshno Shipyard, Osaka, Japan - hull number 355</td>
</tr>
<tr>
<td>YEAR OF HULL CONSTRUCTION</td>
<td>1965</td>
</tr>
<tr>
<td>YEAR OF CONVERSION</td>
<td>1976</td>
</tr>
<tr>
<td>DATE OF LAST DRY-DOCKING</td>
<td>2010</td>
</tr>
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</table>

### DISCOVERER DIMENSIONS

<table>
<thead>
<tr>
<th>DIMENSIONS</th>
<th>LENGTH</th>
<th>514 ft</th>
<th>156.7 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>LENGTH BETWEEN PERPENDICULARS (LBP)</td>
<td>486 ft</td>
<td>148.2 m</td>
<td></td>
</tr>
<tr>
<td>WIDTH</td>
<td>85 ft</td>
<td>26 m</td>
<td></td>
</tr>
<tr>
<td>MAXIMUM (MAX) HEIGHT (ABOVE KEEL)</td>
<td>274 ft</td>
<td>83.7 m</td>
<td></td>
</tr>
<tr>
<td>HEIGHT OF DERRICK ABOVE RIG FLOOR</td>
<td>175 ft</td>
<td>53.3 m</td>
<td></td>
</tr>
</tbody>
</table>

### DISCOVERER MOORING EQUIPMENT

Anchor pattern symmetric 8 points system. The unit is fitted with Sonat Offshore Drilling patented roller turret mooring system giving the unit the ability to maintain favorable heading without an interruption of the drilling operations.

| ANCHORS             | Stevpris New Generation 15,400 lb each; 7,000 kilograms (kg) each (ea) |
| ANCHOR LINES        | Chain Wire Combination                                                |
| SIZE/GRADE          | 2.75 inch (in.) wire 3 in. ORQ Chain                                  |
| LENGTH              | 2,750 ft (838 m) wire + 1,150 ft (351 m) chain (useable) per anchor |

### DISCOVERER OPERATING WATER DEPTH

| OPERATING WATER DEPTH | MAX WATER DEPTH 1,000 ft (305 m) with present equipment (can be outfitted to 2,500 ft [762 m]) |
|                       | MAX DRILLING DEPTH 20,000 ft | 6,098 m |
### Table 1.c-2 Discoverer Specifications (continued)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DRAW WORKS</strong></td>
<td>EMSCO E-2,100 - 1,600 horsepower (hp)</td>
</tr>
<tr>
<td><strong>ROTARY</strong></td>
<td>National C-495 with 49-1/2 in. (1.3 m) opening</td>
</tr>
<tr>
<td><strong>MUD PUMPS</strong></td>
<td>2 ea. Continental Emasco Model FB-1600 Triplex Mud Pumps</td>
</tr>
<tr>
<td><strong>DERRICK</strong></td>
<td>Pyramid 170 ft. (51.8 m) with 1,300,000 lb nominal capacity</td>
</tr>
<tr>
<td><strong>PIPE RACKING</strong></td>
<td>BJ 3-arm system</td>
</tr>
<tr>
<td><strong>DRILL STING COMPENSATOR</strong></td>
<td>Shaffer 400,000 lb with 18-ft (5.5-m) stroke</td>
</tr>
<tr>
<td><strong>RISER TENSIONS</strong></td>
<td>8 ea. 80,000 lb Shaffer 50-ft (15.2-m) stroke tensioners</td>
</tr>
<tr>
<td><strong>CROWN BLOCK</strong></td>
<td>Pyramid with 9 ea. 60-in. (1.5 m) diameter sheaves rated at 1,330,000 lb</td>
</tr>
<tr>
<td><strong>TRAVELING BLOCK</strong></td>
<td>Continental - Emisco RA60-6</td>
</tr>
<tr>
<td><strong>BLOWOUT PREVENTOR (BOP)</strong></td>
<td>Cameron Type U 18. 3/4-in. x 10,000 pounds per square inch (psi)</td>
</tr>
<tr>
<td><strong>RISER</strong></td>
<td>Cameron RCK type (21-in.)</td>
</tr>
<tr>
<td><strong>TOP DRIVE</strong></td>
<td>Varco TDS-3S, with GE-752 motor, 500 ton</td>
</tr>
<tr>
<td><strong>BOP HANDLING</strong></td>
<td>Hydraulic skid based system, drill floor</td>
</tr>
</tbody>
</table>

#### DISCOVERER DISPLACEMENT

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td><strong>FULL LOAD</strong></td>
<td>20,253 metric tons (mt)</td>
</tr>
<tr>
<td><strong>DRILLING</strong></td>
<td>18,780 mt (Drilling, max load, deep hole, deep water)</td>
</tr>
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</table>

#### DISCOVERER DRAUGHT

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DRAFT AT LOAD LINE</strong></td>
<td>27 ft (8.2 m)</td>
</tr>
<tr>
<td><strong>TRANSIT</strong></td>
<td>27 ft (8.2 m) (fully loaded, operating, departure)</td>
</tr>
<tr>
<td><strong>DRILLING</strong></td>
<td>25.16 ft (7.7 m)</td>
</tr>
</tbody>
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#### DISCOVERER HELIDECK

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td><strong>MAXIMUM HELICOPTER SIZE</strong></td>
<td>Sikorsky S-92N</td>
</tr>
<tr>
<td><strong>FUEL STORAGE</strong></td>
<td>2 ea. 720-gallon (gal) tanks</td>
</tr>
</tbody>
</table>

#### DISCOVERER ACCOMODATIONS

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NUMBER OF BEDS</strong></td>
<td>140</td>
</tr>
<tr>
<td><strong>SEWAGE TREATMENT UNIT</strong></td>
<td>Hamworthy ST-10</td>
</tr>
</tbody>
</table>

#### DISCOVERER PROPULSION EQUIPMENT

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td><strong>PROPELLER</strong></td>
<td>1 ea 15 ft 6 in. (4.8 m) diameter, fixed blade</td>
</tr>
<tr>
<td><strong>PROPULSION DRIVE UNIT</strong></td>
<td>Marine Diesel, 6 cylinder, 2 cycle, Crosshead type</td>
</tr>
<tr>
<td><strong>HORSEPOWER</strong></td>
<td>7,200 hp @ 135 revolutions per minute (RPM)</td>
</tr>
<tr>
<td><strong>TRANSIT SPEED</strong></td>
<td>8 knots</td>
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#### GENERAL STORAGE CAPACITIES

<table>
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<th>Details</th>
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<tbody>
<tr>
<td><strong>SACK STORAGE AREA</strong></td>
<td>934 cubic meters (m³)</td>
</tr>
<tr>
<td><strong>BULK STORAGE</strong></td>
<td></td>
</tr>
<tr>
<td>Bentonite / Barite</td>
<td>1,132 bbl - 4 tanks</td>
</tr>
<tr>
<td>Bulk Cement</td>
<td>1,132 bbl - 4 tanks</td>
</tr>
<tr>
<td><strong>LIQUID MUD</strong></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>1,200 barrels (bbl)</td>
</tr>
<tr>
<td>Reserve</td>
<td>1,200 bbl</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>2,400 bbl</td>
</tr>
<tr>
<td><strong>POTABLE WATER</strong></td>
<td>1,670 bbl (aft peak can be used as add. pot water tank)</td>
</tr>
<tr>
<td><strong>DRILL WATER</strong></td>
<td>5,798 bbl</td>
</tr>
<tr>
<td><strong>FUEL OIL</strong></td>
<td>6,497 bbl</td>
</tr>
</tbody>
</table>

1 Sponsons designed and constructed to meet requirements of Det Norske Veritas (DNV) Additional Class Notation ICE-05.
Aircraft

Helicopters are planned to provide support for crew change, provision resupply, and search-and-rescue (SAR) operations during the drilling season. A fixed-wing aircraft will also be part of the program as part of the Marine Mammal Monitoring and Mitigation Plan (4MP) flying marine mammal observers (MMOs) over the Sivulliq and Torpedo prospects to observe and document sightings of marine mammals. The crew change and resupply helicopter and the fixed-wing aircraft will be based in Deadhorse with the SAR helicopter stationed in Barrow, Alaska. See Section 13.0 of the EP for additional information on support vessels and aircraft.

An AW139 or Sikorsky S-92 helicopter based in Deadhorse will be used for flights between the shorebase and drill sites. It is expected that on average, two flights per day (approximately 12 flights per week) will be necessary to transport supplies and rotate crews. A Sikorsky S-92 based in Barrow will be used for SAR operations.

Figure 2.2-2 depicts the helicopter routes (and support vessel routes) to the drill sites. Helicopter flight paths are direct to each drill site, unless there is a need to respond to emergency conditions (including weather). An inland route depicted on the figure is a mitigation measure to lessen any potential interference with caribou hunting along the coast by subsistence hunters.

Fixed-wing aircraft (such as a DeHavilland Twin Otter) would be used to support the marine mammal monitoring program in support of the 4MP. The Twin Otter is expected to fly daily.

Aircraft travel will be controlled by Federal Aviation Administration (FAA)-approved flight paths and will comply with flight restrictions imposed by the Lease Sale 195 stipulations regarding sensitive biological areas (MMS 2003).

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Flight</th>
<th>Trip Frequency</th>
<th>Duration Per Trip</th>
<th>Flight Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sikorsky S-92 (based in Deadhorse)</td>
<td>Return trip Deadhorse to drilling vessel</td>
<td>12/week</td>
<td>2 hrs</td>
<td>125 knots</td>
</tr>
<tr>
<td>Sikorsky S-92 SAR (based in Barrow)</td>
<td>training</td>
<td>1/month</td>
<td>2 hrs</td>
<td>125 knots</td>
</tr>
<tr>
<td>De Havilland DHC-6 (based in Deadhorse)</td>
<td>MMO flights centered around the drilling vessel</td>
<td>daily</td>
<td>6 hrs</td>
<td>120 knots</td>
</tr>
</tbody>
</table>
Figure 2.2-2  Camden Bay Drilling Support Vessel and Flight Corridors
2.3 **Drilling Vessel Mobilization and Drill Site Preparation**

**Mobilization – Entry/Exit from Beaufort Sea and Estimated Schedule**

The *Discoverer*, accompanied by an ice management vessel, anchor handler, supply vessels and OSR vessels will transit from Dutch Harbor through the Bering Strait into the Chukchi Sea on or after 1 July, then east around Barrow and into the Beaufort Sea. In the event Shell uses the *Kulluk* for its Camden Bay exploration drilling operations, a tow-vessel (the anchor handler vessel) will also be necessary to move the *Kulluk* to location.

Timing of entry into the Chukchi Sea for either drilling vessel will be determined by USFWS requirements and sea conditions. MMOs will be onboard all vessels while transiting the Bering Strait, Chukchi Sea, and Beaufort Sea.

Approximate travel routes between Dutch Harbor and the Beaufort Sea for the drilling vessel are depicted on Figure 2.3-1. Exploration drilling activities will end at or before midnight 31 October, depending on ice conditions. The entire fleet will exit the Beaufort Sea along approximately the same route used for initial transit.

All exploration drilling activities will cease on 25 August for the Nuiqsut (Cross Island) and Kaktovik subsistence whale hunts. During the suspension for the whale hunts the drilling fleet will leave the Camden Bay project area and move to an area north of latitude 71° 25’N and west of longitude 146° 4’W. Shell will return to resume exploration drilling activities after the subsistence bowhead whale hunts conclude. Exploration drilling activities will be concluded on or before 31 October, depending on ice, weather and sea state.

**Mobilization at Drill Site and Drill Site Preparation**

Once the drilling vessel is in the Camden Bay area, mobilizing and anchoring over a drill site will require 24 to 48 hours. Mobilization is the process of the drilling vessel moving to the drill site, positioning correctly over the drill site, and mooring (anchoring) to minimize any movement during drilling. Preparation of the drill site, including MLC construction, will require approximately five days.
Figure 2.3-1  Fleet Travel Routes
## Anchoring

The *Discoverer* will be towed into position over a drill site by an assisting anchor handler. The *Discoverer* will be moored over the drill site with its system of eight anchors, with support of the anchor handler. Dimensions of the *Discoverer*’s system of Stevpris anchors are provided in Table 2.3-1. Anchor radii for *Kulluk* are: 3,117 ft (950 m) for Sivulliq G and N; and 2,995 ft (913 m) for Torpedo H and J. Anchor radii for *Discoverer* are: 2,903 ft (885 m) for all drill sites.

The anchors are embedment-type anchors and designed to penetrate the seafloor to the depth of the anchor and drag through the seafloor sediments for a distance of two to three times the anchor length before becoming firmly set in the seafloor. Setting the anchors and subsequent anchor removal disturbs the seafloor and commonly leaves an anchor “scar.” The anchor chain and any landed anchor wire will also be dragged along the seafloor, creating a trough (chain scar). The total scar is the sum of the anchor scar plus the chain/wire scar. The dimensions of scars vary with the size of the anchor, the length of chain and wire, and characteristics of the seafloor material. The scars in this case are expected on average to have a small surface area of 2,124 square feet (ft²) (197 m²) and a disturbed volume of 508 yd³ (388 m³) per anchor. The total scar area for all eight anchors is 16,992 ft² (1,579 m²) and the total volume is 4,064 yd³ (3,107 m³) per drill site. Estimated area and volume of the anchor scar created during deployment and setting of an anchor for the *Kulluk* are listed in Table 2.3-1. Maximum anchor radius for the *Kulluk* is 3,117 ft (950 m) in Camden Bay.

### Table 2.3-1 Dimensions of a Stevpris Anchor and a Potential Anchor Scar from Anchor Deployment of the *Kulluk* and *Discoverer*

<table>
<thead>
<tr>
<th>Anchor Weight</th>
<th>Anchor Width</th>
<th>Anchor Length</th>
<th>Estimated Anchor Seafloor Penetration</th>
<th>Anchor Scar Length</th>
<th>Grounded Chain/Wire Length (estimate)</th>
<th>Total Scar Surface (Anchor/Chain/Wire)</th>
<th>Total Scar Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Kulluk</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33,000 lb</td>
<td>21.5 ft</td>
<td>19.7 ft</td>
<td>10 ft</td>
<td>59.0 ft</td>
<td>1,968 ft</td>
<td>3,249 ft²</td>
<td>543 yd³</td>
</tr>
<tr>
<td>(15 mt)</td>
<td>(6.5 m)</td>
<td>(6.0 m)</td>
<td>(3.06 m)</td>
<td>(18.0 m)</td>
<td>(600 m)</td>
<td>(302 m²)</td>
<td>(415 m³)</td>
</tr>
<tr>
<td><em>Discoverer</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15,430 lb</td>
<td>17 ft</td>
<td>18 ft</td>
<td>11 ft</td>
<td>51 ft</td>
<td>1,204 ft</td>
<td>2124 ft²</td>
<td>508 yd³</td>
</tr>
<tr>
<td>(7 mt)</td>
<td>(5.2 m)</td>
<td>(5.5 m)</td>
<td>(3.4 m)</td>
<td>(15.5 m)</td>
<td>(367 m)</td>
<td>(197 m²)</td>
<td>(388 m³)</td>
</tr>
</tbody>
</table>

lb = pound(s)  
mt = metric ton(s)

The *Kulluk* mooring system consists of twelve 15 metric ton (mt) Stevpris anchors. The system is described in the *Kulluk* specifications (Figure 2.2-1). There are 12 winches on the outboard side of the main deck. Anchor wires lead off the bottom of each winch drum and the wire is redirected by a sheave, down through a hawse pipe to an underwater ice-protected, swivel fairlead. The wires travel from the fairlead directly under the hull to the anchor system on the seafloor.

There is a possibility of pre-setting anchors for the drilling vessel (whether the *Kulluk* or *Discoverer*) in the Beaufort Sea. If this is the case, pre-setting would be accomplished using the anchor handler vessels in the support fleet. Work would be conducted prior to mooring the drilling vessel over the proposed drill site. Final determination regarding pre-setting anchors would be made based on mobilization logistics and sea ice conditions at each of the proposed drill sites.

### Mudline Cellar

The purpose of the MLC is to ensure that the top of any portion of the wellhead and BOP is located below the maximum reported ice gouge depth. The depth of the MLC is such that the top of the uppermost part of the stack is below the maximum ice gouge depth expected at the drill site. Maximum ice gouge depth...
used for design of the MLCs in the Camden Bay project area is based on evaluation of shallow hazards and site clearance geophysical surveys (Section 1.4).

A MLC will be constructed at each drill site as part of site preparation. The MLCs will be constructed in the seafloor using a large-diameter drill bit operated by hydraulic motors. The construction equipment will be suspended from the drilling vessel. The MLC bit is a two-part device; the upper section of the bit remains stationary while the bottom section rotates, powered by three hydraulic motors that operate a series of 3 ft (0.9 m) diameter disks the angles of which are designed to displace seafloor sediments and push them toward the center of the bit. The bit is also equipped with three disks on the outside, and the bit is slightly eccentric so that the bit drills a hole that is 6-12 in. (15-30 cm) greater in diameter than the bit outside diameter (OD). The resulting MLCs constructed by the Discoverer will be at least 20 ft (6.1 m) in diameter and 41 ft (11.3 m) below mudline. For the Kulluk, the diameter will be at least 24 ft (7.3 m) and also 41 ft (11.3 m) below mudline.

Estimated volumes of disturbed sediment for MLC construction for the Kulluk and Discoverer are listed in Table 2.3-2.

<table>
<thead>
<tr>
<th>Drill Site</th>
<th>Kulluk</th>
<th>Discoverer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sivulliq G</td>
<td>4,382 bbl (696.7 m³)</td>
<td>3,049 bbl (484.7 m³)</td>
</tr>
<tr>
<td>Sivulliq N</td>
<td>4,382 bbl (696.7 m³)</td>
<td>3,049 bbl (484.7 m³)</td>
</tr>
<tr>
<td>Torpedo H</td>
<td>4,382 bbl (696.7 m³)</td>
<td>3,049 bbl (484.7 m³)</td>
</tr>
<tr>
<td>Torpedo J</td>
<td>4,382 bbl (696.7 m³)</td>
<td>3,049 bbl (484.7 m³)</td>
</tr>
</tbody>
</table>

Seawater is pumped down lines in the riser to jets positioned near each disk to promote cleanout of the hole. Compressed air flows down an internal string of drillpipe to the bit and spoil (sediment) from the drilling process, along with seawater, is air-lifted up the drillpipe annulus into the moonpool. There, the air is separated from the stream, and cuttings and seawater are returned to the surface of the seafloor where they are disposed.

Once the bit is at the seafloor, pumping and airlift operations begin. The upper 2-8 ft (0.6-2.4 m) of the seafloor at the mudline washes out to form a funnel-like hole. The seafloor below this soft layer is composed of stiff clays such that the bit leaves a vertical hole without the need for a liner or sloping the sides of the MLC.

Large rocks ranging from the size of a basketball to a small car, may be present at the drill site. The MLC bit has a 30 in. (76 cm) OD extension on the bottom, with a pilot bit attached to its nose, called a boulder catcher. This device has large holes at the top, and as boulders are pushed toward the center of the bit, the rocks simply fall into the boulder catcher and they are removed from the hole when the assembly is pulled. Historically, the number and size of boulders varies significantly from well to well. Although boulder-sized materials may be present, this area is not the “Stefansson Sound Boulder Patch” (located 100 mi [161 km]) from the proposed drill sites as described in Section 3.9.1).

When the MLC bit reaches its maximum depth, the hole is cleaned and the entire assembly is pulled from the hole. After the well is drilled and the wellsite abandoned, ocean currents, ice gouging and natural sedimentation will result in the hole filling in over a period of time.
2.4 Vertical Seismic Profiling

Shell may conduct a geophysical survey referred to as Vertical Seismic Profiling (VSP) at each drill site where a well is drilled. During VSP surveys, an airgun array, which is typically much smaller than those used for routine seismic surveys, is deployed at a location near or adjacent to the drilling vessel, while receivers are placed (temporarily anchored) in the wellbore. These airguns can be activated in any combination and Shell would utilize the minimum airgun volume required to obtain an acceptable signal. The sound source (airgun array) is fired repeatedly, and the reflected sonic waves are recorded by receivers (geophones) located in the wellbore. The geophones, typically a string of them, are then raised up to the next interval in the wellbore and the process is repeated until the entire wellbore has been surveyed. The purpose of the VSP is to gather geophysical information at various depths, which can then be used to tie-in or ground-truth geophysical information from the previous seismic surveys with geological data collected within the wellbore.

Shell would likely be conducting a particular form of VSP referred to as a ZVSP, in which the sound source is maintained at a constant location near the wellbore (Figure 2.4-1). A typical sound source that would be used by Shell is the ITAGA eight-airgun array, which consists of four 150 in.³ (2,458 cm³) airguns and four 40 in.³ (655 cm³) airguns. These airguns can be activated in any combination and Shell would utilize the minimum gun volume required to obtain an acceptable signal. Current specifications for the maximum volume of the ITAGA array are provided in Section 2.9, Sound Generation (Table 2.9-6). The airgun array is depicted within its frame or sled, which is approximately 6 ft x 5 ft x 10 ft (1.8 m x 1.5 m x 3.0 m), in Figure 2.4-2. Typical receivers would consist of a Schlumberger wireline four level Vertical Seismic Imager (VSI) tool, which has four receivers 50 ft (15.2 m) apart.

A ZVSP survey is normally conducted at each well after total depth is reached, but may be conducted at a shallower depth. For each survey, Shell would deploy the sound source (airgun array) over the side of the drilling vessel with a crane (sound source would be approximately 50-200 ft (15-60 m) from the...
wellhead, depending on the crane location), to a depth of approximately 10-23 ft (3-7 m) below the water surface. The VSI with its four receivers would be temporarily anchored in the wellbore at depth. The sound source is then routinely pressured up to 2,000 psi, and activated 5-7 times at approximately 20-second (sec) intervals. The VSI would then be moved to the next interval of the wellbore and re-anchored, after which the airgun array would again be activated 5-7 times. This process would be repeated until the entire wellbore is surveyed in this manner. The interval between anchor points for the VSI is usually 200-300 ft (60-91 m). A normal ZVSP survey is conducted over a period of about 10-14 hours depending on the depth of the well and the number of anchoring points.

### 2.5 Drilling Operations and Logistics

The drilling vessel will arrive in the Camden Bay area with supplies to drill one well, a crew of up to 108 (if the *Kulluk* is used), and up to 140 if the *Discoverer* is used.

The estimated number of drilling days per drill site for the drilling vessel *Kulluk* or *Discoverer* at the Torpedo prospect is 44 days. Drilling days for the Sivulliq drill sites are estimated at 34 days. The total days on site for the Torpedo and Sivulliq drill sites include one day to set the anchors, five days to construct the MLC, one day to remove anchors, and one day to move off the location.

**Crew Rotation**

Work rotations will be based on 21-day shifts (21 days on and 21 days off). A helicopter operating from the shorebase at Deadhorse will be used to facilitate crew changes.

**Refueling**

Refueling of the *Kulluk* or *Discoverer* will be accomplished vessel-to-vessel in accordance with USCG regulations, Lease Stipulations and Shell’s operations plans (including Fuel Transfer Plan – Appendix M of the EP). Shell will pre-boom during all fuel transfers per the Fuel Transfer Plan. A more detailed explanation of refueling including spill prevention and response is presented in Section 2.10. Each vessel will require refueling four to six times during the drilling season, depending on fuel consumption based on utilization.

**Resupply**

Resupply of the drilling vessel using marine vessels will be from both Dutch Harbor (OSV) and West Dock (coastwise qualified vessel). Helicopters will also be used for provision resupply and SAR operations. Types of vessels and/or aircraft used for resupply are described in Section 2.2. It is estimated that 10 resupply trips will be conducted between Dutch Harbor and the drilling vessel or associated vessels during a drilling season.

**Shorebase**

Shell’s shorebase for air transportation for the planned drilling program will be located at the Deadhorse Airport. A SAR helicopter, a Sikorsky S-92, will be stationed in Barrow in support of the drilling operations. A crew change helicopter, an AW-139 will be based at the Deadhorse airport. A Twin Otter will also be based at the Deadhorse airport. The Deadhorse airport (airport code SCC) has a paved runway that is 6,500 ft (1,981 m) in length and supports daily commercial and cargo flights from Anchorage and other locations in Alaska.

Marine support for the planned drilling program will be from the BP Exploration (Alaska) Inc.-operated West Dock.
Facilities will be consolidated in Deadhorse to support drilling, logistics, and oil spill response. Approximately 30 Shell personnel will be based in Deadhorse. Facilities include accommodations at the Prudhoe Bay Hotel and Service Area 10, office space at the existing Carlile building, rental of existing Carlile yard space for short term Oil Response and Drilling equipment staging, and the leasing of Era Helicopter's terminal building to support crew change operations across the different functions of Shell offshore drilling. No construction or expansion is planned at the Deadhorse facilities.

Shell will also manage portions of the drilling program from their Anchorage and Houston offices. The SIWAC will be stationed in Anchorage.

### 2.6 Well and Drilling Fluid Plan

During MLC construction and early phases of drilling (through the 26-in. diameter hole section), Shell will use seawater with the biopolymer Duovis (produced from corn). This blend will be used to make the sweeps to clean out the hole during MLC construction and early phases of drilling. Components of the seawater-based fluid are the same for either drilling vessel.

Once the 20-in. casing level is reached, Shell will use water-based drilling mud. During drilling operations, cuttings will be separated from the drilling fluids with shakers, de-sanders and de-silters. Drilling fluids will be recovered, reconditioned and reused as much as practicable. When drilling fluids have been exhausted, those spent drilling fluids will be held in storage aboard the drilling vessel until they are transported to the deck barge or waste barge for temporary storage. Drill cuttings that are recovered off the shakers will be transferred from the drilling vessel to the same adjacent vessel, via a separate flexible hose connection, using compressed air. On the adjacent vessel, the cuttings will be held within lined, covered containers. The material will be transported out of region to a licensed TDS facility for disposal.

### 2.7 Waste Management

This section describes the potential solid and liquid waste generated and disposal methods for four planned exploration wells. The types of solid and liquid wastes and projected amounts are specific to drilling at each prospect.

Drilling support vessels are not subject to the Arctic NPDES GP but are subject to the Vessel GP. Shell has authorization to discharge liquid wastes under the NPDES permit authorization AKG-28-0000. However, Shell has voluntarily decided to not discharge to the ocean the following regulated waste streams:

- drilling mud and cuttings with adhered mud AKG-28-0000 (Discharge 001);
- treated sanitary waste (Discharge 003);
- domestic waste (Discharge 004);
- bilge water (Discharge 011); and
- ballast water (Discharge 010).

These wastes will be transferred from the drilling vessel to an ocean-going deck barge or waste barge by an OSV. The deck barge and waste barge cannot safely tie directly next to the drilling vessel, so an OSV with DP will be used to transfer waste from the drilling vessel to the deck barge or waste barge. Each
barge will be used for temporary storage until the wastes are transported to an EPA-permitted TDS. Possible disposal facilities are listed in Section 6 of the revised Camden Bay EP.

The following minor NPDES-permitted discharges would occur during the exploration drilling program:

- Deck drainage (Discharge 002) – any waste resulting from platform washings, deck washings, spillage, rainwater, snowmelt, runoff from drains including drip pans and work areas;
- Desalination unit wastes (Discharge 005) – waste associated with the process of creating fresh water from seawater;
- BOP fluid (Discharge 006) – fluid used to actuate hydraulic equipment on the BOP;
- Non-contact cooling water (Discharge 009) – once-through cooling water;
- Excess cement slurry (Discharge 012) – excess cement and wastes from equipment washdown after a cementing operation;
- Mud, cuttings, cement at seafloor (Discharge 013) – materials discharged at the surface of the seafloor in the early phases of drilling, before well casing is set, and during well abandonment and plugging. In the Camden Bay exploration plan, this includes no drilling mud, but does include cuttings and drilling fluids used to construct the MLCs and to drill through the 26-in. diameter hole section.

Each of these minor discharges is discussed below. In some cases, no impact is expected and these discharges are not addressed in the Section 4 (e.g. BOP fluid and excess cement).

**Deck drainage (Discharge 002)** - There are no NPDES-required limitations on volume for this discharge. Discharges of deck drainage are subject to the effluent limitations and monitoring requirements for Discharge 002 as stated in the NPDES GP.

The primary pollutant of concern in deck drainage is oil. Under the NPDES GP all discharges of deck drainage that has been contaminated with oil will be processed through the onboard oil-water separator prior to discharge. No free oil will be discharged. Only uncontaminated water may be discharged from the oil-water separator, and the use of a photo-electronic monitoring device prevents oil from being discharged from the unit. Like other discharges, the uncontaminated water stream must meet the “sheen test” requirement of the NPDES GP. Therefore, no free oil discharges are anticipated because all deck drainage will be treated through this system. Oily water will be stored onboard and later transported to a licensed TDS facility for disposal. Impact associated with discharge of deck drainage is negligible.

**Desalination unit wastes (Discharge 005)** - The waste stream has slightly higher concentrations of all dissolved solids than incoming seawater. Thus, the waste stream is seawater with more salt, hardness, and all other dissolved components. Impact associated with desalination unit wastes is negligible.

**BOP Fluid (Discharge 006)** - BOP fluid for the Camden Bay will be within in the NPDES required pH range (and within other required parameters). As the BOP is opened or closed, the BOP fluid is discharged (vented) at the device to the ocean. Dilution is immediate and thorough within a few feet of the BOP. Thus, the implied 100-m mixing zone dictated by the NPDES permit is not exceeded. The small volume of fluid (Tables 2.7-1 through 2.7-4) and benign nature of the components results in negligible impacts.

**Non-contact Cooling Water (Discharge 009)** – Non-contact cooling water represents over 99 percent of the discharges by volume. Shell has modeled the cooling water discharge from both the Kulluk and
Discoverer (Section 6.0 of the EP). Modeling of the use and discharge of cooling water indicates that the discharged non-contact cooling water will be at ambient temperature 256 ft (78 m) from the end of the disposal caisson on the Discoverer and at 164 ft (50 m) from the end of the disposal caisson on the Kulluk, and any temperature difference within the cooling water plume discharge would be quickly ameliorated. Impact of non-contact cooling water is negligible.

Excess Cement Slurry (Discharge 012) - This material is excess cement and wastes from equipment washdown after a cementing operation. Impacts resulting from this discharge are negligible and are not further addressed. Mud, Cuttings, and Cement at Seafloor (Discharge 013) – As defined in the NPDES Permit: “Mud, Cuttings, Cement at Seafloor,” are materials discharge at the seafloor in the early phases of drilling operations, before well casing is set, and during well abandonment and plugging. For the revised Camden Bay EP, Discharge 013 includes cuttings resulting from construction of the MLC and drilling through 26-in. hole diameter to the depth of the 20-in. diameter casing. No drilling mud is included in Discharge 013 for this exploration plan and none will be discharged to the seafloor. Seawater will be used for constructing the MLC and drilling the non-cased holes. Tables 2.7-1 through 2.7-4 list the approximate discharge of material under Discharge 013.

For both the Kulluk and Discoverer, Shell has modeled the deposition of cuttings on the surface of the seafloor. Modeling of the discharge of cuttings generated while constructing the MLC, as well as the 36- and 26-inch hole segments, was completed assuming a discharge point of approximately 10 ft (3 m) above the seafloor (Section 6c).

The cuttings pile is thickest and widest approximately 66 ft (20 m) down-current from the diffuser where the cuttings are discharged. Modeling indicated the cuttings pile will be approximately 10 ft (3.0 m) thick and 328 ft (100 m) wide. Other cuttings pile dimensions from the diffuser are expected to be:

- 295 ft (90 m) down-current: 246 ft (75 m) wide and 4 in. (10 cm) thick
- 886 ft (270 m) down-current: 246 ft (75 m) wide and 0.4 in. (1 cm) thick
- 1,592 ft (485 m) down-current: end of the plume.

Results of modeling cuttings deposition are also described in Section 6.0 of the revised Camden Bay EP.

General requirements for all discharges include, but are not limited to:

- No discharge of floating solids, debris, deposits, foam, scum or other residues of any kind
- No discharge of diesel, trisodium nitrilotriacetic acid, sodium chromate, or sodium dichromate
- pH must not be less than 6.5 or greater than 8.5.

The potential total generated waste stream (discharged or collected) volumes were estimated or calculated based on the following sources:

- Drill cuttings, mud and cement volumes: calculated based on the various widths and lengths of portions of each well, while taking into account an additional factor for hole “washout” during drilling;
- Volume for non-contact cooling water, sanitary waste, domestic waste, ballast water, desalination unit water, firewater, used oil, hazardous waste and trash/debris: supplied by the drilling contractor currently operating both the drilling vessel;
• Deck drainage: estimated based on collected precipitation expected during the drilling season and probable wash-down water; and

• Solid wastes, (trash, debris) will be segregated and disposed of, or recycled at approved disposal or recycling facilities on shore. Solid food wastes will be incinerated aboard the drilling vessel. In addition to these waste streams, Shell will also temporarily store trash and debris, used petroleum products, and hazardous waste (e.g., paint, solvents, unused chemicals, batteries, lamps) to be disposed at an EPA-licensed TDS.

Certain minor discharges will be made through the disposal caisson of either the Kulluk or Discoverer. The disposal caissons are described below.

**Kulluk Disposal Caisson**

If the *Kulluk* is used to conduct the revised Camden Bay EP exploration drilling activities, all wastes not captured for off-site disposal will be discharged to the ocean through the disposal caisson.

The base of the disposal caisson while drilling is approximately 38-41 ft (11.5-12.5 m) below the surface of the ocean. Because of heave, the water level inside the caisson is constantly undergoing minor changes. The disposal caisson is not equipped with a one-way or "float" valve; it is a 36-in. (0.9 m) open pipe. Since it remains open to the sea at all times, the disposal caisson is constantly filled with water. It is an open conduit to the sea through which selected waste streams are disposed below sea level. Section 6 of the EP presents a flow diagram of the disposal caisson for the *Kulluk* (EP Figure 6a-1).

**Discoverer Disposal Caisson**

In the event Shell uses the *Discoverer* to conduct the Camden Bay EP exploration drilling activities, all wastes not captured for off-site disposal will be discharges to the ocean through the disposal caisson.

The disposal caisson on the *Discoverer* runs vertically through the sponson from the main deck level to the base of the sponson. The sponson is an exterior reinforced cladding on the hull to provide ice resistance. It is hollow and extends from the main deck level to well below the water line. Certain waste streams are collected aboard the drilling vessel to a point on the main deck near the mud room. A 15-in. (38-cm) diameter pipe exits the hull, turns downwards and is connected to the top of the disposal caisson.

The disposal caisson is also 15-in. (38-cm) diameter pipe welded into the sponson top and bottom (such that the inside of the sponson remains dry). The bottom of the sponson is 5.6 ft (1.7 m) above the keel depth. The disposal caisson is not equipped with a "float" valve; it is an open pipe. Because it remains open to the sea at all times, the disposal caisson is constantly filled with water. This caisson is an open conduit to the sea through which most waste streams are disposed below sea level.

With the bottom of the sponson located 5.6 ft (1.7 m) above the keel, and the draught of the *Discoverer* being 25.2 ft (7.7 m) while drilling, the base of the disposal caisson while drilling is approximately 19.6 ft (6.0 m) below the water surface. Because of heave, the water level inside the caisson changes constantly.

In addition to cuttings and water based muds (WBM) that will be captured and stored for later disposal, there will be an additional 1,500 bbl of mud stored onboard in a reserve tank. At the end of the drilling season, or if the mud should be contaminated, it will also be transferred to a vessel for disposal at one of the facilities listed. Because of the uncertainty in which well will be the last of the season, and the possibility that some of the mud could become contaminated, the calculated discharge includes this 1,500 bbl mud volume for each well.
The estimated volumes of liquid/fluid, slurry, and cuttings expected to be generated and the rates at which they will be discharged for each proposed drill site are listed in Tables 2.7-1 through 2.7-4.

### Table 2.7-1  Projected Wastes Generated and Ocean Discharges for Sivuilliq Location G

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated*</th>
<th>Total Amount to be Discharged</th>
<th>Discharge Rate</th>
<th>Discharge Method**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drill Cuttings – Discharge 013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kulluk – 5,184 bbl (cuttings only; no drilling mud used)</td>
<td>5,184 bbl (cuttings only; no drilling mud used)</td>
<td>432 bbl/day (discharged over 12 days)</td>
<td>Cuttings from the MLC through 26-in. diameter hole section will be discharged on the surface of the seafloor</td>
<td></td>
</tr>
<tr>
<td>Discoverer – 3,851 bbl (cuttings only; no drilling mud used)</td>
<td>3,851 bbl (cuttings only; no drilling mud used)</td>
<td>321 bbl/day (discharged over 12 days)</td>
<td>Cuttings from the MLC through 26-in. diameter hole section will be discharged on the surface of the seafloor</td>
<td></td>
</tr>
<tr>
<td><strong>Water Based Mud – Discharge 001</strong></td>
<td>2,213 bbl (including 1,500 bbl of mud in active pit system remaining at the conclusion of drilling and abandonment operations)</td>
<td>0 bbl</td>
<td><strong>No discharge.</strong> Water-based mud will be collected and transported out of region for disposal at a licensed TDS</td>
<td></td>
</tr>
<tr>
<td><strong>Drill Cuttings From Water Base Drilling Interval – Discharge 001</strong></td>
<td>713 bbl</td>
<td>0 bbl</td>
<td><strong>No discharge.</strong> Cuttings will be collected and transported out of region for disposal at a licensed TDS</td>
<td></td>
</tr>
<tr>
<td><strong>Excess Cement – Discharge 012</strong></td>
<td>50 bbl</td>
<td>50 bbl</td>
<td>Two occasions at 1 bbl/min</td>
<td><strong>45 bbl discharged at seafloor during 30-in. and 20-in. pipe cementing operations with 5 bbl discharged at the surface with wash-up water</strong></td>
</tr>
<tr>
<td><strong>Non-Contact Cooling Water – Discharge 009</strong></td>
<td>Kulluk – 448,052 bbl (13,178 bbl/day for 34 days)</td>
<td>448,052 bbl</td>
<td>13,178 bbl/day</td>
<td>Discharged to the sea through the disposal caisson</td>
</tr>
<tr>
<td>Discoverer – 1,530,000 bbl (45,000 bbl/day for 34 days)</td>
<td>1,530,000 bbl</td>
<td>45,000 bbl/day</td>
<td>Discharged to the sea at several sites around the hull</td>
<td></td>
</tr>
<tr>
<td><strong>Sanitary Waste – Discharge 003</strong></td>
<td>Kulluk – 4,371 bbl all recycled (throughput based on 108 persons at 50 gallons (gal)/person/day for 34 days)</td>
<td>0 bbl/well</td>
<td><strong>No discharge.</strong> Treated in the Marine Sanitation Device (MSD) and recycled for use aboard the Kulluk. Any unrecycled sanitary waste will be transported out of region for disposal at a licensed TDS</td>
<td></td>
</tr>
<tr>
<td>Discoverer – 1,020 bbl (based on 140 persons at 9 gal/person/day for 34 days)</td>
<td>0 bbl/well</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in the MSD and stored on the drilling vessel then transported out of region for disposal at a licensed TDS</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2.7-1  Projected Wastes Generated and Ocean Discharges for Sivulliq Location G

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated*</th>
<th>Total Amount to be Discharged</th>
<th>Discharge Rate</th>
<th>Discharge Method**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Discharge 004</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Kulluk</em> – 8,742 bbl (based on 108 persons at 100 gal/person/day for 34 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated as required and stored aboard then transported out of region for disposal at a licensed TDS. Food wastes will not be discharged, they will be incinerated</td>
<td></td>
</tr>
<tr>
<td><em>Discoverer</em> – 11,333 bbl (based on 140 persons at 100 gal/person/day for 34 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desalination Unit Brine Water</td>
<td>4,200 bbl (based on 125 bbl/day for 34 days)</td>
<td>4,200 bbl</td>
<td>125 bbl/day</td>
<td>Discharged through disposal caisson below water surface</td>
</tr>
<tr>
<td>– Discharge 005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deck Drainage</td>
<td>170 bbl (based on 5 bbl/day for 34 days)</td>
<td>170 bbl</td>
<td>5 bbl/day (dependent on rainfall)</td>
<td>Processed though oil-water separator then discharge uncontaminated water through disposal caisson below water surface. Oil is stored onboard.</td>
</tr>
<tr>
<td>– Discharge 002</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncontaminated Ballast Water</td>
<td><em>Kulluk</em> – 1,500 bbl (approximately 44 bbl/day for 34 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Ballast water is stored aboard then transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td>– Discharge 010</td>
<td><em>Discoverer</em> – 170 bbl (based on 5 bbl/day for 34 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td></td>
</tr>
<tr>
<td>Firewater Bypass</td>
<td><em>Kulluk</em> – 286 bbl (1 test)</td>
<td>286 bbl (1 test)</td>
<td>Monthly test of fire hoses at 200 gallons per minute (gal/min) for 60 minutes</td>
<td>Discharged through disposal caisson below water’s surface</td>
</tr>
<tr>
<td>– Discharge 008</td>
<td><em>Discoverer</em> – no testing</td>
<td>No testing</td>
<td>No testing</td>
<td>No testing</td>
</tr>
<tr>
<td>Bilge Water</td>
<td><em>Kulluk</em> – 170 bbl (based on 5 bbl/day for 34 days)</td>
<td>0 bbl/well</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in an oil/water separator; uncontaminated water is stored aboard then transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td>– Discharge 011</td>
<td><em>Discoverer</em> – 442 bbl (based on 13 bbl/day for 34 days)</td>
<td>0 bbl/well</td>
<td>0 bbl/day</td>
<td></td>
</tr>
<tr>
<td>BOP Fluid</td>
<td>56.4 bbl</td>
<td>56.4 bbl</td>
<td>Up to 6 BOP tests at an average 9.4 bbl/test</td>
<td>Discharged at the seafloor at the BOP</td>
</tr>
<tr>
<td>– Discharge 006</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trash and Debris</td>
<td>300 bbl/month</td>
<td>0 bbl/well</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Segregated and disposed of at an approved TDS</td>
</tr>
<tr>
<td>Used Oil (Lube Oil)</td>
<td>50 bbl</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Stored aboard in waste oil tanks. Transferred to lube cubes for transport by boat to an approved TDS</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>10 bbl</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Stored aboard in an approved container. Transferred</td>
</tr>
</tbody>
</table>
Table 2.7-1  Projected Wastes Generated and Ocean Discharges for Sivulliq Location G

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated*</th>
<th>Total Amount to be Discharged</th>
<th>Discharge Rate</th>
<th>Discharge Method**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>by boat to an approved TDS</td>
</tr>
<tr>
<td></td>
<td>Discharges for the Kulluk or Discoverer are the same unless where noted.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The types of wastes whose discharge method is listed as “No Discharge” will be shipped to one of the EPA-approved facilities listed in Section 6 a).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.7-2  Projected Wastes Generated and Ocean Discharges for Sivulliq Location N

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated*</th>
<th>Total Amount to be Discharged</th>
<th>Discharge Rate</th>
<th>Discharge Method**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill Cuttings – Discharge 013</td>
<td>Kulluk – 5,187 bbl (cuttings only; no drilling mud used)</td>
<td>5,187 bbl (cuttings only; no drilling mud used)</td>
<td>432 bbl/day (discharged over 12 days)</td>
<td>Cuttings from the MLC through 26-in. diameter hole section will be discharged on the surface of the seafloor</td>
</tr>
<tr>
<td>Discoverer – 3,854 bbl (cuttings only; no drilling mud used)</td>
<td>3,854 bbl (cuttings only; no drilling mud used)</td>
<td>321 bbl/day (discharged over 12 days)</td>
<td>Cuttings from the MLC through 26-in. diameter hole section will be discharged on the surface of the seafloor</td>
<td></td>
</tr>
<tr>
<td>Water Based Mud – Discharge 001</td>
<td>2,213 bbl (including 1,500 bbl of mud in active pit system remaining at the conclusion of drilling and abandonment operations)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td>No discharge. Water-based mud will be collected and transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td>Drill Cuttings From Water-Based Drilling Interval – Discharge 001</td>
<td>713 bbl</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td>No discharge. Cuttings will be collected and transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td>Excess Cement – Discharge 012</td>
<td>50 bbl</td>
<td>50 bbl</td>
<td>Two occasions at 1 bbl/min</td>
<td>45 bbl discharged at seafloor during 30-in. and 20-in. pipe cementing operations with 5 bbl discharged at the surface with wash-up water</td>
</tr>
<tr>
<td>Non-Contact Cooling Water – Discharge 009</td>
<td>Kulluk – 448,052 bbl (13,178 bbl/day for 34 days)</td>
<td>448,052 bbl</td>
<td>13,178 bbl/day</td>
<td>Discharged to the sea through the disposal caisson</td>
</tr>
<tr>
<td>Discoverer – 1,530,000 bbl (45,000 bbl/day for 34 days)</td>
<td>1,530,000 bbl</td>
<td>45,000 bbl/day</td>
<td>Discharged to the sea at several sites around the hull</td>
<td></td>
</tr>
<tr>
<td>Sanitary Waste – Discharge 003</td>
<td>Kulluk - 4,371 bbl all recycled (throughput based on 108 persons at 50 gal/person/day for 34 days)</td>
<td>0 bbl/well</td>
<td>0 bbl/day</td>
<td>No discharge. Treated in the Marine Sanitation Device (MSD) and recycled for use aboard the Kulluk. Any unrecycled sanitary waste will be transported out of region for disposal at a licensed TDS.</td>
</tr>
</tbody>
</table>
### Table 2.7-2  Projected Wastes Generated and Ocean Discharges for Sivulliq Location N

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated*</th>
<th>Total Amount to be Discharged</th>
<th>Discharge Rate</th>
<th>Discharge Method**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discoverer</strong></td>
<td><strong>1,020 bbl</strong> (based on 140 persons at 9 gal/person/day for 34 days)</td>
<td>0 bbl/well</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in the MSD and stored on the drilling vessel then transported out of region for disposal at a licensed TDS.</td>
</tr>
<tr>
<td><strong>Domestic Waste</strong></td>
<td><strong>Kulluk</strong> – 8,742 bbl** (based on 108 persons at 100 gal/person/day for 34 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated as required and stored aboard then transported out of region for disposal at a licensed TDS. Food wastes will not be discharged, they will be incinerated</td>
</tr>
<tr>
<td><strong>Discoverer</strong></td>
<td><strong>11,333 bbl</strong> (based on 140 persons at 100 gal/person/day for 34 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in the MSD and stored on the drilling vessel then transported out of region for disposal at a licensed TDS.</td>
</tr>
<tr>
<td><strong>Desalination Unit Brine Water</strong></td>
<td><strong>4,200 bbl</strong> (based on 125 bbl/day for 34 days)</td>
<td><strong>4,200 bbl</strong></td>
<td><strong>125 bbl/day</strong></td>
<td>Discharged through disposal caisson below water’s surface</td>
</tr>
<tr>
<td><strong>Deck Drainage</strong></td>
<td><strong>170 bbl</strong> (based on 5 bbl/day for 34 days)</td>
<td><strong>170 bbl</strong></td>
<td><strong>5 bbl/day (dependent on rainfall)</strong></td>
<td>Processed through oil-water separator then discharge uncontaminated water through disposal caisson below water surface. Oil is stored onboard.</td>
</tr>
<tr>
<td><strong>Uncontaminated Ballast Water</strong></td>
<td><strong>Kulluk</strong> – 1,500 bbl** (approximately 44 bbl/day for 34 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Ballast water is stored aboard then transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td><strong>Discoverer</strong></td>
<td><strong>170 bbl</strong> (based on 5 bbl/day for 34 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in the MSD and stored on the drilling vessel then transported out of region for disposal at a licensed TDS.</td>
</tr>
<tr>
<td><strong>Firewater Bypass</strong></td>
<td><strong>Kulluk</strong> – 286 bbl (1 test)</td>
<td><strong>286 bbl (1 test)</strong></td>
<td>Monthly test of fire hoses at 200 gal/min for 60 minutes</td>
<td>Discharged through disposal caisson below water’s surface</td>
</tr>
<tr>
<td><strong>Discoverer</strong></td>
<td>no testing</td>
<td>No testing</td>
<td>No testing</td>
<td>No testing</td>
</tr>
<tr>
<td><strong>Bilge Water</strong></td>
<td><strong>Kulluk</strong> – 170 bbl** (based on 5 bbl/day for 34 days)</td>
<td>0 bbl/well</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in an oil/water separator; uncontaminated water is stored aboard then transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td><strong>Discoverer</strong></td>
<td><strong>442 bbl</strong> (based on 13 bbl/day for 34 days)</td>
<td>0 bbl/well</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in the MSD and stored on the drilling vessel then transported out of region for disposal at a licensed TDS.</td>
</tr>
<tr>
<td><strong>BOP Fluid</strong></td>
<td><strong>56.4 bbl</strong></td>
<td><strong>56.4 bbl</strong></td>
<td>Up to 6 BOP tests at an average 9.4 bbl/test</td>
<td>Discharged at the seafloor at the BOP</td>
</tr>
<tr>
<td><strong>Trash and Debris</strong></td>
<td><strong>300 bbl/month</strong></td>
<td>0 bbl/well</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Segregated and disposed of at an approved TDS</td>
</tr>
<tr>
<td><strong>Used Oil (Lube Oil)</strong></td>
<td><strong>50 bbl</strong></td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Stored aboard in waste oil tanks. Transferred to...</td>
</tr>
</tbody>
</table>
Table 2.7-2  Projected Wastes Generated and Ocean Discharges for Sivulliq Location N

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated*</th>
<th>Total Amount to be Discharged</th>
<th>Discharge Rate</th>
<th>Discharge Method**</th>
</tr>
</thead>
<tbody>
<tr>
<td>lube cubes for transport by boat to an approved TDS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazardous waste</td>
<td>10 bbl</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td>No discharge. Stored aboard in an approved container. Transferred by boat to an approved TDS</td>
</tr>
</tbody>
</table>

*Discharges for the Kulluk or Discoverer are the same unless where noted.

**The types of wastes whose discharge method is listed as "No Discharge" will be shipped to one of the EPA approved facilities listed in Section 6 a).

Table 2.7-3  Projected Wastes Generated and Ocean Discharges for Torpedo Location H

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated</th>
<th>Total Amount to be Discharged**</th>
<th>Discharge Rate</th>
<th>Discharge Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill Cuttings – Discharge 013</td>
<td><strong>Kulluk</strong> – 5,335 bbl (cuttings only; no drilling mud used)</td>
<td>5,335 bbl (cuttings only; no drilling mud used)</td>
<td>445 bbl/day (discharged over 12 days)</td>
<td>Cuttings from the MLC through 26-in. diameter hole section will be discharged on the surface of the seafloor</td>
</tr>
<tr>
<td>Drill Cuttings – Discharge 013</td>
<td><strong>Discoverer</strong> – 4,002 bbl (cuttings only; no drilling mud used)</td>
<td>4,002 bbl (cuttings only; no drilling mud used)</td>
<td>334 bbl/day (discharged over 12 days)</td>
<td>Cuttings from the MLC through 26-in. diameter hole section will be discharged on the surface of the seafloor</td>
</tr>
<tr>
<td>Water Based Mud – Discharge 001*</td>
<td>3,022 bbl (including 1,500 bbl of mud in active pit system remaining at the conclusion of drilling and abandonment operations.)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td>No discharge. Water based mud will be collected and transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td>Drill Cuttings From Water Base Drilling Interval – Discharge 001</td>
<td>1,522 bbl</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td>No discharge. Cuttings will be collected and transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td>Excess Cement – Discharge 012</td>
<td>50 bbl</td>
<td>50 bbl</td>
<td>two occasions at 1 bbl/min</td>
<td>45 bbl discharged at seafloor during 30-in. and 20-in. pipe cementing operations with 5 bbl discharged at the surface with wash-up water</td>
</tr>
<tr>
<td>Non-Contact Cooling Water – Discharge 009</td>
<td><strong>Kulluk</strong> – 579,832 bbl (13,178 bbl/day for 44 days)</td>
<td>579,832 bbl</td>
<td>13,178 bbl/day</td>
<td>Discharged to the sea through the disposal caisson</td>
</tr>
<tr>
<td></td>
<td><strong>Discoverer</strong> – 1,980,000 bbl (45,000 bbl/day for 44 days)</td>
<td>1,980,000 bbl</td>
<td>45,000 bbl/day</td>
<td>Discharged to the sea at several sites around the hull</td>
</tr>
<tr>
<td>Sanitary Waste – Discharge 003</td>
<td><strong>Kulluk</strong> – 5,657 bbl all recycled (throughput based on 108 persons)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td>No discharge. Treated in the Marine Sanitation Device (MSD) and</td>
</tr>
</tbody>
</table>
### Table 2.7-3 Projected Wastes Generated and Ocean Discharges for Torpedo Location H

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated</th>
<th>Total Amount to be Discharged**</th>
<th>Discharge Rate</th>
<th>Discharge Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discoverer – Discharge 004</td>
<td>Discoverer – 1,320 bbl (based on 140 persons at 9 gal/person/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in the MSD and stored on the drilling vessel then transported out of region for disposal at a licensed TDS.</td>
</tr>
<tr>
<td>Domestic Waste</td>
<td>Discoverer – 14,667 bbl (based on 140 persons at 100 gal/person/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated as required and stored aboard then transported out of region for disposal at a licensed TDS. Food wastes will not be discharged, they will be incinerated</td>
</tr>
<tr>
<td>Desalination Unit Brine Water – Discharge 005</td>
<td>5,500 bbl (based on 125 bbl/day for 44 days)</td>
<td>5,500 bbl</td>
<td>125 bbl/day</td>
<td>Discharged through disposal caisson below water’s surface</td>
</tr>
<tr>
<td>Deck Drainage – Discharge 002</td>
<td>220 bbl (based on 5 bbl/day for 44 days)</td>
<td>220 bbl</td>
<td>5 bbl/day (dependent on rainfall)</td>
<td>Processed though oil-water separator then discharged uncontaminated water through disposal caisson below water surface. Oil is stored onboard</td>
</tr>
<tr>
<td>Uncontaminated Ballast Water – Discharge 010</td>
<td><strong>Kulluk</strong> – 1,500 bbl (approximately 34 300 bbl/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Ballast water is stored aboard then transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td>Firewater Bypass – Discharge 008</td>
<td>Discoverer – 220 bbl (based on 5 bbl/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td></td>
</tr>
<tr>
<td><strong>Firewater Bypass – Discharge 008</strong></td>
<td><strong>Kulluk</strong> – 572 bbl (2 tests)</td>
<td>572 bbl (2 tests)</td>
<td>Monthly test of fire hoses at 200 gal/min for 60 minutes</td>
<td>Discharged through disposal caisson below water’s surface</td>
</tr>
<tr>
<td><strong>Discoverer – no testing</strong></td>
<td>No testing</td>
<td>No testing</td>
<td>No testing</td>
<td>No testing</td>
</tr>
<tr>
<td>Bilge Water – Discharge 011</td>
<td><strong>Kulluk</strong> – 220 bbl (based on 5 bbl/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in an oil/water separator; uncontaminated water is stored aboard then transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td>BOP Fluid – Discharge 006</td>
<td>56.4 bbl</td>
<td>56.4 bbl</td>
<td>Up to 6 BOP tests at an average 9.4 bbl/test</td>
<td>Discharged at the seafloor at the BOP</td>
</tr>
<tr>
<td>Trash and Debris</td>
<td>300 bbl/month</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Segregated and</td>
</tr>
</tbody>
</table>
### Table 2.7-3  Projected Wastes Generated and Ocean Discharges for Torpedo Location H

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated</th>
<th>Total Amount to be Discharged**</th>
<th>Discharge Rate</th>
<th>Discharge Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used Oil (Lube Oil)</td>
<td>50 bbl</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Stored aboard in waste oil tanks. Transferred to lube cubes for transport by boat to an approved TDS.</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>10 bbl</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Stored aboard in an approved container. Transferred by boat to an approved TDS.</td>
</tr>
</tbody>
</table>

*Discharges for the Kulluk or Discoverer are the same unless where noted.
**The types of wastes whose discharge method is listed as “No Discharge” will be shipped to one of the EPA approved facilities listed in Section 6 a).

### Table 2.7-4  Projected Wastes Generated and Ocean Discharges for Torpedo Location J

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated</th>
<th>Total Amount to be Discharged**</th>
<th>Discharge Rate</th>
<th>Discharge Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill Cuttings – Discharge 013 Kulluk – 5,335 bbl (cuttings only; no drilling mud used)</td>
<td>5,335 bbl (cuttings only; no drilling mud used)</td>
<td>445 bbl/day (discharged over 12 days)</td>
<td>Cuttings from the MLC through 26-in. diameter hole section will be discharged on the surface of the seafloor</td>
<td></td>
</tr>
<tr>
<td>Discoverer – 4,002 bbl (cuttings only; no drilling mud used)</td>
<td>4,002 bbl (cuttings only; no drilling mud used)</td>
<td>334 bbl/day (discharged over 12 days)</td>
<td>Cuttings from the MLC through 26-in. diameter hole section will be discharged on the surface of the seafloor</td>
<td></td>
</tr>
<tr>
<td>Water Based Mud – Discharge 001</td>
<td>3,003 bbl (including 1,500 bbl of mud in active pit system remaining at the conclusion of drilling and abandonment operations.)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Water based mud will be collected and transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td>Drill Cuttings From Water Base Drilling Interval – Discharge 001</td>
<td>1,503 bbl</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Cuttings will be collected and transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td>Excess Cement – Discharge 012</td>
<td>50 bbl</td>
<td>50 bbl</td>
<td>Two occasions at 1 bbl/min</td>
<td>45 bbl discharged at seafloor during 30-in. and 20-in. pipe cementing operations with 5 bbl discharged at the surface with wash-up water</td>
</tr>
<tr>
<td>Non-Contact Cooling Water – Discharge 009 Kulluk – 579,832 bbl (13,178 bbl/day for 44 days)</td>
<td>579,832 bbl</td>
<td>13,178 bbl/day</td>
<td>Discharged to the sea through the disposal caisson</td>
<td></td>
</tr>
<tr>
<td>Discoverer – 1,980,000 bbl (45,000 bbl/day for 44 days)</td>
<td>1,980,000 bbl</td>
<td>45,000 bbl/day</td>
<td>Discharged to the sea at several sites around the hull</td>
<td></td>
</tr>
</tbody>
</table>
Table 2.7-4  Projected Wastes Generated and Ocean Discharges for Torpedo Location J

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated</th>
<th>Total Amount to be Discharged**</th>
<th>Discharge Rate</th>
<th>Discharge Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary Waste</td>
<td>Kulluk – 5,657 bbl all recycled (throughput based on 108 persons at 50 gal/person/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in the Marine Sanitation Device (MSD) and recycled for use aboard the Kulluk. Any unrecycled sanitary waste will be transported out of region for disposal at a licensed TDS.</td>
</tr>
<tr>
<td></td>
<td>Discoverer – 1,320 bbl (based on 140 persons at 9 gal/person/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in the MSD and stored on the drilling vessel then transported out of region for disposal at a licensed TDS.</td>
</tr>
<tr>
<td>Domestic Waste</td>
<td>Kulluk – 11,314 bbl (based on 108 persons at 100 gal/person/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated as required and stored aboard then transported out of region for disposal at a licensed TDS. Food wastes will not be discharged, they will be incinerated</td>
</tr>
<tr>
<td></td>
<td>Discoverer – 14,667 bbl (based on 140 persons at 100 gal/person/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td></td>
</tr>
<tr>
<td>Desalination Unit Brine Water</td>
<td>5,500 bbl (based on 125 bbl/day for 44 days)</td>
<td>5,500 bbl</td>
<td>125 bbl/day</td>
<td>Discharged through disposal caisson below water’s surface</td>
</tr>
<tr>
<td>Deck Drainage</td>
<td>220 bbl (based on 5 bbl/day for 44 days)</td>
<td>220 bbl</td>
<td>5 bbl/day</td>
<td>Processed through oil-water separator then discharge uncontaminated water through disposal caisson below water surface. Oil is stored onboard</td>
</tr>
<tr>
<td>Uncontaminated Ballast Water</td>
<td>Kulluk – 1,500 bbl (approximately 34 300 bbl/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Ballast water is stored aboard then transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td></td>
<td>Discoverer - 220 bbl (based on 5 bbl/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td></td>
</tr>
<tr>
<td>Firewater Bypass</td>
<td>Kulluk – 572 bbl (2 tests)</td>
<td>572 bbl (2 tests)</td>
<td>Monthly test of fire hoses at 200 gal/min for 60 minutes</td>
<td>Discharged through disposal caisson below water’s surface</td>
</tr>
<tr>
<td></td>
<td>Discoverer – no testing</td>
<td>No testing</td>
<td>No testing</td>
<td>No testing</td>
</tr>
<tr>
<td>Bilge Water</td>
<td>Kulluk – 220 bbl/well (based on 5 bbl/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td><strong>No discharge.</strong> Treated in an oil/water separator; uncontaminated water is stored aboard then transported out of region for disposal at a licensed TDS</td>
</tr>
<tr>
<td></td>
<td>Discoverer – 572 bbl (based on 13 bbl/day for 44 days)</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td></td>
</tr>
<tr>
<td>BOP Fluid</td>
<td>42 bbl</td>
<td>42 bbl</td>
<td>Up to 6 BOP tests at an average 9.4</td>
<td>Discharged at the seafloor at the BOP</td>
</tr>
</tbody>
</table>

*Table 2.7-4  Projected Wastes Generated and Ocean Discharges for Torpedo Location J*

Table 2.7-4  Projected Wastes Generated and Ocean Discharges for Torpedo Location J

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Total Generated</th>
<th>Total Amount to be Discharged**</th>
<th>Discharge Rate</th>
<th>Discharge Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trash and Debris</td>
<td>300 bbl/month</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td>No discharge. Segregated and disposed of at an approved TDS</td>
</tr>
<tr>
<td>Used Oil (Lube Oil)</td>
<td>50 bbl</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td>No discharge. Stored aboard in waste oil tanks. Transferred to lube cubes for transport by boat to an approved TDS.</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>10 bbl</td>
<td>0 bbl</td>
<td>0 bbl/day</td>
<td>No discharge. Stored aboard in an approved container. Transferred by boat to an approved TDS.</td>
</tr>
</tbody>
</table>

*Discharges for the Kulluk or Discoverer are the same unless where noted.  
**The types of wastes whose discharge method is listed as "No Discharge" will be shipped to one of the EPA approved facilities listed in Section 6 a).

A list of the components that may be added to the drilling fluid is summarized in Table 2.7-5. This component list and the respective volumes have been designed for various drilling depths from the MLC to total depth for the Sivulliq and Torpedo wells.

Table 2.7-5  Drilling Fluid Components and Load Out List

<table>
<thead>
<tr>
<th>Product</th>
<th>Units</th>
<th>Unit Size</th>
<th>Units per Box</th>
<th>Total Sacks</th>
<th>Number of Pallets</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-I WATE</td>
<td>SACK</td>
<td>bulk</td>
<td>N/A</td>
<td>6,800</td>
<td>340 tons</td>
</tr>
<tr>
<td>M-I GEL</td>
<td>SACK</td>
<td>bulk</td>
<td>30</td>
<td>1,500</td>
<td>75 tons</td>
</tr>
<tr>
<td>CAUSTIC SODA</td>
<td>SACK</td>
<td>50 lb</td>
<td>50</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>SODA ASH</td>
<td>SACK</td>
<td>50 lb</td>
<td>50</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>SODIUM BICARBONATE</td>
<td>SACK</td>
<td>50 lb</td>
<td>50</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>DUOVIS</td>
<td>SACK</td>
<td>25 lb</td>
<td>80</td>
<td>320</td>
<td>4</td>
</tr>
<tr>
<td>KLASTOP</td>
<td>DRUM</td>
<td>55 gal</td>
<td>4</td>
<td>240</td>
<td>60</td>
</tr>
<tr>
<td>POLY PAC R</td>
<td>SACK</td>
<td>50 lb</td>
<td>40</td>
<td>80</td>
<td>2</td>
</tr>
<tr>
<td>POLY PAC UL</td>
<td>SACK</td>
<td>50 lb</td>
<td>40</td>
<td>160</td>
<td>4</td>
</tr>
<tr>
<td>CITRIC ACID</td>
<td>SACK</td>
<td>50 lb</td>
<td>50</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>SALT *** (or Brine)</td>
<td>SACK</td>
<td>BIG BAG</td>
<td>1500 kg</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>DEFOMAX</td>
<td>CAN</td>
<td>5 gal</td>
<td>32</td>
<td>32</td>
<td>1</td>
</tr>
<tr>
<td>NUT PLUG (ASST.)</td>
<td>SACK</td>
<td>50</td>
<td>40</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>MIX II (ASST.)</td>
<td>SACK</td>
<td>25</td>
<td>40</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>DESCO CF</td>
<td>SACK</td>
<td>25 lb</td>
<td>80</td>
<td>80</td>
<td>1</td>
</tr>
<tr>
<td>IDCAP D</td>
<td>SACK</td>
<td>50</td>
<td>40</td>
<td>160</td>
<td>4</td>
</tr>
<tr>
<td>SAPP</td>
<td>SACK</td>
<td>50</td>
<td>45</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>DUROGEL</td>
<td>SACK</td>
<td>50</td>
<td>40</td>
<td>320</td>
<td>8</td>
</tr>
<tr>
<td>MYACIDE</td>
<td>SACK</td>
<td>5 gal</td>
<td>32</td>
<td>128</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total Containers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>BRINE (9.8 ppg) only 8 Big bags of salt for contingencies</td>
<td>8,214 bbl</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

lb = pound(s)  
kg = kilogram(s)  
ppg = pounds per gallon
2.8 Air Emissions

Shell has submitted an application for a synthetic Minor Source operating permit from the EPA Region 10 for exploration drilling using the Kulluk on OCS lease blocks in the Beaufort Sea. The leases are beyond the Alaska seaward boundary, which is 3 mi (4.8 km) out from the shoreline. Therefore, air permits are administered by the EPA through 40 CFR Part 55 rules ("OCS rules"). However, within 25 mi (40 km) of the Alaska seaward boundary the EPA incorporates Alaska rules as well. Therefore, only federal rules apply to the leases beyond the 25-mi (40-km) distance, but Alaska and federal rules apply within the 25-mi (40-km) distance. The application covers all OCS leases currently issued in the Beaufort Sea that are owned by multiple oil and gas companies, including Shell. Inclusion of all leases is necessary because the Kulluk may be subject to agreements between one or more lessees of record where the Kulluk would be used to drill wells on non-Shell leases.

Air emissions from the Discoverer and support vessels are authorized through a PSD air quality permit R10OCS/PSD-AK-2010-01, issued by EPA. The PSD permit was remanded back to the EPA by the Environmental Appeals Board on 30 December 2010 and will be re-issued prior to 2012 exploration drilling.

The primary sources of the emissions by the drilling vessel and support vessels will be combustion engines including the vessel engines, generators, compressors, draw works, and pumps. Regulated air emissions include nitrogen oxides (NOx), sulfur dioxide (SO2), carbon monoxide (CO), volatile organic compounds (VOC), particulate matter less than 2.5 micrometers (PM2.5), and particulate matter less than 10 micrometers (PM10). The emissions are regulated under the Clean Air Act and must be permitted.

PSD permitting rules (40 CFR Section 52.21) apply to new major sources or major modifications of existing major sources. The Discoverer operating by itself would not be subject to the PSD permitting rules, but rules that apply to OCS activities arguably require emissions from the support vessels to be included in the total project emissions when determining PSD applicability. The PSD permitting rules require air quality modeling analyses, and public involvement in the permitting process.

Projected Emissions – Kulluk

Total annual emissions from sources on the Kulluk and support vessel sources are provided in Table 2.8-1. These emissions are based on a maximum 120-day drilling season although it is likely that environmental conditions will limit the Kulluk to less than 120 drilling days.

Emission units on the Kulluk are primarily associated with the generation of electricity, compressed air, and hydraulic energy to support drilling. All others are secondary and related to general purpose heating, transfer of materials about the deck, pumping of cement, incineration of (primarily) domestic waste, and other small emission sources. All emission units on the Kulluk will use ultra low sulfur diesel fuel with sulfur content at or below 15 parts per million (ppm).

Table 2.8-1  Kulluk Annual Potentials to Emit

<table>
<thead>
<tr>
<th>Emissions</th>
<th>Kulluk and Sources (includes support vessels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>229</td>
</tr>
<tr>
<td>PM2.5</td>
<td>28</td>
</tr>
<tr>
<td>PM10</td>
<td>28</td>
</tr>
<tr>
<td>SO2</td>
<td>5</td>
</tr>
<tr>
<td>CO</td>
<td>162</td>
</tr>
<tr>
<td>VOC</td>
<td>40</td>
</tr>
<tr>
<td>Total Hazardous Air Pollutants (HAPs)</td>
<td>Est. less than one ton/year</td>
</tr>
</tbody>
</table>

Annual potential to emit is limited to 120 days
Projected Emissions - Discoverer

Emissions estimates prepared for the air quality permit application for the Discoverer are provided in Table 2.8-2 for the drillship and support vessels. Support vessel emissions are included only when the vessel is within 25 mi (40 km) of the drilling vessel.

Emission units on the Discoverer are primarily associated with the generation of electricity, compressed air, and hydraulic energy to support drilling. All others are secondary and related to general purpose heating, transfer of materials about the deck, pumping of cement, incineration of (primarily) domestic waste, and other small emission sources. All emission units on the Discoverer will use ultra low sulfur diesel with sulfur content at or below 15 ppm.

Total annual potential emissions for the Discoverer combined with support vessel sources are provided in Table 2.8-2.

Table 2.8-2  Discoverer Annual Potentials to Emit

<table>
<thead>
<tr>
<th>Emissions</th>
<th>Discoverer and Sources (includes support vessels)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tons/year</td>
</tr>
<tr>
<td>NO\textsubscript{x}</td>
<td>336</td>
</tr>
<tr>
<td>PM\textsubscript{2.5}</td>
<td>21</td>
</tr>
<tr>
<td>PM\textsubscript{10}</td>
<td>22</td>
</tr>
<tr>
<td>SO\textsubscript{2}</td>
<td>1</td>
</tr>
<tr>
<td>CO</td>
<td>154</td>
</tr>
<tr>
<td>VOC</td>
<td>43</td>
</tr>
<tr>
<td>Total Hazardous Air Pollutants (HAPs)</td>
<td>Est. less than one ton/year</td>
</tr>
</tbody>
</table>

Annual potential to emit is limited to 120 days.

Emissions Reduction/Mitigation Measures

Kulluk

Shell offers the following emission reduction measures, 30 CFR 250.218(b), and restrictions on its operation for the purposes of limiting emissions and air quality impacts from the Kulluk:

- The Kulluk will have selective catalytic reduction (SCR) as a nitrogen oxide (NOx) tailpipe emission control on its primary engines, reducing NOx emissions to less than 1.6 g/kW-hr. The primary generators will also have oxidation catalysts installed for control of particulate matter less than 2.5 microns (PM\textsubscript{2.5}), volatile organic compounds (VOC), and carbon monoxide (CO). Oxidation Catalysts are assumed to control engine emissions to 50 percent for PM\textsubscript{2.5}, 80 percent for CO, and 70 percent for VOC.

- The other engines normally used in the drilling activities (the air compressors, the MLC, hydraulic power units (HPU), and cranes) will also have oxidation catalysts as tailpipe control for oxidizing all oxidize-able substances, including PM\textsubscript{2.5}, VOC, and CO. Control of engine emissions is assumed to be 50 percent for PM\textsubscript{2.5}, 80 percent for CO, and 70 percent for VOC.

- Ice management vessels and anchor handlers will have SCR as a nitrogen oxide (NOx) tailpipe emission control, and oxidation catalyst on its primary propulsion and generation engines with the same reduction efficiencies as the Kulluk primary engines.

- Ultra Low Sulfur Diesel (ULSD) (0.0015 percent sulfur) fuel will be purchased for the Kulluk and support vessels to reduce sulfur dioxide (SO\textsubscript{2}) emissions.
Discoverer

Shell offers the following emission reduction measures, 30 CFR 250.218(b), and restrictions on its operation for the purposes of limiting emissions and air quality impacts from the Discoverer:

- Primary generators on the Discoverer are retrofitted with selective catalytic reduction devices to reduce NOx emissions to under 0.5 g/kW-hr, and catalytic oxidation devices to reduce CO, VOCs and particulate matter less than 10 microns (PM10).
- 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) and fine particulate matter.
- ULSD (0.0015 percent sulfur) fuel will be purchased for the Discoverer and support vessels to reduce sulfur dioxide (SO2) emissions.
- Ice management vessels and anchor handlers will have SCR as a nitrogen oxide (NOx) tailpipe emission control, and oxidation catalyst on its primary propulsion and generation engines.

2.9 Sound Generation

Sound Generation by Drilling

Discoverer

Exploratory drilling will be conducted from the Kulluk or Discoverer, vessels specifically prepared for such operations in the Arctic. Underwater sound propagation results from the use of generators, drilling machinery, and the rig itself. Sound levels during vessel-based operations may fluctuate depending on the specific type of activity at a given time. Underwater sound levels may also depend on the specific equipment in operation. Lower sound levels have been reported during well logging than during drilling operations (Greene 1987b), and underwater sound appeared to be lower at the bow and stern aspects than at the beam of a ship-shaped vessel (Greene 1987a).

Sounds from the Discoverer have not previously been measured in the Arctic. However, measurements of sounds produced by the Discoverer were made in the South China Sea in 2009 (Austin and Warner 2010). The activities included repositioning of the ship on its turret using the thrusters, tripping, drill string handling, drilling, and anchor retrieval. Some of these activities were simulated by running most, but not all, of the required equipment. The measured underwater sound levels generated during the study of the Discoverer in the South China Sea are presented in Table 2.9-1.

<table>
<thead>
<tr>
<th>Measured Activity</th>
<th>Broadband Source Level (dB 1 μPa @1 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turret turning using jacking system</td>
<td>185.7 176.1 174.0</td>
</tr>
<tr>
<td>Turret turning using thrusters</td>
<td>191.5 182.8 180.7</td>
</tr>
<tr>
<td>Turret turning using main engine &amp; rudder (dead slow ahead)</td>
<td>180.0 189.6 181.1</td>
</tr>
<tr>
<td>Turret turning using main engine &amp; rudder (slow ahead)</td>
<td>182.3 187.6 194.6</td>
</tr>
<tr>
<td>Tripping</td>
<td>177.5 185.3 176.2</td>
</tr>
<tr>
<td>Drill string handling</td>
<td>178.7 185.1 177.6</td>
</tr>
<tr>
<td>Drilling</td>
<td>179.9 185.4 178.5</td>
</tr>
<tr>
<td>Anchor retrieval</td>
<td>197.6</td>
</tr>
</tbody>
</table>
The results of those measurements were used to model the sound propagation from the *Discoverer* (including a nearby support vessel) at planned drilling locations in the Chukchi and Beaufort Seas (Warner and Hannay 2011). Ensonified areas from exploration drilling activities with a nearby support vessel were estimated using JASCO Applies Science’s Marine Operations Noise Model (MONM) at the Sivulliq and Torpedo prospects. The model predicts the transmission loss or reduction in sound that would occur with distance from the drilling vessel. Results are presented in Table 2.9-2 Sound transmission loss was found to vary with the season due to changes in water temperature and salinity.

### Table 2.9-2 Predicted 95 Percentile Radii and Total Areas Ensonified For Drilling Activities with a Support Vessel Standing By at the Sivulliq and Torpedo Prospects (Warner and Hannay 2011)

<table>
<thead>
<tr>
<th>Received Level</th>
<th>Sivulliq 95% radius mi (km)</th>
<th>Area mi² (km²)</th>
<th>Torpedo 95% radius mi (km)</th>
<th>Area mi² (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 dB</td>
<td>1.37 (2.20)</td>
<td>6.14 (15.9)</td>
<td>2.06 (3.32)</td>
<td>13.5 (35.0)</td>
</tr>
<tr>
<td>130 dB</td>
<td>0.265 (0.427)</td>
<td>0.234 (0.603)</td>
<td>0.347 (0.559)</td>
<td>0.405 (1.05)</td>
</tr>
<tr>
<td>140 dB</td>
<td>0.070 (0.112)</td>
<td>0.020 (0.052)</td>
<td>0.070 (0.112)</td>
<td>0.020 (0.052)</td>
</tr>
<tr>
<td>150 dB</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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

**Kulluk**

The *Kulluk* or *Discoverer* is likely to introduce somewhat different levels of continuous sound into the water during exploration drilling activities.

Sounds from the *Kulluk* were measured in the Beaufort Sea in 1986 and reported by Greene (1987a, 1987b). The back propagated broadband source level from the measurements (185.5 dB re 1 μPa · m rms; calculated from the reported 1/3-octave band levels), which included sounds from a support vessel operating nearby, were used to model sound propagation at the Sivulliq prospect near Camden Bay. The model estimated that sounds would decrease to 120 dB re 1 μPa · m rms at ~8.25 mi (~13.27 km) from the *Kulluk* (Zykov and Hannay 2007). As a precautionary approach, that distance was multiplied by 1.5 and the resulting radius of 12.37 mi (19.91 km) was used to estimate the total area that may be exposed to continuous sounds ≥120 dB re 1 μPa rms by the *Kulluk* at each drill site. If one well site is drilled in one season, the total area of water ensonified to 120 dB rms in each season will be 480.7 mi² (1,245 km²).

For analysis of the potential effects of drilling sounds on migrating bowhead whales, we calculated the total distance perpendicular to the east-west migration corridor that would be ensonified to ≥120 dB rms. We used that distance to determine the ensonified area and then estimated the number of migrating whales passing the activities that might be exposed to that sound level. For the *Kulluk*, that distance is
two times 12.4 mi (19.9 km) (the estimated radius of the 120 dB rms zone), or 24.7 mi (39.8 km) (i.e., 12.4 mi [19.9 km] north and 12.4 mi [19.9 km] south of the drill site). For the Discoverer, that distance is two times 4.6 mi (7.4 km), or 9.2 mi (14.8 km). At the two Sivulliq sites (G and N, which are located close together and positioned similarly relative to the 131 ft and 656 ft [40 and 200 m] bathymetric contours), the 24.7 mi (39.8 km) distance from the Kulluk covers all of the 23 mi (37 km) wide 0-131 ft (0-40 m) water depth category, and ~11% of the 22.1 mi (35.5 km) wide 131-656 ft (40-200 m) water depth category. The 9.2 mi (14.8 km) distance from the Discoverer covers 40% of the 0-131 ft (0-40 m) category and none of the 131-656 ft (40-200 m) category at the Sivulliq sites.

The two drill sites on the Torpedo prospect (designated as H and J) are not as close together as the Sivulliq sites, but their position relative to the 131 ft and 656 ft (40 m and 200 m) bathymetric contours are similar. For simplicity, only the slightly greater estimates from calculations at the Torpedo “H” site are provided here and are used to represent activities at either of the two Torpedo sites. At the Torpedo H site, the 24.7 mi (39.8 km) distance from the Kulluk covers ~74% of the 23 mi (37 km) wide 0-131 ft (0-40 m) water depth category and ~35% of the 22.1 mi (35.5 km) wide 13-656 ft (40-200 m) water depth category. The 9.2 mi (14.8 km) distance from the Discoverer covers 40% of the 0-131 ft (0-40 m) category and none of the 131-656 ft (40-200 m) category at the Torpedo H site.

The percentages of water depth categories described in the previous two paragraphs were multiplied by the estimated proportion of the whales passing within those categories on each day to estimate the number of bowheads that may be exposed to sounds ≥120 dB if they showed no avoidance of the drilling operations.

**Sound Generation by Aircraft**

Both the level and duration of sounds received underwater from passing aircraft depend on altitude and aspect of the aircraft, receiver depth, and water depth. Received sound level decreases with increasing altitude of the aircraft and with increasing depth to the receiver when the aircraft is directly overhead.

Sound levels, both at the source and at receptors at various distances, are provided below in Tables 2.9-3 and 2.9-4 for some of the models of aircraft commonly used in oil and gas exploration. The models of helicopters and fixed-wing aircraft to be used in the exploration drilling program are expected to be similar to these.

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Received Underwater Sound Levels from Aircraft Operating over Offshore Areas as Reported in the Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Received Underwater Sound Level (dB)</td>
</tr>
<tr>
<td></td>
<td>Altitude 2,000 ft (610 m)</td>
</tr>
<tr>
<td></td>
<td>Water Depth ft/m</td>
</tr>
<tr>
<td>Twin Otter</td>
<td>72/22</td>
</tr>
<tr>
<td>B-N Islander</td>
<td>49/15</td>
</tr>
<tr>
<td>Bell 212</td>
<td>82/25</td>
</tr>
<tr>
<td>Bell 214ST</td>
<td>72/22</td>
</tr>
<tr>
<td>Sikorsky 61</td>
<td>121/37</td>
</tr>
</tbody>
</table>

1 Source: Greene 1985
2 Measured sound levels relative to one μPa at one meter distant for five types of aircraft at altitudes of 500-2,000 ft (152-610 m) from hydrophones at depths of 10, 30, and 60 ft (3, 9, and 18 m) below the water surface.
Dominant tones in noise spectra from helicopters are generally below 500 Hz (Greene and Moore 1995). Harmonics of the main rotor and tail rotor usually dominate the sound from helicopters; however, many additional tones associated with the engines and other rotating parts are sometimes present.

Because of Doppler shift effects, the frequencies of tones received at a stationary site diminish when an aircraft passes overhead. The apparent frequency is increased while the aircraft approaches and is reduced while it moves away.

Aircraft flyovers are not heard under water for very long, especially when compared to how long they are heard in air as the aircraft approaches an observer. Helicopters flying to and from the drilling vessel will generally maintain straight-line routes at altitudes of 1,500 ft (457 m) ASL or greater, thereby limiting the received levels at and below the surface.

**Sound Generation by Ice Management Vessels**

Ice management vessels generally produce more sound energy associated with exploration drilling in the Arctic. When ice is present at the drill site, ice disturbance will be limited to the minimum needed to allow exploration drilling to continue. First-year ice will be the type most likely to be encountered. The ice management vessels will be tasked with managing the ice so that it will flow easily around and past the Kulluk or Discoverer without building up in front of, or around it. Ice breaking could be conducted if the ice poses an immediate safety hazard at the drill sites, but is far from preferred as indicated in the IMP. The sounds are generally 10 to 15 dB higher during ice-breaking than when simply underway in open water or “nudging” ice floes. The majority of the sound generated during ice management activity is produced by cavitation of the propeller as opposed to the engines or by ice contacting the hull (Richardson et al. 1995a). Some reported sound pressure source levels for active ice management vessels are provided below in Table 2.9-5.

Although other factors also influence the level of sound produced during ice-breaking, total horsepower is one indicator. Each of the ice management vessels planned for Shell’s exploration drilling program has a total horsepower similar to the large vessels indicated in Table 2.9-5.
Table 2.9-5  Reported Sound Pressure Levels for Vessels During Ice Management

<table>
<thead>
<tr>
<th>Ice Breaker</th>
<th>Vessel Power</th>
<th>Activity</th>
<th>Source Level (^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kalvik (^1)</td>
<td>23,400 hp</td>
<td>Ice management</td>
<td>181 dB</td>
</tr>
<tr>
<td>Ikaluk (^1)</td>
<td>14,900 hp</td>
<td>Ice management</td>
<td>184 dB</td>
</tr>
<tr>
<td>Canmar Supplier (^1)</td>
<td>7,040 hp</td>
<td>Ice management</td>
<td>174 dB</td>
</tr>
<tr>
<td>Robert Lemeur (^1)</td>
<td>9,600 hp</td>
<td>Ice management</td>
<td>182 dB</td>
</tr>
<tr>
<td>Kalvik (^2)</td>
<td>23,400 hp</td>
<td>Ice management</td>
<td>176 dB</td>
</tr>
</tbody>
</table>

\(^1\) From Hall et al. 1994, sound levels are for the 10 Hz to 10,000 Hz band (broadband), Kalvik now known as the Vladimir Ignatjuk

\(^2\) From Brewer et al. 1993, sound levels are for the 20 Hz to 20,000 Hz band

\(^3\) Source levels are referenced at \(1 \mu Pa \cdot m\) rms

**Sound from Vertical Seismic Profiling**

Shell may conduct a geophysical survey referred to as Vertical Seismic Profiling (VSP) at each drill site where a well is drilled. During VSP surveys, an airgun array is deployed at a location near or adjacent to the drilling vessel, while receivers are placed (temporarily anchored) in the wellbore.

Airguns function by venting high-pressure air into the water. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by oscillation of the resulting air bubble. The sizes, arrangement, and firing times of the individual airguns in an array are designed and synchronized to suppress the pressure oscillations subsequent to the first cycle. Typical high-energy airgun arrays emit most energy at 10-120 Hz. However, the pulses contain significant energy up to 500-1,000 Hz and some energy at higher frequencies (Goold and Fish 1998; Potter et al. 2007). The estimated source level used to model sound propagation from the airgun array is \(\sim 241\ dB\ re\ 1\ \mu Pa \cdot m\) rms, with most energy between 20 and 140 Hz.

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

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

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

Table 2.9-6  Sound Source (airgun array) Specifications for ZVSP Surveys in the Beaufort Sea

<table>
<thead>
<tr>
<th>Source Type</th>
<th>No. Sources</th>
<th>MAX Total Chamber Size</th>
<th>Pressure</th>
<th>Source Depth</th>
<th>Calibrated Peak-Peak Vertical Amplitude</th>
<th>Zero-Peak Sound Pressure Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLB, ITAGA Sleeve Array</td>
<td>8 airguns, 4 X 40 in.(^3) (12,454 cm(^3))</td>
<td>760 in.(^3)</td>
<td>2,000 psi 140 bar</td>
<td>9.8 ft (3.0 m) 16.4 ft (5.0 m)</td>
<td>16 bar @1 m 23 bar @1 m</td>
<td>238 dB re1(\mu)Pa @1 m 241 dB re1(\mu)Pa @1 m</td>
</tr>
</tbody>
</table>
**Estimated Area Exposed to Impulse Sounds ≥160 dB re 1μPa rms from VSP Activities**

A typical sound source that would be used by Shell for the ZVSP survey in 2012 is the ITAGA eight-airgun array, which consists of four 150-in.³ (2,458-cm³) airguns and four 40-in.³ (655-cm³) airguns. The ≥160 dB re 1 μPa rms radius for this source was estimated from measurements of a similar seismic source used during the 2008 BP Liberty seismic survey (Aerts et al. 2008). The BP Liberty source was also an eight-airgun array, but had a slightly larger total volume of 880 in.³ (5,677 cm³). Because the number of airguns is the same, and the difference in total volume only results in an estimated 0.4 dB decrease in the source level of the ZVSP source, the 100th percentile propagation model from the measurements of the BP Liberty source is almost directly applicable. However, the BP Liberty source was towed at a depth of 5.9 ft (1.8 m), while the ZVSP source will be lowered to a target depth of 13 ft (4 m) (from 9.8-23 ft [3-7 m]). The deeper depth of the ZVSP source has the potential to increase the source strength by as much as 6 dB. Thus, the constant term in the propagation equation from the BP Liberty source was increased from 235.4 to 241.4 while the remainder of the equation (–18*LogR – 0.0047*R) was left unchanged. This equation results in the following estimated distances to maximum received levels: 190 dB = 1,719 ft (524 m); 180 dB = 4,068 ft (1,240 m); 160 dB = 12,041 ft (3,670 m); 120 dB = 34,449 ft (10,500 m). The ≥160 dB distance was multiplied by 1.5 for use in estimating the area ensonified to ≥160 dB rms around the drilling vessel during VSP activities. Therefore, the total area of water potentially exposed to received sound levels ≥160 dB rms by ZVSP operations at one exploration well sites during each season is estimated to be 73.7 mi² (190.8 km²).

**Sound Generation by Support Vessels**

In addition to either drilling vessel, various types of vessels will be used in support of the operations including ice management vessels, anchor handler, OSV(s), and oil-spill response vessels. Sounds from boats and vessels have been reported extensively (Greene and Moore 1995; Blackwell and Greene 2002, 2005, 2006). Numerous measurements of underwater vessel sound have been performed in support of recent industry activity in the Chukchi and Beaufort Seas. Results of these measurements were reported in various 90-day and comprehensive reports since 2007. For example, Garner and Hannay (2009) estimated sound pressure levels of 100 dB at distances ranging from approximately 1.5-2.3 mi (2.4-3.7 km) from various types of barges. MacDonald et al. (2008) estimated higher underwater sound pressure levels from the seismic vessel *Gilavar* of 120 dB at approximately 13 mi (21 km) from the source, although the sound level was only 150 dB at 85 ft (26 m) from the vessel. Like other industry-generated sound, underwater sound from vessels is generally at relatively low frequencies.

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

**2.10 Oil Spill Prevention and Contingency Planning**

Shell is committed to conducting safe and environmentally responsible operations. Shell’s Beaufort Sea Regional Exploration Drilling Program ODPCP emphasizes the prevention of oil pollution by employing the best control mechanisms for blowout prevention and fuel transfer operations, as well as implementing mandatory programs for ensuring personnel practice prevention in all aspects of operations. In addition, all project personnel, including employees and contractors, involved in oil spill contingency response would receive prevention and response training as described in the ODPCP. Training drills also will be
conducted periodically to familiarize personnel with on-site equipment, proper deployment techniques, and maintenance procedures.

Despite the very low likelihood of a large oil spill event, Shell has designed a response program based upon a regional capability of responding to a WCD from an exploration well blowout. During the proposed exploration drilling program, the drilling vessel will be accompanied by an ice management vessel, an arctic-class ice management/anchor handler, and other support vessels that include an OSR barge with an associated ice-class tug. The OSR barge and tug will provide the primary oil spill response platforms along with assistance from the anchor handler serving as a VOSS to supplement the response when necessary. The drilling vessel OSV will serve as a second VOSS. Vessels of similar type and class will be used if these specific vessels are not available.

The dedicated OSR barge, VOSS and other support vessels would be staged in the vicinity of the drilling vessel and possess sufficient containment, recovery, and storage for the initial 42-hour operational period. An Arctic OST would be staged within range of the Beaufort Sea drill site to arrive at the recovery site before the on-site initial response vessels reach their cumulative onboard storage capacities for recovered liquids. By hour 42, additional dedicated VOSS may be available from operations in the Chukchi Sea to relieve the on-site recovery barge and response vessels to lighter recovered fluids to the OST. If not, the OSR barge and VOSS will work in conjunction to maintain containment and skimming operations and to lighter recovered fluids to the OST. Prior to completely filling the on-site OST, a second Shell-chartered OST would arrive at the recovery site to provide sufficient capacity to store all recovered liquids (oil and emulsified oil/water) from the 30-day blowout. Additional personnel may also be transported via helicopter or vessel from a land- or vessel-based staging area.

Shell’s primary response action contractor for Beaufort Sea offshore, nearshore, and onshore spill response is Alaska Clean Seas (ACS). Nearshore recovery efforts implemented by ACS are staged out of Prudhoe Bay with assistance from Auxiliary Contract Response Teams (ACRTs) and Village Response Teams (VRTs) personnel. Additionally, ASRC Energy Services – Response Operations, LLC (AES-RO) acts as Shell’s support response action contractor to provide dedicated response vessels, skimmers and equipment for the nearshore and offshore operations. Response activities will be conducted using ACS or Shell tactics, as defined in the ACS Technical Manual and Shell Beaufort and Chukchi Seas Regional Tactics Manual, or otherwise defined in the ODPCP.

**Potential Releases**

Although not expected to occur, this section addresses the most likely type of hydrocarbon spill that might occur during Camden Bay exploration drilling activities. This discussion is presented as background. More detailed discussion and analysis of spill issues is included in the impact assessment section of the EIA (Section 4).

Shell’s analysis of liquid hydrocarbon spills defines and distinguishes between two categories of spills:

- **Small** - 48 bbl or less, and
- **Large** - greater than 48 bbl.
These categories are different than the categories of spills defined by volume typically used by BOEMRE in its analyses. For BOEMRE, spills are categorized by volume as:

- Small - 1,000 bbl;
- Large - greater than or equal to 1,000 bbl; and
- Very Large - greater than or equal to 150,000 bbl.

Shell’s spill categories, however, are not incompatible with those used by BOEMRE. Shell chose to use its spill definitions as that reflects the fact that the most likely source of a liquid hydrocarbon spill during oil and gas exploration drilling operations is a spill incidental to a refueling operation, and the most likely size of such a spill is 48 bbl (or less).

For purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shell’s program is a frontier exploration drilling program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 of this EIA provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

Small Spills

Historic operational spill data suggests that the most likely cause of a spill of liquid hydrocarbons during exploration drilling would be operational, such as a hose rupture, and the spill would be relatively small (33 CFR 154.1029(b)). The likely size of such a spill is expected to be equal to or less than 48 bbl (i.e., a “small” spill by Shell definition). The analysis underlying these conclusions is presented in Table 2.10-1.

In addition, the potential impacts of a small spill are discussed in each of the EIA sections on impacts to specific resources (Section 4).

<table>
<thead>
<tr>
<th>Type</th>
<th>Cause</th>
<th>Product</th>
<th>Size</th>
<th>BOEMRE Size Category Equivalent</th>
<th>Duration</th>
<th>Actions Taken To Prevent Potential Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer from fuel barge to drilling or support vessel</td>
<td>Hose rupture</td>
<td>Diesel</td>
<td>Approximately 48 bbl</td>
<td>Small (&lt;1,000 bbl)</td>
<td>5.5 minutes (refer to ODPCP Section 1.6)</td>
<td>Strict adherence to fuel transfer procedures in place.</td>
</tr>
<tr>
<td>Diesel</td>
<td>Tank rupture</td>
<td>Diesel</td>
<td>1,555 bbl</td>
<td>Large (≥1,000 bbl)</td>
<td>Minutes to hours</td>
<td>The diesel tanks are internal to the drilling vessel rather than deck-mounted, where the potential for marine spills is much greater. As a result, tanks are monitored as part of an ongoing tank inspection program.</td>
</tr>
</tbody>
</table>
Table 2.10-1  Summary of Potential Discharges

<table>
<thead>
<tr>
<th>Type</th>
<th>Cause</th>
<th>Product</th>
<th>Size</th>
<th>BOEMRE Size Category Equivalent</th>
<th>Duration</th>
<th>Actions Taken To Prevent Potential Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blowout*</td>
<td>Uncontrolled flow at the mudline</td>
<td>Crude oil</td>
<td>480,000 bbl (16,00 bbl/day for 30 days)**</td>
<td>Very large (≥150,000 bbl)</td>
<td>30 days (refer to ODPCP Section 1.0)</td>
<td>BPO and related procedures for well control.</td>
</tr>
</tbody>
</table>

Notes:
* also referred to as “loss of well control”. BOEMRE defines loss of well control as:
- uncontrolled flow of formation or other fluids. The flow may be to an exposed formation (an underground blowout) or at the surface (a surface blowout);
- flow through a diverter;
- or uncontrolled flow resulting from a failure of surface equipment or procedures.

**For planning purposes, Shell assumes that 10 percent of the WCD will escape primary offshore recovery efforts (Section 1.6.7 of Shell’s Beaufort Sea Regional ODPCP – Revision 1). Therefore, impacts analyses are based on 48,000 bbl released to the environment.

Small Spills Analysis

No BOEMRE-defined “large” spills or “very large” crude oil spills have occurred on the Alaskan OCS and the probability of a blowout releasing crude oil to the environment is highly unlikely. The most likely event is a relatively small spill resulting from vessel fuel transfer operations or loss of containment aboard a vessel such as parted hydraulic lines. For purposes of analysis, the 48 bbl (7.6 m³) fuel transfer discharge calculated for the USCG and Department of Homeland Security in Shell's Beaufort Sea ODPCP, Summary of Potential Discharges has been used.

The 48 bbl (7.6 m³) fuel discharge volume was selected as a conservative estimate of the most likely event based upon historic experience and risk analysis. The historic record of spills from all 35 Beaufort and Chukchi OCS exploration drilling projects shows a total spill volume of 26.7 bbl (4.2 m³) of which approximately 24 bbl (3.8 m³) were subsequently recovered. The 48 bbl (7.6 m³) volume is also larger than BOEMRE’s estimate that a typical spill during exploration drilling operations in the Alaska Beaufort would be 25 bbl (4 m³) or less of diesel or other refined product (MMS 2007b).

The fate of a discharge can be estimated based upon the predicted weathering of a particular type of oil in seawater over a certain period of time. The estimates of a diesel fuel discharge were derived using the National Oceanic and Atmospheric Administration’s (NOAA’s) ADIOS2 (Automated Data Inquiry for Oil Spills) model. This model uses the physical properties of oils in its database to predict the rate of evaporation and dispersion over time, as well as changes in the density, viscosity and water content of the product spilled. Table 2.10-2 summarizes the results assumed for the fate and behavior of a 48-bbl (7.6 m³) diesel fuel spill. Based on the viscosity of the diesel fuel and spreading without containment, it is estimated that the maximum area of the sea with diesel fuel on the surface would be 20 to 200 acres (ac) depending on sea state and weather conditions.

Table 2.10-2  Fate and Behavior of a Hypothetical 48-bbl Diesel Fuel Spill During Summer

<table>
<thead>
<tr>
<th>Fate of Spilled Diesel Fuel</th>
<th>6</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel Fuel Remaining (%)</td>
<td>32</td>
<td>16</td>
<td>5</td>
<td>2</td>
<td>≤1</td>
</tr>
<tr>
<td>Diesel Fuel Evaporated (%)</td>
<td>42</td>
<td>46</td>
<td>48</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Diesel Fuel Dispersed (%)</td>
<td>26</td>
<td>38</td>
<td>47</td>
<td>50</td>
<td>51</td>
</tr>
</tbody>
</table>

Notes:
Calculated with the NOAA ADIOS2 oil-weathering model and assuming diesel fuel no. 2, 11-knot wind speed, 4° Celsius water temperature, 0.5-m wave height.
% = percent
≤ = less than or equal to
Small Spill Prevention and Recovery

The fate and behavior estimates of a 48 bbl (7.6 m³) fuel spill do not consider the mitigating effects of potential containment and recovery operations to remove spilled product. Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures (including Fuel Transfer Procedures).

Shell’s operating procedures ensure that transfer operations would be scheduled at least 24 hours in advance to allow operations personnel to review the planned transfer, ensure suitable weather conditions will occur, make appropriate notifications, and ensure response personnel and equipment is properly staged and boom deployed as required. Transfer operations would be visually monitored at all times and in conjunction with continuous communications to provide prompt discharge detection and control.

Prior to initiating transfer operations exceeding 100 bbl (16 m³), a pre-transfer conference is conducted between the fuel vessel, the receiving vessel, and response team personnel. During the transfer, the person-in-charge of the fuel transfer operation on each vessel, as well as the officer in the wheelhouse of the fuel vessel and the deck watch of the vessels involved in the fuel transfer, shall remain in radio contact. In addition, the deck watch of each vessel will have visual contact during the operation. The response team pre-deploys containment boom around the receiving vessel or around the delivery vessel if transferring to a larger vessel. The boom would encompass the vessel’s transfer or receiving manifold and be configured to minimize the effects of wind and currents to the extent possible. The ends of the boom would be secured to the hull of the receiving or delivery vessel, as appropriate. Response workboats will remain on standby during the entire transfer operation to tend boom, perform any necessary ice management, monitor the transfer process, and detect any discharges. In the event the fixed boom configuration would be unsafe or risk damages, the boom will be used in standby mode. In standby mode, vessels may proceed at slow speed to maintain heading and steerage. In these situations where vessels maintain slow forward speed, workboats may deploy a U-boom configuration down current of transfer operations in order to be in position to encounter, contain, and recover any discharges should they occur. Workboats will have both small and large capacity oleophilic skimmers that can be deployed into the boom configuration to recover product. Portable storage systems (e.g., mini-barge or floating storage bladder) are available to temporarily contain recovered product until it can be transferred to the Arctic tanker or another larger vessel possessing available storage capacity.

In the unlikely event the shipboard prevention procedures fail to prevent a fuel spill, the response team and pre-deployed boom or boom in standby mode would be expected to provide spill containment and recovery. The response workboats on standby during transfer operations would deploy one or more oleophilic skimming devices to begin recovery of the fuel while contained. Oleophilic skimmers are preferred to reduce the volume of water recovered with the fuel product. Efforts would be directed at maintaining the boom effectiveness for containment while skimming is underway. A portable storage bladder or mini-barge would be positioned alongside the recovery vessel to receive recovered liquids. The available pre-staged response resources have far greater skimming and storage capacity than required to handle a spill of this quantity. These prevention procedures and pre-positioned response assets would ensure that any spill effects are localized and would result only in short-term environmental consequences.
2.11 Other Mitigation Measures

In addition to meeting all regulatory requirements, Shell is committed to other mitigation measures including those that will decrease any potential conflicts between exploration drilling activities and subsistence harvests. For the Camden Bay drilling program, these mitigation measures include:

**Communications**

- Shell has developed a Communication Plan and will implement this plan before initiating exploration drilling operations to coordinate activities with local subsistence users, as well as Village Whaling Captains’ Associations, to minimize the risk of interfering with subsistence hunting activities, and keep current as to the timing and status of the bowhead whale hunt and other subsistence hunts. The Communication Plan includes procedures for coordination with Com Centers to be located in coastal villages along the Chukchi and Beaufort Seas during Shell’s proposed exploration drilling activities.

- Shell will employ local SAs from the Beaufort and Chukchi Sea villages that are potentially impacted by Shell’s exploration drilling activities. The SAs will provide consultation and guidance regarding the whale migration and subsistence activities. There will be one per village, working approximately 8-hr per day and 40-hr weeks during the drilling seasons. The subsistence advisor will use local knowledge (Traditional Knowledge) to gather data on subsistence lifestyle within the community and to advise in ways to minimize and mitigate potential negative impacts to subsistence resources during the drilling season. Responsibilities include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; coordinating with the Com and Call Center personnel; and advising how to avoid subsistence conflicts. Subsistence advisors will have a handbook that will specify work tasks in more detail.

**Aircraft Travel**

- Aircraft shall not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, in poor weather (fog or low ceilings) in an emergency situation. Aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft (457 m) in areas of active whaling; such areas to be identified through communications with the Com Centers. Except for airplanes engaged in marine mammal monitoring, aircraft shall use a flight path that keeps the aircraft at least 5 mi (8 km) inland until the aircraft is south of its offshore destination, then at that point it shall fly directly north through the Mary Sachs Entrance to its destination. Shell reserves the right to use an alternative flight route in the event that transit through the Mary Sachs Entrance is unsafe due to weather, other environmental conditions, or in the event of an emergency.

- Aircraft and vessels will not operate within 0.5 mi (0.8 km) of walrus or polar bears when observed on land or ice.

- Shell will also implement non-MMO flight restrictions prohibiting aircraft from flying within 1,000 ft (300 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs and landings or in emergency situations) while over land or sea. This flight will also help avoid disturbance of and collisions with birds.
Vessel Travel

- The *Kulluk* or *Discoverer* and support vessels will enter the Chukchi Sea through the Bering Strait on or after 1 July, minimizing effects on marine mammals and birds that frequent open leads and minimizing effects on spring bowhead whale hunting.

- Exploration drilling activities at the Sivulliq or Torpedo drill sites are planned to begin on or about 10 July following transit into the Beaufort Sea and run through 31 October, with a suspension of all operations beginning August 25 for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. During the suspension for the whale hunts the drilling fleet will leave the Camden Bay project area and move to an area north of latitude 71° 25’N and west of longitude 146° 4’W. Shell does not plan to anchor during the suspension. Shell will return to resume activities after the subsistence bowhead whale hunts conclude. Exploration drilling activities will be completed by 31 October, depending on ice and weather.

- The drilling support fleet transit route will avoid known fragile ecosystems, including the Ledyard Bay Critical Habitat Unit (LBCHU), and will include coordination through Com Centers.

- To minimize impacts on marine mammals and subsistence hunting activities, the drilling vessel and support fleet will transit through the Chukchi Sea along a route that lies offshore of the polynya zone. In the event the transit outside of the polynya zone results in Shell having to break ice (as opposed to managing ice by pushing it out of the way), the drilling vessel and support vessels will enter into the polynya zone far enough so that ice breaking is not necessary. If it is necessary to move into the polynya zone, Shell will notify the local communities of the change in the transit route through the Com Centers. As soon as the fleet transits past the ice, it will exit the polynya zone and continue a path in the open sea toward the Camden Bay drill sites.

- MMOs will be aboard the *Kulluk* or *Discoverer* and all support vessels (see the 4MP in Appendix D of the revised Camden Bay EP).

- When within 900 ft (274 m) of marine mammals, vessels will reduce speed, avoid separating members from a group and avoid multiple changes of direction.

- Vessel speed is to be reduced during inclement weather conditions in order to avoid collisions with marine mammals.

- All vessels must maintain cruising speed not to exceed 9 knots while transiting the Beaufort Sea. This measure would reduce the risk of ship-whale collisions.

- Shell will communicate and coordinate with the Com Centers regarding all vessel transit.

Drilling Operations

- Shell will collect all drilling mud and cuttings with adhered mud from all well sections below the 26-in. (20-in. casing) hole section, as well as treated sanitary waste water, domestic wastes, bilge water and ballast water, and transport them outside the Arctic for proper disposal in an EPA-licensed TDS. These waste streams will not be discharged to the ocean.

- Drilling mud will be cooled to mitigate any potential permafrost thawing or thermal dissociation of any methane hydrates encountered during drilling, if such materials are present at the drill site.

- Drilling muds will be recycled to the extent practicable based on operational considerations (e.g., whether mud properties have deteriorated to the point where they cannot be used further) so that the volume of the spent mud is reduced.
Critical operations will not be started if potential hazards (ice floe, inclement weather, etc.) are in the vicinity and there is not sufficient time to complete the critical operation before the arrival of the hazard at the drill site (see Critical Operations and Curtailment Plan [COCP] in Appendix J of the revised Camden Bay EP).

All casing and cementing programs will be certified by a registered professional engineer.

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

The blowout prevention program will be enhanced through the use of two sets of blind/shear rams, increased frequency of BOP performance tests from 14 days to 7 days, a remotely operated vehicle (ROV) control panel on the seafloor with sufficient pressured water-based fluid to operate the BOP, a containment system that includes treatment and flaring capabilities, capping stack equipment and a fully-designed relief well drilling plan and provisions for a second relief well drilling vessel (Discoverer or Kulluk) to be available to drill the relief well if the primary drilling vessel is disabled and not capable of drilling its own relief well.

Lighting on the drilling vessel will be shaded and has been replaced with ClearSky lighting. ClearSky lighting is designed to minimize the disorientation and attraction of birds to the lighted drilling vessel to reduce the possibility of a bird collision (see the Bird Strike Avoidance and Lighting Plan in Appendix I of the revised Camden Bay EP).

Ice Management

Ice management will involve preferentially redirecting, rather than breaking, ice floes while the floes are well away from the drill site (see the Ice Management Plan in Appendix K of the revised Camden Bay EP).

Real time ice and weather forecasting will be from the Shell Ice and Weather Advisory Center (SIWAC).

Oil Spill Response

The primary OSR vessel will be on standby at all times when drilling into zones containing oil to ensure that oil spill response capability is available within one hour, if needed.

Shell will deploy an OSR fleet that is capable of collecting oil on the water up to the calculated Worst Case Discharge flowrate of a blowout in the unlikely event that one should occur. The primary OSR vessel will be on standby when drilling into zones containing oil to ensure that oil spill response capability is available within one hour, if needed. The remainder of the OSR fleet will be fully engaged within 72 hours.

In addition to the OSR fleet, oil spill containment equipment will be available for use in the unlikely event of a blowout. The barge will be centrally located in the Beaufort Sea and supported by an
Invader Class Tug and possibly an anchor handler. The containment equipment will be designed for conditions found in the Arctic including ice and cold temperatures. This equipment will also be designed for maximum reliability, ease of operation, flexibility and robustness so it could be used for a variety of blowout situations.

- Capping stack equipment will be stored aboard one of the ice management vessels and will be available for immediate deployment in the unlikely event of a blowout. Capping stack equipment consist of subsea devices assembled to provide direct surface intervention capability with the following priorities:
  - Attaching a device or series of devices to the well to affect a seal capable of withstanding the maximum anticipated wellhead pressure (MAWP) and closing the assembly to completely seal the well against further flows (commonly called “capping and killing”)
  - Attaching a device or series of devices to the well and diverting flow to surface vessel(s) equipped for separation and disposal of hydrocarbons (commonly called “capping and diverting”)

- A polar bear culvert trap has been constructed in anticipation of OSR needs and will be deployed near Point Thomson or Kaktovik prior to drilling.

- Pre-booming is required for all fuel transfers between vessels.
3.0 RESOURCES, CONDITIONS, AND ACTIVITIES

This section of the EIA describes the resources, conditions, and activities that could be affected by the proposed exploration program or could affect the operation or the activities proposed in the EP.

3.1 Climate and Meteorology

3.1.1 Air Temperature

Shell’s Beaufort Sea prospects are located in the Arctic Climatic Zone, which is characterized by cold temperatures, nearly constant wind, and low precipitation. The nearest communities to the offshore prospects are Nuiqsut to the southwest and Kaktovik (on Barter Island) to the southeast along the Alaskan coastline, and the industrial facilities of Deadhorse/Prudhoe Bay to the southwest. During the brief summer season from June through August, temperatures are generally above freezing and precipitation falls in the form of rain. The mean, maximum and minimum temperatures along the Beaufort Sea coast for Barter Island and Prudhoe Bay are shown in Table 3.1.1-1. The timeframe shown in Table 3.1.1-1 is coincident with the occurrence of Shell’s exploration drilling program. Below-freezing temperatures in Arctic locations are experienced during more than 80 percent of the year and have been recorded during every calendar month (MMS 2007a). Below-freezing temperatures can create icing on vessels and equipment.

Table 3.1.1-1 Temperatures Along Beaufort Sea Coast

<table>
<thead>
<tr>
<th>Month</th>
<th>Prudhoe Bay</th>
<th></th>
<th>Barter Island</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>°F  °C</td>
<td>°F  °C</td>
<td>°F  °C</td>
<td>°F  °C</td>
</tr>
<tr>
<td>July</td>
<td>48  8.9</td>
<td>55  13</td>
<td>40  4</td>
<td>40  4</td>
</tr>
<tr>
<td>August</td>
<td>44  6.7</td>
<td>51  11</td>
<td>38  3</td>
<td>39  4</td>
</tr>
<tr>
<td>September</td>
<td>34  1.1</td>
<td>38  3</td>
<td>29  -2</td>
<td>32  0</td>
</tr>
<tr>
<td>October</td>
<td>15 -9.4</td>
<td>21 -6</td>
<td>10 -12</td>
<td>15 -9</td>
</tr>
</tbody>
</table>

F = degrees Fahrenheit  
C = degrees Centigrade  

3.1.2 Precipitation

Mean precipitation data along the Beaufort Sea coast for Kaktovik (Barter Island) and Deadhorse/Prudhoe Bay industrial facilities area are shown in Table 3.1.2-1. The timeframe shown in Table 3.2.1-1 is coincident with the proposed schedule for Shell’s exploration drilling program.

In the Barter Island area, fog is common from May through September and cloudy weather is common from February through October.
Table 3.1.2-1  Precipitation Along Beaufort Sea Coast

<table>
<thead>
<tr>
<th>Month</th>
<th>Prudhoe Bay</th>
<th>Barter Island</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Precipitation</td>
<td>Mean Precipitation</td>
</tr>
<tr>
<td></td>
<td>Inches</td>
<td>Millimeters</td>
</tr>
<tr>
<td>July</td>
<td>0.68</td>
<td>17.2</td>
</tr>
<tr>
<td>August</td>
<td>1.14</td>
<td>29.0</td>
</tr>
<tr>
<td>September</td>
<td>0.61</td>
<td>15.5</td>
</tr>
<tr>
<td>October</td>
<td>0.38</td>
<td>10.0</td>
</tr>
</tbody>
</table>


3.1.3 Winds

The Beaufort Sea coastal winds usually are easterly and strongly influenced by channeling due to the Brooks Range to the south. In the eastern portion of the Beaufort Sea around Barter Island, westerly winds become more frequent in the summer and fall months (MMS 2007a); however, the most prevalent wind direction within the project area during the drilling season of July through October is easterly to northeasterly (MMS 2003). Average wind speed at the Barter Island area is about 11 mph (10 knots) during the summer months. The average wind speed for the Barrow area during the summer/fall is 13 mph (11 knots) (WRCC 2009). A multiyear meteorological study including stations at Badami, Endicott, Northstar, Cottle Island, and Milne Pointe provides a data trend for the months of July through October. The average wind speed from 2001 to 2005 was approximately 15.5 mph (13 knots) with the average low around 9.5 mph (8 knots) and the average high around 41 mph (37 knots) (MMS 2006).

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 common, 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 (MMS 2007a).

3.1.4 Storms

Storms and associated high winds, ice, snow, fog, and extreme cold are the primary meteorological conditions that affect offshore operations in the Alaska planning areas (MMS 2007a).

There has been a major effort to document large storm events in the Barrow area as part of the Integrated Assessment of the Impacts of Climate Variability on the Alaskan North Slope Coastal Region (UC 2009). Brunner et al. (2004) documents damaging storms with associated storm surges along the Barrow coast in the months of October 1963, September 1986, February 1989 and August 2000. An analysis of high-wind events in Barrow from 1955 through 2000 indicates that the extreme winds in the fall have decreased slightly and the winds in the summer have increased slightly over the period (Lynch et al. 2004).

Iñupiat residents have relayed many accounts of their experiences with extreme storms. Weather is described in the Beaufort Sea as being unpredictable and dynamic. With little warning, sudden and extreme storms can occur in the Alaskan Beaufort Sea.

3.1.5 Daylight Hours

Daylight hours during the operations, representative of the area at 70° N latitude during the planned period of operations in Camden Bay are presented in Table 3.1.5-1.
Table 3.1.5-1  Daylight Hours by Month at 70 Degrees N Latitude

<table>
<thead>
<tr>
<th>Month</th>
<th>Daylight Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>24.0</td>
</tr>
<tr>
<td>July</td>
<td>24.0</td>
</tr>
<tr>
<td>August</td>
<td>21.2</td>
</tr>
<tr>
<td>September</td>
<td>15.5</td>
</tr>
<tr>
<td>October</td>
<td>11.2</td>
</tr>
</tbody>
</table>

### 3.1.6 Climate Change

There are many factors that contribute to climate change. On a large scale, the orbital configuration of the earth described by Milankovitch (1941) has affected the glacial cycles over the Quaternary Period (last 1.6 million years). Milankovitch cycles include the eccentricity (orbital shape), which has a periodicity of 100,000 years, obliquity (tilt angle of the earth’s axis which varies between 22.1 and 24.5 degrees) with a periodicity of 41,000 years, and precession (axial rotation) has a periodicity of 26,000 years. These changes in orientation and movement change amount of solar radiation reaching a given location on the Earth’s surface, which influences the Earth’s climate system and glacial cycles.

There are also natural cyclical variations in the dominant patterns of sea-level pressures (SLP) in the world oceans. These oscillations have positive and negative phases depending where the high-pressure system is located. During the positive phase for the Arctic Oscillation (AO), the high pressure is located around 45 degrees North and the low pressure is located over the Pole. During this phase, Alaska received wetter weather due to ocean storms moving further north; the western U.S. had drier conditions and east of the Rocky Mountains is warmer than normal. Weather patterns during the negative phase tend to be opposite of the positive phase. The AO has historically alternated, but since the 1970s the oscillation has been in a positive position, causing higher than normal temperatures and lower than normal arctic air pressure (National Snow and Ice Data Center 2009).

Likewise, the North Atlantic Oscillation (NAO) and Pacific Decadal Oscillation (PDO) affect the climate in their specific ocean realms. The NAO is more tied to the AO because the cold meltwater flows into the Atlantic Ocean (ACIA 2005). The effect of climate change on AO/NAO is still under investigation. Changes predicted by models, incorporating increased greenhouse gas (GHG) concentrations, have not been realized by 20\(^{th}\) Century observations of the AO/NAO patterns (Fyfe 2003). Recent studies at the Woods Hole Oceanographic Institution (WHOI) using measurements from coral have indicated that anthropogenic warming does not seem to alter the polarity of oscillation phase on a multi-decadal timescale. However, the variability of phase changes appears to be increasing, which could increase severity of storms and droughts (WHOI 2009).

The Council on Environmental Quality (CEQ) has issued guidance under NEPA indicating that climate change is a reasonably foreseeable impact of GHG emissions. In 2005, the total GHG emission from all statewide Alaska sources was estimated to be 53 million metric tons CO\(_2\) equivalent (MMtCO\(_2\)e). Large industrial sources in Alaska accounted for 20.6 MMtCO\(_2\)e; total industrial sources accounted for 24.6 MMtCO\(_2\)e. The Alaska oil and gas industry accounted for 15.3 MMtCO\(_2\)e of the industrial source total. For comparison, the Alaska total transportation sector accounted for almost 19 MMtCO\(_2\)e (ADEC 2008a).

The estimated GHG emission from the Discoverer including the support fleet is 57,586 tons (Air Sciences Inc., 2011a). The estimated GHG emission for the Kulluk including the support fleet is 60,413 tons GHG.
(Air Sciences Inc., 2011b). The Kulluk or Discoverer and support vessels combined projected emissions will account for approximately 0.1 percent of the Alaska 2005 total statewide estimated greenhouse gases of 53 million tons and 0.37 percent of the Alaska 2005 statewide oil and gas industry estimated greenhouse gases of 15 million tons. The projected emissions from the proposed Shell exploration activities will be insignificant in relationship to the Alaska 2005 total statewide and Alaska oil and gas industry GHG/CO₂ emissions.

There is little historic data that can be used for establishing climatic trends in the Arctic; the meteorological station density in Alaska is one station per 100,000 km². The overall temperature trend increased during the 20th Century; however, a period of decreasing temperatures occurred between the mid-1940s and mid-1960s. Between 1900 and 2003, data from the Global Historical Climatology Network database (GHCN Peterson and Vose 1997) and Climate Research Unit database (Jones and Moberg 2003) dataset indicate a warming trend of 0.16 °F (0.09 °C) per decade (ACIA 2005).

In northwestern North America, between 1966 and 2003, arctic temperatures increased 1.8-2.6 °F (1-2 °C). In Alaska, the average temperature change between 1947 and 2008 was 3.1 °F (1.7 °C); individual stations in Kodiak and Barrow recorded the lowest and highest temperature changes 1.0 °F (0.5 °C) and 4.3 °F (2.4 °C) respectively. The most dramatic temperature change for Alaska is during the winter when the average temperature increase has been 6.0 °F (3.3 °C). The increase is not linear, and reflects the polarity of the PDO. A cool stage from 1949 to 1976 abruptly changed as the PDO moved into a positive phase. Since this time, there has been very little change in temperature trends in most of Alaska except in Barrow and Talkeetna with increases of 4.0 °F (2.2 °C) and 2.2 °F (1.2 °C), respectively, and a decrease of 2.3 °F (1.3 °C) in Kodiak (Alaska Climate Research Center 2009).

Climate models project more warming in the Arctic compared with the rest of the world (IPCC 2007). At this time there is no definitive evidence of an anthropogenic signal in the Arctic causing this warming. There are few data and the natural fluctuations in the Arctic are larger than the rest of the world, making it challenging to detect an anthropomorphic signal (ACIA 2005). Temperature variations in Eurasian and North American regional studies are probably not due to natural variability alone (Karoly et al. 2003; Zwiers and Zhang 2003; and Stott, et al. 2003) and tend to support the conclusion that temperature variations in North America and Eurasia probably are not due to natural variability alone.

Climate change is evident in the Arctic and its associated trends are anticipated to continue. Changes observed in the Arctic include: changes in sea ice; increased snowfall; drier summers and falls; forest decline; reduced river and lake ice; permafrost degradation; increased storms and coastal erosion and ozone depletion. Adverse effects to habitat and resource alteration associated with climate change may affect the distribution and abundance of particular species. Stress factors for marine mammals associated with climate change could result in a shift of migration routes, altered habitat and food sources. Loss of important habitat due to coastal erosion and storm surges may produce changes in the dynamics of rivers and deltas, potentially jeopardizing fish and animal populations using these areas (MMS 2005).

Alaskan Natives who live within coastal communities along the Bering, Chukchi, and Beaufort Seas have noticed changes in the weather, oceans, and resources. Over the last 20 years, extreme weather such as strong winds and storms has increased from Elim to Barrow (ACIA 2005). “Weather temperatures have been warmer in recent years than they have been in the past.” (Arnold Brower Sr. and Joseph M. Leavitt in Shell 2008). Warming conditions have affected sea ice as well. Increased temperatures and winds prevent the sea ice from setting up in autumn, delaying the freezing season; early spring melting decreases the safety of the spring ice for hunting. “Multiyear ice near the North Slope shoreline is not as prevalent as it was a half a generation ago.” (Arnold Brower Sr. and Joseph M. Leavitt in Shell 2008). The ice conditions have deteriorated to the point that some whalers from Barrow are choosing not to spring whale due to safety concerns (M. Ahmaogak personal communication 2009). Changes in wildlife have also been recorded in the Bering Sea. There has been a decrease in spotted seals and chum salmon
and the spring bird migrations are earlier (ACIA 2005). “In recent years, the ice is not forming as close to shore as it used to. The walrus beach themselves; they are not heading out to the sea ice like they used to. Some birds are not coming back to the area like they used to” (Arnold Brower Sr. and Joseph M. Leavitt in Shell 2008).

### 3.1.7 Air Quality

The EPA established NAAQS for six “criteria pollutants” to provide protection from adverse effects on human public health and public welfare. The six criteria pollutants include:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO₂)
- Small-diameter particulate matter (PM₁₀ and PM₂.₅)
- Sulfur dioxide (SO₂)
- Ozone (O₃)
- Lead (Pb)

The CAA established two types of national air quality standards. Primary standards set limits to protect human public health, including the health of “sensitive” populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings (EPA 2009). The Primary and Secondary NAAQS are identical for four of the six criteria pollutants (NO₂, [PM₁₀ and PM₂.₅], O₃ and Pb). The SO₂ Secondary NAAQS is less strict than it primary standard, and there is no Secondary NAAQS for CO.

The NAAQS set a limit to the concentration of the criteria pollutants in the ambient air. When an area does not meet the air quality standard for one of the criteria pollutants, EPA designates the area as a nonattainment area. The CAA sets forth the regulatory process to be applied to an area in order to comply with the standards by a designated date. This date varies by the type of pollutant and the severity of the nonattainment air quality problem. The State of Alaska adopted the federal NAAQS for the six criteria pollutants and established state ambient standards for two other air pollutants, reduced sulfur compounds and ammonia (ADEC 2008). The NAAQS and Alaska Ambient Air Quality Standards (AAAQS) are summarized in Table 3.1.7-1.

The onshore area adjacent to the Beaufort 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 Camden Bay project area is a portion of the Fairbanks North Star Borough that EPA designated as nonattainment for PM₂.₅ in December 2010. Fairbanks is located approximately 400 mi (645 km) south of the project area. In addition, Eagle River area of Anchorage is also designated nonattainment for PM₁₀ and located approximately 620 mi (1,000 km) south of the project area. The nearest PSD Class I area is Denali National Park including the Denali Wilderness, but excluding the Denali National Preserve. Denali National Park is located approximately 450 mi (725 km) south of the project area (ADEC 2008c).

The onshore air quality for most areas adjacent to the Beaufort Sea is considered to be good. Concentrations of regulated air pollutants in this area are much lower than the maximum allowed by the NAAQS and AAAQS. In 2006, Alaska Department of Environmental Conservation (ADEC) accepted the BPXA’s 1999 Arctic North Slope Eastern Region (ANSER) monitoring program ambient air measurements, located east (and therefore generally upwind) of the Badami facility, as being representative of Beaufort Sea shoreline ambient air concentrations. Baseline ambient concentrations for PM₁₀, SO₂, and NO₂ range between three and six percent of the applicable NAAQS (Table 3.1.7-1). With
increasing distance from shore toward the Camden Bay project area, the ambient air quality concentrations are expected to be equal to or lower than the measured shoreline concentrations. In February 2009, Shell submitted a Quality Assurance Project Plan to EPA to upgrade the Badami monitoring station to collect meteorological and ambient PM$_{2.5}$ and NO$_2$ data. Monitoring at Badami began in August 2009 and was decommissioned in January 2011. Collected ambient data is provided in Table 3.1.7-2. A new monitoring program is expected to begin in Kaktovik in July 2011.

### Table 3.1.7-1 National and Alaska AAQS and Representative Shoreline Baseline Concentrations

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Times</th>
<th>NAAQS a</th>
<th>AAAQS b</th>
<th>ANSER Measured Baseline ($\mu$g/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>8-hour average</td>
<td>9 ppm</td>
<td>10 mg/m$^3$</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>1-hour average</td>
<td>35 ppm</td>
<td>40 mg/m$^3$</td>
<td>None</td>
</tr>
<tr>
<td>Lead</td>
<td>Rolling 3-Month average Quarterly average</td>
<td>0.15 $\mu$g/m$^3$ (1978 std)</td>
<td>0.15 $\mu$g/m$^3$</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>1-hour average</td>
<td>0.1 ppm</td>
<td>--</td>
<td>None</td>
</tr>
<tr>
<td>NO$_2$</td>
<td>1-hour average</td>
<td>0.053 $\mu$g/m$^3$</td>
<td>100 $\mu$g/m$^3$</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>Annual (arithmetic mean)</td>
<td>235 $\mu$g/m$^3$</td>
<td>15 $\mu$g/m$^3$</td>
<td>7.9</td>
</tr>
<tr>
<td>PM$_{10}$</td>
<td>24-hour average</td>
<td>150 $\mu$g/m$^3$</td>
<td>150 $\mu$g/m$^3$</td>
<td>7.9</td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>Annual (Arithmetic Mean)</td>
<td>35 $\mu$g/m$^3$ (2006 std)</td>
<td>35 $\mu$g/m$^3$</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>24-hour average *</td>
<td>0.08 ppm (1997 std); 0.075 ppm (2008 std)</td>
<td>0.075 ppm</td>
<td>None</td>
</tr>
<tr>
<td>Ozone</td>
<td>8-hour average</td>
<td>0.12 ppm c (1997 std); 0.075 ppm (2008 std)</td>
<td>235 $\mu$g/m$^3$</td>
<td>Not available</td>
</tr>
<tr>
<td></td>
<td>1-hour average</td>
<td>0.12 ppm c</td>
<td>235 $\mu$g/m$^3$</td>
<td>Not available</td>
</tr>
<tr>
<td>SO$_x$ measured as SO$_2$</td>
<td>Annual (arithmetic mean)</td>
<td>0.03 ppm</td>
<td>80 $\mu$g/m$^3$</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>24-hour average</td>
<td>0.14 ppm</td>
<td>365 $\mu$g/m$^3$</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>3-hour average</td>
<td>0.5 ppm d</td>
<td>1,300 $\mu$g/m$^3$</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td>1-hour average</td>
<td>0.075 ppm</td>
<td>--</td>
<td>None</td>
</tr>
<tr>
<td>Reduced Sulfur compounds measured as SO$_2$</td>
<td>30-minute average</td>
<td>--</td>
<td>50 $\mu$g/m$^3$</td>
<td>Not available</td>
</tr>
<tr>
<td>Ammonia</td>
<td>8-hour average</td>
<td>--</td>
<td>2.1 mg/m$^3$</td>
<td>Not available</td>
</tr>
</tbody>
</table>

ANSER = Arctic North Slope Eastern Region
mg = milligram(s)
$\mu$g = microgram(s)

Notes:
(BPXA 1999)

a = National Primary and Secondary Ambient Air Quality Standards, 40 CFR Part 50, July 1, 2010
b = State of Alaska Ambient Air Quality Standards, 18 AAC 50.010, April 1, 2010
c = primary standard is the same as secondary standard
d = secondary standard
e = Lead rolling 3-month average. EPA final rule signed October 15, 2008 and published in Federal Register November 12, 2008, v. 73, No. 219, pp 66964 - 67062
-- = no standard
* = The PM$_{2.5}$ 24-hour NAAQS under 40 CFR 50.7 is 65 $\mu$g/m$^3$; the 24-hour NAAQS under 40 CFR 50.13 is 35 $\mu$g/m$^3$. 
Air emissions from OCS facilities in the Beaufort Sea are regulated by the EPA pursuant to 40 CFR Part 55. For OCS facilities located within 25 mi (40 km) of the state seaward boundary, the air quality regulations would be the same as if the facility was located onshore and thus subject to the ADEC air quality regulations, 18 AAC 50. The Part 55 regulations also may incorporate other federal air regulations including the New Source Performance Standards (40 CFR Part 60), the PSD (40 CFR 52.21), and/or Title V Air Operating Permits (40 CFR Part 71).

The major local source of industrial emissions is from the existing North Slope oil production complex including Prudhoe Bay, Kuparuk, Alpine, and other North Slope oil production facilities. Additional emissions from the North Slope come from generators in villages such as Kaktovik, Nuiqsut, and Barrow. Small amounts of pollutants are also emitted from vehicles such as cars, trucks, and all-terrain vehicles (ATVs), drill rigs, and heavy construction equipment such as dozers and graders. The latest data from the Western Regional Air Partnership (WRAP) Emissions Data Management System (EDMS) indicates North Slope Borough (NSB) annual emissions in 2002 from all sources (point, mobile, etc.) of approximately 42,500 tons NO\textsubscript{x}, 2,600 tons PM\textsubscript{10}, and 900 tons SO\textsubscript{2}. The large majority of these emission totals were attributed to the North Slope oil & gas industry (WRAP 2002).

**Arctic Haze**

During the winter and early spring, the Arctic atmosphere becomes contaminated with anthropogenic pollution from long-range transport of pollutants from sources on the Eurasian continent (Rahn and Shaw 1982). This unusual form of regional air pollution consists of approximately 90 percent sulfate aerosols and 10 percent soot and is commonly referred to as “Arctic Haze” (Wilcox and Cahill 2003). These pollutants are effective at scattering light and reducing visibility. The arctic aerosols are limited primarily to the lowest three mi (five km), peaking in the lowest one mi (two km) of the atmosphere, due to strong inversions present in the Arctic (AMAP 1997).

The first scientific observations of Arctic Haze were made in the 1950s. However, the existence of Arctic Haze most likely dates back to the widespread use of coal in Europe. Maximum concentrations of some pollutants forming Arctic Haze, sulfates and fine particles, were observed in the early 1980s, but some lower concentrations were observed at select stations at the end of the 1980s (Pacyna 1995). The decline in atmospheric sulfur in the Arctic was due to a downward trend in emissions. Emissions reduction in Europe occurred as a result of improved environmental practices and the use of cleaner technologies whereas emissions reduction from the former Soviet Union occurred due to the increased use of natural gas for fuel rather than coal and the sharp economic downturn following the dissolution of the Soviet Union. However, the decline in emissions from the former Soviet Union may be reversing as a consequence of economic revitalization and an increasing reliance on coal as natural gas becomes more valuable for export (Wilcox and Cahill 2003).

Despite the seasonal, long-distance transport of pollutants into the Arctic, regional air quality still is far better than the NAAQS.
Greenhouse Gas Emissions

Estimated 2005 GHG in Alaska totaled nearly 53 MMtCO$_2$e (ADEC 2008a). The GHG estimated in the ADEC report include CO$_2$, methane (CH$_4$), and NO$_2$. The ADEC report estimated total Alaska industrial sources produced 24.6 MMtCO$_2$e. The Alaska oil industry accounted for approximately 73 percent of the industrial source total or 15.3 MMtCO$_2$e. For comparison, the report estimated the Alaska total transportation sector produced (commercial, military, and general aviation; rail, marine, and on-road vehicles) 18.8 MMtCO$_2$e.

<table>
<thead>
<tr>
<th>Monitoring Period</th>
<th>NO$_2$ Concentration (ppm)</th>
<th>Maximum 24-hour PM2.5 Concentration ($\mu$g/m$^3$)$^1$</th>
<th>Period Average PM2.5 Concentration ($\mu$g/m$^3$)$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1-hr Max$^2$</td>
<td>Period</td>
</tr>
<tr>
<td>Oct - Dec 2009 (4Q09)</td>
<td>0.039</td>
<td>0.001</td>
<td>7</td>
</tr>
<tr>
<td>Jan - Mar 2010 (1Q10)</td>
<td>0.023</td>
<td>0.001</td>
<td>11</td>
</tr>
<tr>
<td>Apr - Jun 2010 (2Q10)</td>
<td>0.009</td>
<td>0.001</td>
<td>12</td>
</tr>
<tr>
<td>Jul - Sep 2010 (3Q10)</td>
<td>0.022</td>
<td>0.000</td>
<td>10</td>
</tr>
<tr>
<td>Aug 2009 - Sep 2010</td>
<td>0.039</td>
<td>0.001</td>
<td>12</td>
</tr>
<tr>
<td>NAAQS</td>
<td>0.100$^3$</td>
<td>0.053$^4$</td>
<td>35$^5$</td>
</tr>
</tbody>
</table>

1 Period average calculated from non-overlapping blocks starting at midnight standard time each day.  
2 The 1-hr maximum NO$_2$ concentration provides a conservative comparison of measured NO$_2$ concentrations to the 1-hour NO$_2$ ambient air quality standard.  
3 Compliance is assessed by comparison to the 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentration.  
4 Compliance is assessed by comparison to the annual average of measured concentrations.  
5 Compliance is based on the 3-year average of the 98th percentile of 24-hour concentrations reported to actual conditions.  
6 Compliance is assessed by comparison to the 3-year average of the weighted measured annual mean PM2.5 concentration reported to actual conditions.

3.2 Oceanography and Water Quality

This section summarizes the regional bathymetry, water level variations and movement, fluctuations, water circulation and currents, waves, and ice conditions. The water depths at the planned drill sites are as follows:

- Sivulliq G – 110 ft (33.5 m)
- Sivulliq N – 107 ft (32.6 m)
- Torpedo H – 120 ft (36.6 m)
- Torpedo J – 124 ft (37.8 m)
3.2.1 Bathymetry

The Alaskan Beaufort Sea extends from Point Barrow to the Canadian border. The Beaufort Shelf varies in width from about 57 mi (90 km) in the west to about 30 mi (50 km) in the east (Craig et al. 1985).

The seabed between the mainland beach and the barrier islands is shallow and flat. Shoreward of the barrier islands, the water depths are typically less than 25 ft (8 m) and rapidly become shallower toward the shoreline. North of the barrier islands, the water depths gradually increase until the Beaufort Shelf break is reached approximately 40 mi (64 km) offshore, where depths rapidly increase. The project area is about 16-23 mi (26-35 km) offshore of Point Thomson, beyond the barrier islands. In the vicinity of the proposed drilling locations water depth is approximately 107-124 ft (32.6-40.8 m).

Water depths in the Sivulliq Prospect including Flaxman Island Area OCS Blocks 6658, 6659, 6708, and 6709 range from 115 ft (35m) in the northwest to about 128 ft (39 m) in the southeast. Water depths at the Sivulliq N and G drill sites (OCS Block 6658) are approximately 107 ft (32.5 m) and 110 (33.5 m), respectively. The seafloor slopes regionally from the south to the north at a gradient of less than 1° (less than 1.7 percent). Local small-scale gradients are variable along the numerous ice gouge ridges within the area that was surveyed (Fugro 2009a). These ice gouges have local relief varying from less than 1.6 ft (0.5 m) to about 8.2 ft (2.5 m) from ridge to trough and average local gradients of about 20° (40 percent). Seafloor gradient and relief at the drill sites is typical of the prospect as described above. Maximum ice gouge depth in the Sivulliq prospect area is estimated at 8.2 ft (2.5 m).

Water depths in the Torpedo Prospect, including Flaxman Island Area OCS Blocks 6559, 6609 and 6610, range from 115 ft (35m) in the south to 128 ft (39 m) in the north. Water depths at the Torpedo H (Block 6610) and J (Block 6559) drill sites are approximately 120 ft (36.6 m) and 124 ft (37.8 m), respectively. The seafloor slopes regionally from the south to the north at a gradient of less than 1°. Local small-scale gradients are variable along the numerous ice gouge ridges within the area that was surveyed (Fugro 2009b). These ice gouges have local relief varying from less than 1.6 ft (0.5 m) to about 3.3 ft (1.0 m) from ridge to trough and average local gradients of about 20° (40 percent). Seafloor gradient and relief at the drill sites is typical of the prospect as described above. Maximum ice gouge depth in the Torpedo prospect area is estimated at 4.1 ft (1.3 m).

3.2.2 Water Movement

Tide

The mean lunar tidal range is about 6-12 in. (15-30 cm). Few variations of this normal tidal range occur except in the case of storm surges.

Storm Surge

Storm surges are a result of meteorological conditions (e.g., wind, pressure gradients, temperature) interacting with the physical attributes (e.g., open water, fetch, density gradients, bathymetry, shoreline topography) creating wave, current, and water mass accumulations that can cause major changes in sea level.

The Coriolis Effect in the Northern Hemisphere causes seas to be deflected clockwise about the earth’s axis. Along the north coast of Alaska, the current runs predominantly from east to west due to the Coriolis Effect. Westerly winds tend to force water toward shore, causing an effect called “set-up.” Easterly winds tend to force water away from the shoreline, resulting in lower water levels, or “set-down.” Therefore, greatest wave height is a result of westerly winds. Storm surges most frequently occur in September and October when eastward moving storms cross the face of the Beaufort coast and long...
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stretches of open water are present. Storm surge in the vicinity of the proposed drilling locations is diminished because of greater water depths.

Storm surges can cause major local changes in sea level. Storm surges as high as 7 ft (2 m) have been reported during the drilling season along the Beaufort coast (U.S. Army Corps of Engineers [USACE] 1999). Gale-force westerly winds during an autumn storm in 1970 created a storm surge that elevated sea level 5-11 ft (1.5-3.4 m) inundating the low lying lands up to three miles inland (Reimnitz and Maurer 1979). Previous storm surges have been reported in 1905, 1928, 1940, and 1970 (Reimnitz and Maurer 1978). The longer open water period and the increase in storm events could lead to increased storm surge events (MMS 2003).

Circulation

The inner shelf region defined by the 130 ft (40 m) isobath of the Beaufort Sea is characterized by mean westward water and ice motion primarily driven by the prevailing winds, which are from the east and northeast. Bottom currents also tend to travel from east to west. Strong winds periodically develop from the west causing major flow reversals in the surface current; the response time is rapid, usually a matter of hours. Nearshore currents are modified by bottom topography, the presence of ice, river discharge, and the location of offshore barrier islands and shoals (MMS 2003).

Seaward of the 130 ft (40 m) isobath, just north of the project area, the circulation is dominated by the Beaufort Gyre that controls surface ice movement and by the Beaufort undercurrent that generally runs counter to the predominantly westward ice drift (Aagaard 1984). The long-term mean speeds of this current are normally in the range of 0.2-0.3 ft/sec (5-9 cm/sec), although mean daily current velocities may be 10 times this rate (MMS 2003). Frequent current reversals have been observed and are attributed to the along-shore wind component. Such current reversals occur on the lee (downwind) side of large embayments and extended promontories.

3.2.3 Ice

Sea ice is ocean water that freezes in polar regions. The sea ice is generally classified as landfast, stamuhki (shear), and pack ice. The majority of the Beaufort Sea is covered with sea ice for most of November through July. However, sea ice generally begins forming in September or early October and covers most of the nearshore areas by mid-November. According to Jonah Leavitt (in Shell 2009), “If the sea ice hasn’t formed by late December it is late.” By mid-May the nearshore ice begins to melt, creating openings and ice movements as the areas of open water expand. “There are a lot more open water polynyas than a half a generation ago” (Arnold Brower Sr. and Joseph M. Leavitt in Shell 2008). By July the pack ice starts to retreat northward and has reached its furthest extent north in 2007 and 2008. According to Mr. Brower and Mr. Leavitt: “The ice never used to go out completely in the summer. Sometimes even barges would get stuck in the ice. Now the ice goes out completely in the summer” (Arnold Brower Sr. and Joseph M. Leavitt in Shell 2008.). “If the ice is not as thick as three or more feet and the weather is warmer than usual, it will melt much sooner than later” (Jonah Leavitt in Shell 2009).

While the ice has recently retreated into the high arctic, throughout the summer, ice floes and pack ice usually can be found anywhere offshore in the Beaufort. Ice can be blown in nearshore during any part of the drilling season. As on all Arctic coasts, wind is a factor that can move ice and cause cooler temperatures in mid-summer when it blows in from the north. In the Beaufort Sea, “west winds cause the ice to close up, and east winds cause the ice to open up.” (Arnold Brower Sr. and Joseph M. Leavitt in Shell 2008).

The extent of the sea ice has varied greatly between 1982 and 2008 (Lage 2009). The sea ice extent in 2007 was 39 percent below the 1979 to 2000 average and up to 50 percent lower than the 1950 to 1970
average. The ice retreat in 2008 was second only to that recorded in 2007, continuing the negative trend of sea ice cover over the past 30 years (Richter-Menge et al. 2008). Figure 3.2-1 depicts mean September sea ice extents between 1982 and 2007 in five-year increments. Data continued to be collected through 2010, but the information is not specifically included in Figure 3.2-1 because of the depiction of the result in 5-year increments (would be 2012).

Several studies have noted a shorter season for landfast ice extent off the coast and less stable ice cover over the past several decades. Ice-free coastlines occur more than a month earlier in the Beaufort Sea and approximately two weeks earlier in the Chukchi Sea (Eicken et al. 2006; Vinnikov et al. 1999; Mahoney et al. 2007a).

**Landfast Ice**

Landfast ice is attached to and extends from the shoreline to form a relatively immobile sheet that generally terminates around the 66 ft (20 m) isobath. It occurs as bottomfast ice, which is frozen to the seabed out to depths of approximately 6.5 ft (2 m), or floating fast ice seaward of the coupled bottomfast ice. It usually consists of first-year ice, but can also incorporate multiyear pack ice during formation (US MMS 2008, Eicken et al. 2006). Ice ridges form and act as anchors to help stabilize this landfast ice (see next section, Stamukhi Zone). Landfast ice remains relatively undisturbed through winter until it begins to melt in mid May to late June. Movement during winter is primarily attributed to thermal contraction and expansion of the continuous ice sheets, but atmospheric forcing over long time periods will affect the landfast ice stability (Mahoney et al. 2007b). Throughout the summer, the landfast zone is generally open water. The Iñupiat recognize that the landfast ice is weak at the iiguaq, where two sections of shorefast ice attach to each other, and that sudden changes in sea level and pressure from sea currents can affect the stability of the landfast ice (George et al. 2004a).

The Camden Bay area is part of ice zone number 2, which extends from Point Barrow to Barter Island (Mahoney et al. 2007a). The landfast ice in this zone typically forms first, stabilizing earlier than zones to the east or west. In the Camden Bay area, between 1996 and 2004, the seaward landfast ice edge varied in extent from less than 30 mi (50 km) in 2001 to more than 155 mi (250 km) in 2000 (Mahoney et al. 2007a). Atmospheric circulation and temperature closely correlate with the timing of landfast ice breakup. In zone 2, offshore bathymetry is more important during breakup of the ice than any coastline effects (Mahoney et al. 2007a). Once breakup has begun, overfloods from the Shavirovik and Canning Rivers clear the ice in the near shore area (ADEC 2006).

**Stamukhi or Shear Zone**

The stamukhi or shear zone occurs when currents and wind buckle, fracture and shear the pack ice forming grounded pressure ridges in depths of 33-82 ft (10-25 m) (Inman 2005). The stamukhi zone consists of fragments of seasonal ice, multiyear ice, and ice ridges that can rise more than 30 ft (9.1 m) above the adjacent ice. This zone is often associated with the boundary of landfast ice. However, stable extensions of pack ice have been mapped in the Beaufort Sea more than 155 miles (250 km) from the coast in water depths greater than 656 ft (200 m) where stamukhi ice cannot ground (Mahoney et al. 2005; Eicken et al 2006). Leads form along the offshore side of the stamukhi zone, and produce open water that freezes and forms new ice which in turn is deformed by pressure (Eicken et al 2006).

**Pack Ice**

Pack ice occurs beyond the shear zone and consists predominantly of a multiyear aggregation of permanent ice floes that are consistently moving. During summer, the ice floes are surrounded by open water, thin ice, or small fragments of ice. In winter, the ice floes are surrounded by first-year ice. In the
Beaufort, ice movement generally is westerly. During summer, ice movement rates in excess of 12 mi
(19 km) per day are common.

To better understand ice dynamics in the Beaufort Sea, Shell deployed buoys in the winters of 2008, 2009
and 2010 (AES-RTS 2008, 2009, 2010). These buoys use satellite telemetry to transmit location, air
temperature, and barometric pressure on an hourly basis. In 2008, Shell deployed five buoys at four
locations near the Camden Bay prospect area, 10-20 mi (16-32 km) offshore from the mouth of the
Canning River. While the overall trend of the buoy movement was to the northwest, the buoys recorded
periods with little to no movement or movement back to the east or southeast. Four of the five buoys
moved into the Chukchi Sea and one came ashore near Tangent Point. In April 2008, the buoy movement
exceeded 30 mi/day (48 km/day) for two of the buoys.

The 2009 program consisted of two deployments. The first buoy deployment event (Deployment 1)
ocurred on January 12, 2009, at which time four buoys were deployed at four distinct locations in the
Beaufort Sea. Each buoy was equipped with instrumentation that records and transmits location,
temperature, and barometric pressure data through an Argos telemetry system. The data uploaded from
each deployed buoy was routinely evaluated on a realtime basis to identify missing information, data
gaps, or anomalous data that could indicate malfunctioning sensors or other problems with
instrumentation. A second deployment event (Deployment 2) occurred on March 20, 2009, at which time
four additional Argos-equipped buoys were deployed in proximity to the points of origin of the first set of
buoys (Deployment 1). Detailed information associated with both deployment events can be found in
monthly reports included in monthly reports in the 2009 On-Ice Buoy Program Summary Report. During
the 2009 program buoy movements was similar to 2008.

The 2010 buoy survey consisted of two deployments. Shell deployed five buoys on January 11 and five
on April 4. In the second deployment two Iridium-equipped buoys were deployed in proximity to two of
the buoys from the first deployment, and three data buoys were deployed at new locations in Harrison
Bay. The Harrison Bay buoys ultimately washed ashore between July 21 and 28, and stopped sending
data as of August 11, 2010. Buoy movement in 2010 was thought to be affected by a blocking ridge that
formed early in the summer and prevented low pressure systems from pushing warmer water and air
northward to augment ice melt. All reporting buoys were stationary the month of April 2010.

### 3.2.4 Water Quality

Offshore oil and gas activities have caused no long-term deleterious effects to biological resources
utilizing marine waters of the Beaufort Sea. Within Sivulliq and Torpedo prospects, common indicators
of water quality (temperature, salinity, pH, turbidity and total suspended solids) occur within the range
expected for Arctic marine waters transitioning from summer to winter. Trace metals, hydrocarbons, and
persistent organic compounds occur at low levels in the Beaufort Sea. These materials enter the water
column through natural means (river runoff, erosion, natural seeps) and through some anthropogenic
activities. Most rivers flowing into Camden Bay remain unpolluted by human activity, but discharge
activity is capable of transporting fine grain sediments, trace metals, and hydrocarbons into waters
surrounding Camden Bay (MMS 2003). Wind, ocean current, and drifting sea ice transport trace metals
and hydrocarbons and organic compounds throughout the Arctic.

Discharges to the Beaufort Sea are regulated to prevent pollution sources from degrading water quality.
The oil and gas industry must operate in conformance with the CWA of 1972 and NPDES Arctic GP AK-
2800000 issued by the EPA. Water quality is monitored prior to and during exploration drilling.
Figure 3.2-1  Mean September Sea Ice Extents 1982 to 2007 at 5-Year Increments
Water and sediment samples were collected in Camden Bay during August 2008 to further develop the baseline data set in advance of future offshore oil and gas exploration (Trefry and Trocine 2009; Dunton et al. 2009). Surface sediments were collected at 46 locations, and hydrographic profiles and water samples were collected at eight locations (Figure 3.2-2).

**Turbidity and Total Suspended Solids**

Turbidity reduces clarity of the water column due to the presence of suspended particles termed total suspended solids (TSS), and is determined by measuring by the amount of light reflected or absorbed by suspended particles relative to a known light intensity. Increased turbidity and TSS can be expected along the coast where wave action stirs up sediment. A larger degree of turbidity and TSS can be expected when thawing rivers force large volumes of freshwater into Camden Bay during spring breakup. These discharge surges typically generate a turbid plume at coastal river mouths.

In offshore waters, unless storm activity disrupts the ocean floor, turbidity is typically low. Most turbidity and TSS activity occurs in water depths less than 16-26 ft (5-8 m) or within the Barrier Islands. The turbidity and TSS at Sivulliq and Torpedo prospects can be expected to occur below background levels (MMS 2003) in the greater water depths of 107-124 ft (32.6-37.8 m). Baseline monitoring serves a means for determining water quality changes and may assist in detecting pollution such as elevated trace metals.

To determine the water column turbidity under open water conditions prior to exploration drilling activity, samples were collected at Sivulliq and Torpedo prospects (Trefry and Trocine 2009; Dunton et al. 2009). The turbidity measured at the Torpedo Prospect (HEX-19) ranged from 1.8-3 Nephelometric Turbidity Units (NTU). Levels were at the minimum detection limit for the sensor to perform a reading. The TSS levels in water samples averaged between 0.26 ± 0.13 milligrams per liter (mg/L) at depths of 7-10 ft (2.1-3 m) and 0.73 ± 0.31 mg/L at 33-82 ft (10-25 m) (Figure 3.2-3). A presence of particle organic carbon contributed to a portion of TSS values measured, 26 percent and 11 percent respectively.

Turbidity measurements collected at approximately 4 mi (6 km) from the Sivulliq Prospect (Trefry and Trocine 2009; Dunton et al. 2009) were comparable to those collected at the nearby Torpedo Prospect, TSS values were slightly larger in shallow waters less than 16 ft (5 m). In waters approximately 82 ft (25 m) deep, the presence of particle organic carbon also contributed to a portion of TSS values measured (Figure 3.2-4).
Figure 3.2-2  Sampling Locations During 2008 Study of Camden Bay
Dissolved Oxygen

The cold arctic waters of the Beaufort Sea maintain dissolved oxygen (DO) levels near or at full saturation. Often oceans in more northern locations exceed the oxygen found in marine waters of warmer climates. The amount of oxygen required to sustain marine vegetation in the water column is 1 mg/L (WCC 1981).

DO levels in the Beaufort Sea range from 8-12 mg/L during the open water period when higher rates of photosynthesis take place (WCC 1981). In winter when sunlight diminishes to nil, DO remains comparable to summer except in some ice-covered areas, where higher circulation adds more oxygen to
the water column. Unless the water is poorly circulated, oxygen rarely drops below 6 mg/L circulation increases oxygen contents (MMS 2002a).

The DO measurements at sampling sites in the Sivulliq and Torpedo prospects area ranged from 9.5-10.4 mg/L within surface waters and 11-12.2 mg/L in bottom waters greater than or equal to 25 m. The percent oxygen saturation for surface water ranged from 89-98, and 96-104 in bottom waters at Sivulliq and Torpedo, respectively (Trefry and Trocine 2009; Dunton et al. 2009).

Temperature and Salinity

In summer, Beaufort Sea coastal waters become stratified with warm, fresh water blanketing underlying colder dense seawater. Stratification produces warmer, brackish water along the shoreline where an abundance of fish, birds, marine mammals, and other biota can feed and travel. Stratification is disrupted by storm activity or wind that agitates the water column delivering nutrient rich water to the surface. Stratification ceases as temperatures cool surface waters producing a uniform temperature water column. October through June, the water column remains unstratified and fairly uniform with salinities range from 24 to 35 parts per thousand (ppt). Marine waters colder than 28.4 °F (-2.0 °C) typically freeze.

In 1996, ADEC designated the nearshore Beaufort Sea lagoon waters from the Sagavanirktok River to Simpson Lagoon as “impaired” (ADEC 2008). Reports indicated hydrology and water quality (temperature and salinity) were affected by causeway development. To mitigate the effects, breaches were cut in the West Dock and Endicott causeways. This reversed the problem and two years later in 1998 the waters were delisted but continue to be tracked and monitored.

During the summer of 2008, the vertical profiles of salinity and temperature within Sivulliq and Torpedo prospect areas showed stratification (Figures 3.2-5 and 3.2-6). The sea at Torpedo demonstrated greater display of stratification, with warmer surface water and salinity lower than that measured near the Sivulliq Prospect. (Trefry and Trocine 2009; Dunton et al. 2009).

Camden Bay Area Water Velocity

Voparil (2009) summarizes that the open-water circulation depends mostly on the wind, and the wind’s direction is more important than its speed (Hanzlick et al. 1990). Other controls on circulation include river discharge, ice-melt, bathymetry, and the configuration of the coastline. The mean surface-current direction year-round is to the west and parallels the bathymetry. Average currents are generally 10 centimeters per second (cm/s) in summer, though storms create short-lived currents that approach 100 cm/s (MBC Applied Environmental Sciences 2003).
Figure 3.2-5  Vertical Profiles of Temperature and Salinity Near the Sivulliq Prospect

Temperature (°C)

Salinity

Station L250-1
August 20, 2008
Figure 3.2-6  Vertical Profiles of Temperature and Salinity Near the Torpedo Prospect

Temperature (°C)

Water Depth (m)

Station HEX-19
August 19, 2008

Salinity

Water Depth (m)

Station HEX-19
August 19, 2008
pH

pH indicates the concentration of para-hydronium ions that determine the acidity or alkalinity of a water-base fluid (USACE 1999). The pH of the Beaufort Sea water averages 7.5-8.4 where river flow dilutes the seawater and allows the pH to drift toward that of freshwater. Measurements collected in Prudhoe Bay are 6.8-7.9 under the ice and 7.8-8.2 during the drilling season (USACE 1999). Directly offshore of West Dock, pH values were 8.0-8.2 under the ice, and 7.9-8.1 during the open water period (USACE 1999).

The pH recorded in surface waters at four of the northern most sampling stations, including Torpedo, and a sampling station approximately 4 mi (6.4 km) from the current Sivulliq Prospect (see Figure 3.2-2) ranged from 7.8-8.4. The pH in bottom waters less than 82 ft (25 m) deep at these sites ranged from 7.7 to 8.0 (Trefry and Trocine 2009; Dunton et al. 2009).

Trace Metals

Trace metal concentrations in specific areas of the Beaufort Sea are highly variable. There are elevated levels in specific areas compared to concentrations in the eastern portions of the Arctic Ocean. Overall, concentrations are lower than EPA criteria for the protection of marine life (Boehm et al. 1987). Snyder-Conn (1990) measured elevated levels of barium (Ba), chromium (Cr), lead (Pb) and zinc (Zn) near disposal sites of drilling effluents. Elevated levels of Ba were found in specific areas of Harrison Bay and Cr near the mouth of the Canning River (MMS 2003). Boehm et al. (2001) found West Dock in the Prudhoe Bay oil and gas development area has the highest concentration of trace metals, attributed to high construction and development activities in the area.

The behavior of trace metals is a function of substrate sediment composition, suspended sediment composition, and water quality. In the Beaufort Sea, trace metal concentrations are highly variable with most elevated sources occurring near exploration drill sites in the Prudhoe Bay oil and gas development area.

Based on a study of 46 sample locations in Camden Bay only the Hammerhead prospect (HH-5) exceeded the Effects Range Low (ERL) for copper (Cu) and Pb. However, these concentrations are well below the median effect range (ERM) for the respective metals. HH-5 also exhibited elevated levels of Ba, likely released as residual drilling mud and cuttings. Industrial barite is approximately 53 percent Ba. A sediment core sample collected at HH-5 was 23 percent barite (Trefry and Trocine 2009). Analytical results from this study are shown in Table 3.2.4-1.

Concentrations of aluminum (Al), iron (Fe), Zn, cadmium (Cd) and mercury (Hg) were at background levels and consistent with other areas along the Beaufort Sea coast from Harrison Bay to Camden Bay. The concentrations of Zn, Cd, Hg and Ag sediments sampled in Camden Bay were below the minimum level believed to cause adverse effects to benthic organisms (ERL) (Trefry and Trocine 2009). Outside of the exploration drilling program area, elevated levels of Ba ranging between 5,000 and 6,600 ppm were reported near Cross Island along the Beaufort Sea. Ba levels may have been 10-20 times lower than the actual amount due to laboratory treatments used to extract Ba from the sediment core. A location in Harrison Bay reported Ba at a level of 1,100 ppm. The highest Ba levels were reported in Camden Bay during the summer of 2008. Four of 46 stations near HH-5 had Ba levels exceeding the background value of approximately 600 ppm. Samples were 1.4 to 200 ppm above background values.

In the 1980s chromium lignosulfonate was commonly added to drill fluids as a thinner. Cr levels at Hammerhead fell within a normal range in all but one location (HH-5) where the concentration was 135ppm. Concentrations were reported as high as 331 ppm near Cross Island where drilling occurred in
Hydrocarbons

Most historical Beaufort Sea sampling stations report low total dissolved hydrocarbon concentrations, ranging from 0.21-16 ppm (Boehm et al. 2001). Hydrocarbon inputs are generally a result of biogenic sources, such as land-derived plant material, or petrogenic sources, such as fossil sources (coal and tar). They are transported primarily by river runoff and coastal erosion. The highest reported total dissolved hydrocarbon sampling result, 50 ppm, was found at a sampling station west of West Dock in Prudhoe Bay (Boehm et al. 2001). The sample from this station contained high concentrations of metals and indicated contamination from an anthropogenic source. This site is near an area of construction and development activity.

Concentrations of total petroleum hydrocarbons (TPH) and total polycyclic aromatic hydrocarbons (TPAH) in surface sediments sampled throughout Camden Bay during summer 2008 remained at background values for 45 of 46 locations (Trefry and Trocine 2009; Dunton et al. 2009). The HH-5 site (Figure 3.2-2) located approximately 2.5 mi (4 km) west of the current Sivulliq prospect held a TPH and TPAH concentration between 4 and 6 times greater than that measured at other sampling locations. All 46 samples of PAH however, remained below ERL and ERM. The nature of the hydrocarbons at HH-5 indicates deposition from a naturally occurring source rather than an industrial one. The HH 2 well was never flow tested, and no oil was ever produced from the well.

Persistent Organic Pollutants

Persistent organic pollutants (POPs) are organic compounds (normally anthropogenic) that do not readily degrade in the environment. They are capable of being transported over long distances, tend to bioaccumulate in some animal tissues, and increase in concentration higher in the food chain. Many POPs have been used or are currently used as pesticides, solvents, or in industrial processes (Ritter et al. 1983 and 1984. Al, Fe, Zn, Cd and Hg were at natural background concentrations in all of the surface and subsurface sediments collected.

** units of measurement are in percent (%) 
Trefry et al. 2003

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The presence of POPs such as polychlorinated biphenyls and organochlorine pesticides (e.g., dichlorodiphenyltrichloroethane or DDT) in Arctic seawater is generally a result of circumpolar transport.

Of recent concern are the high contaminant concentrations observed for hexachlorocyclohexane (HCH), an organochlorine pesticide widely used in Asia and Russia (Strachan et al. 2001). Recent evidence suggests that most of the HCH that originates in Asia is deposited into the Pacific Ocean. The Beaufort Sea then receives these compounds by transport through the Bering Strait (Li et al. 2003).

### 3.3 Geology and Shallow Hazards

This section addresses geology, geologic hazards, and man-made hazards.

#### 3.3.1 Geology

The geology of the northern coast and offshore of Alaska is characterized by two geologic provinces: the Arctic Platform and the Brookian Basin. The two provinces are separated by the Hinge Line, a crustal flexure of down-to-the-north basement faults. The Hinge Line trends roughly parallel to the coastline and trends northwest beyond Point Barrow. Both the Torpedo and Sivulliq prospects are northeast of the Hinge Line and within the Brookian Basin. The uppermost sediments in the vicinity of the prospect areas are comprised of coastal plain/delta plain to shelf-margin sediments derived from the ancestral Brooks Range. These sediments range from Early Cretaceous to Pliocene (late Tertiary) in age (MMS 2002a).

The Quaternary geologic history of most of Alaska (about the last 2 million years) generally reflects the advance and retreat of large glaciers and the direct effects of glacial processes. However, glaciers played only a small or indirect role in shaping the physical environment of the Beaufort. The processes associated with glacial and eustatic sea-level fluctuations were much more influential in the Quaternary history and geomorphology along the Beaufort coast. The shelf of the Beaufort is essentially a seaward extension of the low, flat coastal plain of northern Alaska.

Offshore, the Pleistocene strata generally are a continuation of those under the Arctic Coastal Plain. Pleistocene strata underlie the Beaufort Shelf or are exposed at the seafloor where Holocene sediments are absent. Pleistocene strata were deposited during fluctuating sea levels and are collectively called the Gubik Formation. When sea level dropped, streams and rivers deposited sediments as alluvial layers and deltas that together formed a seaward-thinning wedge. When sea levels rose, silts and clays with some boulders carried by floating pack ice were deposited to form a landward-thinning wedge. The upper Pleistocene units generally consist of marine silts, clays, sands, and isolated organic silt and peat. In the project vicinity of the Sivulliq prospect, the Pleistocene sediments are reported to be 820-984 ft (250-300 m) thick (Nortec 1985). At the Torpedo prospect, Pleistocene sediments range in thickness between 320 ft (98 m), and 500 ft (152 m) (Geo LLC 2008).

The Holocene sediments are comprised of soft, reworked silts, clays, and fine-grained sands. The sources of these deposits are stream sediment, eroded coastal sediments, and fine-grained marine sediments carried by coastal currents. Seasonal storms, offshore currents, and ice scour rework and redistribute the fine-grained sediments. This reworked Holocene veneer covers older Holocene and Pleistocene features such as drowned lagoons, stream channels, and more recent features such as ice gouge and strudel scour depressions.

Geologic structure in the area is mainly comprised of folding and faulting within the deep pre-Pleistocene units. Relatively little deformation is noted in shallower, younger sediments (Nortec 1985). Two major parallel faults striking northwest-southeast were identified by Nortec (1985) in the Sivulliq Prospect;
these faults are part of a regional trend of growth faults that also exist at the Torpedo Prospect. The shallowest of these was detected about 330 ft (100 m) below the seafloor. The only area of seismically active faults is deeply buried strike-slip faults north of the Arctic National Wildlife Refuge (ANWR). The largest earthquake recorded in northeast Alaska was centered in this area and was a Richter scale magnitude of 5.3.

The Beaufort Shelf was exposed to below-freezing annual temperatures during several Pleistocene low stands of sea level. During this time, permafrost formed to depths of hundreds of feet beneath the exposed shelf. During subsequent high stands of sea level, the bonded permafrost partially melted from above by thermal heating by warm seawater, and by saline advection from the seawater into the underlying sediment; and from below by geothermal heating.

The mean annual bottom water temperature for the inner shelf of the Beaufort is between 30 and 34.7 °F (-1.1 and -1.5 °C). Sediments within the offshore area of interest regionally meet the broad definition of permafrost. In the offshore, the terms “bonded” or “unbonded” (abbreviated forms of ice-bonded or ice-unbonded) permafrost are used to describe offshore soils. Soils whose particles are cemented by ice are referred to as either well-bonded or partially bonded. If no cementation is present, then the soils are referred to as non-bonded. Except for shallow water areas (less than 6 ft [1.8 m] deep) and under the barrier islands, bonded permafrost is restricted to the deeper Pleistocene sediments. The distribution of permafrost in the offshore is highly irregular and may be controlled in part by coarse shallow gravel deposits. Permafrost thickness decreases away from the shoreline in the deeper waters of the Beaufort Sea. Permafrost may be possibly encountered during exploration drilling possibly at depths of about 78 ft (24 m) (Nortec 1985).

Trace metals found in the bottom layer of the sediment can indicate cumulative deposition from industrial sources (Trefry et al. 2003), while trace metals found in the upper layer indicate more recent inputs. Recent studies (Trefry et al. 2003; Trefry and Trocine 2009) have evaluated sediment quality in the nearshore Beaufort Sea and around the proposed drill sites with respect to trace metal concentration. Trefry and Trocine (2009) found trace metal concentrations consistent with historical background levels around the Hammerhead prospect as well as the proposed exploration drilling prospects. Past studies reported high variability of trace metal concentration in the Beaufort Sea, but Crecelius et al. (1991) suggested that metal concentration is highly related to the grain size of associated sediments.

**Seafloor Sediments and Sediment Quality**

The general sediment quality of the Alaska Arctic OCS is very good due to the remote location, harsh but active ecological system, and limited presence of human-generated inputs. Degradation of sediment quality is primarily due to naturally occurring processes. North Slope rivers carry hydrocarbons from peat, coal, and natural seeps into the coastal waters (Naidu 2001, 2005; Brown 2003).

The composition, texture, and distribution of surficial sediments on the Beaufort shelf are influenced by river and coastal sediment input, ice gouging, wave and current action, and historic geologic and oceanographic conditions of the Beaufort shelf (MMS 2003; Barnes et al. 1979). Sediments along the inner shelf consist of moderately to well-sorted silts and fine sands, which come from river and coastal input. Nearshore sediments undergo reworking year-round. Ice push, keel gouge, and strudel scour are associated with ice cover. These geomorphic features are affected during the drilling season; waves and currents redistribute the sediments and infill some of the scours and gouges (Barnes and Reimnitz 1979). Sediments along the central shelf consist of gravelly muds; ice gouging within the stamukhi zone of the seasonal sea ice cover disturbs these sediments. Ice gouging occurs primarily in water depths between approximately 66-164 ft (20-50 m) when deep ice keels intensely scour the seafloor (Barnes et al. 1984). The gravels in the sediments are coarse and typically angular and striated, indicating deposition as ice-
rafted debris. Studies indicate that ice-rafting of fine-grained sediment entrained in shorefast ice may also be a significant mode of transport for these materials in the Beaufort Sea (Barnes et al. 1982; Reimnitz et al. 1998).

Shelf break sediments consist primarily of a 2-8 in. (5-20 cm) thick layer of muddy gravel overlying a clay-silt base. The clay has been deposited as detritus, and not formed in place, indicating recent sedimentation rates are low on the outer parts of the shelf.

Petroleum hydrocarbon concentrations are at very low levels in Arctic sediments and do not pose an ecological risk to marine organisms in the OCS (Brown et al. 2001, 2003; MMS 2006). Measurements of methane concentration in sediments around Harrison Bay, indicated that methane is present in the sediment, and escapes more readily from clean sand than from silt and clay. A likely source for this methane is gas hydrates on the shelf (Lorenson and Kvenvolden 1995). A study of inshore sediments, inland of Demarcation Bay at the Beaufort Lagoon in ANWR examined the concentrations of metals and hydrocarbons. The hydrocarbon components in the sediments were of terrestrial and biogenic sources with undetectable petroleum inputs (Naidu et al. 2005).

### 3.3.2 Geologic Hazards

The following discussion of hazards pertains to drilling of exploration wells from the Kulluk or Discoverer in the Torpedo and Sivulliq prospects of the Camden Bay Area during the drilling season. This section addresses hazards surveys, historic geologic hazards, and ice gouge.

The Camden Bay drill sites are not in a significant earthquake-prone area as recognized by seismic hazard maps available on the U.S. Geological Survey (USGS) website.

#### Shallow Faulting

Reinterpretation of shallow hazards surveys by Geo LLC (2007), in conjunction with additional supplemental data interpreted by Fugro (2009a) identified no seafloor faults within the Sivulliq study area. Eight buried faults were mapped in the western portion of the study area. The nearest buried fault to the Sivulliq N drill site is located 1,378 ft (420 m) northeast of the proposed drill site. This fault trends northwest and dips to the northeast away from the proposed wellbore. (Fugro 2009a) The closest buried fault to the Sivulliq G drill site is approximately 2,558 ft (780 m) to the northeast and trends southeast and dips to the northeast away from the wellbore (Fugro, 2009a).

Reinterpretation of shallow hazards surveys by Geo LLC (2008a), in conjunction with additional supplemental data interpreted by Fugro (2009b) identified no seafloor faults within the Torpedo study area. Five buried normal faults were mapped. The lengths and depths of burial of the individual faults are variable. The nearest buried fault to the Torpedo H drill site is located about 7,119 ft (2,170 m) southwest of the proposed drill site and trends northwest. This fault dips to the northeast but will not intersect the proposed drill site within the depth limit of investigation (4,734 ft [1,443 m] below seafloor) (Fugro 2009b). The nearest buried fault to the Torpedo J drill site is 1,900 ft (579 m) to the northeast (Fugro 2011). The fault trends to the northwest and dips to the northeast away from the wellbore.

#### Recent Shallow Hazards Surveys

Shell conducted shallow hazards surveys in the Camden Bay Area during open water seasons in 2007 and 2008 (Fugro 2009a and 2009b). The results of these shallow hazards surveys allowed Shell to conclude that the areas to be included in the anchor arrays around the proposed drill sites in the Torpedo and Sivulliq, areas are free of man-made or geologic risks.
Historic Shallow Hazards

Shallow Gas

Shallow gas is common in marine sediments and can pose a hazard to exploration drilling if concentrated and under pressure. Shallow gas, while present at some locations in the area of previous drilling operations has not been problematic in offshore Beaufort exploration wells to date. In a shallow hazards survey conducted in 1985, some seismic anomalies were noted near the HH-1 and HH-2 drill sites that could have indicated shallow gas but drilling was performed at both sites without incident (Nortec 1985). Shallow gas has been identified at several other potential drill sites in the Beaufort Sea. The drill sites were moved to avoid the indicated shallow gas accumulations.

Interpretation of the Sivulliq shallow hazards surveys by Geo LLC (2007), in conjunction with additional supplemental data interpreted by Fugro (2009a), indicate there is no shallow gas hazard at the Sivulliq N and G drill sites. Fugro describes the potential for a vertical well to encounter shallow gas at these drill sites as negligible to low.

Geo LLC (2008a) and Fugro (2009b and 2011) interpretation of the shallow hazards data at Torpedo concluded that there are no shallow gas hazards at the Torpedo H or J drill sites. Fugro describes the potential for a vertical well to encounter shallow gas at these drill sites, as negligible to low.

Natural Gas Hydrates

Gas hydrates are composed of methane that is in a water matrix. The molecular interaction of the methane and water forms an ice-like structure that can exist at temperatures higher than 32° F (0° C). These normally occur in gas production operations, but they can occur naturally in deep water areas of continental margins under low-temperature and high-pressure conditions (MMS 2003). Hydrates have also been found below the permafrost layer in the Prudhoe Bay and Kuparuk oil fields. A multiyear study by the USGS found methane in the water and ice of the Beaufort Sea between Camden Bay and Cape Halkett. The primary source of the methane was not defined, but the report presented gas hydrate as a reasonable candidate (Lorenson and Kvenvolden 1995). Therefore, there is a possibility of gas hydrates in the Torpedo and Sivulliq prospects. While there is the possibility of gas hydrates in the Torpedo and Sivulliq prospects, there is no evidence in the geophysical records that indicates the presence of gas hydrates at any of the proposed Sivulliq or Torpedo drill sites (Fugro 2009a, 2009b).

In at least one well, the Shell-Corona No. 1, a small gas “bubble” entrained in the returned drilling mud from the well was attributed to thermally dissociated methane hydrates while drilling in a shallow section of the well. A mud cooler on the drilling rig, used to keep drilling fluid temperatures low to avoid permafrost thawing, malfunctioned allowing mud temperature to rise. The “bubble” pushed a small volume of mud out of the hole, but well control was not lost (Rick Fox personal communication 2006).

Sediment Slides

Sediment slides occur along the length of the Beaufort outer shelf and upper slope seaward of the 164-197 ft (50-m) isobath. Gas hydrate thermal dissociation during Pleistocene fluctuations in sea level is a likely cause of these slides (Kayen and Lee 1991). These slides are not in the vicinity of the Sivulliq and Torpedo prospects. In the proposed drill site areas, the seafloor is flat and featureless, so exploration drilling at the Sivulliq and Torpedo prospects will not be affected by sediment sliding.
Ice Gouge

Ice gouging occurs along the stamuhki zone or in other areas where ice is forced in to depths shallower than its keel by currents, wind, or ice interaction (OTA 1985). Ice gouges were found throughout the study during the Hammerhead shallow hazards survey. They were 3-16 ft (1-5 m) deep and up to 656 ft (200 m) wide (MMS 2002a). Ice gouge depths in the vicinity of the proposed Sivulliq drill sites show a maximum recent depth of 8.2 ft (2.5 m), whereas at the proposed Torpedo drill sites the depth is 4.1 ft (1.3 m).

3.3.3 Man-made Hazards

There are no known man-made hazards in the proposed exploration drilling areas or vicinity.

3.4 Lower Trophic Organisms

This section discusses lower trophic organisms, which include phytoplankton, zooplankton, and benthic communities. Lower trophic organisms provide food for fish, birds, and marine mammals, including the bowhead whale. Phytoplankton species produce chlorophyll and serve as an integral source of energy in the marine ecosystem. Areas with the largest biomass of phytoplankton occur near Barrow, approximately 220 mi (354 km) from the project area, and Barter Island near Kaktovik, approximately 50 mi (80 km) from the project area (Dunton et al. 2007). Zooplankton organisms provide food for large marine mammals such as bowhead whales and ringed seals. Benthic communities, plants and animals living in or on the sediment of the seafloor, support Pacific walrus, bearded seals, gray whales, and some duck populations. Benthic communities flourish during the summer months because of a spike in primary productivity and reduced ice gouging.

During the 2008 summer/fall season, Shell commissioned benthic sampling in the Sivulliq project area (Dunton et al. 2009). Much of the Beaufort Sea floor is covered by silt and sand (Barnes and Reimnitz 1974). A regional classification of shoreline segments along the Alaskan Beaufort Sea Coast reveals sediments are mostly silts and sands, with occasional gravel (Jorgenson and Brown 2005). Because Shell’s prospects are located on the nearshore shelf of the Beaufort Sea, where the sediment is predominately composed of silty sands and mud, it can be reasonably predicted that the resources in the Torpedo prospect to be similar to those found in Sivulliq.

3.4.1 Phytoplankton

Phytoplankton are resistant unicellular species including small diatoms, dinoflagellates, microflagellates, algae, and microscopic plants that live in the water column or on ice surfaces (epontic organisms).

Distribution

Seasonal patterns in light intensity, nutrients, and oceanographic conditions influence the distribution of phytoplankton (MMS 1996). Chlorophyll concentrations are related to levels of primary productivity and to the presence of phytoplankton. Scientists have analyzed multiple data sets on chlorophyll concentrations and identified areas of high levels of primary productivity that indicate the presence of phytoplankton (Dunton et al. 2003). The highest concentration of chlorophyll in the Beaufort Sea was observed near Barrow (Dunton et al. 2003). This may be attributed to currents coming from more productive areas such as the Chukchi and Bering Seas passing through this area. The Barter Island coast near Kaktovik is another productive area (Dunton et al. 2003). This area exhibits upwelling of nutrient-rich water from offshore areas. The combination of increased light intensity and regular upwelling from deep offshore waters in such areas allows for increased productivity.
A survey in Stefansson Sound, west of Camden Bay closer to Prudhoe Bay, phytoplankton in the water column contributed about one-third of the lower trophic primary production while the algae dependent on sea ice contributed two-thirds of the primary production (Horner and Schrader 1982). The period of time that ice is present temporally limits the contribution of ice algae, or epontic species. The ice algal community is present primarily during April through early June. Shell exploration drilling activities at the proposed Sivulliq and Torpedo drill sites will occur after the ice algal community largely disappears.

Shell funded a study in 2008 to collect baseline information regarding chlorophyll $\alpha$, carbon, and nitrogen in the water column within the Sivulliq prospect. The data can be compared to post-exploration conditions to assess change in the ecosystem as a result of anthropogenic activities from oil exploration. Information on the ecosystem prior to exploration activities is important for discussions of any changes due to prevailing environmental conditions versus Shell’s exploration drilling activities.

Dunton et al. (2009) reported strong correlations between chlorophyll levels and elevated $^{13}$C (an isotope of carbon) values within the sediment. High $^{13}$C values are associated with marine primary producers. They recorded high carbon to nitrogen ratios at nearshore sites. The combination of high chlorophyll levels in the water column and high levels of $^{13}$C in the sediment at these sites suggests sediment resuspension may enhance water column production.

**Life History**

Phytoplankton are characterized by large populations, short generation times, and high natural mortality. The rate of primary production in the lower trophic level organisms varies from year to year (Horner 1984). Since light availability limits phytoplankton productivity, years with low ice coverage have the greatest phytoplankton productivity. Conversely, ice algae contribute more energy in those years with more ice coverage. Shell’s exploration drilling activities are planned to be conducted after the ice algae community largely disappears. Spring blooms of primary production occur close to shore (water shallower than 16 ft [5 m]) shortly after the ice melts, but there is little data supporting a spring bloom offshore (Horner 1984; Schell et al. 1982).

**Abundance**

Phytoplankton abundance is tied to the amount of light penetrates the water, often through an ice layer (Gradinger et al. 2005). Ice thickness, snow cover, and turbidity affect light penetration. Phytoplankton populations peak in late July and early August as a result of increased light availability coupled with upwelling of nutrient-rich water from offshore areas. The greatest abundance of phytoplankton occurs at water depths of less than 16 ft (4.8 m) because light is not able to penetrate beyond these depths.

Sampling in the Beaufort Sea identified 94 species of phytoplankton (Horner 1984). Chaetoceros were the most abundant of the 94 species found and were distributed across the Beaufort Sea (Horner 1984).

Coastal zones (within 3 mi [5 km]) are the most productive areas for phytoplankton in the Beaufort Sea. (MMS 2003). Chlorophyll $\alpha$ concentrations in coastal waters have been measured at 100 times greater than in offshore surface waters. Shell’s prospects are located 16-20 mi (26-32 km) offshore and are outside the most productive areas for phytoplankton.

**3.4.2 Zooplankton**

Zooplankton are multi-cellular invertebrates and egg and larval stages of some vertebrates. Zooplankton are a primary food source for fish and some birds and marine mammals. Among the species of zooplankton, krill are important food sources for bowhead whales (Lowry 1993) and ringed seals (Frost and Lowry 1984). Food availability can limit the abundance of the bowhead whale population in Arctic
waters (Lowry 1993). The whales must find water with a sufficient zooplankton abundance to feed and properly care for young.

**Distribution**

High-biomass areas of zooplankton have patchy distributions and can be thousands of meters long and only a few meters deep (Richardson 1986). Currents, temperature ranges, and salinity levels influence zooplankton production. Zooplankton drift in the water column and have little ability to control their movements against the ocean currents. Most of the zooplankton communities are detritus feeders (Truet 1984). The Yukon and Kuskokwim Rivers deposit detritus into the Bering Sea where currents transport the material into and through the Chukchi Sea and into the Beaufort Sea. The amounts of detritus decrease as the currents flow east. Therefore, the abundance of detritus-feeding organisms also decreases to the east (Stoker 1981). Areas with the highest biomass in the Beaufort generally occur just below 33 ft (10 m) deep and just above the seafloor (Griffiths and Buchanan 1982). During both the summer and winter, calanoid copepods may dominate the zooplankton community in biomass and density (Craig et al. 1984; Lowry 1993).

Ongoing research conducted by BOEMRE and the National Science Foundation (NSF) shows oceanographic fronts are formed by a combination of wind and tides between water masses offshore of Elson Lagoon (MMS 2008a). Elson Lagoon is located on the western side of the Beaufort Sea just off of Point Barrow. These fronts provide for higher concentrations of zooplankton in the lagoon. Water pulsations and discharges observed near Barter Island (Hachmeister et al. 1987) indicate similar oceanographic fronts in that area, closer to Camden Bay, which explains higher primary production there (MMS 2008a).

**Life History**

Most zooplankton are filter feeders, using their appendages to strain bacteria, algae, phytoplankton, and other fine particles in the water while others are predatory and feed on smaller zooplankton. Zooplankton have short life-cycles and high reproductive rates, allowing them to regenerate their population quickly. Zooplankton are comprised of organisms that either spend their entire life cycle in the planktonic stage and those that are only planktonic for part of their life cycle. Zooplankton include organisms such as krill that produce thousands of eggs at a time and can spawn several times during a season.

**Abundance**

Areas with high primary productivity are important areas for zooplankton since they feed on the phytoplankton and other species. Currents also influence areas of high zooplankton abundance. Samples collected near Camden Bay at depths less than 656 ft (200 m) near Shell’s prospects (Griffith et al. 2002) yielded groups of zooplankton. These groups included copepods (the most abundant species collected in the sampling), ctenophores, cnidarians, chaetognaths, mysids, and fish larvae (Griffith et al. 2002). Because the two prospects are in close proximity to each other on the nearshore shelf of the Beaufort Sea, where the physical characteristics of one area along the shelf are essentially the same as another, it is reasonably assumed that zooplankton populations in the vicinities of the prospects are representative of the areas studied.

Scientists found high densities of euphausids in areas where whales were skim-feeding (Wartzok et al. 1990). The data could imply bowhead whales follow high densities of zooplankton for feeding. In stomach samples examined from 35 bowhead whales taken for subsistence purposes (Lowry 1993), copepods and euphausids accounted for the majority of the content found in the bowhead stomachs (Frost and Lowry 1984).
3.4.3 Benthos

The benthos consists of organisms living within, on, or near the surface of seafloor sediment. During the 2008 summer/fall season, Shell commissioned baseline information be collected regarding biomass and density of the benthos at 45 sites within the Sivulliq Prospect. The baseline data can be compared to post-exploration conditions to assess change in the ecosystem as a result of anthropogenic activities from oil exploration. Information on the ecosystem prior to exploration activities is important for discussions of any changes due to prevailing environmental conditions versus Shell’s exploration drilling activities.

Distribution

Benthic invertebrate communities include organisms living on top of (epifauna) and within bottom sediments. Small benthic invertebrates are important, because they provide a crucial link between primary producers and larger organisms within the benthic community. These organisms contribute greatly to the transfer of energy within the ecosystem (Bessiere et al. 2007). Amphipods, isopods, and mysids are the epifaunal organisms inhabiting nearshore water. Amphipods appear to occupy wider ranges of salinity than mysids (USACE 1984). Isopods dominate the invertebrate biomass in certain locales (MMS 1996).

Sea ice gouge affects these organisms by disturbing sediments thereby limiting their abundance and distribution. Bottomfast ice in depths less than 6.6 ft (2 m) prevents the development of benthic communities. Recolonization from offshore areas replenishes the invertebrate communities in these areas during ice-free periods (MMS 1990).

Sediment grain size influences benthic species composition, with deposit feeders predominating in fine sediments and suspension feeders thriving in coarse sediments. Nearshore habitats provide for large fluctuations in salinity and temperature. Many benthic organisms survive these fluctuations by either temporarily burrowing into the sediment or moving out of the area. In lagoon areas, the water current helps move invertebrates and their larvae nearshore to recolonize shallow areas after bottomfast ice moves out, exposing the inshore sediments (Griffiths and Dillinger 1980). As the distance from the shore increases, available nutrients decrease, thereby resulting in decreased productivity.

Hard-bottom communities contain aggregations of macrophytic algae (large kelps), benthic microalgae, and benthic invertebrates associated with rocks and other hard substrate (MMS 1996). For example, the “boulder patch” in Stefansson Sound east of Prudhoe Bay provides substrate for invertebrates and brown algae (kelp) (Dunton 1984). There are also some areas in western Camden Bay with sparse kelp distributions. Kelp, in general, provides about 60 percent of the particulate organic matter found in the Beaufort Sea (Dunton 1984). Sponges, soft corals, hydroids, sea anemones, bryozoans, nudibranchs, and sea squirts are species supported by hard-bottom substrate (Dunton and Schonberg 1980). The sediments in the area including the proposed Sivulliq and Torpedo drill sites are predominantly composed of soft-bottom sand and mud (Barnes and Reimnitz 1974).

Life History

Benthic organisms spend their entire life cycle associated with the seafloor. Because there are a wide variety of types of animals included in benthic communities, it is difficult to summarize the life history of this group as a whole. Some species are more long-lived than others and some species are able to disperse to wider ranges than their benthic neighbors. With the exception of shallow protected areas, the seafloor in Camden Bay can be expected to be recolonized by benthic organisms frequently due to ice gouge.
Polychaete worms accounted for most of the species found in grab samples from the Sivulliq prospect (Dunton et al. 2009). They have several parapodia that aid in locomotion and respiration. A majority of these worms burrow in the sediment and some secrete their own encasing tube. Some polychaetes are asexual reproducers while others reproduce sexually.

Bivalves were the second most abundant group found in Dunton’s study (Dunton et al. 2009). They feed by siphoning and filtering particles from the water column. Clams are common bivalves found in the area of the prospects.

**Abundance**

Frost and Lowry (1983) reported echinoderms such as starfish being the most abundant invertebrate in the western Beaufort Sea. Polychaetes, mollusks, and crustaceans are the primary infaunal animals in the Beaufort Sea near the Sivulliq and Torpedo drill sites (Dunton et al. 2009). Table 3.4.3-1 shows the number of species in groups of benthic organisms found during a study in the Sivulliq Prospect. Benthos communities in the prospect areas are assumed representative of the remainder of the Beaufort Sea at depths between 95 and 165 ft (29 and 50 km) deep.

Benthic organisms are abundant and increase in numbers and diversity in the summer during open water conditions. Ice gouging disturbance limits infaunal biomass in the shear zone (MMS 1990). Biomass increases with depth and distance from shore with the highest at approximately 460 ft (140 m) deep (Carey et al. 1974). High benthic abundance in the Beaufort Sea occurs because the fauna is not capable of consuming all of the phytoplankton that is available.

These areas of high benthic biomass serve as important feeding grounds for benthic grazers such as gray whales, bearded seals, walrus, and some ducks. A high abundance of benthic-feeding animals indicates a healthy benthic population (Feder et al. 2007).

During benthic studies conducted by NOAA/MMS during the summer of 2008, data on benthic diversity and abundance were collected. Brittle stars made up 41 percent of the total weight of invertebrates found in bottom trawl samples (Rand and Logerwell 2009).

Dunton et al. (2009) observed no obvious spatial trends in the biomass or density of benthic organisms in the study area during 2008. However, several sites contained some of the highest biomass values recorded on the nearshore shelf of the central Alaskan Beaufort Sea so far. Apparently, the benthic communities have not been adversely affected by previously discharged mud and cuttings during drilling operations at the former Hammerhead prospect drill sites.
### Table 3.4.3-1 No. of Species Collected from Grab Samples Near the Sivulliq and Torpedo Prospects

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polychaete</td>
<td>41</td>
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<tr>
<td>Bivalve</td>
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</tr>
<tr>
<td>Amphipod</td>
<td>20</td>
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<td>Gastropod</td>
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</tr>
<tr>
<td>Cumacea</td>
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</tr>
<tr>
<td>Anemone</td>
<td>3</td>
</tr>
<tr>
<td>Bryozoan</td>
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</tr>
<tr>
<td>Holothurian</td>
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</tr>
<tr>
<td>Isopod</td>
<td>2</td>
</tr>
<tr>
<td>Nemertean</td>
<td>2</td>
</tr>
<tr>
<td>Anthozoan</td>
<td>1</td>
</tr>
<tr>
<td>Ascidian</td>
<td>1</td>
</tr>
<tr>
<td>Fish</td>
<td>1</td>
</tr>
<tr>
<td>Foraminifera</td>
<td>1</td>
</tr>
<tr>
<td>Hydrozoan</td>
<td>1</td>
</tr>
<tr>
<td>Mysid</td>
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</tr>
<tr>
<td>Priapulid</td>
<td>1</td>
</tr>
<tr>
<td>Sipunculid</td>
<td>1</td>
</tr>
</tbody>
</table>

Dunton et al. 2008

### 3.5 Fisheries Resources of the Beaufort Sea

Fish distribution and abundance in Camden Bay can be described by the unique migration strategies employed by each species. Instinctual migration strategies of Arctic fish initiate movement to feeding and spawning locations at the optimal time specific to their species. These biological cues ultimately affect fish distribution and abundance in Camden Bay. Anadromous or amphidromous fish in the Arctic spend most of their lives in freshwater. They do not travel far from the shoreline and are unlikely to be in the Sivulliq and Torpedo prospect area. In comparison, marine fish spend their entire life cycle in ocean waters. The more abundant marine species are shown in Table 3.5-1, and these species are likely to occur in the Sivulliq and Torpedo prospects.

In February 2011, BOEMRE released a fish population study for a portion of the western Beaufort Sea titled “Beaufort Sea Marine Fish Monitoring 2008: Pilot Survey and Test of Hypotheses”. The eastern extent of the survey area was approximately longitude 152°W, near the Cape Halkett area west of Nuiqsut, well outside the exploration drilling program area. The prospects are situated approximately 140 mi (224 km) west of the fish survey area. A similar study of the central Beaufort Sea is scheduled to begin summer 2011.
Table 3.5-1  Marine Fish Species Documented Within Camden Bay

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arctic cod</td>
<td>Boreogadus saida</td>
</tr>
<tr>
<td>fourhorn sculpin</td>
<td>Myxocephaurus quadricornis</td>
</tr>
<tr>
<td>Arctic flounder</td>
<td>Pleuronectes glacialis</td>
</tr>
<tr>
<td>saffron cod</td>
<td>Eleginus gracilis</td>
</tr>
<tr>
<td>Capelin</td>
<td>Mallotus villosus</td>
</tr>
</tbody>
</table>

Fruge et al. 1989; Thorsteinson et al. 1992

Marine fish typically feed and spawn in coastal waters during winter. They spawn during mid-winter with eggs hatching in late winter. They are likely to spawn inside the barrier islands in colder zones with high salinity (November to February) (Craig 1984; Schmidt et al. 1983). They may also use areas far offshore. A large abundance of select marine fish species were also documented over 100 mi (160 km) offshore during winter (Craig et al. 1982).

Most anadromous and amphidromous fish inhabit the Camden Bay coastline temporarily during summer for the purpose of feeding in productive marine waters. Unless there is a storm, the highest concentrations of fish can be expected to occur within 330 ft (100 m) of the shoreline (Craig 1984). They typically begin to arrive in coastal waters in early June and return to freshwater in August to September to spawn and overwinter. There are seven commonly occurring anadromous and amphidromous fish species in Camden Bay (Table 3.5-2). Anadromous and amphidromous fish are expected to occur incidentally within Sivulliq and Torpedo prospects.

Table 3.5-2  Anadromous and Amphidromous Fish Species Documented Within Camden Bay

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arctic cisco</td>
<td>Coregonus autumnalis</td>
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<tr>
<td>Dolly Varden</td>
<td>Salvelinus malma malma</td>
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<tr>
<td>pink salmon</td>
<td>Oncorhynchus gorbuscha</td>
</tr>
<tr>
<td>chum salmon</td>
<td>Oncorhynchus keta</td>
</tr>
<tr>
<td>broad whitefish</td>
<td>Coregonus nasus</td>
</tr>
<tr>
<td>least cisco</td>
<td>Coregonus sardinellia</td>
</tr>
<tr>
<td>humpback whitefish</td>
<td>Coregonus pidschian</td>
</tr>
</tbody>
</table>

Fruge et al. 1989; Thorsteinson et al. 1992

Fish surveys conducted in the eastern Beaufort Sea, July through September, documented fish species and abundance (Fruge et al. 1989; Thorsteinson et al. 1992). The most abundant fish species recorded in the vicinity of the project area were Arctic cod, Arctic cisco and fourhorn sculpin (Table 3.5-3 and Figure 3.5-1).
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Fig.
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Kelp
Snailfish

Fish Species and Abundance, Eastern Beaufort Sea

Shell Offshore Inc.

8/21/1990
8/21/1990
8/22/1990
8/22/1990
8/22/1990
8/23/1990
9/5/1990
9/5/1990
9/5/1990
8/9/1990
8/9/1990
8/9/1990
8/9/1990
8/10/1990
9/4/1990
8/27/1990
9/3/1990
9/3/1990
9/3/1990
9/3/1990
9/3/1990
8/2/1990
8/2/1990
8/2/1990
8/5/1990
8/5/1990
8/25/1990
8/26/1990
9/2/1990
9/2/1990
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9/2/1990

Date

Table 3.5-3

Environmental Impact Analysis
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Broad
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May 2011

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Chum
Salmon

Camden Bay, Alaska


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<th>Arctic Cisco</th>
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<th>Arctic Cod</th>
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<th>Capelin</th>
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<th>Sculpins</th>
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<td>234</td>
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</tr>
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</table>


Note: Arctic cisco II * indicate juvenile Arctic cisco
Figure 3.5-1  Marine and Migratory Fish Distribution in the Beaufort Sea
3.5.1 Marine Fish

Marine fish occupy coastal waters within a few miles from the shoreline or distribute into deeper offshore waters. In winter, fish travel to waters deeper than 6 ft (2 m) near the coastline to avoid freeze up. Some species may travel offshore where they can occupy the edge of the ice for feeding opportunities and predator protection. Many fish, such as Arctic cod, sustain Arctic food webs and higher trophic species, such as the bowhead whale (Dehn et al. 2007; Craig 1984). Following is a discussion of the distribution, life history, and abundance of these species in Camden Bay.

Arctic Cod

Arctic cod are one of the most abundant and widely distributed fish in the Beaufort Sea (Gillispie 1997). Their large numbers in northern Arctic waters provide important biomass for marine mammals and seabirds (Gillispie 1997). In the Beaufort, an estimated 28,630 metric tons of Arctic cod biomass contribute to higher trophic species, such as marine mammals, birds, and fish species (Craig et al. 1982; Bradstreet et al. 1986; Craig et al. 1984).

Compared to other fish species, minimal quantities of Arctic cod are harvested for subsistence use in Nuiqsut and Kaktovik, located approximately 120 mi (200 km) west and 60 mi (100 km) east of Camden Bay, respectively. The larger harvest occurs in Kaktovik with a reported catch of 118 fish (Pedersen and Linn 2005).

Distribution

Arctic cod are expected to occur within the Sivulliq and Torpedo prospects during the drilling season. The highest abundance of Arctic cod is distributed offshore in the Beaufort Sea during the summer. The catch per unit effort (CPUE), 110 mi (175 km) from the shoreline in the Beaufort Sea was 30 times greater than in waters along the coast (Craig et al. 1982). Juveniles can be found 31-93 mi (50-150 km) away from shore in summer and at least 110 mi (175 km) offshore in winter (Craig et al. 1982).

Arctic cod movements are typically associated with ice, which provides protective cover from predation by birds and marine mammals, as well as feeding opportunities (Gillispie 1997). When coastal ice is absent, and temperature and salinity are adequate, Arctic cod are found frequenting coastal lagoons for prime feeding benefits (Craig et al. 1982).

Life History

Arctic cod are considered to have an r-selected reproductive strategy exhibiting a small body size, early maturity, rapid growth, and large numbers of offspring (Craig et al. 1982, Gillispie 1997). This type of strategy yields a quick recovery in unpredictable environments where the possibility of mortality rates is increased. They spawn under the ice typically in January and February (Gillispie 1997). Their eggs float near the surface of the water column (Dunn and Matarese 1984), developing and hatching under the ice – usually in May or June (Lowry et al. 1980). The larvae live in surface waters until August or September, at which time they metamorphose into juvenile stage and descend to the seafloor. Arctic cod in the coastal Beaufort Sea were found to mature at ages 2-3 for males and 3 for females (Craig et al. 1982), and they may live to ages 7 or 8 (Wolotira et al. 1977; Gillespie 1997).

Abundance

Arctic cod are the most abundant fish species in the coastal waters of Camden Bay and farther offshore. A total of 15,897 Arctic cod were sampled between July and September (Table 3.5-3 and Figure 3.5-1) at a location approximately 40 mi (65 km) from the project area (Fruge et al. 1989). A total of 5,530 Arctic cod were sampled between August and September at a location within 6 mi (10 km) of the project area...
(Thorsteinson et al. 1992). The same study reported a mean density of 57.9 fish per 1,000 m$^3$ and average catch of 194 fish per set.

**Fourhorn Sculpin**

In the Beaufort Sea, fourhorn sculpin can be expected in warmer 41-50 °F (5-10 °C) productive waters 650 ft (200 m) or less in depth (Craig 1989). They are not typically a target species for subsistence in Nuiqsut and Kaktovik (MMS 2008; ADF&G 2009a; ADF&G 2009b). Fourhorn sculpin are often unwelcomed by subsistence fisherman as they provide very little meat and their spiny horns make them difficult to remove from gill nets. Historically villagers ate sculpins, but today they are returned to sea (Craig 1989).

**Distribution**

Fourhorn sculpin are a species prevalent in coastal waters with periodic movements well beyond the barrier islands (Griffiths et al. 1998). Their abundance does not show a large fluctuation at coastal depths occurring between 7 and 367 ft (2 and 112 m) (Craig 1984). However, several studies have captured a large distribution of fourhorn specifically within the barrier islands where sand or sandy mud and vegetation provide protective cover (Thorsteinson et al. 1992; Underwood et al. 1995). Fourhorn sculpin sampled in winter comprised 80 percent of the total winter catch when sampling in ice in nearshore coastal waters (Craig 1984).

Fourhorn sculpin typically move offshore throughout the year. Certain events may trigger sculpin to travel offshore to areas in the vicinity of the Sivulliq and Torpedo prospects. During the spring break-up, with the outflow of rivers entering the marine environment decreasing salinity levels along the coast, sculpin are driven farther offshore into deeper waters. Sculpins appear to prefer more saline areas, and can be found in waters with salinity reaching 27,000 ppm (Griffiths et al. 1998). From late November to February, biological cues drive them offshore specifically in search of adequate spawning habitat (Thorsteinson et al. 1992).

**Life History**

Fourhorn sculpin are distributed along the Arctic coast from Norton Sound to waters of the Alaskan and Canadian Beaufort Sea. Overwintering and spawning occurs along the coast during winter. Males remain with the young, guarding them until they are a suitable size. Females usually weigh more than males of the same length, but since the ratio is subject to inter-annual variation, this can change during different times of the year.

**Abundance**

Fourhorn sculpin are most abundant in nearshore waters. Fruge et al. (1989) sampled a total of 16,794 fourhorn sculpin in coastal waters of the Eastern Beaufort Sea around Camden Bay. Another study determined the average catch of sculpin from Prudhoe Bay to Camden Bay was 0.5 fish per tow, an approximate density of 0.12 sculpin/1,000 m$^3$ (Thorsteinson et al. 1992). Sculpins were consistently captured at shallow inshore locations.

**Arctic Flounder**

Arctic flounder occur throughout coastal waters of the Beaufort Sea. Though rare, they have been reported at a depth of 300 ft (91 m). Greatest abundance can be expected in waters less than 66 ft (20 m) deep (Mecklenberg et al. 2002). Though they have been reported at a depth of 300 ft (91 m), they are expected to occur incidentally within the Sivulliq and Torpedo prospects.
Distribution

Though Arctic flounder occur throughout coastal waters of the Beaufort Sea, they are rarely found in waters exceeding 66 ft (20 m) deep (Mecklenberg et al. 2002). They have been reported at a depth of 300 ft (91 m), but are expected to occur incidentally within the Sivulliq and Torpedo prospects. Habitat utilization includes shallow brackish coastal waters with a fall movement of less than 66 ft (20 m) and a coastal movement parallel to the shoreline during spring (Schmidt et al. 1983). In general Arctic flounder have localized movements. When tagged and recaptured, Arctic flounder were found to remain within the same area (Wiswar and Fruge 2006).

Life History

Spawning occurs during winter from January to March in nearshore waters at a depth between 16 and 33 ft (5 and 10 m). Based on their distribution, Arctic flounder are not expected to spawn within the Sivulliq and Torpedo prospects.

Abundance

Arctic flounder populations increased between 1990 and 2003, exceeding the numbers previously documented in the Beaufort Sea (Fechhelm et al. 2005). In a survey conducted in the months of July through September (Fruge et al. 1989), a total of 1,939 Arctic flounder were counted from Camden Bay to Pokok Bay. Of these, only 59 were counted within Camden Bay (Fruge et al. 1989). Another study estimated the catch rate of Arctic flounder in Camden Bay from 0-67 fish per day (Wiswar and Fruge 2006).

Saffron Cod

Saffron cod occur in waters less than 200 ft (60 m) deep (MMS 2008; Gillispie et al. 1992). They are important prey items for marine mammals and seabirds. Neither Nuiqsut nor Kaktovik targets saffron cod for subsistence. Historically, saffron cod were caught by jigging a lure. However, current fishing gear is not suitable for catching these smaller-bodied fish.

Distribution

Saffron cod distribution extends through the Bering Sea north into the Beaufort Sea. Saffron cod are typically found in waters at temperatures lower than shallow coastal waters (Gillispie 1997). Saffron cod distribution extends into marine waters at depths determined for Sivulliq and Torpedo prospects.

Life History

Spawning occurs from December to February, when fish will move into shallow nearshore waters until planktonic eggs are released (Schmidt et al. 1983). Though extremely rare, saffron cod may travel slightly beyond the divide where freshwater flows into the sea (Schmidt et al. 1983). Eggs are adhesive and can be deposited onto sandy-pebbly substrate within coastal waters (Gillispie 1997). Saffron cod remain in larval form for 2-3 months. Larvae are vulnerable and cannot withstand temperatures greater than 46 °F (8 °C) (Gillispie 1997). As juvenile saffron cod remain close to shore, they have the ability to remain in coastal waters with lower salinity, but eventually distribute into colder high saline waters (Gillispie 1997).

Abundance

Compared to southerly locations such as the Chukchi Sea, saffron cod abundance in Camden Bay is minimal. While saffron cod occur within the Beaufort Sea, historically, they have only made up a small fraction of the total gadid (cod) catch at Prudhoe and Camden Bay (Jarvela and Thorsteinson 1999).
distribution of saffron cod at the Sivulliq and Torpedo prospects is expected to be low. In 1988, 125 saffron cod were caught in Camden Bay during July through September (Frue et al. 1989). In Camden Bay, 82 percent of saffron cod sampled (n=225) were between 3.5 and 4 inches (90 and 100 mm) in length corresponding to one-year-old fish (Wiswar and Frue 2006). A separate survey during winter further suggested low saffron cod abundance in Beaufort Sea waters (Craig and Haldorson 1981).

**Capelin**

Capelin is not a target for subsistence in Nuiqsut and Kaktovik, but are harvested farther west in Barrow and Wainwright (more than 100 mi from the project location) (ADF&G 2009b; ADF&G 2009a; MMS 2008). Capelin is important prey for marine mammals, specifically in southern locations such as the Bering Sea and North Pacific (MMS 2008).

**Distribution**

Camden Bay provides important habitat for juvenile fish. Older fish, age two or three, occur less frequently (Jarvela and Thorsteinson 1999). Capelin distribution is expected to occur within the Sivulliq and Torpedo prospects during the drilling season. Capelin occur up to 5 mi (8 km) off the coast. However, most occur within 2.5 mi (4 km) off the coastline in waters less than 10 ft (3 m) deep (Thorsteinson et al. 1992). Common habitat includes the shallow coastal locations such as mouths of rivers where salt and fresh waters mix (Mecklenburg et al. 2002). Juveniles typically float on the surface coastal waters (Thorsteinson et al. 1992). Some of the best habitat for Capelin occurs in waters around Kaktovik and nearby Barter Island, approximately 60 mi (100 km) east of Camden Bay (Thorsteinson et al. 1992).

**Life History**

Capelin travel in large schools, spawning in sandy nearshore waters of the Arctic in August (Yang et al. 2005). They reproduce between the ages of two and six years and return to sea after spawning where they feed on plankton (Fishbase 2008). The eggs are demersal and adhesive attaching to the gravel substrate (Jangaard 1974). The eggs hatch in about 55 days, and the larvae are pelagic. Capelin were described as the fastest maturing fish in the Arctic, with most of the spawning population occurring in the western Beaufort Sea (Fechhelm et al. 1984; Jarvela and Thorsteinson 1999). Capelin feed on mainly small crustaceans such as copepods (Fechhelm et al. 1984).

**Abundance**

Capelin density in the Beaufort Sea was estimated at 10.7 fish/ yd³ (8.2 fish/m³) (Jarvela and Thorsteinson 1999). The average catch was 41.9 fish per sample location in Camden Bay and 86.2 fish per sample station in coastal waters of Prudhoe Bay. While, on average, the western Beaufort Sea may contain a higher overall capelin population. More than 10,000 capelin were captured in fyke nets in Camden Bay waters during the month of August. The catch consisted primarily of fish of ages 2 and 3 years believed to be spawning along the beach (Jarvela and Thorsteinson 1999).

**3.5.2 Anadromous and Amphidromous Fish**

Migratory fish within Camden Bay include anadromous and amphidromous forms. Young anadromous fish travel away from their natal streams until returning to freshwater to spawn as adults. Anadromous fish originating in freshwaters inland from Camden Bay spend a short period of time in coastal waters before traveling to more productive waters where they remain for most of their lives. When returning to spawn as adults they will likely use Camden Bay only as a travel corridor back to natal streams. Anadromous fish include pink salmon, chum salmon, Pacific salmon, broad whitefish, Dolly Varden, Arctic char, Arctic cisco, and least cisco.
Amphidromous fish migrate from freshwater to coastal waters during the summer, but remain in freshwater for most of the year. During their migration, they typically remain in river deltas or near the shoreline and are not likely to travel beyond the barrier islands. They achieve optimal growth in coastal waters and return to freshwater to spawn and overwinter. Both anadromous and amphidromous fish spawn late summer to early-fall in freshwater.

The abundance of anadromous and amphidromous fish is determined by the availability of overwintering habitat (Craig 1989). The Alaska Department of Fish and Game (ADF&G) has determined the importance of unfrozen pools in rivers and streams of 5 ft (1.5 m) deep or more as potential overwintering fish habitat for these fish species (Jack Winters personal communication 2008).

In identifying this type of habitat, Schmidt et al. (1989) estimated the Sagavanirktok River held only 0.8 mi (1.3 km) of deep pool habitat, while the Colville River, further west of Camden Bay and inland of the Beaufort Sea, held over 136 mi (220 km) of main channel habitat (See Figure 3.5-2). This suggests the Colville River has the potential to support larger populations of anadromous and amphidromous fish. The project area in Camden Bay is far removed from this important habitat.

Rivers and streams with anadromous fish are of regulatory importance. Land based rivers and streams accessible to Pacific salmon are designated as Essential Fish Habitat (EFH). Chum and pink chum salmon are present on the Itkillik River, Sagavanirktok River, Ivashik River, and Canning Rivers (Johnson and Daigneault 2008) while pink salmon occur on the Itkillik River, Sagavanirktok River, Canning River, and Staines River (Johnson and Daigneault 2008). The Canning River is the closest river to the Shell project area. It is approximately 18 mi (29 km) from the proposed Sivulliq drill sites, and approximately 22 mi (35 km) from the Torpedo drill sites.

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<td>2</td>
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<td>Dolly Varden, Whitefish</td>
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<td>3</td>
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<tr>
<td>5</td>
<td>Kachemach River</td>
<td>whitefish</td>
</tr>
<tr>
<td>6</td>
<td>Miluveach River</td>
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<td>Kalubik Creek</td>
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<tr>
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<td>Ugnuravik River</td>
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<td>11</td>
<td>Oogrukpuik River</td>
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<tr>
<td>12</td>
<td>Sakonowayak River</td>
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<td>Fawn Creek</td>
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<td>Putuliayuk River</td>
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<tr>
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<td>Sagavanirktok River</td>
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<td>Echooka River</td>
<td>Dolly Varden</td>
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<td>Ivishak River</td>
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<td>East Sagavanirktok Creek</td>
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### Table 3.5.2-1  Anadromous Fish Streams of the Beaufort Sea

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<tr>
<td>27</td>
<td>no name assigned</td>
<td>Dolly Varden</td>
</tr>
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<td>28</td>
<td>Canning River</td>
<td>chum salmon, pink salmon, Dolly Varden, whitefish</td>
</tr>
<tr>
<td>29</td>
<td>Staines River</td>
<td>pink salmon, Dolly Varden, whitefish</td>
</tr>
<tr>
<td>30</td>
<td>Marsh Fork - Canning River</td>
<td>Dolly Varden</td>
</tr>
<tr>
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<td>Tamayariak River</td>
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<td>Nataroarok Creek</td>
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<td>Okpilak River</td>
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<td>Sikrelurak River</td>
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<td>Kogotpak River</td>
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<td>Kongakut River</td>
<td>Dolly Varden</td>
</tr>
<tr>
<td>52</td>
<td>Pagilak River</td>
<td>Dolly Varden</td>
</tr>
</tbody>
</table>

(Johnson and Daigneault 2008)
Figure 3.5-2  Anadromous Fish Streams of the Beaufort Sea
While Pacific salmon hold a special regulatory importance, Arctic cisco, Broad whitefish, and Dolly Varden are important to personal use in Nuiqsut and Kaktovik. Arctic cisco is an important subsistence fish species in Nuiqsut and supports a small commercial harvest on the Colville River. In addition to Arctic cisco, broad whitefish are also an important subsistence species in Nuiqsut. Dolly Varden are targeted for subsistence primarily in Kaktovik. The distribution, life history, and abundance of each species are addressed below.

**Arctic Cisco**

Arctic cisco originate in the Canadian Mackenzie River and are transported to the Beaufort Sea coast by wind-driven currents (ABR, Inc. 2007). This mechanism transports Arctic cisco west to the Sagavanirktok and Colville River deltas (ABR, Inc. 2007).

Arctic cisco are a key subsistence species for the community of Nuiqsut. In 1993, Nuiqsut residents harvested 45,237 individuals (ADF&G 2009a). The harvest provided an estimated 31,666 pounds of foods for families (ADF&G 2009a). The subsistence harvest in Kaktovik is much lower. The use of anadromous and amphidromous fish as subsistence resources is discussed in detail in Section 3.11.6 and 4.1.17.

**Life History**

Arctic cisco enter rivers during mid-August and typically spawn in late-September or October (ADNR 1999). Overwintering occurs in brackish waters where fish can feed on crustaceans during the winter (Fechhelm et al. 2005; Moulton and Seavey 2005; Craig and Haldorson 1980).

**Distribution**

In the Beaufort Sea, Arctic cisco range from Point Barrow to the Mackenzie River in Canada (Mecklenburg et al. 2002). Arctic cisco migrate west from the Mackenzie River during the summer and enter the lower Colville River deltas in August and September to overwinter (ADNR 1999). Smaller numbers of Arctic cisco end their migration on the Sagavanirktok River (approximately 60 mi [80 km]) west of drill site prospects), but usually relocate to the Colville River, (120 mi [183 km]) west, between one and three years of age.

**Abundance**

Second to Arctic cod, Arctic cisco are one of the most abundant fish in the Beaufort Sea. Fruge et al. (1989) counted a total of 20,130 within ANWR coastal waters in the months from July to September. The harvest in Kaktovik is lower due to a lower abundance. When Arctic cisco migrate from Canada to Alaska as juveniles, they are more likely to end their journey on the Colville River, where there is greater abundance and the subsistence catching effort is greater.

**Broad Whitefish**

Broad whitefish use a variety of habitat throughout their lives. They typically spawn in deep pools of large rivers in August and September (NRC 2003). Broad whitefish rarely are found beyond the barrier islands (Craig and Haldorson 1981). When spring breakup occurs, whitefish typically travel from freshwater to shallow bays and lagoons in nearshore waters of the Beaufort Sea (Schmidt et al. 1983). Up to 12,193 broad whitefish have previously been harvested in Nuiqsut (ADF&G 2009b).
Life History

Broad whitefish spawn in mid- to late-August within the Sagavanirktok and Colville Rivers and juveniles typically migrate downstream until they are two years of age (Schmidt et al. 1983). Broad whitefish spawn between four and fourteen years (Schmidt et al. 1983).

Distribution

In northern Alaska, broad whitefish extend from the Kuskokwim River to the Beaufort Sea (Schmidt et al. 1983). Broad whitefish are found in freshwater and in areas where freshwaters mix with marine waters, but typically do not extend far beyond open marine waters (Schmidt et al. 1983).

Overwintering areas have been identified in the east and west channels of the Sagavanirktok River 12 mi (19 km) from the river mouth (Morris 2000). On the Colville River they overwinter upstream from the Itkillik River. They also overwinter in lakes around the Prudhoe Bay coast accessible by tributaries (Morris 2000).

Abundance

Broad whitefish or related species were identified on 17 river systems from the Colville River to the Staines River (Table 3.5.2-1 and Figure 3.5-1) (ADF&G 2008). An ongoing survey of the Sagavanirktok River population estimated a range from 172,298 at the beginning of the study to 133,227 at completion. The lowest count was 25,800 in 1984 and the high count exceeded 432,000 individuals in 1990 (Gallaway et al. 1997).

Dolly Varden


Life History

Dolly Varden spawn, rear, and overwinter in 44 freshwater rivers and streams along the Beaufort Sea (see Table 3.5.2-1). Dolly Varden typically spawn in freshwater streams mid-August to October, and occasionally into December depending on water temperature and ice cover (Arvey 1991). Dolly Varden migrate to sea between the ages of three and four years. Unlike Pacific salmon, Dolly Varden may spawn more than once during their lives (Johnson and Daigneault 2008).

Distribution

When Dolly Varden migrate to coastal waters, they typically travel parallel to the shoreline migrating long distances along the coast during the summer (Wiswar and Fruge 2006). Though abundance is expected to decline further offshore, Dolly Varden are expected to occur incidentally within the Sivulliq and Torpedo lease blocks. Most Dolly Varden typically remain within 1,650 ft (500 m) of the shoreline in areas such as the Camden Bay until mid-August (Jarvela and Thorsteinson 1997; Arvey 1991).

Abundance

The daily catch rate in Camden Bay was estimated between zero and 114 fish per day; but during about 90 percent of the sample period, the average catch was 10 fish per day (Wiswar and Fruge 2006). The abundance estimate on the Ivishak River approximately 60 mi (97 km) west of the project area was a maximum of 36,432 Dolly Varden in 1982 and a minimum abundance of 8,306 in 1975 (Arvey 1991).
Least Cisco
The subsistence harvest of least cisco by residents in Nuiqsut is far greater than that which occurs in Kaktovik (ADF&G 2009b). Residents in the Nuiqsut area take part in a commercial and subsistence harvest of least cisco and the harvest ranks second to Arctic cisco. The Nuiqsut harvest was nearly 20,000 least cisco for subsistence use. The largest harvest occurred between 1992 and 2004.

Life History
Least cisco spawn in rivers, river deltas, tributaries, streams and lakes. In September when nearshore brackish water freezes, least cisco move into the freshwater environment to spawn and overwinter. Adults spawn over sand and gravel in shallow areas in late September and October. They typically reach maturity between the ages of four and five or, when food is scare, they might mature at a later age (Johnson and Daigneault 2008).

Distribution
Least cisco are primarily distributed in the Colville River Delta east to Mikkelsen Bay (Morrow 1980; Bendock and Burr 1984; BLM 2004; BPXA 1998). Tagging studies revealed that the Colville River (120 mi [193 km] east of the project area) is one of their primary freshwater sources (Craig and Haldorson 1981). Least cisco occupy freshwater for much of their life before traveling into brackish nearshore waters in the Beaufort Sea (Mecklenburg et al. 2002). The abundance of least cisco are expected to decline within 330 ft (100 m) of the shoreline (Craig 1984). Least cisco are not expected to occur within the Sivulliq and Torpedo prospect areas.

Abundance
A total of 9,007 least cisco were collected in coastal waters of Point Thomson approximately 22 mi (35 km) from Torpedo and 16 mi (26 km) from proposed Sivulliq drill sites. The CPUE ranged from 38.9-71.5 fish per net per 24 hour increment in coastal waters. Further offshore near the barrier islands a CPUE of 3.1 fish per hour was measured. Catch rate is greater in early summer and declines through the month of July (Fechhelm et al. 1999).

Pink Salmon
Recent reports indicate a recent trend with larger catches of pink salmon in Arctic waters (ADN 2006; NMFS 2005). While increased catches may indicate that numbers are growing, pink salmon make up only a small percentage of the overall subsistence fishery harvest compared to other fish species.

Life History
In the pink salmon two-year life cycle, juveniles travel to nearshore marine waters after hatching in freshwater. When they reach a length of 2.4-3.1 inches (6-8 cm), they move out to sea where they spend 18 months maturing before returning to their stream of origin in freshwater (Mecklenburg et al. 2002).

Distribution
Pink salmon populations are distributed throughout Alaska and maintain small populations within Beaufort drainages and in the Mackenzie River Delta of Canada (Mecklenburg et al. 2002; Craig and Haldorson 1986). Most of the prime habitat areas are associated with river systems, so pink salmon are not expected to occur within the Sivulliq and Torpedo prospects.
Abundance

Pink salmon populations in the Beaufort are relatively small and occur only in larger river systems where fish can spawn and eggs do not freeze (Peltz 2003). Pink salmon occur in the Colville, Itkillik, Sagavanirktok, Canning, and Staines Rivers (Table 3.5-1 and Figure 3.5-1) (Johnson and Daigneault 2008).

Pink salmon abundance is greater on the Colville River. This river is deeper than others in the area and provides more suitable overwintering habitat (Schmidt et al. 1989). The larger number of pink salmon on the Colville River is represented in the subsistence harvest. Kaktovik harvested a total of 8 pink salmon in 1992 and Nuiqsut harvested 160 pink salmon in 1993 (ADF&G 2009b; ADF&G 2009a; ADF&G 2009b).

Chum Salmon

Chum salmon are minimal in waters around Kaktovik, adjacent to the project area.

Life History

As with pink salmon, the Colville River holds greater habitat significance than the Sagavanirktok River. The Colville and Sagavanirktok Rivers are the two largest rivers inland from the project area.

Distribution

Like pink salmon and juvenile chum salmon migrate to coastal waters until reaching a size adequate for Sea (Mecklenburg et al. 2002). Slower growing chum salmon in the Arctic may remain at sea from two to seven years (NMFS 2005).

Abundance

Chum salmon are distributed throughout Alaska and occur in low numbers along the Beaufort coast (Morrow 1980; Buklis 1994). Chum salmon accounted for just over 0.1 percent of captures in a 10-year monitoring program along the central Beaufort Sea coast (BPXA 1998). A total of 70 chum salmon were harvested in Nuiqsut in 1993 (ADF&G 2009b).

Chum salmon occur in the Colville, Itkillik, Sagavanirktok, Ivashak and Canning Rivers (Table 3.5.2-1 and Figure 3.5-1) (Johnson and Daigneault 2008).

Humpback Whitefish

Life History

Spawning occurs in the freshwater environment from September to October (Schmidt et al. 1983). The Colville River system is considered the largest producer of humpback whitefish (Schmidt et al. 1983). Alaskan populations of humpback whitefish typically mature between four to six years with an age range between 11 and 13 years (Schmidt et al. 1983).

Distribution

Humpback whitefish are present within coastal waters of the Bering Sea, Chukchi Sea, and Beaufort (Mecklenburg et al. 2002). In the Beaufort region, humpback whitefish have been documented in coastal lakes and all of the major drainages east of Barrow to the Sagavanirktok Rivers (Schmidt et al. 1983; Mecklenburg et al. 2002).
Abundance

A total of 728 humpback whitefish were reported taken in Nuiqsut in 1993. Kaktovik did not report a harvest of broad whitefish in 1992 (Kaktovik did report a catch of 13 unknown whitefish species) (ADF&G 2009a).

3.5.3 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act defines Essential Fish Habitat as: “Those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” In this definition, “waters” includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate. “Substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities. “Necessary” means the habitat required to support a sustainable fishery and a healthy ecosystem (NPFMC 2009).

Federal agencies that authorize projects that may adversely affect EFH are required to consult with NMFS in accordance with EFH regulations.

Within the Sivulliq and Torpedo prospects, EFH applies to:

- All freshwater rivers and streams that support Pacific salmon and flow into the Beaufort Sea
- Marine waters of the Beaufort Sea that support the EFH species Arctic cod and saffron cod

The State of Alaska’s Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes specifies the anadromous fish streams under EFH jurisdiction. In the Beaufort Sea, chum and pink salmon have been documented in the Itkillik River, Sagavanirktok River, Ivashik River, and Canning River (Johnson and Daigneault 2008). Pink salmon also have been documented on the Staines River (Johnson and Daigneault 2008).

Marine waters are subject to EFH jurisdiction through the development of Fishery Management Plans (FMP). NMFS has recently developed an Arctic FMP that provides policy recommendations for potential commercial fisheries in the Beaufort Sea. The FMP process also requires that EFH species be identified prior to opening a commercial fishery (NPFMC 2009). Beaufort Sea fish species protected under EFH designation will include Arctic cod, saffron cod, capelin, and rainbow smelt (NPFMC 2009).

3.6 Coastal and Marine Birds

The coastal and marine birds found within the proposed exploration areas are predominantly foraging seabird species, including alcids, gulls, terns, jaegers, loons, sea ducks, and possibly phalaropes. These species are not expected in large numbers near the project because Shell’s proposed activities will be located at least 16-22 mi (26-35 km) offshore from Point Thomson and 13-20 mi (20-31 km) from the nearest barrier island.

A majority of the birds in the Arctic are migrants and use coastal areas for breeding and nesting. In the Beaufort Sea, bird concentrations tend to occur in nearshore waters less than 65.6 ft (20 m) deep and in coastal lagoons and river deltas (Dickson and Gilchrist 2002; Divoky 1983; Fischer and Larned 2004).

Spring migration for some birds starts with the ice lead openings and many birds follow open leads that typically form along the edges of landfast ice. These open spring leads (polynyas) are not commonly found within the project area. Other birds migrate as onshore areas thaw.
With the onset of winter, few birds will be found in the project area. Most bird species in the Arctic marine and coastal areas are seasonal residents from May through September. The majority migrate south by late fall before the formation of sea ice. Exploration activities will occur during a time period when there will be few birds near the project area.

3.6.1 Shore Birds

Shorebirds
Shorebird species include sandpipers, phalaropes, and allies, which are part of the Scolopacidae family. Approximately 16 shorebird species use the North Slope and another 20 occur as migrants, vagrants, or rare breeders (Troy 2000).

Common shorebird species breeding on the North Slope include dunlin (Calidris alpina), semipalmated sandpiper (Calidris pusilla), pectoral sandpiper (Calidris melanotos), and red phalarope (Phalaropus fulicaria) (Johnson and Herter 1989).

General Distribution
The North Slope coastline provides productive shorebird habitat for foraging and replenishing fat reserves after breeding and prior to southward migration. Shorebirds nest on the tundra, but many move to the coastline to use intertidal habitats for feeding and staging prior to and during migration.

Generally, shorebirds are present on the North Slope from May to mid-August. Adults often migrate before juveniles and juveniles may not leave until late August. Fall flocks sometimes are composed entirely of juvenile birds. Most shorebirds use coastal areas for migration routes (Johnson and Herter 1989).

Alcids
Alcids are part of the auk family. They are small birds that fly with rapid wing beats and use their wings to swim underwater. Many alcid species use rocky cliffs for nesting.

Distribution
Species of alcids found in the Beaufort Sea include the common murre (Uria aalge), thick-billed murre (Uria lomvia), short-tailed shearwater (Puffinus tenuirostris), and black guillemot (Cepphus grille) (Johnson and Herter 1989).

Murrels are rare in the Alaskan Beaufort Sea (Johnson and Herter 1989). Though rare, Divoky (1983) observed more murrels in nearshore waters than in the pelagic waters of the Alaskan Beaufort Sea.

The occurrence of short-tailed shearwaters is dependent on the oceanographic conditions in the northern Chukchi Sea and western Beaufort Sea, when conditions allow for good prey availability. Their numbers can be irregular or sometimes abundant depending on conditions (Divoky 1983).

Black guillemots are rare offshore in the Beaufort Sea, particularly in the eastern Beaufort Sea (in the vicinity of Camden Bay) (Divoky 1983). They are most prevalent in the western Beaufort Sea and can be found there during the summer and winter as they do not migrate far from breeding sites. The winter presence of black guillemots is often associated with the availability of open leads (Divoky 1983).
Few black guillemots have been found in the Beaufort Sea in winter (Johnson and Herter 1989). During expeditions, specimens have been collected near Barrow and along the Beaufort Sea coast in December and January. Bailey et al. (1933) reported that black guillemots were commonly found in the Beaufort Sea during mid-winter and typically present near open leads. Most black guillemots nesting in the Beaufort Sea likely move to the Chukchi or Bering Seas in winter, or at least to the western Beaufort Sea where open leads are common (Divoky 1983).

Life History

Alcids are monitored consistently as they are considered early indicators of the health of an ecosystem. They are long-lived and have a low reproductive rate. They are not quick to rebound in population and are slow to recover from catastrophic events. Most of their lives are spent in the open ocean except when they come to land to nest and breed in colonies.

Abundance

Alcids are uncommon in the Beaufort Sea (Johnson and Herter 1989). They may inhabit the coastal areas to forage and nest during the open water season, but the rolling coastal terrain is not conducive to supporting breeding colonies. Some nesting colonies are found along the Barrier Islands (Figure 3.6-1, Table 3.6.1-1), including a colony of black guillemots on Cooper Island (Johnson and Herter 1989), southeast about 19 mi (31 km) from Barrow. Black guillemots may also be found on other barrier islands in the Beaufort Sea.

Table 3.6.1-1 Species and Number of Birds in Colonies by General Location Along the Beaufort Sea

<table>
<thead>
<tr>
<th>Species</th>
<th>Colville River</th>
<th>Colville River delta to Gwydyr Bay</th>
<th>Elson Lagoon</th>
<th>Goose/ Long Lake</th>
<th>Prudhoe Bay to Staines River</th>
<th>Staines River to Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Eider</td>
<td>-</td>
<td>476</td>
<td>-</td>
<td>-</td>
<td>1,426</td>
<td>56</td>
</tr>
<tr>
<td>Glaucous Gull</td>
<td>67</td>
<td>76</td>
<td>-</td>
<td>14</td>
<td>640</td>
<td>79</td>
</tr>
<tr>
<td>Sabine’s Gull</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Arctic Tern</td>
<td>2</td>
<td>-</td>
<td>130</td>
<td>4</td>
<td>38</td>
<td>35</td>
</tr>
<tr>
<td>Black Guillemot</td>
<td>-</td>
<td>-</td>
<td>446</td>
<td>-</td>
<td>-</td>
<td>36</td>
</tr>
<tr>
<td>Horned Puffin</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Birds</strong></td>
<td><strong>69</strong></td>
<td><strong>574</strong></td>
<td><strong>578</strong></td>
<td><strong>28</strong></td>
<td><strong>2,104</strong></td>
<td><strong>212</strong></td>
</tr>
</tbody>
</table>

(Source: USFWS 2000)

Gulls, Terns, and Jaegers

Distribution

Various types of gulls inhabit the Beaufort Sea and some nest along coastal areas. Gulls, terns, and jaegers occur during the spring and summer months and some may stay until late September. Nesting colonies of gulls and terns have been documented along the coast and barrier islands (Figure 3.6-1, Table 3.6.1-1).

Gulls and jaegers are well distributed in the pelagic waters of the Beaufort Sea, while terns are most common in the nearshore waters. However, gulls, terns, and jaegers have been found in the both pelagic and nearshore environments (Divoky 1983).
Figure 3.6-1  Seabird Colonies in 2000 Along the Alaskan Beaufort Sea Coastline
Life History

Glaucous gulls (*Larus hyperboreaus*) are known to nest in colonies or individual pairs on islands and sandbars that are located near the coast, cliffs, inland river bars, or small islands in lakes (Johnson and Herter 1989) laying two to four eggs in mid-June to early July (Roseneau and Herter 1984). Incubation takes 27-28 days, with the young leaving the nest in another 45-50 days (Denlinger 2006). Fledging is usually complete by late August (Roseneau and Herter 1984). There is also a large influx of sub-adults and non-breeding birds in late summer. Most of the fall migration occurs along the coast in September and October; however, many birds may still be present as late as early December. Glaucous gulls are scavengers and predators, feeding on carcasses, bird chicks, eggs, and fish such as arctic cod, herring, and sand lance (Swartz 1966; Roseneau and Herter 1984).

Sabine’s gulls (*Xema sabini*) nest on the shores or islands of tundra lakes and on barrier islands (Johnson and Herter 1989). Ross’s gulls (*Rhodostethia rosea*) often nest in colonies on tundra tussocks and lake islands in very limited areas in northern Siberia and parts of Canada, sometimes with arctic terns (*Sterna paradisaea*) (Johnson and Herter 1989). Their winter range is not well known, but they may be present in arctic waters throughout the winter (Roseneau and Herter 1984). Ivory gulls (*Pagophila eburnean*) are closely associated with pack ice throughout their life-cycle (Johnson and Herter 1989).

Carcasses and feces of marine mammals make up much of their diet (Divoky 1976) but they also consume some fish and invertebrates (Roseneau and Herter 1984). Arctic terns winter in the Southern Hemisphere near Antarctica. They are a common migrant and breeder in the Beaufort Sea area (Johnson and Herter 1989). Nesting starts in late June or early July (Lehnhausen and Quinlan 1981). In marine environments, they nest in small colonies on islands and spits. Nests consist of shallow depressions in which one to three eggs are laid. Incubation is 21-23 days long and the young fledge in an additional 21-24 days (Denlinger 2006). Terns obtain most of their food, which includes arctic cod, sand lance, euphausiids, mysid shrimp, and amphipods, just below the water surface by plunge diving (Divoky 1983; Roseneau and Herter 1984). They primarily use coastal waters with most observations occurring within 25 mi (40 km) of shore landward of the 20 m isobath (Divoky 1987).

Jaegers spend most of their life at sea coming to land only to nest. All three species winter at sea in the Southern Hemisphere. Jaegers nest on the tundra and the breeding birds prey on lemmings, voles, small birds, eggs, and young birds. Non-breeding birds are found in offshore waters, commonly along the ice front, where they pirate fish from other birds, or capture their own by seizing them at the surface. Fall migration begins in late August and is complete by late September (Roseneau and Herter 1984).

Abundance

Abundance estimates for gulls, terns, and jaegers on the North Slope are few and in the form of an index or trend. Aerial surveys on the North Slope indicate that the glaucous gull index has remained level and stable over the long term (Larned et al. 2007). The Sabine’s gull has shown significant increases in numbers on the North Slope in the past ten years (Larned et al. 2007).

Considerable numbers (20,000-40,000) of Ross’s gulls have been observed regularly each fall near Barrow to feed prior to migration. Few Ross’s gulls have been seen elsewhere in the Beaufort Sea (Johnson and Herter 1989). Black-legged kittiwakes (*Rissa tridactyla*) are also common, particularly in the pelagic zone of the western Beaufort Sea during the ice free season (Johnson and Herter 1989).

From 1992-2000, arctic tern numbers increased on the North Slope, but have been more stable from 2000-2007 (Larned et al. 2007). Jaeger (*Stercorarius spp.*) numbers on the North Slope fluctuate widely following the prey abundance of brown lemmings (*Lemmus trimucronatus*) (Larned et al. 2007). Annual counts are extremely variable, and no trends are noted in North Slope populations.
Worldwide population estimates for pomarine, parasitic, and long-tailed jaegers are 50,000-100,000; 500,000-1,000,000; and 100,000-500,000, respectively, with all populations apparently stable (del Hoyo et al. 1996). Jaeger numbers on the North Slope are known to fluctuate widely following prey abundance, primarily brown lemmings (*Lemmus trimicronatus*) (Larned et al. 2007).

## Loons

Loon species that occur across the Arctic coast and marine environment include the Pacific loon (*Gavia pacifica*), red-throated loon (*G. stellata*), and yellow-billed loon (*G. adamsii*). The USFWS has determined that listing the yellow-billed loon as a threatened or endangered species is warranted under the Endangered Species Act (ESA), but that listing is precluded by other higher priority species. The “warranted but precluded” finding was published in the Federal Register on March 25, 2009. The yellow-billed loon is now designated as a candidate species. The yellow-billed loon is further discussed in Section 3.8, Threatened and Endangered Species.

### Distribution

Loons are common in the nearshore (waters inside the 20 m contour) during the summer and have not been found in pelagic waters (waters deeper than 20 m) until post-breeding and fall migration (Divoky 1983). Loons became more commonly found in the pelagic regions beginning in mid-August and became more common up to mid-September (observations ceased September 18) (Divoky 1983). Loons are expected to be found near the proposed drill sites, particularly for the commonly-found Pacific loon.

The red-throated loon nests across northern North America and Eurasia. In Alaska, they nest primarily in coastal areas from southeastern Alaska to Canada. Red-throated loons tend to select small shallow wetlands, apparently due to competition with the larger and more abundant Pacific loons, and mostly within about 12 mi (20 km) off the coast (Larned et al. 2007).

Pacific loons nest in northern Canada, Alaska, and parts of Siberia. They nest throughout much of Alaska and are commonly found across the Arctic Coastal Plain including areas along the western Beaufort Sea coastline. Pacific loons winter in marine environments along the western coast of North America from Alaska to Mexico (Schmutz 2009).

### Life History

Loons feed extensively on small fish species in both freshwater and marine environments, which they obtain by diving. In the marine environment, arctic cod are one of the more common prey species (Divoky 1978; Roseneau and Herter 1984). The number of loons moving through the area in the spring is thought to be in the tens of thousands. They disperse to nest sites at low densities across the Arctic Coastal Plain. Fall migration begins in late August and peaks in September but continues through October (Watson and Divoky 1972). Loons nest and breed near tundra lakes and ponds as soon as the ice and snow melt. An average of two eggs are laid in June and are incubated for about a month. The young leave the nest within a day or two and in September migrate to coastal waters before fall migration. Fall migration typically begins at the end of August and early September.

Red-throated loons tend to select small shallow wetlands within about 12 mi (20 km) off the coast (Larned et al. 2007), apparently because of competition with the larger and more abundant Pacific loons. They are closely associated with the marine environment and most nests are found within 12 mi (19 km) off the coast (Larned et al. 2007). The red-throated loon is the only species that feeds the young almost exclusively on marine species (Schmutz 2008). Most red-throated loons from the North Slope migrate to, and winter in East Asia.
Abundance

Aerial surveys on the Arctic Coastal Plain have indicated that the Pacific loon population has been generally steady since 1992 (Larned et al. 2007). The highest population index was recorded in 2007.

Red-throated loon densities across the Beaufort Sea coast have been documented by the USFWS (Figure 3.6-2). Aerial surveys on the Arctic Coastal Plain have indicated that the red-throated loon population has generally declined since 1992 (Larned et al. 2007).

3.6.2 Waterfowl

Waterfowl species include ducks and geese that are part of the Anatidae family. They are important for subsistence as residents traditionally hunt them in the spring and fall. This group includes species of mergansers, ducks, geese, and swans. Species of waterfowl commonly found in marine habitats of the Beaufort Sea and adjacent coastal areas are listed in Table 3.6.2-1. The distribution, life history, and abundance of the species most likely to be encountered in Shell’s prospects during the proposed exploration activities are discussed below. The spectacled and Steller’s eiders are discussed in Section 3.8, Threatened and Endangered Species.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red-Breasted Merganser</td>
<td>Mergus serrator</td>
</tr>
<tr>
<td>Northern Pintail</td>
<td>Anas acuta</td>
</tr>
<tr>
<td>Greater Scaup</td>
<td>Aythya marila</td>
</tr>
<tr>
<td>Black Scoter</td>
<td>Melanitta nigra</td>
</tr>
<tr>
<td>White-Winged Scoter</td>
<td>Melanitta fusca</td>
</tr>
<tr>
<td>Long-Tailed Duck</td>
<td>Clangula hyemalis</td>
</tr>
<tr>
<td>Common Eider</td>
<td>Somateria mollissima</td>
</tr>
<tr>
<td>King Eider</td>
<td>Somateria spectabilis</td>
</tr>
<tr>
<td>Lesser Snow Goose</td>
<td>Chen caerulescens</td>
</tr>
<tr>
<td>Greater White-Fronted Goose</td>
<td>Anser albifrons</td>
</tr>
<tr>
<td>Canada Goose</td>
<td>Branta canadensis</td>
</tr>
<tr>
<td>Pacific Black Brant</td>
<td>Branta bernicula nigricans</td>
</tr>
<tr>
<td>Tundra Swan</td>
<td>Cygnus columbianus</td>
</tr>
</tbody>
</table>

Distribution

Sea ducks and geese use the Beaufort Sea coastal areas for migration, brood-rearing, molting, and feeding. Sea ducks include long-tailed ducks, king eider, common eider, spectacled eider, and Steller’s eider. Geese include the Pacific black brant. These waterfowl use the Arctic environments during the ice-free season and depart in August and September.

Often these species are found foraging nearshore and within the barrier islands in the Chukchi and Beaufort Seas. Long-tailed ducks can be found nesting on lake islands and coastal sandbars, as these areas are less accessible for terrestrial predators (Johnson and Herter 1989). They also frequent shallow lakes where euphyllopods are an important food source for ducklings (Johnson and Herter 1989). Long-tailed ducks are commonly found in nearshore habitats, particularly during molting at the end of July and early August (Divoky 1983). They typically use the pelagic waters for migration (Divoky 1983).
Figure 3.6-2   Red-Throated Loon Densities
Common eiders prefer nesting sites that are associated with driftwood, detritus, and the vegetation found on peninsulas and barrier islands (Dau and Larned 2005). King eiders nest close to the coast on the mainland. They also have international migration patterns; some king eiders have been tracked from Canada through Alaska and into Russia (Dickson et al. 1999). Eiders appear to use the nearshore waters of the Beaufort for migration and little, if any, staging occurs prior to their westward movement (Divoky 1983).

Along the Alaska North Slope, Pacific black brant prefer to nest in colonies scattered on offshore spits and barrier islands, or on islands in river deltas away from terrestrial predators (Johnson and Herter 1989). Brant are the most marine of the geese species present on the North Slope and are found adjacent to the mainland and barrier islands (Divoky 1983).

**Life History**

Most waterfowl stay in the Beaufort Sea during the summer months and through the drilling season for nesting and molting. A clutch of six to eight eggs takes 24-29 days to incubate, and the ducklings can fly within an additional 35-40 days (Sea Duck Joint Venture 2003). At that time they move to marine habitats where the female undergoes molt during which she is flightless. The molting, which may take place in lagoons and other shallow waters, continues through July and August, after which the birds utilize coastal waters to feed and stage for the fall migration. Waterfowl migrate through the exploration areas during the spring and fall migrations.

Many factors can influence success of raising young. For example, during the summer, common eider production can fluctuate with ice conditions (Dau and Larned 2005) and predation rates from Arctic fox (*Alopex lagopus*) and glaucous gulls (Noel et al. 2002). Coastal nesting areas can be changed as a result from storms and tides that cause erosion.

**Abundance**

From 1992 to 2007, aerial surveys of the North Slope show that long-tailed duck populations declined (Larned et al. 2007). From 1976-1996, the common eider population declined by 53 percent, from 156,081 birds to 72,606. The king eider declined by 56 percent, from 802,556 birds to 350,835 (Suydam et al. 2000). Long-tailed duck densities along the Beaufort Sea coast documented by the USFWS are represented in Figure 3.6-3 and king eider densities, which vary across the Beaufort Sea coast, are shown in Figure 3.6-4.

Causes of the declines are uncertain. However, it may be due to hunting, extreme weather (Suydam et al. 2000), changing environments and ecosystems, disturbances, (Dickson and Gilchrist 2002), and lead shot poisoning (Flint et al. 1995).

For Pacific black brant, aerial surveys indicated positive growth on the North Slope from 1992-2007 (Larned et al. 2007). However, this trend may be spurious as annual surveys can include non-breeders or failed breeders from western Alaska. Brant densities across the Beaufort Sea coast surveyed by the USFWS are represented in Figure 3.6-5.
Figure 3.6-3  Long-Tailed Duck Densities
Figure 3.6-4  King Eider Densities
Figure 3.6-5  Pacific Black Brant Densities
A 1998-2004 North Slope-wide study of the distribution of shorebirds documented a total of 19 species breeding along the coast (Table 3.6.2-2; Johnson et al. 2007). Information on the Alaska distribution of shorebirds found on the North Slope is summarized in Table 3.6.2-2. The Colville River to the Canning River region is most representative since it is adjacent to the offshore project area.

### Table 3.6.2-2 Shorebird Frequency of Occurrence, Alaska North Slope 1998 to 2004

| Common Name            | Scientific Name          | Region²  
|------------------------|--------------------------|----------
|                        |                          | Icy-Nal | Nal-Ikp | Ikp-Col | Col-Can | Can-Aic |
| Black-Bellied Plover   | Pluvialis Squatarola     | 20.0    | 44.5    | 22.6    | 22.2    | 1.5     |
| American Golden Plover | Pluvialis Dominica       | 5.0     | 21.8    | 28.1    | 36.1    | 34.8    |
| Semipalmated Plover    | Charadrius Semipalmatus  | -       | -       | -       | -       | 4.4     |
| Whimbrel               | Numenius Phaeopus        | -       | -       | -       | -       | 1.5     |
| Bar-Tailed Godwit      | Limosa Lapponica         | 25.0    | 14.9    | 8.7     | 8.3     | -       |
| Ruddy Turnstone        | Arenaria Interpres       | -       | 3.3     | 6.0     | -       | 4.4     |
| Sanderling             | Calidris Alba            | -       | -       | -       | -       | 0.7     |
| Semipalmated           | Calidris Pusilla         | 70.0    | 80.8    | 69.7    | 66.7    | 47.4    |
| Western Sandpiper       | Calidris Mauri           | 60.0    | 16.8    | -       | -       | 0.7     |
| White-Rumped           | Calidris Fuscicolis      | -       | 2.4     | 14.2    | -       | 0.7     |
| Baird’s Sandpiper      | Calidris Bairdii         | -       | 7.2     | 2.8     | 5.6     | 2.2     |
| Pectoral Sandpiper     | Calidris Melanotus       | 90.0    | 83.6    | 82.4    | 80.6    | 52.6    |
| Dunlin                 | Calidris Alpina          | 50.0    | 73.1    | 60.7    | 33.3    | 14.1    |
| Stilt Sandpiper        | Calidris Himantopus      | -       | 23.2    | 13.0    | 27.8    | 15.6    |
| Buff-Breasted Sandpiper| Tryngites Subruficollis  | -       | 11.9    | 5.7     | 19.4    | 8.1     |
| Long-Billed Dowitcher  | Limnodromus Scolopacens  | 70.0    | 59.2    | 48.4    | 52.8    | 12.6    |
| Wilson’s Snipe         | Galinago Delicate        | -       | -       | 0.4     | 2.8     | -       |
| Red-Necked Phalarope   | Phalaropus Lobatus       | 55.0    | 46.2    | 23.9    | 33.3    | 40.7    |
| Red Phalarope          | Phalaropus Fulicaria     | 70.0    | 67.3    | 53.2    | 38.9    | 20.0    |

1 Frequency of occurrence is the percent transects with the region along which birds of that species were observed
2 Region: Icy-Nal = Icy Cape to Nalimiut Point, Nal-Ikp = Nalimiut Point to Ikpikpuk River, Ikp-Col – Ikpikpuk River to Colville River, Col-Can = Colville River to Canning River, Can-Aic – Canning River to Aichilik River

(Source: Johnson et al. 2007)

Generally, shorebirds are present in nearshore areas (Divoky 1983) on the North Slope from May to mid-August. Dunlins stage or stop-over in silt tidal flats and salt-grass meadows (Johnson and Herter 1989). Semipalmated sandpipers reach their greatest nesting densities in wet tundra areas that are slightly inland from the coast, and during the fall can be found at coastal locations (Johnson and Herter 1989). Pectoral sandpipers generally follow the same inland routes for fall migration that they used during spring, while others migrate along the coastlines. Red and red-necked phalaropes are present in the Beaufort and gather in large concentrations in late August on lagoons. Fall and spring migration for red phalaropes occurs along routes well out at sea where flocks concentrate at ice edges and oceanic fronts and where invertebrate prey is plentiful (Johnson and Herter 1989).

### Life History

Shorebirds feed at or near the water’s edge; some wade in the water and others forage in low vegetation consuming mostly invertebrates. As a whole, shorebirds are highly migratory and often cover long distances over the ocean. They can also follow coasts, major waterways, or travel over land, using staging areas for feeding stops during migration. Shorebirds species on the North Slope nest on the tundra, but many move to the Beaufort Sea coastline to use intertidal habitats for feeding and staging prior to and during migration. These shores provide productive shorebird habitat that is used for foraging and replenishing fat reserves after breeding and prior to southward migration.
Abundance

Many shorebird species in North America are thought to be declining (Morrison et al. 2006). Of 75 biogeographic populations of shorebirds in North America considered in a recent study, 42 were thought to be declining and two increasing (Morrison et al. 2006). The remainder were thought to be stable, possibly stable, unknown, or possibly extinct (Morrison et al. 2006). Reasoning for the declines are not clear, but may include habitat loss and alteration, hunting, predator increases, and climate change (Johnson et al. 2007).

The species from this study that are commonly found on the Alaska North Slope are identified in bold in Table 3.6.2-3. Those species experiencing the greatest population declines or of high concern, as identified by the Alaska Shorebird Group (2008), are shaded. Only two of the North Slope species represented here are also classified as in decline or of high concern.

Table 3.6.2-3 North American Shorebird Populations Prioritized by Decline in Population

<table>
<thead>
<tr>
<th>Common Name1</th>
<th>Scientific Name</th>
<th>North American Population2</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Golden-Plover</td>
<td>Pluvialis dominica</td>
<td>200,000</td>
</tr>
<tr>
<td>Upland Sandpiper</td>
<td>Bartramia longicauda</td>
<td>350,000</td>
</tr>
<tr>
<td>Whimbrel</td>
<td>Numenius phaeopus rufiventris</td>
<td>26,000</td>
</tr>
<tr>
<td>Bar-tailed Godwit</td>
<td>Limosa lapponica baueri</td>
<td>80,000–120,000</td>
</tr>
<tr>
<td>Red Knot</td>
<td>Calidris canutus roselaari</td>
<td>less than 50,000</td>
</tr>
<tr>
<td>Sanderling</td>
<td>Calidris alba</td>
<td>30,000</td>
</tr>
<tr>
<td>Semipalmated Sandpiper</td>
<td>Calidris pusilla</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Pectoral Sandpiper</td>
<td>Calidris melanotos</td>
<td>500,000</td>
</tr>
<tr>
<td>Dunlin</td>
<td>Calidris alpina arctica</td>
<td>200,000–750,000</td>
</tr>
<tr>
<td>Buff-breasted Sandpiper</td>
<td>Tryngites subruficollis</td>
<td>30,000</td>
</tr>
<tr>
<td>Long-billed Dowitcher</td>
<td>Limnodromus scolopaceus</td>
<td>400,000</td>
</tr>
<tr>
<td>Red-necked Phalarope</td>
<td>Phalaropus lobatus</td>
<td>2,500,000</td>
</tr>
<tr>
<td>Red Phalarope</td>
<td>Phalaropus fulicarius</td>
<td>1,250,000</td>
</tr>
</tbody>
</table>

1 Priority species found in the Alaskan Arctic are shaded. Species are considered priority by the Alaska Shorebird Group (2008) due to population declines or high concerns. Species most commonly found in the Alaskan Arctic are bold.

2 Maximum number estimated to be present in North America at any time.

(Source: Alaska Shorebird Group 2008)

3.6.3 Bird Use of Offshore and Coastal Waters

Aerial bird surveys for bird use of offshore and coastal waters in the western Beaufort were conducted by Fischer and Larned (2004) up to 62 mi (100 km) offshore. The areas surveyed were between Cape Halkett and Brownlow Point in June, July, and August 1999 and 2000 and between Point Barrow and Demarcation Point in July 2001. Approximately 90 percent of the birds observed were sea ducks; predominantly long-tailed ducks, king eiders, and scoters (Table 3.6.3-1). Densities of most species decreased with distance from shore except for king eiders, where densities were higher in deeper offshore waters. Mean distance offshore for king eiders was 10 mi (16.5 km), with 81 percent occurring more than 6.2 mi (10 km) from shore. However, densities of king eiders were higher in shallow (less than 32.8 ft [10 m]) and mid-depth (32.8-65.6 ft [10-20 m]) zones between Barrow and Oliktok Point than in other
study area zones to the east: King eiders were not present in mid-depth and deep (more than 65.6 ft [20 m]) waters in the eastern part of the study area despite large open water areas.

### Table 3.6.3-1 Total Count and Percentages of Birds Observed in the Western Beaufort Sea During Aerial Surveys 1999 to 2001

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Total Count</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-tailed duck</td>
<td>Clangula hyemalis</td>
<td>12,330</td>
<td>44.81</td>
</tr>
<tr>
<td>King eider</td>
<td>Somateria spectabilis</td>
<td>8,034</td>
<td>29.2</td>
</tr>
<tr>
<td>Surf scoter</td>
<td>Melanitta perspicillata</td>
<td>1,434</td>
<td>5.21</td>
</tr>
<tr>
<td>Glaucous gull</td>
<td>Larus hyperboreus</td>
<td>1,116</td>
<td>4.06</td>
</tr>
<tr>
<td>Common eider</td>
<td>Somateria mollissima</td>
<td>1,047</td>
<td>3.8</td>
</tr>
<tr>
<td>Unidentified eider spp.</td>
<td>Somateria spp.</td>
<td>632</td>
<td>2.3</td>
</tr>
<tr>
<td>Unidentified scoter spp.</td>
<td>Melanitta spp.</td>
<td>620</td>
<td>2.25</td>
</tr>
<tr>
<td>Pacific loon</td>
<td>Gavia pacifica</td>
<td>406</td>
<td>1.48</td>
</tr>
<tr>
<td>Shorebird spp.</td>
<td>Charadriidae &amp; Scolopacidae spp.</td>
<td>249</td>
<td>0.9</td>
</tr>
<tr>
<td>Scaup spp.</td>
<td>Aythya spp.</td>
<td>237</td>
<td>0.86</td>
</tr>
<tr>
<td>White-winged scoter</td>
<td>Melanitta fusca</td>
<td>204</td>
<td>0.74</td>
</tr>
<tr>
<td>Northern pintail</td>
<td>Anas acuta</td>
<td>173</td>
<td>0.63</td>
</tr>
<tr>
<td>Spectacled eider</td>
<td>Somateria fischeri</td>
<td>163</td>
<td>0.59</td>
</tr>
<tr>
<td>White-fronted goose</td>
<td>Anser albilors</td>
<td>155</td>
<td>0.56</td>
</tr>
<tr>
<td>Arctic tern</td>
<td>Sterna paradisaea</td>
<td>128</td>
<td>0.47</td>
</tr>
<tr>
<td>Red-throated loon</td>
<td>Gavia stellata</td>
<td>106</td>
<td>0.39</td>
</tr>
<tr>
<td>Jaeger spp.</td>
<td>Stercorarius spp.</td>
<td>90</td>
<td>0.33</td>
</tr>
<tr>
<td>Pacific black brant</td>
<td>Branta bernicla nigricans</td>
<td>85</td>
<td>0.31</td>
</tr>
<tr>
<td>Sabine’s gull</td>
<td>Xema sabini</td>
<td>53</td>
<td>0.19</td>
</tr>
<tr>
<td>Black scoter</td>
<td>Melanitta nigra</td>
<td>46</td>
<td>0.17</td>
</tr>
<tr>
<td>Shearwater spp.</td>
<td>Puffinus spp.</td>
<td>37</td>
<td>0.13</td>
</tr>
<tr>
<td>Yellow-billed loon</td>
<td>Gavia adamsii</td>
<td>34</td>
<td>0.12</td>
</tr>
<tr>
<td>Red-breasted merganser</td>
<td>Mergus serrator</td>
<td>33</td>
<td>0.12</td>
</tr>
<tr>
<td>Canada goose</td>
<td>Branta canadensis</td>
<td>28</td>
<td>0.1</td>
</tr>
<tr>
<td>Lesser snow goose</td>
<td>Chen caerulescens</td>
<td>25</td>
<td>0.09</td>
</tr>
<tr>
<td>Tundra swan</td>
<td>Cygnus columbianus</td>
<td>21</td>
<td>0.08</td>
</tr>
<tr>
<td>Black-legged kittiwake</td>
<td>Rissa tridactyla</td>
<td>22</td>
<td>0.08</td>
</tr>
<tr>
<td>Steller’s eider</td>
<td>Polysticta stelleri</td>
<td>3</td>
<td>0.01</td>
</tr>
<tr>
<td>Black guillemot</td>
<td>Cepphus grylle</td>
<td>3</td>
<td>0.01</td>
</tr>
<tr>
<td>Auklet spp.</td>
<td>Aethia spp.</td>
<td>3</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>27,517</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

(Source: Fischer and Larned 2004)

Oceanographic expeditions in the Beaufort and Chukchi Sea found gulls, kittiwakes, jaegers, and terns far from shore and amongst pack ice (Harwood et al. 2005). The northernmost sightings consisted of black-legged kittiwakes and ivory gulls 460 mi (740 km) from shore in an area of pack ice. Gulls, kittiwakes, and fulmars were numerous 37-62 mi (60-100 km) northwest of Barrow at the Northwind Ridge area and near Barrow Canyon. Likewise, gulls and kittiwakes were often found along the Chukchi Sea shelf break. Waterfowl, mostly eiders, were observed 12-25 mi (20-40 km) from shore. Bird distributions were clumped, with birds tending to occur in areas where productivity is enhanced because of oceanographic features such as canyons, upwellings, and shelf breaks.

Divoky (1983) observed and recorded bird densities in the Beaufort Sea within the pelagic (deeper than 20 m) and nearshore (within the 20 m isobath) waters during August and September in 1971 to 1972 and 1976 to 1978. His data collection included the areas of the Beaufort Sea near the project areas:

- Jones Islands, the area from Prudhoe Bay west roughly 44 mi (71 km) to the Jones Islands
- Prudhoe Bay, the area from Prudhoe Bay east roughly 57 mi (92 km) to Flaxman Island
- East of Flaxman Island, the area from Flaxman Island (57 mi [92 km] east of Prudhoe Bay) east to the Alaska/Canada border roughly 121 mi (195 km)
Average and maximum densities were recorded during a series of trips by boat for each species offshore and nearshore (Tables 3.6.3-2 and 3.6.3-3, respectively). Average densities are for each region and each cruise. This is useful in demonstrating whether an area has consistently high or low densities and how much annual variation occurs. Maximum densities are the highest density encountered in each region on each trip. This demonstrates the degree to which a species can congregate in a given region. In table 3.6.3-2, the Jones Islands and Prudhoe Bay area observations were combined for the data collected in pelagic waters (i.e., deeper than 20 m).

Overall, the average and maximum variation of densities can vary greatly. The pelagic waters were found to consist primarily of surface feeding species (gulls, terns, phalaropes, and jaegers) with little use by diving species (long-tailed duck, loons, and eiders), except as a migratory area (Divoky 1983). Nearshore waters contained large numbers of long-tailed ducks, loons, and migrant eiders with low densities of surface feeders relative to what was found in pelagic waters (Divoky 1983).

### Table 3.6.3-2 Average and Maximum Bird Densities for the Eastern Alaskan Beaufort Sea Deeper than 20 m, 1971 to 1972 and 1976 to 1978

<table>
<thead>
<tr>
<th>Species or Group of Species</th>
<th>Jones Islands/ Prudhoe Bay Area (birds/sq km)</th>
<th>East of Flaxman Island (birds/sq km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean¹</td>
<td>Maximum¹</td>
</tr>
<tr>
<td>Loons</td>
<td>0 - 0.5</td>
<td>0 - 13.6</td>
</tr>
<tr>
<td>Long-Tailed Duck</td>
<td>0 - 1.3</td>
<td>0 - 77.4</td>
</tr>
<tr>
<td>Eider</td>
<td>0 - 0.9</td>
<td>0 - 63</td>
</tr>
<tr>
<td>Phalaropes</td>
<td>0 - 4.8</td>
<td>0 - 94.3</td>
</tr>
<tr>
<td>Jaegers</td>
<td>less than 0.1 - 0.3</td>
<td>1.5 - 4.0</td>
</tr>
<tr>
<td>Glauocous Gulls</td>
<td>0.4 - 0.7</td>
<td>3 - 12</td>
</tr>
<tr>
<td>Ivory Gulls</td>
<td>0 - less than 0.1</td>
<td>0 - 3.6</td>
</tr>
<tr>
<td>Black-legged Kittiwakes</td>
<td>less than 0.1 - 0.5</td>
<td>1.5 - 11.2</td>
</tr>
<tr>
<td>Sabine's gull</td>
<td>0 - 0.2</td>
<td>0 - 13</td>
</tr>
<tr>
<td>Arctic Tern</td>
<td>0.1 - 0.7</td>
<td>6.8 - 18</td>
</tr>
</tbody>
</table>

¹ Ranges are given since data was collected over multiple voyages, years, and months.
(Source: Divoky 1983)

### Table 3.6.3-3 Average and Maximum Bird Densities for the Eastern Alaskan Beaufort Sea Within the 20 m isobath, 1971 to 1972 and 1976 to 1978

<table>
<thead>
<tr>
<th>Species or Group of Species</th>
<th>Jones Islands (birds/km²)</th>
<th>Prudhoe Bay (birds/km²)</th>
<th>East of Flaxman Island (birds/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean¹</td>
<td>Maximum¹</td>
<td>Mean¹</td>
</tr>
<tr>
<td>Loons</td>
<td>0.5 - 0.6</td>
<td>3.9 - 6.6</td>
<td>0.4 - 1.0</td>
</tr>
<tr>
<td>Long-Tailed Duck</td>
<td>16 - 100</td>
<td>244 - 1,997</td>
<td>1 - 114</td>
</tr>
<tr>
<td>Eider</td>
<td>0.1 - 6</td>
<td>5 - 113</td>
<td>3 - 111</td>
</tr>
<tr>
<td>Phalaropes</td>
<td>2 - 7</td>
<td>32 - 156</td>
<td>0.2 - 13</td>
</tr>
<tr>
<td>Jaegers</td>
<td>0 - 0.1</td>
<td>0 - 3.6</td>
<td>0 - 0.2</td>
</tr>
<tr>
<td>Glauocous Gulls</td>
<td>0.1 - 0.6</td>
<td>1.7 - 9.4</td>
<td>0.4 - 1.5</td>
</tr>
<tr>
<td>Black-legged Kittiwakes</td>
<td>0 - 0.1</td>
<td>1.8 - 8.4</td>
<td>0 - 0.2</td>
</tr>
<tr>
<td>Sabine's gull</td>
<td>0 - 0.1</td>
<td>0 - 3.3</td>
<td>0 - 0.2</td>
</tr>
<tr>
<td>Arctic Tern</td>
<td>0.5 - 1.0</td>
<td>9.9 - 26.9</td>
<td>0.2 - 3.9</td>
</tr>
</tbody>
</table>

¹ Ranges are given since data was collected over multiple voyages, years, and months.
(Source: Divoky 1983)
3.7 Mammals

3.7.1 Marine Mammals

This section discusses marine mammals that potentially could occur in Camden Bay near the project area during Shell’s exploration drilling activities. The most common marine mammals that the Camden Bay area supports are ringed seals (*Phoca hispida*); spotted seals (*Phoca largha*); bearded seals (*Erignathus barbatus*); polar bear (*Ursus maritimus*); bowhead whales (*Balaena mysticetus*); beluga whales (*Delphinapterus leucas*), and gray whales (*Eschrichtius robustus*). Small numbers of Pacific walrus (*Odobenus rosmarus divergens*), harbor porpoises (*Phocoena phocoena*), narwhals (*Monodon monoceros*), killer whales (*Orcinus orca*), minke whales (*Balaenoptera acutorostrata*), and ribbon seals (*Histriophoca fasciata*) occur in the Beaufort Sea. These less common species will be discussed in less detail in this EIA than the common marine mammals.

The Shell Camden Bay EP IHA application (Appendix C to the EP) should be referenced for more information on the less common species, and that discussion is incorporated here by reference. All marine mammals are federally protected species under the MMPA. There are no state-listed marine mammal species of special concern within the project area. Discussions on the bowhead whale, humpback whale (*Megaptera novaeangliae*), ringed and bearded seals, Pacific walrus, and polar bear are presented in Section 3.8, Threatened and Endangered Species. Fin whales (*Balaenoptera physalus*) are not likely to occur in the project area at all.

**Harbor Porpoise**

**Distribution**

Harbor porpoises are rarely present in the Beaufort Sea including the proposed Shell project area in Camden Bay. Harbor porpoises are small cetaceans generally found in shallow coastal waters less than 330 ft (100 m) in depth (Angliss and Outlaw 2008). Although there is no official designation of separate stocks of harbor porpoises in Alaska, three stocks have generally been recognized. Harbor porpoises are not migratory animals and do not exhibit wide geographical movements.

MMOs onboard industry vessels reported one harbor porpoise sighting in the Beaufort Sea in 2006 and no sightings were recorded in 2007 or 2008 (Savarese et al. 2010). Monnett and Treacy (2005) did not report any harbor porpoise sightings during aerial surveys in the Beaufort Sea from 2002 through 2004. Small numbers of harbor porpoises could occur in the general area of the planned Beaufort Sea exploration drilling program.

**Life History**

Harbor porpoises feed mainly on non-spiny fish, cephalopods such as squid and octopus, and crustaceans such as shrimp. They use echolocation to locate prey while foraging (Nowak 1999). Harbor porpoises normally travel in small groups consisting of a few individuals, but form larger groups for feeding and mating purposes. Calving occurs between spring and early summer, and calves are generally weaned within one year (Read 1999).

**Abundance**

An abundance of 16,271 was estimated for the Bering Sea stock as a result of aerial surveys conducted in Bristol Bay in 1999 (Angliss and Allen 2009). Using correction factors, the estimate was adjusted to 66,078 for the entire stock. Harbor porpoises do not typically enter the Beaufort Sea (Angliss and Outlaw 2008) or move as far east as the project areas.
Narwhal

Distribution
There are scattered records of narwhal in Alaskan waters where the species is considered extralimital (Reeves 2002). Thus, it is possible, but very unlikely, that individuals could be encountered in the area of the proposed exploration drilling activities. Narwhals have a discontinuous arctic distribution (Hay and Mansfield 1989; Reeves 2002).

Life History
Male narwhals are distinguishable due to a long helical tusk that protrudes from their upper left jaw. This tusk is rarely used for fighting and is thought to be a specialized trait for sexual selection. They mainly feed on flatfish and other benthic organisms. They are thought to use echolocation to locate prey. These whales can live to be 50 years old. The gestation period is between 10 and 16 months. Calves are nursed for about four months.

Abundance
A large population inhabits Baffin Bay, West Greenland, and the eastern part of the Canadian Arctic archipelago, and much smaller numbers inhabit the Northeast Atlantic/East Greenland area. Population estimates for the narwhal are scarce, and the IUCN-World Conservation Union lists the species as Near Threatened (IUCN 2008).

Killer Whale

Distribution
Killer whales can be found in all Alaskan waters, although they are considered rare in the Beaufort Sea. Of the eight killer whale stocks recognized in the Pacific, the trans-boundary Alaska Resident stock, found from southeastern Alaska to the Chukchi Sea (Angliss and Outlaw 2005) is the only stock that could possibly be encountered by Shell’s exploration drilling operations. Killer whales probably do not occur regularly in the Beaufort Sea although sightings have been reported (Lowry et al. 1987, George and Suydam 1998). George et al. (1994) reported that they and local hunters see a few killer whales at Point Barrow each year.

Life History
Adult killer whales generally grow to reach 27 ft (8.2 m). They are the largest members of the delphinidae family. Transient killer whales prey on marine mammals while resident animals often feed on fish and invertebrates. They are long-lived and reproduce slowly. Gestation typically lasts between 15 and 16 months. Calving usually occurs during the spring and fall.

Abundance
The National Marine Mammal Laboratory (NMML) began killer whale studies in 2001 in Alaskan waters west of Kodiak Island, including the Aleutian Islands and Bering Sea. Line-transect surveys were conducted in July and August in 2001 through 2003. Based on surveys conducted by the NMML, a minimum estimate of 1,123 killer whales comprises the Alaska Resident stock (Angliss and Outlaw 2005). The eastern North Pacific Alaska resident stock of killer whales is not classified as a strategic stock.
Minke Whale

Distribution

Minke whales are not likely to be present near the Shell project area in Camden Bay. The Alaska stock of minke whales ranges from near the equator north to the Bering and Chukchi Seas (Leatherwood et al. 1982) where they have been observed penetrating loose ice in the summer (Leatherwood et al. 1982). Minke whales found in the Chukchi Sea are believed to be migratory and travel along the coast to California (Dorsey et al. 1990). These whales are a separate stock from the minke whales that inhabit the coast of Washington and California year-round. Minke whales range into the Chukchi Sea but are not likely to occur in the Bering Sea. Savarese et al. (2010) reported one minke whale sighting in the Beaufort Sea in 2007 and 2008. Minke whales are not likely to be observed in the Beaufort Sea near the planned exploration drilling program.

Life History

Minke whales are relatively small baleen whales. They mainly feed upon euphausids and other zooplankton. Sexual maturity is reached at 7-8 years. Gestation usually lasts 10 months, and weaning typically occurs after five months. Their life span is generally 30-50 years.

Abundance

No population estimates are available for the Alaska stock of minke whales (Angliss and Outlaw 2008). Moore et al. (2000a) conducted vessel-based surveys across portions of the Bering Sea in 1999 and 2000 and reported an average estimate of 1,813 whales in the central eastern and southeastern Bering Sea (Moore et al. 2000a). However, this estimate did not take into consideration a correction factor for whales not visible during the survey. The Alaska stock of minke whales is not considered depleted under the MMPA, and they are not considered threatened or endangered under the ESA.

Ribbon Seal

Distribution

Ribbon seals rarely occur in the Beaufort Sea and are not likely to be present in the proposed Shell Camden Bay during the drilling season. The Alaska stock of ribbon seals is the only stock found within U.S. waters where they range from Bristol Bay, across the Bering Sea, to and throughout the Chukchi Sea. Ribbon seals haul out on the northern pack ice in the Bering Sea from late March to early May until the ice begins receding (Burns 1994a; Braham 1984). Recent literature indicates that the seals move into the Chukchi Sea in the summer (Kelly 1988). Ribbon seals are rarely seen on shorefast ice (Kelly 1988). Little is known about the distribution of ribbon seals in the summer.

Life History

Ribbon seal size is intermediate relative to other seals in the Alaskan Arctic. They mainly prey on fish. They reach sexual maturity between the ages of 2 and 6 years. Pups are born on the ice between April and May with a thick coat of white fur called lanugo. Adults have dark fur with light-colored “ribbons” encircling the head, tail, and flippers. Nursing lasts 3-4 weeks, during which time mating also occurs.

Abundance

A current reliable abundance estimate is not available for the Alaska stock of ribbon seals. In the 1970s, Burns (1994a) estimated 240,000 ribbon seals worldwide, and he added that the estimate for the Bering Sea was 90,000-100,000. Ribbon seals are not listed as depleted under the MMPA, and they are not considered threatened or endangered under the ESA. A status review conducted by NOAA in 2008 determined that ribbon seals do not currently warrant listing under the ESA.
Ribbon seals are not common in the Beaufort Sea. MMOs reported two ribbon seals during Shell vessel surveys operating in the Beaufort Sea in 2008 (Funk et al. 2009). MMOs considered 49 percent of the seals recorded unidentified species because of the difficulty distinguishing between similarly-sized seal species. Obviously, this applies to other seal species discussed below. Because of their low occurrence in the Beaufort Sea, it is not likely that many of the unidentified seals were ribbon seals.

Ribbon seals appeared to be relatively rare in the Beaufort Sea during recent vessel-based surveys in summer and fall of 2006-2007 with only three sightings among 997 seal sightings identified to species (Savarese et al. 2010). Only two ribbon seal sightings were reported during vessel-based activities near Prudhoe Bay in 2008 (Savarese et al. 2010). Regardless, ribbon seals are unlikely to occur in the vicinity of the planned exploration drilling program in Camden Bay.

**Spotted Seal**

Spotted seals are known to occur in the Beaufort Sea during the drilling season and, although unlikely, they could occur near the proposed project areas. Spotted seals are an important subsistence species for Alaskan Natives. According to a database maintained by the ADF&G, at least 5,265 individuals are taken annually for subsistence purposes (ADF&G 2000b). The Alaska stock of spotted seals is not classified as a strategic stock by the NMFS.

**Distribution**

The summer distribution of the Alaska stock of spotted seals includes the Bering, Chukchi, and Beaufort Seas along the continental shelf. This species also occurs in open water far offshore (BPXA 2004). As the ice cover thickens with the onset of winter, spotted seals leave the Beaufort and Chukchi Seas in October and November before ice formation to overwinter at the southern edge of the pack ice in the Bering Sea (Simpkins et al. 2003). During the summer, spotted seals are found primarily in the Bering and Chukchi Seas, but some range into the Beaufort Sea (Rugh et al. 1997; Lowry et al. 1998) from July until September. At this time of year, spotted seals haul out on land part of the time, but they also spend extended periods at sea. Spotted seals are commonly seen in bays, lagoons and estuaries, but also range far offshore as far north as 69–72°N. In summer, they are rarely seen on the pack ice, except when the ice is very near shore. As the ice cover thickens with the onset of winter, spotted seals leave the northern portions of their range and move into the Bering Sea (Lowry et al. 1998).

Figure 3.7-2 depicts spotted seal sightings from 1979-2007 in the Beaufort Sea.

**Life History**

Spotted seals are roughly the same size as ribbon seals. The diet of spotted seals is very similar to that of ringed seals, except these seals also have been known to eat sand lance, sculpins, flatfish, and octopus, while juveniles eat mostly shrimp. Sexual maturity is reached between 3 and 5 years. Pups are born between April and May with a coat of thick white fur called lanugo. Mating and weaning occurs for approximately 3-4 weeks after the female gives birth. They are annual breeders. Spotted seals typically live to reach 35 years.

**Abundance**

The Bering Sea population of spotted seals, which includes Russian waters, is estimated between 200,000 and 250,000 (Burns 1973). However, a reliable population estimate is currently not available because of the difficulty associated with counting species that spend much of their time underwater (Rugh et al. 1995).
The summer distribution of the Alaska stock of spotted seal extends eastward in the Beaufort Sea along the continental shelf. Spotted seals have been reported in relatively low numbers (approximately 30 to 40) along the central Beaufort Sea coast (BPXA 2004) to Demarcation Point and beyond (Burns 1994b; Angliss and Lodge 2002).

Relatively low numbers of spotted seals are present in the Beaufort Sea. Spotted seals use coastal haulouts in summer and fall, including sites along the East Channel of the Colville River where groups of up to five were observed in 1997 (BPXA 2004). This species also occurs in open water far offshore (BPXA 2004). About 1,000 spotted seals are thought to reside in the Beaufort Sea during summer (MMS 2003). Historically, these sites supported as many as 400–600 spotted seals, but in recent times <20 seals have been seen at any one site (Johnson et al. 1999). In total, there are probably no more than a few tens of spotted seals along the coast of the central Alaska Beaufort Sea during summer and early fall. A total of 12 spotted seals were positively identified near the source vessel during open-water seismic programs in the central Alaskan Beaufort Sea during the 6 years from 1996-2001 (Moulton and Lawson 2002, p. 317). Numbers seen per year ranged from zero (in 1998 and 2000) to four (in 1999). More recently Greene et al. (2007) reported 46 spotted seal sightings during barge operations between West Dock and Cape Simpson. Most sightings occurred from western Harrison Bay to Cape Simpson with only one sighting offshore of the Colville River Delta. Some of these could have been repeat sightings of the same individuals as the barges traversed the same area on numerous occasions. Two spotted seal sightings were recorded during aerial surveys in the central Alaskan Beaufort Sea in 2008 (Hauser et al. 2008). Although unlikely, small groups of spotted seals may occur in the vicinity of the drilling areas mid- to late summer. Spotted seals are relatively uncommon in the central Beaufort Sea.

**Beluga Whale**

Beluga whales will likely occur in the project areas during the drilling season. Beluga whales are hunted for subsistence by North Slope villages from the first week in April to July or August. Between 1999 and 2003, the average annual beluga subsistence harvest from the Chukchi Sea stock was 65 (Angliss and Outlaw 2008) and the Beaufort Sea stock was 53 (Angliss and Outlaw 2008).

**Distribution**

Beluga whales summer in the waters of the Chukchi and Beaufort Seas and winter in the Bering Sea. Beluga whale sightings (1979-2010) are depicted on Figure 3.7-3. Living in areas mostly covered in ice, they are associated with leads and polynyas (Angliss and Outlaw 2008) although they are also seen in open water. There are five beluga stocks in Alaska (Angliss and Outlaw 2008). Only the eastern Chukchi Sea and Beaufort Sea stocks occur near the project area. Both stocks overlap in the Beaufort Sea, and both winter in the Bering Sea (Suydam et al. 2001, 2005; Angliss and Outlaw 2008). Many belugas aggregate in Kasegaluk Lagoon in the Chukchi Sea in June and July to molt.

Beluga whales of the Beaufort Sea stock occur seasonally from spring to fall in the Beaufort Sea eastward to the Mackenzie River Delta, and winter with several other stocks in the Bering Sea (Lowry 1994; Richard et al. 1998; Angliss and Outlaw 2008). In the spring, belugas migrate along open leads extending eastward from Point Barrow, following routes far from the Beaufort Sea coast, similar to bowhead whales (BLM 2005; BPXA 2004). During summer marine mammal surveys (2008), a few belugas were seen in the central Beaufort Sea (Funk et al 2009). Few belugas remain in the central Beaufort Sea in the summer (BPXA 2004), but small numbers have been reported within the Colville River Delta (BLM 2005). Lyons et al. (2008) reported the highest sighting rates of belugas during the first two weeks of September in the northernmost portion of their survey area.
Figure 3.7-2  Spotted Seal Sightings 1979 through 2010
Few belugas remain in the central Beaufort in the summer (BPXA 2004), but small numbers have been reported within the Colville River Delta (BLM 2005). Fall migrant beluga whales from the Canadian Beaufort transit the Alaskan Beaufort Sea along the southern edge of pack ice to reach western Chukchi Sea waters primarily during September (Richard et al. 1998). Aerial surveys in 2000 and 2001 found most fall migrants 35-104 mi (56-167 km) offshore in the Alaskan Beaufort Sea (Treacy 2002a), and some beluga whales pass further than 250 mi (400 km) offshore in this area (Richard et al. 1998). The proposed Shell drill sites are well within 22 mi (35 km) of shore and, therefore, will be away from the majority of fall beluga migrants. The main beluga whale migration corridor is about 62 mi (100 km) offshore, well beyond the proposed Shell project area (Lyons et al. 2008). Christie et al. (2010) reported higher beluga sighting rates at locations >60 km offshore than at locations nearer shore during aerial surveys in the Alaskan Beaufort Sea in 2006-2008. The main fall migration corridor of beluga whales is typically ~100+ km north of the coast.

Life History

Pod structure revolves around matrilineal lines; males form separate aggregations. Calves are born in summering areas between May and July. They are weaned after two years. Mating occurs during early spring. Fall migrant beluga in Alaska waters are now known to routinely dive to greater than 1,312 ft (400 m) over continental slope or abyssal areas (Richard et al. 1998). A small number of beluga whales are occasionally expected to occur near the proposed drill sites during the drilling season.

Beluga whales primarily feed on schooling fish, but also take some marine invertebrates over the continental shelf and in estuarine and riverine waters (Lowry 1994).

Abundance

The abundance estimate considered the “most reliable” for the eastern Chukchi Sea beluga whale stock is 3,710, a result of aerial surveys conducted 1989 through 1991 (Frost et al. 1993; Angliss and Lodge 2004). Additional surveys were conducted in 1998 (DeMaster et al. 1998) and again in July 2002 (Lowry and Frost 2002), but both were partial surveys and therefore a more complete abundance estimate for this stock is not available. Based on the most recent reliable aerial survey in the Beaufort Sea (1992), and a conservative correction factor for visibility bias, the Beaufort Sea stock contained an estimated 39,258 whales and the population is believed to be stable or increasing. This estimate was based on the application of a sightability correction factor of 2× to the 1992 uncorrected census of 19,629 individuals made by Harwood et al. (1996). This estimate was obtained from a partial survey of the known range of the Beaufort Sea population and may be an underestimate of the true population size. This population is not considered by NMFS to be a strategic stock and is believed to be stable or increasing (Allen and Angliss 2010).

MMOs aboard Shell vessels have reported no beluga whales from marine vessels, but they observed several during aerial surveys. Surveys during 2008 showed the highest number of beluga whales. However, the significant increase in reported sightings is attributed to an increase in survey effort rather than an increase in the local population. Table 3.7-1 shows the number of sightings during vessel and aerial surveys between 2006 and 2010. Beluga whales accounted for about 38 percent of animal sightings during the MMO aerial surveys.
Figure 3.7-3  Beluga Whale Sightings 1979 through 2010
Table 3.7-1  Number of Beluga Whales Sightings From Shell Vessels and Aerial Surveys Between 2006 and 2010 in the Beaufort Sea, Alaska

<table>
<thead>
<tr>
<th>Year</th>
<th>Number Observed from Vessel Surveys</th>
<th>Number Observed from Aerial Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>2007</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>2008</td>
<td>0</td>
<td>118</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
<td>0*</td>
</tr>
<tr>
<td>2010</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

(Source: Reiser et al. 2010)

* Shell did not have an aerial survey program in 2009

**Gray Whale**

A small number of gray whales may be present in the project areas during the drilling season. Gray whales this far east in the Beaufort Sea are rare, and no more than a few individual whales, if any, are expected to be in the vicinity of Shell’s Beaufort prospect areas during the Camden Bay exploration activities. The eastern Pacific stock is not considered by NMFS to be endangered or to be a strategic stock.

**Distribution**

The eastern North Pacific population of gray whales ranges from the Bering, Chukchi, and Beaufort Seas (in summer) to the Gulf of California (in winter) (Rice 1998). However, gray whales have also been documented foraging in waters off of Southeast Alaska, British Columbia, Washington, Oregon, and California (Rice and Wolman 1971; Berzin 1984; Darling 1984; Quan 2000; Calambokidis et al. 2002). Most of the eastern north Pacific population makes a round-trip annual migration of more than 4,970 mi (8,000 km) from Alaska waters to Baja California and Mexico.

From late-May to early-October, the majority of the population concentrates in the northern and western Bering Sea and the Chukchi Sea. Small numbers of gray whales have been observed entering the Beaufort Sea east of Point Barrow. Maher (1960) reported hunters at Cross Island took one gray whale in 1933. Aerial surveys conducted in the central Alaskan Beaufort Sea documented only one gray whale from 1979 to 1997. Since 1997, small numbers of gray whales have been reported on several occasions in the central Alaskan Beaufort Sea—mainly in the Harrison Bay area (Miller et al. 1999; Treacy 2000). Other reports of single gray whale sightings have been documented farther east of Harrison Bay (Rugh and Fraker 1981). In August 2001, Williams and Coltrane (2002) reported a gray whale near the Northstar production facility, suggesting small numbers do travel in the offshore waters of the Prudhoe Bay during some summers. They have been seen east of Point Barrow in late-spring and summer, as far east as Smith Bay (Greene et al. 2007). Given their rare occurrence in the eastern portion of the Beaufort Sea in summer, only a few gray whales are expected to occur near the Shell project area during the summer and early fall (Figure 3.7-4).

Typically, gray whales are found in shallow water, and usually remain closer to shore than any other large cetacean. Gray whales are considered common summer residents in the nearshore waters of the eastern Chukchi Sea, and occasionally are seen east of Point Barrow in late-spring and summer, as far east as Smith Bay (Greene et al. 2007) (Figure 3.7-4). On wintering grounds, mainly along the west coast of Baja California, gray whales utilize shallow, nearly land-locked lagoons and bays (Rice et al. 1981). From late February to June, the population migrates back to arctic and subarctic seas (Rice and Wolman 1971). They prefer areas with little or no ice cover and spend most of their time in water less than 197 ft (60 m) deep (Moore and DeMaster 1997).
Life History

Gray whales feed in the northern Bering and Chukchi Seas (Braham 1984). They are benthic feeders and feed primarily on amphipods, a key prey species (Moore et al. 2003). They are subject to killer whale predation (Weller et al. 2002). Gray whales are taken by commercial whalers, but very rarely by Native subsistence hunters (IWC 1997).

Abundance

Gray whales originally inhabited both the north Atlantic and north Pacific oceans. The Atlantic populations are believed to have become extinct by the early 1700s, while a relic population survived in the western north Pacific. The eastern Pacific stock was removed from the Endangered Species List in 1994 and is not considered by NMFS to be a strategic stock. The eastern north Pacific, or California, gray whale population has recovered from commercial whaling. Rugh et al. (2005) estimated that the abundance of gray whales was 18,178. The minimum population estimate is 17,752 (Angliss and Outlaw 2007). Rugh et al. (2008) estimated the population in winter 2006–2007 to have been 20,110 ±1766. MMOs onboard Shell vessels reported few gray whale sightings in the Beaufort Sea. Table 3.7-2 shows the number of individual gray whales seen during vessel and aerial surveys between 2006 and 2010.

Table 3.7-2 Number of Individual Gray Whales Sighted From Shell Vessels and Aerial Surveys Between 2006 and 2010 in the Beaufort Sea, Alaska

<table>
<thead>
<tr>
<th>Year</th>
<th>Number Observed from Vessel Surveys</th>
<th>Number of Observed from Aerial Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2007</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2008</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
<td>0*</td>
</tr>
<tr>
<td>2010</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(Source: Funk et al. 2010)
* Shell did not have an aerial survey program in 2009

3.7.2 Terrestrial Mammals

Caribou (*Rangifer tarandus*), muskox (*Ovibos moschatus*), moose (*Alces alces*), and brown bears (*Ursus arctos*) have been the subject of extensive research on the North Slope. Caribou, moose and muskox are important subsistence species and all are prized big game. Caribou regularly use coastal areas of the Beaufort Sea at specific times of the year. Brown bears occur in coastal areas and in developed oil field areas. The Arctic Fox (*Alopex lagopus*) is found across the North Slope, east and into Canada. The other large mammals of the North Slope are more uncommon along the Beaufort Sea coastal habitats.

Caribou

Caribou are carefully managed and studied by the ADF&G. Much of the agency interest in caribou is related to their importance as a highly valued game animal and as a subsistence species. Caribou are the predominant large herbivores on the North Slope, where they are widely distributed (Manville and Young 1965; Miller 1982; Valkenburg 1999). Their sheer numbers make them the primary food source for native hunters and for many predatory animals.

Distribution

Caribou are found throughout the North Slope. The Central Arctic Herd (CAH) and the Porcupine Caribou Herd (PCH) inhabit the project area. Both the CAH and PCH are expected in high densities near the Beaufort Sea coastal areas during calving in early June (Valkenburg 1999) and during the July insect-harassment season. However, caribou distributions can change and are sometimes difficult to predict from year to year.
Figure 3.7-4  Gray Whale Sightings 1979 through 2010
Life History

Caribou migrate seasonally between their winter, calving, and summer ranges. Spring migration of parturient females from the overwintering areas to the calving grounds begins in late March (Hemming 1971). Bulls and non-parturient females generally migrate later. Calving occurs on the open tundra from late April to early June (Whitten and Cameron 1985).

Habitat preferences on the calving grounds are related to terrain ruggedness. Caribou distributions during the calving period prefer areas dominated by fine-textured rugged terrain. Rugged terrain relates to the diversity of vegetation and biomass of forage species. Caribou tend to avoid areas with flatter terrain (Nellemann and Cameron 1996). Wet, low lying tundra areas are generally not selected for calving (Whitten and Cameron 1985).

North Slope caribou herds often use coastal areas to escape inland predators and biting insects (Cameron and Smith 1992), which have a profound effect on the behavior and movement of caribou. Caribou will move to the coast where cooler temperatures and onshore winds provide insect relief (Lawhead 1997).

Caribou aggregate and feed on emerging vegetation during the post-calving (July through August) period. Caribou begin migrating inland during the fall when biting insects decline. Most caribou spend the winter inland near the foothills of the Brooks Range (Lenart 2003; BLM 2004). Small numbers of caribou may remain on the Arctic Coastal Plain at low densities during the winter (MMS 2002; BLM 2004).

Abundance

The CAH has grown from an estimated 5,000 animals in 1975 (Cameron and Whitten 1979) to about 31,857 animals in 2002 (Lenart 2003). They are generally distributed between the lower Colville and Canning Rivers (Lenart 2003; BLM 2004).

The PCH has demonstrated fluctuations in population from an estimated 100,000 in 1972 to 178,000 by 1989, and to 123,000 in 2001 (Stephenson 2003). The PCH migrates between Alaska, the Yukon, and the Northwest Territories (Griffith et al. 2002). The PCH females calve on the coastal plain and northern foothills of the Brooks Range in the ANWR and the Yukon (Griffith et al. 2002).

Muskox

Many Inupiat still consider the muskox a subsistence species (Pedersen et al. 1991). In 1992, 53.2 percent of households in Kaktovik used muskox from a harvest of approximately five animals (ADF&G 1993). In 1993, 8.1 percent of households in Nuiqsut used muskox, although no harvest was recorded for subsistence use in that year (ADF&G 1993).

Distribution

By the early 1900s, muskox were extirpated from the North Slope, likely by over hunting. In 1969 and 1970, 64 muskoxen from Nunivak Island were reintroduced into ANWR (Jingfors and Klein 1982, Reynolds 1998). Released at Barter Island and the Kavik River, muskox initially moved into the 1002 Area (Reynolds et al. 2002). Today muskox are found as far west as the Colville River Delta (BLM 2004) and are commonly observed in the Itkillik, Kuparuk, Sagavanirktok, Canning, Sadlerochit, Hulahula Okpilik, Jago, and Aichilik river drainages (Lenart 2005).

These year-round residents of the North Slope are found near river corridors and adjacent uplands, which serve as important muskox habitat. Muskox tend to stay near areas that are conducive to foraging. Muskox favor wind-swept habitats during winter, for easy food access. Muskox are commonly found in
the Sagavanirktok River valley in summer, despite the presence of the Dalton Highway and Trans Alaska Pipeline System (Reynolds et al. 2002).

**Life History**

Muskox breed during late summer (August through October) and calve in the spring (April through June). They are gregarious in nature with herds numbering up to 75 individuals. During the mating season, the herd breaks up into small harems with around 15 females and subadult males and one dominant male. The dominant male defends his harem from other breeding males. Muskox form compact lines or circles as a defense technique against predators such as wolf packs and bears. Muskox feed in areas with little snow accumulation.

**Abundance**

After reintroduction to the North Slope, the muskox population increased dramatically from 1974-1986 in the 1002 Area of ANWR. In 1998, 800 muskoxen were observed in the area between the Itkillik River west of Prudhoe Bay and the Babbage River in northwestern Canada (Reynolds 1998). In recent times, the muskox population has declined, due to significant predation by grizzly bears (Reynolds et al. 2002). In 2005, the ADF&G estimated a population of 450-550 muskoxen in eastern Alaska and northwestern Canada (Lenart 2005).

**Brown Bear**

Brown bears are the largest terrestrial predator within the project area. Brown bears have been seen on the coastal plain and in and around the developed oil field infrastructure. They eat the caribou fox and ground squirrels which are plentiful along the coastal areas.

**Distribution**

Brown bears occur throughout mainland Alaska (Manville and Young 1965; Eide et al. 2003). They are dispersed throughout the Arctic coastal plain during the summer but generally den in the higher elevations of the Brooks Range and the foothills in the winter.

**Life History**

Brown bears mate May through June. Males may mate with more than one female during breeding season. The young, weighing less than a pound, are born the following January or February in a winter den. Litter size ranges from one to four cubs. Offspring separate from their mothers in the spring season when they are from two to four years old. Following separation, the mother can breed again and produce a new litter of cubs the following year (Eide and Miller 2003).

To meet their nutritional needs, North Slope brown bears select foods from a wide variety of sources. Bears feed seasonally on vegetation, such as plants, roots and berries. They are also opportunist feeders that prey and scavenge on a variety of wildlife. Bears on the Arctic Coastal Plain prefer riparian habitats (areas along rivers and streams) because they provide the greatest diversity of foods (ConocoPhillips 2005).

In Arctic environments, denning typically begins in October, with emergence in April and May (MMS 2002a). Denning frequently occurs in snow-accumulating areas of moderate to high relief such as pingos, riverbanks, lake basins, dunes, and gullies, often with southern exposures (MMS 2002a).
Abundance

On the North Slope, brown bear densities are typically only one to five individuals/1,000 mi$^2$ (386 km$^2$) (BLM 2004). Home range sizes are large; approximately 1,000-2,000 mi$^2$ (2,600-5,200 km$^2$) in the Prudhoe Bay region (MMS 2002a). The North Slope is considered marginal brown bear habitat because of the severe climate, short growing season, and limited supply of food resources. The quality of the marginal habitat suggests brown bears are expected to be uncommon near North Slope coastal areas.

Brown bears are most abundant in the foothills and mountains of the Arctic Coastal Plain (Young et al. 2002). An estimated 60 to 70 brown bears, or approximately four/386 mi$^2$ (1,000 km$^2$) currently inhabit the central North Slope Coastal Plain (Shideler and Hechtel 2000). In 1992, the estimated population for Game Management Unit 26A, the area west of the Itkillik River that includes all of National Petroleum Reserve-Alaska (NPR-A), was 900-1,120 bears (Reynolds 1989). There have been no surveys since then, but the population appears to be stable.

Moose

Moose are also considered to be at the northern extent of their range on the North Slope because of limited food resources (Hicks 1998). Nevertheless, 5-10 moose a year have been harvested by subsistence communities such as Kaktovik and Nuiqsut before the area was closed for moose hunting (Hicks 1998).

Distribution

Moose on the North Slope range as far north as the Beaufort Sea in the summer. The few adequate moose browse habitats found on the North Slope are generally associated with willow thickets along the major river systems. Moose spend the winter in river valleys containing riparian shrub vegetation that provides both cover and browse. Moose are not expected to be found in significant numbers in the project area.

Life History

Cow moose generally breed at 28 months. Calves are born from mid-May to early June after a gestation period of about 230 days. Moose breed in the fall with the peak of the rut activities coming in late September and early October. By late October, adult males have exhausted their summer accumulation of fat and once again begin feeding. Antlers are shed from November through January. Most moose make seasonal movements for calving, rutting, and wintering areas. They travel anywhere from a few miles to 60 miles during these transitions (Rausch and Gasaway 1994).

Moose eat a variety of foods, particularly sedges, equisetum (horsetail), pond weeds, and grasses. During summer, moose feed on vegetation in shallow ponds, forbs, and a variety of trees.

Abundance

Moose populations on the North Slope declined from the early to mid-1990s, which was followed by an upward trend in the late 1990s (Carroll 2002). Currently there are an estimated 1000 moose in Game Management Unit 26 (North Slope of the Brooks Range and Arctic Coastal Plain east of the Itkillik River) with the greater population occurring on the west side of this unit (ADF&G 2005). Due to the limited habitat of the North Slope, moose numbers are not expected to significantly increase. (MMS 2008a)
3.8 Threatened and Endangered Species

BOEMRE regulation 30 C.F.R. § 250.227(b)(4) requires a description of species classified as threatened or endangered under the Endangered Species Act of 1973 (ESA) that could potentially be affected by the activities proposed in this EP. Three species of baleen whale are listed as endangered: bowhead (*Balaena mysticetus*), fin (*Baleanoptera physalus*) and humpback (*Megaptera novaeanglie*). The fin whale has not been reported in the Beaufort Sea. Three species of pinnipeds are proposed for listing as endangered: bearded seal (*Erignathus barbatus*) and ringed seal (*Phoca hispida*). Another species of pinniped, Pacific walrus (*O. rosmarus divergens*), is considered a candidate species for listing under the ESA by USFWS. The yellow-billed loon is also a candidate species for listing under the ESA.

The bowhead whale is an important subsistence resource for villages and residents on the North Slope. It is also at the center of many cultural and spiritual beliefs and rituals. A thorough understanding of the bowhead’s distribution, life history, and abundance places it in context of the greater Beaufort Sea environment and provides a foundation for the discussion of potential impacts resulting from project activities. Given its cultural significance and greater abundance, the bowhead is addressed in more detail in this document than the fin or humpback whales.

Other species listed as threatened are the Polar bear (*Ursus maritimus*), the Steller’s eider (*Polysticta stelleri*), and spectacled eider (*Somateria fischeri*).

3.8.1 Whales

**Fin Whale**

Fin whales are not likely to occur in the project area during Shell’s Camden Bay exploration program.

There are no known reported sightings of fin whales in the Beaufort Sea (personal communication Funk 2010).

**Humpback Whale**

The humpback whale is rarely seen in the Beaufort Sea. It is highly unlikely that humpback whales would be present during Shell’s Camden Bay exploration program.

**Distribution**

Only one humpback whale has been documented in the Beaufort Sea (Greene et al. 2007). This whale was observed near Smith Bay west of Camden Bay near Barrow (MMS 2008). The southern Chukchi Sea is considered the northernmost range of the Pacific humpback whales. In the winter, most humpback whales migrate to subtropical and tropical waters of the Northern and Southern hemispheres. Greene et al. (2007) reported and photographed a humpback whale cow/calf pair about four km east of Cape Simpson in western Harrison Bay in 2007, which is the first known occurrence of humpback whale in the Beaufort Sea. A second humpback whale sighting which was likely in the Beaufort Sea was reported near Barrow by Goetz et al. (2010).

**Life History**

Humpback whales feed on zooplankton and small schooling fish. Females are typically larger than males and average 42 ft (12.7 m) while males average 40.5 ft (12.3 m) in total length.

Humpback whales have a gestation period of 11-12 months and calve in tropical waters. Weaning occurs after about a year. Sexual maturity is reached at 4-6 years. Females give birth every two or three years.
Humpback whales are known for the elaborate, unique songs the males produce in winter to attract mates. They also produce limited songs in summer that are thought to be associated with feeding activities.

**Abundance**

There is no reliable estimate of the north Pacific stock of humpback whales (the only stock with potential to enter the Beaufort Sea) because surveys conducted to date are incomplete in their coverage (Angliss and Outlaw 2008). However, Calambokidis et al. (1996) estimated the abundance of the Western North Pacific stock of humpback whales in their usual wintering areas outside the Beaufort was 394 in the mid-1990s.

**Bowhead Whale**

Bowhead whales will likely be present in the project area during the drilling season, especially during their fall migration. Shell’s EP includes detailed plans and mitigation measures, which were developed over several seasons of Arctic operations and have proven effective in identifying, tracking, and avoiding impacts to bowhead whales. These measures are contained in Section 5 of the EP and are incorporated here by reference.

**Distribution**

There are five stocks of bowhead whales worldwide. The Western Arctic stock of bowhead whales is the only stock found within U.S. waters. They are distributed seasonally in ice-covered waters of the Arctic and near-Arctic, generally between 60° and 75° N latitude in the Western Arctic Basin (Moore and Reeves 1993).

The majority of bowhead whales overwinter in the central and northwestern Bering Sea (November to March), migrate through the Chukchi Sea in the spring (March through June) following offshore ice leads around the coast of Alaska in continental shelf waters, and spend summers in the Canadian Beaufort Sea (mid-May through September) (Braham et al. 1980; Moore and Reeves 1993). Bowheads frequently interrupt their migration to feed (Ljungblad et al. 1986; Lowry 1993; Lowry et al. 2004) and their stops vary in duration from a few hours to a few weeks (MMS 2002). A commonly used feeding area is in and near Smith Bay, east of Barrow. Less consistently used feeding areas are in coastal and shelf waters near and east of Kaktovik. In 2007 and 2008 bowhead whales also used areas near Camden Bay to feed during the migration (Ireland et al. 2008, Funk et al. 2010). The Bowhead Whale Feeding Ecology Study (BOWFEST) is a multiyear BOEMRE-funded study started in 2007 that focuses on late summer oceanography and prey densities relative to whale distribution over continental shelf waters within 100 miles north and east of Point Barrow, Alaska. Research is ongoing to determine the extent to which bowheads might feed in the western Beaufort Sea.

During the fall migration (September through November) bowhead whales typically travel in continental shelf waters that are less than 164 ft (50 m) deep on their way back to the Bering Sea. Ice cover influences the timing, duration, and path that the whales follow (Treacy 2002b). In heavy ice conditions they divert north and migrate in deeper water further offshore (Moore et al. 2000).

Fall whaling for Kaktovik and Nuiqsut residents occurs from late-August to mid-September. Traditional Knowledge (TK) gathered from local Inupiat residents suggests that migration pods are segregated by sex and age (Braham et al. 1980). Bowhead whales typically reach the Barrow area in mid-September to late-October during their westward migration from the feeding grounds in the Canadian Beaufort. Fall bowhead whaling near Barrow normally begins in mid-September, but may begin as early as August if
whales are present and ice conditions are favorable (BLM 2005). Whaling near Barrow may continue into October, depending on the quota and conditions.

In 2008, Shell conducted studies designed to evaluate whale locations and movements with respect to industry activities. They were:

- MMO Program for all vessels
- Aerial Survey Program
- Acoustic monitoring in the Beaufort Sea

In 2007, 2008, 2009, and 2010, Shell used Directional Autonomous Seafloor Acoustic Recorders (DASARs) to conduct a large-scale underwater acoustic monitoring program. The study provided information on migration paths and movements of bowhead whales along the Alaskan coast in late summer and early fall. The study was performed to investigate whale behavior with respect to industrial operations and examine possible effects of anthropogenic sounds. Call locations were consistent with BWASP data collected over several years by BOEMRE. Figures 3.8.1-1(A) and 3.8.1-1(B) show data collected by the DASARs in the Beaufort Sea and recent BOEMRE BWASP data.

These years were all low ice years. The red (middle) line shows the median distance from shore for whale sightings during these years, the green (inshore) line is the 10th percentile and the blue (offshore) line is the 90th percentile.

The functional DASAR locations are shown as red triangles. Note that the longitude range on the two maps is different. (Funk et al 2009).

A small number of bowhead whales have been seen or heard offshore near Prudhoe Bay in late August. (LGL and Greenridge 1996, Greene et al. 1999, Blackwell et al. 2004, 2008; Greene et al. 2007; Goetz et al. 2008). Figure 3.8.1-2 shows bowhead whale sightings by BOEMRE in the Beaufort Sea.

During Shell-funded marine mammal surveys flown in 2008-2010 a few bowhead whales were observed during July and August in nearshore areas of the Alaskan Beaufort Sea (Funk et al. 2010). Table 3.8.1-1 shows the number of bowhead whale sightings reported from Shell MMOs during vessel and aerial surveys.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number Observed from Vessel Surveys</th>
<th>Number Observed from Aerial Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>2007</td>
<td>20</td>
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</tr>
<tr>
<td>2008</td>
<td>48</td>
<td>87</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
<td>0*</td>
</tr>
<tr>
<td>2010</td>
<td>49</td>
<td>37</td>
</tr>
</tbody>
</table>

(Source: Reiser et al. 2010)

*Shell did not have an aerial survey program in 2009

Bowhead whales tend to migrate to deeper water (farther offshore) in the fall during years with higher-than-average ice coverage (Moore 2000b). Most bowhead whales migrate west in water ranging from 50-650 ft (15-200 m) deep (Miller et al. 2002). Some individuals enter shallower water, particularly in light ice years. Ice cover influences the timing, duration, and path that the whales follow (Treacy 2002b).
Life History

Bowhead whales feed primarily on copepods and euphausids (Lowry 1993; Lowry and Sheffield 2002). To satisfy energy requirements, bowheads may need to find areas with above-average concentrations of zooplankton (Lowry 1993).

They are long-lived, slow-growing, late-maturing, and reproduce infrequently (Koski et al. 1993). Females and males become sexually mature around 25 years of age (George et al. 2007). Bowhead whales mate and calve during spring migration (Nerini et al. 1984), and calving occurs every 3-4 years (Koski et al. 1993). The majority of bowhead whale mating occurs in March and April (IWC 2004). Gestation lasts between 12 and 16 months (Nerini et al. 1984).

Abundance

The population of bowhead whales in the Bering, Chukchi, and Beaufort Seas is estimated to have been 10,400-23,000 whales. Commercial whaling activities may have reduced this population to perhaps 3000 animals (Woodby and Botkin 1993). Up to the early 1990s, the population size was believed to be increasing at a rate of about 3.2 percent per year (Zeh et al. 1996) despite annual subsistence harvests of 14 to 74 bowheads from 1973-1997 (Suydam et al. 1995). A census in 2001 yielded an estimated annual population growth rate of 3.4 percent (95 percent CI 1.7–5 percent) from 1978-2001 and a population size (in 2001) of ~10,470 animals (George et al. 2004) which was subsequently revised to 10,545 by Zeh and Punt [2005]). A population estimate from photo identification data collected in 2004 was 12,631 (Koski et al. 2010) which further supports the estimated 3.4 percent population growth rate. Assuming a continuing annual population growth of 3.4%, the 2012 bowhead population may number around 15,232 animals. The large increases in population estimates that occurred from the late 1970s to the early 1990s were partly a result of actual population growth, but were also partly attributable to improved census techniques (Zeh et al. 1993). Although apparently recovering well, the BCB bowhead population is currently listed as endangered under the ESA and is classified as a strategic stock by NMFS and depleted under the MMPA (Allen and Angliiss 2010).

During 2009 Shell had very limited activity in the Beaufort Sea and did not have a vessel based MMO program, resulting in no sighting during 2009. In 2010 Shell did have a vessel-based MMO program which was primarily in Harrison Bay, where vessel-based MMOs only sighted 49 individuals.
Figure 3.8.1-1(A)  BWASP Sightings in the Years 1998 Through 2004, 2007 and 2008

Figure 3.8.1-1(B)  Comparison of the Call Locations Obtained in 2008 (gray dots) with the BWASP Sightings Shown in (A)
Figure 3.8.1-2  Bowhead Whale Sightings 1979 through 2010
3.8.2 Seals and Walrus

**Ringed Seal**

Ringed seals were the most frequently identified pinniped species during Shell vessel surveys operating in the Beaufort Sea in 2006 through 2008 (Funk et al 2009). A total of 775 ringed seals were recorded during these years. 2008 had by far the greatest number of sightings, but this should be attributed to an increase in survey effort, not population size. MMOs considered 49 percent of the seals recorded unidentified species because of the difficulty distinguishing between similarly-sized seal species. Therefore, the number of ringed seals in the area was probably much higher.

Ringed Seals will likely occur in the project areas during the drilling season. Alaska Natives use ringed seals as a source of nutrition. In 2000, the annual estimated subsistence “harvest” from Alaska of ringed seals was 9,567 (ADF&G 2000). They are found throughout the Beaufort, Chukchi, and Bering Seas (Allen and Angliss 2010). The Alaska stock, part of the Arctic subspecies of ringed seal, has been proposed for listing as threatened under the ESA (NMFS 2010b).

**Distribution**

Throughout their range, ringed seals have an affinity for ice-covered waters and are well adapted to occupying seasonal and permanent ice although they also occur in open water. Ringed seals are the most common and widespread seal in the area. They are found in the southern Bering Sea and range as far south as the Seas of Okhotsk and Japan.

They are year-round residents throughout the Beaufort, Chukchi, and Bering Seas and as far south as Bristol Bay in years of extensive ice coverage. Seals tend to be widely distributed over the ice during winter months, but as the spring breakup period begins, densities increase toward the ice edge and decrease inshore from the ice edge (Moulton et al. 2002). This could be strictly due to seals moving outward toward the ice edge or due to the added effect of an influx of seals looking for new haul out areas during this time. They tend to prefer large floes (i.e., greater than 157 ft [48 m] in diameter) and are often found on the interior ice pack where the sea ice coverage is greater than 90 percent (Simpkins et al. 2003). Figure 3.8.2-1 depicts sighting of seals between 1979 and 2007 in the Beaufort Sea.

**Life History**

Ringed seals give birth between mid-March and April. Once the pup is born, it is nursed for 5-8 weeks in a lair excavated in the snow and ice around breathing holes. There is a positive relationship between lack of maternal experience and increased predation by polar bear. This could account for poor reproductive success of less experienced females bearing young (Eley 1994).
Abundance

A reliable abundance estimate of ringed seals in Alaska does not exist (Angliss and Outlaw 2005). This could be due to the variability in the proportion of seals hauled out compared to those not visible across survey efforts (Frost et al. 2002). Between 1996 and 1999, Frost et al. (2004) conducted aerial surveys over the Beaufort Sea coast between Point Barrow and Kaktovik to assess the effects that environmental covariates (e.g., water depth, relative distance from the fast ice edge, and quality of the ice) had on ringed seal counts. They determined that the densities were highest in intermediate water depths 16.4-115 ft (5-35 m) and areas of smooth ice nearest to the edge of the fast ice (Frost et al. 2004). Angliss and Outlaw (2005) estimated a minimum abundance of 249,000 ringed seals in the eastern Chukchi Sea and Beaufort Sea. Estimates based on extrapolation from aerial surveys and on predation estimates for polar bears (Amstrup 1995) suggest an Alaskan Beaufort Sea population at approximately 326,500 animals.

Ringed seals were the most frequently identified pinniped species during Shell vessel surveys operating in the Beaufort Sea in 2006 through 2008 (Funk et al 2009). A total of 775 ringed seals were recorded during these years. 2008 had by far the greatest number of sightings, but this should be attributed to an increase in survey effort, not population size. MMOs considered 49 percent of the seals recorded unidentified species because of the difficulty distinguishing between similarly-sized seal species. Therefore, the number of ringed seals in the area was probably much higher.

Bearded Seal

Bearded seals may be present in the project areas during the drilling season depending on the location of the pack ice edge as they are highly associated with ice. Bearded seals are an important source of meat and hide for Beaufort Sea villages. According to the ADF&G subsistence harvest database (2000), the 2000 annual harvest of bearded seals in Alaska was 6,788. They tend to be targeted by subsistence users over ringed and spotted seals, because their large size provides an abundance of meat and skins for constructing boats (BLM 2005). The Alaska stock of bearded seals, part of the Beringia distinct population segment, has been proposed by NMFS for listing as threatened under the ESA (NMFS 2010a).

Distribution

Bearded seals (Kelly 1988) extend from the Bering Sea through the Chukchi and Beaufort Seas (Angliss and Outlaw 2007). Bearded seals use the Beaufort Sea year-round, but numbers are less in winter when habitat is limited to areas of open leads and active pack ice (BPXA 2004). In the Beaufort Sea, suitable habitat is limited to areas where the continental shelf is narrow because the pack ice edge frequently occurs seaward of the shelf and over water too deep for benthic feeding. The preferred habitat in the western and central Beaufort Sea during the open-water period is the continental shelf seaward of the scour zone, although a recent tagging study showed occasional movements of adult bearded seals seaward of the continental shelf (Cameron et al. 2009). Figure 3.8.2-2 depicts bearded seal sightings from 1979 to 2007 in the Beaufort Sea.

The distribution of bearded seals is dictated by the presence of ice. They prefer water depths of less than 656 ft (200 m) (Burns 1981). Bearded seals feed mainly near the seafloor, thus are rarely found in water depths where they cannot access the bottom. Similar to the ringed seal, the bearded seals maintain breathing holes (Burns and Frost 1979). However, they avoid regions of continuous, thick, shorefast ice (Burns and Frost 1979). The bearded seal is migratory and largely ice-associated; they stay near mobile pack ice (Burns 1967) with most of the Alaska population following the retreat and advance of the seasonal pack ice north and south across the Chukchi and northern Bering Sea (Nelson et al. 1985). During the summer in the Beaufort Sea, bearded seals are most associated with the pack ice edge near the continental shelf.
Figure 3.8.2-1 Ringed Seal Sightings 1979-2010
Figure 3.8.2-2  Bearded Seal Sightings 1979 through 2010
Distribution
Pacific walrus are uncommon in the Beaufort Sea and their presence in the project areas is highly unlikely.

Life History
During the summer in the Beaufort Sea, bearded seals, the largest of the northern seals, are most associated with the pack ice edge near the continental shelf. Bearded seals weigh up to 750 lbs (341 kg) and feed on benthic invertebrates including crabs, shrimp, clams, and snails (Burns 1994c). Adults average in length around 7.9 ft (2.4 m) (Burns 1994c). These seals have four mammary teats, unlike most seals, which have only two.

Female bearded seals give birth to a single pup during late April or early May. Pups weigh an average of 75 lbs (34 kg) at birth (Burns 1994c). Mating will typically occur again within two weeks after weaning of the pup (Burns 1994c). These seals exhibit delayed implantation, which means development is put on hold for about 2.5 months (Burns 1994c).

Abundance
A reliable abundance estimate for the Alaska stock of bearded seals is not available because of the difficulty associated with counting species that spend much of their time underwater and are often located far offshore. This was reaffirmed for the Beaufort Sea in Allen and Angliss (2010). One of the most recent surveys occurred in May and June of 1999 and 2000 between Shisamaref and Barrow with average seal densities of .03-.05/sq mi (0.07-0.14/sq km), respectively. However, there is no correction factor available for these data. Early estimates of the Bering - Chukchi Sea population ranged from 250,000-300,000 (Burns 1981). Aerial surveys conducted by MMS in September and October of 2000 and 2001 sighted a total of 46 bearded seals (Treacy 2002b), with all but two sightings recorded east of 147 degrees West, and all sightings were within 46 mi (74 km) of shore. WesternGeco conducted marine mammal monitoring during its open-water seismic program in the Alaskan Beaufort Sea from 1996 to 2001. Operations were conducted in nearshore waters, and of a total 454 seals that were identified to species while no airguns were operating, 4.4% were bearded seals, 94.1% were ringed seals and 1.5% were spotted seals (Moulton and Lawson 2002). Savarese et al. (2010) reported bearded seal densities in the Beaufort Sea ranging from 0.0001-0.0572 seals/km², during vessel-based surveys in 2006-2008. A total of 164 bearded seals were recorded during Shell MMO surveys in 2006 through 2008.

Pacific Walrus
The Pacific walrus can be found throughout the continental shelf waters of the Bering and Chukchi Seas, occasionally moving into the East Siberian and Beaufort Seas (Figure 3.8.2-3). Walrus are often found moving with the pack ice year-round. In winter they are found in the Bering Sea, and in summer they are found throughout the Chukchi Sea (Angliss and Outlaw 2005). However, their range varies with the extent of sea ice (Angliss and Outlaw 2005). Few walrus may move as far east as the Canadian Beaufort Sea during the drilling season (MMS 2003). The majority is found west of Barrow along the pack-ice front (MMS 2003). Spring migration usually begins in April, with most walrus moving north through the Bering Strait by late June. Most early spring migrants are comprised of females with calves. Walrus begin to migrate south with the advance of pack ice during fall south of the Bering Strait.

Pacific walrus prefer water less than 656 ft (200 m) deep, because they are benthic feeders and must often dive to great depths obtain their food (Fay and Burns 1988). In a study by Jay and Hills (2005) in Bristol Bay, 98 percent of the satellite locations of tagged walrus were in water depths of less than or equal to 197 ft (60 m). The primary food source for walrus is bivalve mollusks, but they are opportunistic feeders in that they will also feed on other benthic organisms.
Figure 3.8.2-3  Walrus Sightings 1979 through 2010
**Life History**

Reproductive rates for walrus are low with one calf being born every two or more years, because it normally takes two years to wean a calf (Fay 1982). Breeding occurs between January and March, but implantation is delayed until June or July. Gestation lasts 11 months (Fay 1982). During migration, walrus exhibit gender segregation (Fay 1982); females, subadults, and calves go to the Chukchi Sea, and males go to Bristol Bay and the Gulf of Anadyr (Jay and Hills 2005).

The combination of shallow water and broken ice is an important habitat for walrus, because their young often cannot dive for extended periods and need accessible haulout platforms, usually ice, for resting and limiting time spent in cold water. Ice also provides a moving platform that increases the likelihood of fresh sources of food with each foraging trip. Near land haulouts, food is exhausted quickly and results in high competition for the resources. When stress is high because of the lack of food resources, walrus are more prone to death by stampedes. Ice is also important for giving birth (Angliss and Outlaw 2005). Walrus are gregarious; they spend about a third of their time hauled out in groups exhibiting very close bodily contact.

**Abundance**

The size of the Pacific walrus population is not accurately known because of the difficulty associated with counting species that spend much of their time underwater. Human exploitation may have reduced the population to an estimated 50,000-100,000 animals in the mid-1950s (Fay et al. 1997). A reduction of hunting pressure in the 1960s-1970s is believed to have allowed the population to increase rapidly (Fay et al. 1989). Surveys by the United States and Russia between 1975 and 1990 produced estimates from 201,039-234,020 animals (Angliss and Outlaw 2005). However, these estimates are considered conservative and have large confidence intervals (Gilbert et al. 1992 in Angliss and Outlaw 2005). Current information reports that the population is likely declining (Kochnev 2004). Harvest mortality is about 5,458 (USFWS 2005).

Pacific walrus are uncommon in the Beaufort Sea. Shell MMOs observed two adult walrus in the Beaufort Sea during aerial surveys in 2008. Table 3.8.2-1 shows the number of individual pacific walrus seen during vessel and aerial surveys between 2006 and 2010.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Sightings During Vessel Surveys</th>
<th>Number of Sightings During Aerial Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
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<td>5</td>
</tr>
<tr>
<td>2007</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>2008</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
<td>0*</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

(Source: Funk et al. 2010)

*Shell did not have an aerial survey program in 2009

**3.8.3 Polar Bear**

The polar bear was listed by the USFWS as a threatened species under the ESA in 2008. Based on the best available science, USFWS has determined that the continued loss of sea ice in the Alaskan Arctic region threatens polar bear habitat (DOI 2008). Polar bear are protected under a number of regulations and constraints to protect their population. Requirements under the MMPA of 1972 prohibit the taking or importation of marine mammals, such as polar bear, and their parts or products. They are also protected by international treaties. In 2006, Congress passed the United States-Russia Polar Bear Conservation and
Management Act of 2006. This management act implements a treaty with Russia designed to conserve polar bear populations using habitat combined between the two countries. On October 29, 2009, a federal register notice (74 Federal Register [FR] 56058) was published outlining proposed critical habitat for the polar bear under the ESA. The USFWS published a final critical habitat designation December 7, 2010, which became effective January 6, 2011.

**Distribution**

Polar bear distribution changes dramatically with seasonal sea ice conditions in order to maximize food availability. In winter, polar bear prefer ice lead systems where the shear zone occurs between the shorefast ice and the active offshore ice. These openings are often used by ringed seals, their primary prey, to reach the surface. Polynyas are an important habitat for polar bear as these upwellings provide long-term access to the water surface for seals (Lentfer and Lowry 1994; Stirling 1997).

As ice forms and spreads from the polar pack ice in the fall, polar bear move with it and start to appear along the coast in October. Polar bear are typically on land only during the winter denning season (Lentfer 1972). During past summers, few polar bear were found on land; most were found along the edge of the permanent pack ice (Frame 1972; Moore and Quimby 1975; Eley and Lowry 1978). In recent years there have been more polar bear sightings and bear/human interactions as pack ice has receded further north due to climate change.

Polar bear locations throughout the Beaufort Sea pack ice have been recorded from aerial surveys (Figure 3.8.3-1). Polar bear were observed on several barrier islands during fall whale surveys in 2000, including an island east of Oliktok Point (Treacy 2002a). Observers identified tracks on ice offshore of the Colville River Delta during 2001 whale surveys (Treacy 2002b). A joint monitoring program in support of seismic exploration activities recorded polar bear observations in the late summer and early fall from 2006, 2007, 2008, and 20010, and no surveys were conducted during 2009 Aerial and sea-based survey transects in and adjacent to the project area observed a total of five polar bear in 2006; 63 in 2007; 91 in 2008, 27 in 2010 (Harrison Bay), no surveys were conducted during 2009 (Funk et al. 2010).

**Life History**

Polar bear are the apex predator of the Arctic marine ecosystem. They are specialized in preying on seals, mainly ringed seals. Ringed seal populations have been found to be tied to the birth rate of polar bear and the survival of subadults (Stirling 2002). When populations of ringed seal decline, polar bear reproduction and subadult survival also decline.

Polar bear have delayed maturation, small litter sizes, and high adult survival rates. Thus, they are K-selected species with a low population growth rate. A female may produce eight to ten cubs in her lifetime, and only half will likely survive (Amstrup 2003). This means that polar bear populations will take time to recover from adverse effects that reduce numbers.

Pregnant females enter dens in October or November to give birth in December or January and emerge in late March or April (Lentfer and Hensel 1980; Amstrup and Gardner 1994). Females that are not pregnant and males do not hibernate in winter but continue to hunt on sea ice and along coastlines, particularly in zones of shear ice and active leads used by seals (USFWS 2003a, 2003b; Durner et al. 2004). Each year, females tend to return to the same general area to den (Amstrup and Gardner 1994). Historical polar bear den locations have been recorded and potential denning sites have been determined through polar bear den characteristics (Figure 3.8.3-2).
Recent studies have predicted polar bear declines. Models of anticipated sea ice reductions were developed to help understand the consequences of sea ice losses on polar bear populations (Durner et al. 2007). Simulated and projected rates of habitat loss during the late-20th Century and into the future tend to be less than observed rates of loss during the past two decades (Durner et al. 2007).

Exact relationships between habitat losses and population demographics remain unknown as less available habitat will likely reduce polar bear populations (Durner et al. 2007). Warming of the climate and associated declines in Arctic sea ice have raised concerns about the conservation of polar bear. A study on polar bear in the southern Beaufort Sea has predicted a high probability of serious declines unless there are fewer years of low ice than current models suggest (Hunter et al. 2007).

On a wide-range scale, a prototype model based on population trends, health, and changing ice conditions has forecasted polar bear numbers to decline through the 21st Century (Amstrup et al. 2007). Capture-recapture models suggest that yearly survival rates depend on the duration of the ice-free period (Regehr et al. 2007). Capture-recapture studies between 1982 and 2006 have shown that individual stature and body mass were positively related to the percent of days in which sea ice covered the continental shelf (Rode et al. 2007).

Abundance

Polar bear have a circumpolar range in the Northern Hemisphere with a worldwide population estimated to be 21,500 to 25,000 (Lunn et al. 2002). The polar bear stocks in Alaska are divided between the Chukchi Sea and the Bering Sea stock and the southern Beaufort Sea stock, though there is considerable overlap between the two stocks between Point Hope and Point Barrow (Amstrup 1995).

Polar bear are year-round residents of the central Beaufort region and Camden Bay with an estimated 2,200 bear present in the southern population in 2002 (Lentfer and Lowry 1994; USFWS 2003a, 2003b). However, the distribution of polar bear and their local abundance vary widely dependent on adequate pack ice (which changes seasonally) and availability of food. Much lower densities occur 100 mi or more offshore and polar bear are found in higher densities near ice leads, where seals concentrate during the winter. Estimated polar bear densities from Point Barrow to Cape Bathurst are one bear every 54-103 mi² (141-269 km²) (Amstrup et al. 1986).

These data suggest that polar bear of the southern Beaufort have experienced a declining trend in nutritional status, which may be associated with changing sea-ice conditions (Rode et al. 2007). Nutritional status may also be associated with the increased distances polar bear are traveling to denning areas. Polar bear females returning to Alaska to den have experienced an annual increase in travel, likely due to a reduction in summer sea-ice extent throughout the Arctic (Bergen et al. 2007). Increased travel will likely increase energetic demands on the polar bear.
Figure 3.8.3-1  Polar Bear Sightings 1979 through 2010
Figure 3.8.3-2   Historic Polar Bear Denning Locations
3.8.4 Waterfowl

Steller’s Eider

The Alaska breeding population of Steller’s eider was listed as threatened under the ESA in 1997.

Distribution

Few Steller’s eiders are expected to be within the project area during the drilling period because they are few in number on the eastern North Slope and Alaskan Beaufort. During offshore aerial surveys by the USFWS in July 2001, three individual Steller’s eiders were observed near Cape Simpson in Smith Bay during transects flown in late July (Fischer 2001). No critical habitat areas have been designated for Steller’s eiders in the Beaufort Sea.

Historically, Steller’s eiders nest throughout the coastal areas of western and northern Alaska (USFWS 2005). The Arctic Alaska breeding population is primarily confined to the Arctic Coastal Plain of Alaska’s North Slope, with a concentration around Barrow (USFWS 2005). Low numbers nest on the Yukon-Kuskokwim Delta (USFWS 2005). The Steller’s eider may have abandoned much of the eastern North Slope nesting and breeding habitat in recent decades, but still occur in low densities from Wainwright as far east as Prudhoe Bay (USFWS 2003a), where a few individuals have been observed (Anderson et al. 2004).

Life History

The smallest of the four eider species, Steller’s eiders breed only once every few years (USFWS 2005). Steller’s eiders nest near tundra ponds or in drained lake basins but occupy marine waters during the remainder of the year (USFWS 2005). After nesting, they move into the nearshore marine waters of southwest and southcentral Alaska and mix with the Russian Pacific population. They molt in autumn in lagoons along the north side of the Alaska Peninsula (USFWS 2005). Some birds winter near the molting areas, while others winter off the south side of the Alaska Peninsula, eastern Aleutian Islands, Kodiak Archipelago, and southern Cook Inlet (USFWS 2005). In spring, Steller’s eiders concentrate in the Kuskokwim River and Bristol Bay areas and wait for the ice to recede before migrating to nesting areas (USFWS 2005).

Abundance

Aerial surveys have documented the relative densities of Steller’s eiders throughout the coastal areas of the North Slope (Figure 3.8.4-1). The Alaska-breeding population is thought to number in the hundreds or low thousands on the Arctic Coastal Plain and in the dozens on the Yukon-Kuskokwim Delta (USFWS 2005). Although not precisely known, the Russian Atlantic population is thought to be 30,000-50,000 individuals, and the Russian Pacific population 50,000-100,000 (USFWS 2005).

Spectacled Eider

The spectacled eider was listed as threatened under the ESA throughout its range in 1993.

Distribution

Relatively few spectacled eiders are expected to be found within the project area during the drilling season. The overlap of areas used by spectacled eider and the project area is minimal. Onshore densities are relatively low along the eastern Alaskan Beaufort coast (Figure 3.8.4-2). Higher offshore concentrations are likely to the west of the project area. Molting flocks of spectacled eiders gather off the coast in shallow waters less than 120 ft (36 m) deep and travel along the coast up to 31 mi (50 km) offshore (USFWS 2005). The only critical habitat designated for spectacled eiders in the Arctic is in Ledyard Bay along the Chukchi coast, where molting eiders gather.
Figure 3.8.4-1  Steller’s Eider Densities
Figure 3.8.4-2 Spectacled Eider Densities
The breeding distribution area of the spectacled eider includes the central coast of the Yukon-Kuskokwim Delta, the Arctic Coastal Plain of Alaska, and the Arctic Coastal Plain of Russia (USFWS 2005). Historically, spectacled eiders nest along much of the Alaskan coast from the Nushagak Peninsula north to Barrow and east near the Canadian border (USFWS 1996, 2005).

In the spring, when eiders are migrating to the North Slope, few have been observed in marine areas along the Beaufort Sea coast that may suggest that many migrate to the nesting areas onshore near the Chukchi Sea (Troy Ecological Research Associates 1999 in MMS 2003).

Female spectacled eiders that have failed nests as well males and non-nesting females use Beaufort Sea waters for molting from late June through August (MMS 2003). Satellite telemetry data has indicated use of the Beaufort coastal waters by both females and males for molting and feeding (MMS 2003 citing USGS data). It is likely that spectacled eiders may be found in occasional groups offshore near the project area for roughly two months (July and August).

Aerial surveys in the central Beaufort conducted by the USFWS in July 2000 located five flocks that made up 144 individual spectacled eiders in offshore waters off the Colville Delta (Fischer and Larned 2004). These flocks were found in waters that were more than 66 ft (20 m) deep. Given that all spectacled eiders seen were found off the Colville River Delta and not in other areas of the surveys may indicate that this area is important for staging (Fischer and Larned 2004).

**Life History**

Spectacled eiders spend most of their lives in marine waters feeding on mollusks and crustaceans. In the spring, breeding pairs move to areas on wet coastal tundra where they establish nests near shallow ponds and lakes. During nesting time, they add insects and vegetation to their diet of crustaceans (USFWS 2005). The male leaves for offshore molting areas soon after eggs are laid, usually by the end of June (USFWS 2005). Females with failed nests leave to molt at sea by mid-August (USFWS 2005). Successful females stay with their young on the nesting grounds until late August to early September, the time they start their southward migration.

**Abundance**

The spectacled eider population is estimated to be about 360,000 worldwide, which includes non-breeders (USFWS 2005). Between the 1970s and 1990s, the Yukon-Kuskokwim breeding population declined by over 96 percent (USFWS 2005) and by 2007 an estimated 4,399 pairs nested on the Yukon-Kuskokwim Delta (Fischer et al. 2007). Because of the lack of historical data, scientists are uncertain if spectacled eiders ever declined in northern Alaska and Russia (USFWS 2005). Aerial survey results indicated that populations of spectacled eiders on the Arctic Coastal Plain were relatively stable from 1992 through 2005 (Larned et al. 2005). However, the population could be in slow decline on the Arctic Coastal Plain, where 3,000-4,000 nest today (USFWS 2005). At least 40,000 pairs are thought to nest in Arctic Russia.

**Yellow-Billed Loon**

In March 2009, the USFWS determined that listing the yellow-billed loon as a threatened or endangered species is warranted under the ESA, but the listing is precluded by other higher priority species. The yellow-billed loon is now designated as a candidate species. A “warranted but precluded” finding requires subsequent annual reviews of the finding until such time as either a listing proposal is published, or a “not warranted” finding is made based on new information.
Distribution

Yellow-billed loons nest across northern Russia from Novaya Zemlya east to Alaska, and across Alaska and Canada as far east as Hudson Bay (Earnst 2004). Within the U.S., this species breeds almost entirely within the NPR-A (Earnst 2004). Yellow-billed loon nesting densities vary across the Arctic Coastal Plain and are indicated in Figure 3.8.4-3.

Yellow-billed loons prefer large, deep, tundra lakes where they nest on low islands or near the lake edges to avoid terrestrial predators (Johnson and Herter 1989). They winter in ice-free marine waters primarily from southern Alaska through British Columbia and off the coast of Norway, the Kamchatka Peninsula, Japan, North Korea, and China (Earnst 2004). Recent telemetry studies indicate that most yellow-billed loons from the North Slope winter off North Korea, Japan, and China (Schmutz 2009).

Aerial bird surveys for bird use of offshore and coastal waters in the Beaufort were conducted by Fischer and Larned (2004) up to 62 mi (100 km) offshore. The areas surveyed in June, July, and August 1999 and 2000 were between Cape Halkett and Brownlow Point and between Point Barrow and Demarcation Point in July 2001. These areas make up most of the Alaskan Beaufort Sea. Fischer and Larned (2004) found 34 yellow-billed loons, which made up 0.12 percent of the total birds seen. Most were seen in July within the shallow-water stratum of 32 ft (10 m) in Harrison Bay. Out of 34 yellow-billed loons observed, only three were detected beyond 32 ft (10 m) depth.

Life History

With low numbers and a patchy distribution, narrow habitat requirements may make the yellow-billed loon more susceptible to the effects of disturbance or habitat alteration than abundant species that have greater distributions and use a wide variety of habitat (Hunter 1996). Yellow-billed loons are probably K-selected species (long-lived and dependent on high adult survival rates to maintain populations). On the North Slope, nesting begins as early as mid-June and the normal clutch size is two eggs (Johnson and Herter 1989). This species reaches sexual maturity at three years, but may not acquire breeding territories until at least four years (North 1994).

During the breeding season, foraging habitats include lakes, rivers, and the nearshore marine environment (Earnst 2004). Young are fed entirely from the brood-rearing water body (Earnst 2004).

Yellow-billed loon migration routes are thought to be primarily in marine areas. They begin to arrive along the Beaufort Sea coast in early May and leave at the end of August through mid-September (Johnson and Herter 1989).

Sources of adult mortality include, subsistence harvest, by catch in commercial and subsistence fisheries, die-offs during spring migration in years when open-water leads are not available, and disease; but, the relative importance of these sources cannot be estimated with existing data (Earnst 2004). Predation on nests and young are common, but thought to be rare on adults (Earnst 2004).

Abundance

Yellow-billed loon densities vary across the Arctic Coastal Plain (Figure 3.8.4-3). Approximately 3,369 individuals use the breeding grounds on the North Slope, with most occurring within the NPR-A (Earnst et al. 2005). However, there are likely less than 2,000 nesting individuals on the North Slope since not all yellow-billed loons found on the breeding grounds attempt to nest. In addition, approximately 1,500 individuals, most likely adult non-breeders and juveniles, remain at sea. In total, there are an estimated 4,892 yellow-billed loons on the North Slope breeding grounds and at sea (Earnst et al. 2005).
Figure 3.8.4-3  Yellow-Billed Loon Densities
3.9 Sensitive Biological Resources

There are no areas in the immediate vicinity of the Camden Bay exploration drilling locations that are considered sensitive biological areas or habitats. This section discusses areas in or near the Beaufort Sea, generally that are considered sensitive areas or habitats. The Stefansson Sound boulder patch, which is approximately 100 mi (161 km) from the project area, is considered an isolated highly-productive benthic community surrounded by less productive seafloor sediment types. This area is used extensively by invertebrates and fish, and, in turn, it can be an important feeding area for marine mammals. ANWR is 25 mi (40 km) from the project area as land-based sensitive area and is not expected to be impacted by exploration drilling activities located 16-23 mi (26-37 km) offshore in the Beaufort Sea. Teshekpuk Lake Special Use Area, over 150 mi (241 km) to the west of the exploration drilling activities, and the Canadian Ivvavik National Park, over 125 mi (201 km) to the east, are not addressed as a sensitive biological resource due to their large distance from the exploration drilling activities.

3.9.1 Boulder Patch

The “boulder patch” is an area in Stefansson Sound with patches of scattered rocks on the sea bottom ranging in size from pebbles to boulders. This significant and unique biological community is located approximately 100 mi (161 km) southwest of the proposed drilling location near the Sagavanirktok River Delta (BPXA 1996). The cobbles and boulders were discovered in the early 1970s by the USGS and provide the substrate that supports a highly diverse and productive biota, including Arctic kelp and sessile invertebrates (Reimnitz and Ross 1979; Dunton et al. 1982). Because of its rarity in a region known for soft sediments, the boulder patch was intensively studied as part of the NOAA/OCS EA Program (Sekerak 1982) in the late 1970s and early 1980s. To date, no confirmed “boulder patch” habitat has been identified at the proposed drilling locations.

3.9.2 Fish Habitat

The nearshore waters of the Camden Bay areas of the Beaufort Sea include several rivers and adjacent bays, one main lagoon, several barrier islands, and deltaic mudflats which offer feeding and overwintering habitat for several fish species of the region (Brown et al. 2005). The Meade, Colville, Sagavanirktok, Canning, and Kongakut Rivers support various types of overwintering habitat for anadromous and amphidromous fish. These rivers run into Harrison Bay, Gwydyr Bay, Prudhoe Bay, Foggy Island Bay, Mikkelsen Bay, and Camden Bay. Both Simpson lagoon and the barrier islands around Stefansson Sound are also important fish habitats. The freshwater-marine mixing zone provides a staging area for anadromous fish prior to spawning.

Both the Colville and Sagavanirktok River deltas provide an expanse of essential habitat necessary to sustain anadromous and amphidromous fish and sometimes marine fish species. The Colville River delta is an area of 230 mi² (600 km²) and compared to other Arctic deltas, it is small. The salinity ranges from 15,000-22,000 ppm from November to May (Schmidt et al. 1989). The depth of the delta is 49 ft (15 m). It freezes only for a short period during winter (Brown et al. 2005).

3.9.3 Refuges, Preserves, and Sanctuaries

The only refuge, preserve, or sanctuary in the vicinity of the proposed exploration drilling area is ANWR. The project area is located approximately 25 mi (41 km) offshore and northwest of ANWR.

3.10 Archaeological Resources

This section addresses the cultural resources potentially affected by the proposed exploration project. Information regarding cultural resources, both archaeological and historical, within the project area is
limited. Systematic cultural resource surveys have not been conducted for much of Alaska’s coast and offshore areas, including the project area. However, geohazard assessments of the Sivulliq and Torpedo prospects provide site specific information necessary for this analysis.

Shell conducted geohazard assessments of the Sivulliq and Torpedo prospects in 2008 (Fugro 2009a, 2009b). Fugro’s review of side scan sonar and other shallow hazards data detected no shipwrecks or other potential archaeological sites. Additionally, their analysts identified numerous episodes of ice gouging in both prospect areas. Ice gouging has the potential to damage, destroy or bury cultural resources at or just below the seafloor. Fugro concluded that the probability of the presence of historical and/or prehistoric cultural resources is low. Additional and expanded information regarding geohazards assessment is found in Section 3 of the revised Camden Bay EP.

Shell has reviewed the following sources to identify the previously known cultural resources potentially impacted by the proposed exploration drilling activities:

- The National Register of Historic Places (National Register) (NPS 2008a, 2008d)
- National Historic Landmarks (NHL) database (NPS 2008b, 2008c)
- The BOEMRE Shipwreck Database (MMS 2008b)
- Published and unpublished cultural resource documents relevant to the project

### 3.10.1 Archaeological Sites

Archaeological sites are those locations that exhibit evidence of past human activity. In the National Historic Preservation Act (NHPA), both archaeological and historic sites are designated historic properties, meaning "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places" (36 CFR 800.16(l)(1)). Prehistoric archaeology, as it is practiced in the United States, is the study of Native American people prior to contact with Europeans. Historical archaeology is defined by the Society for Historical Archaeology (SHA) (2007) as the study of material remains of past societies that also left behind historical documentary evidence. Historical archaeology focuses on the more recent past, after contact with Europeans.

### 3.10.2 Historical Sites

Historical sites include buildings, structures, and objects of past human activity. They may include complexes of historic buildings and other features. Strict distinction between archaeological sites and historic sites and properties does not always exist.

Historical sites that may be within the project area include shipwrecks, submerged aircraft, and other submerged and abandoned items.

### 3.10.3 Traditional Cultural Properties Potentially Impacted

A traditional cultural property (TCP) is a place (often an ethnographic landscape) that is eligible for inclusion in the National Register of Historic Places because of the:

- Association with cultural practices or beliefs of a living community that are rooted in that community’s history
- Importance in maintaining the continuing cultural identity of the community (Parker and King 1998)
Traditional refers to beliefs, customs, and practices of a living community passed down through generations.

Similarities exist between TCPs and historic and archaeological properties. In fact, historic and archaeological properties can be all or part of a TCP. The key difference is TCPs exhibit a continuing role and importance to people today.

An example of a TCP may be a location or area in which people have traditionally conducted and continue to conduct economic, artistic, or other cultural activities that are important in maintaining their traditional identity. Subsistence activity areas, such as those used by Iñupiat for traditional bowhead whaling, are potentially eligible as TCPs in the National Register of Historic Places, and the Traditional Land Use Inventory (TLUI) sites of the North Slope Borough (NSB).

To date, no TCPs have been identified in the project area.

### 3.10.4 Offshore Cultural Resources Potentially Impacted

Offshore historic cultural resources of concern would include any human-made items 50 years of age or older. Historic cultural resources include shipwrecks, submerged aircraft, and abandoned items of importance. Prehistoric cultural resources include archaeological sites on relic sub-aerially exposed landforms.

While Shell’s Torpedo and Sivulliq lease blocks are outside of those areas identified by BOEMRE that require an archaeological assessment and report (Figure 3.10-1), the shallow hazards surveys areas were evaluated for prehistoric and historic cultural resources at the proposed drill sites (Geo LLC 2006, 2008a, and 2008b; Fugro 2009a, 2009b). A review of the side scan sonar and other shallow hazards survey data detected no shipwrecks. Additionally, Geo LLC and Fugro identified numerous episodes of ice gouging in both prospect areas. Ice gouging has the potential to damage, destroy or bury cultural resources at or just below the seafloor. They both concluded that the probability of the presence of historical and/or prehistoric cultural resources are present in the project area is low.

While the probability is low, there is some potential that cultural resources exist at the Sivulliq and Torpedo sites. Therefore, the potential cultural resources are addressed below.

**Prehistoric Landscape**

The earliest undisputed date for human occupation in Alaska is 12,360 years before present (YBP) (Bever 2006). Present is equivalent to A.D. 1950. These date estimates are based on radiocarbon dating techniques in which 1950 is a “start” date. The BOEMRE noted that research indicates the Beaufort Sea and Chukchi Sea shorelines were at 200 ft (60 m) below their current level (MMS 2003, 2007). Thus, based on sea-level history alone, any area 200 ft (60 m) or shallower would have been exposed during the time of human occupation and has the potential for archaeological resources.
Figure 3.10-1  Historic and Prehistoric Site Potential
Submerged relic landforms having a high probability for prehistoric archaeological sites include preserved levees associated with paleo-river channels, river confluences, ponds, lakes, lagoons, or paleo-shorelines. Prehistoric sites are not expected in some areas where the continental shelf is less than 197 ft (60 m) below current sea level. These are areas where: “(1) there are no Quaternary sediments, and (2) where extensive ice gouging has reworked the Quaternary section, but these are not well defined and will have to be determined on a case-by-case basis” (MMS 2003).

In EIS evaluations predating the Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 (MMS 2003), BOEMRE concluded that there was low potential for archaeological resources in this planning area. However, data collected during remote-sensing activities associated with the Beaufort Sea prospects Liberty, Warthog, and McCovey indicate that there is little evidence of ice gouging in these areas and that there are well-preserved landforms just below the seafloor. The existence of these landforms suggests that archaeological resources may also be preserved (MMS 2008a).

Based on their review of data from Liberty, Warthog, and McCovey (MMS 2008a), BOEMRE re-evaluated its conclusion on archaeological potential in the Beaufort Sea. BOEMRE determined areas of little or no ice gouging have the potential for undisturbed prehistoric archaeological sites. The areas corresponding to no or limited ice gouging are areas of stable, shorefast floating ice that are shoreward of the stamukhi zone, and areas shoreward of the barrier islands (MMS 2003, 2008a).

BOEMRE identified specific blocks in the Beaufort that have a higher potential of containing prehistoric cultural resources (MMS 2003, 2008a). Shell’s proposed Sivulliq and Torpedo drill sites fall outside the blocks designated as having high potential for prehistoric cultural resources.

Shallow hazards surveys conducted for Shell show evidence of several ice gouging events within the Sivulliq and Torpedo prospects (Fugro 2009a, 2009b). Therefore the potential of preserved prehistoric archaeological resources is low.

**Shipwrecks**

Shipwrecks are a special type of cultural resources. Treatment, management, and ownership vary depending on whether the shipwreck was abandoned or not and in what waters the wreck is located (See the Abandoned Shipwreck Act [Public Law 100-298; 43 U.S.C. 2101-2106] and NPS 2008d). Abandoned shipwrecks are included under many other laws governing cultural resources and historic properties as well.

The BOEMRE Shipwreck Database (MMS 2008b) is the most comprehensive dataset of shipwrecks in Alaska waters. This database contains 21 shipwrecks in the Beaufort Sea Planning Area. Most of these foundered, wrecked, or sunk outside of the Sivulliq and Torpedo project areas.

While locations are noted for these wrecks, many of the locations are generalized because they are based on historical accounts. Few exact locations of shipwrecks have been located in recent years. Ice keels could easily have moved the shipwrecks off these sites. Based on the generalized locations of reported wrecks, the BOEMRE created “Archaeology Blocks – Historic” (MMS 2003, 2008a).

The probability of a shipwreck being in the Sivulliq or Torpedo prospects is low. However, of the 21 shipwrecks in the BOEMRE database, remains of two may be in or near the project area. These are the *Duchess of Bedford* and the *Baychimo*.
The Duchess of Bedford and the Anglo-American Polar Expedition

Of the shipwrecks in the BOEMRE database, the Duchess of Bedford (Duchess) is the only one lost in or near the area in which Shell intends to conduct exploration drilling. Remains of this vessel are not likely to exist in the project area.

It was in this vessel that geologist Ernest K. Leffingwell and Ejnar Mikkelsen commanded an expedition entitled the Anglo-American Polar Expedition in 1906. In the beginning of September of that year, the Duchess was trapped in pack ice near Flaxman Island. The expedition wintered on the island, investigating interesting areas of ice in the vicinity and conducting onshore research.

In the spring or summer of 1907, the expedition determined the Duchess was not seaworthy. They dismantled the vessel and used its material to build a small house on the island. With their quest unsuccessful and their ship destroyed, they abandoned the expedition. Most of the expedition’s members left, but Leffingwell stayed to make scientific observations of the Arctic coast of Alaska. Between 1906 and 1914 he spent nine summers and six winters on the Arctic coast. He provided the first detailed mapping effort of the Beaufort Sea coast (Morton 1987). Leffingwell’s contributions to Arctic science are recognized and considered historically significant. Because the Duchess was salvaged in 1907, little potential exists for remains of the ship on the seafloor (MMS 2003).

Baychimo

The Baychimo, also known as the Arctic Ghost Ship, was a 1,322-ton cargo steamer owned by the Hudson Bay Company and used in the fur trade. The location of the Baychimo is unknown. Its remains may be in the Alaskan Beaufort, Canadian Beaufort, or the Chukchi Sea due to the unique history of the vessel after it became trapped by the ice pack. There is a low probability that its remains could have come to rest within the project area.

On October 1, 1931, the Baychimo was caught in the ice near Barrow (Gunston 1991; MMS 2008b). The crew weathered two days in Barrow, then the ice broke free allowing the crew and ship to continue on their voyage west. They traveled for three hours before being caught in the ice again. Freed once more on October 8, the ship headed shoreward. On October 15, the Hudson Bay Company evacuated 21 crew members via two aircraft. Fifteen members remained to wait until the Baychimo broke free from the ice (Gunston 1991).

On November 24, a blizzard buried the ship in 67 ft (20 m) of ice. Thinking the ship had been crushed to pieces, the crew abandoned her (Gunston 1991; MMS 2008b). A few days later, an Inupiaq seal hunter noted the ship 43.5 mi (70 km) southwest of the location it was presumed lost. The following months brought reports of the ship hundreds of kilometers further east. One year later, in March 1933, the Baychimo was seen in the approximate location where she was abandoned.

Over the following three decades the Baychimo was seen from Herschel Island, Canada to somewhere between Icy Cape and Point Barrow, Alaska. Each time that people were able to board her they had no means of capturing her. She was last seen in 1969 somewhere between Icy Cape and Point Barrow (Gunston 1991; MMS 2008b).

No one knows what became of the Baychimo. The ship has not been seen in almost four decades and is presumed sunk. In 2006, the State of Alaska began a project to look for the vessel. The fate of the ship remains a mystery.
Other Submerged Resources Potentially Impacted

Other submerged historic resources include downed aircraft and other abandoned items. Much of Alaska’s offshore area has not been systematically surveyed for the presence of these resources.

Sigismund Levanevsky

August 12, 1937, Sigismund Levanevsky, also known as Russia’s Lindbergh, and five fellow Russians set out from Moscow to fly across the North Pole to Fairbanks. The aircraft and Russians never made their destination (Rozell 1999, 2000; Time 1937a, 1937b; Wilkins 1938; and Yeletskevsky 2008). On August 13, the party experienced inclement weather, radio contact was disrupted, and the aircraft and aviators were lost.

Remains of Sigismund Levanevsky’s aircraft or another aircraft may reside in Camden Bay. In 1999, side scan sonar results from a shallow hazards survey depicted an image interpreted as a possible airplane fuselage. Subsequent data recovery attempts to determine the identity of the image have been unsuccessful.

Various theories exist as to where the four-engine Russian bomber and its passengers ended up. One theory states Leavanevsky landed in the Canadian Archipelago on August 14, where the crew remained until at least September 30; after which, Levanevsky and crew took off and subsequently crashed in McClintok Inlet (Yeletskevsky 2008). Others believe Levanevsky was lost somewhere in Alaskan waters (Wilkins 1938; Vojir 2000).

Another theory proclaims that due to navigational error from an asymmetric pull of the engines while flying over the Pole, Levanevsky made an 80 degree turn and was headed toward Siberia. This theory states the plane crashed in a lake called Seben-Kjuel and several crew members made it to shore. Skeletal remains have been found and said to be those of crew members (Vojir 2000).

Still another theory claims after a forced landing on an ice floe, the survivors were rescued by a German submarine (Vojir 2000).

In 1999, side scan sonar results from a shallow hazards survey in Camden Bay showed a 60 ft (18.3 m) cigar shaped image resembling an airplane fuselage (Rozell 1999, 2000). In 2000, Dennis Thurston with the BOEMRE, David Stone and Kevin Abnett with the Geophysical Institute, and pilot Ron Sheardown investigated the area in which the image was seen. Using a remotely controlled submarine with a camera, the researchers found sea life and a pile of rocks. They determined that the sonar may have picked up a rock ridge or their camera may have been near, not near enough to the wreckage. Abnett was quoted as saying, “We could have been about 200 feet away from the plane and not seen it” (Rozell 2000).

3.10.5 Onshore Cultural Resources Potentially Impacted

Onshore cultural resources do not fall within the projects area of potential effect (APE) due to the nature and location of Shell’s Camden Bay exploration drilling program. It is located offshore, and any onshore support activities will take place in established facilities.

Because the APE does not include onshore areas, Shell determined it unnecessary to conduct exhaustive inventory of onshore resources at this point – prior to the initiation of NEPA and Section 106. Suffice it to say, cultural resources tend to be located where historic and prehistoric people had access to necessary resources, such as fresh water and subsistence resources. Some of these locations include coast shoreline, river banks, and lake shores.
3.11 Socioeconomic Resources

The socioeconomic resources of the North Slope and related communities that could be affected by the proposed exploration activities or could impact the exploration program are identified and reviewed in the following section. These resources include:

- Community profiles
- Population and employment demographics
- Health issues affecting residents
- NSB economy and employment
- Existing offshore and coastal infrastructure
- Land use
- Subsistence resources
- Recreation and commercial fishing
- Minority and lower income groups
- Coastal and marine management and uses

3.11.1 Community Profile

This section provides an overview of the NSB, Barrow, and other communities in relation to the proposed exploration drilling area and that could potentially be affected by project activities. The exploration drilling prospects are approximately 16-22 mi (26-35 km) offshore from the NSB coast. The closest population centers are Kaktovik and Nuiqsut. Kaktovik is on the coast 60 mi (96.5 km) east of the project area. Nuiqsut is 118 mi (201 km) west, and about 20 mi (32 km) inland along the Colville River (Figure 1.1-1).

The NSB area has been inhabited by the Iñupiat Eskimos for centuries. Although trading, whaling, and coal extraction have intermittently brought outsiders to the region, the discovery and subsequent development of the Prudhoe Bay oil reserve in the 1960s has greatly influenced the regional and state economy and impacted the Iñupiat way of life. Despite these changes, residents of the NSB maintain their subsistence way of life as the underlying foundation for their social, cultural, socioeconomic, and physical health.

North Slope Borough

The NSB is the largest borough in the State of Alaska and encompasses 89,000 mi² (230,509 km²) of land and 5,945 mi² (15,399 km²) of water – over 15 percent of the land area of Alaska (ADCC&ED 2007). It extends across northern Alaska from Point Hope, on the Chukchi Sea, to the Canadian border and from the Brooks Range to the Arctic Ocean (NSB 2005). The NSB is approximately 240 mi (386 km) north-to-south and approximately 660 mi (1,062 km) east-to-west. The coastline is approximately 1,988 mi (3,200 km) long. The NSB was established in 1972 (ADCA 2007).

The NSB geographic area includes three regions with different climate, drainage, and geological characteristics: the Arctic Coastal Plain, the Brooks Range Foothills, and the northern portion of the Brooks Range (ADNR 2007). Arctic Slope Regional Corporation (ASRC), one of 13 Alaska Native regional corporations, the NSB and has substantial land and mineral rights.

The Iñupiat Eskimo are the predominant inhabitants of the region with approximately 7,307 residents spread throughout eight villages. Roughly half of the population resides in Barrow, the regional center.
Other NSB villages include Kaktovik (in ANWR), Nuiqsut, Anaktuvuk Pass, Atqasuk (in the NPR-A), Wainwright, Point Lay, and Point Hope.

The NSB government is funded by oil tax revenues, provides public services to all of its communities, and is the primary employer of local residents. In addition to local employees, North Slope oil field operations provide employment to over 5,000 nonresidents. U.S. Census figures are not indicative of this transient work site population (ADCC&ED 2007).

Air travel provides the only year-round access. The Dalton Highway provides roadway access to Prudhoe Bay, although it is restricted during winter months. "Cat-trains" (Caterpillar, or similar equipment and vehicles) are sometimes used to transport freight overland from Barrow during the winter.

**Barrow** – The northernmost community in the United States, Barrow is also the largest city on the North Slope. It has a population of 4,429 (Shepro et al. 2003) and is located on the Chukchi Sea coast, 10 mi (16 km) south of Point Barrow. It is 725 air miles (1,167 air kilometers [air-km]) from Anchorage and is the economic, transportation, and administrative hub of the NSB. Ukpeagvik Iñupiat Corporation (UIC) is the resident Native village corporation and owns approximately 252 mi² (652 km²) in the area.

Barrow has a rich history. The community’s traditional name is Ukpeagvik, which means “place where snowy owls are hunted” (University of Arkansas 2007). Archaeological evidence indicates habitation of the area dates from at least 500 A.D. The Birnirk archaeological site is a large and important site dating from about 500-900 A.D. The people there were among the earliest people of Alaska’s Arctic Coast. This site was designated a National Landmark in 1962 (NPS 2007).

The name Barrow comes from Point Barrow, which was named by Captain Beechey of the Royal Navy in 1825 after Sir John Barrow of the British Admiralty (ADCA 2007; ASRC 2007; NSB 2007a; University of Arkansas 2007). In 1881, the U.S. Army established a meteorological and magnetic research station near the community (ADCA 2007; University of Arkansas 2007). Construction of the Distant Early Warning (DEW) Line station and exploration of the NPR-A in the mid 1900s brought many people into the area (ADCA 2007; ASRC 2007; NSB 2007a; University of Arkansas 2007). The City of Barrow was incorporated in 1958 (ADCA 2007).

Most, but not all, of the houses in Barrow are connected to a piped water and sewage system and heated using natural gas. The Barrow Utilities and Electric Cooperative supplies electricity, natural gas, water, and sewer services to residents. Communication infrastructure includes telephone, mail, public radio, cable television, and internet access.

**Deadhorse/Prudhoe Bay** – The U.S. Census Bureau and Alaska Division of Community Advocacy (ADCA) discuss Prudhoe Bay and Deadhorse as one population center. Prudhoe Bay is an unincorporated community and was established as an oil and gas industry service area (Service Area 10) in 1975 to provide utilities to industrial customers in the area. Prudhoe Bay is located approximately 62 mi (100 km) east of Nuiqsut, 115 mi (185 km) west of Kaktovik, and 5 mi (8 km) south of the Beaufort shoreline. According to the ADCA, Prudhoe Bay encompasses 416 mi² (1,078 km²) of land and 141 mi² (367 km²) of water.

The facilities and settlement were established in the 1970s to support the extensive oil field exploration, development, and production in the area. During this period the Trans Alaska Pipeline System was constructed to transport crude oil from Prudhoe Bay to Valdez. From there the oil is shipped by marine tankers throughout the United States. The Prudhoe Bay oil fields produce 20 percent of the domestic oil for the nation. Over 5,000 individuals are employed in these oil fields and, when on duty, stay in Prudhoe
Bay and Deadhorse. Oil field employees are not permanent residents of this community and reside in Anchorage or in the lower 48 states when not working onsite.

**Kaktovik** – Located on Barter Island, Kaktovik is on the northern coast of ANWR and has a population of 286 (Shepro et al. 2003). It is 90 mi (145 km) west of the Canadian border and 278 mi (447 km) east of Barrow. Kaktovik is the traditional home of the Kaktovikmiut Inupiat. Ruins of Old Kaktovik are evident in the area (ASRC 2007; NSB 2007b). Traditionally, Barter Island was a major meeting and trading location for the Inupiat of what is now Alaska, and the Inuit of what is now Canada, until the late nineteenth century (ADCA 2007). As a result of abundant fur resources in the area, a trading post was established in 1923 and stimulated the growth of a permanent settlement. In 1947, the U.S. Air Force began construction of an airstrip on the island. Later the U.S. Air Force constructed a Distance Early Warning (DEW) Line station in the area. As a result of military operations and construction, the settlement moved three times (NSB 2005). The Village of Kaktovik was incorporated in 1971 (ADCA 2007).

The NSB supplies electricity, water, and trash and sewage removal for the community and recently completed a water and sewage system in the city. Communication into and within the village includes mail, telephone, public radio, and cable television (ASRC 2007; NSB 2007b). The Harold Kaveolook School provides public education for pre-school through grade 12 and basic adult education. Kaktovik has one health clinic, a public safety building, and a fire station that is equipped with fire engines and an ambulance (NSB 2007b).

The village corporation, the Kaktovik Inupiat Corporation, owns approximately 144 mi² (372 km²) around the community (ASRC 2007). The corporation also runs a grocery and general merchandise store. Marine gas, diesel, propane, unleaded, and regular fuel are available for purchase in the village (ASRC 2007; NSB 2007b).

**Nuiqsut** – Located on the west bank of the Colville River, Nuiqsut is 136 mi (219 km) southeast of Barrow and has a population of 416 (Shepro et al. 2003). The village sits approximately 18 mi (29 km) south of the mouth of the Nechelik Channel. The Colville River delta was traditionally a hunting, fishing, gathering, and trading place for the Inupiat (ASRC 2007; NSB 2007c). Although occupation and use of the Colville River Delta region extends well back into prehistory, modern families relocated to Barrow or the Mackenzie River Delta region of Canada in the 1940s after the fur trade collapsed. Schooling and health care were additional incentives for this migration, something only Barrow and Canadian communities could provide at that time. Because it lacked a school, the old village of Nuiqsut (known then as Itquilippaa) was abandoned in the late 1940s.

Nuiqsut was resettled in 1973 when 27 families traveled by snow machine from Barrow to permanently settle at Nuiqsut’s present location (ADCA 2007; University of Arkansas 2007). The village was incorporated in 1975 (University of Arkansas 2007).

The NSB supplies electricity, water, and trash and sewage removal for the community. Communication into and within the village includes mail, telephone, public radio, and cable television (ASRC 2007; NSB 2007c). According to the NSB, the fire station is equipped with five fire engines and an ambulance. The community also has a public transit system (ASRC 2007; NSB 2007c).

The village corporation, the Kuukpik Village Corporation, owns approximately 227 mi² (590 km²) of the surface estate around the community (ASRC 2007). Ultimately, when all lands selected by Kuukpik Village Corporation are conveyed to the corporation, it will own approximately 123,000 acres. The village corporation also owns a grocery store and a general merchandise store (ASRC 2007; NSB 2007c).
Kuukpik has acquired a leading voice in the management of subsistence access and resources on its own and adjoining lands through the Kuukpik Subsistence Oversight Panel.

In the mid-1990s when major discoveries of producible hydrocarbons were identified under Kuukpik/ASRC lands, both corporations became, in effect, partners with the developer, Atlantic Richfield Company (ARCO), in the construction of the Alpine oilfield. Alpine is the tenth largest oilfield in the U.S. This same pattern of partnership continued to evolve with Alpine’s new operator, ConocoPhillips Alaska Inc., with the expansion of the Alpine infrastructure and satellite locations.

The Alaska Native Claims Settlement Act (ANCSA) provided the opportunity for those families who had left the region to return, establish a tribal status, and acquire land on which to build a permanent village settlement. Following the pattern employed by many other Alaska Native groups in the wake of ANCSA, Nuiqsut was organized as a second-class city within the jurisdiction of the regional government. The NSB provides the majority of services (schools, health care, public safety, public works) often supplied by municipalities.

ASRC played a major supporting role in Nuiqsut’s early years by funding construction of the first permanent houses. Subsequently, the NSB invested heavily in the community through provisions of basic services and capital improvements. Through these investments, Nuiqsut evolved into a thoroughly modern town by the mid 1980s. Upgrades continue in the areas of housing, public facilities, water supply, and sewage disposal. The upgrades include conversion of fuel supply from diesel to natural gas for electrical generation and home heating); school facilities; and health clinics.

Nuiqsut remains a primarily Native community (more than 85 percent Iñupiat) whose residents principally describe themselves as fishermen, whalers, and hunters. Despite the modernization that has taken place since 1973, subsistence values remain a priority.

### 3.11.2 Population and Employment

Two relatively distinct populations inhabit the North Slope: 1) local residents who are indigenous Iñupiat Natives; and 2) the oil and gas workforce, who rotate on a regular basis and are temporary residents in the region. The oil and gas workers have minimal participation in the local economy. Industry provides for their needs and services. In 2004, non-Alaska residents made up 28 percent of all workers in the oil industry (ADL&WD 2006). In the NSB, 28.5 percent of private-sector workers are non-residents. However, local residents comprise 55 percent of state government employment, 76.5 percent of local government, and 19.7 percent of all private sector workers (ADL&WD 2006).

#### Population Trends

According to the North Slope Borough Comprehensive Plan (NSB 2005), the population within the NSB increased steadily from 1,258 residents in 1939 to 7,555 residents in 1998. The population decreased to 7,307 residents in 2003 (Figure 3.11-1). A national census completed in 2010 lists the NSB population at 9,430 residents, a 27.7 percent increase over the 2000 census population (April 21 data at http://2010.census.gov/2010census/).
According to the NSB 2003 census, the villages of Anaktuvuk Pass, Atqasuk, Kaktovik, and Point Lay gained residents between 1998 and 2003. The communities of Barrow, Nuiqsut, Point Hope, and Wainwright lost residents during this same time period. According to the NSB 2003 census (Shepro et al. 2003), the year-round populations of Barrow, Nuiqsut, Deadhorse/Prudhoe Bay, and Kaktovik were as follows:

- Barrow – 4,429
- Nuiqsut – 416
- Deadhorse/Prudhoe Bay – 4
- Kaktovik – 286

Population figures from 1993 to 2003 and projections for 2010 to 2020 for NSB communities are presented in Table 3.11.1-1.
Demographics

The majority of the population of the NSB is Iñupiat. Figure 3.11-2 depicts the population by ethnicity. Data is derived from the NSB’s 2003 Economic Profile and Census report, Volume IX.
The proportion of Iñupiat residents in Nuiqsut and Kaktovik is higher than that in Barrow (Shepro et al. 2003). The percentage of Iñupiat residents in Kaktovik is 88.2 percent and in Nuiqsut 91.8 percent. In Barrow, Iñupiat residents are 59.3 percent of the population, although the NSB 2003 census estimates that 61.3 percent of Barrow’s population is Iñupiat /American Indian.

The NSB has a generally young population. This results in a high ratio of dependents-to-wage-earners. This demographic has implications for education funding, housing, healthcare, other services, as well as job opportunities, and workforce development and training programs. Figure 3.11-3 illustrates the NSB’s population distribution by age and gender.

(Source: Shepro et al. 2003 in NSB 2005)
3.11.3 Health

The baseline public health and welfare of the NSB residents is a fundamental component of any review of the communities in the region. Community health is specifically addressed in original NEPA legislation in relation to natural resource development and is now considered more thoroughly in the EIS process (MMS 2008a; Wernham 2007). The proximity of Kaktovik and Nuiqsut to the project area in Camden Bay requires an understanding of the public health issues and concerns communicated by local residents.

Nuiqsut residents have expressed specific concerns about the potential associations between oil development and health. They have testified to concerns ranging from possible effects of contaminants in increasing the risks of cancer, asthma, and thyroid disease to a rise in social problems such as alcoholism, domestic violence, and suicide (Ahtuangaruak 2003 in Wernham 2007).

To mitigate any concerns, it is important to clarify why the activities associated with the proposed Camden Bay exploration activities will not pose any risks to the residents and communities of Kaktovik and Nuiqsut. The project is designed to avoid any interference with Kaktovik or Nuiqsut residents, in the following manner:

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

Health Status and Health Determinants

Public Health issues of the NSB include: general health, psychosocial, injuries, contaminants exposure, nutrition, noncommunicable disease, infectious diseases, maternal-child health, sanitation and health services. Some commonly used indicators of general population health include life expectancy, mortality rates, infant mortality, and general health and well being surveys (Lanier 2003).

Programs to control tuberculosis epidemics and other infections were initiated in the 1950s and improved through upgraded safe water and sanitation systems (ADEC 2008). By 1989, infectious disease accounted for only 1.3 percent of deaths in Alaskan Natives. Mortality rates have declined and life expectancy has increased; however, overall mortality rates are still 1.5 times higher than the U.S. white population.

The health status of North Slope communities since the era of epidemic infectious disease is now characterized by a rise in diabetes, cancer, and ongoing social and psychological strain and change, including alcohol and substance abuse, violence, and suicide.

Psychosocial concerns such as alcohol-related problems, and the links between a cultural shift to a cash economy, western education, and health impacts are complex (ANTHC 2008). For instance, the studies that examine the current pattern of suicide for indigenous peoples suggest that acculturative stress and economic development exert opposing influences on suicide rates in Inupiat communities (Travis 1984).
Suicide rates for Alaskan Natives in the NSB are still are markedly higher than national rates but appear to be decreasing in recent years (ANTHC 2008 in MMS 2008a).

Few studies have directly examined the influence of oil and gas operations on social and psychological health in the North Slope, however benefits related to economic gains and employment are well-documented and according to some social studies, may underlie some of the documented improvement in social and psychological health indicators discussed above, including the importance of a cash economy to support subsistence activities (Pedersen et al. n.d.; MMS 2008a)

**Accidental injury** is the second leading cause of death on the North Slope and, although declining, mortality rates remain over 3.5 times higher than the overall rate for U.S. whites. The NSB rate for ATV and snowmachine accidents is more than twice as high as the rate for Alaskan Natives in general (ANTHC 2008).

**Nutrition:** Based on available harvest data, ADF&G estimated that subsistence foods accounted for 33 percent of protein requirements and nearly half the caloric requirements for residents of Arctic communities (ADF&G 2000). Available data suggest that younger Iñupiat people are consuming relatively higher proportions of market foods (Nobmann et al. 2005), which are often of poor nutritional value (Pederson n.d. in MMS 2008a).

Because of the importance of subsistence foods to the nutrition of North Slope communities, food security depends on access to traditional foods, as well as economic resources. Health risks based on nutritional intake choices, therefore, would depend on the degree of impacts on subsistence activities (Wernham 2007).

**Noncommunicable Diseases** are increasingly prevalent in Alaska Native communities and include diabetes; high blood pressure and related metabolic disorders; vascular disease; chronic lung diseases; cancer; and endocrine disorders such as thyroid disease. In the NSB, type II diabetes, high blood pressure (hypertension), and dyslipidemia are increasing rapidly (Alaska Native Medical Center 2008). The subsistence diet is the most important protective factor against these problems; numerous studies have demonstrated that this transition has been caused by a transition to market foods and an increasingly sedentary lifestyle (Adler et al. 1996; Murphy et al. 1995; Bjerregaard et al. 2004).

**Cardiovascular and Cerebrovascular Disease** rates are lower than Alaska and overall U.S. rates. Although it is the third leading cause of death in the North Slope region, it has been decreasing consistent with statewide and national trends.

**Chronic Lung Disease** includes chronic obstructive pulmonary disease (COPD), asthma, and chronic bronchitis, which are associated with these risk factors: smoking, air pollution, poor indoor air quality, and possibly severe pulmonary infections in early childhood. The NSB had the highest mortality rate for COPD of any region in the state (Day et al. 2008).

Air pollution is an exacerbating factor for chronic pulmonary disease (EPA 2006); see section below on air pollution under Contaminant Exposure and Impacts-Air Quality and also a more complete discussion in Section 3.1.6, Air Quality.

**Cancer** is now the leading cause of death in the NSB and has increased by more than 33 percent in recent decades and has become a matter of great concern to communities. Lung cancer is the most common type of cancer (41 percent) and is highly associated with tobacco smoke. The high rates of smoking documented on the North Slope are one identified risk factor for lung cancer. Radon gas exposure also is
a risk factor, but radon levels in Alaska generally are low (AMAP 1998). Other risk factors for lung
cancer include industrial exposure to asbestos, uranium, arsenic, nickel, and chromium.

Stomach cancer is more frequent in Alaskan Natives than the U.S. population. The major known risk
factor is infection with the bacteria *Helicobacter pylori*, and is present in 85 percent of Alaskan Native
adults who live in rural Alaska (Parkinson et al. 2000).

**Contaminant Exposure to Environmental Pollutants** such as Persistent Toxic Substances/Persistent
Organic Pollutants (PTS/POP) are of great concern to the circumpolar community as a whole. The Arctic
is a focus for atmospheric, riverine, and marine pathways that result in the long range transport of
contaminants into and within the Arctic (UNEP 2002).

The NSB has maintained an extensive program of monitoring and testing subsistence resources for
contaminants. The results have been encouraging; the levels of contaminants such as PCBs (organic
pollutants not typically associated in high quantities with modern oil and gas operations) in subsistence
foods have been substantially lower than those reported in similar resources in Canada and Greenland
(MMS 2008a).

Assessing the risks from radionuclides, persistent organic pollutants, heavy metals, PCBs, dioxins, and
furans, the State of Alaska advises that the “benefits of a traditional food diet far outweigh the relative
risks posed by the consumption of small amounts of contaminants in traditional foods”. Exposure to POP
can be limited by eating smaller, younger animals, animals from a lower trophic level, and by choosing
lean tissues over fatty tissues from marine mammals (ADH&SS 2004). A risk assessment for exposure to
PCBs and DDT (not generally associated with oil and gas operations) on fish in the Colville River, found
no evidence of a health risk (ATSDR 2003).

There are a number of health effects associated with exposure to PTS; however, there have been few
Alaska-based health studies examining these effects. Overall PCB concentrations are declining in
humans, including in Arctic regions. One study into an eastern Arctic Canadian community between
1993 and 2000 found that concentrations of PCBs and organochlorine pesticides steadily declined
(ADH&SS 2004).

Other contaminant sources include air pollution for which the EPA uses six criteria pollutants as
indicators of air quality. The EPA has established maximum allowable concentrations for the pollutants
to avoid effects on human health. These criteria pollutants are lead, ozone, particulate matter, carbon
monoxide, nitrogen dioxide, and sulfur dioxide. Air monitoring data is limited on the North Slope,
especially in the NPR-A; however, current data is collected by the oil companies as part of air permit
requirements in the immediate project facility area. North Slope air quality data has not shown violations
of the NAAQS near the facilities (ADEC 2007).

**Respiratory Infections** are highly prevalent in Alaskan Natives and have been the subject of several
studies that have shown particularly high rates of lower respiratory infections in infants and children in at
least one rural Alaska region (Singleton et al. 2006). The contribution of existing oil and gas operations
to rates of respiratory infections has not been studied.

**HIV** prevalence in the Northern Region of Alaska appears to be substantially lower than prevalence in the
general U.S. population (ADH&SS 2007).
Maternal-Child Health reflects important health disparities in the NSB and includes an elevated rate of teen pregnancies and premature deliveries, compared with the average Alaska population. Premature birth, low birth weight, and Fetal Alcohol Syndrome have complex and similar risk factors including smoking, alcohol use, drug abuse, poor prenatal care, and lower educational attainment.

Sanitation is important to Alaskan Native health and infrastructure improvements were instrumental in efforts to control early infectious epidemics in rural Alaska. The NSB provides water and sewer services in villages.

Health Services Infrastructure is provided through a mix of federal, state, and local government services. The NSB Department of Health and Social Services (DHSS) provides health care services to the residents of the region. However, the physical isolation of Kaktovik and Nuiqsut can make access to health care extremely difficult for these two communities (NSB 2005).

Cultural stress mitigation is necessary at times because of the large influx of nonresident workers creating the potential for cultural conflict. Recognizing this potential conflict, BOEMRE has developed lease stipulations that require lessees to develop and institute a cultural orientation program for workers (MMS 2008a).

3.11.4 North Slope Borough Economy and Employment

ASRC and the village corporations exert considerable economic influence in the region, providing employment in all sectors of the economy. Most NSB revenue comes from oil and gas development. These revenues are currently on the decline due to current economic conditions. Other revenue generation comes from the federal government, State of Alaska, and local governments (Figure 3.11-4). The NSB is at the center of the region’s economy, providing public services and facilities funded by oil and gas tax revenues (Figure 3.11-4).

OCS oil and gas exploration drilling has the potential to yield direct and indirect economic benefits to NSB residents in terms of employment and business opportunities. However, congressional legislation will be needed to enable federal revenue sharing with the State and NSB in the form of impact funds from OCS development. Workforce development and training programs in the region are vital to increasing local hire in the villages and residents’ employment within the resource development economy.
High unemployment and underemployment remain characteristic of the North Slope, according to the North Slope Borough 2003 Economic Profile and Census Report (Shepro et al. 2003).

The number of jobs held by NSB residents in the oil industry from 1980-2003 has not been remarkable (Figure 3.11-5). Numbers of jobs ranged from 16 in 1998 to a high of 46 in 1988. Workforce participation by NSB residents in the oil industry in 2003 was 23 jobs. In order to increase the economic benefit within the villages, more local hire is needed. This is a challenge for the oil and gas industry in partnership with the NSB, ASRC, the State of Alaska, community colleges, University of Alaska, vocational technical schools, and job training facilities. Figure 3.11-6 illustrates the specific employment break-down for 2003.

Figure 3.11-5  North Slope Borough Resident Employment by Sector in 2003
3.11.5 Existing Offshore and Coastal Infrastructure

There is limited offshore and coastal infrastructure in the immediate vicinity of the proposed project area. East of the project area are the Deadhorse and Prudhoe Bay industrial facilities and British Petroleum Exploration Alaska (BPXA) Northstar production island. Buried subsea pipelines and power cables connect the BPXA in the Northstar facilities west of Stump Island to onshore transportation facilities in Prudhoe Bay. In spring 2007, a buried subsea flowline bundle was installed from the Oooguruk drill site (now in production) to the shore, west of Oliktok Point in the Kuparuk River Unit. Both facilities are located in state waters southwest of Shell’s proposed drilling locations.

The exploration drilling program will use existing infrastructure in the industrialized area near Deadhorse and Prudhoe Bay, an area zoned as a resource development district within the NSB. West Dock near Point McIntyre northeast of the industrial facilities in Prudhoe Bay will be the staging area and marine service area for the support vessels involved in the exploration drilling project. The airport at Deadhorse will be the staging area for helicopter support for drilling and support vessels. Crew changes will occur at Deadhorse. The following infrastructure serves the NSB region, its residents, and the operations related to commercial activities.

Service Area 10

In 1975, the NSB established Service Area 10 to provide utilities to industrial customers in the Deadhorse and Prudhoe Bay area. These services include solid waste collection and disposal, potable water production and distribution, and sanitary waste collection and disposal. Police protection is also provided by the NSB to Deadhorse and Prudhoe Bay in Service Area 10.
Airports and Airstrips

The State of Alaska Department of Transportation and Public Facilities (ADOT&PF) owns and maintains the Wiley Post-Will Rogers airport in Barrow and the Deadhorse Airport in Deadhorse. Kaktovik and Nuiqsut each have airstrips sufficient for use by commercial and chartered passenger aircraft.

Medical Facilities

The Samuel Simmonds Memorial Hospital located in Barrow is a qualified acute care facility and state-certified medevac service (NSB 2005). Critical care air ambulance services are provided by NSB Search and Rescue in Barrow. Emergency services include coastal and seaport access via helicopter. The NSB Clinic is a qualified emergency care center.

Utilities

The NSB owns water and sewer utilities. Private utility companies operate and maintain some community systems while the NSB maintains and operates others (NSB 2005). The NSB also owns and oversees eight landfills in the region.

Power

Generally, the NSB owns utilities, but private utility companies operate the facilities. Except for Barrow, other communities use diesel as a primary source of heat. Barrow uses natural gas from the Barrow gas field. Some communities have back-up generators but remain vulnerable to breakdowns and problems with fuel supply. Kaktovik experienced a winter outages in 2005 and 2011 that resulted in damage and threatened public health and safety.

Communications

Residents use a fully digital local telephone system, local dial-up internet, a community teleconference center, cable television, public radio broadcast, an interactive video distance education system, wide area data network, and two-way radio technologies. Kaktovik and Nuiqsut lack capacity for higher bandwidth service. In addition, there is a need for more emergency dispatch radio connections and improved telecommunications between Barrow and the outlying communities.

Roads

Traditional road access is not available to NSB villages, but seasonal ice roads and well-used snowmachine trails are used in winter. Powerboats and ATVs are common transportation in the summer.

Kaktovik

The U.S. Air Force constructed an airstrip on Barter Island in Kaktovik in 1947 and later constructed a DEW Line station in the area (NSB 2005). Commercial and chartered service is available.

Nuiqsut

At Nuiqsut there is an airstrip with regularly scheduled and chartered service available from commercial airlines, but no terminal facilities. There is a health clinic, police station, fire station, city hall, recreation center, community center, and the Nuiqsut Trapper School K-12.
3.11.6 Land Use

The NSB Comprehensive Plan defines four land-use zoning districts: Village District, Barrow District, Conservation District, and Resource Development District. With adoption of the NSB Comprehensive Plan in 2005, two new districts were proposed for implementation through Title 19 Land Management Regulations. These proposed districts are a Special Habitat District and Subsistence Use District and have not yet been adopted by the NSB Assembly. Figure 3.11-7 shows land use in the Beaufort Sea region.

NSB villages, except Barrow, are zoned as Village Districts. These districts maintain traditional values and lifestyles for NSB communities. Traditional land uses have occurred for thousands of years for subsistence and cultural purposes and continue through present day. It is difficult to map traditional land use and subsistence areas because patterns and locations change with the seasons, animal migrations, and weather. Because of the complexity in mapping traditional land use areas, subsistence areas are generally documented on a project-specific basis.

A Conservation District encompasses a large part of the NSB, in addition to the Barrow District, Village Districts, and Resource Development District. The goal of the Conservation District is preservation of the natural ecosystem, including subsistence resources.

The purpose of the Resource Development District is to accommodate large-scale resource exploration, development, and production in balance with protecting subsistence resources with the NSB Comprehensive Plan policies. Rezoning a Conservation District to a Resource Development District requires a Master Development Plan and approval by both the NSB Planning Commission and Assembly. As of 2005, the NSB had rezoned 932,903 acres (3,775 km²) through this process. The industrial areas in the vicinity of Deadhorse and Prudhoe Bay, along with the air strip and West Dock, are within the Resource Development District.

The NSB coordinates the Coastal Management Program and land use regulations for the region. The Coastal Management Program is discussed in greater detail in Section 3.12.

3.11.7 Subsistence Resources

Subsistence resources are an integral part of the traditions, culture, and economy of NSB residents. Subsistence use is defined by Alaska Statute (AS) 16.05.940 as:

> “the noncommercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural area of the state for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal or family consumption, and for the customary trade, barter, or sharing for personal or family consumption; in this paragraph, "family" means persons related by blood, marriage, or adoption, and a person living in the household on a permanent basis” (AS 16.05.940).

Regional subsistence activities include fishing, waterfowl harvests, and hunting for seals, polar bears, walrus, and whales. Travel in the region is likely to be by small boat in summer and snowmachine in winter. Residents have historically used coastal areas near the barrier islands and river deltas for subsistence activities.
Despite high paying job opportunities, many young Iñupiat men have chosen to balance wage employment with seasonal subsistence activities (Kleinfield et al. 1983). The Iñupiat draw upon collective experiences to respond to the challenges of life in the Arctic. Wild foods and other products traditionally have been traded among households within a community via extensive, non-commercial, kinship-based networks (MMS 2006). Surveys of subsistence harvests confirm these resources continue to be vital in household economies (Table 3.11.7-1).

### Table 3.11.7-1 North Slope Borough Household Consumption of Subsistence Resources

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<tr>
<td>None</td>
<td>35</td>
<td>3</td>
<td>165</td>
<td>13%</td>
</tr>
<tr>
<td>Very little</td>
<td>128</td>
<td>12%</td>
<td>217</td>
<td>17%</td>
</tr>
<tr>
<td>Less than half</td>
<td>211</td>
<td>20%</td>
<td>182</td>
<td>14%</td>
</tr>
<tr>
<td>Half</td>
<td>216</td>
<td>21%</td>
<td>241</td>
<td>19%</td>
</tr>
<tr>
<td>More than half</td>
<td>188</td>
<td>18%</td>
<td>183</td>
<td>14%</td>
</tr>
<tr>
<td>Nearly all</td>
<td>134</td>
<td>13%</td>
<td>165</td>
<td>13%</td>
</tr>
<tr>
<td>All</td>
<td>126</td>
<td>12%</td>
<td>130</td>
<td>10%</td>
</tr>
<tr>
<td>Total</td>
<td>1038</td>
<td>100%</td>
<td>1283</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: Data indicates households that responded to a question regarding how much of the meat, fish, and birds eaten in the household came from local food sources.

(Source: Shepro et al. 2003 in NSB 2005; ASCG Inc. 2005)

### Subsistence Species

The species integral to the subsistence economy and traditions of the NSB include land mammals, waterfowl, fish, and marine mammals. There are differences in the abundance and use of resources depending upon location. The following review of these resources includes harvest counts, subsistence uses, and life history information, specifically for caribou, from the villages of Kaktovik and Nuiqsut.

### Whaling

Whaling is perhaps one of the most culturally significant subsistence activities for the coastal Iñupiat communities. Considered one of the ancient traditions connecting present-day Iñupiat people with their past, it is thought of as a way-of-life more than an activity (University of Arkansas 2007). Whaling crews continue to be primarily kinship-based (MMS 2008a). While not every member of the community participates in the taking of the whale, the hauling, cleaning, and distribution of a whale involves an entire community. An umialik, or whaling captain, shares whale meat and maktak with the successful captain’s crew members, with some set aside to be served at the Thanksgiving and Christmas feasts held in the community churches. Nalukataq is a traditional celebration of the whale that continues to play an important cultural role for Iñupiat today (Chance 1990). This celebration, held in the summer, honors the whales that have given themselves (Brower 2004). Symbolic of this festival is nalukataq, or the blanket toss, hosted by the successful whaling crew or crews. Bearded seal or walrus hide is used to toss a person up to 20 ft (6 m) into the air. While in the air, a person can toss out treats to the crowd (Chance 1990).
Kaktovik

Approximately 93 percent of the Iñupiat households in Kaktovik participate in the local subsistence economy (Shepro et al. 2003). Residents harvest seals and ptarmigan year-round, and whales, geese, and bear when they are seasonally available. Subsistence harvest data from ADF&G (ADF&G 2000b) and the NSB (Fuller and George 1999; Brower et al. 2000) reveal that in terms of pounds per person harvested, the residents of Kaktovik use large amounts of marine mammals. However, a balance of caribou, Dall sheep, muskox, small mammals, fish, and waterfowl continue to be a traditional part of subsistence use.

Large Land Mammals

Large land mammals (MMS 2008a) harvested by Kaktovik residents include caribou, Dall sheep, muskox, brown bear, and moose (MMS 2008a). These animals are used primarily as food resources and are harvested depending upon abundance, distribution, and season. Residents also use the hides as a secondary resource for clothing and other items (MMS 2008a).

Caribou

Caribou are the most prevalent land mammal subsistence species for North Slope residents (Pedersen 1990). Caribou are an important resource not only for the food value, but also for the hides and skins that are used to make clothing (Burch 1998). Caribou are also used for arts, crafts, and other cultural expressions. The land use area for caribou encompasses nearly 7,000 mi² (18,130 km²) and stretches east from the Sagavanirktok River to Demarcation Point. Hunters travel as far south as the headwaters of the Huliabula River to find caribou (Pedersen 1990; Pedersen et al. 1985). The majority of caribou harvested are taken from coastal sites; an average of 69 percent are taken on the coast compared to 29 percent from inland sites (Pedersen 1990).

Caribou can be harvested throughout most of the year, but the Kaktovik hunt peaks during the summer, usually in July (Brower et al. 2000; Pedersen 1990). The hunt is concurrent with the migration of the caribou to the coastal plain, where most of the calving occurs (MMS 2008a). Fall is considered a good time to harvest caribou for hides, when the hair is best for making clothing (Burch 1998). There are an estimated 117 lbs (53 kg) of useable weight per animal harvested (Brower et al. 2000). In 1992, Kaktovik hunters harvested between 136 and 158 caribou, resulting in somewhere between 15,926 and 19,136 edible lbs (7,224 and 8,680 edible kg) (ADF&G 2009; Fuller and George 1999).

Dall Sheep

Dall sheep are a permanent and relatively resilient population and are considered one of the more stable subsistence resources for Kaktovik hunters (USFWS 2008; MMS 2008a). They live on high, rocky terrain and prefer steep mountain slopes and outcrops above timberline where they are safe from predators (USFWS 2008). Sheep are usually hunted in the winter and spring when the hunters can use snowmachines to more easily access the mountainous habitat. In 1992, 53 sheep were harvested and 30 sheep were harvested during the 1994 to 1995 season, second only to caribou in terms of individual land mammals taken that season (Brower et al. 2000).
Muskox

While muskox occupied the Alaskan Arctic during the Pleistocene and through the early historic period, the population had been depleted by the end of the 19th Century. The ADF&G, USFWS, and the residents of Kaktovik worked together to release more than 50 muskoxen on Barter Island in an effort to reestablish the population (Pedersen et al. 1991). Muskox are a source of edible meat, providing an average of 600 lb (272 kg) per animal (1999). Muskox are hunted both on the coastal plain and in the foothills, and are generally taken during the winter months when access is easier. In 1992, five or six muskoxen were harvested by Kaktovik residents for a combined total of 3,179 edible lbs (1,442 edible kg) or 16 lb (7 kg) per person (ADF&G 2009a; Fuller and George 1999). In the 1994-1995 season a total of nine animals were harvested (Brower et al. 2000). The State of Alaska requires a permit to hunt muskox.

Brown Bear

The brown bear is harvested when available but does not usually constitute a large percentage of the edible pounds harvested for the community of Kaktovik (Brower et al. 2000; Fuller and George 1999). Brown bear on the North Slope hibernate longer than in other regions, staying in their dens up to eight months a year (USFWS 2008). They usually den in the mountains south of the coastal plain, but their range in the summer months includes the entire coastal plain. In 1995, the most recent year for brown bear harvest data, one bear was taken. There were no reports of brown bear having been harvested in 1992 (Fuller and George 1999).

Moose

The moose population on Alaska’s North Slope increased dramatically through the 1980s and then crashed, reaching a low of 97 moose counted between the Canning River and the Dalton Highway in 1997. The reduction of the moose population was possibly a result of overpopulation or increased predators (such as bear and wolves) or a combination of the two factors (USFWS 2008). Moose on the North Slope range as far north as the Beaufort Sea, but they are most often found in the willow thickets associated with the major river systems (ANWR 2009). Moose are generally harvested in low numbers, but can be an important supplemental resource during years when the caribou are scarce (Brower et al. 2000). During the 1994-1995 season, one moose was harvested by Kaktovik hunters; none were reported harvested in 1992 (Brower et al. 2000; Fuller and George 1999).

Furbearers

Smaller mammals commonly harvested in the vicinity of Kaktovik include fox, wolverine, wolf, and ground squirrel. Less frequently harvested are river otter, marmot, mink, and weasels. These furbearing mammals are an essential subsistence resource, as they provide the materials required to make clothing, boots, gloves, and other fundamental items for arctic living. Furbearers are not usually consumed and are not factored into the total percentages of edible pounds harvested by the community. Furbearing animals can be hunted, but are more commonly trapped (Pedersen et al. 1985).

Fox

The two species of fox that are most commonly harvested by Kaktovik hunters are arctic fox and red fox. Five arctic fox were harvested during the 1994-1995 season, (Brower et al. 2000). In 1992, two red foxes were taken (Fuller and George 1999).

Wolverine

Ten wolverines were taken in 1992, compared to one in 1995 (Brower et al. 2000; Fuller and George 1999).
Wolves

Wolves typically prey on moose and caribou, but have been known to take polar bear cubs, small mammals, and muskox. The wolf population in the Arctic is closely tied to that of the moose, and to a lesser extent caribou (MMS 2008a). The harvest of wolves usually takes place in the winter, between November and April. In 1994-1995, eight wolves were taken; seven were taken in 1992 (Brower et al. 2000; Fuller and George 1999). Wolves have been known to hunt seal pups on offshore ice and have been seen traveling distances of up to 44 mi (70 km) on the ice (MMS 2008a).

Ground Squirrels

Ground squirrels are commonly referred to as parka squirrels and most often taken in the spring. In 1995, 30 of the 45 reported for the year were harvested in April (Brower et al. 2000), while 32 were harvested in 1992 (Fuller and George 1999).

Coastal and Marine Birds

Several species of coastal and marine birds are harvested by Kaktovik residents. Pacific black brant account for a larger percentage of the total harvest than any other species. Geese, including brants, accounted for a combined 48.5 percent harvested in 1992 and 51.3 percent in 1994-1995 (Brower et al. 2000; Fuller and George 1999). Willow and rock ptarmigan are the second most commonly harvested species after geese. Others include several types of duck, tundra swan, and loon (MMS 2008a).

Table 3.11.7-2  Birds and Waterfowl Harvested in Kaktovik, 1992 and 1994 to 1995

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Willow ptarmigan</td>
<td>179</td>
<td>15.7</td>
<td>-</td>
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<tr>
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<td>189</td>
<td>16.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ptarmigan (unidentified)</td>
<td>-</td>
<td>-</td>
<td>119</td>
<td>22.5</td>
</tr>
<tr>
<td>Tundra (whistling) swan</td>
<td>2</td>
<td>1.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>0.1</td>
<td>-</td>
<td>-</td>
</tr>
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<td>King eider</td>
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<td>3.6</td>
<td>47</td>
<td>8.9</td>
</tr>
<tr>
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<td>11.7</td>
<td>64</td>
<td>12</td>
</tr>
<tr>
<td>Snow goose</td>
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<td>0.1</td>
<td>2</td>
<td>0.4</td>
</tr>
<tr>
<td>Canada goose</td>
<td>39</td>
<td>3.4</td>
<td>19</td>
<td>3.5</td>
</tr>
<tr>
<td>White fronted goose</td>
<td>180</td>
<td>15.8</td>
<td>-</td>
<td>-</td>
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<td>Black brant</td>
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<td>29.2</td>
<td>239</td>
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</tr>
<tr>
<td>Goose (unidentified)</td>
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<td>-</td>
<td>13</td>
<td>2.4</td>
</tr>
<tr>
<td>Long-tailed duck (oldsquaw)</td>
<td>23</td>
<td>2</td>
<td>25</td>
<td>4.7</td>
</tr>
<tr>
<td>Common loon</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,141</td>
<td><strong>100</strong></td>
<td>530</td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

(Source: Fuller and George 1999; Brower et al. 2000)

Fish

Kaktovik residents get their fish from the many lakes and streams near the community, as well as from boats along the shore. Participation is relatively high with 66 percent of households reporting to have fished sometimes or often in 1992 (Fuller and George 1999). While Pacific salmon hold a special regulatory importance, Arctic cisco, broad whitefish, and Dolly Varden are important to personal use in Kaktovik.

Fish can account from anywhere between 10 and 20 percent of the annual subsistence harvest. It is considered to be a relatively stable resource and available year round (MMS 2008a). In 1992, the fish harvest amounted to 18.3 percent of the total food harvest and 11 percent in 1993 (Brower et al. 2000; Fuller and George 1999).
Figure 3.11-8  Selected Kaktovik Subsistence Use Areas for Walrus and Waterfowl
Marine Mammals

Marine mammals account for the largest portion of total edible pounds harvested by residents of Kaktovik. The community depends on the food that whales and seals provide for subsistence purposes, but the hunting of marine mammals, especially whales, is a way of maintaining a cultural connection with the past. In 1995, marine mammals comprised 61 percent of the edible pounds harvested (Brower et al. 2000). In 1992, marine mammals made up 66.2 percent of all of the edible pounds harvested (Fuller and George 1999). In less successful years, marine mammals have made up a much smaller percentage of harvested resources (Pedersen 1995a).

Polar Bear

While polar bear are not necessarily sought out as a subsistence resource by Kaktovik hunters, they are taken occasionally. Polar bear are now listed as a threatened species under the Endangered Species Act, as well as protected by the MMPA (see chapter 3.8.2), but the federal government allows the hunting of polar bear by Alaska Natives. Residents of Kaktovik are especially likely to take nuisance or hungry bear that come into the village when food is otherwise scarce (City of Kaktovik 2005). Polar bear are taken during the winter months. The fur is used for boots, mittens, and coats (MMS 2008a).

Seal

Three types of seals are harvested in Kaktovik: ringed seals, spotted seals, and bearded seals. Seal oil is eaten with meals and also used as a preservative (MMS 2008a). Seals can be hunted all year, but are usually harvested between July and September, when the water is open.

Walrus

Walrus are not commonly harvested in Kaktovik as the population is low in the Beaufort Sea. When available, they are harvested in the summer while crews are out seal hunting (MMS 2008a). Conflicting reports put the number of walrus harvested by Kaktovik hunters in 1992 between three and five (Brower et al. 2000; Fuller and George 1999). In addition to walrus meat, the ivory tusks are highly valued and used for traditional arts and crafts (MMS 2008a).

Bowhead Whale

Considered one of the most ancient traditions connecting present-day Inupiat people with their past, it is thought of as a way-of-life more than an activity (University of Arkansas 2007; MMS 2008a). While not every member of the community participates in the taking of a whale, the hauling, cleaning, and distribution involves an entire community. An umialik, or whaling captain, shares whale meat and maktak with the other whaling captains and with everyone that helps pull and cut up the whale. Fresh whale meat is usually distributed by the successful captain’s crew members, with some set aside to be served at the Thanksgiving and Christmas feasts held in the community churches. Nalukataq is a traditional celebration of the whale that continues to play an important cultural role for Inupiat today (Chance 1990). This celebration, held in the summer, honors the whales that have given themselves (Brower 2004). Symbolic of this festival is nalukataq, or the blanket toss, hosted by the successful whaling crew or crews.

Bowhead whale often accounts for the largest percentage of Kaktovik’s total harvest. Although Kaktovik residents did not resurrect the practice of whaling for bowheads until 1964, bowhead whales currently provide a substantial portion of the total edible pounds of resources harvested (Pedersen et al. 1985).

Traditional understanding of bowhead whale behavior is more complex than simple stimulus-reaction predictions. Inupiat TK teaches that bowhead whales, like other animals, have an innate spirituality and
can hear sounds in the water or in the air for hundreds of miles. They believe whales can hear and understand what people say about them. Based on what they hear or how people behave toward them, TK teaches that whales choose to make themselves available to hunters or avoid them (MMS 2008a).

Because of the Inupiat peoples’ understanding of the bowhead’s sensitivity to sound energy and rude disrespectful manners, hunters take precautions. They are quiet when camped on the ice so they will not scare whales. Hunters keep camps clean and wear white parkas so not to offend the whales, and paddle boats without splashing and making sound (Brower 2004).

The whalers use aluminum skiffs for the fall hunt, which ranges between 10 and 20 miles off the coast (MMS 2008a). Bowheads do not enter Kaktovik Lagoon, but stay offshore between West Barter Island and the Kuvritovik Entrance. Whaling can take place anywhere between Camden Bay and Tapkaurak Entrance, with specific locations at Jago Entrance, Kuvritovik Entrance, and Tapkaurak Entrance (ADNR 1999).

Bowhead whales are hunted between late August and early October, depending on weather, ice conditions, and the presence of whales (ADNR 1999; MMS 2008). The hunt occurs when the whales are returning west from the feeding grounds in the Canadian Beaufort Sea (ADNR 1999). The hunt will continue until the whalers have reached their quota, or until weather or ice conditions make it too dangerous to be out in the open water.

**Beluga Whale**

Beluga whales are much smaller than bowheads, averaging just over 1,000 edible lbs (454 edible kg) per whale, but they can be a very important supplemental harvest, especially in years of poor bowhead returns. Of the five distinct beluga stocks in Alaska, the Eastern Chukchi Sea and Beaufort Sea stocks may be found near the project area. Both these stocks winter in the Bering Sea. Few belugas remain in the central Beaufort Sea in the summer, but small numbers have been reported within the Colville River Delta (BLM 2005). Fall migrant beluga whales from the Canadian Beaufort Sea transit the Alaskan Beaufort Sea along the southern edge of pack ice to reach western Chukchi Sea waters primarily during September (Richard et al. 1998). See Section 3.7.9 and Appendix C of the EP for more information on beluga whales near the project area.

Residents of Kaktovik usually hunt beluga at the same time as bowhead whales, but may take them as early as April. In 1992, two beluga whales were harvested by Kaktovik whalers (Fuller and George 1999). Between 1999 and 2003, North Slope residents harvested an average of 53 beluga whales from the Beaufort Sea stock and 65 from the Chukchi Sea stock.
Figure 3.11-9 Selected Kaktovik Subsistence Use Areas for Bowhead and Seal
Plants/Berries/Wood

Plants and berries contributed less than one percent of the community’s wild resource harvest in 1992, but are a special treat for Kaktovik residents, who get 99 percent of their subsistence harvest from fish, birds, and mammals. Wild rhubarb, salmonberries, cranberries, and blueberries were harvested in 1992, but other plant resources sometimes harvested are willow leaves, wild potatoes, wild chives, Labrador tea, and crowberries (Fuller and George 1999). Approximately 50 percent of Kaktovik residents surveyed in 1992 said that they picked berries sometimes or often. Salmonberries were the most abundantly harvested resource in this category with 191 edible lbs (87 edible kg). Fifteen pounds (7 kg) of wild rhubarb were collected, as well as seven lbs (approximately 3 kg) of cranberries and six lbs (approximately 3 kg) of blueberries (Fuller and George 1999). The combined 219 lb (99 kg) of plants and berries is the equivalent of nearly one pound per person in the community.

Wood collected for fuel and construction purposes is not always reported. Pedersen et al. (1985) believes this to be an issue of poor questioning as opposed to low utilization. Dry willows and driftwood were used for firewood when camping by all families observed in the field. Sometimes it is also used in the construction of cabins and small shelters, but observed numbers were low (Pedersen 1985). A survey conducted in 1992 (ADF&G 2009) shows an estimated 40 cords of wood were harvested in Kaktovik.

Nuiqsut

Of the Iñupiat residents in Nuiqsut, 94.5 percent use subsistence resources (Shepro et al. 2003). Nuiqsut villagers hunt large land and small mammals, coastal and marine birds, and a high percentage of marine mammals including seals, walrus and bowhead whales.

Large Land Mammals

Large land mammals constitute a larger percentage of the annual subsistence harvest in Nuiqsut than in Kaktovik. The two primary large land mammals harvested by Nuiqsut hunters are caribou and moose. Caribou are harvested in much larger numbers than moose as they are more numerous and readily available. The harvest of other large land mammals such as brown bear and Dall sheep is opportunistic and less common. Muskox is harvested less frequently than the other large land mammals. The majority of households in Nuiqsut, 98 percent used land mammals as a subsistence resource in 1993 and 76 percent of households were involved in the direct harvesting (Pedersen 1995b).

Caribou

As in Kaktovik, caribou are the largest category of land mammals harvested in Nuiqsut. Members of the CAH migrate towards the Colville Delta in May and June. They calve on the coast between the Colville and Sagavanirktok River deltas (ADNR 1999). Caribou are available year-round, but most are harvested between July and October (Brower and Hepa 1998; Fuller and George 1999; MMS 2008). During the 1992 subsistence season an estimated 278 caribou were taken for approximately 32,550 edible lbs (14,764 edible kg) or 21.7 percent of the total harvest (Fuller and George 1999). In 1993, caribou accounted for 30 percent of the overall subsistence harvest for the community (ADNR 1999). In the 1994-1995 subsistence season, Caribou constituted approximately 58 percent of the overall harvest in edible pounds (Brower and Hepa 1998).

There has been concern in recent years regarding the lower numbers of caribou being harvested by Nuiqsut hunters. Hunters have to travel longer distances to get to the caribou, and increasing numbers of muskox in traditional caribou hunting areas are keeping the caribou away (Brower and Hepa 1998).
Dall Sheep

Dall sheep are used as a subsistence resource by residents, but the data available between 1985 and 1995 do not indicate that any households attempted to directly harvest any sheep. Sheep meat is likely traded in from other villages. Thirteen percent of households in Nuiqsut reported using Dall sheep as a subsistence resource in 1993 (Pedersen 1995b).

Muskox

Similar to sheep, muskox are considered a subsistence resource by residents of Nuiqsut but are rarely harvested, despite reports that the numbers of muskox in the vicinity of Nuiqsut are increasing. In 1993, eight percent of households surveyed reported using muskox (Pedersen 1995b).

Brown Bear

Brown bear are occasionally taken by Nuiqsut hunters, but they are not normally eaten and are not factored into the edible pounds harvested by the community. Available data show that three brown bear were harvested in 1992 (Fuller and George 1999), ten in 1993 (Pedersen 1995b), and none in 1994-1995 (Brower and Hepa 1998). The estimated lbs harvested for the community for 1993 is 733 (332 kg), or approximately two lbs (one kg) per person (Pedersen 1995b). The data for that year also show that 16 percent of households attempted to harvest brown bear in 1993. Approximately half of the households that attempted to harvest brown bear were successful (ADF&G 2009).

Moose

Nuiqsut residents most often hunt for moose between the village and the confluence of the Anaktuvuk and Colville Rivers. In recent years, hunters have had to travel further south as the moose population on the North Slope is on the decline (ADNR 1999). Moose are also found further from the community on the Chandler and Itkillik rivers (MMS 2008a). They are usually harvested in the fall, between the months of August and October, but can be taken all year (Brower and Hepa 1998). Hunters can travel upriver in boats during the fall, but have been known to take moose on snowmachines in the winter as well (MMS 2008a). In 1992, moose was fifth in the top five species harvested in Nuiqsut, accounting for 5.9 percent of the total edible harvest (Fuller and George 1999). A typical annual harvest for Nuiqsut is six or seven moose (Fuller and George 1999).

Furbearers

The hunting or trapping of furbearing animals receives one of the lowest participation rates among subsistence activities in Nuiqsut, though the use of such resources remains relatively high at around 50 percent (ADF&G 2009). Commonly harvested furbearing animals are wolf, wolverine, red fox, arctic fox, weasel, and squirrel. Additional resources less frequently harvested include marmot, lynx, snowshoe hare, and mink (Brower and Hepa 1998; Fuller and George 1999; Pedersen 1995b). Modes of transportation for the harvest of furbearers are snowmachine and truck. Furbearers are harvested in the winter months, usually between November and April (Brower and Hepa 1998).

In 1992, approximately 20 percent of Nuiqsut households took part in trapping for furbearers and nearly 45 percent reported activities related to the processing of skins, such as sewing and making parkas (Fuller and George 1999). Wolf was the primary species taken that year with a harvest of 14. Other species harvested that year were arctic fox, red fox, wolverine and squirrel (Fuller and George 1999). In 1993 participation was slightly lower. Fifteen percent reported trapping or hunting, and 19 percent reported processing (Pedersen 1995b). Despite the lower participation rates in 1993, more furbearers were harvested that year. Foxes, squirrels, weasels, wolverines, and wolves were all harvested in 1993.
(Pedersen 1995b). During the 1994-1995 season, wolf was again the principal species harvested. Wolverine, fox, and red fox were also taken, for a total harvest of 41 animals (Brower and Hepa 1998).

**Coastal and Marine Birds**

The percentage of coastal and marine birds harvested in relation to the other subsistence resources fluctuates, depending on the year. Similar to the reported harvest in Kaktovik for the 1992 and 1994-1995 subsistence seasons, the recorded harvest declined by more than 50 percent. (It should be noted that the study period for Kaktovik was December 1, 1994 to November 30, 1995, while the study period for Nuiqsut was July 1, 1994, to June 30, 1995.)

Marine birds are most intensively harvested in the spring, as migratory species are on the way east (ADNR 1999). However, all coastal and marine species are hunted through the summer and into fall opportunistically when the hunters are out looking for other resources. Geese and ducks are harvested near the river mouths as the river ice begins to break (MMS 2008a). Willow and rock ptarmigan are the only upland birds regularly harvested. Migratory birds harvested by Nuiqsut hunters include king, common, and spectacled eiders; long-tailed and pintail ducks, greater scaup, sandhill cranes, and whistling swans. Species of geese include black brant, snow geese, white-fronted geese, and Canadian goose (Brower and Hepa 1998; Pedersen 1995b).

In 1985, five percent of the total edible harvest in Nuiqsut came from birds. Eighty-five percent were migratory birds and the remaining 15 percent was ptarmigan. The entire amount harvested in the community that year equaled 20 lb (9 kg) per person (ADF&G 2009). In 1992, birds accounted for 2.6 percent of the edible harvest, or approximately nine lbs (four kg) per person (Fuller and George 1999) (Table 3.11.7-3). In 1993, birds and bird eggs accounted for around two percent of the edible harvest, or approximately 12 lb (5 kg) per person (Pedersen 1995b). Between July 1994 and June 1995, birds represented five percent of the edible subsistence harvest for Nuiqsut (Brower and Hepa 1998).

**Table 3.11.7-3**  **Birds and Waterfowl Harvested in Nuiqsut, 1992 and 1995**

<table>
<thead>
<tr>
<th>Species</th>
<th>1992</th>
<th>Percent of Bird Harvest</th>
<th>1995</th>
<th>Percent of Bird Harvest</th>
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<tr>
<td>Long-tailed duck (oldsquaw)</td>
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<td>-</td>
</tr>
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<td>Pintail duck</td>
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<tr>
<td>Greater scaup</td>
<td>1</td>
<td>0.07</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sandhill crane</td>
<td>1</td>
<td>0.07</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,483</td>
<td><strong>100</strong></td>
<td>605</td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

(Source: Fuller and George 1999; Brower and Hepa 1998)
Fish

Fish is one of the primary subsistence categories in Nuiqsut, often comprising 30 percent or more of the annual edible subsistence harvest (ADF&G 2009; Brower and Hepa 1998). Fishing has one of the highest reported participation rates for the community, if not the highest, depending on the year (Fuller and George 1999; Pedersen 1995b). In 1993, non-salmon fish were shared more than any other resource category, with 87 percent of the households surveyed reporting giving or receiving this resource (Pedersen 1995b).

In addition to being the largest river system on the North Slope, the Colville River supports the largest areas of overwintering for whitefish (Craig 1989). The arctic cisco is the main species harvested, but other major contributors are broad whitefish, humpback whitefish, least cisco, burbot and grayling (ADNR 1999; Pedersen 1995b). Fishing is concentrated along the Nigliq Channel between Nuiqsut and the coast. In 2004, 76 percent of the effort on the Nigliq Channel was in the Nigliq Delta area. Another major fishing area is on the outer delta of the Colville River, northeast of Nuiqsut (Moulton and Seavey 2005).

Residents harvest fish from the river in the summer and fall with nets. Sometimes they use rod and reel to catch ling cod, grayling, and lake trout (ADNR 1999). Residents also take Arctic cisco and whitefish in large quantities in the fall, just before freeze-up, as they are heading upstream. Residents travel after river ice has formed, when they can access fishing spots on snow machines (ADNR 1999; Brower and Hepa 1998). Nuiqsut residents reported harvesting “sled loads” of these fish “every couple of days” throughout October and November of 1994 (Brower and Hepa 1998).

Arctic cisco is a key subsistence species for the community of Nuiqsut. They are harvested in the late fall, after ice forms on the Colville River delta near Nuiqsut. The annual subsistence harvest between 1985 and 2004 has covered a broad range, between 6,000 and 47,000; an average of 22,075 fish per year (Moulton and Seavey 2005).

Broad whitefish are another important subsistence species for residents on the North Slope. Between 1985 and 2004, the annual subsistence harvest ranged between six and 1,514 fish taken during the Colville Delta fall fishery.

The subsistence harvest of least cisco by residents in Nuiqsut is far greater than the harvest in Kaktovik (Pedersen 1995b). Between 1992 and 2004, an average of 8,890 least cisco were harvested in the Colville fishery, with a high take of 15,854 in 1996 and a low of 1,973 in 2000 (Moulton and Seavey 2005).

Humpback whitefish is also commonly represented species in the subsistence fishery in Nuiqsut. Between 30 and 6,395 fish were taken annually between the years of 1992 and 2004 (Moulton and Seavey 2005).

Several reports discuss the amount of fish harvested in Nuiqsut annually; however, the consensus is that those prepared by Moulton and Seavey (2005) contain the most accurate data. These studies are conducted by counting the fish as they are pulled from the nets, whereas other studies are conducted through interviews after the season is over (Fuller and George 1999).

Marine Mammals

Marine mammals are a highly valued subsistence resource in Nuiqsut, despite the distance from the village to the coast, and the edible pounds harvested ranges from two percent to 35 percent, or more. Marine mammals commonly taken are polar bear, ringed seal, bearded seal, spotted seal, and bowhead whales. Beluga whales are often mentioned as a subsistence resource, but infrequently reported as a harvested resource. Walrus are uncommon in the Beaufort Sea and rarely harvested.
Figure 3.11-10 Selected Nuiqsut Subsistence Use Areas for Waterfowl
Figure 3.11-11  Selected Nuiqsut Subsistence Use Areas for Bowhead and Seal
Polar Bear

Nuiqsut residents hunt polar bear from mid-September through late winter, but they do not hunt them often. However, they use the fur to make boots, mittens, and coats, and may hunt polar bear 10 mi (16 km) beyond the barrier islands. When hunting polar bear, residents generally hunt them during the winter (MMS 2008a).

Seal

The majority of marine mammals harvested in Nuiqsut are seals. Seals are valued for their meat and oil as well as their skins, which are used to make clothing, including boots, slippers, and mittens (MMS 2008a). They can be hunted year-round, but are taken in highest numbers in the summer months. Seal-hunting trips can take Nuiqsut hunters several miles offshore; the majority of seal hunting, however, takes place closer to shore. The mouth of the Colville River is considered a productive seal hunting area, as well as the edge of the sea ice. Years in which the sea ice is closer to shore are known to be better seal-hunting years (MMS 2008a). Participation in seal hunting is the highest of all the marine resource subsistence activities for Nuiqsut. Fifty percent of households reported participating in seal hunting in 1992 (Fuller and George 1999).

Ringed seals are usually harvested in the highest numbers, though the meat of the bearded seals is preferred (MMS 2008a). In 1992, 24 ringed seals were harvested by Nuiqsut hunters for an estimated 1,026 edible lbs (465 edible kg) (Fuller and George 1999). 1993 was a very productive year for the harvest of ring seals; 98 seals were harvested for a combined total of over 7,000 edible lb (over 3,175 edible kg) (Pedersen 1995b). Twenty-three ringed seals were taken in 1994-1995, totaling approximately 1,000 edible lbs (454 kg) (Brower and Hepa 1998; Brower et al. 2000).

Bearded seals are harvested in lower numbers than ringed seals, but are considerably larger, resulting in nearly four times the amount of edible meat per animal (Brower et al. 2000). Sixteen bearded seals were taken in 1992, totaling nearly 3,000 edible lb (1361 edible kg) (Fuller and George 1999). In 1993 six bearded seals were harvested, and no bearded seals were reported from the 1994-1995 subsistence season (Brower and Hepa 1998; Pedersen 1995b).

Spotted seals are especially valued for their beautiful skins used for clothing and decorative trim for boots and parkas (MMS 2008a). Following the salmon and char runs, they swim up the Colville River. They are harvested as far south as the confluence with the Itkillik River (ADNR 1999). Spotted seals accounted for approximately six percent of the edible pounds of seal meat harvested in 1992 (Fuller and George 1999).

Whaling

Whaling in Nuiqsut is both a symbolic and fundamental part of Arctic life. Whaling provides ties to the cultural heritage of those who inhabit the far north and ensures this connection with the past is carried forward to future generations. Whaling is perhaps one of the most culturally significant subsistence activities for the coastal Iñupiat communities. Considered one of the most ancient traditions connecting present-day Iñupiat people with their past, it is thought of as a way-of-life more than an activity (University of Arkansas 2007). Whaling crews continue to be primarily kinship-based (MMS 2008a). While not every member of the community participates in the taking of a whale, the hauling, cleaning, and distribution involves an entire community. An umialik, or whaling captain, shares whale meat and maktak with the other whaling captains and everyone that helps pull and cut up the whale. Fresh whale meat is usually distributed by the successful captain’s crew members, with some set aside to be served at the Thanksgiving and Christmas feasts held in the community churches. Nalukataq is a traditional
celebration of the whale that continues to play an important cultural role for Inupiat today (Chance 1990). This celebration, held in the summer, honors the whales that have given themselves (Brower 2004). Symbolic of this festival is nalukataq, or the blanket toss, hosted by the successful whaling crew or crews. Bearded seal or walrus skin blankets are used to toss people up to 20 ft (6 m) into the air. While in the air, the person being tossed will throw out candies to the crowd (Chance 1990). More than a substantial source of food, the significance of whaling lies in its social organization and expression of cultural values (Galginaitis 2009).

Nuiqsut's location on the Colville River south of the coast makes whaling more difficult than in other villages on the North Slope, but does not preclude villagers from taking part in the fall hunt. It does, however, require more planning and effort. There is no spring hunt in Nuiqsut, but whalers sometimes participate in Barrow’s hunt (MMS 2008a). The further the whalers have to go out to sea in search of whales, the longer it will take to get a whale back to shore. According to Burton Atqaan Rexford, retired whaling captain and former chairman of the AEW, it takes approximately 10 hours to tow a 35-50 ft (11-15 m) whale a distance of 25 mi (40 km).

**Bowhead**

In early September, Nuiqsut whalers travel down the Colville River and across Simpson Lagoon to Cross Island where they set up camp. They sometimes set up camp on Nora Island as well. From Cross Island, the whaling crews travel into the Beaufort Sea. Once a whale is taken, it is brought back to the Cross Island camp to be butchered (ADNR 1999). Ideally, whales will be taken within 10 mi (16 km) of Cross Island, but in the more recent past whaling crews have had to search further offshore (MMS 2008a). Whalers sometimes have to go as far as 40 mi (64 km) from the coast to find whales, risking the possibility of rough seas or storms that can be extremely dangerous if encountered in their aluminum skiffs (ADNR 1999). The activities described in the EP will not interfere with whaling even if it occurs this far from shore, as work will be suspended for the duration of the fall hunt.

Whaling is a community activity, though not all members of the community participate directly. In 1992, 40 percent of Nuiqsut residents reported spending time on the fall hunt and 20 percent reported spending time on the spring hunt (Fuller and George 1999). There is no spring hunt from Nuiqsut, but whalers sometimes participate in Barrow’s hunt (MMS 2008a). The whale meat and maktak is distributed throughout the community. In 1993, nearly 97 percent of Nuiqsut residents reported using bowhead whale as a subsistence resource, while only 37 percent attempted to harvest the resource. A total of 4.8 percent of residents harvested the three whales that were taken that year (Pedersen 1995b).

Subsistence bowhead whaling occurs generally during August to October. Nuiqsut whalers use an area extending from a line northward of Nechelik Channel of the Colville River to Flaxman Island, seaward of the barrier islands.

Nuiqsut whalers had less success in the 1970s, 1980s and early 1990s than in previous years, with a harvest of only 20 whales between 1972 and 1995. Recent years have proven more successful (MMS 2008a) (Table 3.11.7-4). Four whales, the quota for Nuiqsut, were harvested in Nuiqsut in 1998, 2000, 2002, 2003, and 2006 (Galginaitis 2009).

<table>
<thead>
<tr>
<th>Year</th>
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</thead>
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<td>0</td>
</tr>
<tr>
<td>1987</td>
<td>1</td>
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</table>
Table 3.11.7-4 Bowhead Whales Harvested Near Cross Island, 1973 Through 2010

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<tr>
<td>2009</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

(Source: Galginaitis 2009. Years of no harvest and no lost whales are not listed.)

Beluga

Beluga whales are much smaller than bowheads, averaging just over 1,000 edible lbs (454 edible kg) per whale, but they can be a very important supplemental harvest, especially in years of poor bowhead returns. Of the five distinct beluga stocks in Alaska, the Eastern Chukchi Sea and Beaufort Sea stocks may be found near the project area. Both these stocks winter in the Bering Sea. Few belugas remain in the central Beaufort Sea in the summer, but small numbers have been reported within the Colville River Delta (BLM 2005). Fall migrant beluga whales from the Canadian Beaufort Sea transit the Alaskan Beaufort Sea along the southern edge of pack ice to reach western Chukchi Sea waters primarily during September (Richard et al. 1998). See Section 3.7.9 and Appendix C of the EP for more information on beluga whales near the project area.

Beluga whales are also reported as a subsistence resource for Nuiqsut residents, but are harvested much less frequently than bowheads. This could reflect the higher desirability of the bowhead, both in terms of status and amount of meat provided, but more likely is a result of resource availability and success of the hunters. In 1993, 4.8 percent of Nuiqsut residents attempted to harvest beluga whales. None were taken in Nuiqsut that year, though 32 percent of the community reported using the resource (ADF&G 2009). No beluga whales were harvested in 1985, 1992, or 1994 (ADF&G 2009; Brower and Hepa 1998; Fuller and George 1999).

Plants/Berries/Wood

September is the prime month for berry picking and the harvesting of wild plants. Salmonberry, cranberry, blackberry, and blueberry are most commonly harvested berries. Crowberries are sometimes picked as well. Wild plants harvested include wild rhubarb, wild potato, wild chives, and Labrador tea leaves (Brower and Hepa 1998; Fuller and George 1999). Plants and berries typically account for less than one percent of the overall edible subsistence harvest for Nuiqsut (Brower and Hepa 1998). Approximately 32 percent of Nuiqsut households reported picking berries in 1992. An estimated 66 lbs (30 kg) of berries were picked that year; 35 lbs (16 kg), were blueberries (Fuller and George 1999). Sixty cords of wood were harvested in 1993 (Pedersen 1995b).
Figure 3.11-12  Selected Barrow Subsistence Use Areas for Walrus and Waterfowl
Figure 3.11-13  Selected Barrow Subsistence Use Areas for Bowhead and Seal
Figure 3.11-14  Selected Barrow, Nuiqsut, and Kaktovik Subsistence Use Areas
3.11.8 Recreation and Tourism

An increase in tourism on Alaska’s North Slope has followed the development of the oil and gas industry almost since beginning in the 1960s and 1970s (Everett 2004). Tourists and the tourist industry have become common in areas that were originally solely industry-related, such as Deadhorse (Prudhoe Bay). The Dalton Highway, once mainly used to support resource development activities, now is also used by tour buses and private vehicles. Tourist interests and activities include those related to the resource development industry (e.g., tours of oil fields and associated facilities); however, industrial facilities and infrastructure also provide a jumping off point for wilderness trips. There has also been an increase in tourism associated with wildlife viewing, such as polar bear viewing in Kaktovik and birding supported by the Barrow Birding Center.

Currently, there are few restrictions and guidelines in place to deal with impacts of increased tourism (Everett 2004). This may result in increased impacts to the arctic environment and existing communities. Kaktovik, a community located in close proximity to ANWR, has experienced impacts from tourist activities. The NSB Comprehensive Plan (2005) states that sport hunters and tourist activities are an issue for the community. Residents believe that they have no control over the tourist activities and impacts (e.g., in 2003 hunters ruined a subsistence camp with no restitution or repercussions). In addition, local residents are not seeing much financial benefit from increased tourism such as jobs as guides or an increase in tourism dollars spent in the community.

Kaktovik residents have indicated a need to develop a policy to regulate tourist activities and coordinate them with the community (NSB 2005). In addition, Kaktovik residents would appreciate better coordination between USFWS (which manages ANWR) and the community, tribe, and the Native Corporation.

3.11.9 Recreational and Commercial Fishing

A small commercial fishery has historically occurred west of the project area near the mouth of the Colville River. The quantity of fish harvested commercially is similar to that harvested for subsistence use by Nuiqsut, averaging approximately 83,500 lbs/year (37,875 kg/year) between 1987 and 1992 (BLM 2005). Although there are no other permitted commercial harvests of fish on the North Slope, there have been quasi-commercial harvests in Barrow and Nuiqsut where harvested fish were sold locally. In general, Arctic cisco has been the species targeted for harvest.

The subsistence harvest of fish is important throughout NSB communities. The community of Nuiqsut in particular relies on fish for subsistence with approximately 34 percent of harvest coming from fish (NSB 2005). The majority primary species relied upon for the subsistence fish harvest is Arctic cisco. Because of the life cycle of Arctic cisco, activities in coastal waters of the Beaufort may impact numbers of fish available for harvest. The adults spawn in the Mackenzie River in Canada; in spring juveniles transit to the Colville River where they winter; subadults remain in the vicinity of the Colville River until maturity, traveling to the Beaufort coastal waters to feed; and adults return to the Mackenzie River in fall to spawn.

Fish are also an important subsistence resource for the communities of Kaktovik and Barrow. Kaktovik residents rely on fish for approximately 13 percent of their subsistence harvest (NSB 2005). Although ocean-going fish are harvested, a large number of Dolly Varden and lake trout are taken from lakes west and south of the community near the Canning River (Sverre Pederson personal communication 2009).

North Pacific Fishery Management Council developed an Arctic Fishery Management Plan to establish a process for considering requests to develop future fisheries in federal waters (Chukchi and Beaufort Seas) based upon the best available science. The Arctic Fishery Management Plan governs commercial fishing
for all stocks of finfish and shellfish in federal waters, except Pacific salmon and Pacific halibut (these are managed under other agencies). The plan went into effect December 3, 2009. To develop the plan, the Council communicated extensively with communities on Alaska’s North Slope and other stakeholders. The Council decided on a precautionary approach, voting to prohibit commercial fisheries until sufficient information is available to sustainably manage commercial fishing. The plan does not affect fisheries for salmon, whitefish and shellfish in Alaskan waters near the Arctic shore. The plan does not affect Arctic subsistence fishing or hunting (http://alaskafisheries.noaa.gov).

### 3.11.10 Minority and Lower Income Groups

The Iñupiat residents, with their subsistence-harvest activities and sociocultural systems, are a minority/Native American community included under the Presidential Executive Order on Environmental Justice. The Iñupiat are a minority population in the state of Alaska and are the indigenous habitants within the vicinity of the proposed exploration project. Shell’s exploration planning includes input from the resident populations in Iñupiat villages, especially those closest to the project area, through comments on official documents and solicitation of traditional knowledge to add to the scientific and analytical sections of the environmental analysis.

Although the quality of life for many North Slope residents has improved with oil and gas revenues to the NSB, and resulting public facilities and services, poverty level in communities outside Barrow have increased. In 1998, 76 households were either at the poverty level or very low income (ADL&WD 2008). By 2003, this had increased to 100 households (Shepro et al. 2003). Of those families in the NSB whose incomes were below the poverty line in 1999, 86 percent were Native (NEI 2006). Poverty-level households for Kaktovik and Nuiqsut reported in 2003 are listed in Table 3.11.8-1.

The NSB 2003 Census and Economic Profile was used as background information for the North Slope Comprehensive Plan that addresses the issues, goals, and objectives of the communities in the region to maintain subsistence and to improve the quality of life in the region (NSB 2005).

<table>
<thead>
<tr>
<th>Community</th>
<th>Poverty Level (No. of Households)</th>
<th>Total Households Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaktovik</td>
<td>3</td>
<td>41</td>
</tr>
<tr>
<td>Nuiqsut</td>
<td>12</td>
<td>65</td>
</tr>
</tbody>
</table>

Notes: Results include only those households responding to the census survey and the questions of household income and size. (Source: Shepro et al. 2003)

There has been extensive outreach to the residents in the region on the part of BOEMRE during the EIS process and by Shell. Shell has made frequent visits to NSB communities for POC meetings and open houses. The community meetings are documented in an Appendix H of the Camden Bay Area EP. Job fairs have been held by Shell to provide residents with opportunities to seek employment.
3.12 Coastal and Marine Uses

3.12.1 Coastal Zone Management Programs

The Coastal Zone Management Act (CZMA), enacted in 1972, is intended to help regulate coastal development. The corresponding Alaska statute, the Alaska Coastal Management Act (ACMA), went into effect in 1977. The ACMA provides for shared management of coastal areas and resources by state and federal jurisdictions, as well as by appropriate federal and state agencies. The Alaska Coastal Management Program (ACMP) uses the ACMA as a guide to manage coastal resources within the Alaskan coastal zone. In February 2008, the authority to administer the ACMP was shifted from the ADNR, Office of Project Management and Permitting (OPMP) to the newly established Division of Coastal and Ocean Management (DCOM) within the ADNR.

Under the ACMP, all coastal districts must periodically revise their local plans to conform to the statewide standards. The existing North Slope Borough Coastal Management Plan (NSBCMP) dated May 1988 remained in effect as a whole until March 1, 2007. At that point, any existing NSB enforceable policies that duplicated, restated, or incorporated by reference a federal or state standard or regulation or subject addressed by the Alaska Department of Environmental Conservation (ADEC) were repealed. As of October 31, 2007, the proposed NSBCMP enforceable policies were approved with recommended amendments. However, the Final Plan Amendment is not yet implemented and currently the NSB and DCOM are in mediation over the Final Plan Amendment (OPMP 2007a). For this reason, only the State of Alaska ACMP standards are available for consistency evaluation for projects located in the NSB or on OCS lands adjacent to the NSB.

Any project in the OCS that requires the submission of an OCS plan (e.g., exploration plan, development and production plan) is subject to review under through the ACMP. The geographic location of the project determines if district standards need to be addressed in addition to state standards for consistency determination. However, for the Camden Bay EP activities, Shell is proposing to stage and transfer personnel and supplies within the coastal zone areas and facilities at West Dock using already permitted facilities. These facilities have previously gone through ACMP review. Unless additional facilities requiring permitting are necessary, these areas are not included in the EP consistency evaluation located in Section 15 of the Camden Bay EP.

Alaska State Statute AS 46.40.020 states the following:

*The Alaska coastal management program shall be consistent with the following objectives:*

1. the use, management, restoration, and enhancement of the overall quality of the coastal environment;
2. the development of industrial or commercial enterprises that are consistent with the social, cultural, historic, economic, and environmental interests of the people of the state;
3. the orderly, balanced utilization and protection of the resources of the coastal area consistent with sound conservation and sustained yield principles;
4. the management of coastal land and water uses in such a manner that, generally, those uses which are economically or physically dependent on a coastal location are given higher priority when compared to uses which do not economically or physically require a coastal location;
5. the protection and management of significant historic, cultural, natural, and aesthetic values and natural systems or processes within the coastal area;
6. the prevention of damage to or degradation of land and water reserved for their natural values as a result of inconsistent land or water usages adjacent to that land;
7. the recognition of the need for a continuing supply of energy to meet the requirements of the state and the contribution of a share of the state's resources to meet national energy needs; and
8. the full and fair evaluation of all demands on the land and water in the coastal area.

The ACMP requires project sponsors to prepare a consistency evaluation of their proposed activity that meets certain threshold requirements. These threshold requirements typically address the permits needed from resource agencies for the project. Statewide standards which may be relevant to the proposed exploration drilling activities in this Camden Bay EP include: coastal development; coastal access; natural hazard areas; energy facilities; subsistence; transportation routes and facilities; habitats; air, land, and water quality; and historic, prehistoric, and archaeological resources.

A consistency evaluation for each state standard (NSBCMP are not available to evaluate at this time) is completed by the applicant or project sponsor as part of the ACMP process. The approval process begins with a review for completeness of the consistency evaluation by the DCOM. This review must take place within 21 days of the DCOM receiving the evaluation (provided as part of the EP submittal package).

After the consistency evaluation is determined to be complete, a public notice is provided and a 30-day public comment period begins. The agency performing the consistency review considers public and agency comments in making its consistency determination. Proposed consistency findings from DCOM are presented 14 days after the public comment period has ended. Fifty days following the determination by DCOM that the applicant-prepared consistency evaluation is complete, the final findings are published. However, there are several different points within the 50-day review period in which the review clock can be stopped. The first is during the public comment period. The clock will stop in order to fulfill a request for additional information to be provided by the applicant. Another stop may occur on day 45 if there is an irreconcilable disagreement between the applicant and state or federal agencies, or the coastal district, regarding the proposed findings. The consistency review will then be given to the ADNR Commissioner or designee who will decide the final finding.

3.12.2 Military Activities

The USCG has conducted relatively limited activities in the Beaufort in recent past, but it is likely to increase activities in the near future. Based on observations of changing climate, and specifically, retreating ice pack, the USCG has planned to extend its operations to Northern Alaska (Fredrickson 2008; Committee on the Assessment of U.S. Coast Guard Polar Icebreaker Roles and Future Needs [Icebreaker Committee] 2005; USCG 2008a). In 2005, the Icebreaker Committee found that economic activity including commercial fishing, cruise ships, and natural resource exploitation was moving north, and gave a recommendation that the United States should maintain year-round icebreaker capability to support national security and science interests (Icebreaker Committee 2005). Additionally, there is interest in international boundary claims (Figure 3.12-1) and future international maritime arctic shipping routes (Figure 3.12-2) (USCG 2008a). District 17 (Alaska) of the USCG has stated that, “all Coast Guard missions in Southern Alaska must be expanded to Northern Alaska” (USCG 2008a).
Figure 3.12-1  Boundary Claims

![Boundary Claims](source: USCG 2008a)

1) North Pole  
2) Lomonosov Ridge  
3) 200 nautical mile line  
4) Russian-claimed territory

Figure 3.12-2  Future Potential Arctic Shipping Routes

![Future Potential Arctic Shipping Routes](source: USCG 2008a)
The USCG uses both aircraft and marine vessels to carry out its mission in Alaska, and use of these will be discussed separately in the following sections.

**Ice Management Vessels**

The USCG conducts activities in the Arctic and Antarctic regions. It has three ice management vessels in its fleet: U.S. Coast Guard Cutter (USCGC) *Polar Star*, USCGC *Polar Sea*, and the USCGC *Healy*. The USCGC *Polar Sea* is currently inactive. All three of these vessels are part of the USCGC’s science operations (USCG 2008b). At this time, two ice management vessels operate in Arctic waters.

To schedule scientific cruises, the USCG meets with agencies sponsoring scientific endeavors the fall of the year prior to the proposed project or activity. It is difficult to know at this time whether USCG ice management vessels will be in the Beaufort during the proposed Camden Bay exploration activities (USCG 2008c).

**USCGC *Polar Sea***

Until recently, the USCGC *Polar Sea*’s primary missions entailed breaking routes to U.S. research stations in Antarctica (Doughton 2007). During the summer of 2007, it underwent considerable changes. USCG District 17 publicized that the USCGC *Polar Sea* would embark on an Arctic mission in 2008 (USCG 2008a), and the ship’s crew reports that it routinely operates in the Bering and Chukchi Seas, the Arctic Ocean, and around the continent of Antarctica (USCG 2008d). In April and May of 2008 the USCGC *Polar Sea* conducted a multi-mission Homeland Security patrol in Arctic waters (Brooks 2008). The vessel was tracked throughout the Bering Sea (sailwx.info 2008). Table 3.12.2-1 depicts specifications of the USCGC *Polar Sea*.

**Table 3.12.2-1 USCGC *Polar Sea* Specifications**

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<td>Full Load Displacement</td>
<td>13,439 metric ton (13,227 Long Tons)</td>
</tr>
<tr>
<td>Top of Mast above Waterline</td>
<td>138 ft (42.1 m)</td>
</tr>
<tr>
<td>Height of Eye from Bridge above Waterline</td>
<td>55 ft (16.8 m) (10 mi [16 km] to horizon)</td>
</tr>
<tr>
<td>Height of Eye from Aloft Conn above Waterline</td>
<td>104 ft (31.7 m) (13.8 mi [22 km] to horizon)</td>
</tr>
<tr>
<td>Max Sustained Open Water Speed</td>
<td>17.5 knots</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power Train Information</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Diesel Electric Engines</td>
<td>6</td>
</tr>
<tr>
<td>Number of Gas Turbines</td>
<td>3</td>
</tr>
<tr>
<td>Number of Shafts</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Horsepower per Shaft</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Diesel Engine/Shaft</td>
<td>3,000 hp continuous</td>
</tr>
<tr>
<td>2 Diesel Engine/Shaft</td>
<td>6,000 hp continuous</td>
</tr>
<tr>
<td>1 Gas Turbine/Shaft</td>
<td>20,000 hp continuous</td>
</tr>
<tr>
<td></td>
<td>25,000 hp demand boost</td>
</tr>
</tbody>
</table>

Notes: ft = feet/foot; hp = horsepower; m = meter(s)
(Source: USCG 2008d)
USCGC Healy

The USCGC Healy is the USCG’s newest and largest icebreaker. According to the USCG, the ship’s primary mission is, “to function as a world-class high-latitude research platform with emphasis on Arctic science” (USCG 2008b). Since 2002, the USCGC Healy has supported scientific endeavors in waters off Alaska, during its Arctic West Summers Mission (USCG 2008e). These missions have taken the ship, crew, and researchers to the Beaufort, Chukchi, and Bering Seas, and the Gulf of Alaska (USCG 2008b).

For Arctic Summer 2008, USCGC Healy traveled over 7,000 nautical miles and conducted over 1,100 individual science evaluations in the course of completing two separate science missions. The USCGC Healy’s missions were part of the National Science Foundation’s Bering Ecosystem Study and the North Pacific Research Board’s Bering Sea Integrated Ecosystem Research Program (USCG 2008f). The missions were times to study sea ice retreats through the Bering Sea and focused on improving the ecological understanding of the Bering Sea.

Table 3.12-2 lists the vessel specifications of the USCGC Healy.

<table>
<thead>
<tr>
<th>Vessel Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length, Overall</td>
</tr>
<tr>
<td>Beam, Maximum</td>
</tr>
<tr>
<td>Draft, Full Load</td>
</tr>
<tr>
<td>Displacement, Full Load</td>
</tr>
<tr>
<td>Propulsion</td>
</tr>
<tr>
<td>Generating Drive Motors Plant</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Shaft Horsepower</td>
</tr>
<tr>
<td>Propellers</td>
</tr>
<tr>
<td>Auxiliary Generator</td>
</tr>
<tr>
<td>Fuel Capacity</td>
</tr>
<tr>
<td>Cruising Speed</td>
</tr>
<tr>
<td>Max Speed</td>
</tr>
<tr>
<td>Icebreaking Capability</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Science Labs</td>
</tr>
<tr>
<td>Accommodations</td>
</tr>
</tbody>
</table>

Notes: AC/DC = alternating current/direct current; ft = feet/foot; gal = gallon(s); hp = horsepower; kW = kilowatts; L = liter(s); m = meter(s); MW = megawatt; rpm = revolutions per minute.
(Source: USCG 2008e)
Aircraft

Considering the USCG initiative to expand all its current Alaska operations to the north, it is reasonable to assume that USCG air patrol operations in the North Slope area will increase. The USCG is currently using aircraft to gather information regarding northern Alaska to establish Arctic operations baseline information. With this information, the USCG will determine what kind of USCG presence will be needed in the future (Fredrickson 2008).

On October 25, 2007, the USCG conducted its first air mission in northern Alaska. The HC-130 Hercules airplane flew from Barrow to the North Pole, initiating its Arctic Domain Awareness mission. According to PA1 Kurt Fredrickson, the main purpose of this flight was to determine how well instruments and radio communications worked in the cold weather conditions (2008). The overall purpose of the mission is to provide the USCG a better understanding of the current Arctic environment by testing personnel and equipment capabilities. The program has continued annually since 2007. The first 2011 domain awareness flight was conducted March 22. Planned 2011 operations include three exercises to practice elements of search and rescue, pollution response, towing operations and mass casualty response with local communities and state agencies. The 2011 season has expanded operations utilizing cutters, aircraft and personnel from across the state to support 2011 operations from May through August (USCG 2008b, c, d, e, and f). Associated with this mission, members of the USCG participate in engagement with North Slope communities, Native corporations, and tribal representatives (Brooks 2008). It is presumed that the USCG will conduct missions over the next few years in the Arctic to collect baseline information. While the USCG has publicized that it will increase activities in this region in the future, the extent of the increase is currently not defined.

3.12.3 Shipping

Commercial offshore activities in the project area, other than oil and gas exploration and production, are limited to open water barge traffic providing fuel and other materials to North Slope villages, occasional barge traffic between Prudhoe Bay and the Mackenzie River in Canada, and infrequent traversing of the Beaufort by small cruise ships. Barge travel is typically limited to coastal regions between the shoreline and multi-year pack ice where water depths permit. Barge travel does not occur during winter months. Cruise ship activity also occasionally occurs north of the barrier islands and does not occur during winter months.

3.12.4 Commercial Fishing

A single commercial fishery exists in the Alaskan Beaufort; operated by the Helmericks family since the 1950s from their property within the northern Colville River delta. The fishery targets Arctic cisco, least cisco, and, to a lesser extent, broad whitefish during the summer and fall months. Fish are sold for human consumption and dog food in Fairbanks and Barrow.

3.12.5 Mariculture

No mariculture exists or is anticipated in the project area.

3.12.6 Other Mineral Uses

Aside from gravel extraction associated with the construction of onshore and near shore oil field development facilities, there are no other existing or anticipated mineral uses in the project area.
4.0 ENVIRONMENTAL IMPACTS

This section discusses impacts of the Camden Bay exploration drilling activities on the physical, biological, and sociocultural resources in the project area. Discussions of sociocultural and socioeconomic resources are focused on those resources that occur in the marine environment in the vicinity of Camden Bay and the communities that are most likely to be affected by the proposed activities (Nuiqsut and Kaktovik).

Minimal or negligible direct or indirect environmental impacts are expected from Shell’s proposed exploration drilling activities at the Torpedo and Sivulliq prospects. Activities will be supported from existing onshore infrastructure. The scope of the exploration activities analyzed includes transit of the Kulluk or Discoverer and associated support vessels to Camden Bay and Dutch Harbor, mooring and stabilizing the Kulluk or Discoverer, ice management, exploration drilling operations, permitted discharges, helicopter support and crew changes, supply trips to West Dock/Deadhorse, and marine mammal monitoring. Shell has requested and anticipates receiving a 1,640-ft (500-m) minimum safety zone surrounding the Kulluk and Discoverer (pursuant to 33 CFR 147.10 from the USCG) as a measure to prohibit unauthorized vessels from approaching the Kulluk or Discoverer and its support vessels, thereby, reducing potential vessel collisions and avoiding interference with refueling operations. At the proposed four drill sites, some local disturbance of bottom sediment, temporary increase in turbidity, and increased potential for marine wildlife encounters are expected. However, general effects on the marine and coastal environment during the exploration drilling program will be minimal (MMS 2003).

For each of the resources, conditions, and activities described in Section 3, where applicable, the individual impacts analyses Sections are organized as follows:

- Analysis of Impact of Vessel Traffic
- Analysis of Impact of Vessel Mooring, MLC construction, and Early Phase Drilling
- Analysis of Impact of Drill Cuttings and Drilling Mud Discharges
- Analysis of Impact of Other Permitted Discharges
- Analysis of Impact of Aircraft Traffic
- Analysis of impact of Sound Energy from Drilling and Ice Management Analysis of Impact of Liquid Hydrocarbon Spill
- Analysis of Impact of Project Air Emissions

4.1 Direct and Indirect Impacts

4.1.1 Ice

It is unlikely that ice flows will be in the exploration drilling program area in substantial quantities during this time. Operations will continue through October 31, and Shell anticipates a low probability of encountering ice during this period. Shell does not intend to break ice, except in case of emergency that has immediate threat to the vessel or personnel. However, an IMP consisting of constant ice forecasting and support from ice management vessels will be implemented to ensure safe operations during the drilling season. Ice forecasting will use real-time satellite imagery to chart the location and extent of sea ice. To assist the ice management vessel and anchor handler with ice management duties, the ice forecasts will aid in determining the safest navigation routes and the location of sea ice in the vicinity of a drill site.
It is anticipated that the ice management vessels will be managing ice for up to 38 percent of the time when within 25 mi (40 km) of the Kulluk or Discoverer. The ice floe frequency and intensity are unpredictable and could range from no ice to ice sufficiently dense that the fleet has insufficient capacity to continue operating, and the Kulluk or Discoverer would need to disconnect from its anchors and move off site. If ice is present, ice management activities may be necessary in early July and towards the end of operations in late October, but it is not expected to be needed throughout the proposed drilling season. Shell has indicated that when ice is present at the drill site, ice disturbance will be limited to the minimum needed to allow exploration drilling to continue. First-year ice will be the type most likely to be encountered. The ice-management vessels will be tasked with managing the ice so that it will flow easily around and past the Kulluk or Discoverer without building up in front of, or around it. This type of ice is managed by the ice management vessel continually moving back and forth across the drift line, directly updrift of the Kulluk or Discoverer and making turns at both ends. During ice management, the vessel’s propeller is rotating at approximately 15–20 percent of the vessel’s propeller rotation capacity. Ice management occurs with slow movements of the vessel using lower power and therefore slower propeller rotation speed (i.e., lower cavitation), allowing for fewer repositions of the vessel, thereby reducing cavitation effects in the water. Occasionally, there may be multi-year ice ridges that would be managed at a much slower speed than that used to manage first-year ice. Shell does not intend to break ice with the ice management vessels, but rather, intends to push it out of the area as described here. Shell has indicated that ice breaking could be conducted if the ice poses an immediate safety hazard at the drill sites, but is far from preferred as indicated in the IMP (see Appendix K).

Shell’s proposed exploration activities will have no adverse, long-term impact on the marine environment of Camden Bay, including any ice encountered in Camden Bay during the period of operations. In the event Shell encounters ice during its operations, implementation of the IMP and proactive management of ice floes will minimize any impacts Shell might have on the marine environment.

**Analysis of Impact of Vessel Traffic (Including Transit) on Ice**

No impacts to sea ice from vessel traffic are anticipated because most traffic will occur during ice-free or near ice-free conditions. Typically, nearshore ice begins melting in mid-May and pack ice starts to retreat northward in July. This creates an opening along the coastline through which vessels can transit. The opening remains and increases until new ice begins to form along the coastline and the pack ice begins to advance southward, about September or October.

Because pack ice and ice floes can be blown nearshore during the exploration drilling season, ice management vessels will assist the drilling vessel and support vessels during transit and routine daily operations. Travel routes will be established from ice forecasts to navigate around or through any ice that might encroach in the area of proposed operations. Managing ice floes to redirect those around operations is the main objective of the IMP, and ice management vessels will break ice floes that cannot otherwise be redirected and pose an immediate safety hazard for the drill site.

**Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Ice**

No impacts to sea ice from vessel mooring, MLC construction, or early phases of drilling are anticipated because minimal sea ice conditions are expected during operations. Active ice management will use ice forecasts and ice management vessels to locate and divert ice from entering the area surrounding the drill site.

**Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Ice**

Drill cuttings with adhered mud and drilling mud discharges will be captured and will be transported out of region and disposed of at a licensed TDS. The only cuttings that will be discharged are from
construction of the MLC and drilling the 36-in. and 26-in. diameter hole sections portions will be
discharged to the seafloor. These cuttings will be discharged to the seafloor and therefore, will not impact
sea ice. See also text above titled: “Analysis of Impact of Vessel Mooring, MLC Construction and Early
Phases of Drilling on Ice.”

**Analysis of Impact of Other Permitted Discharges on Ice**

Shell plans to collect and transport treated sanitary waste, domestic waste, bilge water and ballast water
out of region to a licensed TSD facility. The other permitted discharges will be deck drainage,
desalination unit waste, BOP fluid, non-contact cooling water, and excess cement slurry. Discussion of
non-contact cooling water discharge modeling is addressed in Section 6 of the EP. Discharge of these
waste streams will have no impact on sea ice.

**Analysis of Impact of Aircraft Traffic on Ice**

Because minimal sea ice is expected during the exploration drilling season, no impacts to sea ice from
aircraft traffic are anticipated. Aircraft supporting the exploration activities will travel according to daily
schedules between the shore base and the offshore vessels. In emergency situations, aircraft will have to
deploy to the emergency site(s) from the shore base. In the case that an aircraft would need to land on the
sea ice, real-time satellite imagery and ice forecasting would be used to choose the safest landing site.

**Analysis of Impact of Sound Energy from Drilling and Ice Management on Ice**

Sound energy generated by drilling and ice management will not impact sea ice.

**Analysis of Impact of Liquid Hydrocarbon Spill on Ice**

Section 2.10 of this EIA describes the potential sources of a hydrocarbon spill, the probability of various
types of spills occurring, and Shell’s plans for responding to a “small” spill (defined as 48 bbl or less).
As explained in Section 2.10, Shell’s categories of spill sizes are different from, but not incompatible
with, those used by BOEMRE. The probability of a large (> 48 bbl) liquid hydrocarbon spill is
sufficiently small to conclude it would not occur during the proposed exploration drilling program.
Prudent planning and state and federal regulatory requirements nevertheless require that Shell have
comprehensive spill prevention and response plans and capabilities in place. Shell’s plans include
measures to prevent any spill release from occurring and to respond in the event of a spill.

In the unlikely event of a spill, implementation of Shell’s ODPCP would minimize the impacts from the
spill and any effects on ice. Response equipment and trained personnel would be available on site to
deploy boom and recovery equipment for the control and removal of fuel spilled into the environment.
Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be conducted in
accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

Shell will not perform refueling activities in an area with ice coverage to the extent it would impact
refueling activities including required pre-booming procedures. Pre-booming will be conducted in such a
manner that ice would not be present within the boomed area, and care would be taken to limit to the
extent possible, ice in the water in the area of refueling activities. As mentioned, in the unlikely event
of a spill during refueling, Shell will have the necessary recovery equipment for the control of a spill and ice
which may be affected by the fuel would also be recovered. Therefore, the impacts from a small
hydrocarbon spill on ice during refueling are expected to be negligible and similar between Sivulliq and
Torpedo prospects.
Analysis of Impact of Small Liquid Hydrocarbon Spill on Ice

A small spill, such as a release of 48 bbl of diesel fuel, is the most probable type and volume of spill, if any, to occur as a result of this EP (33 CFR 154.1029(b)). A small spill would have a short duration, with more than 99 percent of the diesel evaporated or dispersed within 48 hours.

The probability of a small spill occurring would be minimized by implementing Shell’s oil spill prevention measures. In the unlikely event of a small spill (48 bbl or less), the duration of the spill and opportunity for impacting sea ice would be very brief, given the open ocean location of Shell’s proposed drill sites. In addition, Shell’s spill response measures, including pre-booming before any over-water fueling operation, are expected to ensure that spill impacts are localized and short-term. The impacts of a small spill on sea ice are expected to be negligible and similar between the Sivulliq and Torpedo prospects.

Analysis of Impact of Large Liquid Hydrocarbon Spill on Ice

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

Analysis of Impact of Project Air Emissions on Ice

The impact of project air emissions in Camden Bay on ice would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SO₂, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on ice.
Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

4.1.2 Air Quality

The existing air quality in the region of the proposed Shell exploration activity is good as described in Section 3.1.7. The background air pollutant concentrations are less than six percent of the applicable NAAQS. The projected emissions from the proposed Shell exploration activities will not significantly deteriorate the existing good air quality. EPA air permit requirements will ensure that Shell 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 rates from the Kulluk or Discoverer and its support vessels.

The following discussion combines analysis of impact of vessel traffic and drilling on air quality as these are the primary sources of project air emissions.

Analysis of Impact of Vessel Traffic and Drilling on Air Quality

While in transit, emissions from the Kulluk or Discoverer and its associated fleet will mostly be from propulsion engines and generation of power for domestic use onboard. Shell has committed to using ultra-low sulfur fuel for its drilling vessels and associated fleet and will have emission controls on the main engines for the Kulluk or Discoverer, ice management vessels, and anchor handler as discussed in Section 2.8. For these reasons, impacts to air quality from vessel transit are expected to be negligible and short-term due to movement of vessels and dispersion.

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

Emissions generated from the proposed Shell exploration activities will include NOₓ, CO, and SOₓ, small-diameter particulate matter such as PM₁₀ and PM₂·₅, and lead (Pb). The project will also generate lesser quantities of VOC, HAP, and ammonia, as well as CO₂. The majority of emissions will be generated from the combustion of diesel fuel for power production for the movement of the ice management and OSR vessels. The remainder of emissions will 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 NOₓ.

Total annual potentials to emit by pollutant for the Kulluk and support vessels is provided in Section 7 (Table 7.a-2) and for the Discoverer and support vessels these amounts are provided in Section 7 in Table 7.a-7 of this EP. The project emissions are based on a maximum 120-day drilling season, which is conservative and was used for air modeling purposes. Actual emissions are expected to be less than these estimated emissions as the generators are not expected to operate at full capacity and the operating level of ice management vessels could range from no use (no ice) through moderate use (redirecting ice) to heavy use for ice management depending on the amount of ice encountered during the drilling season.
The estimated air quality impacts (Section 7 of the EP) represent maximum potential impacts. Actual impacts are expected to be lower. Even under these conservative dispersion model assumptions and emission estimates, the model results indicate that the concentration of pollutants in the air will remain below national primary and secondary ambient air quality standards, within the 1,640-ft (500-m) ambient air boundary of the *Kulluk* or *Discoverer* and at the Beaufort Sea shoreline.

Support vessel emissions will be significantly lower with favorable ice conditions (e.g., less ice coverage). Ice management vessel activity account for a larger percentage of support vessels emissions, thus total emissions will be lower in favorable ice conditions. Ice management support vessel emissions are based on the 2003 to 2005 statistics on ice at the Sivulliq drill site showing 15 percent frequency of ice that would need to be fragmented (i.e., deflecting and/or breaking up ice floes to protect the *Kulluk* or *Discoverer*) and a 23 percent frequency of ice within 30 mi (49 km) of the drill site (Craik 2009). The sum of these two (38 percent frequency) was used as a conservative estimate of the possible need for ice management activity and estimating the ice management vessel emissions. The OSR vessel emissions that account for less than ten percent of the support vessel emissions are based on daily training exercises, eight hours per day, for the 120-day drilling season. The project actual emissions will be less with favorable open water, ice coverage conditions and a less than 120-day drilling season.

**Discoverer**

EPA has established air permit requirements in 40 CFR 52.21, the PSD that Shell must comply with before commencing their exploration activities using the *Discoverer*. Specifically, EPA has established significant emission rate thresholds in 40 CFR 52.21 as part of the permitting process for new sources to ensure air quality is not significantly deteriorated.

Shell has received a PSD permit from the EPA, and BACT has been applied to all pollutants. The BACT is described in Shell’s air permit application (Preconstruction Permit Application for the Frontier (now owned by Noble) *Discoverer* Drilling Vessel in Chukchi Sea, beyond the 25 mi (40.2 km) Alaska Seaward Boundary), prepared by Air Sciences Inc. Impacts are estimated using dispersion modeling procedures provided by EPA Region 10. Results of the modeling and impact analysis are provided in Shell’s air permit and are summarized in Section 7 of the EP (Table 7.f-3 and 7.f-4). The impacts were remodeled using the AERMOD model for SO₂ and NO₂. The EPA-acceptable dispersion modeling indicates that the NAAQS and PSD increments will be met at and beyond 1,640 ft (500 m) from the hull of the *Discoverer*.

The inclusion of required emission controls and the ambient air quality impact analysis is a prerequisite in obtaining a PSD permit to commence the project operation. The description of the source emission units, operating restrictions, emission controls, and emissions are included in the *Discoverer* Beaufort Sea PSD permit application and summarized in Section 7 of the EP. The permit includes a thorough air quality impact analysis demonstrating compliance with the NAAQS, the AAAQS, and the PSD Increments, and the additional air quality related values impact analysis.
**Kulluk**

Shell has applied for a minor source operating permit from EPA Region 10 for exploration drilling using the *Kulluk* on OCS leases in the Beaufort Sea. The estimated emissions and impacts have been greatly reduced by mitigation measure that will be implemented by Shell as discussed in Section 7 of the EP.

Results of the modeling and impact analysis are provided in Shell’s air permit application (ASI 2011) and are included in Section 7 of the EP (Table 7.f-1 displays the maximum estimated concentrations of NO₂, PM₂.₅, PM₁₀ and SO₂ near the drilling vessel). The concentrations do not exceed NAAQS or AAAQS at or beyond 1,640 ft (500 m) from the hull of the *Kulluk*.

A summary of the maximum modeled impacts of the *Kulluk* and associated fleet plus background concentrations for comparison to the NAAQS/AAAQS for the Beaufort Sea analysis is also provided in Section 7 of the EP. Modeling demonstrates that Shell’s proposed Camden Bay exploration drilling program with the *Kulluk* will comply with the NAAQS/AAAQS.

The nearest coastal villages to the OCS lease blocks are Nuiqsut, and Kaktovik, which are located 23, 20 and 9 mi (37, 32, and 14 km) from the nearest OCS lease blocks, respectively. Modeling from the nearest lease block was done since the permit application was drafted to cover the *Kulluk* if it were permitted to drill on any lease block currently valid in the Beaufort Sea. Table 7.f-2 (of the EP) provides a summary of the modeled impacts from the proposed *Kulluk* project at the nearest coastal village locations and shows that impacts are well below the NAAQS/AAAQS. Shell-only impacts are no higher than 5 percent of the NAAQS/AAAQS for any pollutant.

The projected emissions from the proposed Shell exploration activities will not significantly deteriorate existing good air quality. EPA air permit requirements will ensure that Shell 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 *Kulluk* or *Discoverer* and support vessels.

**Greenhouse Gas Emissions**

In May 2010, EPA established a tailoring rule for greenhouse gases/carbon dioxide (GHG/CO₂) (EPA 2010). The Shell exploration activities will not exceed the 75,000 tons per year of GHG equivalent PSD reporting threshold. The estimated GHG emission for the *Discoverer* and support fleet is approximately 57,568 tons (Air Sciences Inc., 2011a). The estimated GHG for the *Kulluk* and support fleet is approximately 60,413 tons (Air Sciences Inc., 2011b). The *Kulluk* or *Discoverer* and the support vessels combined projected CO₂ emissions will account for approximately 0.1 percent of the Alaska 2005 total statewide estimated GHG of 53 million tons and 0.40 percent of the Alaska 2005 statewide oil and gas industry estimated GHG of 15 million tons.

The projected CO₂ emissions from the proposed Shell exploration activities will be insignificant in relationship to the Alaska 2005 total statewide and Alaska oil and gas industry GHG/CO₂ emissions.

**Impact on Arctic Haze**

The Shell exploration activities will occur in the arctic summer, early fall months of July through October. Arctic haze is a winter, early spring phenomenon caused by anthropogenic air pollution from the Eurasian continent. Thus, Shell exploration activities will have no impact on arctic haze due to its summer-time activity.
Analysis of Impacts of Vessel Mooring and MLC Construction, and Early Phases of Drilling on Air Quality

Analysis of impacts on air quality from emissions of air pollutants by the *Kulluk* or *Discoverer* and anchor handling vessel during the setting of the anchors, construction of the MLC, and drilling are included in the emissions described above in Section 7 of the EP for both the *Kulluk* and the *Discoverer*. The analysis of impacts of air emissions during these activities is described in the section above titled: Analysis of Impact of Vessel Traffic and Drilling on Air Quality.

Analysis of Impact of Drill Cuttings and Mud Discharges on Air Quality

Shell plans to collect and transport drilling mud and cuttings with adhered mud. The only cuttings Shell plans to discharge are those generated during MLC construction and early phases of drilling through the 36-in. and 26-in. diameter hole sections. This material will be discharged to the seafloor. All other cuttings and drilling mud will be collected and transported out of region to a licensed TDS. Therefore, there is no impact on air quality.

Analysis of Impact of Other Permitted Discharges on Air Quality

Shell plans to collect and transport treated sanitary waste, domestic waste, bilge water and ballast water for disposal at a licensed TDS facility. The only other permitted discharges will be deck drainage, desalination unit waste, BOP fluid, non-contact cooling water and excess cement slurry. Discussion of the non-contact cooling water discharge modeling is presented in Section 6 of the revised Camden Bay EP. Discharges of these waste streams will have no impact on air quality.

Analysis of Impact of Aircraft Traffic on Air Quality

Fixed-wing aircraft and helicopters will be used to support the planned exploration drilling program. Engines on these aircraft will emit criteria air pollutants, but in small quantities compared to the *Kulluk* or *Discoverer* and support vessels. The emissions from these aircraft are therefore expected to have only negligible and temporary impact on air quality.

Analysis of Impact of Sound Energy from Drilling and Ice Management on Air Quality

Sound energy generated by drilling and vessel use will have no impact on air quality.

Analysis of Impact of a Liquid Hydrocarbon Spill on Air Quality

The types of oil spills that could occur, the probabilities of such spill occurring, response actions, and impacts are discussed in Section 2.10. A small spill, such as a release of 48 bbl of diesel fuel, is the most probable type and volume of spill, if any, to occur as a result of this exploration drilling program. Such a spill would have only minor and temporary effects on air quality. These potential impacts of a small spill are analyzed below.

**Impact of a Small Liquid Hydrocarbon Spill (48 bbl diesel) on Air Quality**

An unconfined release of 48 bbl of diesel would result in the volatilization of HAPs such as benzene, ethylbenzene, naphthalene, toluene, and xylenes (BLM 2002). However, in the open ocean conditions of the Beaufort Sea, they would be quickly dispersed. Emissions would also occur only over the small area of the spill (about 20 - 200 acres [ac] [0.1 – 0.8 km²]) for a brief time period. This represents the unmitigated scenario; required pre-booming before fuel transfers should contain the spill to a very small area, less than 5 ac (0.02 km²). For example, emissions of VOCs from crude oil spills are generally negligible about 24 hours after the release (IT Alaska 2001). Emissions from a diesel spill would likely
be reduced to negligible levels in a brief time period. More than 99 percent of a 48 bbl diesel spill in the Beaufort Sea would evaporate or disperse within 48 hours of the release (Section 2.10, Table 2.1-2). Effects on air quality from a 48-bbl spill of diesel are therefore considered minor and short term.

**Impact of a Large Liquid Hydrocarbon Spill on Air Quality**

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

**4.1.3 Water Quality**

Shell will collect and transport all NPDES-permitted discharges except for discharges as follows: deck drainage, desalination unit wastes, BOP fluid, non-contact cooling water, excess cement slurry. Shell will discharge cuttings generated by MLC construction and drilling through the 36-in. and 26-in. diameter hole sections which does not involve drilling mud. With these self-imposed restrictions on discharges for the Camden Bay exploration program, impacts to water quality in the project area will be negligible or non-existent. Section 2.7 describes discharges and waste management in detail.

**Analysis of Impact of Vessel Traffic and Drilling on Water Quality**

Vessel traffic and drilling will have little or no effect on water quality.

**Analysis of Vessel Mooring, MLC Construction, and Early Phase of Drilling on Water Quality**

Placement and retrieval of the anchors will disturb the seafloor sediments and some sediments will be resuspended in the water column during these processes. The increased sediment loads would be restricted to a very small area and would be expected to remain suspended for a very short time. Any such impacts to the water quality would be negligible and temporary, lasting only minutes to a few hours at most after the activity is complete.

It is expected that four wells will be drilled over the duration of the exploration program. For the **Kulluk**, construction of each MLC, 36-in. hole section and 26-in. hole section would result in a range of displaced material from approximately 5,184 bbl (824 m³) for Sivulliq G to 5,335 bbl (848 m³) for Torpedo J. For the **Discoverer**, the range of displaced volume of material ranges from 3,851 bbl (612 m³) for Sivulliq G to 4,002 bbl (636 m³) for Torpedo J. The larger displaced volume for the **Kulluk** is due to the larger diameter MLC construction in using the **Kulluk**. These sediments would be discharged to the seafloor. A portion of the sediments would be suspended in the water column, resulting in a temporary plume with increased TSS, turbidity, and biochemical oxygen demand (BOD). TSS loading in the plume is expected to be less than 1,000 ppm and could be less than 300 ppm (LaSalle et al. 1991). Previous construction work in the Beaufort Sea resulted in incremental TSS loads of 200-600 ppm (Slaney 1977, Envirocon 1977), but these loads were reduced to 14-100 ppm within about 1,640 ft (500 m) from the discharge point. Water quality effects of MLC construction and drilling the 36-in. and 26-in. diameter hole sections in the Beaufort will be localized and temporary, lasting only about as long as the MLC construction is ongoing.
Drill cuttings from MLC construction through the 36-in. and 26-in. diameter hole section will be discharged to the seafloor. Section 4.1.4 includes a summary of modeling of cuttings deposition on the seafloor. These materials comprise Discharge 013 and will have negligible or no potential impact on water quality.

**Analysis of Impact of Drill Cuttings and Mud Discharges on Water Quality**

The only cuttings Shell plans to discharge are those generated during MLC construction and early phases of drilling through the 36-in. and 26-in. diameter hole sections. This material will be discharged to the seafloor. All other cuttings and drilling mud will be collected and transported out of region to a licensed TSD facility. Therefore, there is no impact on water quality. Impacts on water quality would be temporary and short-term increased turbidity in the immediate area of the hole sections.

**Analysis of Impact of Other Permitted Discharges on Water Quality**

Discharge of deck drainage, desalination wastes, BOP fluid, non-contact cooling water and excess cement slurry could have minor short-term and temporary effects on water temperature, salinity, and pH. Associated impact on water quality associated with disposal of these wastes is negligible.

**Analysis of Impact of Air Traffic on Water Quality**

Aircraft traffic will have no effect on water quality.

**Analysis of Sound Energy from Drilling and Ice Management on Water Quality**

Sound energy from drilling and ice management would have no effect on water quality. Sounds associated with drilling do not have sufficient energy to affect bottom sediments, so increases in turbidity and BOD are not expected.

**Analysis of Impact of Possible Liquid Hydrocarbon Spill on Water Quality**

Releases of oil in the marine environment can affect water quality as well as other resources. The only reasonably foreseeable release, based on spill statistics, is a small spill. Potential impacts associated with the event of a small spill are greatly minimized by Shell’s operations plans (including Fuel Transfer Plan and ODPCP) and the distance from shore at which most activities would be conducted.

Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill, including capabilities for responding to a “worst case” scenario release. In the unlikely event of a spill, implementation of Shell’s ODPCP would minimize the impacts from the spill and any effects on water quality. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

**Analysis of Impact of Small Liquid Hydrocarbon Spill**

Given the open ocean location of Shell’s prospects, the duration of a small spill and opportunity for effect would be very brief. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours, but recovery controls would ensure that any spill effects are localized and would result only in short-term environmental consequences. Effects would be similar among the Sivulliq and Torpedo prospects.

Light refined products, such as diesel, are narrow-cut fractions that have low viscosity and spread rapidly into a thin sheen. Based on the viscosity of the diesel fuel to be used by Shell, the maximum area of the
sea with diesel on the surface in an uncontained 48 bbl (7.6 m³) spill (i.e., no pre-booming) would be about 20 to 200 ac (0.1 to 0.8 km²) depending on sea state and weather conditions.

Diesel fuels do not tend to form emulsions. Because they are of low viscosity, light distillates tend to evaporate and disperse readily into the water column by even gentle wave action. There is also a high potential for dissolution to occur, from both surface sheens and droplets dispersed in the water column. The NOAA’s ADIOS2 (Automated Data Inquiry for Oil Spills) model indicates that about 51 percent of a small diesel spill would disperse into the water column and 48 percent would evaporate after 48 hours. The water-soluble fractions of diesel are dominated by two- and three-ringed polycyclic aromatic hydrocarbons (PAH), which are moderately volatile (NRC 2003). Cripps and Shears (1997) reported maximum concentrations of 540 ppm for n-alkanes and 222 ppm for PAH, on the day after a release of diesel fuel in coastal Antarctica, and that these levels returned to background levels within one week. The constituents of these oils are light to intermediate in molecular weight and can be readily degraded by aerobic microbial oxidation. Diesel is so light that 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 TSS loads (NRC 2003), and would not be expected to occur to any appreciable degree in offshore waters of the Beaufort Sea. Long-term persistence in sediments can occur under heavy loading and reducing conditions where biodegradation rates for anaerobic bacteria are low, but again that would not be expected to occur from a small spill offshore. Diesel oil is readily and completely degraded by naturally occurring microbes, generally in time frames of one to two months (NOAA 2006).

Water column effects from a small spill would likely be restricted to a small area (less than 200 ac [0.8 km²]) and have a duration of less than one week, and therefore are considered to be minor and short-term. This effects analysis is based on an uncontrolled release. The probability of such a spill occurring is greatly minimized by Shell’s ODPCP, Fuel Transfer Plan, best management practices and regulatory compliance. Any effects would be greatly minimized and mitigated by prevention and recovery efforts.

Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOMERE lease stipulations, USCG requirements, and Shell’s operating procedures.

**Analysis of Impact of Large Liquid Hydrocarbon Spill on Water Quality**

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

**Analysis of Impact of Project Air Emissions on Water Quality**

The impact of project air emissions in Camden Bay on water quality would be negligible. Shell has a major source PSD permit for the *Discoverer* (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the *Kulluk* (and associated fleet) in the Beaufort Sea as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated
with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (*Kulluk* or *Discoverer*).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO$_2$, PM, SO$_x$, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO$_2$, CO, SO$_2$, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on water quality.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

### 4.1.4 Seafloor Sediments

The seafloor in proximity to the drill sites will be disturbed by anchoring, construction of MLCs and early phases of drilling. Wastes to be discharged during the Camden Bay exploration program are described in Section 2.7 of this EIA and Section 6 of the EP. Seafloor sediments are described in Section 3.3.1. These discharges would have no effect or negligible effect on sediments. The amount and duration of disturbed or turbid conditions will depend on sediment material and consolidation and specific activity.

Drilling will be conducted through use of a MLC. MLCs will be excavated using a large-diameter bit (disk harrow) to excavate below the depth of anticipated ice gouge tracks. Material excavated by drilling will be air-lifted then deposited adjacent to the excavation. The amount of material displaced during the excavation of the MLC will depend on the size of the MLC (Table 4.1.4-1 and Section 6 of the EP, Tables 6a.1 through 6a. 4).

**Analysis of Impact of Vessel Traffic on Seafloor Sediments**

No disturbance to the seafloor sediments would be caused by vessels. There will be no impacts from vessel traffic on seafloor sediment.

**Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Seafloor Sediments**

Volume of disturbed sediment caused by anchoring of either the *Kulluk* or *Discoverer* is addressed in Section 2.3, Table 2.3-1. Direct and indirect effects would include slight changes in seafloor relief and sediment consistency. Both the anchor and anchor chain will disturb sediments and create an “anchor
scar,” which is a depression in the seafloor caused by the anchor embedding. The anchor scar is a depression with ridges of displaced sediment and the area of disturbance will often be greater than the size of the anchor itself, because the anchor is dragged along the seafloor until it takes hold and sets.

After the anchors are removed, the disturbed areas will eventually fill in from natural processes, such as ice gouging and natural movement of seafloor sediments. Time required for filling in the anchor scars will depend on currents, characteristics of the sea bottom sediments, and frequency and depth of ice gouging. Times on the order of five to 10 years have been reported for other areas such as the North Sea (DTI 2003).

Volumes of materials displaced by construction of each MLC are listed in Table 4.1.4-1.

<table>
<thead>
<tr>
<th>Drill Site</th>
<th>Kulluk bbl (m³)</th>
<th>Discoverer bbl (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sivulliq G</td>
<td>4,382 (696.7)</td>
<td>3,049 (484.7)</td>
</tr>
<tr>
<td>Sivulliq N</td>
<td>4,382 (696.7)</td>
<td>3,049 (484.7)</td>
</tr>
<tr>
<td>Torpedo H</td>
<td>4,382 (696.7)</td>
<td>3,049 (484.7)</td>
</tr>
<tr>
<td>Torpedo J</td>
<td>4,382 (696.7)</td>
<td>3,049 (484.7)</td>
</tr>
</tbody>
</table>

*Kulluk* MLC - 24 ft (7.3 m) diameter and 41 ft (12 m) deep  
*Discoverer* MLC - 20 ft (6.1 m) diameter and 41 ft (12 m) deep.

Using the *Kulluk*, construction of each MLC will directly disturb an approximate area of 452 ft² (42.0 m²) on the seafloor. Using the *Discoverer*, construction of each MLC will directly disturb an approximate area of 314 ft² (29.2 m²) on the seafloor.

Material will be excavated from the MLC using a large-diameter bit (disk harrow). Pressurized air and water will be used to assist in removal of the excavated materials from the MLC. Some of the excavated sediments will be displaced to adjacent seafloor areas and some will be removed via the air-lift system and discharged on the seafloor away from the MLC. These excavated materials will also have some indirect effects as they are deposited on the seafloor in the vicinity of the MLCs. Direct and indirect effects would include slight changes in seafloor relief and sediment consistency.

**Cuttings Deposition Model**

For both the *Kulluk* and *Discoverer*, Shell has modeled the deposition of cuttings on the seafloor. Shell has modeled the deposition of cuttings on the seafloor from a height of 10 ft (3.0 m) for each drilling vessel (described in Section 6 of the EP).

The cuttings pile is thickest and widest approximately 66 ft (20 m) down-current from the MLC. Modeling indicated the cuttings pile will be approximately 10 ft (3.0 m) thick and 328 ft (100 m) wide. Other cuttings pile dimensions from the diffuser are expected to be:

- 295 ft (90 m) down-current: 246 ft (75 m) wide and 4 in. (10 cm) thick
- 886 ft (270 m) down-current: 246 ft (75 m) wide and 0.4 in. (1 cm) thick
- 1,592 ft (485 m) down-current: end of the plume.
Analysis of Impact of Drill Cuttings and Mud Discharges on Water Quality

The only cuttings Shell plans to discharge are those generated during MLC construction and early phases of drilling through the 36-in. and 26-in. diameter hole sections. This material will be discharged to the seafloor. All other cuttings and drilling mud will be collected and transported out of region to a licensed TSD facility. Impacts from drill cuttings are addressed in the section above titled: Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Seafloor Sediments.

Analysis of Other Permitted Discharges on Seafloor Sediments

Permitted discharges such as deck drainage, cooling water and desalination unit waste will have little or no effect on seafloor sediments. These discharges will have very minor impact on the water column, but these effects would be ephemeral and restricted to the area immediately down current of the discharges. The discharges would have negligible impact on the seafloor sediments.

Analysis of Impact of Sounds from Drilling and Ice Management on Seafloor Sediments

Sound energy associated with drilling and ice management will have no effect on seafloor sediments.

Analysis of Impact of Liquid Hydrocarbon Spill on Seafloor Sediments

Section 2.10 of this EIA describes the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, Shell’s plans for responding to a “small” spill (defined as 48 bbl or less). As explained in Section 2.10, Shell’s categories of spill sizes are different from, but not incompatible with, those used by BOEMRE. The probability of a large (> 48 bbl) liquid hydrocarbon spill, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place. Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill.

In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill and any effects on sediments. Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

A small spill, such as a release of 48 bbl of diesel fuel, is the most probable type and volume of spill, if any, to occur as a result of this EP. Diesel is much lighter than water. It is therefore not possible for this oil to sink to the bottom and pool on the seafloor where it could contaminate sediments. Oil dispersed in the water column can adhere to fine-grained sediments that could then settle to the seafloor. However, this is more probable in nearshore areas with high suspended sediment loads (NOAA 2006). This would not be expected to occur in offshore waters of the Beaufort Sea, where evaporation and dispersion are rapid, and suspended sediment loads are low. A small spill would have a short duration, with over 99 percent of the diesel evaporated or dispersed within 48 hours. Diesel that was to reach the seafloor through adsorption and deposition would be degraded naturally by microbes within a period of one to two months (NOAA 2006).

A release of 48 bbl of diesel would be expected to have negligible effects on seafloor sediments in the offshore prospect areas.
**Impact of Large Liquid Hydrocarbon Spill on Seafloor Sediments**

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

**Analysis of Impact of Project Air Emissions on Seafloor Sediments**

The impact of project air emissions in Camden Bay on seafloor sediments would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea as required by the EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SO₂, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on seafloor sediments.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

**4.1.5 Lower Trophic Organisms**

Lower trophic level organisms present in the prospect areas include phytoplankton, zooplankton, and benthic invertebrates. The types of lower trophic organisms found in the prospect areas are discussed in Section 3.4 along with information on their abundance and distribution. No sensitive benthic
communities are known to occur within any of the prospects. Impacts to lower trophic organisms will result from vessel mooring, MLC construction, and early phases of drilling. Any such impacts will be negligible because the effects would be limited to an extremely small portion of the Beaufort Sea and the resources are widespread, and because of the short generation times of planktonic organism and the ability of benthic organisms to recolonize.

During the planned period of project operations, impacts to lower trophic organisms will be only temporary and localized, and cause no significant adverse impacts.

**Analysis of Impact of Vessel Traffic on Lower Trophic Organisms**

*Phytoplankton* - Propeller agitation and resulting turbulence in the surface waters may result in some destruction of phytoplankton organisms in the upper water column. These impacts would be similar to those experienced with normal vessel traffic in the Beaufort Sea and would not have a demonstrable impact on phytoplankton populations.

*Zooplankton* - Any effects from exposure of zooplankton to vessel sound energy or drilling-generated sound energy would be localized and short term. Studies on euphausids and copepods, which are some of the more biologically important groups of zooplankton in the Beaufort Sea, document the use of hearing receptors to maintain schooling structures (Wiese 1996) and detection of predators (Hartline et al. 1996). Studies on other crustaceans, such as brown shrimp in the Wadden Sea (Webb and Kempf 1998), indicate no particular sensitivity to sounds generated by air guns used in seismic survey activities (190 dB) at 3 ft (1 m) in water depths of 6.6 ft (2 m). Sound energy from drilling and vessel traffic would therefore have negligible impact to zooplankton as sound levels generated from these activities are at lower levels than those generated by seismic survey equipment (Burns et al. 1993). Populations of zooplankton are characterized by short generation times and high natural mortality rates, up to 99 percent in some species (McCauley 1994); therefore, even in the unlikely case of a high rate of mortality resulting from drilling and vessel sound, such effects would have minor or no impact to localized populations.

*Benthos* - Sound energy generation will not have a major effect on the habitat of benthic communities or population levels. Several evaluations have been completed comparing the potential effects of sound energy generated from seismic surveys on marine invertebrates (e.g., crabs, bivalves, sea sponges, and polychaetes). Those studies concluded that seismic survey sound pulses have limited effect on benthic invertebrates, and observed effects are typically restricted to animals within a few meters of the sound source, (Thomson and Davis 2001; Moriyasu et al. 2004). A recent Canadian government review of the impacts of seismic sound on invertebrates and other organisms (Canadian Department of Fisheries and Oceans [CDFO] 2004) includes similar findings. This review notes “there are no documented cases of invertebrate mortality upon exposure to seismic sound under field operating conditions” (CDFO 2004). Some sublethal effects (e.g., reduced growth, behavioral changes) were noted (CDFO 2004). However, no appreciable adverse impact on benthic populations is likely due in part to the large reproductive capacities and naturally high levels of predation and mortality of these populations.

**Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Lower Trophic Organisms**

In some years, phytoplankton and zooplankton may be abundant in the project area as evidenced by feeding bowhead whales in and around Shell’s seismic programs in 2007 and 2008 (Funk et al. 2010). However, the conditions that support abundant plankton in the waters of the area are highly variable and do not occur each year. Phytoplankton primary production requires sunlight. Sediment plumes (increased turbidity) generated during vessel mooring operations, MLC construction and the early phases of drilling have the potential to temporarily increase TSS in the water column and decrease the amount of light penetration. These plumes could affect the total primary production of phytoplankton communities...
in the project area though the effects overall would be small and limited to short time periods during operations. Moreover, lower trophic organisms are known to regenerate quickly. Given their capacity to regenerate quickly, and the short duration of the planned activities, any local communities of planktonic organisms impacted by the proposed operations are expected to recover quickly.

Impacts to benthic organisms and their habitat could result from direct disturbance of the seafloor from anchors, vessel mooring, and construction of MLCs. Such impacts would be localized and temporary. Lethal impacts to small populations of benthic organisms are possible from the placement of anchors and MLC Construction but would be limited to a relatively small area. Using the Kulluk, construction of each MLC will directly disturb an approximate area of 452 ft$^2$ (42.0 m$^2$) on the seafloor. Using the Discoverer, construction of each MLC will directly disturb an approximate area of 314 ft$^2$ (29.2 m$^2$) on the seafloor.

On a population level, this small area of disturbance to numbers and habitat of benthic infaunal and epifaunal organisms would be negligible, resulting in only localized and temporary impacts.

Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Lower Trophic Organisms

The only cuttings discharged will be from MLC construction and the early phases of drilling through the 36-in. and 26-in. diameter hole sections which do not contain drilling mud (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling.

Analysis of Impact of Other Permitted Discharges on Lower Trophic Organisms

The impact of other NPDES permitted discharges on phytoplankton in the project area will be temporary and result in no adverse impacts to phytoplankton populations.

Other permitted discharges include deck drainage, desalination unit waste, non-contact cooling water, BOP fluid, and excess cement slurry. These discharges will be conducted under the conditions and limitations of the required NPDES General Permit AKG-28-0000.

These types of discharges would result in changes in pH, temperature, TSS, and BOD in the water column, but the materials dilute and disperse rapidly in open ocean conditions and not have any direct effect on lower trophic organisms. Any indirect effect on lower trophic organisms would last only as long as the discharge is ongoing, would affect only a small portion of the total water column and, thus, would and be negligible.

Phytoplankton - Minor changes in water quality, such as increases in turbidity and decreased dissolved oxygen expected near the discharge site will have no effect on phytoplankton. These effects would largely be limited to the area within 330 ft (100 m) of the discharge location and would not impact phytoplankton in the area. The discharge produced from the water cooling unit is expected reach ambient temperature at a distance of 164 ft (50 m) from the discharge point on the Kulluk and 256 ft (78 m) from the discharge point of the Discoverer. Results of the cooling water modeling are presented in Section 6 of the EP. There will be no adverse impacts to phytoplankton as a result of these discharges.

Zooplankton - Discharge of the NPDES-permitted discharges would also have minor effects on water quality such as changes in temperature, salinity, and pH. These effects would largely be limited to the area within 330 ft (100 m) of the discharge location (EPA 1985), and will not adversely impact zooplankton in the area. Some entrainment of zooplankton will occur in the intake, use, and discharge of seawater. Entrainment effects would not be sufficient to result in a noticeable change in regional zooplankton populations and are considered minor and short term (less than one year).
The discharge produced from the water cooling unit is expected to reach ambient temperature at a distance of 164 ft (50 m) from the discharge point on the *Kulluk* and 256 ft (78 m) from the discharge point of the *Discoverer*.

Results of the cooling water modeling are presented in Section 6 of the EP. Cooling water discharges will have no adverse impact on zooplankton.

**Benthos** - The discharge of NPDES-permitted wastes will have no effect on benthic organisms. Some changes in water quality such as increases in turbidity and biological and chemical oxygen demand will occur in the area immediately adjacent to the discharge site but those changes will have no adverse effect on benthic plants or animals.

The discharges would also have minor effects on water quality such as changes in temperature, salinity, and pH. These effects would largely be limited to the area within 330 ft (100 m) of the discharge location, and will not adversely impact benthic organisms in the area.

The discharge produced from the water cooling unit is expected to reach ambient temperature at a distance of 164 ft (50 m) from the discharge point on the *Kulluk* and 256 ft (78 m) from the discharge point on the *Discoverer*. Results of the cooling water discharge model are presented in Section 6 of the EP.

Therefore, cooling water discharges will have no adverse impact on benthic plants or animals.

**Analysis of Impact of Aircraft Traffic on Lower Trophic Organisms**

*Phytoplankton* - Aircraft traffic associated with the exploration drilling program in Camden Bay will have no direct or indirect effects on phytoplankton. No reported instances of impacts to phytoplankton from overflights of helicopter or fixed-wing aircraft were found during a review of the scientific literature. Sound energy levels as great as 200 dB have been shown to have no effect on phytoplankton (Kosheleva 1992 in Turnpenny and Nedwell 1994); therefore, the lower sound energy levels produced by the aircraft proposed for Shell’s exploration project are expected to have no impact.

*Zooplankton* - Aircraft traffic associated with the exploration drilling program in Camden Bay will have no direct or indirect effects on zooplankton. No reported instances of impacts to zooplankton from overflights of helicopter or fixed-wing aircraft were found during a review of the scientific literature. Aircraft will fly at a minimum altitude of 1,500 ft (457 m) to minimize impacts of aircraft sound. As there is no impact from seismic, vessel traffic, or drilling sound energy, there will be no impact from aircraft sound.

*Benthos* - Aircraft traffic associated with the exploration drilling program in Camden Bay will have no direct or indirect effects on benthic plants or animals. The level and duration of sound received underwater from passing aircraft depends on altitude and aspect of the aircraft as well as depth and nature of the receiver. No reported instances of impacts to benthic organisms from overflights of helicopter or fixed wind aircraft were found during a review of the scientific literature. Aircraft will fly at a minimum altitude of 1,500 ft (457 m) to minimize impacts of aircraft sound energy. As there is no impact from seismic sounds, vessel traffic, or drilling, there will be no impact from aircraft sound energy.
Analysis of Impact of Sound from Drilling and Ice Management on Lower Trophic Organisms

Phytoplankton - Studies of sound energy produced by seismic operations at distances greater than 3 ft (0.9 m) concluded that such sound energy had no effect on phytoplankton (Kosheleva 1992 in Turnpenny and Nedwell 1994).

The sound energy resulting from the drilling activities and associated ice management activities will be at lower levels than sound energy produced by seismic survey sound sources. Therefore, sound energy resulting from the drilling operations and associated ice management activities will have no adverse impact on phytoplankton.

Zooplankton - Sound energy generated by drilling activities will not impact the diversity and abundance of zooplankton. The primary generators of sound energy are the drilling vessel and marine vessels. Ice management vessels are likely to be the most intense sources of sound associated with the exploratory drilling program (Richardson et al. 1995a). It is expected that the lower level of sound produced by the drilling vessel and other vessels would have less impact on zooplankton than seismic (survey) sound. No appreciable adverse impact on zooplankton populations will occur due in part to large reproductive capacities and naturally high levels of predation and mortality of these populations. Any mortality or impacts on zooplankton as a result of Shell’s operations is insignificant as compared to the naturally-occurring reproductive and mortality rates of these species. This is consistent with previous conclusions that crustaceans (such as zooplankton) are not particularly sensitive to sound produced by seismic sounds (Wiese 1996). Impact from sound energy generated by an ice breaker, other marine vessels, and drill ships would have less impact, as these activities produce lower sound energy levels (Burns et al. 1993). Historical sound propagation studies performed on the Kulluk by Hall et al. (1994) also indicate the Kulluk and similar drilling vessels would have lower sound energy output than three-dimensional seismic sound sources (Burns et al. 1993). The Discoverer will emit sounds at a lower level than the Kulluk and therefore the impacts due to drilling sounds would be even lower than the Kulluk. Therefore, zooplankton organisms would not likely be affected by sound energy levels by the vessels to be used during Shell’s exploration drilling activities in Camden Bay.

Benthos - Sound energy generated by drilling activities will not appreciably affect diversity and abundance of plants or animals on the seafloor. The lower level of sound produced by the drilling vessel and other vessels will have less impact on bottom-dwelling organisms than seismic (survey) sound. No appreciable adverse impacts on benthic populations would be expected due in part to large reproductive capacities and naturally high levels of predation and mortality of these populations. Any mortalities or impacts of benthic organisms as a result of Shell’s operations are insignificant compared to the naturally-occurring high reproductive and mortality rates. This is consistent with previous BOEMRE conclusions that the effect of seismic exploration on benthic organisms probably would be immeasurable (MMS 2007). Impacts from sound energy generated by ice breakers, other marine vessels, and drilling units or vessels would have less impact, as these activities produce much lower sound energy levels (Burns et al. 1993).

Analysis of Impact of Sound Energy from  on Lower Trophic Organisms

The ZVSP survey is short-term (approximately 12 hours per drill site). Sound energy generated by airguns associated with the ZVSPs would be expected to have little or no impact benthic invertebrates. Bodies of marine invertebrates are generally the same density as the surrounding water so that sudden changes in pressure, such as that caused by sudden loud sound, are unlikely to cause physical damage. Some research has evaluated potential effects of sound energy generated by airguns associated with seismic surveys on marine invertebrates (e.g., crabs and bivalves) and other marine organisms (e.g., sea sponges and polychaetes). Studies on brown shrimp in the Wadden Sea (Webb and Kempf 1998) have
revealed no particular sensitivity to sounds generated by airguns used in seismic activities with sound levels of 190 dB at 3.3 ft (1.0 m) in water depths of 6.6 ft (2.0 m). According to reviews by Thomson and Davis (2001) and Moriyasu et al. (2004), seismic survey sound pulses have limited effect on benthic invertebrates, and observed effects are typically restricted to animals within a few meters of the sound source. A recent Canadian government review of the impacts of seismic sound on invertebrates and other organisms ([CDFO 2004] included similar findings. This review noted “there are no documented cases of invertebrate mortality upon exposure to seismic sound under field operating conditions” ([CDFO 2004]). Some sublethal effects (e.g., reduced growth, behavioral changes) were noted ([CDFO 2004]). However, no appreciable adverse impact on benthic populations would be expected due in part to large reproductive capacities and naturally high levels of predation and mortality of these populations. This is consistent with BOEMRE’s ([MMS 2007b] conclusions that the effect of seismic exploration on benthic organisms probably would be very low and not measurable ([MMS 2007b]).

**Analysis of Impact of Liquid Hydrocarbon Spill on Lower Trophic Organisms**

Section 2.10 of this EIA analyzes the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, and Shell’s plans for responding to a “small” spill (<48 bbl). As explained in Section 2.6, Shell’s categories of spill sizes are different from, but not incompatible with, those used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place.

Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill, including capabilities for responding to a “worst case” scenario release. In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill and any effects on phytoplankton. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to hydrocarbon transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

**Analysis of Impact of Small Liquid Hydrocarbon Spill on Lower Trophic Organisms**

The probability of a small spill occurring would be minimized by implementing Shell’s oil spill prevention response plan and maintaining preventative measures. In the unlikely event of a small spill (48 bbl or less), the duration of the spill and opportunity for impacting sediments would be very brief, given the open ocean location of Shell’s well sites. More than 99 percent of a small spill (presumed to consist of diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours. In addition, Shell’s spill response measures, including pre-booming before any over-water fueling operation, are expected to ensure that spill impacts are localized and short-term.

**Phytoplankton** - Phytoplankton are typically found in the water column below the surface, below where adverse impacts resulting from oil spills or other hydrocarbon discharge would most likely occur ([MMS 2003]). Likely, only small numbers of phytoplankton would contact hydrocarbons in the case of a spill. Phytoplankton regeneration is within nine to 12 hours. This, along with rapid replacement of phytoplankton from adjacent non-impacted waters, would preclude any major effect on phytoplankton population levels resulting from exposure to any spills ([National Research Council 1985 in MMS 2003]). Those that are killed after contact with a spill would be replaced quickly as a result of the high reproductive rates of these organisms ([National Research Council 1985 in MMS 2003]). The impacts of a small spill on phytoplankton are expected to be negligible and similar between the Sivulliq and Torpedo prospects.
Zooplankton - The impacts of a small spill on zooplankton are expected to be negligible and similar between the Sivulliq and Torpedo prospects.

Releases that result in dissolved or dispersed hydrocarbons in the water column have the greatest potential of adversely affecting zooplankton. Lethal concentrations of hydrocarbons range from 0.05-10 ppm, with sublethal effects at concentrations between one and 0.05 ppm (National Research Council 1985 in MMS 2003). Lethality is dependent on exposure time, toxicity of the contaminant, and species and lifestage of the organism at time of exposure (earlier life stages are more susceptible) (MMS 2003).

Zooplankton species are more likely to suffer harmful effects from a spill than phytoplankton. Both lethal and sublethal effects can be expected in only a small percentage of the total population and over a short term. Sublethal effects may include lower reproductive rates, depressed feeding, and changes in behavior. The level of effect depends upon the concentration of the oil, its toxicity, exposure time, and the life stage of the planktonic individual. If a spill were to occur during the summer months in high productivity areas where population levels of zooplankton are already high, it has been estimated that less than one percent of the zooplankton population in the project area would be subject to lethal or sublethal effects (Griffiths et al. 2002b in MMS 2003). Johansson et al. (1980) observed zooplankton at spill sites and found that the communities were negatively affected, but the effects were short-term. The plankton community would recover from harmful effects quickly because of their large distribution, high reproductive rate, and short generation time. Phytoplankton are expected to recover in two days, while recovery of zooplankton in these areas would take up to two weeks.

In the unlikely event that such a release were to occur, implementation of Shell’s comprehensive spill response plan would minimize any impacts to zooplankton from an unintentional release of hydrocarbons.

Benthos - The impacts of a small spill on benthic organisms are expected to be negligible and similar between the Sivulliq and Torpedo prospects. The following is a discussion of impacts from a small crude oil spill on benthic organisms. However, effects from diesel fuel are expected to be similar.

Impacts on benthic organisms from unintentional release of hydrocarbons would be minimal. A hydrocarbon spill may have an effect on benthic invertebrates, depending on water column depth, due to either short-term exposure to high concentrations of hydrocarbons or long-term exposure to lower concentrations of hydrocarbons. Most of the harmful effects on benthic organisms from a diesel fuel spill would come from hydrocarbons that have been mixed into bottom sediments by waves and currents (MMS 2003). This would likely only occur in shallow water. The organisms most likely to come into contact with the hydrocarbons, and thus most likely to suffer negative effects, are those that colonize in shallow water close to shore. However, the Beaufort does not have a productive intertidal zone, because shorefast ice prevents the colonization of benthic organisms at depths less than 6.6 ft (2 m). All organisms at depths greater than 6.6 ft (2 m), such as the water depth in the project area, would have a significantly lower probability of coming in direct contact with hydrocarbons. Most persistent effects from diesel fuel spills would likely occur in the intertidal and shallow subtidal areas where benthic communities would be exposed to hydrocarbons from spills. Shell’s prospects are located in areas with water depths in excess of 100 ft (30 m); in such depths impacts on benthic organisms would be unlikely. For example, studies of active dispersion using dispersants have shown dilution is sufficient in water depths greater than 33 ft (10 m) to minimize impacts to benthos and sediments. Sedentary organisms exposed to hydrocarbons within the first 48 hours could be killed or be subject to decreased growth rates, developmental abnormalities, increased risk of disease or predation, and other physiological effects. However, within 48 hours of a release of diesel fuel, approximately 50 percent of the diesel fuel would evaporate and would not even be present to expose the benthic organisms. Thus, any such effects would be minor, short term, and restricted to a small area. Effects would be similar between the two prospects.
Analysis of Impact of Large Liquid Hydrocarbon Spill Lower Tropic Organisms

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shell’s program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

Analysis of Impact of Project Air Emissions on Lower Trophic Organisms

The impact of project air emissions in Camden Bay on lower trophic organisms would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO2, PM, SOx, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO2, CO, SO2, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on lower trophic organisms.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

4.1.6 Fish

Marine fish species and those that migrate between freshwater and salt water (i.e., diadromous fish) occurring near the Camden Bay project area during the period of operation are identified and discussed in
Section 3.5. The fish most likely to be within the project area during the drilling season are the Arctic cod, saffron cod, and fourhorn sculpin. During this time, impacts to fish species, if any, in the project area will be temporary and localized.

The following section addresses the potential effects of the exploration drilling activities on fish. Spawning of most of the common marine fish species occurs in river systems and under the ice during the winter, outside of the drilling season, and would not be directly affected by the planned activities.

As discussed herein, discharges associated with the Camden Bay exploration program would, at most, have a temporary, minor effect on fish species in the vicinity of the project, but the level of effects ultimately is determined by concentration of fish in the immediate area of any discharges and the life stage of the species.

Eggs and younger fish are more vulnerable to discharges. It is anticipated that a statistically insignificant portion of the total available fish habitat will experience minor indirect effects from these activities.

**Analysis of Impact of Vessel Traffic on Fish**

Any impact of sound energy generated by vessel traffic, including transit, on fish will be localized and temporary, and will not result in any significant, population level impacts. Fish may demonstrate avoidance behavior near the path of vessel transit. Investigations of fish behavior in relation to vessel sound energy (Ona 1988; Ona and Godo 1990) have shown that fish react and move away when the sound from the engines and propeller exceeds a certain level, but no long-term impacts were noted.

In order for fish to detect sounds other than background, the sound level must be about 120 dB. Typical sound source levels of vessel sound energy in the audible range for fish are 150 dB (Richardson et al. 1995). Avoidance reactions have been observed in cod and herring when vessels approached close enough that the sound level received by the fish ranged from 110-130 dB (Nakken 1992; Ona and Godo 1990; Ona and Toresen 1988). Avoidance impacts, however, are local and temporary and therefore will not have any long-term impact on individuals or overall fish populations. Potential temporary behavioral effects are listed in Table 4.1.6-1.

<table>
<thead>
<tr>
<th>Source Level</th>
<th>Temporary Behavioral Effect</th>
<th>Range from Source for Exhibited Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>160 dB</td>
<td>Subtle Changes</td>
<td>1.3-7.5 mi (2.1-12 km)</td>
</tr>
<tr>
<td>180 dB</td>
<td>Alarm Response</td>
<td>0.4-1.2 mi (630-2,000 m)</td>
</tr>
<tr>
<td>200-205 dB</td>
<td>Startle Response</td>
<td>0.2-0.6 mi (316-1,000 m)</td>
</tr>
</tbody>
</table>

Source: McCauley 1994

Currently, no commercial, recreational, or subsistence fisheries are within the range of such effects in the project areas. No important spawning habitats are known to be near the proposed drill sites.

**Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Fish**

Resuspension of sediments and subsequent deposition resulting from MLC construction or vessel mooring associated with Shell’s exploration program would have only a localized and temporary effect on fish. These effects are dependent on the species of fish, the life stage (e.g., eggs, larvae, juveniles, or adults), the concentration of suspended sediments, the type of sediment, and duration of exposure (IMG Golder 2004).
Eggs and larvae have been found to exhibit greater sensitivity to suspended sediments (Wilber and Clarke 2001) and other stresses, which is thought to be related to their relative lack of motility (Auld and Schubel 1978). Sedimentation could affect fish by causing egg morbidity of demersal fish feeding near or on the ocean floor (Wilber and Clarke 2001). Surficial membranes are especially susceptible to abrasion (Cairns and Scheier 1968). However, most of the abundant Beaufort Sea fish species with demersal eggs spawn under the ice in the winter well before MLC excavation will occur. Exposure of pelagic eggs would be much shorter as they move with ocean currents (Wilber and Clarke. 2001).

Although severe abrasion and puncture damage to herring eggs has been reported at suspended sediment loads at 4,000 mg/L (Boehlert and Yoklavich 1984), TSS loads in MLC cuttings plumes have lower sediment loads, usually less than 1,000 mg/L, and are often less than 300 mg/L (LaSalle et al. 1991). Cuttings from MLC construction and early phases of drilling will be deposited immediately outside the MLC on the seafloor. Cuttings plumes will only be a few feet in height. Therefore, the impacts of the MLC sediment load should be negligible. No important spawning or nursery habitats in the vicinity of the project area would be affected.

Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Fish

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections for which drilling mud is not used (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling.

Analysis of Impact of Other Permitted Discharges on Fish

Other permitted discharges include deck drainage, desalination unit waste, non-contact cooling water, BOP fluid, and excess cement slurry. These discharges will be conducted under the conditions and limitations of the required NPDES General Permit AKG-28-0000.

These types of discharges would result in changes in pH, temperature, TSS, and BOD in the water column, but the materials dilute and disperse rapidly in open ocean conditions and not have any direct effect on fish. Any indirect effect on fish or habitat would last only as long as the discharge is ongoing, would affect only a small portion of the total water column and, thus, would and be negligible.

Minor changes in water quality, such as increases in turbidity and decreases in dissolved oxygen expected near the discharge site may have a temporary, localized effect on fish. Any changes of water quality related to drilling are well below the range of variability experienced by fish from natural fluctuations of water chemistry related to ice formation, melting, and coastal runoff. These effects would largely be limited to the area within 330 ft (100 m) of the discharge location and would not be expected to affect fish in the area. The discharge produced from the water cooling unit is expected reach ambient temperature at a distance of 164 ft (50 m) from the discharge point on the Kulluk and 256 ft (78 m) from the discharge point on the Discoverer. Results of the cooling water discharge model are presented in Section 6 of the EP.

Analysis of Impact of Aircraft Traffic on Fish

Aircraft traffic associated with the exploration drilling program in Camden Bay will have no direct or indirect effects on fish. No reported instances of impacts to fish from overflights of helicopter or fixed-wing aircraft were found during a review of the scientific literature. In addition, measures to minimize noise will be implemented - such as flying at a minimum altitude of 1,500 ft (457 m) when transiting to
Analysis of Impact of Sound Energy from Drilling and Ice Management on Fish

Sounds sources for drilling and ice management are described in Section 2.9. Fish react to sound and use sound to communicate (Tavolga et al. 1981). Experiments have shown that fish can sense both the intensity and direction of sound (Hawkins 1981). Whether or not fish can hear a particular sound depends upon its frequency and intensity. Wavelength and the natural background sound also play a role. The intensity of sound in water decreases with distance as a result of geometrical spreading and absorption. Therefore, the distance between the sound source and the fish is important. Physical conditions in the sea, such as temperature thermoclines and seabed topography, can influence transmission loss and thus the distance at which a sound can be heard.

Sound energy associated with drilling and ice management could cause some temporary avoidance of the area by fish, but these effects would be minor and short term. The impact of sound energy from drilling and ice management activities will be negligible and temporary. Fish typically move away from sound energy above a level that is at 120dB or higher (Ona 1988). This avoidance behavior is temporary and limited to periods when a vessel is underway or drilling. Potential temporary behavioral effects are listed in Table 4.1.6-1.

There have been no studies of the direct effects of ice management vessel sounds on fish. However, it is known that the ice management vessels produce sounds generally 10-15 dB higher when moving through ice rather than open water (Richardson et al. 1995).

In general, fish show greater reactions to a spike in sound energy levels, or impulse sounds, rather than a continuous high intensity signal (Blaxter et al. 1981). Fish sensitivity to impulse sound varies depending on the species of fish. Fish such as mackerel, flatfish and other bottom-living species lack a swim bladder and are not capable of hearing sounds, unlike species such as cod and herring. Cod and herring have a well-developed swim bladder and therefore are sensitive to sound. An alarm response in these fish is elicited when the sound signal intensity rises rapidly compared to sound rising more slowly to the same level (Blaxter et al. 1981).

Sound energy associated with drilling and ice management could cause some temporary avoidance of the area by fish, but these effects would be minor and short term. The impact of sound energy from drilling and ice management activities will be negligible and temporary. Fish typically move away from sound energy above a level that is at 120 dB or higher (Ona 1988). This avoidance behavior is temporary and limited to periods when a vessel is underway or drilling. Potential temporary behavioral effects are listed in Table 4.1.6-1.

Analysis of Impact of Sound Energy from ZVSP on Fish

Several effects and potential effects of airgun sounds on fish have been identified and studied fairly intensively. The results of these studies, along with an assessment of the fish communities of the western Beaufort Sea, indicates that the ZVSPs would have minimal effect on fish or fish populations and that most impacts to individual fish would occur within only a few meters of the sound source (LGL 2005, Thomson and Davis 2001). There is some evidence indicating that seismic survey acoustic-energy sources can damage eggs and fry of some fish. Eggs and larvae of some species may sustain sublethal to lethal effects if they are within very close proximity to the seismic-energy-discharge point. These types of effects have been demonstrated by some experiments (e.g., Kosheleva 1992; Matishov 1992; Holliday et al. 1987), while other studies have found no significant increases in mortality or morbidity due to
airgun exposure (Dalen and Knutsen 1986; Kostyuvchenko 1973). The effects, when they occurred, were limited to the area within 3-6 ft (1-2 m) of the airgun-discharge ports. In their detailed review of studies on the effects of airguns on fish and fisheries, Dalen et al. (1996) concluded that airguns can have deleterious effects on fish eggs and larvae out to a distance of 16.4 ft (5.0 m), but that the most frequent and serious injuries are restricted to the area within 4.9 ft (1.5 m) of the airguns. Despite these reports, many authors recommend that seismic surveys not take place in important spawning grounds when spawning is occurring. Most investigators and reviewers (Gausland 2003; Thomson and Davis 2001; Dalen et al. 1996) have concluded that seismic survey impacts to fish eggs and larvae are not significant at the population or fisheries level.

The proposed ZVSPs would be conducted in marine waters ~16-23 mi (25.7-37 km) from shore. Most of the important marine fish species in the Beaufort Sea spawn in the winter (e.g., arctic cod, saffron cod, staghorn and fourhorn sculpins, Canadian eelpout, arctic flounder, and sand lance) or spawn in shallow waters near the beach (e.g., herring, capelin) and have demersal or adhesive eggs. The ZVSPs would take place in mid to late summer and, therefore, would not overlap the spawning period of the aforementioned marine fish species. Overall, the proposed seismic surveys should have minimal effects on fish eggs and larvae.

Airgun noises can also affect fish at life history stages after the larval stage. Documented effects include benign behavioral responses, emigration, swim bladder rupture, damage to the ear, and death. Studies have shown that intense sounds can affect the auditory system of fish or, within a few yards of the sound source, other tissues and organs such as swim bladders (Hastings et al. 1996, McCauley et al. 2003, Cook 2005). Seismic surveys using airguns have been found to disturb and displace fish and interrupt feeding (Pearson et al. 1992), although information suggests that displacement may vary among species, depending on life history strategies (demersal vs. pelagic). Research shows both benthic and pelagic fish exhibit a startle response (McCauley et al. 2000, Wardle et al. 2001); while this response is not harmful to fish, many pelagic fish typically leave the survey area during seismic surveys (Løkkeborg and Soldal 1993, Engas et al. 1996). Studies of the effects of sound on caged or confined fish showed that fish moved away from the sounds and swam faster during the seismic energy test. Fish behavior returned to a pre-exposure state within 30 minutes after completion of the test. These studies suggest that fish will respond to acoustic energy, but that behavioral changes will be temporary.

Analysis of Impact of Liquid Hydrocarbon Spill on Fish

Oil spills could potentially impact fish. (MMS 2008a). Small spills, such as releases of fuel oil, could affect fish, but would be limited to a biologically insignificant proportion of the total species population for all fish, and short term because of the limited duration of spills of this size. Further, as any spilled oil or fuel would float in a relatively thin layer on the surface of the water, fish at depth in the water column would not be exposed to the spilled oil or fuel thereby limiting any impacts from a purely physical standpoint. Migrating fish would simply swim out from under the slick. Moreover, any potential effects from oil spills would be mitigated by the implementation of Shell’s comprehensive oil spill response plan.

Section 2.10 of this EIA analyzes in detail the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, and Shell’s plans for responding to a “small” spill (defined as 48 bbl or less). As explained in Section 2.10, Shell’s categories of spill sizes are different from, but not incompatible with, those used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place. Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill, including capabilities for responding to a “worst case” discharge. In the unlikely event of a spill,
implementation of Shell’s spill response plan will limit any effects on fish. Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

**Analysis of Impact of Small Liquid Hydrocarbon Spill on Fish and Shellfish**

While still a remote possibility due to the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Given the open ocean location of Shell’s prospects and the limited duration of a small spill, the likelihood of adverse impacts on fish would small. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours. Implementation of recovery controls also would ensure that any spill effects are localized and of short duration.

Adult fish would likely avoid the released oil; floating fish eggs or larvae exposed to the oil within the first 48 hours could be killed or be subject to decreased growth rates, developmental abnormalities, increased risk of disease or predation, and other physiological effects. Any such effects would be minor with respect to total fish populations in the vicinity, short term in relation to species habitat reduction, and restricted to a small area. Effects would be similar among the Sivulliq and Torpedo prospects.

Fish assimilate hydrocarbons through their gills when exposed to water-soluble impediments but also ingest hydrocarbons by feeding on oil particles or contaminated prey. However, observations at the Exxon Valdez oil spill in Prince William Sound revealed that free-swimming fish are rarely at risk from oil spill and typically move away from oiled areas. This explains why there has never been a commercially important fish-kill on record from an oil spill (MMS 1998).

Impacts to fish from oil spills or unintentional releases of hydrocarbons would be minimal.

**Analysis of Impact of Large Liquid Hydrocarbon Spill on Fish**

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

**Analysis of Impact of Project Air Emissions on Fish**

The impact of project air emissions in Camden Bay on fish would be negligible. Shell has a major source PSD permit for the *Discoverer* (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the *Kulluk* (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (*Kulluk* or *Discoverer*).
The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SO₂, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on fish.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

4.1.7 Coastal and Marine Birds

This Section analyzes the potential impacts of the exploration drilling program on the coastal and marine birds of the Beaufort Sea that are found near the drill sites in Camden Bay. Steller’s eider, spectacled eider, and the yellow-billed loon (candidate) are addressed in greater detail in Section 4.1.5.

Exploration drilling activities at the Sivulliq or Torpedo drill sites are planned to begin on or about 10 July and run through October 31, with a suspension of all drilling operations beginning 25 August for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. The drilling vessel and support vessels will leave the Camden Bay project area and will return to resume activities once the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts conclude. Activities will extend through 31 October, depending on ice and weather and other factors.

As discussed in Section 3.6, bird densities are expected to be low in the project area within Camden Bay during the short period of proposed operations. Therefore, impacts, if any, to coastal or marine birds will be temporary, localized, and negligible.

Activities associated with Shell’s Camden Bay exploration drilling program will have no adverse impact on coastal or marine bird populations. Most bird species, other than gulls and terns, will avoid vessels transiting to and from the drill sites and avoid the drilling vessel and other vessels while anchored. The implementation of appropriate mitigation measures will reduce the likelihood of bird strikes, which are often a risk as vessel lights attract certain species. Vessel mooring and MLC construction will, at most, cause only temporary displacement of birds. Aircraft traffic may cause temporary disturbances, but those will be mitigated by implementing appropriate flight path restrictions, establishing minimum flight altitudes, and restricting flight times. Impacts due to sound energy caused by drilling and ice management activities are expected to be minimal because few birds are present during drilling operations.
There will be no direct impacts from permitted discharges associated with the exploration program. Some indirect impacts are possible on bird prey (benthic organisms and fish, see Sections 4.1.5 and 4.1.6). However, any impacts on prey species will be minimal and the indirect impacts will be negligible on birds.

Oil spills could potentially impact birds; however, large oil spills, such as crude oil releases from blowouts are extremely rare. Small spills, such as releases of diesel fuel, could affect birds, but would be limited to a biologically insignificant proportion of the total species population, and short term because of the limited duration of spills of this size. Any potential effects from oil spills would be mitigated by the implementation of Shell’s comprehensive oil spill response plan and precautionary pre-booming procedures for fuel transfers between vessels.

Steller’s eider, spectacled eider, and yellow-billed loon (candidate), are addressed under Section 4.1.9.5, Threatened and Endangered Species and Critical Habitat.

Analysis of Impact of Vessel Traffic on Coastal and Marine Birds

Disturbances from Vessels

Shell’s proposed exploration drilling program in the Beaufort Sea near Camden Bay involves support vessels, either the Kulluk or Discoverer, OSR vessels, and vessels for transporting supplies. Vessel traffic will not disturb any designated coastal and marine birds critical habitat areas or other areas likely to have large bird concentrations. The impacts of Shell exploration activities are negligible and will not influence bird mortality.

Vessel traffic may disturb some foraging and resting birds. Flushing distances vary between species and between individuals (Rodgers and Schwikert 2002). The disturbances will be limited to flushing birds away from vessel pathways; for example, known distances are from 65-160 ft (20-49 m) for personal water craft and 75-190 ft (23-58 m) for an outboard-powered boat (Rodgers and Schwikert 2002). Flushing distances may be similar or less for the slower and larger vessels to be used for Shell’s exploration project, and some species such as gulls are attracted to boats. Vessels transit routes will not approach the shoreline and therefore, no disturbance to nesting birds, eggs and chicks is expected.

Avian Collisions

Lighted vessels and structures in open waters pose a collision risk to many species of birds, as growing scientific evidence indicates some bird species are attracted to certain light sources. Most studies note that increased darkness, foggy and misty conditions, or low cloud cover increases this attraction. Birds drawn to these artificial lights often become disoriented and collide with structures and incur injury and increased mortality. Little information is currently available on the cause and effect of light-induced bird strikes. The most relevant studies are those assessing the behavior of birds at the Endicott facilities and Northstar (Day, et al. 2005). Northstar and Endicott are oil production facilities located on artificial islands in nearshore waters of the Beaufort Sea to the west of the project area.

Flying altitudes of many species are low enough for potential collisions: eiders fly an average of 23 ft (7 m) above the ocean surface; loons, 36 ft (11 m); other ducks, 66 ft (20 m); and gulls, 49 ft (15 m) (Day et al. 2005). Other factors affecting bird strike risks include the location of the vessels or structures, types of lighting, atmospheric conditions and time of year, such as during migration.

Project activities are proposed for July through October, which is a period when migratory birds are present in the Beaufort. Exploration drilling operations and the vessels that support them require lighting to provide a safe environment for workers to accomplish tasks in a time and cost efficient manner. Therefore, some risk of bird strikes with the drilling vessel and support vessels will exist. During July
and part of August, vessel lighting will often not be needed due to the high amounts of daylight at these arctic locations, thus reducing the probability of a bird strike event.

Bird strikes will also be reduced because the proposed exploration drilling activities will occur approximately 16-23 mi (26-37 km) or more offshore where bird densities are relatively low. In addition, as discussed in Section 3.8, the threatened spectacled and Steller’s eiders, and yellow-billed loon (candidate) populations are anticipated to be minimal in the vicinity of the proposed drill sites. Given the timing and location of operations, any bird mortalities resulting from bird strikes are expected to be minimal and not at a level that would threaten total bird populations. To further reduce the risk of bird strikes, Shell will mitigate potential effects by minimizing vessel light output, using green lighting, and monitoring conditions to assess risk. These actions are detailed in the Shell Bird Strike Avoidance and Lighting Plan (EP Appendix I).

**Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Coastal and Marine Birds**

The impacts on birds from vessel mooring, MLC construction, and early phases of drilling will be negligible. Only temporary displacement will occur during vessel mooring and MLC construction. Shell's proposed locations are in areas not utilized heavily by benthic feeding birds, such as eiders (Section 3.8.4) and other sea ducks (Section 3.6.2). Impacts would be similar to impacts from vessel transit as noted above.

**Analysis of Impact of Drill Cuttings and Drilling Mud Discharges**

The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections which does not contain drilling mud (Discharge 013) as defined by the NPDES general permit. Any effects of the Discharge 013 are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling.

**Analysis of Impact of Other Permitted Discharges on Coastal and Marine Birds**

Other permitted discharges include non-contact cooling water, desalination wastes, excess cement slurry, BOP fluid and deck drainage. These discharges will be conducted under the conditions and limitations of the required NPDES General Permit AKG-28-0000.

These types of discharges would result in changes in pH, temperature, TSS, and BOD in the water column, but the materials dilute and disperse rapidly in open ocean conditions and not have any direct effect on birds. Any indirect effects on bird prey or habitat would last only as long as the discharge is ongoing, would affect only a small portion of the total water column and, thus, would and be negligible.

Discharges of free oil, floating solids, or trash that could potentially affect marine birds are not allowed under the terms of the NPDES general permit.

**Analysis of Impact of Aircraft Traffic on Coastal and Marine Birds**

Aircraft traffic may cause some disturbance to birds onshore and offshore. Aircraft have the potential to displace birds from preferred habitat, thereby affecting their energy budgets, and inducing stress. Stress from aircraft overflights on molting birds can potentially make it difficult for them to maintain or acquire sufficient nutrients for subsequent migration to staging areas (Taylor 1993 in Miller 1994). Aircraft, especially helicopters, seem to cause the most intense responses over other human disturbances (Bélanger and Bédard 1989 in Miller 1994) and birds do not habituate well to small low-flying aircraft (Owens
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Aircraft may disturb birds, but aircraft activities associated with the proposed exploration activities are not anticipated to lead to increased bird mortality.

Shell will use fixed-wing aircraft, flying six hours per day, seven days per week, as part of the marine mammal monitoring program. Shell will also use, on average, two helicopter flights per day to transport supplies and rotate crews. The Deadhorse airport has existing commercial operators and flights near the Camden Bay coast. Flights attributed to exploration support will be in addition to those commercial flights.

Mitigation to reduce bird disturbances will include flight path selection, high flight altitudes, and flight timing to avoid those times when large concentrations of birds are present in the vicinity of the Deadhorse airport or the drilling vessel. Most helicopter flights will be over the Beaufort Sea and away from nesting areas. The helicopter flight path will be along the coastline at 1,500 ft (457 m) altitude approximately 5 mi (8 km) from the coastline to a point at which the helicopters will turn and fly generally perpendicular to the coastline and on to the drill site, thus reducing disturbances on nearshore birds to a very small geographic area. This flight path avoids overflights of any barrier island.

Given the timing of proposed exploration operations, the remote offshore location of those operations, and implementation of appropriate mitigation measures, aircraft activity associated with Shell’s proposed exploration operations are not anticipated to lead to increased bird mortality. Any impacts on coastal or marine birds would be localized and temporary and not result in significant, population impacts.

Analysis of Impact of Sound Energy from Drilling and Ice Management on Coastal and Marine Birds

Studies on the effects of seismic surveys on birds provide an indication of how drilling and ice management sounds could affect birds. Seismic surveys produce underwater sound that is generally much stronger than what is produced from drilling and ice management activities (220-250 dB for seismic and 125-190 dB for drilling). 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 display differences in behavior when close to or far from the survey vessels and the birds were not repelled by or 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 on-going seismic surveys. Therefore, drilling and ice management sounds, which are less than seismic sounds, are anticipated to have negligible effects on birds.

Analysis of Impact of Sound Energy from ZVSP on Coastal and Marine Birds

Studies on the effects of seismic surveys on birds provide some indication of how the sound energy generated by ZVSPs could affect birds, as both seismic surveys and ZVSPs use airguns as the energy source, although the airgun arrays used in seismic surveys are typically much larger. Seismic surveys produce underwater sound that is generally much stronger (source levels of ~220-250 dB rms). 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), 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.

**Analysis of Impact of Liquid Hydrocarbon Spill on Coastal and Marine Birds**

Section 2.10 of this EIA analyzes in detail the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, Shell’s plans for responding to a “small” spill (defined as 48 bbl or less), and Shell’s worst case discharge planning scenario. Section 1.6.11 of the Shell’s Beaufort Sea Regional Oil Discharge prevention and Contingency Plan (2011) addresses Wildlife Protection in compliance with 18 AAC 75.425(e)(1)(F)(xi). As explained in Section 2.10, Shell’s categories of spill sizes are different from, but not incompatible with, those used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place.

Shell’s plans include measures to prevent spills from occurring and to quickly and effectively respond in the event of a spill, including capabilities for responding to a “worst case” discharge. In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill and any effects on coastal and marine birds. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

**Analysis of Impact of Small Liquid Hydrocarbon Spill on Coastal and Marine Birds**

While still a remote possibility due to the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Impacts analyzed below are based on a small spill of crude oil. Impacts from crude oil are assumed to be similar to diesel fuel.

Bird mortality can occur through direct contact with an oil spill. Oiled feathers can result in a loss of water repellency, thermal insulation, buoyancy, and the ability to forage and fly. Consequently, oiled birds can die of hypothermia and starvation. Oil sticks to a bird’s feathers, causing them to separate and mat. Instinctively, birds try to remove the oil through preening, which then leads to oil ingestion and can result in damage to the internal organs and direct mortality. Oil ingestion could also result in reproductive failure in birds.

Indirect effects of oil include a reduction in egg productivity, decreased survival of embryos and chicks, poor chick growth, delayed maturation of ovaries, altered hormone levels, and abandonment of nests by adults (Burger and Fry 1993). Oil could kill multiple organisms that make up the food chain in the Beaufort Sea. A reduction in populations of a lower trophic organism such as fish may have subsequent negative effects on birds. In addition, oil spill cleanup in the open ocean and coastal areas could displace birds from feeding, molting, or resting areas. Cleanup along coastal areas would especially disturb birds in concentrated areas where birds may congregate for brood rearing, staging, or feeding.

Whether birds come into contact with oil depends on the location, timing, and magnitude of a spill, ice conditions, and effectiveness of cleanup activities. Shell will have an agency-approved ODPCP prior to commencing operations in the Beaufort Sea. Spill prevention is paramount to Shell’s drilling operations in the prospect area (and worldwide). Regardless, Shell will have OSR vessels nearby with fully trained
response personnel and equipment at all times when drilling into zones containing oil to respond to an oil spill in the unlikely event that one should occur.

Spilled oil in the project area, if a spill should occur, could affect gulls, terns, loons, kittiwakes, jaegers, fulmars, guillemots, and sea ducks, including eiders, scoters, and long-tailed ducks all of which could be present in different concentrations depending on when the event occurred.

Any such effects would be minor with respect to total bird populations in the vicinity, short term in relation to species habitat reduction, and restricted to a small area. Effects would be similar between the Sivulliq and Torpedo prospects.

Given the open ocean location of Shell’s prospects, the duration of a small spill and opportunity for effect would be very brief. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours, but recovery controls would ensure that any spill effects are localized and would result only in short-term environmental consequences. Effects would be similar among the Sivulliq and Torpedo prospects.

Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with lease stipulations, USCG requirements, and Shell’s operating procedures.

Impacts to coastal and marine birds from a small spill of hydrocarbons would be minimal.

Analysis of Impact of Large Liquid Hydrocarbon Spill on Coastal and Marine Birds

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

Analysis of Impact of Project Air Emissions on Coastal and Marine Birds

The impact of project air emissions in Camden Bay on coastal and marine birds would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO2, PM, SO2, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.
The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on coastal and marine birds.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

4.1.8 Mammals

Marine Mammals

Pursuant to 30 C.F.R. § 250.227(c) a project applicant is required to analyze the potential direct and indirect impacts of the proposed OCS exploration activities on marine mammals likely to be in the vicinity of the proposed operations. Marine mammals potentially occurring in the Camden Bay project area are identified and described in Section 3.7 of this document.

Bowhead whale, humpback whale, polar bear, bearded seal, and ringed seal are either listed as threatened or endangered under the ESA or have been proposed for listing. Impacts to these species are discussed in Section 4.1.9, Threatened and Endangered Species and Critical Habitat. The Pacific walrus is currently considered a candidate species for listing and is also discussed in Section 4.1.9.3 though walrus are unlikely to occur in the project area (Section 3.8.2).

Exploration activities at the Sivulliq and Torpedo drill sites are planned to begin on or about 10 July and extend through 31 October for the duration of the EP. This time period includes suspension of all drilling activities on 25 August of each exploration drilling season for the subsistence bowhead whale hunts conducted by Nuiqsut (Cross Island) and Kaktovik. During the suspension the drilling vessel and support fleet will leave the project area. The drilling vessel and support fleet will return and exploration drilling will resume after the hunts have concluded.

The main sources of potential disturbance to marine mammals from the exploration drilling program could result from aircraft traffic, and operations on the drilling vessel and associated support vessels. Drilling equipment and operations including ZVSP surveys and ice management emit low-frequency sound energy into the water that may alter marine mammal behavior and at least theoretically could damage marine mammals hearing abilities. Increased vessel traffic associated with the exploration drilling program increases the potential for vessel strikes of animals and, on-site vessel mooring and MLC construction could alter sediment characteristics that potentially influence prey density of some mammal species. Small hydrocarbon spills and various permitted discharges could alter water quality thus affecting marine mammal prey species, the animals themselves or causing avoidance of the area.
Mitigation measures designed to limit potential impacts from operations will be in place throughout the proposed program. Potential impacts to marine mammals (ESA-listed and non-listed species) will largely be mitigated by implementation of Shell’s Marine Mammal Monitoring and Mitigation Plan (4MP). Shell’s 4MP is attached as Appendix D to the EP and is an integral part of Shell’s exploration drilling program. Shell’s 4MP serves multiple purposes; it protects marine mammal resources, fulfills reporting requirements of BOEMRE, NMFS and USFWS and establishes a means of collecting scientific data on marine mammals to inform future planning. The principal components of the 4MP are summarized below.

Shell’s 4MP integrates marine mammal monitoring and real-time mitigation measures. These goals are accomplished by vessel-based, acoustic, and aerial monitoring programs. Dedicated personnel (MMOs) onboard each vessel involved with this project will actively monitor the surrounding area for the presence of any marine mammals. These MMOs will be trained, experienced field observers, including both biologists and Inupiat personnel. Throughout the period of operations MMOs will be stationed on the drilling and support vessels in locations that maximize their view of the waters surrounding the activities. Observers collect data on the numbers and species of marine mammals observed, as well as the distance at which the animals are seen and their behavior, including their reactions to the operations. Reports describing the data and interactions of the animals with the exploration drilling program operations will be prepared and available to agencies and the public. Significantly, MMOs will initiate mitigation measures when appropriate. For example, for vessels in transit, MMOs will assist the vessel in maintaining the 0.5 mi (800 m) exclusion zone around polar bear and walrus. Vessels must also reduce speed and avoid course changes within 900 ft (274 m) of other marine mammals to avoid collisions with marine mammals, and groups of marine mammals will be avoided to prevent separating members of the group. Each drilling support vessel will have at least one Inupiat MMO to facilitate outreach and communication with hunters and the local communities. These activities will coordinate with Shell’s broad POC to avoid impacts to subsistence resources and activities.

Acoustic monitoring will measure the sound levels produced by the drilling vessel, including variations in the sound produced with time, distance and direction. Acoustic monitoring will also measure the sound levels produced by support vessels, including ice management and anchor-handling vessels. Drilling and vessel sounds will 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 will be located within 1,640-3,281 ft (500-1,000 m) of the drilling vessel. These will feed real-time sound data back to the drilling vessel. An activity log will be used to correlate sound levels with particular vessel activities. The second method will deploy additional hydrophone systems at various distances and locations around operations. Acoustic data from the second system will be stored digitally for later retrieval. Drilling sound monitoring equipment will be deployed as soon as possible after the drilling vessel is on site.

Acoustic recorders will also be used to understand the distribution of marine mammals along the Beaufort Sea coast in relation to drilling activities. These recorders will provide measurements of sound levels produced by drilling operations at various distances from the sound source. This will be accomplished by deploying arrays of acoustic recorders at five sites from Harrison Bay to Kaktovik, an area that encompasses Camden Bay. Shell has used these sites for acoustic data collection since 2007.

This system of acoustic recorders is able to localize the position of bowhead whale and other marine mammal vocalizations. These data provide information on bowhead whale calling behavior in relation to industrial activity and allow inferences about the locations of whales’ migration paths and any variation from typical migration routes that could be associated with the drilling activities. The system uses directional autonomous seafloor acoustic recorders (DASARs) and will monitor sound levels
continuously for six to ten weeks during the migration from the five coastal sites, subject to ice and weather conditions.

Aerial surveys will provide a key visual link with the acoustic data and will enhance the monitoring of onboard MMOs by covering a much greater area around the drilling operations. Aerial surveys will begin five to seven days prior to field operations and continue five to seven days after operations at a drill site are complete. Daily aerial surveys will be conducted during operations, subject to weather and flight conditions, and follow pre-determined survey grids tailored to maximize coverage of Shell’s specific operations. Each survey flight will have two monitors seated at bubble windows (to facilitate downward viewing) on either side of the aircraft. Aerial monitors will be in real-time communication with operating vessels. Aerial monitors will advise vessel operators of the presence of marine mammals in the area of operations and will collect data on the distribution, numbers and movements of marine mammals near the drilling vessel and support vessels. Aerial monitors will record data on the impacts, if any, to migrating whales and other marine mammals (e.g., the distance of any noted deflection). This will document actual impacts on affected species and support regulatory reporting requirements.

These measures have proven effective at minimizing impacts to marine mammals. The data gathered is used to monitor the effectiveness of operational mitigation measures, satisfy regulatory reporting obligations, and collect valuable scientific data on mammals that otherwise would not be collected. Discrete features of Shell’s exploration drilling activities and any impacts to marine mammals are analyzed further below.

**Analysis of Impact of Vessel Traffic on Marine Mammals**

Increased vessel traffic in the Camden Bay area associated with exploration drilling operations may potentially impact marine mammals by collisions of the vessels with animals in the water or by effects of the sounds emanating from the vessels into the water.

**Vessel Collisions**

Few vessel strikes of marine mammals have been reported in the Beaufort Sea. However, increased numbers of vessels working in an area increase the likelihood of vessel strikes of marine mammals. All Shell vessels will have MMOs onboard to assist in spotting marine mammals and avoiding vessel strikes of animals, groups of marine mammals will be avoided, and vessels will reduce speed and avoid course changes within 900 ft (274 m) of marine mammals. Shell has successfully operated a large number of vessels in the Beaufort Sea since 2006 without any marine mammal strikes. Further, George et al. (1994) examined subsistence-harvested bowheads and quantified how many of them had scars that appeared to have been inflicted by vessels. Among 236 whales examined between 1976 and 1992, they found two whales that exhibited evidence of past interactions with vessels, and one with questionable scarring. One carcass was reported more recently that appeared to have been struck by a vessel (Rosa, 2009). In light of the success of Shell’s historic MMO program in preventing ship strikes and Shell’s commitment to continuing the program, it is unlikely that a ship strike of a marine mammal would occur during this project. Even if ship strikes occurred, they could impact individual animals but would not affect animal populations in the project area.

**Vessel Sounds**

In addition to the drilling vessel, various types of vessels will be used in support of the operations including ice management vessels, anchor handlers, and oil spill response vessels. Sounds from boats and vessels have been reported extensively (Greene and Moore 1995; Blackwell and Greene 2002, 2005, 2006). Numerous measurements of underwater vessel sounds have been performed in support of recent industry activity in the Chukchi and Beaufort seas. Results of these measurements have been reported in various 90-day and comprehensive reports since 2007. For example, Warner and Hannay (2009)
estimated sound pressure levels of 100 dB at distances ranging from ~1.5-2.3 mi (~2.4-3.7 km) from various types of barges. MacDonald et al. (2008) estimated higher underwater sound pressure levels from the seismic vessel *Gilavar* of 120 dB at ~13 mi (~21 km) from the source, although the sound level was only 150 dB at 85 ft (26 m) from the vessel. Like other industry-generated sound, underwater sound from vessels is generally at relatively low frequencies.

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross 1976). Propeller cavitation and singing are produced outside the hull, whereas propulsion or other machinery noise originates inside the hull. There are additional sounds produced by vessel activity, such as pumps, generators, flow noise from water passing over the hull, and bubbles breaking in the wake. Ice management vessels contribute greater sound levels during ice-breaking activities than ships of similar size during normal operation in open water (Richardson et al. 1995a). This higher sound production results from the greater amount of power and propeller cavitation required when operating in thick ice. Shell does not intend to break ice except for cases of emergency that threaten the drill site (see also the IMP, Appendix K of the EP).

**Cetaceans**

Various cetacean species have been reported to avoid vessels that are under way. It is often not clear if the animals avoid vessels because of the sound of the vessel or if visual cues are also important. Information below describes studies that have examined cetacean interactions with vessels. We include studies that have looked at threatened and endangered species, considered in more detail later in this chapter, as well as species that do not occur in the project area. Additionally, not all of these studies have occurred in Arctic waters, but they all provide information that may be important to understanding how marine mammals, in this case cetaceans, react to ships and other vessels when they are present.

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. In 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).

A startle response of belugas was observed in a study by Fraker et al. (1978) where 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 individuals would depend upon the amount of previous exposure to moving vessels and the level of importance of the need for an individual to be in the area of vessel traffic (Finley and Davis 1984). In some studies, more intense reactions to large vessels have been noted (Finley et al. 1990; LGL and Greenridge 1996), but it is not clear that the intensity of the reaction was specifically related to the size of the ship.

Baker et al. (1982) reported some avoidance by humpback whales to vessel noise when received levels were 110-120 dB rms, and clear avoidance at 120-140 dB (sound measurements were not provided by Baker but were based on measurements of identical vessels by Miles and Malme 1983).

Palka & Hammond (2001) analyzed line transect census data in which the orientation and distance off transect line were reported for large numbers of minke whales. Minor changes in locomotion speed, direction, and/or diving profile were reported at ranges from 1,847-2,352 ft (563-717 m) at received levels of 110-120 dB.

Frankel & Clark (1998) conducted playback experiments with wintering humpback whales using a single speaker producing a low-frequency “M-sequence” (sine wave with multiple-phase reversals) signal in the 60-90 Hz band with output of 172 dB at 3 ft (1 m). For 11 playbacks, exposures were between 120-130 dB.
dB re: 1 μPa and included sufficient information regarding individual responses. During eight of the trials, there were no measurable differences in tracks or bearings relative to control conditions, whereas on three occasions, whales either moved slightly away from \((n = 1)\) or towards \((n = 2)\) the playback speaker during exposure. The presence of the source vessel itself had a greater effect than did the M-sequence playback.

Nowacek et al. (2004) used controlled exposures to demonstrate behavioral reactions of northern right whales to various nonpulse sounds. Playback stimuli included ship noise, social sounds of conspecifics, and a complex, 18-min “alert” sound consisting of repetitions of three different artificial signals. Ten whales were tagged with calibrated instruments that measured received sound characteristics and concurrent animal movements in three dimensions. Five out of six exposed whales reacted strongly to alert signals at measured received levels between 130 and 150 dB (i.e., ceased foraging and swam rapidly to the surface). Two of these individuals were not exposed to ship noise and the other four were exposed to both stimuli. These whales reacted mildly to conspecific signals. Seven whales, including the four exposed to the alert stimulus, had no measurable response to either ship sounds or actual vessel noise.

Gordon et al. (1992) conducted opportunistic visual and acoustic monitoring of sperm whales in New Zealand exposed to nearby whale-watching boats (within 1,476 ft or 450 m). Sperm whales respired significantly less frequently, had shorter surface intervals, and took longer to start clicking at the start of a dive descent when boats were nearby than when they were absent. Noise spectrum levels of whale watching boats ranged from 109-129 dB/Hz. Over a bandwidth of 100-6,000 Hz, equivalent broadband source levels were ~157 dB; received levels at a range of 1,476 ft (450 m) were ~104 dB.

Buckstaff (2004) reported elevated dolphin whistle rates with received levels from oncoming vessels in the 110 to < 120 dB. These hearing thresholds were apparently lower than those reported by a researcher listening with towed hydrophones.

Morisaka et al. (2005) compared whistles from three populations of Indo-Pacific bottlenose dolphins (Tursiops aduncus). One population was exposed to vessel noise with spectrum levels of ~85 dB/Hz in the 1- to 22-kHz band (broadband received levels ~128 dB) as opposed to ~65 dB/Hz in the same band (broadband RL ~108 dB) for the other two sites. Dolphin whistles in the noisier environment had lower fundamental frequencies and less frequency modulation, suggesting a shift in sound parameters as a result of increased ambient noise.

Finally, several recent papers deal with important issues related to changes in marine mammal vocal behavior as a function of variable background noise levels. Foote et al. (2004) found increases in the duration of killer whale calls over the period 1977 to 2003, during which time vessel traffic in Puget Sound, and particularly whale-watching boats around the animals, increased dramatically. Scheiße et al. (2005) demonstrated that belugas in the St. Lawrence River increased the levels of their vocalizations as a function of the background noise level (the “Lombard Effect”). Lesage et al. (1999) reported that beluga whales changed their call type and call frequency when exposed to boat noise. It is possible that the whales were adapting to the ambient noise levels and were able to communicate despite the sound.

In general, cetacean species avoid vessels that are under way. It is often not clear if the animals avoid vessels because of the sound of the vessel or if visual cues are also important. Effects on cetaceans in the project area, however, will be temporary and will involve localized avoidance of the ships, and are not expected to significantly impact the populations of any of these animals. Relatively few cetaceans are expected to be in the project area during operations except for bowhead whales (which are analyzed in more detail in Section 4.1.9.2) during their fall migration. Gray whales could be present but are not abundant in the Beaufort Sea. Beluga whales are typically found further offshore than the prospect areas, near the continental shelf break, but could be present. Harbor porpoise are also known to tolerate ships
and may approach moving ships to bow ride (Richardson et al. 1995), however, this species is uncommon in the Beaufort Sea and any impacts from vessel sounds would be negligible.

**Pinnipeds**

There are relatively few publications describing pinniped responses to boats or ships. Most of the available information is anecdotal. Salter (1979) reported no detectable response by walrus at a terrestrial haulout site to approach by outboard motorboats at distances of 1.1-4.8 mi (1.8-7.7 km). For walruses hauled out on ice the probability and type of reaction depended on distance (Bruggeman et al. 1990, 1991, 1992). Reaction distance also depends on ship speed, and is likely influenced by sight of the ship as well (Fay et al. 1984). Walrus reactions to ships include waking up, head raises, and entering the water. Walruses in open water appeared less responsive than those on ice, showing little reaction unless the ship was very near to the animals (Fay et al. 1984).

In general, evidence about the reaction of seals to vessels is meager. The limited amount of data, plus the responses of seals to other noisy human disturbances (Richardson et al. 1995) suggest that seals often show considerable tolerance of vessels. Seals are not expected to be adversely impacted by sound or the presence of vessels associated with the proposed project.

**Analysis of Impact of Sound Energy Generated by ZVSP on Marine Mammals**

An eight airgun array (4×40 in$^3$ airguns and 4×150 in$^3$ airguns, total volume of 760 in$^3$) will be used to perform ZVSP surveys at the end of each exploration well. Each survey will last approximately 12 hours (per drill site) and include ~216 firings of the full array, plus additional firing of a single 40-in$^3$ airgun to be used as a “mitigation airgun” while the geophones are relocated within the wellbore. The estimated source level used to model sound propagation from the airgun array is ~241 dB re 1μPa m rms, with most energy between 20 and 140 Hz.

Airguns function by venting high-pressure air into the water. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by oscillation of the resulting air bubble. The sizes, arrangement, and firing times of the individual airguns in an array are designed and synchronized to suppress the pressure oscillations subsequent to the first cycle. A typical high-energy airgun arrays emit most energy at 10-120 Hz. However, the pulses contain significant energy up to 500-1,000 Hz and some energy at higher frequencies (Goold and Fish 1998; Potter et al. 2007).

**Summary of the Potential Effects of Airgun Sounds**

The effects of sounds from airguns might include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical effects (Richardson et al. 1995). Given the moderate size of the sources planned for the proposed project, plus mitigation measures to be applied, it is unlikely that there would be any cases of temporary or especially permanent hearing impairment, or non-auditory physical effects. Subtle behavioral changes may occur related to this survey, however, given the small size of the array, short time period for the survey, and monitoring and mitigation measures, these impacts are anticipated to be well below the threshold of biological relevance to individuals or populations of marine mammals occurring in the project area. Below we describe the potential effects of airgun sound on marine mammals. As with previous sections we include descriptions of studies across a wide range of cetacean and pinniped species to present the best available science.
Tolerance

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Numerous studies have shown that marine mammals at distances more than a few kilometers from operating seismic vessels often show no apparent response. That is often true even in cases when the pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of the particular mammal group. Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to airgun pulses under some conditions, at other times mammals of all three types have shown no overt reactions. In general, pinnipeds, and small odontocetes, seem to be more tolerant of exposure to airgun pulses than are baleen whales.

Masking

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data of relevance. Some whales are known to continue calling in the presence of seismic pulses. Their calls can be heard between the seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995; Greene et al. 1999; Nieuwirk et al. 2004). Although there has been one report that sperm whales cease calling when exposed to pulses from a very distant seismic ship (Bowles et al. 1994), a more recent study reports that sperm whales off northern Norway continued calling in the presence of seismic pulses (Madsen et al. 2002). That has also been shown during recent work in the Gulf of Mexico (Tyack et al. 2003). Masking effects of seismic pulses are expected to be negligible in the case of the smaller odontocete cetaceans because the sounds important to small odontocetes are predominantly at much higher frequencies than are airgun sounds.

Disturbance Reactions

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous changes in activities, and displacement. Based on NMFS (2001, p. 9293), we assume that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially significant manner, do not constitute harassment or “taking.” By potentially significant, we mean “in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations.”

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors. If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on the animals could be significant. Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many mammals were present within a particular distance of industrial activities, or exposed to a particular level of industrial sound. That likely overestimates the numbers of marine mammals that are affected in some biologically-important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically-important degree by a seismic or ZVSP program are based on behavioral observations during studies of several species. However, information is lacking for many species. Detailed studies have been done on humpback, gray, and bowhead whales, and on ringed seals. Less detailed data are available for other species of baleen whales, sperm whales, and small toothed whales.

Baleen Whales—Baleen whales generally tend to avoid operating airguns, but distances of avoidance radii are quite variable. Whales are often reported to show no overt reactions to pulses from large arrays
of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the case of the migrating gray and bowhead whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors.

Studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160–170 dB re 1 μPa rms range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed. In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from 2.8-9.0 mi (4.5-14.5 km) from the source. A substantial proportion of the baleen whales within those distances may show avoidance or other strong disturbance reactions to the airgun array. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and recent studies have shown that some species of baleen whales, notably bowhead and humpback whales, at times show strong avoidance at received levels lower than 160–170 dB re 1 μPa rms. Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with substantial avoidance occurring out to distances of 12.4–18.6 mi (20–30 km) from a medium-sized airgun source (Miller et al. 1999; Richardson et al. 1999). However, more recent research on bowhead whales (Miller et al. 2005; Christie et al. 2010) corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources. In summer, feeding bowheads typically begin to show avoidance reactions at a received level of about 150-160 dB re 1 μPa rms (Richardson et al. 1986; Ljungblad et al. 1988; Miller et al. 1999, Christie et al. 2010). The Shell project will be conducted at least partially during fall migration in the area of the known bowhead migration corridor. Recent evidence suggests that some bowheads feed during migration and feeding bowheads might be encountered in the project area (Lyons et al. 2009; Christie et al. 2010). The primary bowhead summer feeding grounds however, are far to the east in the Canadian Beaufort Sea, and the primary feeding area used during fall migration is near Barrow, though bowheads fed near Shells seismic programs in Camden Bay in both 2007 and 2008.

Malme et al. (1986, 1988) studied the responses of feeding eastern gray whales to pulses from a single 100 in³ airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50% of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1 μPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast, and on observations of Western Pacific gray whales feeding off Sakhalin Island, Russia (Johnson 2002).

Data on short-term reactions (or lack of reactions) of cetaceans to impulsive noises do not necessarily provide information about long-term effects. It is not known whether impulsive noises affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales continued to migrate annually along the west coast of North America despite intermittent seismic exploration and much ship traffic in that area for decades (Malme et al. 1984). Bowhead whales have continued to travel to the eastern Beaufort Sea each summer despite seismic exploration in their summer and autumn range for many years (Richardson et al. 1987, Funk et al. 2010). Populations of both gray whales and bowhead whales grew substantially during this time. In any event, the brief exposures to sound pulses from the proposed ZVSP airgun source are highly unlikely to result in any prolonged effects on individual baleen whales or their populations.

**Toothed Whales**—Little systematic information is available about reactions of toothed whales to noise pulses. Few studies similar to the more extensive baleen whale/seismic pulse work summarized above...
have been reported for toothed whales. However, systematic work on sperm whales is underway (Tyack et al. 2003), and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (e.g., Stone 2003; Smultea et al. 2004; Moulton and Miller 2005).

Seismic operators sometimes see dolphins and other small toothed whales near operating airgun arrays, but in general there seems to be a tendency for most delphinids to show some limited avoidance of seismic vessels operating large airgun systems. However, some dolphins seem to be attracted to the seismic vessel and floats, and some ride the bow wave of the seismic vessel even when large arrays of airguns are firing. Nonetheless, there have been indications that small toothed whales sometimes move away, or maintain a somewhat greater distance from the vessel, when a large array of airguns is operating than when it is silent (e.g., Goold 1996a,b,c; Calambokidis and Osmeek 1998; Stone 2003). Aerial surveys during seismic operations in the southeastern Beaufort Sea recorded much lower sighting rates of beluga whales within 6.2-12.4 mi (10-20 km) of an active seismic vessel. These results were consistent with the low number of beluga sightings reported by observers aboard the seismic vessel, suggesting that some belugas might be avoiding the seismic operations at distances of 6.2-12.4 mi (10-20 km) (Miller et al. 2005). Similarly, aerial surveys conducted in 2007 and 2008 during Shell seismic programs in the Beaufort Sea generally reported beluga whale sightings out near the shelf break well away from the seismic operations. However, this may simply be the whales’ preferred habitat and not a reaction to the seismic program.

Similarly, captive bottlenose dolphins and beluga whales exhibit changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran et al. 2000, 2002). However, the animals tolerated high received levels of sound (peak-to-peak [pk–pk] level >200 dB re 1 μPa) before exhibiting aversive behaviors.

Odontocete reactions to large arrays of airguns are variable and, at least for small odontocetes, seem to be confined to a smaller radius than has been observed for mysticetes. A ≥170 dB disturbance criterion (rather than ≥160 dB) may be more appropriate for small odontocetes (and pinnipeds) which tend to be less responsive than other cetaceans. However, based on the limited existing evidence, belugas should not be grouped with delphinids in the “less responsive” category.

Given the moderate size of the sources planned for the proposed project, plus mitigation measures to be applied, it is unlikely that there would be any cases of temporary or permanent hearing impairment, or non-auditory physical effects in any toothed whale species that would be found in the project area. However, behavioral disturbance could occur at longer distances than auditory effects. Behavioral disturbance to toothed whales from ZVSP surveys would be minimal and would only be likely to result in brief periods of avoidance of the project area since the ZVSP surveys will occur only intermittently for a maximum of approximately 12 hours.

**Pinnipeds**—Pinnipeds are not likely to show a strong avoidance reaction to the moderately-sized airgun source that will be used for the ZVSP program. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds, and only slight (if any) changes in behavior. Pinnipeds frequently do not avoid the area within a few hundred meters of operating airgun arrays (e.g., Miller et al. 2005; Harris et al. 2001). However, initial telemetry work suggests that avoidance and other behavioral reactions to small airgun sources may at times be stronger than evident to date from visual studies of pinniped reactions to airguns (Thompson et al. 1998). Even if reactions of the species occurring in the proposed survey area are as strong as those evident in the telemetry study, reactions are expected to be confined to relatively small distances and durations, with no long-term effects on pinniped individuals or populations.
Polar Bears — Airgun effects on polar bears have not been studied. However, polar bears on the ice would be unaffected by underwater sound. Sound levels received by polar bears in the water would be attenuated because polar bears generally do not dive much below the surface. Received levels of airgun sounds are reduced near the surface because of the pressure release effect at the water’s surface (Greene and Richardson 1988; Richardson et al. 1995).

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds, but there has been no specific documentation of this for marine mammals exposed to sequences of airgun pulses. Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds ≥180 and 190 dB re 1 μPa (rms), respectively (NMFS 2000). These exposure levels have also been applied by the USFWS to walrus and polar bear, respectively. Those criteria have been used in defining the safety (shutdown) radii planned for the proposed ZVSP survey. However, those criteria were established before there were any data on the minimum received levels of sounds necessary to cause temporary auditory impairment in marine mammals summarized here:

- The 180 dB criterion for cetaceans is probably quite precautionary, i.e., lower than necessary to avoid temporary threshold shift (TTS), let alone permanent auditory injury, at least for belugas and delphinids.

- The minimum sound level necessary to cause permanent hearing impairment is higher, by a variable and generally unknown amount, than the level that induces barely-detectable TTS.

- The level associated with the onset of TTS is often considered to be a level below which there is no danger of permanent damage.

NMFS is presently developing new noise exposure criteria for marine mammals that account for the now-available scientific data on TTS and other relevant factors in marine and terrestrial mammals (NMFS 2005; Orenstein et al 2004).

Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airguns, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment (Section 4.3.3, Mitigation Measures). In addition, many cetaceans are likely to show some avoidance of the area with high received levels of airgun sound (see above). In those cases, the avoidance responses of the animals themselves will reduce or (most likely) avoid any possibility of hearing impairment.

Non-auditory physical effects might also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that theoretically might occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds. However, as discussed below, there is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns and beaked whales do not occur in the present study area. It is unlikely that any effects of these types would occur during the present project given the brief duration of exposure of any given mammal, and the planned monitoring and mitigation measures. The following subsections discuss in somewhat more detail the possibilities of TTS, permanent threshold shift (PTS), and non-auditory physical effects.
Temporary Threshold Shift (TTS).—TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. TTS can last from minutes or hours to (in cases of strong TTS) days. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ends. Only a few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals, and none of the published data concern TTS elicited by exposure to multiple pulses of sound.

For toothed whales exposed to single short pulses, the TTS threshold appears to be, to a first approximation, a function of the energy content of the pulse (Finneran et al. 2005, 2002). Given the available data, the received level of a single seismic pulse might need to be ≈210 dB re 1 μPa rms (≈221–226 dB pk–pk) in order to produce brief, mild TTS. Exposure to several seismic pulses at received levels near 200–205 dB (rms) might result in slight TTS in a small odontocete, assuming the TTS threshold is (to a first approximation) a function of the total received pulse energy. Seismic pulses with received levels of 200–205 dB or more are usually restricted to a radius of no more than 656 ft (200 m) around a seismic vessel operating a large array of airguns.

For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. However, no cases of TTS are expected given the moderate size of the source, and the strong likelihood that baleen whales would avoid the area of operations (or vessel) before being exposed to levels high enough for there to be any possibility of TTS.

In pinnipeds, TTS thresholds associated with exposure to brief pulses (single or multiple) of underwater sound have not been measured. Initial evidence from prolonged exposures suggested that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak et al. 1999; Ketten et al. 2001; cf. Au et al. 2000). For harbor seal, which is closely related to the ringed seal, TTS onset apparently occurs at somewhat lower received energy levels than for odontocetes.

A marine mammal within a radius of ≤328 ft (≤100 m) around a typical large array of operating airguns might be exposed to a few seismic pulses with levels of ≥205 dB, and possibly more pulses if the mammal moved with the seismic vessel. The received sound levels will be reduced for the proposed array to be used during the current survey compared to the larger arrays thus reducing the potential for TTS for the proposed survey. (As noted above, most cetacean species tend to avoid operating airguns, although not all individuals do so.) However, several of the considerations that are relevant in assessing the impact of typical seismic surveys with airgun arrays are directly applicable here:

- “Ramping up” (soft start) is standard operational protocol during startup of airgun arrays in many jurisdictions. Ramping up involves starting the airguns in sequence, usually commencing with a single airgun and gradually adding additional airguns. This practice will be employed when the airgun array is operated during the proposed survey.

- It is unlikely that cetaceans would be exposed to airgun pulses at a sufficiently high level for a sufficiently long period to cause more than mild TTS, given the relative movement of the marine mammal.

- With a large array of airguns, TTS would be most likely to occur in odontocetes that linger near the airguns. Harbor porpoises occur in the Beaufort Sea but are unlikely to be in the project area in large numbers if at all.
NMFS (1995, 2000) concluded that cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding, respectively, 180 and 190 dB re 1 μPa rms. These sound levels are not, however, considered to be the levels above which TTS might occur. Rather, they are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before TTS measurements for marine mammals started to become available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. As summarized above, data that are now available imply that TTS is unlikely to occur unless odontocetes are exposed to airgun pulses much stronger than 180 dB re 1 μPa rms and it is unlikely such exposures will occur.

**Permanent Threshold Shift (PTS).**—When PTS occurs, there is physical damage to the sound receptors in the ear. In some cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges.

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the possibility that mammals close to an airgun array might incur TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage in terrestrial mammals. Relationships between TTS and PTS thresholds have not been studied in marine mammals, but are assumed to be similar to those in humans and other terrestrial mammals. PTS might occur at a received sound level at least several decibels above that inducing mild TTS if the animal were exposed to the strong sound pulses with very rapid rise time.

It is highly unlikely that marine mammals could receive sounds strong enough (and over a sufficient duration) to cause permanent hearing impairment during a project employing the medium-sized airgun sources planned here. For the proposed project, marine mammals are unlikely to be exposed to received levels of seismic pulses strong enough to cause TTS. Marine mammals would probably need to be within 328-656 ft (100-200 m) of the airguns and be exposed for some time period for TTS to occur. Given the higher level of sound necessary to cause PTS, it is even less likely that PTS could occur. In fact, even the levels immediately adjacent to the airgun may not be sufficient to induce PTS, especially because a mammal would not be exposed to more than one strong pulse unless it remained immediately alongside the airgun for a period longer than the inter-pulse interval. Baleen whales generally avoid the immediate area around operating seismic vessels. The planned monitoring and mitigation measures, including visual monitoring, power downs, and shut downs of the airguns when mammals are seen within the “safety radii”, will minimize the already-minimal probability of exposure of marine mammals to sounds strong enough to induce PTS.

**Non-auditory Physiological Effects.**—Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, and other types of organ or tissue damage. However, studies examining such effects are very limited. If any such effects do occur, they probably would be limited to unusual situations when animals might be exposed at close range for unusually long periods. It is doubtful that any single marine mammal would be exposed to strong seismic sounds for a sufficient period of time that significant physiological stress would develop. That is especially so in the case of the proposed project where the airgun configuration is moderately sized and the survey will occur for only a short period of time.

In general, little is known about the potential for seismic survey sounds to cause auditory impairment or other physical effects in marine mammals. Available data suggest that such effects, if they occur at all, would be limited to short distances and probably to projects involving large arrays of airguns. However, the available data do not allow for meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes (including belugas), and some
pinnipeds, are especially unlikely to incur auditory impairment or other physical effects. Also, the planned monitoring and mitigation measures include shut downs of the airguns, which will reduce any such effects that might otherwise occur.

**Strandings and Mortality**

Marine mammals close to underwater detonations of high explosive can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten et al. 1993; Ketten 1995). Airgun pulses are less energetic and have slower rise times, and there is no proof that they can cause serious injury, death, or stranding even in the case of large airgun arrays. However, the association of mass strandings of beaked whales with naval exercises and, in one case, a Lamont-Doherty Earth Observatory (L-DEO) seismic survey, has raised the possibility that beaked whales exposed to strong pulsed sounds may be especially susceptible to injury and/or behavioral reactions that can lead to stranding.

Seismic pulses and mid-frequency sonar pulses are quite different. Sounds produced by airgun arrays are broadband with most of the energy below 1 kHz. Typical military mid-frequency sonars operate at frequencies of 2–10 kHz, generally with a relatively narrow bandwidth at any one time. Thus, it is not appropriate to assume that there is a direct connection between the effects of military sonar and seismic surveys on marine mammals. However, evidence that sonar pulses can, in special circumstances, lead to physical damage and mortality (NOAA and USN 2001; Jepson et al. 2003; Fernández et al. 2005a), even if only indirectly, suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity pulsed sound.

In May 1996, 12 Cuvier’s beaked whales stranded along the coasts of Kyparissiakos Gulf in the Mediterranean Sea. That stranding was subsequently linked to the use of low- and medium-frequency (250-3,000 Hz) active sonar by a North Atlantic Treaty Organization (NATO) research vessel in the region (Frantzis 1998). In March 2000, a population of Cuvier’s beaked whales being studied in the Bahamas disappeared after a U.S. Navy task force using mid-frequency tactical sonars passed through the area; some beaked whales stranded (Balcomb and Claridge 2001; NOAA and USN 2001).

In September 2002, a total of 14 beaked whales of various species stranded coincident with naval exercises in the Canary Islands (Jepson et al. 2003; Fernández et al. 2003). Also in Sept. 2002, there was a stranding of two Cuvier’s beaked whales in the Gulf of California, Mexico, when the L-DEO vessel *Maurice Ewing* was operating a 20-airgun, 8,490 in³ (139,126 cm³) array in the general area. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence (Hogarth 2002; Yoder 2002). Nonetheless, that plus the incidents involving beaked whale strandings near naval exercises suggests a need for caution in conducting seismic surveys in areas occupied by beaked whales. However, no beaked whales are found within this project area and the planned monitoring and mitigation measures are expected to minimize any possibility for injury or mortality of other species.

**Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Marine Mammals**

Resuspension of sediments and subsequent deposition resulting from anchoring, construction of the MLC, and early phases of drilling associated with Shell’s exploration drilling program would have only localized and temporary effects on marine mammals. Such effects would be limited to whales within a very close proximity to operations and would affect, at most, a small number of individuals. Marine mammals would likely avoid areas where vessel mooring, MLC construction, and drilling are occurring.

**Cetaceans**

Most of the cetacean species expected to be in the project area will not be affected by vessel mooring or MLC construction beyond reactions to the vessels that are present, described above, or reactions to
drilling sounds which are described below. The only species that might be affected by these operations directly is gray whale, which would be few in number in the project area if they are present at all. Gray whales will likely avoid drilling activities and therefore not come into close contact with drilling cuttings. Gray whales are benthic feeders and the area of seafloor that will be covered by cuttings discharge and disturbed by construction of the MLCs or anchor placement will be unavailable to the whales for foraging. Size of areas disturbed by anchoring and MLC construction are described in Section 2.3 and distribution of cuttings from MLC construction and early phases of drilling is addressed in Section 2.7. This is not expected to impact individual whales or the population, because the areas of disturbance are insignificant when compared to the habitat that will still be available to gray whales for foraging.

**Pinnipeds**

Seals are not expected to be impacted by drill cuttings. Distribution of cuttings from MLC construction and early phases of drilling is addressed in Section 2.7. It is highly unlikely that a seal would remain within 330 ft (100 m) of the discharge source for any extended period of time. Bearded seals are benthic feeders and feed on organisms living on the seafloor. The digging of MLCs and the placement of anchors would result in the death of benthic organisms in the immediately disturbed area. Smothering of benthic organisms by drilling discharges (during early phases of drilling) could also impact prey. However, bearded seals have a wide feeding range and are highly opportunistic feeders; therefore, it is unlikely that these small disturbances will affect bearded seals or their population numbers. Walrus are also benthic feeders but are unlikely to be in the project area. Ringed seal, bearded seal and Pacific walrus are addressed again in Section 4.1.9.

**Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Marine Mammals**

The only cuttings discharged will be from the MLC construction and early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Marine Mammals.

**Analysis of Impact of Other Permitted Discharges on Marine Mammals**

The impact of other NPDES-permitted discharges will be negligible and temporary. These discharges include deck drainage, desalination unit wastes, non-contact cooling water, BOP fluid, and excess cement slurry.

Minor, temporary changes in water quality, such as increases in turbidity and decreases in dissolved oxygen expected near the discharge site would have little or no impact on marine mammal species. These changes in water quality would largely be limited to the area within 330 ft (100 m) of the discharge location. Based on modeling results (section 6 of the EP), the temperature of the non-contact cooling water is expected to reach ambient water temperature within 164 ft (50 m) of the Kulluk discharge point and 256 ft (78 m) from the discharge point on the Discoverer. Similarly, this would not be expected to affect any marine mammal species in the project area.

**Analysis of Impact of Aircraft Traffic on Marine Mammals**

Levels and duration of sounds received by marine mammals underwater from a passing helicopter or fixed-wing aircraft are a function of the type of aircraft, orientation of the aircraft, depth of the animal, and water depth. Aircraft sounds are detectable underwater at greater distances when the receiver is in shallow rather than deep water. Generally, sound levels received underwater decrease as the altitude of the aircraft increases (Richardson et al. 1995). Aircraft sounds are audible for much greater distances in air than in water.
Helicopters will be used for personnel and equipment transport to and from the drilling vessel. Under calm conditions, rotor and engine sounds are coupled into the water within a 26º cone beneath the aircraft. Some of the sound will transmit beyond the immediate area, and some sound will enter the water outside the 26º area when the sea surface is rough. However, scattering and absorption will limit lateral propagation in shallow water.

Dominant tones in noise spectra from helicopters are generally below 500 Hz (Greene and Moore 1995). Harmonics of the main rotor and tail rotor usually dominate the sound from helicopters; however, many additional tones associated with the engines and other rotating parts are sometimes present.

Because of Doppler shift effects, the frequencies of tones received at a stationary site diminish when an aircraft passes overhead. The apparent frequency is increased while the aircraft approaches and is reduced while it moves away.

Aircraft flyovers are not heard underwater for very long, especially when compared to how long they are heard in air as the aircraft approaches an observer. Helicopters flying to and from the drillship will generally maintain straight-line routes at altitudes of 1,500 ft (457 m) ASL or greater, thereby limiting the received levels at and below the surface.

**Cetaceans**

The nature of sounds produced by aircraft activities above the surface of the water does not pose a direct threat to the hearing of marine mammals that are in the water; however minor and short-term behavioral responses of cetaceans to aircraft have been documented in several locations, including the Beaufort Sea (Richardson et al. 1985a,b; Patenaude et al. 2002). Cetacean reactions to aircraft depend on several variables including the animal’s behavioral state, activity, group size, habitat, and the helicopter flight pattern, among other variables (Richardson et al. 1995).

During spring migration in the Beaufort Sea, beluga whales reacted to helicopter noise more frequently and at greater distances than did bowhead whales (38% vs. 14% of observations, respectively; Patenaude et al. 2002). Most reaction occurred when the helicopter passed within 820 ft (250 m) lateral distance at altitudes <492 ft (≤150 m). Neither species exhibited noticeable reactions to single passes at altitudes >150 m. Belugas within 820 ft (250 m) of stationary helicopters on the ice with the engine running showed the most overt reactions. Whales were observed to make only minor changes in direction in response to sounds produced by helicopters, so all reactions to helicopters were considered brief and minor. Cetacean reactions to helicopter disturbance are difficult to predict and may range from no reaction at all to minor changes in course or (infrequently) leaving the immediate area of the activity.

**Pinnipeds**

Few systematic studies of pinniped reactions to aircraft overflights have been completed. Documented reactions range from simply becoming alert and raising the head, to escape behavior such as hauled out animals rushing to the water. Ringed seals hauled out on the surface of the ice have shown behavioral responses to helicopter overflights with escape responses most probable at lateral distances <656 ft (<200 m) and overhead distances <492 ft (<150 m; Born et al. 1999). Spotted seals haul out on beaches in summer and appear to be sensitive to aircraft. Spotted seals on ice react to aircraft at considerable distances by “erratically racing across flos and eventually diving off” (Burns and Harbo, in Cowles et al. 1981). Spotted seals on beaches were reported to move into water when a survey aircraft flew over at altitudes of 3,281 ft (1,000 m) or more (Frost and Lowry 1990; Frost et al. 1993; Rugh et al. 1993; Thomas et al. 2010). In general, spotted seals returned to the beaches quickly after the aircraft departed.
Although specific details of altitude and horizontal distances are lacking from many largely anecdotal reports, escape reactions to a low-flying helicopter (<492 ft [<150 m] ASL) can be expected from all pinnipeds potentially encountered during the proposed operations. These responses would likely be relatively minor and brief in nature. Whether any response would occur when a helicopter is at the higher suggested operational altitudes is difficult to predict and probably a function of several other variables including wind chill, relative wind chill, and time of day (Born et al. 1999).

As mentioned in the previous section, momentary behavioral reactions “do not rise to the level of taking” as defined by NMFS (NMFS 2001). In order to limit behavioral reactions of marine mammals during crew changes, the helicopter will maintain a minimum altitude of 1,500 ft (457 m) above the water except when taking off or landing. Airplanes involved in marine mammal monitoring may fly at an altitude of 1,000 ft (305 m). Given these mitigation measures and that the most sensitive species, spotted seals, are unlikely to be in the area in large numbers the effects of aircraft on pinnipeds in the project area will be negligible.

Analysis of Impact of Sound from Drilling and Ice Management on Marine Mammals

Continuous or non-pulsed sounds associated with drilling activities can also have effects on marine mammals. As with airgun pulsed sound (described above), the effects of such sounds might include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical effects (Richardson et al. 1995, see above section on ZVSP sounds for descriptions of these potential types of effects). None of the equipment planned for use in this project will produce continuous sounds loud enough to cause detrimental physical effects in marine mammals unless the animals were right next to the drillship during operations and remained there for extended periods of time, which is highly unlikely. Sounds associated with drilling and ice management could, however, result in behavioral disturbance of marine mammals and may mask marine mammal communication and other sounds in the natural environment.

**Drilling Sounds**

Exploratory drilling will be conducted from a vessel specifically designed for such operations in the Arctic. Underwater sound propagation results from the use of generators, drilling machinery, and the rig itself. Sound levels during vessel-based operations may fluctuate depending on the specific type of activity at a given time and aspect from the vessel. Underwater sound levels may also depend on the specific equipment in operation. Lower sound levels have been reported during well logging than during drilling operations (Greene 1987b), and underwater sound appeared to be lower at the bow and stern aspects than at the beam (Greene 1987a).

Most drilling sounds generated from vessel-based operations occur at relatively low frequencies below 600 Hz although tones up to 1,850 Hz were recorded by Greene (1987a) during drilling operations in the Beaufort Sea. At a range of 0.11 mi (0.17 km) the 20-1,000 Hz band level was 122-125 dB for the drillship Explorer I. Underwater sound levels were slightly higher (134 dB) during drilling activity from the Explorer II at a range of 0.12 mi (0.20 km) although tones were only recorded below 600 Hz. Underwater sound measurements from the Kulluk at 0.61 mi (0.98 km) were higher (143 dB) than from the other two vessels.

Information below describes studies that have examined cetacean and pinniped interactions with drilling operations. We include studies of threatened and endangered species, considered in more detail later in this chapter, as well as species that do not occur in the project area. Additionally, not all of these studies have occurred in Arctic waters, but they all provide information that may be important to understanding how marine mammals, react to drilling sounds in their environment.
Cetaceans

Baleen Whales—Richardson et al. (1995b) reported changes in surfacing and respiration behavior, and the occurrence of turns during surfacing in bowhead whales exposed to playback of underwater sound from drilling activities. These subtle behavioral effects were temporary and localized, and occurred at distances up to 1.2-2.4 mi (2-4 km).

Brewer et al. (1993) and Hall et al. (1994) reported numerous sightings of marine mammals including bowhead whales in the vicinity of offshore drilling operations in the Beaufort Sea. One bowhead whale sighting was reported within ~1,312 ft (~400 m) of a drilling vessel although other sightings were at much greater distances. Few bowheads were recorded near industrial activities by aerial observers, but observations by surface observers suggested that bowheads may have been closer to industrial activities than was suggested by results of aerial observations.

Richardson et al. (2008) reported a slight change in the distribution of bowhead whale calls in response to operational sounds on BP Exploration (Alaska) Inc. (BP)’s Northstar Island. The southern edge of the call distribution ranged from 0.47-1.46 mi (0.76-2.35 km) farther offshore, apparently in response to industrial sound levels. This result however, was only achieved after intensive statistical analyses, and it is not clear that this represented a biologically significant effect.

Southall et al. (2007) reviewed a number of papers describing the responses of marine mammals to non-pulsed sound. In general, little or no response was observed in animals exposed at received levels from 90-120 dB. Probability of avoidance and other behavioral effects increased when received levels were 120-160 dB. Some of the relevant reviews of Southall et al. (2007) are summarized below.

Malme et al. (1986) observed the behavior of feeding gray whales during four experimental playbacks of drilling sounds (50-315 Hz; 21-min overall duration and 10% duty cycle; source levels 156-162 dB). In two cases for received levels of 100-110 dB, no behavioral reaction was observed. Avoidance behavior was observed in two cases where received levels were 110-120 dB.

Richardson et al. (1990) performed 12 playback experiments in which bowhead whales in the Alaskan Arctic were exposed to drilling sounds. Whales generally did not respond to exposures in the 100 to 130 dB range, although there was some indication of minor behavioral changes in several instances.

Frankel and Clark (1998) conducted playback experiments with wintering humpback whales using a single speaker producing a low-frequency “M-sequence” (sine wave with multiple-phase reversals) signal in the 60-90 Hz band with output of 172 dB at 1 m. For 11 playbacks, exposures were between 120 and 130 dB re: 1 μPa and included sufficient information regarding individual responses. During eight of the trials, there were no measurable differences in tracks or bearings relative to control conditions, whereas on three occasions, whales either moved slightly away from (n = 1) or towards (n = 2) the playback speaker during exposure. The presence of the source vessel itself had a greater effect than did the M-sequence playback.

Nowacek et al. (2004) used controlled exposures to demonstrate behavioral reactions of northern right whales to various nonpulse sounds. Playback stimuli included ship noise, social sounds of conspecifics, and a complex, 18-min “alert” sound consisting of repetitions of three different artificial signals. Ten whales were tagged with calibrated instruments that measured received sound characteristics and concurrent animal movements in three dimensions. Five out of six exposed whales reacted strongly to alert signals at measured received levels between 130 and 150 dB (i.e., ceased foraging and swam rapidly to the surface). Two of these individuals were not exposed to ship noise and the other four were exposed
to both stimuli. These whales reacted mildly to conspecific signals. Seven whales, including the four exposed to the alert stimulus, had no measurable response to either ship sounds or actual vessel noise.

**Toothed Whales**—Most toothed whales have the greatest hearing sensitivity at frequencies much higher than that of baleen whales and may be less responsive to low-frequency sound commonly associated with industry activities. Richardson et al. (1995a) reported that beluga whales did not show any apparent reaction to playback of underwater drilling sounds at distances greater than 656-1,312 ft (200-400 m). Reactions included slowing down, milling, or reversal of course after which the whales continued past the projector, sometimes within 164-328 ft (50-100 m). The authors concluded (based on a small sample size) that playback of drilling sound had no biologically significant effects on migration routes of beluga whales migrating through pack ice and along the seaward side of the nearshore lead east of Pt. Barrow in spring.

In reviewing responses of cetaceans with best hearing in mid-frequency ranges, which includes toothed whales, Southall et al. (2007) reported that combined field and laboratory data for mid-frequency cetaceans exposed to nonpulse sounds did not lead to a clear conclusion about received levels coincident with various behavioral responses. In some settings, individuals in the field showed profound (significant) behavioral responses to exposures from 90 to 120 dB, while others failed to exhibit such responses for exposure to received levels from 120 to 150 dB. Contextual variables other than exposure received level, and probable species differences, are the likely reasons for this variability. Context, including the fact that captive subjects were often directly reinforced with food for tolerating noise exposure, may also explain why there was great disparity in results from field and laboratory conditions—exposures in captive settings generally exceeded 170 dB before inducing behavioral responses. Below we summarize some of the relevant material reviewed by Southall et al. (2007).

Awbrey & Stewart (1983) played back semi-submersible drillship sounds (source level: 163 dB) to belugas in Alaska. They reported avoidance reactions at 300 and 1,500 m and approach by groups at a distance of 3,500 m (received levels ~110-145 dB over these ranges assuming a 15 log R transmission loss). Similarly, Richardson et al. (1990) played back drilling platform sounds (source level: 163 dB) to belugas in Alaska. They conducted aerial observations of eight individuals among ~100 spread over an area several hundred meters to several kilometers from the sound source and found no obvious reactions. Moderate changes in movement were noted for three groups swimming within 656 ft (200 m) of the sound projector.

Several researchers conducting laboratory experiments on hearing and the effects of nonpulse sounds on hearing in mid-frequency cetaceans have reported concurrent behavioral responses. Nachtigall et al. (2003) reported that noise exposures up to 179 dB and 55-min duration affected the trained behaviors of a bottlenose dolphin participating in a TTS experiment. Finneran and Schlundt (2004) provided a detailed, comprehensive analysis of the behavioral responses of belugas and bottlenose dolphins to 1-s tones (received levels 160-202 dB) in the context of TTS experiments. Romano et al. (2004) investigated the physiological responses of a bottlenose dolphin and a beluga exposed to these tonal exposures and demonstrated a decrease in blood cortisol levels during a series of exposures between 130 and 201 dB. Collectively, the laboratory observations suggested the onset of behavioral response at higher received levels than did field studies. The differences were likely related to the very different conditions and contextual variables between untrained, free-ranging individuals vs. laboratory subjects that were rewarded with food for tolerating noise exposure.

**Pinnipeds**

Reactions of pinnipeds to drilling and related activities have not been studied extensively. Pinnipeds generally seem to be less responsive to exposure to industrial sound than most cetaceans. Ringed seals were often seen near drillships in the Arctic during earlier exploration drilling programs (Ward and Pessah 1986, Brueggeman et al. 1991, Gallagher et al. 1992, Brewer et al. 1993, Hall et al. 1994). In...
spring, some ringed and bearded seals approached and dove within 164 ft (50 m) of an underwater sound projector broadcasting steady low frequency drilling sounds (Richardson et al. 1990, 1991). Received sound levels at seals was estimated to be ~130 dB re 1uPa. Frost and Lowery (1988) reported reduced densities of ringed seals within 3 mi (3.7 km) of artificial islands, on some of which drilling was under way.

Southall et al. (2007) reviewed literature describing responses of pinnipeds to non-pulsed sound and reported that the limited data suggest exposures between ~90 and 140 dB generally do not appear to induce strong behavioral responses in pinnipeds exposed to nonpulse sounds in water; no data exist regarding exposures at higher levels. It is important to note that among these studies of pinnipeds responding to nonpulse exposures in water, there are some apparent differences in responses between field and laboratory conditions. In contrast to the mid-frequency odontocetes, captive pinnipeds responded more strongly at lower levels than did animals in the field. Again, contextual issues are the likely cause of this difference.

**Ice Management Sounds**

Shell does not intend to break ice, except in case of emergency that has immediate threat to the vessel or personnel. However, an IMP (Appendix K of the EP) consisting of constant ice forecasting and support from ice management vessels will be implemented to ensure safe operations during the drilling season. Ice management vessels produce more noise while breaking ice than ships of comparable size due primarily to the sounds of the propeller cavitation (Richardson et al. 1995). Icebreakers typically ram into heavy ice until losing momentum, then back off to build momentum before ramming again. The highest noise levels usually occur while backing full astern in preparation to ram forward through the ice. Overall, the noise generated by an icebreaker pushing ice was 10-15 dB greater than the noise produced by the ship underway in open water (Richardson et al. 1995). Little information is available about the effect of the increased sound levels on marine mammals due to icebreaking.

**Cetaceans**

Beluga whales have been documented swimming rapidly away from ships and icebreakers in the Canadian High Arctic when a ship approached to within 22-31 mi (35-50 km), and they may travel up to 50 mi (80 km) from the vessel’s track (Richardson et al. 1995). It is expected that belugas avoid icebreakers as soon as they detect the ships (Cosens and Dueck 1993). The reaction of beluga whales to ships vary greatly and some animals may become habituated to higher levels of ambient noise (Erbe and Farmer 2000).

Little information is available regarding the effect of icebreaking ships on baleen whales. Migrating bowhead whales appeared to avoid an area around a drill site by >16 mi (>25 km) where an icebreaker was working in the Beaufort Sea. There was intensive icebreaking daily in support of the drilling activities (Brewer et al. 1993). Migrating bowheads also avoided a nearby drill site at the same time of year when little icebreaking was being conducted (LGL and Greeneridge 1987). It is unclear as to whether the drilling activities, icebreaking operations, or the ice itself might have been the cause for the whales’ diversion.

**Pinnipeds**

Brueggeman et al. (1992) reported on the reactions of seals to an icebreaker during activities at two prospects in the Chukchi Sea. Reactions of seals to the icebreakers varied between the two prospects. Most (67%) seals did not react to the icebreaker at either prospect. Reaction at one prospect was greatest during icebreaking activity followed by general vessel activity (running/maneuvering/jogging) and was lowest while the vessel was at anchor or drifting. Frequency of reaction was greatest for animals within 0.14 mi (0.23 km) of the vessel and lowest for animals beyond 0.58 mi (0.93 km). At the second prospect however, seal reaction was lowest during icebreaking activity with higher and similar levels of response.
during general (non-icebreaking) vessel operations and when the vessel was at anchor or drifting. The frequency of seal reaction generally declined with increasing distance from the vessel except during general vessel activity where it remained consistently high to about 0.29 mi (0.46 km) from the vessel before declining. Kanik et al. (1980 in Richardson et al. 1995) reported that most ringed seals and harp seals within 0.6-1.2 mi (1-2 km) from an icebreaker remained on ice but that seals closer to the icebreaker often dove into the water.

**Conclusions**

No significant or lasting impacts to marine mammals are expected from the sound energy that will be created by drilling and ice management activities in Camden Bay. The most likely effects of these activities are temporary avoidance of the area by most marine mammals. Avoidance of the area is likely to last as long as operations are ongoing, but is unlikely to persist once activities cease.

Gray whales and harbour porpoises could be present in the project area but it is unlikely that more than a few animals would be found this far east in the Beaufort Sea. Beluga whales regularly use the Beaufort Sea but tend to remain farther offshore than the prospect areas, near the continental shelf break, and only small numbers would be likely to be in the area. These animals would probably avoid the drilling operations but impacts of that avoidance would be minimal since the area is not typically used by large numbers of belugas. Avoidance of this area would not alter typical pathways of migration by beluga whales. Greater numbers of bowhead whales could have direct interactions with the proposed program and these impacts are discussed in more detail in Section 4.1.9.

Belugas primarily use high-frequency sounds to communicate and locate prey; therefore, masking by low-frequency sounds associated with drilling activities is not expected to occur (Gales 1982). If the distance between communicating whales does not exceed their distance from the drilling activity, the likelihood of potential impacts from masking would be low (Gales 1982). Cetaceans that use lower frequencies to call could experience masking of their calls in close proximity to the drilling operation. Any such effects are expected to be minimal as most cetaceans will avoid the operations.

Several seal species could be encountered in the study area, but ringed seal is by far the most abundant. Typical densities of seals in the area suggest that only a small percentage of the ringed seal population might be affected by the proposed exploration drilling program. Spotted seals could be present in the area but are unlikely to be present in large numbers. The closest spotted seal haulouts are in the Coleville River Delta which is ~120 miles (~193 km) west. Bearded seals are also likely to be present in small numbers. Most seals are unlikely to react to continuous sounds until they are much stronger than 120 dB (the zone of disturbance recognised by NMFS for continuous sounds), so it is probable that only a small percentage of these animals would actually be disturbed. Only short term avoidance of the immediate area around the drilling operations is expected to occur. Ringed and bearded seals are discussed further in Section 4.1.9.

**Analysis of Impact of Liquid Hydrocarbon Spill on Marine Mammals**

Section 2.10 of this EIA analyzes in detail the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, and Shell’s plans for responding to a “small” spill (defined as 48 bbl or less). Section 2.10 addresses Shell’s categories of spill sizes are and those that are different, but not incompatible, used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place.
Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill, including capabilities for responding to a “worst case” scenario release. In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill and any effects on marine mammals. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

**Analysis of Impact of Small Liquid Hydrocarbon Spill on Marine Mammals**

While still a remote possibility due to the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Given the open ocean location of Shell’s prospects and the expected duration of a small spill the potential for effects on marine mammals to occur would be small. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours. Recovery controls would ensure that any spill effects are localized and would result only in short-term environmental consequences. Effects would be similar among the Sivulliq and Torpedo prospects. Impacts of a small spill are analyzed below.

There is no evidence of whale mortality from petroleum spills (Richardson et al. 1989). The epidermis of whales has been found to be largely impenetrable by petroleum (Geraci and St. Aubin 1985). However, eyes and mucous membranes could be affected when contact is made with petroleum such as diesel. Diesel can also affect seal and walrus membranes that are not covered by fur. In a study by Geraci and Smith (1976), seals immersed in oil-covered water exhibited irritation of the eyes, swollen noses, ulcers, and scratches on the cornea. Another study by the same scientists later found no tissue damage to ringed seals after being immersed in oil-covered water for 24 hours (Geraci and Smith 1976).

It has been shown that oil would have little or no effect on thermoregulation ability of most marine mammals (Kooyman et al. 1976; Geraci and Smith 1976). However, within two to four weeks of birth, oiling of the fur can be detrimental to newborn seal pups. The pups’ thick fur called “lanugo” keeps them warm until they can build up enough blubber. Oiling of the lanugo may cause heat loss and hypothermia (St. Aubin 1988). The period of time that pups are vulnerable to oil spills is very brief. Drilling in the project area would occur long after pups are born and have shed their lanugo coat. Thus, seal pups are not expected to be impacted by an oil spill.

Aromatics and other toxic molecules from petroleum that is ingested can enter the bloodstream via the intestinal wall and transfer to major body organs. St. Aubin (1988) found that high levels of toxins would be needed before detrimental effects would be seen. He concluded that it would take ingestion of 0.26 gal (1 liter [L]) of crude oil by a seal that was 110 lbs (50 kg) in order to see these effects. Ingestion of oil over time has the potential to cause long-term effects on phocids (St. Aubin 1988). Petroleum residues can be stored in lipids inside the body, but there has been no evidence of resulting metabolic or physiologic effects. Because walrus are benthic feeders and diesel is lighter than water, it is unlikely that walrus would feed on contaminated prey. The area of contamination from a small spill represents an exceedingly small portion of the foraging range for any of the whale or seal species that might be present in the area. Mysticete prey could also carry contaminants that could be ingested (Wursig 1990), but given the small area affected by a small release of diesel, it is unlikely that whales or other marine mammals would consume sufficient quantities of petroleum to result in morbidity or mortality. Even in the unlikely event of a release, there would be no or negligible effects on marine mammals through contact with, or ingestion of, diesel or other petroleum products.
The respiratory system of marine mammals could be compromised by the inhalation of vapors from a release of diesel. Effects of vapor inhalation could potentially include neurological disorders and liver damage if animals were to surface in an area with high concentrations of VOCs (Geraci 1990). However, a release of diesel would evaporate quickly, with over 99 percent of the diesel being evaporated or dispersed within 48 hours, and any vapors would be rapidly dispersed in the windy environment of the Beaufort Sea. Under these conditions it is highly unlikely that the concentration of the vapors would reach levels that would be harmful to marine mammals. Any air quality effects would be limited to a very brief time period and a relatively small area, therefore effects on marine mammals would be negligible or non-existent.

Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures. Hazing would be employed to minimize the possibility of contact between marine mammals and any release. Given the measures that are in place, the probability of a spill occurring is very low, and any such release would likely be contained.

The most likely effect of a spill on marine mammals would be displacement from the area caused by the increased vessel and aircraft traffic that would be involved in spill response and cleanup efforts. Such displacement would be temporary and occur over a relatively short period of time and therefore be unlikely to have more than a negligible effect on marine mammal species in the area. Spill response operations occurring during bowhead whale migration could affect larger numbers of animals by displacing them from their preferred migration route. Effects on bowhead whales are discussed in more detail in Section 4.1.9.

Analysis of Impact of Large Liquid Hydrocarbon Spill to Marine Mammals

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

Analysis of Impact of Project Air Emissions on Marine Mammals

The impact of project air emissions in Camden Bay on marine mammals would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SO₂, ozone, and Pb. Primary
standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on marine mammals.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

**Terrestrial Mammals**

**Analysis of Impact of Vessel Traffic on Terrestrial Mammals**

Vessel traffic is expected to have little or no impact on terrestrial mammals due to the distance the project area is from the coast. The only terrestrial mammals that may be affected by vessel traffic are caribou near the Beaufort Sea coast.

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). Sounds from vessel traffic near the coast and barrier islands may cause caribou to avoid or leave these insect relief areas though most vessel traffic will be far enough off shore that it would be unlikely to have any effect on the use of most insect relief habitat. BOEMRE has concluded that disturbance from this type of sound energy will be localized and temporary (MMS 2008a).

**Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Terrestrial Mammals**

Exploration activities at the drill sites will occur at least 16 mi (26 km) offshore. There will be no impacts from vessel mooring, MLC construction, or early phases of drilling on terrestrial mammals.

**Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Terrestrial Mammals**

The only cuttings discharged will be from the MLC construction and early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Terrestrial Mammals.
Analysis of Impact of Other Permitted Discharges on Terrestrial Mammals

Other NPDES-permitted discharges include deck drainage, desalination unit wastes, non-contact cooling water, BOP fluid, and excess cement slurry. All these discharges will be least 16 mi (26 km) offshore. Permitted discharges are not expected to impact terrestrial mammals.

Analysis of Impact of Aircraft Traffic on Terrestrial Mammals

Aircraft traffic to and from offshore facilities and during aerial surveys associated with Shell’s exploration drilling activities may cause a disturbance to muskox, caribou, grizzly bears, and moose. Disturbance to animals will produce effects that last less than one hour and will have no impacts on their populations (MMS 2008a). Disturbance effects would be limited to temporary and localized displacement or startling responses (MMS 2008a; Harrington and Veitch 1992). Additionally, Shell aircraft will not fly below 1,500 ft (457 m) except during approach for landing or in the case of an emergency. The flight altitude restrictions will minimize disturbance effects on terrestrial mammals.

Many studies have demonstrated several types of negative impacts resulting from sudden sounds from low-flying aircraft on caribou (Harrington and Veitch 1992; Gunn et al. 1985; Calef et al. 1976). These impacts include a startle and run response, decreased calf survival, and reduced lactation. These responses may result in physical injury or an increased use of energy from fat reserves. However, research has shown that caribou that are not actively chased or hunted from aircraft become habituated and do not exhibit these types of responses (Davis et al. 1985; Valkenburg and Davis 1983). Flights to the project area will originate from the Deadhorse and Prudhoe Bay area where aircraft have operated for decades.

Flight paths of aircraft were developed in consultation with affected communities and a consensus reached that coastal flights will occur 5 mi (8 km) inland to minimize impacts on coastal animals, such as caribou seeking relief during the insect season.

Analysis of Impact of Sounds from Drilling and Ice Management on Terrestrial Mammals

Drilling activities will occur at least 16 mi (26 km) offshore. Sounds from drilling and ice management will not affect terrestrial mammals.

Analysis of Impact of Liquid Hydrocarbon Spill on Terrestrial Mammals

Section 2.10 of this EIA analyzes in detail the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, Shell’s plans for responding to a “small” spill (defined as 48 bbl or less), and Shell’s worst case discharge planning scenario. As explained in Section 2.10, Shell’s categories of spill sizes are different from, but not incompatible with, those used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place.

Shell’s plans include measures to prevent any spills and respond quickly and effectively in the unlikely event of a spill, including capabilities for responding to a “worst case” scenario release. In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill on terrestrial mammals. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would
be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

**Analysis of Impact of Small Liquid Hydrocarbon Spill on Terrestrial Mammals**

While still a remote possibility due to the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Impacts analyzed below are based on a small spill of crude oil. Impacts from crude oil are assumed to be similar to diesel fuel.

Terrestrial mammal mortality can occur through direct contact with an oil spill that reaches coastal areas from the drilling sites. Oil that comes in contact with terrestrial mammals may reduce the ability to insulate, resulting in higher stress levels and energy needs. Consequently, oiled terrestrial mammals can die of hypothermia and starvation. Ingestion of oil may result in damage to the internal organs and direct mortality.

However, a small diesel fuel spill at a drilling site would not reach the coastal areas. With drilling activity occurring at least 16 mi (26 km) offshore, a small diesel spill would likely not reach any shoreline where terrestrial mammals may be found. Based on the viscosity of the diesel fuel to be used by Shell, the maximum area of the sea with diesel on the surface in an uncontained 48 bbl (7.6 m³) spill (i.e., no pre-booming) would be about 20-200 ac (0.1-0.8 km²) depending on sea state and weather conditions. Given the open ocean location of Shell’s prospects, the duration of a small spill would be brief. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours, but recovery controls would ensure that any spill effects are localized and would result only in short-term environmental consequences.

Because the small diesel fuel spill at a drilling site would not reach the coast, terrestrial mammals would not be affected.

Shell will have an agency-approved ODPCP prior to commencing operations in the Beaufort Sea. Spill prevention is paramount to Shell’s drilling operations in the prospect area (and worldwide). Regardless, Shell will have OSR vessels nearby with fully trained response personnel and equipment at all times when drilling into zones containing oil to respond to an oil spill in the unlikely event that one should occur.

Impacts to terrestrial mammals from a small spill of hydrocarbons would be negligible.

**Analysis of Impact of Large Liquid Hydrocarbon Spill on Terrestrial Mammals**

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.
Analysis of Impact of Project Air Emissions on Terrestrial Mammals

The impact of project air emissions in Camden Bay on terrestrial mammals would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO$_2$, PM, SO$_x$, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO$_2$, CO, SO$_x$, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on terrestrial mammals.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

4.1.9 Threatened and Endangered Species and Critical Habitat

In Section 3.8 of this EIA and pursuant to 30 C.F.R. § 250.227(b), Shell addressed the threatened and endangered species that could potentially be affected by the activities proposed in this EP. These include three species of endangered baleen whales, bowhead (Balaena mysticetus), fin (Balaenoptera physalus) and humpback (Megaptera novaengelie), polar bear (Ursus maritimus), Pacific walrus (candidate for listing) Odobenus rosmarus divergens); ringed seal (proposed for listing, Phoca hispida), bearded seal (proposed for listing, Erignathus barbatus), and waterfowl including the Steller’s eider (Polysticta stelleri), spectacled eider (Somateria fischeri), and yellow-billed loon (candidate for listing, Gavia adamsii). Section 4.1.9.1 summarizes the history of Section 7 consultations taken to date that have evaluated the impacts of oil and gas activities on these species. The remainder of this Section 4.1.9 provides a species-by-species analysis of the impacts of the proposed activities on these species, and demonstrates why none of the EP activities would have a biologically significant impact to any of these species at the population level.
4.1.9.1 Summary of Inter-Agency Section 7 Consultations to Date

Section 7 of the ESA ensures actions taken by federal agencies do not jeopardize the existence of any listed species.

Pursuant to the ESA of 1973, as amended, and in compliance with the prior consultation regulations reinstated on April 28, 2009, BOEMRE consulted with the USFWS and NMFS on several oil and gas lease sales in this region, including the Beaufort Sea Planning Area Oil and Gas Lease Sale 195. Between 1982 and 1987, NMFS issued several Biological Opinions (BO) related to OCS lease sales concluding the lease sales and associated activities were not likely to jeopardize the continued existence of endangered whales (MMS 2008a, citing the findings of the 1988 Arctic Regional Biological Opinion MMS 2003-001).

In 1999, NMFS consultation with BOEMRE specific to the bowhead whale was reinitiated for reasons including new information on the potential effects of sound energy on bowhead, use of new seismic technology in the OCS, and OCS activity trends. In 2001, NMFS issued a revised Biological Opinion for Oil and Gas Exploration in the Beaufort Sea Planning Area and concluded that activities associated with oil and gas exploration in the Beaufort Sea remained unlikely to jeopardize the continued existence of endangered bowhead whales.

BOEMRE requested reinitiation of consultation in 2006 to expand the area of coverage to include the OCS planning areas in both the Chukchi and Beaufort Seas. NMFS issued a revised Biological Opinion following this reinitiated consultation in March 2006.

Finally, BOEMRE requested reinitiation of consultation in May 2008 to address new information arising from monitoring by industry that indicated the presence of humpback and possibly fin whales in the action area. BOEMRE prepared a Biological Evaluation of the potential consequences of the oil and gas activities on these activities and submitted it to NMFS. After consultation, NMFS concluded that the activities were not likely to jeopardize the continued existing of the whales and issued its July 17, 2008, 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) (NMFS 2008 Biological Opinion). When analyzing Shell’s 2010 Camden Bay EP, BOEMRE determined that Shell’s proposed exploration activities were covered by this Biological Opinion.

BOEMRE also conducting ongoing consultations with USFWS regarding potential impacts of oil and gas activities in the Beaufort and Chukchi Seas on species within the jurisdiction of that agency. In 2003, USFWS issued a Biological Opinion containing a Reasonable and Prudent Measure addressing Steller’s eider and spectacled eider. This Biological Opinion requires BOEMRE develop a protocol, in cooperation with the USFWS, to minimize the likelihood of migrating Steller’s and spectacled eiders from striking exploration or delineation structures (USFWS 2003a, 2003b).

On May 15, 2008 the USFWS published a Final Rule to list the polar bear as a threatened species under the ESA. In June, 2008 an intra-agency conference of the USFWS issued a Biological Opinion on the effects of existing oil and gas industry incidental take regulations (ITR) for polar bears in the Beaufort Sea. The USFWS reviewed the current status of the polar bear; the environmental baseline for the Beaufort Sea Regulations action area; the effects of the Regulations; the documented impacts of industry activities on the species; data provided by monitoring programs in the Beaufort Sea (1993–2006) and the Chukchi Sea (1991–1996); and the cumulative effects on polar bears potentially resulting from oil and gas industry activities. The USFWS concluded in the 2008 Biological Opinion that the ITR, as promulgated, are not likely to jeopardize the continued existence of the polar bear.
In response to changes in status of Steller’s eider and the environmental baseline, as well as the listing of the polar bear as a threatened species and the yellow-billed loon as a candidate species, USFWS conducted a new consultation specific to oil and gas activities in the Arctic. After that consultation was completed, USFWS issued the September 3, 2009 Biological Opinion for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Survey and Exploratory Drilling (USFWS 2009 Biological Opinion). USFWS determined that it is unlikely that seismic survey and exploratory drilling operations would jeopardize the continued existence of the analyzed species (the listed species: Alaska-breeding Steller’s eider, spectacled eider, and polar bear; and the candidate species: Kittlitz’s murrelet and yellow-billed loon) or adversely modify critical habitat (LBCHU), but did identify potential adverse impacts. To minimize these impacts, USFWS included Reasonable and Prudent Measures in the USFWS 2009 Biological Opinion. When analyzing Shell’s 2010 Camden Bay EP, BOEMRE determined that Shell’s proposed exploration activities were covered by this Biological Opinion.

A current analysis of the impacts of project-related oil and gas exploration activities specific to the polar bear is included below. Further information on the bowhead whale (Section 4.1.9.2), and Steller’s and spectacled eider, yellow-billed loon (Section 4.1.9.5) is also presented below.

4.1.9.2 Whales

(Reference Section 3.8.1 and Section 4.1.8)

Three listed species of whales are discussed in detail in Section 3.8.1: fin, humpback, and bowhead. Fin whales occur as far north as the Chukchi Sea (Rice 1974), but no fin whales have ever been observed in the Beaufort Sea (Treacy 2002a; Moore et al. 2000). It is extremely unlikely that fin whales will be encountered during Shell’s exploratory drilling program in Camden Bay. Only one humpback whale has been documented in the Beaufort Sea (Greene et al. 2007). Therefore, there will be negligible impact, if any, on fin and humpback whales from EP activities and the following discussion focuses on potential impacts to bowhead whales.

Bowhead whales migrate westward across continental-shelf waters of the Alaskan Beaufort Sea each fall en route to their primary wintering grounds in the Bering Sea. Shell’s Camden Bay prospect areas are within this migration corridor. The migration begins in August, but September and October are when the majority of the bowhead population passes through the Alaskan Beaufort Sea.

For a Biological Opinion, NMFS recently evaluated the impacts of oil and gas leasing and exploration activities in the Chukchi and Beaufort Seas, as well as the authorization of small takes under the MMPA, on threatened and endangered whales (NMFS 2008). The NMFS analysis considered the potential impacts of such activities and small takes, including exploration drilling from an ocean-going drilling vessel, on bowhead, humpback, and fin whales in these waters. Overall, NMFS concluded that:

Available data do not indicate that noise and disturbance from oil and gas exploration and development activities since the mid-1970s had a lasting population-level adverse effect on bowhead whales. Data indicate that bowhead whales are robust, increasing in abundance, and have been approaching (or have reached) the lower limit of their historic population size at the same time that oil and gas exploration activities have been occurring in the Beaufort Sea and, to a lesser extent, the Chukchi Sea (NMFS 2008).

(NMFS reached the same conclusion regarding fin and humpback whales.)
Citing the growing bowhead whale population, NMFS concluded that "the impacts of oil and gas industry on individual survival and reproduction in the past have likely been minor" (NMFS 2008). As for future oil and gas exploration activities, NMFS noted that "[n]o lethal takes are anticipated because of these activities, nor are population-level consequences to the stock expected" (NMFS 2008). Rather, NFMS found that "[m]ost impact would be due to harassment of whales, which may lead to behavioral reactions from which recovery is fairly rapid" (NMFS 2008).

NMFS noted that past studies have documented behavioral effects on bowhead whale from oil and gas activities as: "primarily, but not exclusively, avoidance" (NMFS 2008). For example, bowheads are believed to avoid an area with a radius of 12-19 mi (20-30 km) around a seismic vessel operating in nearshore waters. But, NMFS noted, there is no data that "such avoidance is long-lasting after cessation of the activity" (NMFS 2008). NMFS expects the reaction of humpback and fin whales to be similar to that of bowheads, although it expects "little overlap of these activities with fin and humpback whale population, given that the distribution of these species is limited in the Arctic and individuals have only been rarely sighted in this region" (NMFS 2008).

NMFS has also analyzed the impacts of specifically exploration drilling on threatened and endangered whales. The NMFS analysis postulated that a scenario for the Beaufort and Chukchi Sea under which the target species could potentially encounter up to three exploration drilling vessels together with "icebreaker" support was appropriate (NMFS 2008).

In general, NMFS found that "[s]ome bowheads in the vicinity of drilling operations would be expected to respond to noise from drilling units by slightly changing their migration speed and swimming direction to avoid closely approaching these noise sources" (NMFS 2008). NMFS noted that bowheads' reaction specifically to drillships "is variable" (NMFS 2008). NMFS reported that bowhead whales exhibiting normal behavior have been sighted within 6-12 mi (10-20 km) and 0.1-3 mi (0.2-5 km) of operating drillships in separate studies. Other studies observed whales well within the zone ensonified by a drilling vessel and, conversely, exhibiting avoidance of 12-19 mi (20-30 km) (NMFS 2008).

The planned exploration activities for Camden Bay are similar, but smaller in scope, than the assumptions used by NMFS in their evaluation of impacts from exploration drilling on threatened and endangered whales. Shell will use only one drilling vessel at a time to drill four wells over the duration of the exploration plan. Because the NMFS found that whale behavior is “variable” with respect to drilling vessels and support vessels and because NMFS assumed a larger operation, the impacts expected from Shell’s planned Camden Bay exploration drilling program would be even less than those anticipated by NMFS.

NMFS reported that a study by Richardson and Malme (1993) suggests a stationary source producing continuous sounds, like a drilling vessel, evokes less of a response by bowheads than a moving source. The Richardson and Malme (1993) study also "suggests that bowheads will habituate to certain noises that they learn are nonthreatening" (NMFS 2008). NMFS reviewed several studies using recorded drilling sounds. These generally demonstrated localized, temporary and biologically insignificant impacts (avoidance) to drilling sounds. Further, NMFS noted a Canadian study finding that the data "do not support the suggestion of a trend for decreasing use of the industrial zone by bowheads as a result of oil and gas exploration activities" (NMFS 2008). The Canadian study authors "concluded that the exclusion hypothesis [i.e., that whales will avoid an area of industrial use] is likely invalid" (NMFS 2008).

NMFS anticipated that drilling operations in the Beaufort Sea likely would include an icebreaker (NMFS 2008). Bowhead whale reactions to ice breaking and non-icebreaking ice management is expected to be variable (NMFS 2008). Generally, bowheads are expected to avoid areas of active ice breaking and ice
management by 1.2-15.5 mi (2-25 km) (NMFS 2008). Most bowhead exhibit avoidance of vessel traffic, although reactions are less dramatic to slower moving vessels and vessels that are not approaching the animals directly (NMFS 2008).

Consistent with the NMFS conclusions, Shell expects the effects on bowhead whales from Shell’s exploration drilling activities and authorized small takes to be minor and temporary and consist primarily of behavioral responses (avoidance). Specifically with respect to drilling, NMFS determined that the impacts of active drilling are variable and at most consist of temporary behavioral changes by whales, primarily avoidance. Once emplaced on location and drilling, the drilling vessel will be a stationary source emitting continuous sound believed to evoke less response in whales than a seismic program with a moving sound source. Moreover, Shell will suspend exploration drilling on 25 August, and the drilling fleet will leave the Camden Bay project area and move to an area north of latitude 71° 25’N and west of longitude 146° 4’W. Drilling operations recommence after the Kaktovik and Nuiqsut (Cross Island) bowhead whale hunts are complete. Therefore, Shell’s exploration drilling will have only minor impacts on bowhead whales and no impact on the Kaktovik and Nuiqsut (Cross Island) fall whale hunts.

Below Shell analyzes the potential effects of discrete activities under this EP. For additional information, including the estimated number of individual whales that are expected to be impacted, refer to the Shell Drilling IHA application (Appendix C of the EP).

Analysis of Impact of Vessel Traffic on Whales

Increased vessel traffic in the Camden Bay area associated with exploratory drilling operations may potentially impact marine mammals by collisions of the vessels with animals in the water or by effects of the sounds from the vessels entering the water. These potential impacts, however, will be mitigated by Shell’s 4MP and would be unlikely to have an impact at the population level.

Vessel Collisions

Few vessel strikes of marine mammals have been reported in the Beaufort Sea. However, increased numbers of vessels working in an area increase the likelihood of vessel strikes of marine mammals. Operations occurring during the fall bowhead migration also would potentially encounter more whales than during other portions of the year. All Shell vessels will have MMOs onboard to assist in spotting marine mammals and avoiding vessel strikes of animals. Shell has successfully operated a large number of vessels in the Beaufort Sea since 2006 without any marine mammal strikes, and Shell plans to suspend operations during a portion of the bowhead fall migration. Each of these mitigation measures will decrease the likelihood of a bowhead whale strike by a vessel. Further, George et al. (1994) examined subsistence-harvested bowheads and quantified how many of them had scars that appeared to have been inflicted by vessels. Among 236 whales examined between 1976 and 1992, they found two whales that exhibited evidence of past interactions with vessels, and one with questionable scarring. One carcass was reported more recently that appeared to have been struck by a vessel (Craig George, NSB Department of Wildlife Management, Personal communication). It is unlikely that a ship strike of a listed whale species would occur during this project. Ship strikes could impact individual animals but would not affect animal populations in the project area.

Vessel Sounds

Like other cetacean species bowhead and humpback whales have been reported to avoid vessels that are under way, but it is often unclear if the animals avoid vessels because of the sound of the vessel or if visual cues are also important. Studies related to this avoidance are reviewed in detail in Section 4.1.8 for marine mammals in general. This section describes the few studies that are specific to bowhead or humpback whales.
Endangered whales have exhibited avoidance behavior to sound energy produced by marine vessels. They have been shown to react more strongly to boats with outboard motors than to diesel ships (Hobbs and Goebel 1982). When a vessel approaches a bowhead whale, the most likely response is to swim away from the vessel (Richardson and Malme 1993). Whales tend to react most strongly when vessels move quickly and directly toward them than if the vessels move more slowly or in any other directions, as noted during a study by Richardson and Finley (1989). The avoidance behavior is temporary and ceases shortly after the boat leaves the immediate area of the whales.

Baker et al. (1982) reported some avoidance by humpback whales of vessel noise when received levels were 110-120 dB rms, and clear avoidance at 120-140 dB (sound measurements were not provided by Baker but were based on measurements of identical vessels by Miles and Malme 1983).

Frankel and Clark (1998) conducted playback experiments with wintering humpback whales using a single speaker producing a low-frequency “M-sequence” (sine wave with multiple-phase reversals) signal in the 60-90 Hz band with output of 172 dB at 1 m. For 11 playbacks, exposures were between 120 and 130 dB re: 1 μPa and included sufficient information regarding individual responses. During eight of the trials, there were no measurable differences in tracks or bearings relative to control conditions, whereas on three occasions, whales either moved slightly away from \((n = 1)\) or towards \((n = 2)\) the playback speaker during exposure. The presence of the source vessel itself had a greater effect than did the M-sequence playback.

MMOs will be stationed on all drilling and support vessels to watch for marine mammals. The anchored drilling vessel will remain at anchor and continue ongoing operations if approached by a marine mammal. An approaching animal, not exhibiting avoidance behavior, is likely curious and not regarded as harassed. The anchored vessel will remain in place and continue ongoing operations to avoid possibly causing avoidance behavior by suddenly changing sound conditions. Moving vessels will avoid groups of whales by a distance of 1,500 ft (457 m), and will reduce speed if within 900 ft (274 m) of other marine mammals. Sound levels determined during sound source verification dictate the distance of the safety radii. MMOs use distance as an indicator of the safety radii. These measures will reduce the sound energy received by the mammals.

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 described in more detail below when the effects of drilling sounds are discussed. Underwater sound could possibly mask important environmental sounds (Terhune 1981) or communication between marine mammals (Perry and Renouf 1987).

The effects from vessels and the sounds they make on bowhead whales will be temporary causing localized avoidance of the ships. Such avoidance is not expected to significantly impact the populations of either of these animals. Bowhead whales are likely to avoid vessels that are under way and will likely avoid the general area of operations unless oceanographic conditions result in zooplankton accumulations in the project area that attract the whales during their westward migration. Whales would still be expected to avoid the vessels but could feed in the project area during operations as occurred in 2007 and 2008 during large seismic programs in the Beaufort Sea (Funk et al. 2010).

The bowhead whale population has remained stable or increased throughout the last 30 years during which oil and gas exploration has taken place in the Beaufort Sea. This strongly suggests that potential impacts from vessel collision and vessel noise have had negligible, if any, effect on this species.
Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Whales

Resuspension of sediments and subsequent deposition resulting from mooring, MLC construction and early phases of drilling associated with Shell’s exploration program would have only a localized and temporary effect on endangered whales. Negative effects on endangered whales from drilling discharges are not expected. Baleen whales, such as bowheads, tend to avoid drilling rigs at distances up to 12 mi (20 km). Therefore, it is highly unlikely that the whales will swim or feed in close enough proximity to discharges to be affected.

Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Whales

The only cuttings discharged will be from the MLC construction and early phases of drilling though the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling.

Analysis of Impact of Other Permitted Discharges on Whales

The impact of other NPDES permitted discharges will be negligible and temporary. Other discharges include deck drainage, desalination unit waste, non-contact cooling water, BOP fluid, cement slurry. Minor and temporary changes in water quality, such as increases in turbidity and decreased dissolved oxygen, are expected near the discharge site and will have no effect on endangered whales. Based on modeling results, the temperature of the non-contact cooling water is expected to reach ambient water temperature within 164 ft (50 m) of the Kulluk discharge point and 256 ft (78 m) from the discharge point on the Discoverer. These effects would largely be limited to the area within 330 ft (100 m) of the discharge location and would not be expected to affect endangered whales in the area. Similarly, this would not be expected to affect individual bowhead whales in the project area or the bowhead population.

Analysis of Impact of Aircraft Traffic on Whales

Sound energy produced by aircraft traffic will likely cause only short-term, temporary behavioral disturbance of bowhead whales if they are directly in the path of the aircraft. Humpback whales are unlikely to be in the area but would have similar reactions to aircraft if they were present. The most common reaction to aircraft traffic is avoidance behavior, such as diving. In a study by Richardson and Malme (1993), most bowhead whales did not show a response to helicopters flying at altitudes above 500 ft (150 m).

Shell will implement numerous measures designed to mitigate potential effects of aircraft on endangered whales, particularly bowheads, which are more likely to be encountered than other cetacean species. Mitigation measures dictate that aircraft maintain an altitude of 1,500 ft (457 m) except during takeoff and landing and that they follow a prescribed route to and from the project site, reducing further the likelihood of impacts.

Potential disturbance to listed whale species from aircraft traffic may temporarily disturb individuals but it will not have an impact at the population level. Additional information regarding the reactions of marine mammals to aircraft traffic is presented above in Section 4.1.8.
Analysis of Impact of Sound from Drilling and Ice Management on Whales

The impacts from drilling and ice management sounds on endangered whales would be identical to those discussed in detail in Section 4.1.8, Marine Mammals, for baleen whales. Key ideas and conclusions are summarized below.

Overall these studies suggest bowhead whales in the project area are likely to respond to drilling sounds by avoiding the area of operations. Bowheads may avoid the area by 12 or more mi (20 or more km) during periods of active drilling, particularly during the fall westward migration. During much of the drilling period few bowheads will be present in or near the project area as most bowheads summer in the Canadian Beaufort Sea well away from the project area. Further, Shell plans to suspend drilling operations on 25 August during the subsistence bowhead hunts of the villages of Kaktovik and Nuiqsut (Cross Island). During the suspension the drilling vessel and support fleet will leave the project area. The drilling vessel and support fleet will return and exploration drilling operations will resume once the hunts have concluded. Because operations will resume before the migration is complete, it is likely that bowhead whales migrating past the drill sites during October following the hunt will be displaced away from the drill site by the drilling sounds. Given the location of the drill sites inside the boundaries of the typical migration pathway of bowhead whales this displacement could affect several thousand bowhead whales.

Previous studies have not found that avoidance of drilling or other industrial operations has impeded the fall migration of bowhead whales (Davis 1987, Gallagher et al. 1992, Brewer et al. 1993, Funk et al. 2010). Acoustic studies in 2007 and 2008 suggested that calling locations of migrating bowhead whales generally remained within their typical migration corridor despite exposure to sounds from a large scale three-dimensional (3D) seismic program on the Sivulliq and Torpedo prospects (Blackwell et al. 2010). Some deflection of whales around the seismic program was evident in the locations of calls but whales apparently moved into and through the area, though a decrease in calling rates was evident during active seismic periods. Aerial surveys during this same seismic program confirmed the presence of whales and their movement through the area. Deflection of whales on the order of 9.3 m (15 km) was evident around the seismic ship during this program (Koski et al. 2009, Christie et al. 2010). Oceanographic conditions during these years concentrated krill in and around the project area and attracted whales into the area to feed. It is unclear if whales would have avoided the area by greater distances if a food source had not been available. Conditions during any year may again create feeding opportunities for whales in the project area. Current evidence suggests that whales are able to feed in and around industrial operations including seismic and exploration drilling programs and will tolerate greater levels of sound if a food source is abundant in the area.

Masking of the ability of bowheads to hear other bowhead calls and their ability to make their calls heard by other whales could also occur for some animals that moved in closer proximity to operations. Larger numbers of animals could experience masking in a year when oceanographic conditions created feeding opportunities in and around the project area that attracted greater numbers of whales into areas closer to operations. These effects would remain as long as operations were ongoing and the whales being affected remained within the area where sound levels were great enough to cause masking. There are no definitive studies to suggest how big the area of masking around a drilling vessel might be for most animals but it would likely extend some distance beyond the 120 dB rms sound pressure level isopleth recognized by NMFS as the behavioral reaction zone around continuous sound sources. Depending upon the drilling vessel that is used the 120 dB zone could be ~8-8.7 mi (~13-14 km).

Analysis of Impact of Sound Energy Generated by ZVSP on Whales

The impacts from ZVSP-generated sounds on endangered whales would be identical to those discussed in detail in Section 4.1.8 for baleen whales. Key ideas and conclusions are discussed below.
Baleen whales generally tend to avoid operating airguns, but the distances of avoidance radii are quite variable. Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much greater distances. However, baleen whales exposed to strong noise pulses often react by deviating from their normal migration route. In the case of migrating gray and bowhead whales, observed changes in behavior appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors. Baleen whale responses to pulsed sound however, may depend on the type of activity in which the whales are engaged. Some evidence suggests that feeding bowhead whales may be more tolerant of underwater sound than migrating bowheads (Miller et al. 2005; Lyons et al. 2009; Christie et al. 2010).

Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, showed substantial avoidance occurring out to distances of 12.4-18.6 mi (20-30 km) from a medium-sized airgun source (Miller et al. 1999; Richardson et al. 1999). Received levels of seismic pulses at these distances were measured at ~120-130 dB. However, more recent research on bowhead whales (Miller et al. 2005; Christie et al. 2010) corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources. In summer, feeding bowheads typically begin to show avoidance reactions at a received level of about 150-160 dB re 1 μPa rms (Richardson et al. 1986; Ljungblad et al. 1988; Miller et al. 1999, Christie et al. 2010). The Shell project will be conducted at least partially during fall migration in the area of the known bowhead migration corridor. More recent evidence suggests that some bowheads feed during migration and feeding bowheads might be encountered in the project area (Lyons et al. 2009; Christie et al. 2010). The primary bowhead summer feeding grounds; however, are far to the east in the Canadian Beaufort Sea, and the primary feeding area used during fall migration is near Barrow, though bowheads fed near Shell’s seismic programs in Camden Bay in both 2007 and 2008.

Data on short-term reactions (or lack of reactions) of cetaceans to impulsive noises do not necessarily provide information about long-term effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. Bowhead whales have continued to travel to the eastern Beaufort Sea each summer despite seismic exploration, drilling, and other industrial operations in their summer and autumn range for many years (Richardson et al. 1987). Populations of bowhead whales have grown substantially during this time.

Given the moderate size of the airgun array proposed for use in the ZVSP survey and the short time period (approximately 12 hours per drill site) during which the guns would be fired relatively few bowhead whales are likely to be affected by the ZVSP survey. The actual number affected would depend on when during the proposed exploration drilling period the ZVSP was conducted. If the ZVSP survey occurs before the onset of the fall bowhead migration few whales would be in the project area. If the ZVSP were conducted during the migration period a greater number of animals could be affected. Mitigation measures in place during the surveys would shut down airguns if whales entered or approached exclusion zones while the guns were firing and would prevent rampup of the airgun array if whales were present in the area around the array. Given these measures it is unlikely that any animals would experience more than behavioral reactions to the planned ZVSP surveys. Behavioral reactions would be limited to short term avoidance of the area around the survey operations. Further the small broadband sound radii caused by the airguns would be unlikely to deflect whales to as great an extent as the drilling and ice management activities described above so it is unlikely that the ZVSP surveys would increase the distance of deflection around the project area or have an impact at the population level.

Analysis of Impact of Liquid Hydrocarbon Spill on Whales

As explained in Section 2.10, Shell’s categories of spill sizes are different from, but not incompatible with, those used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude
oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place.

Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill, including capabilities for responding to a “worst case” scenario release. In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill and any effects on whales. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

Analysis of Impact of Small Liquid Hydrocarbon Spill on Whales

While still a remote possibility due to the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Given the open ocean location of Shell’s prospects and the expected duration of a small spill the potential for effects on marine mammals to occur would be small. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours. Recovery controls would ensure that any spill effects are localized and would result only in short-term environmental consequences. Effects would be similar among the Sivulliq and Torpedo prospects. The impacts from a small hydrocarbon spill on endangered whales would be identical to those discussed in detail in Section 4.1.8 for marine mammals. Key ideas and conclusions are discussed below.

Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

Even for the whales that are exposed to fuel, it is unlikely to have impact on them (Geraci and St. Aubin 1982; St. Aubin et al. 1984). There are no documented reports of baleen whale mortalities due to diesel fuel (Richardson et al. 1989). Bowhead and humpback whales have skin that is nearly impenetrable by diesel fuel (Geraci and St. Aubin 1985). However, oil can cause irritation to eyes and mucous membranes (Geraci 1988). In a study by Geraci and Aubin (1990), oil applied to cetacean skin with a sponge for 45 minutes showed no adverse effects. Even when applied to an open wound, the crude oil did not affect healing. When gasoline was applied in the same manner to healthy skin for 75 minutes there was no severe reaction. However, when the lead-free gasoline was applied to a cut, strong inflammation was observed. This inflammation was undetectable after 24 hours of recovery.

There has been concern that diesel fuel could coat baleen plates and hinder the ability of whales to feed. The coating of baleen by fuel would allow increased amounts of plankton to slip through the plates (Bratton 1993). It is not known how the reduction in feeding efficiency could affect bowhead whales. A heavy fuel spill could reduce feeding efficiency for several days or more (Geraci and St. Aubin 1985). However, bowheads would not likely occupy waters with fuel spilled on it for long and the fuel would be fairly quickly flushed from baleen in clean water. Studies done by Geraci and St. Aubin (1982) showed that water flow was restored up to 15 minutes after baleen was coated by oil.

There have been no scientific reports on whether bowhead whales are displaced due to fuel spills. However, Traditional Knowledge of Alaska Natives suggests that fuel spills reduce the abundance of
bowheads in the area. For example, Thomas Brower Sr. reported it took four years for diesel fuel to disappear after a 25,000-gal fuel spill in 1994. During that time, he observed that the whales were deflected from the area. They migrated further than usual around Elson Lagoon where the spill occurred. However, Von Ziegesar et al. (1994) reported no evidence of change in calving rate, whale abundance, and seasonal use of the area by mothers and calves, or mortality due to an observed spill, but they did notice temporary avoidance of some areas.

The most likely effect of a spill on endangered whales would be displacement from the area caused by the increased vessel and aircraft traffic that would be involved in spill response and cleanup efforts. Such displacement would be temporary and occur over a relatively short period of time and therefore would be unlikely to have more than a negligible effect on whales in the area. Spill response operations occurring during bowhead whale migration could affect larger numbers of animals by displacing them from their preferred migration route. A few whales could encounter fuel in the water and suffer some discomfort associated with exposure to the fuel. Overall the impacts from a small fuel spill from the proposed project would be minimal and have little or no impacts on the bowhead whale population.

**Analysis of Impact of Large Liquid Hydrocarbon Spill on Whales**

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

**Analysis of Impact of Project Air Emissions on Whales**

The impact of project air emissions in Camden Bay on whales would be negligible. Shell has a major source PSD permit for the *Discoverer* (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the *Kulluk* (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (*Kulluk* or *Discoverer*).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SO₂, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality
permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on whales.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

4.1.9.3 Seals and Walrus

Bearded and Ringed Seals

(Reference Section 3.8.2 and Section 4.1.8)

NMFS recently proposed to list the ringed seal (75 FR 77476 December 10, 2010) and the bearded seal (75 FR 77496 December 10, 2010), as threatened under the ESA, but they are not yet officially listed species.

The following discussion of potential direct and indirect impacts considers bearded and ringed seals in the same section. Potential impacts from EP activities on these two seal species are expected to be similar because these two pinniped species have similar life histories and both species inhabit the offshore waters of the Beaufort Sea and the project area, however, no significant impact on individuals or populations is expected.

Bearded and ringed seals are abundant throughout the Alaskan Arctic. The NMFS-proposed rule to list the bearded seal estimated the abundance of the Beringia Distinct Population Stock (Beringia DPS; the population present in the Alaskan Arctic) to be 155,000 (75 FR 77496 December 10, 2010). The proposed rule to list the ringed seal estimated the abundance of the U.S. population to be greater than 1,000,000. Insignificant fractions of each respective seal population will be found in the project area, and therefore, any effects from Shell’s exploration drilling in Camden Bay will be negligible to these two species. Any impacts to individuals would be temporary and minor at most.

Analysis of Impact of Vessel Traffic on Bearded and Ringed Seals

Responses by seals to vessel sounds and traffic from exploration activities are not well documented, however, effects from Shell vessel traffic on bearded and ringed seals is expected to be negligible. These impacts would be similar to those discussed above in Section 4.1.8. The limited amount of data (Richardson et al. 1995) suggests that seals often show considerable tolerance of vessels. Seals are not expected to be adversely impacted by sound or the presence of vessels associated with the proposed project.

Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Bearded and Ringed Seals

Resuspension of sediments and subsequent deposition resulting from anchoring, construction of the MLC, and early phases of drilling associated with Shell’s exploration drilling program would have only localized and temporary effects on bearded and ringed seals. These negligible effects would be identical to those discussed in detail for pinnipeds in Section 4.1.8. Any impacts from these activities on bearded and ringed seals would be biologically insignificant at the population level.
Analysis of Impact of Drill Cuttings Drilling Mud Discharges on Bearded and Ringed Seals

Drill cuttings and drilling mud discharges will not impact bearded or ringed seals in Camden Bay. The only cuttings discharged will be from the MLC construction and early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling.

Analysis of Other Permitted Discharges on Bearded and Ringed Seals

Minor, temporary changes in water quality, such as increases in turbidity and dissolved oxygen are expected near the discharge site. However, these other permitted discharges will have negligible impacts on bearded and ringed seals because of the highly-localized area of influence compared to the total habitat area available to seals (Section 3.8.2). These changes in water quality would largely be limited to the area within 330 ft (100 m) of the discharge location and would not be expected to affect seals in the area. Based on modeling results, the temperature of the non-contact cooling water is expected to reach ambient water temperature within 164 ft (50 m) of the Kulluk discharge point and 256 ft (78 m) of the discharge point on the Discoverer. Similarly, this would not be expected to affect any marine mammal species in the project area. Effects from NPDES permitted discharges will be limited to the area within 330 ft (100 m) of the project area.

Analysis of Impact of Aircraft Traffic on Bearded and Ringed Seals

The effects from aircraft traffic on bearded and ringed seals will be negligible and identical to those discussed for pinnipeds in Section 4.1.8 for marine mammals. Important conclusions and mitigation measures are discussed below.

Any potential impacts on bearded and ringed seals from aircraft would be limited to momentary behavioral reactions and these reactions “do not rise to the level of taking” as defined by NMFS (NMFS 2001). Additionally, Shell will implement numerous measures designed to mitigate potential effects of aircraft on bearded and ringed seals. 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. 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, then at that point it shall fly directly north to its destination. Helicopters will primarily fly direct routes (except to avoid severe weather including poor visibility or during caribou subsistence hunting), which will reduce the area and numbers of seals that are potentially disturbed.

Analysis of Impact of Sound Energy from Drilling and Ice Management on Bearded and Ringed Seals

Potential effects of sound energy from drilling and ice management on bearded and ringed seals are expected to be negligible. These impacts would be identical to those discussed in detail for pinnipeds in Section 4.1.8. Important ideas and conclusions are presented below.

Numerous studies in the Alaskan Arctic have reported a strong tolerance by seals for offshore drilling (Brewer et al. 1993; Gallager et al. 1992) and for icebreaking (Brewer et al. 1993; Brueggeman et al. 1991); These results support our conclusion that there will be no biologically significant impacts to
individual bearded or ringed seals and their respective populations as a result of sounds from drilling and ice management activities.

**Analysis of Impact of Sound Energy from ZVSP on Bearded and Ringed Seals**

The potential effects of sound energy from ZVSP on bearded and ringed seals would be negligible at the population level for each species. Any effects would be identical to those discussed in detail for pinnipeds in Section 4.1.8. Important ideas and conclusions are presented below.

Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by seals, and only slight (if any) changes in behavior. Those studies show that seals frequently do not avoid the area within a few hundred meters of operating airgun arrays (e.g., Miller et al. 2005; Harris et al. 2001). However, initial telemetry work suggests that avoidance and other behavioral reactions to small airgun sources may at times be stronger than evident to date from visual studies of pinniped reactions to airguns (Thompson et al. 1998). Even if reactions of the species occurring in the proposed exploration drilling area of Camden Bay are as strong as those evident in the telemetry study, reactions are expected to be confined to relatively small distances and durations, with no long-term effects on bearded and ringed seal individuals or their respective populations.

**Analysis of Impact of Liquid Hydrocarbon Spill on Bearded and Ringed Seals**

Section 2.10 of this EIA analyzes in detail the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, and Shell’s plans for responding to a “small” spill (defined as 48 bbl or less). Section 2.10 addresses Shell’s categories of spill sizes and those that are different, but not incompatible, used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place.

Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill, including capabilities for responding to a “worst case” scenario release. In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill and any effects on marine mammals. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

**Analysis of Impact of Small Liquid Hydrocarbon Spill on Bearded and Ringed Seals**

While still a remote possibility due to the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Given the open ocean location of Shell’s prospects, the duration of a small spill and opportunity for effect would be very brief. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours, but recovery controls would ensure that any spill effects are localized and would result only in short-term environmental consequences. Effects would be similar among the Sivulliq and Torpedo prospects. The impacts from a small hydrocarbon spill on bearded and ringed seals would be identical to those discussed in detail in Section 4.1.8 for marine mammals. Key ideas and conclusions are discussed below.
Eyes and mucous membranes of bearded and ringed seals could be affected if contact is made with petroleum such as diesel. Diesel can also affect seal membranes that are not covered by fur. In a study by Geraci and Smith (1976), seals immersed in oil-covered water exhibited irritation of the eyes, swollen noses, ulcers, and scratches on the cornea. Another study by the same scientists later found no tissue damage to ringed seals after being immersed in oil-covered water for 24 hours (Geraci and Smith 1976).

It has been shown that oil would have little or no effect on thermoregulation ability of most marine mammals (Kooyman et al. 1976; Geraci and Smith 1976). However, within two to four weeks of birth, oiling of the fur can be detrimental to newborn seal pups. The pups’ thick fur called “lanugo” keeps them warm until they can build up enough blubber. Oiling of the lanugo may cause heat loss and hypothermia (St. Aubin 1988). The period of time that pups are vulnerable to oil spills is very brief. Drilling in the project area would occur long after pups are born and have shed their lanugo coat. Thus, seal pups are not expected to be impacted by an oil spill.

Because bearded seals are benthic feeders and diesel is lighter than water, it is unlikely that bearded seals would feed on contaminated prey. Ringed seals do not rely as heavily on benthic prey items as bearded seals, however, their habit of feeding on prey within the water column as opposed to on the surface also makes it unlikely that they would consume oiled prey. The area of contamination from a small spill represents an exceedingly small portion of the foraging range for bearded and ringed seals that might be present in the area. Marine mammal prey could possibly carry contaminants that could be ingested (Wursig 1990), but given the small area affected by a small release of diesel, it is unlikely that seals would consume sufficient quantities of petroleum to result in morbidity or mortality. Even in the unlikely event of a release, there would be no or negligible effects on bearded or ringed seals through contact with, or ingestion of, diesel or other petroleum products.

Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures. Hazing would be employed to minimize the possibility of contact between marine mammals and any release. Given the measures that are in place, the probability of a spill occurring is very low, and any such release would likely be contained. Therefore, for these reasons and others discussed directly above, any effects on bearded and ringed seals would be negligible.

Analysis of Impact of Large Liquid Hydrocarbon Spill on Bearded and Ringed Seals

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.
Analysis of Impact of Program Air Emissions on Bearded and Ringed Seals

The impact of project air emissions in Camden Bay on bearded and ringed seals would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SOₓ, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on bearded and ringed seals.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analyses for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

4.1.9.4 Pacific Walrus
(reference Section 3.8.2)

The USFWS recently determined that the Pacific walrus (76 FR 76 7634 February 10, 2011) warranted listing under the ESA, but was precluded by higher priorities and is currently considered a candidate species. Pacific walrus are uncommon in the Beaufort Sea (MMS 2003, Harwood et al. 2005) and their presence in the project area is highly unlikely. Thus, any potential impacts to this species as a result of EP activities would be negligible and biologically insignificant to the population.

The majority of the Pacific walrus population is found west of Barrow in the Chukchi and Bering Seas (MMS 2003), and few animals are observed east of Barrow in the Beaufort Sea (Harwood et al. 2005). Pacific walrus observed in the Beaufort Sea tend to be long individuals (MMS 2007b) as opposed to groups of animals that are common in the Chukchi and Bering Seas. Very few individuals are observed east of Barrow in the Beaufort Sea. Additionally, walrus are closely associated with the main pack ice. The main pack ice edge is expected to be further offshore than the drilling area during much of the project, further reducing the likelihood of encountering Pacific walrus.
The spatial distribution of Pacific walrus and the timing of EP activities make it extremely unlikely that few, if any, individuals of this species will be encountered during the exploration drilling program. Any effects on Pacific walrus from all EP activities would affect a negligible portion of the population and be biologically insignificant. As a result and to avoid unnecessary redundancy, there is no meaningful rationale for analyzing potential impacts to walrus by detailed categories as is done for other species and species groups that are more likely to be encountered during the project. Furthermore, in the unlikely event of a walrus being present in the project area, the potential effects from EP activities would be similar to those discussed directly below for bearded and ringed seals.

4.1.9.5 Polar Bear

(reference Section 3.8.3 and Section 4.1.8)

The polar bear was listed by the USFWS as a threatened species under the ESA in 2008. Based on the best available science, USFWS has determined that the continued loss of sea ice in the Alaskan Arctic region threatens polar bear habitat (DOI 2008). USFWS designated approximately 187,000 mi² (484,328 km²) of critical habitat for polar bears within Alaska. In the Beaufort Sea, this critical habitat encompasses sea ice in water depths up to 984 ft (300 m), the barrier islands, and onshore maternal denning regions on the Arctic Coastal Plain (USDOI 2010). The Camden Bay prospect and adjacent vessel transit routes are within the designated polar bear critical habitat. The timing of project activities beginning after July 10, however, will mitigate potential impacts on polar bears and their habitat because the majority of bears are expected to be further offshore with the main pack ice during the drilling period. It is unlikely that biologically significant numbers of polar bears will be encountered during the project to have an impact at the population level. Natural history and seasonal distributions of polar bears are discussed in detail in Section 3.8.3 and summarized below.

Polar bears require sea ice habitats, come ashore, use landfast ice, and hunt along the active flaw zone during winter months (Durner et al. 2004). During summer, polar bears generally occupy offshore pack ice. Polar bears move with the pack ice to hunt seals as summer nears and the sea ice is retreating. Polar bears select areas of high ice concentration in spring and summer and thus generally are found far offshore as nearshore ice melts. Therefore, some polar bears may be encountered near the drill sites during early summer when the pack ice is nearby and later into the season if pack ice lingers. However, much of the drilling will likely occur when the pack ice is well offshore making encounters with polar bears unlikely. Polar bears return shoreward with rapid ice formation in the fall (Durner et al. 2004).

Under the MMPA, the USFWS has promulgated regulations for authorizing small takes of polar bears in the Beaufort Sea that might take place incidental to conducting oil and gas exploration. Prior to issuing regulations in 2008, the USFWS (2008c) evaluated the effects of authorizing such takes on polar bears, and released a Programmatic Biological Opinion. Before issuing incidental take regulations, the USFWS must determine that the total taking will have a negligible impact on the species and will not have an immitigable adverse impact on the availability of the species for subsistence uses. In their evaluation, the USFWS considered that as many as three drilling vessels could be operating simultaneously in the Beaufort Sea, each with one to two supporting ice management vessels, supply barge and tug, and OSR vessels, and serviced with one to two helicopter flights per day and one to two supply boat trips per week. The USFWS assumed that each drilling vessel might drill up to four wells per drilling season. The USFWS concluded that authorizing these activities would result in a small number of takes, have a negligible effect on polar bears, and would not have an immitigable adverse impact on the availability of the species for subsistence uses. The agency reached this conclusion based on:
• Biological and behavioral characteristics of the animals
• Nature of the oil and gas industry
• Potential effects of oil and gas exploration activities
• Documented impacts of industry activities on the species
• Potential impacts of climate change
• Mitigation measures that minimize industry impacts
• Data from monitoring programs at wells in the Beaufort Sea (1999-2006) and Chukchi Sea (1991-1996)

Mitigation measures considered in the USFWS assessment include: an oil spill prevention and response plan, site-specific monitoring program for marine mammal subsistence resources, conflict avoidance mechanisms, and other measures, all of which are part of Shell’s EP and operations plans.

Pursuant to federal regulations, the authorized takes must be small in number. The agency determined that the takes that would occur under the above-described level of oil and gas exploration would be small due to the small footprint of exploration and the low numbers of polar bears using open water habitats. The USFWS also stated that routine aircraft has little to no effect on polar bears, but added that extensive or repeated overflights could disturb polar bears, noting that the behavioral reactions of non-denning bears should be limited to short-term changes in behavior and would have no effect on individual bears or the population. They also reported that vessels traffic could similarly result in short-term behavioral disturbance of polar bears, but added that the vessel would be more likely to attract bears if located in pack ice.

The planned exploration activities for Camden Bay are similar, but smaller in scope, than the assumptions used by the USFWS in their evaluation in the Programmatic Biological Opinion. Shell will use only one drilling vessel at a time to drill four wells over the duration of the plan. Because the USFWS determined that the takes would be small based on their evaluation, which was based on a larger assumed operation, the number of takes for Shell’s planned Camden Bay exploration drilling program would be fewer.

Numerous mitigation measures will be implemented to reduce potential impacts on polar bears, including the timing of operations and the adoption of protocols designed to maximize distance between project activities and bears. Shell intends to start its drilling operations after ice recedes, on or about July 10, to further reduce the likelihood of encounters with polar bears. Offshore drilling activity will be concluded on or about October 31, before the Beaufort Sea in Camden Bay is solidly iced over and prior to the commencement of denning. The timing of the project will minimize the potential for interactions with polar bears, and no denning polar bears will be impacted.

Shell’s Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan contains mitigation measures designed to avoid contacts and incidental takes of polar bears. These measures include:

• A 0.5 mi (800 m) exclusion zone will be enforced around bears observed on land or ice during travel status. Concentrations of polar bears will be avoided by adherence to this 0.5 mi (800 m) exclusion zone.
• Aircraft will maintain a 1,500 ft (457 m) minimum altitude within 0.5 mi (800 m) of bears hauled out onto land or ice, unless weather does not permit this altitude.

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

Analysis of Impact of Vessel Traffic on Polar Bear

Vessel traffic is anticipated to have a negligible effect on any polar bears found near the drilling areas. Polar bears are known to be attracted to vessels on occasion (Harwood et al. 2005), likely due to curiosity or attractants. Brueggeman (1991) reported that polar bears reacted to icebreakers during oil and gas exploration in the Chukchi Sea by walking toward, stopping, looking, and walking/swimming away from the vessel. These reactions, however, were brief and would not be expected to result in any long-term effects.

The USFWS (2008c) also concluded in its Programmatic Biological Opinion that vessel traffic could result in short-term behavioral disturbance of polar bears or attract animals if in pack ice. The seasonal period from July through October when project vessels will be operating in the offshore area coincides with a period when polar bears are more likely to be further offshore on the main pack ice than in the drilling area. Potential impacts on polar bears from vessel traffic would not result in a biologically significant impact at the population level.

A polar bear avoidance and interaction plan (See Appendix E of the EP) has been developed and will be implemented to mitigate potential interactions. The plan requires that exploration drilling and support vessels maintain a 0.5 mi (800 m) exclusion zone around any bear observed on land or ice during transit.

Analysis of Impact of Vessel Mooring and MLC Construction, and Early Stages of Drilling on Polar Bear

There are no impacts anticipated on polar bears from vessel mooring, MLC construction, and early phases of drilling. These activities are scheduled for mid-summer when polar bears are most likely to be further offshore on the main pack ice and would thus minimize interactions with polar bears. Discharges will occur at depths not occupied by polar bears and then settle to the seafloor in a highly localized area (Section 41.4). Discharges will have no on-ice impacts that could affect polar bears. Therefore, there will be no impact to polar bear habitat from these activities.

Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Polar Bear

Drill cuttings and drilling mud discharges will not impact polar bears in Camden Bay. Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling.

Analysis of Impact of Other Permitted Discharges on Polar Bear

Potential effects from other permitted discharges on polar bears will be negligible. Other NPDES-permitted discharges associated with the exploration program are deck drainage, desalination unit wastes, BOP fluid, non-contact cooling water, and excess cement slurry. These discharges will be conducted under the conditions and limitations of the required NPDES General Permit.
Although these discharges will result in minor and localized changes in pH, temperature, TSS, and BOD in the water column, they disperse rapidly in open ocean conditions and do not have any direct or indirect effects on polar bears. Any indirect effects on polar bear prey or habitat will last only as long as the discharge is ongoing and will be negligible.

Under permit limitations, discharges of free oil, floating solids, or trash that could potentially affect polar bears are not allowed. Also, solid food wastes will be incinerated on board the drilling vessel, thereby limiting this waste stream as a potential attractant for polar bears. All of the above factors will result in negligible impacts to individual polar bears and their population from other permitted discharges.

**Analysis of Impact of Aircraft Traffic on Polar Bear**

Potential impacts from aircraft traffic on polar bears are expected to be negligible. The USFWS (2008c) concluded in its Programmatic Biological Opinion that routine aircraft has little to no effect on individual polar bears or the population. It was noted that any reactions of non-denning bears should be limited to short-term changes in behavior before bears resumed their normal activity (denning bears will not be impacted because the timing of the project does not overlap with denning periods).

Shell will implement numerous measures designed to mitigate potential effects of aircraft on polar bears. 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. 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, then at that point it shall fly directly north to its destination. Helicopters will primarily fly direct routes (except to avoid severe weather including poor visibility or during caribou subsistence hunting), which will reduce the area potentially disturbed. Polar bears exposed to aircraft are anticipated to move away and quickly resume their natural habits. When polar bears are seen from aircraft, the aircraft will use alternative routes to prevent disturbances. Aircraft traffic is expected to have negligible effects on the polar bear.

**Analysis of Impact of Sound from Drilling and Ice Management on Polar Bear**

Drilling and ice management sound will have little effect on polar bears. At most, bears have demonstrated curiosity when encountering vessels and will approach them on occasion (Harwood et al. 2005). They can be drawn to areas of human activity, but implementation of the polar bear avoidance and interaction plan (See Appendix E) will minimize encounters and impacts of interactions by increasing the distance between vessels and polar bears.

The greatest potential for impacts to polar bears is associated with ice management as it occurs away from the drilling and results in greater sound energy levels. To minimize these impacts, Shell will not operate vessels within 0.5 mi (800 m) of polar bears observed on land or ice except to prevent damage to the drilling vessel or personnel. Additionally, the timing of the project occurs during a summer and early-fall period when polar bears are more likely to be further offshore with the main pack ice than in the project area. Thus, drilling and ice management sound are expected to have negligible impacts on polar bears.

**Analysis of Impact of Sound Energy from ZVSP on Polar Bear**

Airgun effects on polar bears have not been studied, however, potential impacts from ZVSP on polar bears are expected to be negligible. Polar bears on the ice would be unaffected by underwater sound. Sound levels received by polar bears in the water would be attenuated because polar bears generally do
not dive much below the surface. Received levels of airgun sounds are reduced near the surface because of the pressure release effect at the water’s surface (Greene and Richardson 1988; Richardson et al. 1995).

Analysis of Impact of Liquid Hydrocarbon Spill on Polar Bear

Section 2.10 of this EIA analyzes in detail the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, Shell’s plans for responding to a “small” spill (defined as 48 bbl or less), and Shell’s worst case discharge planning scenario. As explained in Section 2.10, Shell’s categories of spill sizes are different from, but not incompatible with, those used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place.

Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill, including capabilities for responding to a “worst case” scenario release. In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill and any effects on polar bear. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

Analysis of Impact of Small Liquid Hydrocarbon Spill on Polar Bear

While still a remote possibility despite the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Impacts of a small spill on polar bears are analyzed below.

Estimating the number of polar bears that could be directly affected by an accidental fuel spill depends on weather and ice conditions, time of year, and polar bear densities amongst other factors. Engelhardt (1983) reported that thermal stress resulting from oiled fur was a primary threat to polar bears from oil spills. Thermal stress results in an increased metabolism and energy demands and a decreased body temperature. It was also reported (Engelhardt 1983) that oil can be absorbed through the skin of polar bears and also ingested through inhalation and consuming oiled prey. The severity of thermal stress and oil ingestion on any affected polar bears would be determined by the extent of exposure to hydrocarbons.

Given the open ocean location of Shell’s prospects, the duration of a small spill and opportunity for effect would be very brief. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours, and recovery controls would ensure that any spill effects are localized and would result only in short-term environmental consequences. Effects would be similar among the Sivulliq and Torpedo prospects. The number of polar bears immediately around the drilling locations is anticipated to be low, especially when there is no pack ice nearby.

Additionally, response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Further, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

Impacts to polar bears from a small unintentional release of hydrocarbons would be minimal because of the open ocean location of Shell’s prospects and short-lived nature of a diesel spill in this environment, an
immediate spill response with equipment already on-site, and the seasonal timing of the operation when polar bears are more likely to be further offshore on the main pack ice than in the project area. The number of polar bears potentially impacted by a small unintentional release of hydrocarbons would not be large enough to have a biologically significant effect on the population.

Analysis of Impact of Large Liquid Hydrocarbon Spill on Polar Bear

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

Analysis of Impact of Project Air Emissions on Polar Bear

The impact of project air emissions in Camden Bay on polar bear would be negligible. Shell a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SO₂, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on polar bear.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.
4.1.9.6 Waterfowl

Steller’s and Spectacled Eiders

(reference Section 3.8.4 and Section 4.1.7)

The following discussion of potential direct and indirect impacts considers Steller’s and spectacled eiders in the same section. Potential impacts from EP activities on these two eider species are expected to be the same because their range and distribution indicate that very few individuals from either species are expected in the project area.

As discussed in Section 3.8.4, the Alaska breeding population of Steller’s eider has been listed as threatened by the USFWS. The Steller’s eider is primarily confined to the Arctic Coastal Plain of Alaska’s North Slope, with a concentration around Barrow. Survey data indicates that few, if any, Steller’s eiders are expected to be within the project area during the drilling period. No critical habitat has been designated for the Steller’s eider in the Beaufort Sea or along the Beaufort Sea coast. Critical habitat for Steller’s eider has been designated in Southwestern Alaska on the Yukon-Kuskokwim Delta and in adjacent marine waters. Steller’s eiders migrate northward along the Western Alaska coast in spring, but the majority of the world’s population breeds in Siberia and nests only in very low densities on the Arctic Coastal Plain of Alaska (Hodges and Eldridge 2001; Larned and Platt 2009). They make use of coastal areas along the Chukchi Sea coast from Barrow to Cape Lisburne following the breeding season (USDOI/BLM/MMS 2003), and would not be expected in the drilling area in significant numbers during any period of the year.

The spectacled eider is listed as threatened throughout its range, as discussed in Section 3.8.4. Critical habitat has been designated for spectacled eiders in Alaska within Ledyard Bay in the Chukchi Sea. Very few spectacled eiders are expected to be within the Camden Bay project area during the drilling period. Only small numbers of spectacled eiders have been observed in offshore areas of the Beaufort Sea during spring migration, suggesting this species may utilize a more inland route near the Chukchi Sea coast (Troy Ecological Research Associates 1999 in MMS 2003). The Alaska breeding population of spectacled eider is found in higher densities in the western portion of the Alaska Coastal Plain and gradually decreases to the east, although localized areas of relatively high density occur in the eastern portion of their range near the Colville River and Prudhoe Bay (Larned et al. 2006). Fischer et al. (2002) reported that spectacled eiders were generally uncommon in offshore areas from Harrison Bay to Brownlow Point following the nesting season with only small numbers seen during July and August. Spectacled eiders would not be expected in the drilling area in significant numbers during any period of the year.

In general, impacts to the two listed eider species are expected to be negligible. Population densities of each species in the project area, particularly in offshore drilling locations, are low. As a result of such low population densities in the project area, few threatened eiders, if any, are expected to be close enough to project activities to have a chance of being affected. The relatively small project footprint and its transitory nature will further reduce the likelihood that threatened eiders would be affected. No direct or indirect impacts on eider-designated critical habitat are expected given the large distance between the project area and any such habitat.
Analysis of Impact of Vessel Traffic on Steller’s and Spectacled Eiders

Disturbances from Vessels

Vessel traffic within the project area would not be likely to have effects on Steller’s or spectacled eiders. Any influence from vessel traffic on Steller’s and spectacled eiders would be similar to the effects on other birds, as described in Section 4.1.7, and likely only cause birds to flush away from vessels.

Traffic from transiting project vessels will be short in duration and limited to a small area, and the project area itself will occupy a small footprint relative to the total offshore area of the Beaufort Sea. Spectacled eiders are known to gather off the Beaufort Sea coast in shallow waters that are usually less than 120-ft (36-m) deep and up to 31 mi (50 km) offshore (USFWS 2005). However, as discussed above, overall densities of threatened eiders in these offshore areas are very low. This fact, coupled with the short-term duration of vessel transit and relatively small project area will result in few, if any, threatened eiders being affected by vessel traffic.

Additionally, in a 2000 study, sea ducks such as eiders appeared to be relatively tolerant to vessels in harbor areas of the Alaskan Aleutian Islands (USACE 2000a, 2000b, and 2000c in USFWS 2006). Tolerance to nearby vessels would further reduce any potential impacts on threatened eiders from vessel traffic. Potential impacts from vessel traffic on listed eiders would likely be limited to a short-term disturbance and have no biologically significant impact at the population level. See directly below for an analysis of potential strikes from vessels.

To further reduce potential disturbance from vessel traffic on threatened eiders, MMOs aboard all project vessels will watch for molting flocks of threatened eiders and recommend that vessels alter course around the birds. This will increase the distance between the vessel and birds, thus, mitigating potential impacts from birds interacting with vessels.

Strikes with Drilling Unit and Vessels

The risk of bird strikes by Steller’s and spectacled eiders on the drilling vessel and support vessels is low and the impacts from such events are anticipated to be negligible because very few, if any, threatened eiders are expected to be present in the drilling area during the drilling period. Using a generic strike rate of 0.4 spectacled and 0.02 Steller's eider strikes per well year (MMS 2003), 0.8 spectacled and 0.04 Steller's eiders may be taken during one drilling season. The strike rate is an estimate based on eider populations and data collected from one year at a single location and used in the Biological Opinion (MMS 2003), and these rates would not result in a biologically significant impact at the population level. Vessels that travel to the Beaufort Sea will avoid travel through the LBCHU, an important area for spectacled eiders in the Chukchi Sea.

Various factors have been suggested to increase the likelihood of bird strikes with lighted structures, including growing darkness, cloudy conditions, fog/mist, and various combinations of lights. To further reduce the risk of vessel strikes with threatened eiders, Shell will minimize vessel light output during periods of continuous daylight in July and part of August, use green lighting, and monitor conditions to assess potential strike risk. These actions are proposed in detail in the Shell Bird Strike Avoidance and Lighting Plan (EP Appendix I).

Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Steller’s and Spectacled Eiders

The impacts on Steller’s and spectacled eiders from vessel mooring, MLC construction, and early phases of drilling will be negligible. As discussed above, densities of the listed eider species in the drilling area are very low, thus few if any birds would be expected to be in the area during these activities. Only
temporary displacement will occur during these activities mainly due to the presence of project equipment, not the generated disturbances to the seafloor. Vessel mooring, MLC construction, and drilling will not disturb any eider designated critical habitat, all of which is located in northwestern and southwestern Alaska far from the project area.

Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Steller’s and Spectacled Eiders

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TSD facility. The only cuttings discharged will be from the MLC construction and early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 on threatened eiders would be similar to those for coastal and marine birds (Section 4.1.7), and addressed above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling. There would be no biologically significant impact to threatened eider populations as a result of these activities.

Analysis of Impact of Other Permitted Discharges on Steller’s and Spectacled Eiders

Impacts of other NPDES-permitted discharges are anticipated to have negligible effects on Steller’s and spectacled eiders. These discharges are described in Section 2.7 and include deck drainage, desalination unit wastes, BOP fluid, non-contact cooling water, and excess cement slurry. These discharges will be conducted under the conditions and limitations of the required NPDES General Permit.

Although these discharges will result in minor and localized changes in pH, temperature, TSS, and BOD in the water column, they disperse rapidly in open ocean conditions and do not have any direct or indirect effects on the eiders. Any indirect effects on eider prey or habitat will last only as long as the discharge is ongoing and will be negligible. These permitted discharges are not expected to impact any designated eider critical habitat, given the significant distance between the location of any such discharges and the eider designated critical habitat areas in northwestern and southwestern Alaska, far from the project area.

Analysis of Impact of Aircraft Traffic on Steller’s and Spectacled Eiders

As discussed above, densities of the listed eider species east of Prudhoe Bay are very low, thus relatively few birds would be exposed to aircraft traffic. Disturbances from aircraft traffic to Steller’s and spectacled eiders will be similar to other birds as described in Section 4.1.7 and will likely only cause birds to sometimes flush away. The impacts of aircraft traffic on Steller’s and spectacled eiders are expected to be negligible and not cause mortality or reduced reproductive success. Any disturbance to threatened eiders as a result of aircraft traffic would be biologically insignificant to their respective populations.

Mitigation of bird disturbance would include flight path selection, high flight altitudes and flight timing as proposed in the revised Camden Bay EP. All of these measures are described in Section 4.3.3. Given the distance from the project area and proposed aircraft traffic routes, aircraft traffic will not impact any eider-designated critical habitat, which is located exclusively in northwest and southwest Alaska.

Analysis of Impact of Sound from Drilling and Ice Management on Steller’s and Spectacled Eiders

Sound energy generated by drilling and ice management is anticipated to have negligible impacts to Steller’s and spectacled eiders. Densities of the listed eider species in the drilling area are very low, thus few if any birds would be expected to be in the area during these activities.
Eiders that are exposed to sound energy produced by drilling and ice management are anticipated to either move from the area or show little effect. No studies investigating the impacts of sound energy from drilling and ice management were found in the literature. However, studies on the effects of seismic surveys on birds indicate little effect (Evans et al. 1993; Lacroix et al. 2003; Stemp 1985; Webb and Kempf 1998), as described in Section 4.1.9.4. Sound from drilling and ice management will not disturb any eider designated critical habitat, none of which is located in the Alaskan Beaufort Sea.

Analysis of Impact of Sound Energy from ZVSP on Steller’s and Spectacled Eiders

Potential effects of sound energy from ZVSP on threatened eiders would be similar to those on coastal and marine birds discussed above in Section 4.1.7. Little effect, if any, has been reported by studies that investigated the effects of sound from underwater airguns on birds (Evans et al. 1993; Lacroix et al. 2003; Stemp 1985; Webb and Kempf 1998). The results of these studies, coupled with the low densities of Steller’s and spectacled eiders in the project area, would make any potential effects from ZVSP-sounds on threatened eiders negligible. Spectacled and Steller’s eiders critical habitats also would not be affected by sound energy from ZVSP because these designated areas are found exclusively in northwestern and southwestern Alaska, respectively.

Analysis of Impact of Liquid Hydrocarbon Spill on Steller’s and Spectacled Eider

Section 2.10 describes the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, Shell’s plans for responding to a “small” spill (defined as 48 bbl or less), and Shell’s worst case discharge planning scenario. As explained in Section 2.10, Shell’s categories of spill sizes are different from, but not incompatible with, those used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place.

Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill, including capabilities for responding to a “worst case” scenario release. In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill and any effects on Steller’s and spectacled eiders. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

Analysis of Impact of Small Liquid Hydrocarbon Spill on Steller’s and Spectacled Eiders

While still a remote possibility despite the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Impacts of a small spill on threatened eiders are analyzed below.

Given the open ocean location of Shell’s prospects, the duration of a small spill and opportunity for effect would be very brief. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours, and recovery controls would ensure that any spill effects are localized and would result only in short-term environmental consequences. Effects would be similar among the Sivulliq and Torpedo prospects.
Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

Ledyard Bay, which is an area between Icy Cape and Point Hope in the Chukchi Sea is the only designated critical habitat off the Alaska coast for spectacled eiders. This area is ~450 mi (724 km) by sea from Camden Bay. The only designated critical habitat for Steller’s eiders is located in the Yukon-Kuskokwim Delta region of Southwest Alaska, which is ~1,000 mi (1,609 km) by vessel from Camden Bay. An oil spill in Camden Bay would have to travel roughly 450 mi (724 km) first northwest, around Point Barrow, and then southwest to reach Ledyard Bay. To reach the Yukon-Kuskokwim region, the oil spill would have to continue southwestward around Point Hope and then southward through the Bering Strait into the Central Bering Sea. In the unlikely event of an oil spill, response would be initiated promptly, well before oil would disperse this far. Moreover, the oil concentration of the small spill would be diluted by the distance traveled.

Impacts to Steller’s and spectacled eiders from a small unintentional release of hydrocarbons would be minimal because eiders are unlikely to come into contact with the spilled oil by virtue of their rareness in the project area and the mitigating effect of prompt spill response efforts. A small unintentional release of hydrocarbons would not be likely to impact either threatened eider species at the population level.

**Analysis of Impact of Large Liquid Hydrocarbon Spill on Steller’s and Spectacled Eiders**

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

**Analysis of Impact of Project Air Emissions on Steller’s and Spectacled Eiders**

The impact of project air emissions in Camden Bay on Steller’s and spectacled eiders would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO2, PM, SOx, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of
combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO\textsubscript{2}, CO, SO\textsubscript{2}, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on Steller’s and spectacled eiders.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

**Yellow-Billed Loon**

(reference Section 3.8.4 and Section 4.1.7)

The yellow-billed loon is a species of concern (USFWS 2002). Its narrow habitat requirements, restricted range, and low numbers have been the subject of a recent petition for listing under the ESA (Earnst et al. 2005). In March 2009, the USFWS determined that listing the yellow-billed loon as a threatened or endangered species is warranted under the ESA, but the listing is precluded by other higher priority species. The yellow-billed loon is now designated as a candidate species. A “warranted but precluded” finding requires subsequent annual reviews of the finding until such time as either a listing proposal is published, or a “not warranted” finding is made based on new information.

Within Alaska, this species breeds almost entirely within the NPR-A with lower densities found in the rest of the Arctic Coastal Plain (Earnst 2004). Birds arrive on the North Slope of Alaska during the second half of May and depart from late August through mid September. Yellow-billed loons breed on relatively large, deep lakes that support year-round fish populations. Fischer and Larned (2004) surveyed the majority of the Alaskan Beaufort Sea out to 62 mi (100 km) from shore during the months of June, July, and August, 1999–2001. Of the 34 total yellow-billed loons observed, only three were detected in water that was deeper than 32 ft (10 m), which suggests that yellow-billed loons prefer shallower water than is found in the Camden Bay prospects. The distribution of yellow-billed loons in Alaska makes it unlikely that more than a few, if any, individuals will be present in the Camden Bay prospects. Activities covered within this EP are unlikely to result in any biologically-significant impacts to the population of this species.

**Analysis of Impact of Vessel Traffic on Yellow-Billed Loon**

*Disturbances from Vessels*

Vessel traffic within the project area would be unlikely to have effects on yellow-billed loons. Any influence from vessel traffic on yellow-billed loons would be similar to the effects on other coastal and marine birds as described in Section 4.1.7. The most likely effect from vessel traffic on yellow-billed loons would be to cause birds to flush away from vessels resulting in temporary displacement.

Few or no yellow-billed loons are expected to occur in Shell’s offshore prospects during exploration drilling because most are found in coastal areas in water depths less than 32-ft (10-m deep; Fischer and Larned 2004). The densities of the yellow-billed loon are considerably greater to the west of the project area within the NPR-A (Earnst 2004). Therefore, there would be little or no disturbance of yellow-billed
loons due to vessel traffic in the prospects, and any effects on the loons would be insignificant at the population level consisting of temporary displacement of very few birds. Any temporary displacement would last minutes to a few hours, and would not involve displacement from habitat that is crucial or restricted in size.

**Strikes with Drilling Unit and Vessels**

As noted above, few or no yellow-billed loons are expected to occur in Shell’s offshore prospects during exploration drilling or along transit routes to and from the project location. Therefore, the risk of bird strikes by yellow-billed loons on the drilling vessel or support vessels is very low. In the unlikely event bird strikes occur, the impacts would be negligible because yellow-billed loons are found in flock sizes of one to three individuals (Fischer et al. 2002). Thus each bird strike event would only affect one to three birds. The potential impact of vessel strikes on yellow-billed loons would be biologically insignificant at the population level.

Various factors have been suggested to increase the likelihood of bird strikes with lighted structures, including growing darkness, cloudy conditions, fog/mist, and various combinations of lights. To further reduce the risk of vessel strikes with yellow-billed loons, Shell will minimize vessel light output during periods of continuous daylight in July and part of August, use green lighting, and monitor conditions to assess potential strike risk. These actions are proposed in detail in the Shell Bird Strike Avoidance and Lighting Plan (EP Appendix I).

**Analysis of Impact of Vessel Mooring, MLC Construction and Early Phases of Drilling on Yellow-Billed Loon**

Vessel mooring, MLC construction and early phases of drilling could temporarily displace yellow-billed loons from the drill site areas; however, such effects are unlikely given that few or no yellow-billed loons would be expected to be found in these offshore waters during the drilling season. Any such impact that does occur will be negligible consisting of brief behavioral response of very few birds. Vessel mooring, MLC construction and drilling will not disturb any habitat that is especially important to yellow-billed loons. None of these activities would result in a biologically significant impact to yellow-billed loons at the population level.

**Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Yellow-Billed Loon**

The only cuttings discharged will be from the MLC construction and early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 on yellow-billed loons would be similar to those for coastal and marine birds (Section 4.1.7), and these are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling. There would be no biologically significant impact to the population of yellow-billed loons as a result of these activities.

**Analysis of Impact of Other Permitted Discharges on Yellow-Billed Loon**

Impacts of other NPDES-permitted discharges are anticipated to have negligible effects on yellow-billed loons. These discharges are described in Section 2.7 and include deck drainage, desalination unit wastes, BOP fluid, non-contact cooling water, and excess cement slurry. These discharges will be conducted under the conditions and limitations of the required NPDES General Permit.

Although these discharges will result in minor and localized changes in pH, temperature, TSS, and BOD in the water column, they disperse rapidly in open ocean conditions and do not have any direct or indirect effects on yellow-billed loons. Any indirect effects on yellow-billed loon or habitat will last only as long
as the discharge is ongoing and will be negligible. Very few, if any, yellow-billed loons are anticipated in the offshore drilling area where other permitted discharges will occur, and potential impacts of the other permitted discharges are anticipated to have negligible effects on yellow-billed loons, their habitat, and their population.

**Analysis of Impact of Aircraft Traffic on Yellow-Billed Loon**

As discussed above, densities of yellow billed loons in the eastern half of the Arctic Coastal Plain and in the offshore drilling area are low, thus relatively few birds would be exposed to aircraft traffic. Disturbances from aircraft traffic to yellow-billed loons will be similar to other birds as described in Section 4.1.7 and will likely only cause birds to sometimes flush away. The impacts of aircraft traffic activities on yellow-billed loons are expected to be negligible and not cause mortality or reduced reproductive success. Any disturbance to yellow-billed loons as a result of aircraft traffic would be temporary and biologically insignificant to the population.

Mitigation of disturbance from aircraft on yellow-billed loons would include flight path selection, high flight altitudes and flight timing as proposed in the revised Camden Bay EP. All of these measures are described in Section 4.3.3.

**Analysis of Impact of Sound from Drilling and Ice Management on Yellow-Billed Loon**

Yellow-billed loons that are exposed to sound energy produced by drilling and ice management are anticipated to either move from the area or show no reaction. No studies investigating the impact of sound energy from drilling and ice management on loons (or birds in general) were found in the literature. Studies of the effects of seismic surveys on birds indicate little effect (Evans et al. 1993; Lacroix et al. 2003; Stemp 1985; Webb and Kempf 1998). Sound from drilling and ice management will have no onshore impacts and not disturb any yellow-billed loon nesting habitat because these areas are over 16 mi (28 km) away from shore where water depths are greater than 66 ft (20 m). Yellow-billed loons are rarely seen in the Beaufort Sea in water depths greater than 32 ft (10 m).

Densities of yellow-billed loons in the offshore drilling area are very low, thus few if any birds would be expected to be in the area during these activities and exposed to these sounds. Therefore, sound energy generated by drilling and ice management is anticipated to have negligible impacts to yellow-billed loons and no biologically significant impacts to the population.

**Analysis of Impact of Sound Energy from ZVSP on Yellow-billed Loon**

Potential effects of sound energy from ZVSP on yellow-billed loons would be similar to those on coastal and marine birds discussed above in Section 4.1.6. Little effect, if any, has been reported by studies that investigated the effects of sound from underwater airguns on birds (Evans et al. 1993; Lacroix et al. 2003; Stemp 1985; Webb and Kempf 1998). The results of these studies, coupled with the low densities of yellow-billed loons in the offshore project area, would make any potential effects from ZVSP-sounds on this species negligible.

**Analysis of Impact of Liquid Hydrocarbon Spill on Yellow-Billed Loon**

Section 2.10 describes the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, Shell’s plans for responding to a “small” spill (defined as 48 bbl or less), and Shell’s worst case discharge planning scenario. As explained in Section 2.10, Shell’s categories of spill sizes are different from, but not incompatible with, those used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory
requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place.

Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill, including capabilities for responding to a “worst case” scenario release. In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill and any effects on yellow-billed loons. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

Analysis of Impact of Small Liquid Hydrocarbon Spill on Yellow-Billed Loon

While still a remote possibility despite the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Impacts of a small spill on yellow-billed loons are analyzed below.

Given the open ocean location of Shell’s prospects, the duration of a small spill and opportunity for effect would be very brief. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours, but recovery controls would ensure that any spill effects are localized and would result only in short-term environmental consequences. Effects would be similar among the Sivulliq and Torpedo prospects.

Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

Low densities of yellow-billed loon are found along the Beaufort Sea shoreline south of the prospects. An oil spill response would be initiated well in advance before oil would disperse this far and the oil concentration of the small spill would be diluted.

As discussed above, yellow-billed loons are uncommon in the drilling area. As a result, very few birds, if any, would be exposed to a small unintentional release of hydrocarbons and such a spill would not result in any population-level impacts to this species. Potential impacts from a small oil spill would be further mitigated by rapid response efforts.

Analysis of Impact of Large Liquid Hydrocarbon Spill on Yellow-Billed Loon

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.
Analysis of Impact of Air Emissions on Yellow-Billed Loon

The impact of project air emissions in Camden Bay on the yellow-billed loon would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SOₓ, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on the yellow-billed loon.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

4.1.10 Sensitive Biological Resources or Habitats

(reference Section 3.9)

Sensitive biological resources and habitats found near the project area are discussed in Section 3.9 of this document. Exploration activities are not expected to impact these resources due to their distance from the project area. Oil spills could potentially impact the resources or habitats; however, large oil spills, such as crude oil releases from blowouts are extremely rare. Small spills, such as releases from fuel oil could affect these areas or resources, but the impact would be minimal considering their distance from the project area and the limited duration of the potential spills. Any potential effects from oil spills would be mitigated by the implementation of Shell’s comprehensive oil spill response plan.

Analysis of Impact of Vessel Traffic (Including transit) on Sensitive Biological Resources or Habitats

Sound energy generation from vessel traffic would not likely have a significant impact on the sensitive biological resources or habitats due to their distance from the project area.
Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Sensitive Biological Resources or Habitats

Resuspension of sediments and subsequent deposition resulting from vessel mooring, MLC construction, and early phases of associated with Shell’s exploration program would not likely have an impact on sensitive biological resources or habitats. Results of sedimentation modeling for these activities in the project area show that the footprint of sediment accumulation is very localized (Voparil 2009). Shell modeled the distribution of cuttings for the MLC construction and early phases of drilling. Results of project-specific modeling of cuttings dispersion and deposition are described in Section 4.1.4.

Analysis of Impact of Aircraft Traffic on Sensitive Biological Resources or Habitats

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 contact with the Com Centers. Except for aircraft 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, then at that point it shall fly directly north to its destination.

Aircraft traffic associated with the exploration drilling program in the project area is not expected to have any direct or indirect impacts on sensitive biological resources or habitats.

Analysis of Impact of Sound Energy from Drilling and Ice Management on Sensitive Biological Resources or Habitats

Sound energy generated by drilling activities and ice management is not expected to have any direct or indirect impacts to sensitive biological resources or habitats.

Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Sensitive Biological Resources or Habitats

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the MLC construction and early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling.

Analysis of Impact of Other Permitted Discharges on Sensitive Biological Resources or Habitats

Other NPDES-permitted discharges for the exploration project are deck drainage, desalination unit wastes, BOP fluid, non-contact cooling water, and excess cement slurry. Minor changes in water quality, such as increases in turbidity and biological and chemical oxygen demand are expected near the discharge site and will have no effect on sensitive biological resources or habitats. Effects from NPDES permitted discharges will be limited to the area within 330 ft (100 m) of the project area.

Analysis of Impact of Liquid Hydrocarbon Spill on Sensitive Biological Resources or Habitats

Section 2.10 of this EIA analyzes in detail the potential sources of a hydrocarbon spill, the probability of various types of spills occurring, and Shell’s plans for responding to a “small” spill (defined as 48 bbl or less). Section 2.10 addresses Shell’s categories of spill sizes are and those that are different, but not incompatible, used by BOEMRE. The probability of a liquid hydrocarbon spill, such as diesel fuel or crude oil, is sufficiently small to conclude it would not occur during the proposed exploration drilling.
program. Prudent planning and state and federal regulatory requirements nevertheless require that Shell have comprehensive spill prevention and response plans and capabilities in place.

Shell’s plans include measures to prevent any spill release from occurring and to respond in the event of a spill, including capabilities for responding to a “worst case” scenario release. In the unlikely event of a spill, implementation of Shell’s comprehensive spill response plan would minimize the impacts from the spill and any effects on marine mammals. Response equipment and trained personnel would be available and on site to deploy boom and recovery equipment for the control and removal of hydrocarbons spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

Analysis of Small Hydrocarbon Spill on Sensitive Biological Resources or Habitats

While still a remote possibility due to the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Impacts of a small spill are analyzed below.

The probability of small spills and any related effects would be minimized by implementing Shell’s oil spill response plan and maintaining preventative measures, including pre-booming before any over-water fueling. Given the open ocean location of Shell’s prospects, the duration of a small spill and opportunity for effect would be very brief. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours.

Any small spill at the exploration drilling operation would not have an impact on Beaufort Sea sensitive biological resources or habitat due to their distance from the project area and the short duration of any spill.

Analysis of Large Hydrocarbon Spill on Sensitive Biological Resources or Habitats

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells' program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

Analysis of Impact of Project Air Emissions on Sensitive Biological Resources or Habitats

The impact of project air emissions in Camden Bay on sensitive biological resources or habitats would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).
The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO\textsubscript{2}, PM, SO\textsubscript{x}, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO\textsubscript{2}, CO, SO\textsubscript{2}, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on sensitive biological resources or habitats.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

4.1.11 Cultural Resources

(reference Section 3.10)

Shell plans to drill exploration wells on the following lease blocks: Sivulliq (Flaxman Island Area 6658); and Torpedo (Flaxman Island Area 6610 and 6559). These blocks are not among those listed in Section 3.10 as having a high potential of cultural or archaeological resources. Therefore Shell’s activities are anticipated to have a low potential of impacting onshore or offshore prehistoric cultural resources within the Beaufort Planning area.

As part of compliance with BOEMRE stipulations, Shell contracted Geo LLC evaluation of previous shallow hazards surveys and also contracted with Fugro to conduct more recent on-water surveys (Section 1.3 and 1.4) of the proposed Sivulliq and Torpedo well sites. Those surveys did not detect the presence of any archaeological findings such as shipwrecks or other historical materials within the surveyed areas. Based on these studies, the sea floor in this area has been scoured through a series of ice gouging events. Ice gouging reduces the survivability of prehistoric and historical cultural resources (as defined in Section 3.10) on and just below the sea floor.

Although there is a low probability of prehistoric and historical archaeology sites and materials being located within the project areas, a comprehensive discussion of potential impacts is appropriate. Activities associated with the exploration of the Sivulliq and Torpedo prospects could impact resources within the following areas:

- Areas where the seafloor may be disturbed
- Drill site locations and MLC locations
- All areas where anchors or other mooring systems will be used for drill ships and support vessels
- Onshore coastal and intertidal locations
Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Cultural Resources

Vessel mooring, MLC construction, and early phases of drilling cause physical changes to the seafloor and could damage or destroy cultural resources on the seafloor. Prehistoric and historical shipwrecks and sites in areas at 197 ft (60 m) or less and not scoured by a high-density of ice gouging can be adversely affected by offshore activities. The BOEMRE identified specific lease blocks in the Beaufort Sea that fit these criteria and that also have a higher potential of containing cultural resources based on known information and the historic record (MMS 2003, 2008b).

Shell’s proposed exploration locations do not include these high potential resource areas. The probability of drill cuttings discharges impacting prehistoric cultural resources within the Beaufort See Planning area is low.

Shell anticipates minimum to no effects to cultural resources in the project area because shallow hazards and site clearance surveys do not indicate the presence of archaeological material within the project area.

Offshore Cultural Resources

A review of the historical record identified sailing vessels lost in the Beaufort; one in the vicinity of what are now the Shell exploration lease blocks. The Duchess of Bedford was abandoned, lost, and finally salvaged in 1907. There is little cause to assume any remnants of the schooner rest on the seafloor. However, records are vague on the percentage of the boat salvaged and what was left exposed to water currents and melting ice.

Two additional structures may be in or near the project area. These are the shipwreck of the Baychimo and the wreck of Levanevsky’s aircraft. These are discussed in more detail in Section 3.10.

BOEMRE has previously identified specific lease blocks in the Beaufort Sea that have a higher potential of containing prehistoric and historic cultural resources (MMS 2003; 2008b). Shell’s proposed drill site are not included in these locations.

While the probability is low that submerged cultural resources are in or near the proposed drill sites, no one has conducted an exhaustive survey of the Camden Bay area. However, available data suggests that while Shell’s exploration drilling and support activities could impact unidentified cultural resources in the area, it is a remote possibility any such resources exist.

Onshore Cultural Resources

Shell’s offshore exploration project will not directly impact onshore cultural resources. In the highly unlikely event of a catastrophic well blowout and large oil spill, the spilled oil and spill response activities could potentially impact onshore cultural resources in the immediate vicinity of the spill (Section 4.4). Such an occurrence, however, is too remote and speculative to be deemed a potential impact of Shell's proposed offshore exploration drilling activities. BOEMRE studied the potential impacts of a large spill and response activities on onshore cultural resources in its multi-sale FEIS (MMS 2003). That analysis remains current, and there is no new information or other identified need to re-evaluate that study at this time.
Analysis of Impact of Drill Cuttings and Drilling Mud Discharges on Cultural Resources

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the MLC construction and early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). Any effects of the Discharge 013 are addressed in the section above for Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Cultural Resources.

Analysis of Impact of Vessel Traffic (Including Transit) on Cultural Resources

Shell anticipates no impact to offshore or onshore cultural resources from vessel traffic. Vessels will use established facilities for docking. Mooring and anchoring will only occur at the proposed drill sites. Anchoring and mooring have impact potential, but these specific activities are addressed elsewhere. Vessel traffic occurs at some distance from onshore and offshore cultural resources and will not impact them.

The very rare possibility of negative effects from vessel traffic could result if a vessel foundered on a barrier island or on the coastline. In this situation, the vessel could potentially damage surface and subsurface cultural resources in the location it founders. Foundering is a remote possibility.

Analysis of Impact of Aircraft Traffic on Cultural Resources

Shell anticipates no change to cultural resources from aircraft traffic. Aircraft used to support exploration activities will travel between already established airfields to the Kulluk or Discoverer and should not have an impact on cultural resources in offshore or onshore areas.

Analysis of Impact of Sound Energy from Drilling and Ice Management on Cultural Resources

Shell does not anticipate any change to cultural resources from the sound energy of drilling and ice management. It is understood that sound energy can have a detrimental effect on the character of an historic property or the property’s setting. This can influence its eligibility to the National Register. However, the sound energy from drilling and ice management would be localized, temporary, and is not a concern for affecting cultural resource eligibility.

Analysis of Impact of Other Permitted Discharges on Cultural Resources

Impacts to cultural resources from other permitted discharges will be the same as those from mud discharges. Prehistoric and historical cultural resources in areas at 196 ft (60 m) or less and not scoured by a high-density of ice gouging can be adversely affected by offshore activities. BOEMRE identified specific lease blocks in the Beaufort Sea that fit these criteria and also have a higher potential of containing cultural resources based on known information and the historic record (MMS 2003, 2008b).

Shell’s proposed exploration sites do not include these high potential areas. The probability of other permitted discharges impacting prehistoric cultural resources within the Beaufort Sea Planning area is low.

Analysis of Impact of Liquid Hydrocarbon Spill on Cultural Resources

Oil spills and associated cleanup activities can impact archaeological and historical cultural resources directly and indirectly (MMS 2008a). However, the probability of a spill of liquid hydrocarbons is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements require that Shell have comprehensive spill prevention and response plans and capabilities in place. Shell’s plans include measures to prevent
any release from occurring and to respond in the event of a discharge, including capabilities for responding to a “worst case” scenario release. In the unlikely event that such a release were to occur, implementation of Shell’s comprehensive spill response plan would minimize any effects on archaeological and historical resources.

A hydrocarbon spill would have minimal or no direct impact on offshore cultural resources. Potential cultural resources in the Beaufort Sea are on, or under, the seafloor, and are not likely to come in contact with any spilled hydrocarbon, such as oil.

Analysis of Impact of Small Liquid Hydrocarbon Spill on Cultural Resources

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shells’ program is a frontier exploration program. Shell will be drilling a small number of exploration wells (four over the duration of this EP) to assess the potential of identified exploration targets. No oil will be produced and no pipeline or other permanent facilities will be constructed. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247. Further, Section 4.4 provides a summary of that analysis and explanation of how that analysis applies to this site-specific project.

Analysis of Impact of Large Liquid Hydrocarbon Spill on Cultural Resources

As explained in Section 2.10, for purposes of Shell’s proposed exploration drilling program, a “large” liquid hydrocarbon spill (defined as any spill greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. As such, it is reasonable to not analyze the impacts of such a highly conjectural occurrence. Nevertheless, we note that BOEMRE did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-228 to IV-247.

Analysis of Impact of Project Air Emissions on Cultural Resources

The impact of project air emissions in Camden Bay on cultural resources would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SO₂, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary
and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on cultural resources.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

4.1.12 Socioeconomic Impacts

Purpose and Need – Beaufort Sea

The Arctic is the last great unexplored petroleum basin, with an estimated 22 percent of the world’s undiscovered conventional oil and natural gas. The U.S. Geological Survey (USGS) estimates over 400 billion barrels of oil equivalent (BOE – the standard measure of hydrocarbon resources) remain undiscovered in the Arctic (USGS 2008). If tapped, this potentially prolific undeveloped resource could one day make up a quarter of global oil and gas production.

The Alaska offshore could be the next major chapter in America’s energy future, with production forecast to increase domestic oil production by about 15 percent for 30 years (NEI and ISER 2011). Developing this resource will help establish US energy security and make us less dependent on imported oil, while also creating jobs.

Domestic energy production is critical for the security and prosperity of the United States. The money spent on domestic energy cycles in the US economy, thereby increasing domestic economic activity and jobs, while money spent on imported energy leaves the US economy. The majority (77 percent of world oil reserves are owned or controlled by national governments, and the US currently imports over 60 percent of the crude oil we use (CAPP 2010; EIA 2010). Alaskan offshore development could cut this by roughly 9 percent for over 30 years (NEI and ISER 2011).

There is a real cost to the energy we import – in the form of jobs and income. Development of the oil and gas resources of the US Beaufort Sea over a 50-year period would create an estimated annual average of more than 30,100 new jobs nationwide, with 13,700 in Alaska and 16,400 in the rest of the U.S. (NEI and ISER 2011). Employment opportunities cycle with the project phases, from exploration and development, through production and field decline. An estimated $80 billion in new payroll would be paid throughout the United States (ibid). The sustained job creation increases income and further stimulates domestic economic activity.

Significant new government revenues are at stake as well. A total of more than $97 billion in government revenue would be generated from development of the oil and gas resources of the US Beaufort Sea over a 50-year period, with $84.6 billion to the federal government, $7.6 billion to the state of Alaska, $1.2 billion to the NSB, and $3.7 billion to other state governments (NEI and ISER 2011). These estimates increase if the long-term average price of oil exceeds $65 per barrel (in 2010 U.S. dollars).

Development of Alaska OCS oil and gas resources is important for maintaining infrastructure of national strategic importance as well. The Trans-Alaska Pipeline System (TAPS) delivers approximately 11 percent of domestic oil production to refineries on the west coast and has been identified as critical
infrastructure for national security. Built at a cost of $8 billion in 1977, TAPS throughput has fallen from 2.1 million barrels per day in 1988 to less than 650,000 barrels per day as existing North Slope fields age (Alyeska 2011). Without additional oil development, the TAPS is anticipated to encounter operating difficulty below about 500,000 barrels per day and shut down when it reaches 200,000 barrels per day. Alaska OCS development can help extend the operating life of this critical infrastructure.

Development of Alaska OCS oil and gas resources also maximizes the value of the nation’s oil and gas resources by enhancing existing onshore production in both value and volume. Reduced transportation cost, from infrastructure operating nearer to capacity, enhances value. Expanded infrastructure enables development of satellite fields, enhancing volume. Development of natural gas in the Alaska OCS will enhance the probability of an Alaska gas pipeline due to increased certainty in the available resource base.

_A Track Record of Safety in the Alaskan Arctic_

Shell’s long Alaska history dates back nearly 60 years. Shell was one of the original explorers in Alaska, including on the North Slope where Prudhoe Bay was discovered. In the early 1960s, Shell engineers designed and installed the first platforms in Cook Inlet in the toughest ice, tidal and tectonic conditions any company had ever considered. The Shell Cook Inlet Platforms A and B (sold in 1998) stood up to rigorous offshore conditions and continue to produce oil and gas today.

After producing in state waters for nearly 15 years, Shell began prospecting OCS waters in four major basins across the state. In the late 1970s and mid 1980s, Shell drilled offshore wells in the Gulf of Alaska and Bering Sea. In the late 1980s, Shell drilled several wells in the Beaufort Sea and later drilled four of the five wells drilled in the Chukchi Sea. Shell found oil and gas but abandoned those efforts because it was too expensive to operate given the technology of the day and oil price at the time.

In total, more than 500 exploratory, production, and disposal wells have been drilled in the Arctic waters of Alaska, Canada, Norway, and Russia. More than 150 wells have been drilled offshore in Arctic waters of the U.S. and Canada and more than 50 wells have been drilled in the US Beaufort and Chukchi Seas. Shell has drilled 33 wells in Alaska, 32 of which were offshore.

Shell’s proposed project will have positive effects on the NSB economy and provide employment and community development opportunities for residents from the region. An estimated annual average of 30,100 new jobs would be created and sustained for 50 years from development of the oil and gas resources of the US Beaufort Sea, with total payroll of $80 billion (NEI and ISER 2011). Approximately 13,700 of these new jobs would be in Alaska and approximately 3,100 would be located in the NSB (NEI and ISER 2011). New revenue for the North Slope Borough from development of the oil and gas resources of the US Beaufort Sea would total nearly $1.2 billion over this 50-year period under current policies (NEI and ISER 2011).

Shell developed a POC and has contacted and met with community leaders and residents of the borough to solicit comments, questions, and concerns about this project, and will continue that process in the future through an ongoing stakeholder engagement program. Communication with the residents most directly affected by this project is an important part of Shell’s participation in the exploration and evaluation of these potential new energy resources.

The socioeconomic composition of the NSB is a blend of traditional subsistence activities; state, federal and Native corporation services and jurisdictions; and the unique benefits and pressures that are a part of life in the Arctic. A comprehensive review of these resources is provided in Section 3.11 and 3.12 of this EIA.
This Section of the EIA addresses specific components of these socioeconomic resources that are most relevant to the communities of Kaktovik and Nuiqsut: employment, community health, and subsistence. Kaktovik is a coastal community 60 mi (96.5 km) from the proposed project area. Nuiqsut is 125 mi (201 km) west from the project area and about 20 mi (32 km) inland from the coast along the Colville River.

The discussion of subsistence is of particular importance in the ongoing cooperation between Shell and the communities of Kaktovik and Nuiqsut. As Shell’s project is located offshore within a known bowhead whale migration and hunting area, Shell has developed significant mitigation and avoidance plans to support traditional whaling practices, as well as meet project goals. Shell has designed this project to suspend operations during the whaling season and to mitigate any affects on whales prior to and after the hunt.

In 2010, Shell again utilized the services of AES-RTS to develop and manage a North Slope Inupiat Subsistence Advisor (SA) program. 2010 is the fourth consecutive year that Shell has funded this program, a program developed to address the concern and potential conflicts between North Slope residents that practice subsistence and Shell’s exploration activities in the OCS along the Beaufort and Chukchi Seas of Alaska. Information regarding subsistence resources in the villages, including Kaktovik and Nuiqsut, is included in the Subsistence Advisor Program Summary, North Slope Alaska (Attachment A).

The intent of the SA Program is to solicit input from village residents on where people practice subsistence hunting and fishing. This information was gathered by hiring village subsistence advisors that surveyed residents through the use of a questionnaire and maps that could be marked-up on site during the interview process. The program was not designed to be incorporated into a scientific paper for publication. The objective of the project and resultant report was to provide Shell with useful information that could be incorporated into planning efforts so as to avoid impacts to sensitive subsistence use areas and to better understand the concerns of Alaska’s North Slope residents. If proposed exploration and/or development areas are located in subsistence use areas, the feedback obtained from this program would also be used to develop appropriate mitigation measures in collaboration with the village residents that collectively provided the subsistence use information. Although there was no “Principal Investigator” in the true sense of the term with scientific implications, the lead coordinator for the contracted firm was Mr. Mike Sotak (AES-RTS).

As a result of this review and analysis of the socioeconomic sectors of life on the North Slope, research suggests there will be limited, if any, impacts on the resources of the area.

**Plan of Cooperation**

A POC identifies the measures Shell has developed in consultation with North Slope communities and subsistence user groups and will implement during its planned Camden Bay exploration drilling program to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, the POC details Shell’s communications and consultations with local communities concerning its proposed exploration drilling program, potential conflicts with subsistence activities, and means of resolving any such conflicts (50 CFR § 18.128(d) and 50 CFR § 216.104(a) (12) (i), (ii), (iv)). Shell has documented its contacts with North Slope communities, as well as the substance of its communications with subsistence stakeholder groups. Tables summarizing the substance of Shell’s communications, and responses thereto, are included in the POC (Appendix H). This POC may be supplemented, as appropriate, to reflect additional engagements with local subsistence users and any additional or revised mitigation measures that are adopted as a result of those engagements.
The results of the POC meetings (Appendix H) have been documented and submitted to BOEMRE in the revised Camden Bay EP, and contemporaneously to NMFS, and USFWS in applications for MMPA authorizations of incidental takes of the trust species for which these agencies are responsible. The requirements of BOEMRE Stipulation No. 5 parallel requirements of the USFWS LOA and the NMFS IHA. Both the USFWS and NMFS require an applicant to implement a POC to mitigate the potential for conflicts between the proposed activity and traditional subsistence activities (50 CFR § 18.124(c)(4) and 50 CFR § 216.104(a)(12)). The POC must identify the measures that will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, both USFWS and NMFS require an applicant to communicate and consult with local subsistence communities concerning the proposed activity, potential conflicts with subsistence activities, and means of resolving any such conflicts (50 CFR § 18.128(d) and 50 CFR § 216.104(a) (12) (i), (ii), (iv)).

**Analysis of Impact of Project Activities on Employment**

An estimated annual average of 30,100 new jobs would be created and sustained for 50 years from development of the oil and gas resources of the US Beaufort Sea, with total payroll of $80 billion (NEI, 2011). Approximately 13,700 of these new jobs would be in Alaska and approximately 3,100 would be located in the North Slope Borough (NEI 2011).

Since 2005, Shell has implemented several programs that involve the training and subsequent hiring of local residents. Programs include the following:

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

The MMO program employs 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 issues of concern related to subsistence activities and avoid potential conflicts with exploration activities. Shell plans to continue its SA program during each exploration drilling season covered in the revised Camden Bay EP.

The Com Center program involves hiring one or two individuals from each of the Beaufort 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. Shell will implement a Communications Plan during the drilling season in order to avoid conflicts with subsistence users.

During Shell’s proposed exploration program, best efforts will be made 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 will also provide a conduit for communication between Shell and residents.
Analysis of Impact of Project Activities on Local Government Revenue
New revenue for the North Slope Borough from development of the oil and gas resources of the US Beaufort Sea would total nearly $1.2 billion over a 50-year period under current policies (NEI 2011).

Analysis of Impact of Project Activities on State of Alaska Government Revenue
New revenue for the state of Alaska from development of the oil and gas resources of the U.S. Beaufort Sea would total approximately $7.6 billion over a 50-year period, with another $3.7 billion of new government revenue generated in other states (NEI 2011).

Analysis of Impact of Project Activities on Federal Government Revenue
New revenue for the federal government from development of the oil and gas resources of the U.S. Beaufort Sea would total approximately $84.6 billion over a 50-year period (NEI 2011).

Analysis of Impact of Project Activities on 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 project activities are offshore, of limited duration, and will be performed according to all applicable statutes and regulations from a number of federal, state, and local jurisdictions and agencies. This project will have no adverse impact on the health of NSB residents, and specifically the communities of Kaktovik and Nuiqsut.

The following analyses follow the format used throughout this document to address various project activities, with some modification to address the activities most likely to be perceived as impacting community health.

Analysis of Health Impact of Permitted Discharges
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 (MMS 2008a). Please refer to Section 3.2.4 and Section 4.1.3 on water quality and water quality impacts for a more extensive discussion.

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.

But the impact of NPDES permitted discharges associated with Shell’s project will be negligible and temporary. There are no major discharges associated with the Camden Bay exploration drilling program. Other NPDES-permitted discharges include deck drainage, desalination unit wastes, non-contact cooling water, BOP fluid, and excess cement slurry. Shell will discharge cuttings generated from MLC construction and drilling through the 36-in. and 26-in. diameter hole sections. Also, Shell has decided to collect and transport out of region ALL cuttings and drilling mud generated and used from the 20-in. casing level to the bottom of the hole.

Increases in turbidity, minor changes in pH, temperature, and biological and chemical oxygen demand are expected near the discharge site, but the effects will be temporary, minor and have no effect on marine mammals. These effects will be limited to within 330 ft (100 m) of the discharge location and will not likely affect marine mammals in the area.
Analysis of Impact of Liquid Hydrocarbon Spill on Socioeconomics

For purposes of Shell’s proposed exploration drilling program, a large spill (defined as greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shell’s project is a frontier exploration drilling program. Shell plans to drill four wells in Camden Bay to assess the potential of identified exploration targets. No oil will be produced. No pipelines or other permanent facilities will be constructed. All wells will be permanently plugged and abandoned in accordance with BOMRE requirements upon completion of drilling.

While still a remote possibility due to the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Impacts of a small spill are analyzed below.

The probability of small spills would be minimized by implementing Shell’s oil spill response plan and maintaining preventative measures, including pre-booming before any over-water fueling. In the unlikely event of a small spill, implementation of Shell’s response action plans is expected to mitigate and reduce the impacts of a small spill. Given the open ocean location of Shell’s prospects, the duration of a small spill and opportunity for impacts to occur would be very brief. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours.

The probability of an oil spill is sufficiently small to conclude it would not occur during the Camden Bay exploration drilling program. Prudent planning and state and federal regulatory requirements require that Shell have comprehensive spill prevention and response plans and capabilities in place. Shell’s plans include measures to prevent any release from occurring and to respond in the event of a discharge, including capabilities for responding to a “worst case” scenario release. Given the remote location of any potential small spill and its expected short-duration, the potential effects on community health are negligible. In the unlikely event that a small spill were to occur, implementation of Shell’s comprehensive spill response plan would further minimize any effects on community health.

Analysis of Project Activities on Minority and Lower Income Groups

Given that the project involves routine and seasonal exploration drilling activities in one prospect area, it is not anticipated that the project would result in disproportionate adverse effects on the Inupiat residents in the communities of Kaktovik and Nuiqsut. (MMS 2003). In the unlikely event of an accidental oil spill, there could be disproportionately high adverse effects on Inupiat subsistence-harvest activities and sociocultural systems (MMS 2003). Specific mitigation measures have been developed to address impacts of exploration activities on subsistence activities and resources, particularly the subsistence whaling activities and bowhead whales.

Analysis of the Impact of Project Air Emissions on Socioeconomics

The impact of project air emissions in Camden Bay on socioeconomics would be negligible. Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640 ft (500 m) from the hull of the drilling vessel (Kulluk or Discoverer).
The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SO₂, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on cultural resources.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

**Analysis of Habitat Alterations on Socioeconomics**

Habitat alteration for communities is defined as changes caused by construction, new types of infrastructure, alteration of stream flow, influx of different cultural groups, and an increase in available jobs. The project exploration actions discussed in this document will result in opportunities for new jobs and could enhance, not diminish, the quality of life of local residents.

**Analysis of Existing Offshore and Coastal Infrastructure on Socioeconomics**

One the vessels are in the project area, all project activities associated with the Torpedo and Sivulliq prospects will be staged from existing infrastructure located in Deadhorse, Prudhoe Bay, and West Dock areas. Goods and services will be obtained from local village contractors, when available, during the duration of the project, with exception of fuel barged from the western U.S. These impacts are positive and would not generate negative effects on community health.

**Analysis of Impact of Project on Subsistence Resources**

The following Section addresses the potential effects of the exploration drilling program on the subsistence activities and resources near the project areas in Camden Bay. Subsistence hunting and fishing continue to be an essential aspect of Inupiat life, especially in rural coastal villages. The Inupiat participate in subsistence hunting and fishing activities in and around the Beaufort Sea, including Camden Bay.

The animals taken for subsistence provide a significant portion of the food that will last the community throughout the year. As well as necessary for survival, subsistence activities strengthen bonds within the culture, provide a means for educating the young, provide supplies for artistic expression, and are a central feature in important celebrations.

Exploration drilling activities at the Sivulliq or Torpedo drill sites are planned to begin on or about 10 July and run through 31 October, with a suspension of all operations within a defined area beginning 25
August for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. During the suspension for the whale hunts the drilling fleet will leave the Camden Bay project area and move to an area north of latitude 71° 25’N and west of longitude 146° 4’W. Shell will return to resume activities after the subsistence bowhead whale hunts conclude. Exploration drilling activities will be conducted through 31 October, depending on ice, weather and sea state. Activities will extend through 31 October, depending on ice and weather. The impact of project activities on subsistence resources and hunting activities will be temporary and localized.

Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

**General Summary of Socioeconomics**

To Inupiat on the North Slope, no viable alternatives to subsistence foods exist (Ahmaogak 1987 in MMS 2008a). Subsistence activities occur year round because the Inupiat residents make use of a multitude of resources. Specific activities depend on the availability of the specific resources. Because Shell’s project is temporary, it should only impact subsistence activities and resources during the time of project operations. This includes exploration drilling activities and vessel transit.

Impacts to subsistence may be direct or indirect. They include those that affect the subsistence users or user’s activities or affect the subsistence resources. Reductions in subsistence resources and changes in subsistence resource distribution may impact subsistence users and their activities (MMS 2008a).

BOEMRE defines the level of impact any project-related activity on resources as negligible, minor, moderate, and major, as listed in the Arctic Multiple-Sale Draft EIS (MMS 2008a). BOEMRE stresses a clear boundary between major effects from the others. A major effect occurs “if a single important resource becomes unavailable or undesirable for use or available only in greatly reduce[d] numbers for 1 year” (MMS 2008a).

Sound energy levels and physical disturbance can cause notable cumulative effects on subsistence resources and harvests without the implementation of appropriate mitigation measures. However, BOEMRE has determined that, with the mitigation measures required by lease stipulations, an BOEMRE-approved Adaptive Mitigation Management Plan, and the NMFS IHAs, such perceived effects would be reduced to moderate (MMS 2008a).

Shell’s exploration drilling activities at Sivulliq and Torpedo, as well as related support activities, could, without mitigation, affect when, where, and how subsistence users harvest resources in areas near the drilling activities. Subsistence users may choose to change their subsistence practices based on real or perceived restrictions to subsistence resources, use areas, and impacts to the resources. Nuiqsut residents have noted that they altered their subsistence use patterns around Prudhoe Bay due to the development of facilities and the use of the area by oil industry (MMS 2008a).

Shell will take all reasonable steps to minimize conflicts with subsistence hunting activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.
Shell continues to maintain a shareholder engagement plan in an effort to address potential and perceived impacts to subsistence activities. The following analyses of project activities directly address the potential for impacts on subsistence activities.

**Analysis of Impact of Vessel Traffic (Including transit) on Subsistence**

The impact of vessel traffic generated by Shell’s proposed exploration plan will be limited and concentrated in a very short period time during the drilling period. The degree of potential impacts to subsistence users and activities due to project-related vessel traffic varies and depends on the subsistence resource, when it is harvested, and where it is harvested. Shell has developed extensive mitigation measures to address the potential for impacts. Shell’s program will add a minimal amount of additional traffic to the existing vessel operations in the Beaufort Sea from private and industry related activities.

**Impact of Vessel Traffic – Bowhead Whale Hunting**

According to BOEMRE, sound energy from vessel traffic could cause some disruption to the bowhead whale harvest, but would not make the bowhead unavailable to subsistence users as a subsistence resource (MMS 2008a). Information from TK used previously in the document and statements from traditional subsistence users, indicates the perception that whales can hear sounds at much greater distances and may modify their behavior for longer periods of time (MMS 2008a), resulting in potentially greater effects to the subsistence hunters.

While bowhead whales do avoid sound energy sources, BOEMRE indicates they swim only a few kilometers away from their original route. Researchers have reported that bowhead whales appear to be more sensitive to sound energy than other whales (MMS 1987). Sections 4.1.8 and Section 4.1.9.2 provide a comprehensive review on how bowhead whales respond to vessel traffic and sound energy.

Shell will shut down drilling on 25 August and move off location; drilling operations will not recommence until after the Kaktovik and Nuiqsut (Cross Island) bowhead whale hunts are complete. However, Shell may be drilling at Camden Bay drill sites during bowhead whale hunting periods for Chukchi communities, though drilling activities are not expected to impact hunts. Any deflection of whales is anticipated to be short-term and whales would be expected to resume their normal migrations. A study on bowhead whale deflection in the Beaufort Sea, 15 mi (24 km) east of Sivulliq, found that deflected whales appeared to revert back to normal migrations once 19 mi (30 km) away from the drill site (Brewer et al. 1993). Further, bowhead whale deflection response to seismic and other strong sound sources has been shown to disappear within 12 hours of cessation of the activity (Richardson and Thomson, 2002; Ireland et al. 2008). Therefore, deflection of whales near the drilling area would not have impacts on whaling communities from Barrow to Point Hope.

Many Inupiat hunters maintain that the bowhead whale is more sensitive than scientific equipment and thus can pick up sounds much farther away. They state that bowhead whales move away from loud sound energy. They worry oil industry sound energy levels will cause the whales to move further from shore, and force hunters to travel farther, resulting in longer and more dangerous hunts (MMS 2008a).

Traditional understanding of bowhead whale behavior is more complex than simple stimulus-reaction predictions. Inupiat TK teaches that bowhead whales, like other animals, have an innate spirituality and can hear sounds in the water or in the air for hundreds of miles. They believe whales can hear and understand what people say about them. Based on what they hear or how people behave toward them, TK teaches that whales choose to make them available to hunters or avoid them (MMS 2008a).
Because of the Inupiat peoples’ understanding of the bowhead’s sensitivity to sound energy and rude disrespectful manners, hunters take precautions. They are quiet when camped on the ice so they will not scare whales. Hunters keep camps clean and wear white parkas so not to offend the whales, and paddle boats without splashing and making sound (Brower 2004).

Inupiat hunters are concerned that increased oil and gas industry activity will disrupt current whale migration routes. They fear the bowhead might change their route to one much farther from shore (MMS 2008a).

With respect to the beliefs and practices of the Inupiat, Shell does not anticipate transit from the Kulluk or Discoverer to impact bowhead whale hunting activities or resources. Shell will mobilize the Kulluk or Discoverer and its support vessels to and from planned drill sites before and after, but not during, the fall bowhead whale hunting season. Limiting vessel traffic during the hunting season will limit impacts to subsistence hunting activities.

Implementation of Shell’s 4MP will serve to prevent and mitigate impacts to marine mammal subsistence resources, and associated subsistence activities.

Overall, Shell estimates bowhead whale physical disturbance and avoidance behavior from vessel traffic will not last more than 12 hours. BOEMRE does not expect vessel traffic to cause repeated bowhead displacement behavior (MMS 2008a). Therefore, Shell does not anticipate long-term or permanent changes in subsistence use areas and activities, which are dependent on the bowhead behavior, resulting from vessel traffic.

**Impact of Vessel Traffic – Beluga Whale Hunting**

According to BOEMRE, sound energy from vessel traffic could cause brief disruption to beluga whale harvest but not make the resource unavailable to subsistence users (MMS 2008a). Beluga whales respond differentially to vessel sound energy (see Section 4.1.8), but temporary and localized sounds from vessels should cause only brief disturbances to the whales. According to the MMS, the whales should recover within one day. Thus vessel traffic should not affect the distribution and availability of beluga to subsistence hunters (MMS 2008a).

Inupiat hunters and TK assert that sound energy affects beluga whales, and may cause the whales to leave for the long-term. Hunters conduct themselves very quietly when hunting beluga, even going as far as using hand signals to communicate. Beluga are said to have an excellent hearing ability and can identify and remember individual outboard motor boats. Some Inupiat worry that beluga will remember sound energy in an area from one year and avoid that area in following years (MMS 2008a).

Impacts to beluga may have minor impacts to the overall subsistence lifestyle of Nuiqsut residents. Beluga whale does not contribute a large percentage to the subsistence resources of Nuiqsut residents. According to the BOEMRE (MMS 2008a), some sources mention incidental harvest of beluga whales during the bowhead whale hunt. However, Thomas Napageak of Nuiqsut, former AEWC Chairman, said he could not recall a time when Nuiqsut harvested beluga whales (MMS 2008a).

Impacts to beluga will have a greater impact to Kaktovik residents. Kaktovik residents generally harvest beluga whale from August through November, incidental to the bowhead harvest. They sometimes harvest beluga earlier in the open-water season, during seal and caribou hunting or fishing (MMS 2008a).

While vessel traffic may impact beluga whale as a subsistence resource in a limited manner, it may impact the related subsistence activities to a greater extent. Subsistence hunters may view increased
vessel traffic from Shell’s activities and associated sound energy as disruptive and the vessels as imposing on their traditional subsistence areas. They may avoid areas in which they can see and hear vessel traffic.

Shell will take all reasonable steps to minimize conflicts with subsistence hunting activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Impact of Vessel Traffic – Polar Bear Hunting

Shell anticipates minimal impact to subsistence polar bear hunting from vessel traffic. Polar bears react little to vessels because they do not stay long in the open water (MMS 2008a). When they do react, polar bears show a range of behavior responses to vessel traffic – from curiosity to avoidance (see Section 4.1.8). Any impact to the hunt is expected to be short-term and localized. BOEMRE does not expect change in polar bear availability due to vessel traffic (MMS 2008a).

Any impact to the polar bear may impact the subsistence hunters and their activities. Nuiqsut residents hunt polar bear from mid-September through late winter, but they do not hunt them often. While residents hunt polar bear yearly (NSB 2005), residents of Kaktovik generally do not view polar bear as a meat source (City of Kaktovik 2005). However, they use the fur to make boots, mittens, and coats, and may hunt polar bear 10 mi (16 km) beyond the barrier islands. When hunting polar bear, residents generally hunt them during the winter (MMS 2008a). Subsistence hunting for polar bears within the drilling area while drilling activities are occurring is not likely due to safety concerns regarding sea ice stability.

While vessel traffic is unlikely to impact the polar bear as a subsistence resource, hunters are concerned it may impact subsistence activities. These hunters may view increased vessel traffic from Shell’s activities and associated sound energy as disruptive and the vessels as imposing on their traditional subsistence areas. They may avoid areas in which they can see and hear vessel traffic.

Shell will take all reasonable steps to minimize conflicts with subsistence hunting activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Vessel traffic will be minimal and limited in duration to the planned exploration period. This limited duration, the distance offshore of the project location, and the mitigation measures in place would minimize the potential for disturbance. The actual project operations would have little effect, if any, on the activities of NSB subsistence users.
Impact of Vessel Traffic – Seal Hunting

Shell expects temporary and localized impacts to seals, but impacts to subsistence seal hunting activities and to the hunters may vary. Shell’s open water drilling season corresponds with Nuiqsut and Kaktovik seal hunting seasons.

Nuiqsut residents hunt seals year-round, but focus seal hunting during the open-water season, usually starting in June (MMS 2008a), from Harrison Bay in the west along the coast to Anderson Point, almost to Kaktovik. They also hunt seals up the Colville River past Ocean Point (Pederson 1979; Braund and Burnham 1984; ACI et al. 1984; and SRBA and ISER 1993).

While Kaktovik subsistence users hunt seals year round, they focus their seal hunting efforts from July to September, during the open-water season (MMS 2008a). During the winter, Kaktovik hunters hunt primarily ringed seals, while in the summer they hunt ringed, bearded, and spotted seals (MMS 2008a).

Seals may exhibit temporary displacement and avoidance behavior due to trafficking vessels. TK notes that intense sound energy startles, annoys, and can cause flight of seals. Vessel traffic may cause temporary displacement of bearded, ringed, and spotted seals hauled out on the ice or on beaches, as wells as those feeding and swimming in the water (MMS 2008a). Sound energy from supply and other support vessels will be temporary and localized; however, and should result in short-term behavioral changes.

According to the BOEMRE, vessel traffic should not cause long-term effects to seal distribution or availability (MMS 2008a).

Impact of Vessel Traffic – Walrus Hunting

Shell anticipates little or no impact to Kaktovik and Nuiqsut subsistence walrus hunting. Neither Kaktovik nor Nuiqsut residents hunt walrus on a regular basis, but more of an opportunistic basis. This is likely due to the limited walrus distribution in the Alaskan Beaufort Sea (MMS 2008a). Any impact to walrus from vessel traffic will have limited impact to the broader subsistence lifestyle of these two communities.

Impact of Vessel Traffic – Hunting of Terrestrial Mammals

Shell anticipates little to no impact to terrestrial mammal hunting because the distance between vessels and the onshore animals is great enough not to disturb them. The one exception is the caribou. Overall, the impacts of offshore drilling activities are anticipated to have negligible impacts on caribou. Caribou may be exposed to limited impacts from offshore drilling activities.

Caribou occupy the Beaufort Sea coast. Additionally, they swim to the barrier islands and linger in shallow waters to escape harassment from insects when insect densities are high (MMS 2008a). Vessel traffic in shallow waters and in waters between the coast and barrier islands may impact caribou.

Caribou in shallow water and on or near barrier islands may react to sounds from vessel traffic like they may to sound from aircraft. Caribou may show avoidance or fleeing behavior. BOEMRE has concluded that disturbance from this type of sound energy will be localized and temporary (MMS 2008a).

Kaktovik residents hunt caribou along the coast, traveling by boat, during mid-August. In late October, hunters move inland because the snow builds up and they can travel over land by snow machine. Snow machines allow Kaktovik hunters to hunt caribou along valleys and in the mountains, and to a lesser degree in the coastal plain. These inland hunts last until breakup, usually May (MMS 2008a).
Caribou provides fresh meat for Nuiqsut residents year-round. Factors affecting caribou hunts include the fluctuating migration patterns of the Central Arctic and Teshekpuk Lake herds, weather, and ice conditions. Because of this, subsistence users hunt caribou year round. The availability and locations of the caribou herds have fluctuated over the years and because of this the locations of caribou hunts have varied (MMS 2008a).

*Impact of Vessel Traffic – Fishing*

As discussed in Section 4.1.5, investigations of fish response to vessel sound energy suggest that fish react and move away from vessels when engine and propeller sound energy exceeds a certain level. These investigations have not documented long-term impacts. Local and traditional knowledge suggests vessel traffic impacts fish.

Isaac Nukapigak, subsistence user from Nuiqsut, noted that cisco no longer spawn near the Colville River Delta because of the oil industry activities in the area (Nukapigak 1995 in MMS 2008a). Other local residents expressed concern that vessel traffic (whether oil industry, barges, or others) may have negative impacts to fish resources and thus to the subsistence way of life (MMS 2008a).

Such effects to fish as a resource or to fishing practices may impact the subsistence way of life. Fish are important subsistence resources for both Kaktovik and Nuiqsut residents. The availability of fish fluctuates less than other resources, making them a reliable source (MMS 2008a).

Given the analysis and discussion in Section 4.1.6, Shell anticipates minimal, if any, impacts to subsistence fishing activities based on project operations. Subsistence users may choose to alter their patterns of traditional use based upon perceived effects, but the actual exploration drilling will generate negligible effects that would not impact their traditional uses and activities.

Shell will take all reasonable steps to minimize conflicts with subsistence fishing activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

*Impact of Vessel Traffic – Bird Hunting and Egg Collection*

Vessel traffic may disturb birds, which may in turn affect subsistence bird hunting and egg collection, but Shell anticipates impacts to a limited number of birds, and those impacts will localized and temporary.

The location of Shell’s proposed exploration drilling and vessel transit activities avoids any important bird habitat and other areas of high bird concentrations. Shell’s activities may disturb some foraging and loafing birds (see discussion in Section 4.1.7). The impacts of these activities are negligible and will not influence bird mortality. Therefore, these activities should not impact the availability or distribution of birds and bird eggs in the long-term.

Local Kaktovik and Nuiqsut residents expressed concern that sound energy adversely impacts birds (MMS 2008a). However, if vessels remain away from important bird habitat and areas of dense bird concentrations, these impacts will be limited.
Lighted vessels pose a collision risk to many species of birds (see discussion in Section 4.1.7). Shell anticipates threatened spectacled and Steller’s eiders populations to be minimal in the vicinity of the project area. If bird strikes occur, Shell expects the mortality would be low and not influence bird populations. To further reduce the risk, Shell will minimize vessel light output, using green lighting, and monitoring conditions to assess risk. See details of these proposed mitigation actions in Appendix I of the revised Camden Bay EP.

Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Subsistence

General Discussion

Shell expects impacts from vessel mooring, MLC construction, and early phases of drilling (through the 36-in. and 26-in. diameter hole sections) to the availability and distribution of subsistence resources to be minimal because impact to those resources will be limited, localized, and temporary. Impacts to subsistence users and their activities may be greater based on individual understanding and perceptions of impacts to resources and on impacts to activities associated with subsistence, for example impacts to routes or traffic of subsistence boats.

Resuspension of sediments and subsequent deposition resulting from vessel mooring, MLC construction, and early phases of drilling will impact whales and other marine mammals in a minor, localized, and temporary manner. Marine mammals would likely avoid areas where vessel mooring and MLC construction occur. Direct impacts will result from the sound energy associated with mooring, MLC construction, and early phases of drilling. These impacts are similar to those discussed for vessel traffic and sound energy from drilling and ice management. Indirect impacts to marine mammals will include those resulting from impacts to their food sources, such as fish and lower trophic organisms.

Shell’s 4MP serves to prevent and mitigate impacts to marine mammal subsistence resources – and thus associated subsistence activities – and traffic of Shell’s vessels.

Resuspension of sediments and subsequent deposition will have no or negligible effect on terrestrial mammals such as caribou. The Sivulliq and Torpedo proposed drill sites are approximately 16 mi (26 km) and 23 mi (37 km) offshore of the mainland and the shallow waters in which caribou may seek insect relief. Therefore, sound energy or suspension of sediments from the mooring, MLC construction, or early phases of drilling will not impact caribou.

Resuspension of sediments and subsequent deposition resulting from vessel mooring, MLC construction, or early phases of drilling would impact fish in a minor, localized and temporary manner (Section 4.1.6). Eggs and larvae exhibit greater sensitivity to suspended sediments and other stresses, but the impacts of the suspended sediment created by these activities should be minimal. Vessel mooring, MLC construction, and early phases of drilling should not impact any important spawning or nursery habitats in the vicinity of the project area.

The impacts on birds from vessel mooring, MLC construction, and early phases of drilling will be negligible. Only temporary displacement will occur during vessel mooring, MLC construction, and early phases of drilling.

Impacts, real or perceived, to subsistence resources and/or to associated subsistence practices may impact the subsistence way of life. North Slope residents have expressed concern for the general health of subsistence resources resulting from increased oil and gas industry and other industry presence offshore (MMS 2008a). Subsistence users may alter what, how much, when, and where they harvest different resources based on their understanding of the health and availability of them.
Subsistence hunters may view increased industry presence from Shell’s activities and associated sound energy as disruptive and the drilling vessels and support vessels as imposing on their traditional subsistence areas. They may avoid areas in which they can see and hear vessel traffic. Shell anticipates minimal, if any, impacts to these subsistence activities based on planned project operations. Subsistence users may choose to alter their patterns of traditional use based upon perceived effects, but the actual project will generate negligible impacts that would not impact their traditional uses and activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

**Analysis of Impact from Vessel Mooring, MLC Construction and Early Phases of Drilling – Bowhead Whale Hunting**

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit).

Shell anticipates very limited to no effect on bowhead whale hunting. Exploration drilling activities at the Sivulliq or Torpedo drill sites are planned to begin on or about 10 July and run through October 31, with a suspension of all operations within a defined area beginning 25 August for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. During the suspension for the whale hunts the drilling fleet will leave the Camden Bay project area and move to an area north of latitude 71° 25’N and west of longitude 146° 4’W. Shell will resume activities after the subsistence bowhead whale hunts conclude. Exploration drilling activities will be conducted through 31 October, depending on ice, weather and sea state.

The impact of project activities on subsistence should be negligible, temporary and localized.

Impacts to the subsistence resource – bowhead whale – outside the subsistence hunting season should be temporary and localized. Bowheads tend to avoid drilling rigs at distances up to 12 mi (20 km). Therefore, the whales will not likely swim or feed in close enough proximity of discharges to be negatively affected.

Concerns, real or perceived, from local residents regarding impacts from drill cuttings and discharges to bowhead may impact subsistence bowhead whale hunting. Bowhead whale are an important subsistence resource. If drill cuttings and discharges are thought to contaminate the bowhead’s environment or their food sources, Inupiat whalers may change their subsistence patterns and activities. To address local residents’ concerns on potential impacts to bowhead whale subsistence activities from discharge of muds, cutting and other waste streams, Shell will capture discharges as described in Section 2.7 while operating in Camden Bay.

Shell will take all reasonable steps to minimize conflicts with subsistence hunting activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.
Analysis of Impact from Vessel Mooring, MLC Construction, and Early Phases of Drilling – Beluga Whale Hunting

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit).

Shell anticipates limited impact to subsistence beluga whale hunting because Nuiqsut and Kaktovik residents do not often hunt beluga. Additionally, Shell expects any impact to beluga whales to be temporary and localized.

Impacts to beluga may have minor impacts to the overall subsistence lifestyle of Nuiqsut residents. Beluga whale does not seem to contribute much to the subsistence resources of Nuiqsut residents. According to BOEMRE (MMS 2008a), some sources mention incidental harvest of beluga whales during the bowhead whale hunt. However, Thomas Napageak of Nuiqsut, former AEWC Chairman, said he could not recall a time when Nuiqsut harvested beluga whales (MMS 2008a).

Shell anticipates drill cuttings will disperse only up to 330 ft (100 m) from the drilling unit in beluga feeding areas. Therefore, drill cuttings discharges are unlikely to come in contact with beluga whales.

Analysis of Impact from Vessel Mooring, MLC Construction, and Early Phases of Drilling – Polar Bear Hunting

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit).

Shell anticipates very limited to no impact to subsistence polar bear hunting from drilling cuttings. While polar bears swim, they are not expected to be in the vicinity of the discharges. Polar bears do not spend much time on the open water.

Nuiqsut residents hunt polar bear from mid-September through late winter, but they do not hunt them often. While residents hunt polar bear yearly (NSB 2005), residents of Kaktovik generally do not view polar bear as a meat source (City of Kaktovik 2005). However, they use the fur to make boots, mittens, and coats, and may hunt polar bear 10 miles (16 km) beyond the barrier islands. When hunting polar bear, residents generally hunt them during the winter (MMS 2008a).

Analysis of Impact from Vessel Mooring, MLC Construction and Early Phases of Drilling – Seal Hunting

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit).

Shell anticipates limited impacts to subsistence seal hunting. Drill cuttings should not impact the availability or distribution of seals. Inupiat may perceive cuttings to impact seals (e.g., through contamination), which might impact subsistence hunting.

Shell anticipates drilling cuttings will disperse only up to 330 ft (100 m) from the drilling unit in seal areas. Therefore, discharge of drilling cuttings are unlikely to come in contact with beluga whales.

Concerns, real or perceived, from local residents regarding impacts from drill cuttings and discharges to seals may impact subsistence seal hunting. Seals are an important subsistence resource. If drill cuttings...
and discharges are thought to contaminate the seal’s environment or their food sources, Inupiat hunters may change their subsistence patterns and activities.

Shell will take all reasonable steps to minimize conflicts with subsistence hunting activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Analysis of Impact from Vessel Mooring, MLC Construction, and Early Phases of Drilling – Walrus Hunting

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit).

Shell anticipates limited impacts to subsistence walrus hunting. Because of the low occurrence of walrus in the Alaskan Beaufort Sea, residents of Kaktovik and Nuiqsut do not often hunt walrus. Furthermore, Shell anticipates limited impacts to the subsistence resource – walrus. For these reasons, Shell expects limited impacts to subsistence hunting.

Drilling cuttings are unlikely to significantly affect walrus. Shell does not expect direct impacts, but expects potential indirect effects. These effects are those that may be direct impacts to the walrus’ prey. Walrus are benthic feeders and rely upon organisms living on the seafloor for nutrition. Smothering of benthic organisms by drilling cuttings discharges could also impact walrus prey. However, walrus have a wide feeding range and are highly opportunistic feeders. Therefore, these small disturbances will be unlikely to have an impact on walrus.

Analysis of Impact from Vessel Mooring, MLC Construction, and Early Phases of Drilling – Caribou Hunting and Other Terrestrial Mammals

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit).

Shell does not anticipate impact to terrestrial mammal hunting. Drilling cuttings will not disturb caribou habitat or food sources. Furthermore, caribou hunting areas are not in the vicinity of the exploration drilling activities where the mud and discharges will be created.

Analysis of Impact from Vessel Mooring, MLC Construction, and Early Phases of Drilling – Fishing

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit).

Shell anticipates little to no impact to subsistence fishing because Shell expects negligible and temporary impacts to the fish resource. Shell does not expect the planned exploration drilling locations to be within subsistence fishing areas.
Concerns from local residents regarding impacts from discharges to fish may impact subsistence fishing. Fish are an important subsistence resource. If discharges are thought to contaminate the fish’s environment, Inupiat fishermen may change their subsistence patterns and activities.

Shell will take all reasonable steps to minimize conflicts with subsistence fishing activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

*Analysis of Impact from Vessel Mooring, MLC Construction, and Early Phases of Drilling – Bird Hunting and Egg Collection*

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). There are no impacts to bird hunting and egg collection.

*Analysis of Impact of Drill Cuttings and Drilling Mud Discharges*

Shell plans to collect and transport drill cuttings and drilling mud out of region for disposal at a licensed TDS. The only cuttings discharged will be from the early phases of drilling through the 36-in. and 26-in. diameter hole sections (Discharge 013 as defined by the NPDES general permit). Any impacts from cuttings are addressed in the section above titled: Analysis of Impact of Vessel Mooring, MLC Construction, and Early Phases of Drilling on Subsistence.

*Analysis of Impact of Other Permitted Discharges*

Other NPDES-permitted discharges associated with the project include deck drainage, desalination unit wastes, BOP fluid, non-contact cooling water, and excess cement slurry. All these discharges will occur at the offshore drill site. There will be no discharge of free oil, floating solids, or trash that could potentially affect subsistence resources and activities. Any effects on subsistence will be negligible.

Types of discharges allowed by the NPDES General Permit AKG-28-0000 may change pH, temperature, TSS, and BOD in the water column, but disperse rapidly in open ocean conditions and not directly subsistence resources. Shell expects any indirect effects subsistence resources or habitat would last only as long as the discharge is ongoing and would be negligible.

*Analysis of Impact of Aircraft Traffic*

Shell’s proposed exploration drilling activities will result in increased aircraft traffic in the Camden Bay project area. Shell intends to use aircraft to support their exploration drilling activities. 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 emergencies (including adverse weather). Aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft (457 m) in areas of active whaling; such areas to be identified through communications with the Com Centers. Except 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, then at that point it shall fly directly north to its destination.

Approximately one fixed-wing flight per day will fly into the airport at Deadhorse to support exploration drilling activities. Helicopters will be used for crew changes and some resupply and fixed-wing aircraft will be used for marine mammal monitoring. The Deadhorse airport has existing commercial operators and flights near Camden Bay coast. Flights attributed to exploration drilling support will be in addition to those flights and would not have an impact on existing conditions.

**Impact of Aircraft Traffic – Bowhead Whale Hunting**

According to BOEMRE, sound energy from aircraft could cause some disruption to bowhead whale harvest, but not make the bowhead as a subsistence resource unavailable to subsistence users (MMS 2008a). Information from TK and statements from traditional subsistence users indicated the belief that whales can hear sounds at much greater distances and will modify their behavior for longer periods of time (MMS 2008a), resulting in potentially greater effects to the subsistence hunters.

Western science asserts that bowhead whales may respond to low-flying aircraft, but generally exhibit no response to aircraft flying above 500 ft (150 m) (MMS 1987, 2008a). They may temporarily deflect from the sound source. Sections 4.1.8 and 4.1.9.1 discuss analyses of impacts.

Many Inupiat hunters maintain that the bowhead whale is more sensitive than scientific equipment and thus can pick up sounds much farther away, and that they can hear sounds in the air as well as in the water. They state that bowhead whales flee loud sounds. For example, Barrow residents ask pilots not to fly over open leads and disturb the whales (MMS 2008a).

At least one Nuiqsut whaling captain attested that helicopter traffic caused whales to migrate 20 mi (32 km) farther than their normal migration route (MMS 1995 in MMS 2008a). Other North Slope residents believe that aircraft sound energy can be heard well below the water surface and disturbs whales (MMS 2008a).

Bowhead whale behavior is more complex than simple stimulus-reaction behavior. Inupiat TK teaches that bowhead whales, like other animals, have an innate spirituality. Some Inupiat assert that whales can hear sounds in the water or in the air for hundreds of miles. Furthermore, they believe the whales not only hear but also understand what people say about them. Based on what they hear or how people behave toward them, they believe the whales will make themselves available to hunters or avoid hunters (MMS 2008a).

Inupiat hunters are concerned that increased oil and gas industry activity will disrupt current whale migration routes. They fear the bowhead change their route to one much farther from shore (MMS 2008a).

With Shell’s mitigation plan and suspension of operations during the bowhead whaling season, impacts to this resource may be minimal and whaling operations and activities will not be interrupted or disturbed during the hunting season.

**Impact of Aircraft Traffic – Beluga Whale Hunting**

According to the BOEMRE, sound energy from aircraft traffic could cause brief disruption to beluga whale harvest, but not make the beluga as a subsistence resource unavailable to subsistence users (MMS 2008a). Information from TK and statements from traditional subsistence users indicates that, even if the
impacts to the beluga are temporary, the impacts to the whale hunters and to their activities may be greater.

Beluga whales respond differentially to aircraft sound energy (see Section 4.1.10), but temporary and localized sounds from aircraft should cause brief disturbances to the whales. According to the BOEMRE, the whales should recover within one day. Thus aircraft traffic should not affect the distribution and availability of beluga to subsistence hunters (MMS 2008a).

Inupiat hunters and TK assert that sound energy affects beluga whales, and may cause the whales to leave and are for the long-term. Hunters conduct themselves very quietly when hunting beluga, even going as far as using hand signals to communicate. Beluga are said to have an excellent hearing ability and can identify and remember individual outboard motor boats. Some Inupiat worry that beluga will remember sound energy in an area from one year and avoid that area in following years (MMS 2008a).

Impacts to beluga may have minor impacts to the overall subsistence lifestyle of Nuiqsut residents. Beluga whale does not seem to contribute much to the subsistence resources of Nuiqsut residents. According to the BOEMRE (MMS 2008), some sources mention incidental harvest of beluga whales during the bowhead whale hunt. However, Thomas Napageak of Nuiqsut, former AEWC Chairman, said he could not recall a time when Nuiqsut harvested beluga whales (MMS 2008a).

While aircraft sound energy may impact the beluga whale subsistence resource in a limited manner, it may impact the related subsistence activities to a greater extent. Subsistence hunters may view increased air traffic from Shell’s activities and associated sound energy as disruptive and as imposing on their traditional subsistence areas.

Shell will take all reasonable steps to minimize conflicts with subsistence hunting activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Aircraft will follow a defined flight path and maintain a regulated altitude greater than 1,500 ft (457 m). These restrictions will minimize most, if not all, impacts from Shell’s air traffic. Aircraft already occupy the airspace throughout the North Slope for personal and commercial uses. The small scope of Shell’s project and related air traffic will be a minimal addition to the existing conditions.

**Impact of Aircraft Traffic – Polar Bear Hunting**

Shell anticipates minimal impact to subsistence polar bear hunting. Polar bears exposed to aircraft may move away, show curiosity, or show no effect. Polar bears may exhibit avoidance behavior resulting in short-term and localized effects. This may disrupt some polar bear harvest activities, but will not likely affect annual harvest levels (MMS 2008a).

Any impact to the polar bear may impact the subsistence hunters and their activities. Nuiqsut residents hunt polar bear from mid-September through late winter, but they do not hunt them often. While residents hunt polar bear yearly (NSB 2005), residents of Kaktovik generally do not view polar bear as a meat source (City of Kaktovik 2009). However, they use the fur to make boots, mittens, and coats, and
may hunt polar bear 10 mi (16 km) beyond the barrier islands. When hunting polar bear, residents generally hunt them during the winter (MMS 2008a).

While aircraft sound energy may impact this subsistence resource in a limited manner, it may impact the related subsistence activities to a greater extent. Subsistence hunters may view increased air traffic from Shell’s activities and associated sound energy as disruptive and as imposing on their traditional subsistence areas.

Shell will take all reasonable steps to minimize conflicts with subsistence hunting activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Aircraft will follow a defined flight path and maintain a regulated altitude greater than 1,500 ft (457 m). These restrictions will minimize most, if not all, impacts from Shell’s air traffic. Aircraft already occupy the airspace throughout the North Slope for personal and commercial uses. The small scope of Shell’s project and related air traffic will be a minimal addition to the existing conditions. Helicopters will primarily fly direct routes (except to avoid severe weather), which reduces the disturbed area. Shell will implement a polar bear avoidance and interaction plan to prevent problems with human-bear interactions.

**Impact of Aircraft Traffic – Seal Hunting**

Shell anticipates both impacts to seals and seal hunting activities to be temporary and localized. Air traffic sound energy can disturb bearded, ringed, and spotted seals haul out on the ice and along the coast on beaches. If impacting the subsistence resource, air traffic is likely to impact subsistence hunting activities.

Shell’s drilling season corresponds with Nuiqsut and Kaktovik seal hunting seasons. Both Kaktovik and Nuiqsut resident hunt seals year-round. Therefore, aircraft supporting the exploration drilling activities may impact both the seal and the subsistence hunting activities.

TK notes that intense sound startles, annoys, and can cause flight of seals. Aircraft traffic may cause temporary displacement of bearded, ringed, and spotted seals hauled out on the ice or on beaches, as wells as those feeding and swimming in the water (MMS 2008a). Sound energy will be temporary and localized; however, and should result in short-term behavioral changes.

While aircraft sound energy may impact this subsistence resource in a limited manner, it may impact the related subsistence activities to a greater extent. Subsistence hunters may view increased air traffic from Shell’s activities and associated sound energy as disruptive and as imposing on their traditional subsistence areas.

Shell will take all reasonable steps to minimize conflicts with subsistence hunting activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.
Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Aircraft will follow a defined flight path and maintain a regulated altitude. These restrictions will minimize most, if not all, impacts from Shell’s air traffic. Aircraft already occupy the airspace throughout the North Slope for personal and commercial uses. The small scope of Shell’s project and related air traffic will be a minimal addition to the existing conditions.

**Impact of Aircraft Traffic – Walrus Hunting**

Shell anticipates little or no impact to Kaktovik and Nuiqsut subsistence walrus hunting. Neither Kaktovik nor Nuiqsut residents hunt walrus on a regular basis, but more of an opportunistic basis. This is likely due to the limited walrus distribution in the Alaskan Beaufort Sea (MMS 2008a). Any impact to walrus from aircraft traffic will have limited impact to the broader subsistence lifestyle of these two communities.

**Impact of Aircraft Traffic – Caribou Hunting and Other Terrestrial Mammals**

Shell anticipates little to no impact hunting terrestrial mammals because the distance between aircraft and the onshore animals is great enough not to disturb them. The one exception is the caribou.

According to BOEMRE, increased air traffic from oil and gas industry will cause temporary displacement of caribou. Therefore, BOEMRE states subsistence hunters could experience short-term, localized effects on subsistence hunting (MMS 2008a).

Local residents claim the effect on subsistence caribou hunting is greater than agencies claim (MMS 2008a). For example, Nuiqsut residents note that aircraft sound diverts caribou away from the normal hunting grounds. This can cause hunters to travel farther to hunt. Some have claimed they have had to go without caribou (Braund and Associates 2003 in BLM 2004; MMS 2008a). Furthermore, some residents noted they have beenharassed by aircraft (MMS 2008a).

According to BOEMRE, aircraft cause disturbances that last a few minutes to an hour. The caribou generally recover within a day (MMS 2008a). In the testimonies quoted by the BOEMRE (MMS 2008), Inupiat residents did not state how long caribou are disturbed, or how long subsistence practices are effected; however it is apparent from comments that even if one family went without, they observe the effects being longer than one day (BLM 2004, MMS 2008). Additionally, at least one individual suggested that caribou migration patterns were changing (BLM 2004).

The effects of disturbances by aircraft traffic may have the potential to add stress to caribou which can result in habitat loss through avoidance, increased energetic demands, and lost time feeding. Caribou have mixed reactions to sound energy. Unhabituated caribou demonstrated panic responses to helicopter or fixed-wing aircraft (Calef et al. 1976, Valkenburg and Davis 1985) and have been found to alter daily activity cycles and movements as a result of overflights (Maier et al. 2005). Certain evidence, however, suggests that caribou can habituate to some levels of sound energy (Valkenburg and Davis 1985). Caribou consistently overflown, but not chased or hunted by aircraft, were found to react less over time (Davis et al. 1985; Valkenburg and Davis 1985).

Disturbances from helicopter flights from Deadhorse to the offshore drilling unit are anticipated to be negligible since flights will occur after calving season (June) and Deadhorse is an established airport with
existing aircraft traffic. In addition caribou on the North Slope near Deadhorse have indicated some habituation to human disturbances (Curatolo and Murphy 1986; Pollard et al. 1996; Cronin et al. 1998).

Figure 2.2-2 depicts the helicopter routes (and support vessel routes) to the drill sites. Helicopter flight paths are direct to each drill site, except in emergency situations (including poor visibility). The inland route depicted on the figure is a mitigation measure to lessen any potential interference with caribou hunting along the coast by subsistence hunters.

Subsistence hunters may view increased aircraft traffic as disruptive and the aircraft as imposing on their traditional subsistence areas. They may avoid areas in which they can see and hear aircraft traffic.

Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Shell has flight path plan, altitude restrictions of 1,500 ft (457 m) and avoidance of caribou groups. Therefore any impacts will be limited and short in duration.

**Impact of Aircraft Traffic – Fishing**

As discussed in Section 4.1.12, Shell expects no direct or indirect impacts to fish from aircraft traffic. Thus aircraft should have no impact to availability of subsistence fish resources. Aircraft traffic may have minimal impact to subsistence fishermen and activities.

While aircraft sound energy may impact this subsistence resource in a limited manner, it may impact the related subsistence activities to a greater extent. Subsistence hunters may view increased air traffic from Shell’s activities and associated sound energy as disruptive and as imposing on their traditional subsistence areas.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Aircraft will follow a defined flight path and maintain a regulated altitude greater than 1,500 ft (457 m). These restrictions will minimize most, if not all, impacts from Shell’s air traffic. Aircraft already occupy the airspace throughout the North Slope for personal and commercial uses. The small scope of Shell’s project and related air traffic will be a minimal addition to the existing conditions.

**Impact of Aircraft Traffic – Bird Hunting and Egg Collection**

As discussed in Section 4.1.7, aircraft traffic may cause some disturbance to both onshore and offshore birds, resulting in displacement of birds from preferred habitat and induced stress to birds and potential impacts to subsistence bird hunting and egg collection. Shell does not anticipate long-term impacts to subsistence bird hunting and egg collection.

Aircraft traffic may cause short-term impacts to subsistence hunting and egg collecting. Impacts to availability of resources are expected to last no more than one year/season. Stress from aircraft
overflights on molting birds can make it difficult for birds to maintain or acquire sufficient nutrients for subsequent migration to staging areas (Taylor 1993 in Miller 1994). Aircraft, especially helicopters, may cause the most intense responses (Bélanger and Bédard 1989 cited in Miller 1994), and birds do not habituate well to small low-flying aircraft (Owens 1977). While aircraft may disturb birds, the limited aircraft traffic associated with Shell’s exploration drilling activities is not anticipated to directly lead to mortality. Any impacts to birds from aircraft will be biologically insignificant.

Kaktovik and Nuiqsut residents expressed concern that sound energy (aircraft, vessel, and from industry in general) harm waterfowl and other birds. Since birds are important food sources, Inupiat interpret harm to birds as a threat to subsistence and their livelihood (MMS 2008a).

While aircraft sound energy may impact this subsistence resource in a limited manner, it may impact the related subsistence activities to a greater extent. Subsistence hunters may view increased air traffic from Shell’s activities and associated sound energy as disruptive and as imposing on their traditional subsistence areas.

Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Aircraft will follow a defined flight path and maintain a regulated altitude greater than 1,500 ft (457 m). These restrictions will minimize most, if not all, impacts from Shell’s air traffic. Aircraft already occupy the airspace throughout the North Slope for personal and commercial uses. The small scope of Shell’s project and related air traffic will be a minimal addition to the existing conditions.

Analysis of Impact of Sound Energy from Drilling and Ice Management

Sound energy from drilling and ice management could impact subsistence users and their activities by impacting the subsistence resources, but Shell anticipates the impacts to be less than BOEMRE’s major effect threshold. Shell anticipates these impacts to be temporary and localized. The duration of the impacts would last only as long as the proposed exploration drilling activities in the drilling season.

Residents from Barrow, Nuiqsut, and Kaktovik regularly note that whales and other marine mammals are sensitive to sound. They assert past seismic and drilling activities affected marine mammals’ behaviors; often resulting in subsistence hunters traveling farther offshore to hunt (MMS 2008a; AES 2009). The disturbances may result in whales becoming less predictable and more dangerous to hunt (MMS 2008a). Additionally, whaling captains noted that some whales become skittish, harder to approach, and thus harder to hunt (MMS 2008a).

While species-specific sound thresholds of signal characteristics and distance have not been established, the BOEMRE contends past industry mitigation measures effectively limit the effects to marine mammals. These measures include limiting activity in specified areas during critical subsistence use periods. Resulting effects are generally localized to area of the activity; such as seismic vessel, drilling/production unit, or construction site; and to actual during of the activity (MMS 2008a).
Shell anticipates impacts from drilling and ice management would be temporary and limited to the vicinity of the drilling vessel and support vessels. Potential impacts could be reduced through mitigation measures. Because impacts from drilling and ice management traffic – primarily sound energy – are temporary and localized; the effects on the subsistence resources should be temporary and localized.

The degree of potential impacts to subsistence users and activities vary depending on the subsistence resource, when it is harvested, and where it is harvested. Sound energy may impact whaling, seal hunting, bird hunting and egg collection, and fishing in the open water season. Additionally, if drilling and ice management sound energy impacts the behavior, population, or distribution of any subsistence resources, the associated subsistence activities would be impacted (MMS 2008a).

Impact of Sound Energy from Drilling and Ice Management – Bowhead Whale Hunting
Shell anticipates impacts from drilling and ice management sound energy to be limited. Exploration drilling activities at the Sivulliq or Torpedo drill sites are planned to begin on or about July 10 and run through October 31, with a suspension of all drilling operations beginning 25 August for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. The drilling vessel and support vessels will leave the Camden Bay project area and will return to resume activities after the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts conclude. Activities will extend through 31 October depending on ice and weather. The impact of project activities on subsistence should be negligible, temporary and localized. Potential impacts to bowhead are discussed in Section 4.1.8 and 4.1.9.2.

In addition, Shell will station MMOs on the drilling vessel and ice management vessel(s) to survey the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals. For vessels in transit, if an MMO sights a marine mammal, the Shell vessel will reduce activity (e.g. reduce speed) and sound energy level to ensure that the animal is not exposed to sound above their relative safety levels. Shell will not resume full activity until all marine mammals are outside of the exclusion zone and no other marine mammals are likely to enter the exclusion zone before the next overflight survey. Shell will conduct regular overflight surveys for marine mammals to further monitor drilling areas.

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 likely curious and not regarded as harassed. The anchored vessel will remain in place and continue ongoing operations to avoid possibly causing avoidance behavior by suddenly changing sound energy conditions.

Impact of Sound Energy from Drilling and Ice Management – Beluga Whale Hunting
Shell does not expect any lasting impacts to beluga whale hunting from sound energies created from drilling activities in Camden Bay.

If affected, beluga whale will typically exhibit an avoidance behavior. They may temporarily deflect from hunting and migration grounds. This in term may cause short-term impacts to beluga subsistence hunters and their activities.

Impacts to beluga may have minor impacts to the overall subsistence lifestyle of Nuiqsut residents. Beluga whale does not seem to contribute much to the subsistence resources of Nuiqsut residents. According to the BOEMRE (MMS 2008), some sources mention incidental harvest of beluga whales during the bowhead whale hunt. However, Thomas Napageak of Nuiqsut, former AEWC Chairman, said he couldn’t recall a time when Nuiqsut harvested beluga whales (MMS 2008a).
Beluga whales respond differentially to sound energy (see Section 4.1.8), but temporary and localized sound energy from vessels should cause brief disturbances to the whales. According to the BOEMRE, the whales should recover within one day (MMS 2008a).

Inupiat hunters and TK assert that sound affects beluga whales, and may cause the whales to leave and are for the long-term. Hunters conduct themselves very quietly when hunting beluga, even going as far as using hand signals to communicate. Beluga are said to have an excellent hearing ability and can identify and remember individual outboard motor boats. Some Inupiat worry that beluga will remember sound energy in an area from one year and avoid that area in following years (MMS 2008a).

Impacts to beluga will have a greater impact to Kaktovik residents. Kaktovik residents generally harvest beluga whale from August and through November, incidental to the bowhead harvest. They sometimes harvest beluga earlier in the open-water season, during seal and caribou hunting or fishing (MMS 2008a).

While ice management and drilling may impact beluga whale as a subsistence resource in a limited manner, it may impact the related subsistence activities to a greater extent. Subsistence hunters may view increased vessel traffic from Shell’s activities and associated sound energy as disruptive and the vessels as imposing on their traditional subsistence areas. They may avoid areas in which they can see and hear vessel traffic.

Shell will take all reasonable steps to minimize conflicts with subsistence hunting activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Shell will implement mitigation measures to eliminate or minimize any impacts on marine mammals. Depending upon the sound source, different mitigation measures will be implemented. Mitigation measures have been included in the 4MP in the IHA application (Appendix C of the EP).

**Impact of Sound Energy from Drilling and Ice Management – Polar Bear Hunting**

Shell anticipates minimal impact to subsistence polar bear hunting. Polar bears likely react little to drilling and ice management because they do not stay long in the open water (MMS 2008a). When they do react, polar bears show a range of behavior responses to vessel traffic – from curiosity to avoidance (see Section 4.1.8 and 4.1.9.4). Any impact to the hunt is expected to be short-term and localized. BOEMRE does not expect change in polar bear availability due to vessel traffic (MMS 2008a).

Any impact to the polar bear may impact the subsistence hunters and their activities. Nuiqsut residents hunt polar bear from mid-September through late winter, but they do not hunt them often. While residents hunt polar bear yearly (NSB 2005), residents of Kaktovik generally do not view polar bear as a meat source (City of Kaktovik 2005). However, they use the fur to make boots, mittens, and coats, and may hunt polar bear 10 mi (16 km) beyond the barrier islands. When hunting polar bear, residents generally hunt them during the winter (MMS 2008a).

While ice management and drilling are unlikely to impact the polar bear as a subsistence resource, they may impact the related subsistence activities. Subsistence hunters may view Shell’s activities and associated sound energy as disruptive and as imposing on their traditional subsistence areas.
Shell will take all reasonable steps to minimize conflicts with subsistence hunting activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Actual impacts to polar bear and their habitat will be minimal and have little effect on their habits and behavior. The short duration of the project and its location offshore will have little impact on this resource.

**Impact of Sound Energy from Drilling and Ice Management – Seal Hunting**

Responses of seals to sounds produced during exploration drilling activities are not well documented. Shell expects limited impact to seals from drilling and ice management.

Shell expects temporary and localized impacts to seals, but impacts to subsistence seal hunting activities and to the hunters may vary. Shell’s open water drilling season corresponds with Nuiqsut and Kaktovik seal hunting seasons.

Nuiqsut residents hunt seals year-round, but focus seal hunting during the open-water season, usually starting in June (MMS 2008a), from Harrison Bay in the west along the coast to Anderson Point, almost to Kaktovik. They also hunt seals up the Colville River past Ocean Point (Pederson 1979; Braund and Burnham 1984; ACI et al. 1984; SRB&A and ISER 1993).

While Kaktovik subsistence users hunt seals year round, they focus their seal hunting efforts from July to September, during the open-water season (MMS 2008a). During the winter, Kaktovik hunters hunt primarily ringed seals, while in the summer they hunt ringed, bearded, and spotted seals (MMS 2008a).

TK notes that intense sound startles, annoys, and can cause flight of seals. Vessel traffic may cause temporary displacement of bearded, ringed, and spotted seals hauled out on the ice or on beaches, as wells as those feeding and swimming in the water (MMS 2008a). Sound energy from supply and other support vessels will be temporary and localized; however, and should result in short-term behavioral changes.

While drilling and ice management may impact this subsistence resource in a limited manner, it may impact the related subsistence activities to a greater extent. Subsistence hunters may view increased activities and associated sound energy as disruptive and as imposing on their traditional subsistence areas.

Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.
The small scope of Shell’s project and related disturbances will be a minimal addition to the existing conditions.

In order to mitigate impacts to seals and seal hunters, Shell will station MMOs on the drilling vessel and ice management vessel(s). MMOs will survey the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals. For a vessel in transit, if an MMO sights a marine mammal, the Shell vessel will reduce activity (e.g. reduce speed) and sound energy level to ensure that the animal is not exposed to sound above their relative safety levels. Shell will not resume full activity until all marine mammals are outside of the exclusion zone and no other marine mammals are likely to enter the exclusion zone before the next overflight survey. Shell will conduct regular overflight surveys for marine mammals to further monitor drilling areas.

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 likely curious and not regarded as harassed. The anchored vessel will remain in place and continue ongoing operations to avoid possibly causing avoidance behavior by suddenly changing sound energy conditions.

Impact of Sound Energy from Drilling and Ice Management – Walrus Hunting

Shell anticipates little or no impact to Kaktovik and Nuiqsut subsistence walrus hunting. Residents in Kaktovik and Nuiqsut hunt walrus infrequently and based on opportunity, rather than on a regular basis. This is likely due to the limited walrus distribution in the Alaskan Beaufort Sea (MMS 2008a). Any impact to walrus from vessel traffic will have limited impact to the broader subsistence lifestyle of these two communities.

Walrus may exhibit avoidance behavior from ice management vessels and drilling vessels. Section 4.1.9.3 discusses the details regarding these potential impacts.

In order to mitigate any potential impacts to walrus and walrus hunters, Shell will station MMOs on the drilling vessel and ice management vessel(s). MMOs will survey the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals. For vessels in transit, if an MMO sights a marine mammal, the Shell vessel will reduce activity (e.g. reduce speed) and sound energy level to ensure that the animal is not exposed to sound above their relative safety levels. Shell will not resume full activity until all marine mammals are outside of the exclusion zone and no other marine mammals are likely to enter the exclusion zone before the next overflight survey. Shell will conduct regular overflight surveys for marine mammals to further monitor drilling areas.

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 likely curious and not regarded as harassed. The anchored vessel will remain in place and continue ongoing operations to avoid possibly causing avoidance behavior by suddenly changing sound energy conditions.

Impact of Sound Energy from Drilling and Ice Management – Caribou Hunting and Other Terrestrial Mammals

Shell anticipates little to no impact to land mammal hunting because the distance between the drilling vessel and ice management vessel(s) and the onshore animals is great enough not to disturb them.

Caribou occupy the Beaufort Sea coast and shallow water near the coast and barrier islands. However, they are unlikely to be in the vicinity of Shell’s drilling and ice management activities.
Impact of Sound Energy from Drilling and Ice Management – Fishing
Shell anticipates sound energy from drilling and ice management vessels will impact fish temporarily and in a localized manner. Thus, Shell expects impacts to subsistence fishing should be localized and temporary. Conversely, local residents worry that sound energy will impact fish and subsistence fishing. Some fish may exhibit avoidance behavior in the area near the drilling vessel and around ice management vessels in transit and during ice management. Any avoidance reactions will last only minutes. See Section 4.1.6 for a more detailed discussion.

Isaac Nukapigak, subsistence user from Nuiqsut, noted that cisco no longer spawn near the Colville River Delta because of the oil industry activities in the area (Nukapigak 1995 in MMS 2008a). Other local residents expressed concern that vessel traffic (whether oil industry, barges, or others) may have negative impacts to fish resources and thus to the subsistence way of life (MMS 2008a).

Impacts, real or perceived, to fish as a resource and/or to fishing practices may impact the subsistence way of life. Fish are important subsistence resources for both Kaktovik and Nuiqsut residents. The availability of fish fluctuates less than other resources, making them a reliable source (MMS 2008a).

Shell will take all reasonable steps to minimize conflicts with subsistence fishing activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Impact of Sound Energy from Drilling and Ice Management – Bird Hunting and Egg Collection
Based on studies on seismic survey effects, Shell anticipates no long-term impacts to birds, and therefore no long-term effects on subsistence bird hunting or egg collection. Shell found no studies investigating the impacts of sound energy from drilling and ice management in the literature. Such studies may have not been collected due to the low concern over drilling and ice management sound energy on birds.

Studies on the effects of seismic surveys on birds, which might present an indication of how drilling and ice management sounds could affect birds, found no observable difference in bird behavior (Sections 4.1.7 and 4.1.9.5). Birds did not display differences in behavior when close to or far from the survey vessels and the birds were not repelled by or attracted to the vessels.

The location of Shell’s proposed exploration drilling activities avoids any important bird habitat and other areas of high bird concentrations. Shell’s activities may disturb some foraging and loafing birds (Sections 4.1.7 and 4.1.9.5). The impacts of these activities are negligible and will not influence bird mortality. Therefore, these activities should not impact the availability or distribution of birds and bird eggs in the long-term.

Local Kaktovik and Nuiqsut residents expressed concern that sound energy adversely impacts birds (MMS 2008a). However, if vessels remain away from important bird habitat and areas of dense bird concentrations, these impacts will be limited.

Lighted vessels (including drilling vessel) pose a collision risk to many species of birds (Sections 4.1.7 and 4.1.9.5). Shell anticipates threatened spectacled and Steller’s eiders populations to be minimal in the
vicinity of the project area. If bird strikes occur, Shell expects the mortality would be low and not influence bird populations. To further reduce the risk, Shell will minimize vessel light output, using green lighting, and monitoring conditions to assess risk. See details of these proposed mitigation actions in Appendix I of the revised Camden Bay EP.

Analysis of Impact of Liquid Hydrocarbon Spill

For purposes of Shell’s proposed exploration drilling program, a large spill (greater than 48 bbl) is regarded as too remote and speculative an occurrence to be considered a reasonably foreseeable impacting event resulting from Shell’s proposed project. Shell’s project is a frontier exploration drilling program. Shell plans to drill four wells over the duration of the exploration drilling program to assess the potential of identified targets. No oil will be produced. No pipelines or other permanent facilities will be constructed. All wells will be permanently plugged and abandoned in accordance with BOEMRE requirements upon completion of drilling.

While still a remote possibility due to the implementation of rigorous spill control policies and procedures, small spills (48 bbl or less), such as a spill incidental to a refueling operation, have been determined to be the most likely spill scenario during an exploration drilling program. Impacts of a small spill are analyzed below.

The probability of a small spill would be minimized by implementing Shell’s ODPCP and maintaining preventative measures, including pre-booming before any over-water fueling. In the unlikely event of a small spill, implementation of Shell’s response action plans is expected to mitigate and reduce the impacts of a small spill. Given the open ocean location of Shell’s prospects, the duration of a small spill and opportunity for impacts to occur would be very brief. More than 99 percent of a small spill (diesel fuel) evaporates (48 percent) or disperses (51 percent) to very low levels within 48 hours. Effects would be similar among the Sivulliq and Torpedo prospects.

The probability of a large oil spill is sufficiently small to conclude it would not occur during the proposed exploration drilling program. Prudent planning and state and federal regulatory requirements require that Shell have comprehensive spill prevention and response plans and capabilities in place. Shell’s plans include measures to prevent any release from occurring and to respond in the event of a discharge, including capabilities for responding to a “worst case” scenario release. In the unlikely event that a small occurs, implementation of Shell’s comprehensive spill response plan would minimize any effects on subsistence resources or activities.

Response equipment and trained personnel would be available on site to deploy boom and recovery equipment for the control and removal of product spilled into the environment. Additionally, pre-booming of fuel barges or vessels prior to transfer operations would be utilized in accordance with BOEMRE lease stipulations, USCG requirements, and Shell’s operating procedures.

It is possible the respiratory system of marine mammals could be compromised by the inhalation of vapors from a diesel fuel spill. Other effects of vapor inhalation could potentially include neurological disorders and liver damage (Geraci 1990). Diesel fuel spills evaporate quickly and would not be expected to impact whales. Toxins could affect walrus if they are inhaled from vapors rising from the spill directly after it occurs. It is unlikely that the concentration of the vapors would reach levels that would be harmful to marine mammals because of the windy environment of the Beaufort Sea. Even if high concentrations were reached, these vapors usually evaporate within a few hours of the spill. Impacts to subsistence resources from a small unintentional release of hydrocarbons would be negligible.
Analysis of Impact of Project Air Emissions on Subsistence Resources

The impact of project air emissions in Camden Bay on subsistence resources would be negligible. Shell has a major source PSD permit for the *Discoverer* (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the *Kulluk* (and associated fleet) in the Beaufort Sea, as required by EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640-ft (500-m) from the hull of the drilling vessel (*Kulluk* or *Discoverer*).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO\textsubscript{2}, PM, SO\textsubscript{x}, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO\textsubscript{2}, CO, SO\textsubscript{x}, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met. This will ensure that there is no impact of air emissions on cultural resources.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the *Kulluk* and the *Discoverer*, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

Impacts to subsistence practices may be limited or may be greater depending on the perception of harm from permitted emissions.

Inupiat subsistence users may perceive air emissions as polluting or contaminating subsistence resources. Contamination, whether real or perceived, may affect the use of subsistence foods and other resources. Subsistence users may reduce or abandon harvest, stress about consuming contaminated foods, and worry about future availability of subsistence resources (BLM 2004). Inupiat concerns about contamination reach beyond typically measured pollutants. Some worry that areas exist where unknown or unmeasured levels of contaminants are impacting them and the resources they use. Some are concerned that amounts officially deemed harmless may accumulate and cause serious long-term effects (BLM 2004; MMS 2008a).

Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.
Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the resources of the Beaufort Sea.

*Analysis of Impact of Air Emissions – Bowhead Whale Hunting*

Shell anticipates negligible impact of air emissions to bowhead whales. Thus it assumes limited impact to subsistence users and activities. Concern from potential impacts from air emissions may, however, impact subsistence practices.

Concerns from local residents regarding impacts from discharges to whales may impact subsistence hunting. Bowhead whales are an important subsistence resource. If discharges are thought to contaminate the whales’ environment, Inupiat hunters may change their subsistence patterns and activities.

Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

*Analysis of Impact Air Emissions – Beluga Whale Hunting*

Shell anticipates negligible impact of air emissions to beluga whales. Thus it assumes limited impact to subsistence users and activities. Concern from potential impacts from air emissions may, however, impact subsistence practices.

Concerns from local residents regarding impacts from discharges to beluga whales may impact subsistence hunting. If discharges are thought to contaminate the whales’ environment, Inupiat hunters may change their subsistence patterns and activities.

Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

*Analysis of Impact Air Emissions – Polar Bear Hunting*

Shell anticipates negligible impact of air emissions to polar bears. Thus it assumes limited impact to subsistence users and activities. Concern from potential impacts from air emissions may, however, impact subsistence practices.

Concerns from local residents regarding impacts from discharges to polar bears may impact subsistence hunting. If discharges are thought to contaminate the bears’ environment, Inupiat hunters may change their subsistence patterns and activities.
Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Analysis of Impact Air Emissions – Seal Hunting

Shell anticipates negligible impact of air emissions to seals. Thus it assumes limited impact to subsistence users and activities. Concern from potential impacts from air emissions may, however, impact subsistence practices.

Concerns from local residents regarding impacts from discharges to seals may impact subsistence hunting. If discharges are thought to contaminate the seals’ environment, Inupiat hunters may change their subsistence patterns and activities.

Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Analysis of Impact Air Emissions – Walrus Hunting

Shell anticipates negligible impact of air emissions to walrus. Thus it assumes limited impact to subsistence users and activities. Concern from potential impacts from air emissions may, however, impact subsistence practices.

Because of the low occurrence of walrus in the Alaskan Beaufort Sea, residents of Kaktovik and Nuiqsut do not often hunt walrus. Furthermore, Shell anticipates limited impacts to walrus populations. For these reasons, Shell expects limited impacts to subsistence hunting of walrus.

Concerns from local residents regarding impacts from discharges to walrus may impact subsistence hunting. If discharges are thought to contaminate the walrus’ environment, Inupiat hunters may change their subsistence patterns and activities.

Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.
Analysis of Impact Air Emissions – Caribou Hunting and Other Terrestrial Mammals

Shell anticipates negligible impact of air emissions on caribou and other terrestrial subsistence resources. Thus there will be limited impact to subsistence users and activities. Concerns from local residents regarding impacts from emissions to caribou and other land mammals may impact subsistence hunting. While impacts will be negligible, the perception of residents is that emissions will travel far enough and contaminate the animals’ environment, Inupiat hunters may change their subsistence patterns and activities.

Shell will take all reasonable steps to minimize conflicts with subsistence activities of the local residents. Part of this effort is addressed through the POC and the outreach and consultation actions it implements. This is a major component of Shell’s effort to identify and address the perceived impacts to subsistence activities.

Shell cannot address or impact the personal beliefs held by all individuals within a diverse community. However, Shell continues to make every effort to communicate with residents and discuss the project and how to cooperate in developing the many resources of the Beaufort Sea.

Analysis of Impact Air Emissions – Fishing

Shell anticipates negligible impact of air emissions to fish. Thus it assumes limited impact to subsistence users and activities.

Analysis of Impact Air Emissions – Bird Hunting and Egg Collection

Shell expects limited impacts to subsistence bird hunting and egg collection because it expects air emissions under normal operation will have negligible impact on birds. The preliminary air quality impact analysis shows that Shell will meet all applicable NAAQS, AAAQS, and PSD increment standards at the edge of the Kulluk and Discoverer’s 1,640-ft (500-m) ambient air boundary, the immediate vicinity of its support vessels and at the Beaufort Sea shoreline.

4.1.13 Coastal and Marine Uses

Coastal Zone Management Programs

The ACMP governs the coastal zone management program objectives and requirements. The exploration drilling project will performed in a manner consistent with the ACMP.

Military Use

There will be no impacts from this project on military activities.

Shipping

There will be no impacts on the shipping traffic already established in this region. Resupply will be coordinated with existing transport activities and conducted in accordance with any other applicable agreements.

Recreation and Commercial Fishing

There will be no impacts from this project on recreational and commercial fishing because these activities do not occur within the immediate project area.
Mariculture

This exploration project will have no impact upon mariculture. There are no mariculture activities within or near the project area.

Mineral Exploration or Development

This exploration project will have no impact on other mineral exploration or development. There are currently no projects in place in the Camden Bay area engaged in these activities.

4.2 Cumulative Impacts

Cumulative impacts can result from individually minor, but collectively significant, actions taking place simultaneously and over time. Cumulative impacts describe the incremental impact from activities described in this revised Camden Bay EP when added to the aggregate effects of past actions, together with other current and reasonably foreseeable future actions, which include Shell’s concurrent exploration activities planned in the Chukchi Sea. Cumulative impacts may arise from single or multiple actions and may result in additive or interactive effects. Interactive effects may be either countervailing, where the net adverse cumulative effect is less than the sum of the individual effects, or synergistic, where the net adverse cumulative effect is greater than the sum of the individual effects.

4.2.1 Previous Cumulative Impacts Analyses

BOEMRE recently analyzed the cumulative impacts of a proposed exploration drilling program, similar to the activities planned in this revised Camden Bay EP, in several NEPA documents. The level and types of activities planned in Shell's revised Camden Bay EP are within the range of activities described and evaluated in these documents and past, present, and reasonably foreseeable future activities that were identified in BOEMRE’s cumulative impacts scenario. These documents are incorporated by reference and summarized in the following sections along with additional site-specific analyses.

In several documents, BOEMRE has analyzed the cumulative impacts of previously proposed Shell exploration drilling programs in the Beaufort Sea that were very similar to that proposed in this revised Camden Bay EP. BOEMRE’s 2007 EA addressed Shell’s proposed three-year 2007-2009 EP, in which up to 12 exploration wells would have been drilled up to two at a time using two drilling vessels in the Beaufort Sea (MMS 2007b). In October 2009, BOEMRE prepared an EA that contained a site-specific cumulative effects analysis of Shell’s 2010 Camden Bay EP, in which Shell proposed to drill up to two wells in the Beaufort Sea, in the same prospects considered in this revised Camden Bay EP (MMS 2009). In that document, BOEMRE assessed the cumulative impacts of Shell’s 2010 Camden Bay EP, in light of other reasonably foreseeable activities which included Shell’s concurrent plans to drill up to three wells in the Chukchi Sea during the same drilling season. BOEMRE’s cumulative impacts analysis in October 2009 came to the conclusion that “negligible to minor incremental contributions to cumulative effects are expected from the exploration drilling activities as proposed in Shell’s 2010 Camden Bay EP” (MMS 2009). This revised Camden Bay EP proposes exploration drilling activities in the same vicinity, using the same drilling vessels (Discoverer, Kulluk) and involving virtually the same support activities. Shell therefore incorporates the previous BOEMRE cumulative impacts analyses when evaluating the cumulative impacts of this EP. Importantly, the impacts of this revised EP are expected to be reduced from those studied in BOEMRE’s 2007 EA, given the lower level of activities anticipated (i.e., Shell’s 2007 plan contemplated 12 wells over three seasons; whereas this revised EP contemplates four wells over the duration of the plan).
The level and types of activities proposed in this EP are also within the range of activities described and evaluated in the Beaufort Sea Multi-Sale EIS (MMS 2003), and updated in the EAs for Lease Sales 195 and 202 (MMS 2004, 2006a). Past, present, and reasonably foreseeable activities were identified in the cumulative scenario for the Multi-Sale EIS for OCS Lease Sales 186, 195 and 202 (MMS 2003), and the scenario was reviewed and updated as needed before preparation of the EAs for proposed Lease Sales 195 and 202 (MMS 2004, 2006a). The Multi-Sale EIS included a comprehensive, 85-page discussion of cumulative impacts. The EIS’s cumulative impacts analysis included: (1) oil and gas discoveries in the region that had a reasonable probability of being developed on the Alaska North Slope within 15-20 years of the EIS; (2) exploration and development of additional onshore and offshore (currently undiscovered) resources that could occur during that same time frame; (3) certain exploration and development activities that could occur beyond that time frame from future federal and state lease sales: (4) transportation of oil in the Trans Alaska Pipeline System (TAPS) and tankering of oil to western ports; and (5) concurrent activities in the Beaufort Sea, including commercial fishing, and subsistence hunting and fishing (MMS 2003). The Multi-Sale EIS examined the potential cumulative impacts on each specific resource, and the agency concluded that overall, no significant cumulative impacts would result from any of the planned activities associated with the exploration and development of the North Slope and Beaufort Sea oil and gas fields (MMS 2003).

The cumulative impacts analyses in the Lease Sale 195 and Lease Sale 202 EAs updated and reconfirmed this conclusion. For example, the EA for Lease Sale 202 analyzed and responded to the AEWC’s comment that BOEMRE had not properly taken into account the combination of Lease Sale 195, the National Petroleum Reserve-Alaska (NPR-A), the Liberty Prospect, and state lease sales. The Lease Sale 202 cumulative impacts analysis was accordingly updated with regard to spill risk and the assumed level of future seismic operations. The Lease Sale 195 EA addressed the cumulative impacts of the sale in the context of climate change. Even with the expanded scope of cumulative impacts considered in these EAs, both concluded that there would be no new significant cumulative effects for the individual lease sales than those already analyzed in the multiple-sale EIS. The activities proposed to Shell in this revised Camden Bay EP are a small subset of those analyzed in these multiple-sale EISs and subsequent lease sale EAs.

This cumulative impacts analysis incorporates and builds on BOEMRE’s prior analyses by examining the potential cumulative impacts from the work proposed in this EP, in conjunction with the other past, present, and reasonably foreseeable activities expected to occur in the Beaufort Sea.

### 4.2.2 Past, Present, and Reasonably Foreseeable Activities

Few types of activities have occurred or continue to occur in the Beaufort Sea. These include subsistence activities, industrial whaling, vessel traffic, oil and gas exploration and development, and scientific studies. Subsistence activities have been conducted in and along the Beaufort Sea for thousands of years but have had no environmental impact on the Beaufort Sea. Industrial whaling resulted in a severely depleted stock of bowhead whales to the point where they were listed as an endangered species under the ESA. A total of 30 exploration wells have been drilled in OCS waters of the Beaufort Sea. Studies indicate few measureable effects at past exploration well sites (Trefry and Tropicne 2009). Large fields have been developed onshore in the Prudhoe Bay area, resulting in the construction of some coastal infrastructure (e.g., the Endicott causeway, Oliktok Point dock, and West Dock), as well as three offshore developments at Northstar, ODS, and SID. Additionally, there have been continued barge traffic and sea lifts during the open water season, as well as other vessel traffic. Scientific studies have been conducted in the Beaufort Sea for the last few decades. These past activities have had little noticeable effect on the Beaufort Sea ecosystem. Air quality is considered to be good with air pollutant concentrations below NAAQS, water quality is good, and there is no evidence of environmental degradation. Bowhead whale
populations are now thought to approach those of pre-industrial whaling levels leading some scientists to suggest that they be removed from the Endangered Species List (Gerber et al. 2007).

Shell’s exploration drilling program consists of four wells over the duration of the plan. With few exceptions, anticipated effects of the program are ameliorated soon after drilling ceases, and would be expected to be unmeasureable the following year (or before). As BOEMRE has agreed (MMS 2009), the appropriate 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 drilling season timeframe (July-October).

Speculative activities are not appropriate for inclusion in cumulative impacts analyses. Present and reasonably foreseeable activities expected to occur in the Beaufort Sea area during the timeframe of the activities proposed in Shell’s revised Camden Bay EP, and therefore considered in the analysis, are limited to those of which Shell is aware and have been proposed in some fashion or are current activities for which there is no compelling reason to believe they would cease, increase, or diminish and include:

**Subsistence**

Past, present, and reasonably foreseeable subsistence activities are discussed in detail in Section 3.11.7. Subsistence activities in the Beaufort Sea are expected to continue at approximately the same level and in the same areas as identified in Section 3.11.7.

**Offshore Oil and Gas Exploration**

Offshore oil and gas exploration programs have operated in the Alaskan Beaufort Sea since the 1950s, although the extent of these activities has varied significantly among years. Recent seismic exploration activities were conducted by industry in the Alaskan Beaufort Sea in 2006–2008 and 2010, however the 2006 and 2010 programs were exclusively shallow hazards surveys with small airgun arrays. The total number of kilometers of vessel trackline associated with seismic survey activities in the Beaufort Sea since 2006 was greatest in 2008 (Table X1; Funk et al. 2010 and LGL 2011) when five source vessels operated on days that periodically overlapped during the survey period.

It is reasonable to expect that Shell EP activities will result in an increased amount of vessel and aircraft traffic in Camden Bay during each drilling season. Shell’s plan includes a drilling vessel and a number of associated support vessels (see Section 2.2 of this EIA and Section 13.0 of the revised Camden Bay EP). The overall extent of this activity, however, is likely to be comparable with recent years of greater exploration effort (e.g., 2007 and 2008, Table 4.2-1). Shell has no plans to conduct large-scale three-dimensional (3D) or two-dimensional (2D) seismic surveys in the Beaufort Sea during the same timeframe of its revised Camden Bay exploration drilling program. It is possible that the stationary nature of an operating drilling vessel will result in fewer miles transited by some project vessels compared to those involved in seismic and shallow hazards surveys that move continuously. Additionally, Shell knows of no exploratory seismic or site clearance activities planned by other operators in the vicinity of its Camden Bay exploration drilling operations.
The Beaufort Sea is host to a wide range of migratory species as discussed in Section 3.6. Therefore, assessment of cumulative impacts warrants consideration of activities in areas adjacent to the Beaufort Sea. In addition to the proposed four wells under this revised Camden Bay EP, Shell plans to conduct an exploration drilling program in the northeastern Chukchi Sea during the same time frame as that proposed for the revised Camden Bay EP. The Chukchi exploration drilling program includes drilling up to six exploration wells in one prospect located more than 64 mi (103 km) offshore and approximately 410 mi (660 km) west of the Torpedo and Sivulliq prospects in the Beaufort Sea. Seismic exploration has been conducted by industry in the Chukchi and Canadian Beaufort Seas during recent years, although much like in the Alaskan Beaufort Sea, the extent of these activities varied considerably among years.

**Offshore Oil and Gas Production**

Oil and gas are currently being produced from BPXA’s offshore development at Northstar Island, Pioneer’s ODS and Eni’s SID in Harrison Bay. Northstar is located outside of the barrier islands ~10 km (6 mi) offshore of Pt. Storkerson in the Prudhoe Bay area. ODS and SID are located inside the barrier islands near the Colville River delta. No other offshore oil and gas production developments currently exist in the Alaskan Beaufort Sea. Northstar Island, ODS, and SID are man–made, gravel islands. Northstar is further offshore and in deeper water than ODS and SID.

Monthly vessel activity at Pioneer’s ODS in 2006–2010, and Eni’s SID and Exxon’s Pt. Thomson developments for 2008–2010 is presented in Table 4.2-2 (LGL 2011). Vessel routes to ODS and SID are relatively short and localized. Exxon’s Pt. Thomson development is located ~50 mi (80 km) east of Prudhoe Bay. BPXA also operated vessel traffic between West dock and Northstar Island during the 2010 open-water season. Information on BPXA’s 2010 Northstar vessel traffic was not available at the time this draft was prepared.

Shell’s revised Camden Bay EP activities are solely exploration and will not result in an increased level of production-related activities. Other development and production at fields in the Prudhoe Bay area, including sea lifts and other activity at West Dock are expected to remain at approximately the current level. There are no offshore oil developments in the Alaskan Chukchi or Canadian Beaufort Seas.

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### Table 4.2-1 Numbers of Miles Transited by Source Vessels During Seismic, Shallow Hazards, and Ocean Bottom Cable Survey Activity and Various Types of Support Vessel Activity in the Beaufort Sea in 2006–2010

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocean Bottom Cable⁹</td>
<td>0</td>
<td>0</td>
<td>3,997</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Shallow Hazards⁹</td>
<td>61</td>
<td>91</td>
<td>906</td>
<td>0</td>
<td>423</td>
</tr>
<tr>
<td>Deep Seismic⁸</td>
<td>0</td>
<td>492</td>
<td>1,517</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total Vessel Traffic</strong></td>
<td><strong>6,189</strong></td>
<td><strong>23,865</strong></td>
<td><strong>34,906</strong></td>
<td><strong>2,244</strong></td>
<td><strong>10,358</strong></td>
</tr>
</tbody>
</table>

⁹ indicates source vessels and shows miles of vessel trackline while airguns were operating

⁸ total miles of all project vessel tracklines including support vessels
Table 4.2-2  Number of Barges and Crew Vessel Round Trips by Month to Pioneer’s ODS, Eni’s SID and Exxon’s Pt. Thomson Developments, 2006–2010

<table>
<thead>
<tr>
<th></th>
<th>Barges</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Crew Vessel</th>
<th></th>
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<tr>
<td></td>
<td>2006</td>
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<td>2007</td>
<td>2008</td>
<td>2009</td>
<td>2010</td>
<td></td>
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<tr>
<td>Pioneer (ODS)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>July</td>
<td>9</td>
<td>32</td>
<td>6</td>
<td>7</td>
<td>15</td>
<td>*</td>
<td>112</td>
<td>54</td>
<td>13.5</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>13</td>
<td>61</td>
<td>29</td>
<td>78</td>
<td>35</td>
<td>*</td>
<td>183</td>
<td>55</td>
<td>114</td>
<td>113</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>13</td>
<td>36</td>
<td>30</td>
<td>65</td>
<td>36.5</td>
<td>*</td>
<td>198</td>
<td>58</td>
<td>78</td>
<td>93</td>
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<tr>
<td>October</td>
<td>11</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>*</td>
<td>22</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
<td>129</td>
<td>77</td>
<td>150</td>
<td>86.5</td>
<td>327</td>
<td>515</td>
<td>173</td>
<td>205.5</td>
<td>293</td>
<td></td>
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<tr>
<td>Eni (SID)</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>July</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>–</td>
<td>–</td>
<td>34</td>
<td>–</td>
<td>204</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>9</td>
<td>66</td>
<td>–</td>
<td>–</td>
<td>73</td>
<td>38</td>
<td>278</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>–</td>
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<td>October</td>
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<tr>
<td>Total</td>
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<td>–</td>
<td>5</td>
<td>9</td>
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<td>–</td>
<td>114</td>
<td>38</td>
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<td>ExxonMobil</td>
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<td>July</td>
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<td>32</td>
<td>26</td>
<td>15.5</td>
<td>25.5</td>
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<td>3</td>
<td>16</td>
<td>1</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>40</td>
<td>45</td>
<td>44.5</td>
<td>63.5</td>
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<td>137</td>
<td>55</td>
<td>65</td>
<td>246.5</td>
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</tbody>
</table>

* Monthly crew vessel totals for ODS in 2006 and monthly barge totals for Pt. Thomson in 2008 were not available. Eni and Exxon did not conduct vessel operations until in 2006 and 2007. Pioneer’s 2009 and 2010 crew vessel total includes spill response vessel traffic during training activities.

Non-Oil and Gas Related Vessel Traffic

Various types of barge traffic unrelated to industry seismic surveys occurred in the Beaufort Sea in 2006–2010. These activities were conducted by barge companies such as Bowhead Transport, Island Tug and Barge, Seaspan International Ltd., SeaLink Marine Services, and Crowley Marine Services. Miles of barge activity were estimated for activities in the Beaufort Sea based in some cases on actual schedules of barge trips supplied by barge operators and estimated length of barge routes (Table 4.2-3). In other cases the actual barge schedules were not available and vessel traffic was estimated after conversations with barge operators. The barge traffic presented in Table 4.2-3 does not capture all data because some information was not available. Based on our estimates, barge traffic was slightly greater in 2009 than in previous years and in 2010.
Table 4.2-3  Estimated Number of Miles of Non-seismic Vessel Traffic by Month in the Beaufort Sea, 2006–2010*

<table>
<thead>
<tr>
<th>Year</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>303</td>
<td>10,179</td>
<td>5,257</td>
<td>0</td>
<td>15,739</td>
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<tr>
<td>2007</td>
<td>152</td>
<td>6,327</td>
<td>2,128</td>
<td>0</td>
<td>8,606</td>
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<tr>
<td>2008</td>
<td>0</td>
<td>5,146</td>
<td>1,949</td>
<td>825</td>
<td>7,920</td>
</tr>
<tr>
<td>2009</td>
<td>2,787</td>
<td>11,699</td>
<td>1,128</td>
<td>2799</td>
<td>19,238</td>
</tr>
<tr>
<td>2010</td>
<td>1,125</td>
<td>5,309</td>
<td>1,208</td>
<td>99</td>
<td>8,566</td>
</tr>
</tbody>
</table>

*The 2009 total includes one round trip of the Beaufort Sea by Sea-Link Marine Services for which timing of the activity was unknown. The 2009 values also do not include information on the activities for three Crowley barges operating in the Beaufort Sea in late August and early September which was not available or barge activity by BPXA.

Figure 4.2-1 compares the miles of vessel traffic from 2006-2010 in the Beaufort Sea resulting from seismic survey activities, general barge/vessel traffic, and localized vessel activity associated with offshore developments near Prudhoe Bay. The estimated amount of general barge/vessel traffic in the Beaufort Sea was variable among years for which we have data. However, unlike vessel traffic related to seismic operations for which accurate records were available, we do not have complete records for barges, particularly for local traffic associated with hunting and fishing activities. For example, smaller boats used for whaling activities during subsistence hunts are not included in the vessel traffic data in Figure 4.2-1. Vessels associated with the BOWFEST and projects are also not included. Vessel traffic associated with support of offshore developments at ODS and SID which included barges as well as smaller crew vessels, was separated from other barge/vessel traffic due to its localized nature. Information or vessel traffic at Northstar was not available at the time this draft was prepared.

Shell’s revised Camden Bay EP activities are not expected to result in increased barge traffic in the Beaufort Sea. Overall vessel traffic in the proposed exploration drilling area is expected to be limited and consistent with the amount of traffic in recent years. Most vessel traffic is expected to be barges, transiting through the area within 12.5 mi (20 km) off the coast, during open water conditions. 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. Non-oil and gas vessel traffic occurs in the Alaskan Chukchi and Canadian Beaufort Seas as well, however, Shell’s revised Camden Bay EP activities are not expected to change the level or extent of this traffic.
Commercial Fishing

No significant commercial fisheries currently exist in the Beaufort Sea. The North Pacific Fishery Management Council’s Fishery Management Plan (FMP) for the Arctic, which includes the Beaufort Sea (NPFMC 2009), was recently approved by the U.S. Secretary of Commerce. The FMP governs all finfish and shellfish except Pacific salmon and Pacific halibut. The FMP prohibits commercial harvest of all fish species under its jurisdiction until sufficient information is available to support management of a sustainable commercial fishery. There has been concern that potential changes in fish habitat in the Chukchi and Beaufort Seas related to global climate change could result in changes in the distribution and abundance of some marine fish species that could lead to future commercial fishing activities in both seas. Shell’s EP activities are not expected to have any correlation with subsequent commercial fishing activities in the Beaufort Sea.

Scientific Research

The Alaskan Beaufort Sea has been host to a significant amount of scientific research. Research has been conducted primarily from vessel and aerial platforms. Research activities are expected to continue at levels consistent with recent and current investigations. The amount of research could increase in future years, and Shell plans to continue its own scientific studies in addition to collaborating with other private as well as public partners.

4.2.3 Cumulative Impacts

Shell’s exploration drilling program in Camden Bay potentially increases sounds and increases effects on air quality, water quality, sediment quality, and climate change associated with the types of activities described directly above in Section 4.2.2. The following section analyzes potential impacts on resources, subsistence and socioeconomic resources.

The environment within the area of analysis is considered to be relatively free of accumulated human impacts from previous development. The work planned in this revised Camden Bay EP is limited in geographic scope and duration, and is expected to be conducted during summer and early fall and has been assumed to be accomplished over two drilling seasons. Impacts from the proposed exploration drilling program will be correspondingly limited.

**Sound.** For the purpose of the cumulative impact analysis, Shell’s proposed activities have been assumed to begin in 2012 and will introduce industrial sounds into the marine environment from exploration drilling operations, anchor handling, ice management, a short-term (approximately 12 hours per drill site) ZVSP airgun survey, and vessel and aircraft traffic. Vessels are the greatest anthropogenic contributors to overall sound energy in the sea. 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 from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross 1976). Ice management vessels contribute greater sound levels during ice-breaking activities than ships of similar size during normal operation in open water (Richardson et al. 1995). This higher sound production results from the greater amount of power and propeller cavitation required when operating in thick ice.

Marine geophysical surveys, including seismic and shallow hazards surveys, use high-energy sources of sound or vibration to create seismic waves in the earth’s crust beneath the sea. Airguns function by
venting high-pressure air into the water. High-energy, low-frequency sounds usually in the form of short-duration pulses are created along survey grids. Airgun arrays are designed to transmit strong sounds downward through the seafloor, and the amount of sound transmitted in near-horizontal directions is considerably reduced. Nonetheless, they also emit sounds that travel horizontally toward non-target areas. Sound pulses from marine seismic surveys are often detectable in the water at tens or hundreds of kilometers (Richardson et al. 1995).

Underwater sound propagation from drilling vessels results from the use of generators, drilling machinery, and the rig itself. Sound levels during vessel-based operations may fluctuate depending on the specific type of activity at a given time and aspect from the vessel. Underwater sound levels may also depend on the specific equipment in operation. Lower sound levels have been reported during well logging than during drilling operations (Greene 1987b), and underwater sound appeared to be lower at the bow and stern aspects than at the beam (Greene 1987a).

The levels and duration of sounds entering the water from a passing helicopter or fixed-wing aircraft are a function of the type of aircraft, orientation of the aircraft, and water depth. Aircraft sounds are detectable underwater at greater distances when the receiver is in shallow rather than deep water. Generally, sound levels received underwater decrease as the altitude of the aircraft increases (Richardson et al. 1995). Aircraft sounds are audible for much greater distances in air than in water.

All of the above sounds that will be generated during Shell’s planned exploration drilling program will contribute additively to other industrial sounds that enter the Beaufort Sea marine environment from oil and gas production drilling and facility maintenance at Northstar, ODS and SID, island construction and maintenance, and vessel and aircraft traffic. Smaller levels of sound probably enter the water from onshore developments along the Beaufort Sea coast as well. Additionally, small boats used for recreational and subsistence activities as well as non-oil gas barge traffic contribute to in-water sound. In general, sound in the world’s oceans has increased (Weilgart 2007). As described in Section 4.1.8, underwater sound has the potential to cause disturbance to marine organisms, particularly marine mammals.

Shell is not aware of any other anticipated development or seismic activity in the vicinity of its proposed drill sites beginning in 2012. Ion, a geophysical survey company, is planning a large-scale seismic program in fall (October and November) 2011 that spans the Alaskan Beaufort Sea and would include areas near Shell’s proposed drill sites. Should Ion’s program be delayed until 2012, it could occur during a portion of the time period that Shell plans to operate. Additionally, the program would potentially have at least short-term effects typical of large seismic programs in the same general area as Shell’s proposed project.

**Air Quality.** Identified effects on the physical environment from Shell’s EP include minor or negligible, and temporary effects on air quality due to emissions from engines on one drilling vessel and the associated support vessels. Concentrations of regulated air pollutants over the Beaufort Sea and adjacent onshore areas are thought to be below air quality standards (NAAQS). Other 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 Shaw 1982). These pollutants cause a phenomenon referred to as Arctic haze in the region, but has relatively little effect on air quality at ground level.

Shell has a major source PSD permit for the Discoverer (and associated fleet) in the Beaufort Sea and has applied for a minor source permit for the Kulluk (and associated fleet) in the Beaufort Sea, as required by
EPA. Final permits are required by EPA prior to drilling. The air quality permitting ensures that emissions associated with the program (regardless of which drilling vessel is used) will not result in a significant deterioration of ambient air quality or a violation of any NAAQS. Shell will meet all primary and secondary air quality standards at 1,640-ft (500-m) from the hull of the drilling vessel (Kulluk or Discoverer).

The NAAQS are designed by EPA to protect human health and flora and fauna from excessive long- and short-term exposure to ambient levels of six pollutants: CO, NO₂, PM, SO₂, ozone, and Pb. Primary standards set limits to protect public health. Secondary standards set limits to protect public welfare, including, inter alia, animals and vegetation.

The planned drilling will be conducted a minimum of 16 mi (26 km) offshore. As described in Section 3.1.7, air quality in onshore areas adjacent to the Beaufort Sea and offshore in the Beaufort Sea is considered good. The exploration drilling program will emit air pollutants, largely through the use of combustion engines, which are discussed in Section 7 of the EP. The emissions of primary interest from the Shell exploration activities include NO₂, CO, SO₂, small-diameter PM, and VOC. The ambient air quality modeling efforts conducted in support of the air permit for the project area show that the primary and secondary NAAQS standards will be met at the indicated compliance boundary. The air quality permit contains enforceable terms and conditions to ensure that the NAAQS are met.

Anticipated impacts to air quality from vessel traffic and drilling operations have been modeled and analyzed in technical reports submitted to EPA since 2008. These air quality impact analysis for both the Kulluk and the Discoverer, show that Shell will meet all applicable NAAQS standards at the edge of the drilling vessel’s 1,640-ft (500-m) ambient air boundary, in the immediate vicinity of its support vessels, and therefore at the Beaufort Sea shoreline. Therefore, impacts to air quality from emissions associated with the planned exploration drilling program will meet all EPA standards and will be short-term, lasting only as long as the drilling vessel and support vessels are in the Beaufort Sea.

Emissions from Shell’s two planned exploration drilling operations in Camden Bay and the Chukchi Sea would be separated in distance and would not cumulatively affect the same resources. The anticipated emissions at both locations are expected to be well below NAAQS and AAQAS at the shoreline as a result of distance from shore, permit restrictions, and dispersion. The incremental contribution to cumulative impacts on air quality from the proposed EP activities is expected to therefore be negligible. Given that other present and reasonably foreseeable activities will occur during the exploration drilling program at approximately the current level, no additional impacts would be expected and the cumulative effects on air quality are considered minor and last only as long as the drilling, and are therefore not significant.

**Climate Change.** There has been concern for several decades that the earth may be undergoing global climate changes that impact environmental patterns such as ocean temperatures, extent and persistence of the polar pack ice, and weather patterns. Climate models consistently indicate that the Arctic is the most sensitive region of the Northern Hemisphere in terms of potential changes in climate, particularly near sea ice margins. Temperatures in Alaska and throughout the Arctic are thought to have fluctuated considerably over the past few centuries (Mann et al. 1999). Despite this fluctuation, the last 100 years appear to have been the warmest in the last 400 years (Overpeck et al. 1997). While it is unclear to what extent anthropogenic contributions of greenhouse gases (GHGs) have contributed to climate warming, the Arctic marine environment has shown changes over the past several decades that are suggestive of a broader global warming that exceeds the range of natural variability over the past 1,000 years (Walsh 2008). Most scientists attribute these changes at least partly, to emissions of GHGs. The CEQ has issued guidance under NEPA indicating that climate change is a reasonably foreseeable impact of GHG emissions. (Council on Environmental Quality 1997; IPCC 2001a,b).
A synthesis of climate model projections for arctic environments indicates additional warming of several degrees Celsius in much of the Arctic marine environment by 2050 (Walsh 2008). The greatest warming is projected to occur in fall and winter resulting in further retreat of sea ice, which reached record minima in recent years (Stroeve et al. 2008), and longer periods of open water. These changes coupled with hydrographic changes in temperature, salinity and stratification in ocean waters due to freshening, and changes in circulation (Bryden et al. 2005) have the potential to affect biological resources in the Beaufort and Chukchi Seas. Changes in the marine environment due to climate change may interact with other impacts associated with offshore development and result in cumulative impacts to various taxa.

Effects of Climate Change on Marine Mammals

The potential effects of climate change on marine mammals in the Chukchi and Beaufort Seas vary among species. The current warming trend has increased sea–water temperature, and reduced the size of the polar ice cap (Stroeve et al. 2008). Climate change may potentially affect marine mammals in the Chukchi and Beaufort Seas in numerous ways and at locations outside of the Chukchi and Beaufort Seas. The potential impacts of global climate change on marine mammals in the Arctic may be much greater than those that are likely to result from industrial activities or subsistence hunting.

MMS (2007d) described numerous activities or situations related to global climate change that have the potential to impact marine mammals in the Chukchi and Beaufort Seas. These include factors such as:

- potential changes in the distribution, concentration and availability of marine mammal prey species such as fish, benthic invertebrates, and plankton;
- changes in distributions of marine mammals in response to changes in distribution of prey species;
- impacts to subsistence hunting of marine mammals resulting from changes in marine mammal distribution;
- potential expansion of the ranges of some predators such as killer whales that prey on marine mammal species;
- increased shipping and research vessel traffic through the Northwest passage and other areas of the Arctic which could result in increased disturbance to marine mammals, and the potential for collisions of marine mammals with vessels;
- potential for commercial fishing activities to occur in the Chukchi and Beaufort Seas accompanied by increased disturbance from vessel traffic, and potential for marine mammal collision with vessels, entanglement with fishing gear, and possible competition with marine mammals for prey species;
- increased risk of contaminants such as oil or fuel spills from vessel traffic being released into marine environments; and
- increased potential for conflicts between humans and polar bears.

Perhaps the most obvious impact to the environment resulting from climate change in the Arctic has been the retreat of the polar pack ice. Stroeve et al. (2008) reported a declining trend in the extent of Arctic sea ice since 1953. The extent of Arctic sea ice declined to an unprecedented low in 2007 which was a 23% reduction from the previous low in 2005.

Polar bears and ringed seals are year–round residents of the Arctic that rely on the polar pack ice. Ringed seals excavate breathing holes and lairs in the ice which are used for resting, giving birth, and during pup
weaning. Ringed seals also use the pack ice for resting during their annual molt. Polar bears feed primarily on ringed seals and female polar bears build winter dens on ice and land to give birth (Bentzen et al. 2007; Bergen et al. 2007; Fischbach et al. 2007). Earlier melting of sea ice in spring may result in exposure of ringed seal lairs making seals more susceptible to polar bear predation, reduce the availability of molting habitat, and result in reduced growth rate and survival of pups. A reduction in the ringed seal population could reduce availability of food for polar bears and affect polar bear survival. Early melting may also have the potential to cause polar bear dens to collapse reducing survival of cubs and adult females.

It is likely that some effects of global warming on polar bears have already been observed. Regehr et al. (2006) reported reduced survival of polar bear cubs in the southern Beaufort Sea region of the U.S. and Canada that appeared to be related to warming conditions in the Arctic. Regehr et al. (2006) also reported a reduction in the body weight and skull size of adult male polar bears captured from 1990 to 2006 compared to bears captured prior to 1990. The smaller stature of adult males was notable since it corresponded with higher mean age of the captured male bears. Relatively high numbers of polar bears were seen along the Beaufort Sea coast in 2007 and 2008 and the Chukchi Sea coast in 2008. Most of these bears were seen during periods when vessels were not actively working or during aerial surveys. Movement of polar bears to coastal areas has been suggested as an early result of climate warming and has been predicted to increase as the climate warms and the pack ice retreats. The USFWS has recently listed the polar bear as threatened under the Endangered Species Act (USFWS 2008b). USGS information from nine recent studies presenting the relationships of polar bears to present and future sea–ice environments is available online at http://www.usgs.gov/newsroom/special/polar_bears/.

Changes in the extent of the pack ice will likely result in changes in the distribution and abundance of ringed seals, polar bears, and other marine mammals. Pacific walruses and bearded seals move with the ice edge from the Bering Sea during the winter to the Chukchi Sea (and Beaufort Sea for bearded seal) in the spring and summer. Walruses and bearded seals feed primarily on benthic invertebrates and the ice edge provides them with a platform for resting adjacent to feeding habitat. Pacific walruses and bearded seals probably feed in relatively shallow water to ~80 m (87 yd) in depth although deeper dives have been recorded (Fay and Burns 1988).

Pacific walruses (and possibly bearded seals) are probably more common in the Chukchi Sea than the Beaufort Sea due to the greater concentrations of benthic biomass in the Chukchi Sea (Dunton et al. 2005). Most of the Chukchi Sea is relatively shallow with depths generally <50 m (<164 ft) providing extensive feeding habitat for benthic–feeding marine mammals. Pacific walruses normally haul out on ice to rest during the summer in the Chukchi Sea and generally do not haul out on land in large numbers along the Chukchi Sea coast. However, as described earlier, in summer 2007, 2009 and 2010 the pack ice retreated north of the Chukchi Sea into the Arctic Ocean where water depths were much greater and large numbers of Pacific walruses were observed hauled out along coastal locations from Barrow to Cape Lisburne. We suspect that the pack ice retreated to water too deep for walrus feeding and that the use of land–based haulouts along the Chukchi Sea coast was an effect of increasing temperatures due to climate change. How the use of land–based haulouts along the Chukchi Sea coast rather than haulout locations on the pack ice will impact walruses is unknown. However, there may be potential for mortality of young walruses to result during stampedes of large walrus groups at land–based haulouts as occurred in 2009. The USFWS was petitioned to list Pacific walrus as a threatened or endangered species under the Endangered Species Act (CBD 2008). Much of the rationale in the petition was based on the potential effects of global climate change. Pacific walrus was subsequently given candidate species status as described in Section 4.1.9.4.
The retreating pack ice may also increase the likelihood of walrus calf mortality due to cow/calf separation. Cooper et al. (2006) reported the occurrence of walrus calves that had been separated from adult female walruses on ice floes in the Canadian Arctic. Pack ice in the area had retreated and the ice floes were located in water depth of >9,840 ft (>3,000 m), well over depths within which walruses are known to feed.

How changes in environmental variables resulting from global climate change are likely to affect cetaceans in the Arctic is unknown; however, some preliminary analyses have found positive correlations between the extent of open water in bowhead whale summer feeding areas and bowhead calf production. Thus, some types of environmental changes may be beneficial to some species while other changes may have negative impacts.

Increasing temperatures could also result in changes in the distribution and abundance of cetacean prey such as fish, benthic invertebrates, and plankton, which could be beneficial if food availability increased. If prey availability increased further offshore as a result of the current warming trend, bowhead whales may move further offshore during migration and become less available to subsistence hunters. This could produce an overall benefit to the whales but could seriously impact the cultural and social traditions and activities of Native communities.

Alternatively, invasions of new species either through range expansion or as introduced species may impact the availability of various prey species via increased competition among organisms. Very few introduced species are currently known from high latitudes, probably due to environmental resistance due to cold water temperatures, seasonal fluctuations in resources, and the relative lack of human disturbance (Ruiz and Hewitt 2009). As temperatures change, environmental resistance would be lowered for some species allowing range expansion. Increased ship traffic and development of coastline and offshore structures will increase the numbers of introduced species reaching northern waters and the lower environmental resistance may increase the potential for introduced species to become established.

Other cetaceans not normally found in the Arctic could also extend their ranges northward and compete with Arctic cetaceans for food. Sightings of humpback whales, fin whales and increased numbers of harbor porpoises and Minke whales in the Chukchi and Beaufort Seas in 2007 and 2008 (Funk et al. 2007; Ireland et al. 2008; Reiser et al. 2008b; Green et al. 2007) may be an early example of such a range extension. Killer whales are known predators on beluga whales as well as on baleen whale calves and subadults, and increased numbers of killer whales in the Arctic could result in higher predation pressure on beluga, bowhead, and gray whales. MMS (2007d) concluded that the potential effects of climate change on bowhead whale populations are uncertain, and there is no current evidence of negative effects from climate change on the whales.

Interaction of the Effects of Climate Change with Other Potential Cumulative Impacts to Marine Mammals

Various types of anthropogenic activities, which are generally thought to negatively impact cetaceans and other marine mammals, are likely to increase in the Arctic if the pack ice continues to retreat. Increased vessel traffic may result from various sources such as oil and gas exploration and development, scientific research, commercial fishing, and increased shipping activity. Increased vessel traffic could increase disturbance to marine mammals resulting in displacement from preferred habitats as discussed above. However, there is no evidence that temporary displacement or changes in behavior produce impacts that would be biologically significant. Increased vessel traffic would increase the potential for marine mammal collisions with vessels which could result in mortality. Commercial fishing could also impact marine mammals through potential entanglement in gear, and trawling activities have the potential to
disturb benthic communities that serve as food sources for some marine mammals (McConnaughey et al. 2000).

**Effects of Climate Change on Marine and Coastal Birds**

Most predictions of the effects of climate change on marine and coastal birds assume that temperature increases will lead to contraction of species ranges at low latitudes, accompanied by expansion at higher latitudes. In general, climate regimes influence species distributions through species-specific physiological thresholds for tolerance of temperature and other environmental variables. As climate warms these favorable conditions are shifted towards the poles. To the extent that dispersal and resource availability allow, species are expected to track the shifting climate and shift their distributions poleward in latitude as well. Since not all species will respond to climate change at the same rate, some species may be exposed to new competitors for resources in their environment while others may have new areas open to them for colonization and expansion. These interactions may alter distributions and community structure of bird communities.

In general, there are few studies that have documented shifts in bird populations associated with climate. Most birds inhabiting the project area are migratory species that often show large fluctuations from year to year in breeding sites and phenological patterns making it difficult to document long-term shifts.

**Effects of Climate Change on Marine Fish**

Polar marine habitats are characterized by well-oxygenated waters with narrow cold temperature ranges (Rose et al., 2000). Because of their narrow temperature limits, even slight changes in polar temperatures may cause fish populations to shift their migratory patterns and geographical ranges, cold-water adapted fishes may need to seek deeper water for cooler temperatures. Depending on how the ocean currents change, if some areas become isolated and remain very cold, the potential for horizontal migration would also exist. Further, changes in prey availability due to climate factors could also result in changes in the distributions of fish populations and communities. The effects, however, of such migrations on fish foraging patterns and life history strategies are unknown (Roessig et al. 2004).

Hydrographic changes that result is changes in salinity may also affect fish distributions. At present, there is little information available on the salinity tolerances or preferences of polar fishes. If polar fishes are intolerant of wide salinity ranges (stenohaline), they will be limited to the area below the halocline or will have to migrate to more haline areas. On the other hand, these polar waters may eventually resemble the physical conditions in our present-day temperate waters. This may allow temperate fishes to colonize these areas, but such colonization may be at the expense of the polar species (Roessig et al. 2004).

Perry et al. (2005) found that the distributions of both exploited and nonexploited North Sea fishes responded markedly to recent increases in sea temperature, with nearly two-thirds of species shifting in mean latitude or depth or both over a 25 year period. For species with northerly or southerly range margins in the North Sea, half showed boundary shifts with warming, and all but one shifted northward. Species with shifting distributions had faster life cycles and smaller body sizes than nonshifting species. Similar changes have been reported in the Bering Sea (ACIA 2004, 2005) and would be expected in the Chukchi and Beaufort Seas as well.

**Effects of Climate Change on Marine Lower Trophic Organisms**

Reductions in the persistence and extent of sea ice could impact ice associated marine plankton (Clarke 1988). The lower surface of the ice and interstices in the ice are highly productive habitats for plankton which provide an important food source for herbivores both while the sea ice is in place and when it breaks up in the spring (Mellilo et al. 1990). Gulliksen and Lonne (1989) indicated that sea ice habitat
was quantitatively important to the marine food web of high latitude systems for fishes, sea birds and marine mammals. Hydrographic changes in currents, water temperatures, salinity and stratification of ocean waters may affect the productivity and distribution of plankton blooms with subsequent effects on species that utilize these organisms for food. Similarly, hydrographic changes may also alter the distributions and structures of benthic and epibenthic communities and organisms.

The exploration drilling and support activities proposed in Shell’s EP are sources of GHG emissions and will contribute additively to cumulative impacts of such emissions on climate change. However, the exploration drilling and support activities proposed in Shell's revised EP, which will take place over no more than 120 days per season, are expected to contribute an extremely small amount to overall GHG emissions into the planet's atmosphere, refer to Section 4.1.2 Air Quality. BOEMRE estimated the contribution of OCS oil and gas activities to GHG emissions in the EIS for the 2007-2012 five-year OCS leasing plan (MMS 2007d), and determined that these operations will not contribute substantively to GHG emissions in the vicinity of the planned operations. In prior studies, BOEMRE has analyzed the potential cumulative impacts of climate change (Arctic warming) in conjunction with oil and gas exploration and development activities in the Arctic, which would include the activities described in the revised Camden Bay EP (MMS 2007d). These prior analyses are incorporated herein by reference.

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. Therefore, Shell’s proposed activities would contribute a negligible amount to overall GHG emissions.

**Water Quality.** Water quality is considered to be good in the Camden Bay area, with few if any effects of past human activities. Trace metal and hydrocarbon concentrations are low (Trefry et al. 2003). Shell’s planned exploration program will have some minor effects on water quality from the disturbance of seafloor sediments during vessel anchoring, MLC construction, and from the discharge of specific drilling wastes and other discharges for the drilling vessel and support vessels (refer to Section 6.0 of the revised Camden Bay EP). These effects would be minimized by Shell’s mitigative efforts, which include the collection of, and transport of, bilge water, ballast water, domestic wastewater, sanitary waste waters, and drilling fluids and drill cuttings from the lower well sections, for onshore disposal out of region at a licensed facility. The discharge of deck drainage, desalination unit waste, cooling water, BOP fluids, excess cement, and cuttings from the MLC and upper hole sections will have minor effects on water quality, localized to the area within a few hundred yards of the drilling vessel, and temporary, lasting only hours longer than the disturbance or discharge (Section 4.1.2). Modeling has confirmed that the effects from these discharges are temporary and limited to the vicinity of the drilling vessel. Therefore, there would be no opportunity for cumulative effects when considering impacts from Shell’s Chukchi exploration activities, or other activities in the vicinity. For example, any discharges or other effects on water quality from present and reasonably foreseeable activities such as barge traffic or oil and gas activities near West Dock or coastal oil and gas facilities would also be too far removed to result in any additive effects. Any cumulative impacts to water quality are expected to be negligible. BOEMRE in its Beaufort Multi-Sale EIS concluded that sustained degradation of local and regional water quality from discharges and offshore construction activities was unlikely (MMS 2003). Thus, cumulative impacts on water quality from the EP activities are not significant.

**Sediment Quality.** Sediment quality is considered to be good in Camden Bay. Metal concentrations are low and thought to be due to terrigenous rather than anthropogenic input. Contaminated sediments are not known to occur in the area. Anthropogenic disturbances to the seafloor in the area of analysis have been few. Although sedimentation rates are low, sediments are reworked by such natural forces as ice gouging, storms, and currents, ameliorating any lasting effects of such disturbances. Anchoring and MLC construction over the course of the exploration drilling program are expected to directly disturb less than 1.2 ac (4,823 m²) of seafloor and indirectly affect some additional area. There will be some changes
in relief and sediment consistency over these areas as well as minor elevations in concentrations of some metals (Trefry and Trocine 2009). However, these elevations have not been found to exceed risk-based exposure thresholds (Trefry and Trocine 2009) or to produce discernible differences in the benthic biological communities (Dunton et al. 2009). Given the enormity of the seafloor in the area of analysis, these effects are considered negligible. Impacts on sediment quality at each of the proposed drill sites are so localized that they are not expected to affect any other drill site in Camden Bay and certainly will not have synergistic impacts with Shell’s simultaneous operations in the Chukchi Sea.

Some of these effects will last beyond the time frame of the exploration drilling program, but will be ameliorated by natural forces in 10-20 years (DTI 2003).

4.2.4 Cumulative Impacts to Biological Resources

Shell’s planned exploration drilling program will have negligible or minor and short-term effects on biological resources. Most effects on marine mammals, marine birds, and marine fish will be restricted to disturbance with associated short term changes in behavioral activities, and to temporary displacement. Disturbance factors include vessel and aircraft traffic, sound, including vessel, drilling, airguns associated with the ZVSP survey and other industrial sounds from various equipment that is required to complete the drilling, and ZVSP work. Additional impacts to air, water and sediment quality could occur from various discharges. In general, these impacts will add incrementally to the impacts of other activities that have occurred and continue to occur in the offshore areas of the North Slope of Alaska. These other activities include oil and gas exploration and production, non-oil and gas related vessel traffic, and various scientific research activities. Below we address potential cumulative effects on biological resources.

4.2.4.1 Potential Cumulative Impacts on Marine Mammals

Cumulative effects to a species or a group of species may result from the accumulation of impacts of all previous, current, and future activities that affect the species or species group on a population level. Past, present, and potential future actions that have the potential to impact marine mammals in the Beaufort Sea include: historic commercial whaling; past, current, and future subsistence hunting; previous, current, and near-term future oil— and gas—related activity; previous, current, and near-term future non-oil and gas industrial development; past, current, and near-term future research activities.

Shell’s EP activities are not expected to impact marine mammal subsistence activities in any way. There have been no known conflicts between Shell operations and subsistence activities during Shell’s exploration activities in 2006–2010, largely as a result of project timing, cessation of operations for whaling in important hunting areas, consistent communication between operators and Com Centers, and the 4MP. These important safeguards to subsistence will continue during Shell’s EP activities.

Potential cumulative effects from the proposed project on marine mammals could occur primarily due to increased vessel and aircraft traffic, and increased environmental sound from numerous industrial sources including aircraft. Benthic feeding seals in the project area could also be affected by habitat loss associated with MLC construction, and anchoring of vessels.

Commercial Whaling

Commercial whaling from 1848 to about 1915 resulted in depletion of the Bering-Chukchi-Beaufort (BCB; also known as the Western Arctic Stock) bowhead whale population. Woody and Botkin (1993) estimated that the historical population for the BCB bowhead population was likely between 10,400 and 23,000 animals prior to commercial whaling, and that about 1,000 to 3,000 whales remained in 1914. Commercial hunting was discontinued around 1915 and the current BCB bowhead population has recovered to above the lower limits of the historical population estimates. The most recent population
estimate indicated a 2001 BCB bowhead population of 10,545 whales with a confidence interval ranging from 8,200 to 13,500 (Zeh and Punt 2005). From 1978 to 2001 this population grew at ~3.4% per year (95% CI = 1.7 to 5%; George et al. 2004; Zeh and Punt 2005) and if it continued to grow at this rate, the 2008 population was over 13,000 whales.

Subsistence Whaling

The growth of the BCB bowhead whale population has continued in spite of annual Native subsistence hunts from coastal villages in Alaska and Russia. Subsistence hunts have been conducted for several thousand years, and far fewer whales are taken annually during subsistence hunts than during commercial hunting activities, when they took place. There is no evidence that past and current subsistence hunts have affected bowhead whales at the population level, and in fact, data indicate that the population has grown at 3.4% per year. Subsistence hunts for bowhead whales are managed cooperatively by the NMFS, the International Whaling Commission (IWC), and the AEWC under the Whaling Convention Act. Under the preferred alternative of an EIS prepared by NMFS (2008), the AEWC would be granted an annual strike quota of 67 bowhead whales, not to exceed a total of 255 landed whales over the five year period 2008 through 2012, with no more than 15 unused strikes from the previous year added to the annual strike quota. This alternative would continue management of the bowhead subsistence hunt as in the recent past. The annual average subsistence take by Natives of Alaska, Russia and Canada was 42.4 bowhead from 2002-2006 (Angliss and Allen 2009). Because current technology has increased the efficiency of subsistence hunts and fewer whales have been struck and lost during recent years than during the early years of the hunt (Suydam and George 2004), the BCB bowhead population is expected to increase under the current quota system. Subsistence hunting does not appear to have affected bowhead whales at the population level, and NMFS (2008) rated the overall impact of the bowhead subsistence hunt under the preferred alternative as negligible.

Angliss and Allen (2009) reported that on average Alaska Natives landed 25 beluga whales annually from 2002 through 2006 in the Beaufort Sea. No information was given on the locations of the beluga whale subsistence hunts in the Alaskan Beaufort Sea or which villages participate in the hunts. Angliss and Allen (2009) also reported that the annual subsistence harvest of belugas in the Canadian Beaufort Sea averaged 114 whales during the five–year period 2002 through 2006. These harvest numbers for the Alaskan and Canadian Beaufort Seas include only landed animals and do not account for animals struck and lost. The minimum population estimate for the Beaufort Sea beluga population is 32,453 based on an aerial survey conducted in 1992 with a correction factor of 2 to account for availability bias (Angliss and Allen 2009). Because the 1992 survey covered only a small part of the summer range of Beaufort Sea belugas (Richard et al. 1997, 2001), it is likely that the population is much larger than the minimum population estimate.

Subsistence hunts for beluga whales occur annually at Point Lay on the Chukchi Sea coast and opportunistically at other locations in Alaska. The removal of beluga whales from the Eastern Chukchi Sea stock by Alaska Natives during subsistence activities averaged 59 whales annually from 2002–2006 not including animals struck and lost (Angliss and Allen 2009). Most of these whales were probably harvested by villagers from Point Lay. In 2007 ~70 beluga whales were harvested south of Point Hope by villagers at Kivalina in late July. Beluga whales had not been seen in large numbers in this area since the mid–1990s. There was speculation that seismic activities had helped drive the whales close to shore but the harvest in July occurred well before the beginning of seismic activities in the Chukchi Sea in late August.

The most recent estimate of the size of the Chukchi Sea beluga population is 3710 whales (Angliss and Allen 2009) although some evidence (Suydam et al. 2001) suggests overlap in the range of this population with the larger Beaufort Sea population estimated at nearly 40,000 whales. Subsistence harvest of beluga
whales in the Chukchi Sea does not appear to affect this species on a population level, although subsistence hunting of other beluga whale stocks may have had population level impacts.

**Other Marine Mammal Subsistence Hunting**

Native communities also conduct subsistence hunts for other marine mammal species including ringed, bearded, and spotted seals, and Pacific walrus. Seals are much less high-profile species than bowhead whales, and subsistence hunts for seals are less regulated. No current annual estimates of the numbers of ice seals (ringed, bearded, and spotted seals) taken during subsistence hunts are available. The ADF&G collected subsistence data on annual seal harvests that were based on information collected prior to 2000 (Angliss and Allen 2009). The estimates for annual subsistence harvests of ringed, bearded and spotted seals were 9,567, 6,788, and 5,265, respectively. The current population estimates for each of these seal species is in the hundreds of thousands, and current level of subsistence harvests are not expected to affect these species at population levels.

The size of the Pacific walrus population is not known with certainty, but the species is uncommon in the Beaufort Sea. Pacific walruses have been hunted commercially in the past, and it is likely that the population has fluctuated markedly (Angliss and Allen 2009). The actual numbers of walruses currently harvested during subsistence hunts are unknown. The USFWS bases its current estimate of the annual Pacific walrus harvest on the average number of walruses harvested during the 5-year period 1996–2000 resulting in an annual estimated harvest of 5,789 animals. Although there are no current estimates of the size of the Pacific walrus population, estimates of the population from 1975–1990 ranged from ~200,000 to 246,000 animals (Angliss and Allen 2009). Recent declines in sea–ice concentration in the Arctic have raised concerns for walruses due to their reliance on the use of pack ice for haulouts near feeding areas in summer. It is thought that declines in the pack ice might result in poorer nutritional health of walrus and declines in the population.

Subsistence and sport hunting of the southern Beaufort Sea population of polar bears has occurred in Alaska and Canada. The greatest harvest numbers were reported in the mid- to late 1960s when aerial hunting was permitted (Angliss and Allen 2009). Aerial hunting was prohibited in 1972, and current harvest levels are much lower. A management agreement between the Canadian Inuit and the Alaskan Inupiat regulating polar bear hunts has been in place since 1988. The harvest in Canada is regulated by a quota system and in Alaska by voluntary actions of local hunters. The combined annual harvest of southern Beaufort Sea polar bears in Alaska and Canada was 51.8 animals for the period 1995–2000 (Angliss and Allen 2009).

**Vessel Activity**

As described above, since at least 2006, when Shell began accumulating data in the Beaufort Sea, there has been a general increase in vessel traffic, though there is high annual variation since some activities may only occur for one or two years. Most vessel traffic in the Beaufort Sea has been associated with oil and gas exploration and development, though non-oil and gas traffic appears to have increased as well. Shell’s current exploration plan to drill exploration wells in Camden Bay beginning in 2012 will increase vessel traffic in the Beaufort Sea during those years, assuming that other traffic levels generally remain at similar levels. If drilling in Camden Bay is successful and Shell finds economically viable oil and gas prospects, future development of those prospects would also increase vessel traffic in the area. Currently, most vessel traffic occurs in the western portion of the Beaufort Sea between Barrow and the oil and gas developments in the Prudhoe Bay region, including the three offshore developments at Northstar, ODS, and SID. Shell’s work since 2006 has increased traffic to the east of Prudhoe Bay where relatively few vessels currently travel. Other traffic in the area includes barges that move through the Beaufort Sea into Canada, to Kaktovik, and to the onshore development at Pt. Thomson. Additionally, Coast Guard vessels and occasionally other ships travel through the area.
Incremental increases in the number of ships moving through the Beaufort Sea, increase the likelihood of ship strikes of marine mammals. Currently, such impacts are small (see Section 4.1.8) and do not affect any of the populations of marine mammals in the area. Most marine mammals avoid ships of all sizes when they are under way and even with substantial increases in the amount of ship traffic in the Beaufort Sea it is unlikely that ship strikes would increase to a point where they would affect any marine mammal populations.

**Marine Sounds**

Shell’s proposed activities beginning in 2012 will introduce industrial sounds into the marine environment from drilling operations, anchor handling, ice management, ZVSP airgun surveys, and vessel and aircraft traffic. These sounds contribute additively to other industrial sounds that enter the Beaufort Sea marine environment from oil and gas production drilling and facility maintenance at Northstar, ODS and SID, island construction and maintenance and vessel and aircraft transit. Smaller levels of sound probably enter the water from onshore developments along the Beaufort Sea coast as well. Additionally, small boats used for recreational and subsistence activities as well as non-oil gas barge traffic contribute to in-water sound. In general, sound in the world’s oceans has increased. As described in Section 4.1, underwater sound has the potential to cause disturbance to marine organisms, particularly marine mammals.

As described in Section 4.1.8 high levels of sound in water may cause temporary or permanent hearing impairment to some species or individual marine mammals. However, the levels at which hearing impairment might occur are well above levels that are produced by all but the strongest sound sources (Southall et al. 2007). Disturbance reactions including avoidance and displacement, and masking are the most likely impacts of increased sound in the environment on marine mammals. Some behavioral changes such as temporary changes in breathing or diving rates, or avoidance behavior, may not result in biologically significant impacts to individual marine mammals or to marine mammal populations. However, disturbance that causes avoidance of preferred feeding or resting areas could affect energy budgets and result in reduced rates of adult or calf survival.

At current levels, disturbance by marine sounds associated with offshore oil and gas exploration and production are unlikely to have affected bowhead whales or other marine mammal species at the population level. Deflections of migrating whales that have been measured at Northstar Island (Richardson et al. 2008), in Camden Bay in response to seismic surveys (Funk et al. 2010), and during previous exploratory drilling (Richardson et al. 1995, Brewer et al. 1993) appear to be too small to affect whales energetically by increasing their migration distance and do not appear to have prevented whales from accessing their usual feeding areas. Additionally, deflections that have been measured do not appear to have caused whales to vary their migration path beyond the boundaries of statistically established typical or traditional routes given ice conditions in the Beaufort Sea (Blackwell et al. 2010). Further, deflections that have been measured have not affected the ability of Alaska Native hunters to successfully harvest bowhead whales since the adoption of conflict avoidance measures; whale quotas in most years have been reached despite various industry operations. Lastly, the populations of marine mammals in the Beaufort Sea appear to be stable (beluga whale, harbor porpoise, gray whale, ringed, spotted and bearded seal) or increasing (bowhead whale).

Current offshore oil and gas development in the Beaufort Sea is located relatively nearshore. Future development further offshore may have the potential to affect migrating bowhead and beluga whales. Sound resulting from vessel traffic and industrial activities associated with offshore exploration and development may have greater potential to impact migrating whales than sound resulting from production activities on islands or offshore platforms. Seismic operations occurring in Camden Bay at the same time
production operations have occurred at Northstar, ODS, and SID have not so far resulted in increased effects on migrating whales and have not altered local communities’ abilities to harvest whales. However, each new development will add incrementally to the potential for these effects to become great enough to impact whales or the subsistence hunts for whales. Given the long distance migration of bowhead and beluga whales that encompasses the Beaufort, Chukchi, and Bering Seas exploration and development in these other areas, including offshore development in Russia could also be contributing factors. There are currently not enough data to quantify long term changes in the sound levels in the Beaufort and Chukchi Seas, though in general, average levels of in–water sounds have probably increased with development and increases in vessel traffic supporting these developments. It is not known if multi–year exposure of marine mammals to various industrial sounds including seismic and drilling sounds from one or more seismic operations or oil and gas facilities may eventually result in impaired hearing abilities or changes in distribution or behavior though wide variation among species and individuals would be expected.

Masking can occur if ambient sound, including sound produced during industrial activities, interferes with a marine mammal’s ability to detect calls from conspecifics or predators, echolocation pulses, or other important natural sounds in the environment (Richardson et al. 1995). As sound in the environment increases, masking will become more prevalent. Shell’s proposed project in Camden Bay will incrementally contribute to masking of sounds in the environment, but it is unlikely to result in significant impacts to marine mammal species in the project area.

Current level of marine sound are not great enough to affect marine mammal populations in the project area. While it is theoretically possible that impacts could accumulate to that level in the future, it would require much greater impacts than those proposed for this project or for potential associated development, should Shell be successful in their oil and gas exploration.

**Habitat Loss From Construction of MLCs and Mooring of Vessels**

A small amount of seafloor habitat will be lost from construction of MLCs and mooring and anchoring of vessels. This habitat loss will be insignificant when compared to the amount of available similar habitat in the Beaufort Sea, but will contribute additively to seafloor habitat loss from other development projects including island and platform construction, subsea pipeline construction and other activities associated with oil and gas and other industrial development. This habitat loss affects marine mammals through the loss of feeding habitat for benthic feeders (gray whale and bearded seals). The loss added by this project will be so small that it is unlikely to have any effect on these species.

**Potential Changes in Water and Air Quality**

The proposed project will have localized affects on air and water quality in the project area and these will contribute to a very small degree to changes in air and water quality in the North Slope offshore ecosystems as well as to global phenomena such as climate change. These small impacts will not affect marine mammals except through large scale changes such as climate change discussed in more detail in Section 4.2.3 under Climate Change.

**Potential Cumulative Impacts on Migratory Marine Mammals**

Several marine mammal species that occur in the proposed project area are migratory species, therefore consideration has been given to the effects of potential disturbances that these species could encounter anywhere along their migration routes. Sources of cumulative impacts considered in this analysis include marine traffic, commercial fisheries, offshore and nearshore development (related to oil and gas operations, as well as other industries, including tidal power generation and marine construction projects), mining, hunting, invasive species, and military exercises.
Table 4.2.4-1 summarizes a complete, one-year migratory cycle for each marine mammal species that may be encountered during EP activities. For each species, the table outlines specific geographic regions and habitats that are occupied during different periods of the year and identifies sources of potential impacts that individuals might encounter during their migratory cycle. The sources of potential impacts were derived from a global list of developments and activities occurring in offshore and coastal environments. However, developments and activities with the potential to impact migratory marine mammal species are often localized and concentrated in relatively small areas of the oceans as opposed to encompassing entire geographic regions or habitat types. Individual marine mammals may or may not encounter any of the potential impacts from the list of those addressed in Table 4.2.4-1. Additionally, some animals are likely to avoid industrial activities and other potential sources of disturbance (Richardson et al. 1995, 1999; Stone 2003; Gordon et al. 2004; Smultea et al. 2004). It is highly unlikely that individuals from any migratory marine mammal species would experience all of the potential impacts considered in this analysis due to the localized nature of development and activity in their vast ocean environment and the tendency for many animals to avoid sources of disturbance. For all of these reasons, while some individual mammals may experience multiple activities during migration, the cumulative impacts on migratory marine mammal species found in the project area are not expected to result in population-level effects for any species or stock.
### Table 4.2.4-1 Summary of Potential Cumulative Impacts to Migratory Marine Mammal Species During EP Activities

<table>
<thead>
<tr>
<th>Species</th>
<th>Potential presence during EP activities</th>
<th>Feeding/Summering Grounds</th>
<th>Migration Route</th>
<th>Breeding/Wintering Grounds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beluga Whale</strong> <em>Delphinapterus leucas</em> 1, 2</td>
<td>Jul - Oct</td>
<td>Coastal estuaries throughout Eastern Beaufort Sea, Amundsen Gulf, Mackenzie Delta; Northeastern Chukchi Sea, Kasegaluk Lagoon, Kotzebue Sound, Norton Sound, Yukon Delta, Bristol Bay, Kichak &amp; Nushagak Bays</td>
<td>Apr - Sep</td>
<td>Throughout coastal and offshore Bering, Chukchi and Beaufort Seas</td>
</tr>
<tr>
<td><strong>Bowhead Whale</strong> <em>Balaena mysticetus</em> 3</td>
<td>Jul - Oct</td>
<td>U.S. and Canadian Beaufort Sea, Mackenzie Delta, Amundsen Gulf, few individuals may summer in eastern Chukchi Sea</td>
<td>May - Oct</td>
<td>Spring - coastal and offshore Bering, Chukchi and Beaufort Seas; Fall - waters over continental shelf in Beaufort Sea, entire eastern and western Chukchi Sea, including waters of northeastern Russia</td>
</tr>
<tr>
<td><strong>Gray Whale</strong> <em>Eschrichtius robustus</em> 1, 4, 7</td>
<td>Jul - Oct</td>
<td>Shallower waters of western Beaufort Sea, throughout Bering and Chukchi Seas, Northern Gulf of Alaska, occasionally eastern Beaufort Sea</td>
<td>May - Nov</td>
<td>Coastal waters along west coast of North America</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact</th>
<th>Potential Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 noise</td>
<td>Offshore Development C1 Oil &amp; gas rig - noise</td>
</tr>
<tr>
<td>A2 collision risk</td>
<td>Offshore Development C2 Oil &amp; gas rig - effluent discharge</td>
</tr>
<tr>
<td>A3 pollution</td>
<td>Offshore Development C3 Oil &amp; gas rig - toxin release</td>
</tr>
<tr>
<td>B1 Entanglement</td>
<td>Nearshore Development D1 Oil &amp; gas rig - noise</td>
</tr>
<tr>
<td>B2 Competition for prey</td>
<td>Nearshore Development D2 Oil &amp; gas rig - effluent discharge</td>
</tr>
<tr>
<td>B3 Pollution</td>
<td>Nearshore Development D3 Oil &amp; gas rig - toxin release</td>
</tr>
<tr>
<td>B4 Habitat degradation (trawling)</td>
<td>Nearshore Development D4 Exclusion from habitat</td>
</tr>
<tr>
<td></td>
<td>Nearshore Development D5 Land reclamation</td>
</tr>
<tr>
<td></td>
<td>Nearshore Development D6 Dredging</td>
</tr>
<tr>
<td>B Commercial Fisheries</td>
<td>Nearshore Development C7 Tidal power generators</td>
</tr>
<tr>
<td>C Marine Traffic</td>
<td>Nearshore Development D7 Tidal power generators</td>
</tr>
<tr>
<td>D Nearshore Development</td>
<td>Offshore Development E1 Solution - direct</td>
</tr>
<tr>
<td>E Mining</td>
<td>Offshore Development E2 Solution - effects on prey</td>
</tr>
<tr>
<td>F Hunting</td>
<td>Offshore Development E3 Solution - habitat degradation</td>
</tr>
<tr>
<td>G Invasive Species/Range Expansion</td>
<td>Offshore Development F1 Subsistence harvest</td>
</tr>
<tr>
<td>H Military</td>
<td>Offshore Development F2 Illegal poaching</td>
</tr>
<tr>
<td>I Unexploded ordnance</td>
<td>Offshore Development F3 Explosive training exercises</td>
</tr>
</tbody>
</table>
### Table 4.2.4-1
Summary of Potential Cumulative Impacts to Migratory Marine Mammal Species During EP Activities (Continued)

<table>
<thead>
<tr>
<th>Species</th>
<th>Potential presence during EP activities</th>
<th>Feeding/Summering Grounds</th>
<th>Migration Route</th>
<th>Breeding/Wintering Grounds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minke whale</strong> <em>Balaenoptera acutorostrata</em> 1</td>
<td>Apr - Nov, timing likely sea ice dependent</td>
<td>A (1-3), B (1-4), C (1-3), D (1-3), E (1-3), F (1-2), G (1-2), H (1-3)</td>
<td>Throughout Bering and Chukchi seas, route and timing likely sea ice dependent</td>
<td>A (1-3), B (1-4), C (1-3), D (1-6), E (1-3), F (1-2), G (1-2), H (1-3)</td>
</tr>
<tr>
<td><strong>Humpback Whale</strong> <em>Megaptera novaeangliae</em> 1, 4</td>
<td>Apr - Nov, timing likely sea ice dependent</td>
<td>A (1-3), B (1-4), C (1-7), D (1-7), E (1-3), F (1-2), G (1-2), H (1-3)</td>
<td>Throughout the North Pacific, generally along west coast of North America, east coast of Asia, and in the central North Pacific Ocean between Hawaii and Alaska</td>
<td>A (1-3), B (1-4), C (1-7), D (1-7), E (1-3), F (1-2), G (1-2), H (1-3)</td>
</tr>
<tr>
<td><strong>Fin Whale</strong> <em>Balaenoptera physalus</em> 4</td>
<td>Apr - Nov, timing likely sea ice dependent</td>
<td>A (1-3), B (1-4), C (1-7), D (1-7), E (1-3), F (1-2), G (1-2), H (1-3)</td>
<td>Not well defined, may range throughout North Pacific Ocean and Bering Sea</td>
<td>A (1-3), B (1-4), C (1-7), D (1-7), E (1-3), F (1-2), G (1-2), H (1-3)</td>
</tr>
<tr>
<td><strong>Killer Whale</strong> <em>Orcinus Orca</em> 5, 6</td>
<td>Apr - Nov, timing likely sea ice dependent</td>
<td>A (1-3), B (1-4), C (1-7), D (1-7), E (1-3), F (1-2), G (1-2), H (1-3)</td>
<td>Not well defined</td>
<td>A (1-3), B (1-4), C (1-3), D (1-5), E (1-3), F (1-2), G (1-2), H (1-3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activities</th>
<th>A Marine Traffic</th>
<th>B Commercial Fisheries</th>
<th>C Offshore Development</th>
<th>D Nearshore Development</th>
<th>E Mining</th>
<th>G Invasive Species/Range Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 noise</td>
<td>C1 Oil &amp; gas rig - noise</td>
<td>C4 Exclusion from habitat</td>
<td>C7 Tidal power generators</td>
<td>D1 Oil &amp; gas rig - noise</td>
<td>E1 Reduction - direct</td>
<td>G1 Competition for resources</td>
</tr>
<tr>
<td>A2 collision risk</td>
<td>C2 Oil &amp; gas rig - effluent discharge</td>
<td>C5 Marine seismic survey - noise</td>
<td>C8 Marine seismic survey - entanglement</td>
<td>D2 Oil &amp; gas rig - effluent discharge</td>
<td>E2 Reduction - affects on prey</td>
<td>G2 Disease</td>
</tr>
<tr>
<td>A3 pollution</td>
<td>C3 Oil &amp; gas rig - toxic release</td>
<td>C6 Marine seismic survey - noise</td>
<td>C9 Tidal power generators</td>
<td>D3 Oil &amp; gas rig - toxic release</td>
<td>E3 Reduction - habitat degradation</td>
<td>G3 Disease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B1 Entanglement</th>
<th>B2 Competition for prey</th>
<th>B3 Pollution</th>
<th>B4 Habitat degradation (trawling)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Entanglement</td>
<td>B2 Competition for prey</td>
<td>B3 Pollution</td>
<td>B4 Habitat degradation (trawling)</td>
</tr>
</tbody>
</table>

**Notes:**
- * indicates critical or endangered species.
- 1-6 indicate potential impacts during EP activities.

**Species:**
- Minke whale *Balaenoptera acutorostrata*
- Humpback whale *Megaptera novaeangliae*
- Fin whale *Balaenoptera physalus*
- Killer whale *Orcinus Orca*
<table>
<thead>
<tr>
<th>Potential presence during EP activities</th>
<th>Feeding/Summering Grounds</th>
<th>Migration Route</th>
<th>Breeding/Wintering Grounds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Harbor Porpoise</strong> <em>Phocoena phocoena</em></td>
<td>Coastal Bering and Chukchi Seas and occasionally Beaufort Sea</td>
<td>Apr - Nov, timing likely sea ice dependent</td>
<td>A (1-3), B (1-4), C (1-6), D (1-6), E (1-4), G (1-2), H (1-3)</td>
</tr>
<tr>
<td><strong>Ringed Seal</strong> <em>Pusa hispida</em></td>
<td>Throughout Chukchi and Beaufort seas, associated with sea ice</td>
<td>Jul - Oct</td>
<td>A (1-3), C (1-6), D (1-6), E (1-3), F1, G (1-2)</td>
</tr>
<tr>
<td><strong>Spotted Seal</strong> <em>Phoca largha</em></td>
<td>Throughout Chukchi and Beaufort seas, use coastal haulouts, Colville River delta</td>
<td>Jul - Oct</td>
<td>A (1-3), C (1-6), D (1-6), E (1-3), F1, G (1-2)</td>
</tr>
<tr>
<td><strong>Bearded Seal</strong> <em>Erignathus barbatus</em></td>
<td>Throughout Chukchi and Beaufort seas, associated with sea ice, some remain offshore in Bering Sea</td>
<td>Jun - Nov</td>
<td>A (1-3), B (1-4), C (1-6), D (1-6), E (1-4), F1, G (1-2)</td>
</tr>
<tr>
<td><strong>Ribbon Seal</strong> <em>Phoca fasciata</em></td>
<td>Bering, Chukchi Seas, Arctic basin</td>
<td>Jul - Oct</td>
<td>A (1-3), B (1-4), C (1-6), D (1-6), E (1-3), F1, G (1-2)</td>
</tr>
</tbody>
</table>

A Marine Traffic
A1 noise
A2 collision risk
A3 pollution

B Commercial Fisheries
B1 Entanglement
B2 Competition for prey
B3 Pollution
B4 Habitat degradation (trawling)

C Offshore Development
C1 Oil & gas rig - noise
C2 Oil & gas rig - effluent discharge
C3 Oil & gas rig - toxin release
C4 Exclusion from habitat
C5 Marine seismic survey - noise
C6 Marine seismic survey - entanglement
C7 Tidal power generators

D Nearshore Development
D1 Oil & gas rig - noise
D2 Oil & gas rig - effluent discharge
D3 Oil & gas rig - toxin release
D4 Exclusion from habitat
D5 Land reclamation
D6 Dredging
D7 Tidal power generators

E Mining
E1 Pollution - direct
E2 Pollution - effects on prey
E3 Pollution - habitat degradation

F Hunting
F1 Subsistence harvest
F2 Illegal poaching

G Invasive Species/Range Expansion
G1 Competition for resources
G2 Disease
H Military
H1 Unexploded ordnance
H2 Naval mid-frequency sonar exercises
H3 Explosive training exercises
Table 4.2.4-1  
Summary of Potential Cumulative Impacts to Migratory Marine Mammal Species During EP Activities (Continued)

<table>
<thead>
<tr>
<th>Potential presence during EP activities</th>
<th>Feeding/Summering Grounds</th>
<th>Migration Route</th>
<th>Breeding/Wintering Grounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacific Walrus* Odobenus rosmarus 1, 4</td>
<td>Continental shelf waters of Chukchi Sea, occasionally Beaufort Sea and East Siberian Sea, occasionally use terrestrial haulouts when ice unavailable</td>
<td>Jun - Nov</td>
<td>A (1-3), B (1-6), C (1-3), D (1-6), E (1-3), F1, G (1-3)</td>
</tr>
<tr>
<td>Polar bear* Ursus maritimus 1, 8</td>
<td>Associate with pack ice in the Beaufort and Chukchi seas; congregate around bowhead whale carcasses on shore and barrier islands following subsistence harvests</td>
<td>Jul - Nov</td>
<td>A (1-3), C (1-6), D (1-6), E (1-3), F (1-3), G (1-2)</td>
</tr>
</tbody>
</table>

A  Marine Traffic  
A1 noise  
A2 collision risk  
A3 pollution  
B  Commercial Fisheries  
B1 Entanglement  
B2 Competition for prey  
B3 Pollution  
B4 Habitat degradation (trawling)  
* Threatened or Endangered under the Endangered Species Act  
** Candidate species for listing under the Endangered Species Act  
† Ruled warranted but precluded from listing under the Endangered Species Act  
1 Reeves et al. 2002.  
2 Frost and Lowry 1990.  
3 Moore and Reeves 1993.  
4 Allen and Angellis 2010.  
5 Leatherwood et al. 1986.  
7 Rugh and Frair 1981.  
8 Stirling 2002.  
4 Moore and Reeves 1993.  
5 Leatherwood et al. 1986.  
7 Rugh and Frair 1981.  
8 Stirling 2002.
4.2.4.2 Potential Cumulative Impacts on Marine and Coastal Birds

Potential cumulative effects from the proposed project on marine and coastal birds would occur primarily from increased vessel traffic, potential for collisions with vessels and structures, and increased environmental sound from numerous industrial sources including aircraft. Other impacts described (Section 4.1.7) are unlikely to have any cumulative effects on bird species using the project area.

Vessel Traffic

As described above for marine mammals this project will contribute to an increase in vessel traffic in the eastern Beaufort Sea where the project is located and throughout the Beaufort Sea in general. As described in Section 4.1.7, lighted vessels and structures in open waters pose a collision risk to many species of birds, as growing scientific evidence indicates some bird species are attracted to certain light sources. Most studies note that increased darkness, foggy and misty conditions, or low cloud cover increases this attraction. Birds drawn to these artificial lights often become disoriented and collide with structures and incur injury and increased mortality. Increased vessel traffic in the Beaufort Sea will incrementally increase the potential for bird strikes by ships. To reduce the risk of bird strikes, Shell will mitigate potential effects by minimizing vessel light output, using green lighting, and monitoring conditions to assess risk. These actions are proposed in the Shell Bird Strike Avoidance and Lighting Plan (EP Appendix I).

Additionally, if Shell’s exploration program is successful it may stimulate development of platforms for oil and gas production facilities as well as additional exploration all of which would increase the potential for bird strikes of facilities. This would be particularly true for facilities constructed in or along major migration routes of birds, primarily in nearshore areas (e.g., barrier islands and coastal lagoons) where bird densities typically are higher than in areas further offshore.

Sound

As described above for marine mammals Shell’s proposed activities beginning in 2012 will introduce industrial sounds into the environment from drilling operations, anchor handling, ice management, ZVSP airgun surveys, and vessel and aircraft traffic. These sounds contribute additively to other industrial and non-industrial sounds. Birds react to in-air sounds associated with various activities by flushing and moving away from the sound source. If sound in an area increased enough it is possible that birds might abandon use of the area. If that area was preferred feeding, molting, or brood-rearing habitat population level consequences for those species might occur.

Current levels of in-air sound are not great enough to cause abandonment of coastal or marine bird habitat on the North Slope. While it is theoretically possible that impacts could accumulate to that level in the future it would require much greater impacts than those proposed for this project or for potential associated development should Shell be successful in their oil and gas exploration. Most bird species using North Slope habitats are migratory and are often exposed to greater levels of sound in other portions of their habitat than they are exposed to on the North Slope.

Potential Changes in Water and Air Quality

The proposed project will have localized affects on air and water quality in the project area and these will contribute to a very small degree to changes in air and water quality in the North Slope offshore ecosystems as well as to global phenomena such as climate change. These small impacts will not affect marine and coastal birds except through large scale changes such as climate.
4.2.4.3 Potential Cumulative Impacts on Migratory Marine and Coastal Birds

As discussed in Section 3.6, marine and coastal bird species with the potential to be impacted by EP activities are migratory. These species spend the summer months in northern latitudes and overwinter to the south, often in offshore or coastal areas. Migratory bird species could be impacted by activities or events outside the Camden Bay project area and these impacts would be additive to or interactive with impacts from within the project area. Potential impacts from activities and events outside Camden Bay that were considered for this analysis included those that were discussed above in Section 4.2.2, Past, Present, and Reasonably Foreseeable Activities, as well as inland development, competition with invasive species, and military operations. These additional considerations represent sources of potential impacts that migratory bird species may encounter during periods when they are away from the project area.

Table 4.2.4-2 summarizes a complete, one-year migratory cycle for bird species that are most likely to be encountered during EP activities. For each species, the table outlines specific geographic regions and habitats that are occupied during different periods of the year and identifies sources of potential impacts that individuals might encounter during their migratory cycle. The sources of potential impacts were derived from a global list of developments and activities occurring in offshore, coastal, and continental environments. However, developments and activities with the potential to impact migratory bird species are often localized and concentrated in relatively small areas as opposed to encompassing entire geographic regions or habitat types. Individual birds may or may not encounter any of the potential impacts from the list of those addressed in Table 4.2.4-2. Additionally, many marine and coastal birds have been reported to be relatively tolerant of potential sources of disturbance or known to habituate to such sources (Rodgers and Schwikert 2002; Johnson 1984; Kuletz 1996; Speckman et al. 2004). It is highly unlikely that individuals from any migratory bird species would experience all of the potential impacts considered in this analysis due to the localized nature of development and the tendency for many animals to habituate to or be tolerant of developments. For all of these reasons, while some individual birds may experience multiple activities during migration, the cumulative impacts on migratory bird species found in the project area are not expected to result in population-level effects for any species.

Federally-listed bird species from the region (Steller’s and spectacled eiders, yellow-billed loon) were included in this analysis, however, these species are uncommon in the project area. The list of species presented in Table 4.2.4-2 is not exhaustive; however, other migratory bird species are less common in the project area and few, if any, individuals from these species are likely to be encountered. Additionally, cumulative impacts on any other migratory marine or coastal bird species would be similar to those for species addressed in detail Table 4.2.4-2.
<table>
<thead>
<tr>
<th>Species</th>
<th>Potential Presence during EP Activities</th>
<th>Breeding / Summer Habitats</th>
<th>Migration Summary</th>
<th>Winter Habitats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Timing</strong></td>
<td><strong>Location</strong></td>
<td><strong>Timing</strong></td>
<td><strong>Route / Location</strong></td>
</tr>
<tr>
<td>Red-throated Loon (<em>Gavia stellata</em>)</td>
<td>Jul - Sep</td>
<td>Shores of small tundra ponds along Beaufort Sea coast in Alaska and Yukon and most of Northwest Territories including Canadian Arctic Archipelago north to northern Ellesmere Island; offshore waters</td>
<td>Late May - Sep</td>
<td>A, C, D, E, F, G</td>
</tr>
<tr>
<td>Pacific Loon (<em>Gavia pacifica</em>)</td>
<td>Jul - late Aug / early Sep</td>
<td>Prefers islands on large tundra ponds along Beaufort Sea coast in Alaska and Canada and Banks Island and southern Victoria Island in Canada; offshore waters</td>
<td>Jun - late Aug</td>
<td>A, C, D, E, F, G</td>
</tr>
<tr>
<td>Yellow-billed Loon† (<em>Gavia adamsii</em>)</td>
<td>Jul - late Aug / early Sep</td>
<td>Along large, deep tundra lakes in Alaska and Yukon; North Slope from Point Barrow to Herschel Island; Colville River Delta; barren grounds east of Mackenzie River Delta and Banks, Victoria, and Prince of Whales Islands; offshore waters</td>
<td>May - Aug</td>
<td>A, C, D, E, F, G</td>
</tr>
<tr>
<td>Common Eider (<em>Somateria mollissima</em>)</td>
<td>Jul - Sep</td>
<td>Circumpolar distribution; breeds at scattered locations across entire Arctic coast mostly on barrier islands and spits, also south along Pacific coast to Kodiak Island; offshore waters</td>
<td>May - Sep</td>
<td>A, C, D, E, F, G</td>
</tr>
</tbody>
</table>

† indicates species classified as "Warranted but Precluded" by higher-priority species for listing under Endangered Species Act; uncommon in project area.

"Potential Impacts" categories: A) Vessel/Aircraft Traffic; B) Commercial Fisheries; C) Oil and Gas Offshore Development; D) Non-oil and Gas Offshore Development; E) Inland Development; F) Hunting; G) Competition with Invasive Species; H) Military Operations.
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Timing</td>
<td>Location</td>
<td>Timing Potential Impacts</td>
<td>Route / Location</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>King Eider (Somateria spectabilis)</td>
<td>Jul - Sep</td>
<td>Tundra away from coastal fringe from Colville River Delta east to Canadian Arctic Archipelago; also Bering Sea on St. Lawrence and St. Matthew islands; records for nesting on NW coast of AK as well; offshore waters</td>
<td>May - Sep A, C, D, E, F, G</td>
<td>Spring and Fall: coastal Alaska; Spring: along open leads in ice</td>
</tr>
<tr>
<td>Spectacled Eider* (Somateria fischeri)</td>
<td>Jul - Sep</td>
<td>Arctic Coastal Plain NW Alaska to Yukon-Kuskokwim Delta tundra near water; localized areas of higher density near Colville River and Prudhoe Bay; offshore waters</td>
<td>Late May - Aug A, C, D, E, F, G</td>
<td>Spring: possibly along ice leads, close to mountains and along river drainages; Fall: some over coastal plains close to Brooks Range</td>
</tr>
<tr>
<td>Steller's Eider* (Polysticta stelleri)</td>
<td>Jul - Sep</td>
<td>Yukon Delta, St. Lawrence Island and Hooper Bay area north to Pt Barrow and east to Demarcation Bay, on coast near areas of deep water offshore</td>
<td>Early Jun - Jul (males); early Jun Sep (females) A, C, D, E, F, G</td>
<td>Spring: offshore along major ice leads; Fall: along northwest coast of Alaska to Bering Strait and then along coast to winter habitats</td>
</tr>
</tbody>
</table>

* indicates species listed as "threatened" under Endangered Species Act; uncommon in project area

"Potential Impacts" categories: A) Vessel/Aircraft Traffic; B) Commercial Fisheries; C) Oil and Gas Offshore Development; D) Non-oil and Gas Offshore Development; E) Inland Development; F) Hunting; G) Competition with Invasive Species; H) Military Operations
Table 4.2.4-2  Summary of Potential Cumulative Impacts to Migratory Bird Species Most Likely to be Encountered During EP Activities (federally-listed species found in the region are also shown; however, these species are uncommon in the project area) (Continued).

<table>
<thead>
<tr>
<th>Species</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Timing</td>
<td>Location</td>
<td>Timing</td>
<td>Potential Impacts</td>
</tr>
<tr>
<td>Pomarine Jaeger (Stercorarius pomarinus)</td>
<td>Jul - late Aug / early Sep</td>
<td>Low/wet tundra on North Slope of Alaska, northern Canada, northern Siberia, dependent on availability on lemmings as primary food source; offshore waters</td>
<td>Late May - Aug A, C, D, E, F, G</td>
<td>Spring: migrate north over open ocean and along coastal Alaska in Arctic; some inland migration along Colville River valley and across Arctic Coastal Plain; Fall: generally offshore</td>
</tr>
<tr>
<td>Parasitic Jaeger (Stercorarius parasiticus)</td>
<td>Jul - late Aug / early Sep</td>
<td>Holarctic coastal areas from southern Alaska to Labrador, primarily on coastal tundra</td>
<td>Late May - Aug A, C, D, E, F, G</td>
<td>Spring: migrate northward at sea on route that parallels coast, some inland migration as well; Fall: generally offshore</td>
</tr>
<tr>
<td>Long-tailed Jaeger (Stercorarius longicaudus)</td>
<td>Jul - late Aug / early Sep</td>
<td>Inland of coastal tundra from NW AK to Baffin Island</td>
<td>Late May - Aug A, C, D, E, F, G</td>
<td>Spring: migrate northward at sea on route that parallels the coast, some inland migration as well; Fall: generally offshore</td>
</tr>
<tr>
<td>Glaucous Gull (Larus hyperboreus)</td>
<td>Jul - Sep</td>
<td>Mainland coast from Yukon River delta to Northern Labrador on coastal ground, sandbars and cliffs</td>
<td>May - Sep A, C, D, E, F, G</td>
<td>Spring: migration near the coast following open leads in ice; Fall: follows spring migration route</td>
</tr>
<tr>
<td>Black-legged Kittiwake (Rissa tridactyla)</td>
<td>Jul - late Aug / early Sep</td>
<td>Colonies on cliffs, NE Siberia to NW Alaska, south to Sakhalin Island and the Commander and Aleutian Islands and as far south as Glacier Bay in SE Alaska</td>
<td>May - Aug A, C, D, E, F, G</td>
<td>Spring and Fall offshore, typically along ice leads</td>
</tr>
</tbody>
</table>

"Potential Impacts" categories: A) Vessel/Aircraft Traffic; B) Commercial Fisheries; C) Oil and Gas Offshore Development; D) Non-oil and Gas Offshore Development; E) Inland Development; F) Hunting; G) Competition with Invasive Species; H) Military Operations
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<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Timing</td>
<td>Location</td>
<td>Timing</td>
<td>Location</td>
</tr>
<tr>
<td>Arctic Tern (Sterna paradisaea)</td>
<td>Jul - late Aug / early Sep</td>
<td>Circumpolar distribution, coastal and inland nesting preferring ground devoid of vegetation</td>
<td>May - Aug</td>
<td>Spring and Fall: offshore, possibly completing final leg during Spring at high altitudes</td>
</tr>
<tr>
<td>Greater Scaup (Aythya marila)</td>
<td>Jul - late Aug / early Sep</td>
<td>Western Alaska (Kotzebue Sound to Kodiak Island and locally on Aleutian Islands) east across northern Yukon territory; Beaufort Sea coast, especially in Mackenzie River Delta; nest on tufts of grass near small ponds and lakes; offshore waters</td>
<td>Late May - Aug</td>
<td>Spring: overland with evidence of individuals wintering on Atlantic and Gulf coasts traveling to Yukon, Mackenzie Delta and Alaska North Slope; Pacific wintering birds likely follow a northward migration route over land; Fall: follows spring migration route</td>
</tr>
<tr>
<td>Long-tailed Duck (Clangula hyemalis)</td>
<td>Jul - Sep</td>
<td>Arctic coasts of Alaska and northern Canada, southeastern Alaska, and northwestern British Columbia, in AK nest sights are often near shallow lakes in cup-like hollows surrounded by tall grass; offshore waters</td>
<td>Late May - Aug (males); late May - Sep (females)</td>
<td>Spring: abing Pacific coast and interior along major river drainages, also abing interior routes from Great Lakes; Fall: same as spring with possibly larger offshore component</td>
</tr>
<tr>
<td>Long-tailed Duck (Clangula hyemalis)</td>
<td>Jul - Sep</td>
<td>Arctic coasts of Alaska and northern Canada, southeastern Alaska, and northwestern British Columbia, in AK nest sights are often near shallow lakes in cup-like hollows surrounded by tall grass; offshore waters</td>
<td>Late May - Aug (males); late May - Sep (females)</td>
<td>Spring: abing Pacific coast and interior along major river drainages, also abing interior routes from Great Lakes; Fall: same as spring with possibly larger offshore component</td>
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*Potential Impacts:* categories: A) Vessel/Aircraft Traffic; B) Commercial Fisheries; C) Oil and Gas Offshore Development; D) Non-oil and Gas Offshore Development; E) Inland Development; F) Hunting; G) Competition with Invasive Species; H) Military Operations
### Table 4.2.4-2
Summary of Potential Cumulative Impacts to Migratory Bird Species Most Likely to be Encountered During EP Activities (federally-listed species found in the region are also shown; however, these species are uncommon in the project area) (Continued).

<table>
<thead>
<tr>
<th>Species</th>
<th>Potential Presence during EP Activities</th>
<th>Breeding / Summer Habitats</th>
<th>Migration Summary</th>
<th>Winter Habitats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surf Scoter (Melanitta perspicillata)</td>
<td>Jul - Sep</td>
<td>Shrubland and woodland habitat from Mackenzie River Delta SE across central Mackenzie district and Northwest territories, west coast of Alaska from Kotzebue Sound to the Alaska Peninsula; offshore waters</td>
<td>Spring: overland routes from Pacific coast to Mackenzie Valley and through mountain passes in Brooks Range, from Great Lakes along cross-continent large-lake corridor; Fall: same as spring with possibly larger offshore component</td>
<td>Pacific Coast from eastern Aleutian Islands and southeastern Alaska to central Baja California and Sonora, Mexico, Great Lakes, Atlantic Coast</td>
</tr>
<tr>
<td>White-winged Scoter (Melanitta fusca)</td>
<td>Jul - late Aug / early Sep</td>
<td>Wooded or Bushy habitats south of northern limits of trees across northern Canada, Alaska from Kotzebue Sound to the Alaskan Peninsula, Central Alaska, southern Yukon Territory, central British Columbia, central Alberta and northern Saskatchewan, Eurasia from Scandinavia through northern Russia; offshore waters</td>
<td>Spring: overland into Mackenzie River Valley via routes from Atlantic coast, Great Lakes, into Alaska via overland routes from Pacific wintering areas, along Peace or Liard River drainages, along Yukon, Koyukuk, and Porcupine River drainages; Fall: similar routes as spring</td>
<td>Pacific Coast from eastern Aleutian Islands and Alaska Peninsula, Kodiak Island to Baja California, Great Lakes, Atlantic Coast, Asiatic species from Kamchatka south to Korea, eastern China and Japan</td>
</tr>
<tr>
<td>Red-necked Phalarope (Phalaropus lobatus)</td>
<td>Jul - late Aug / early Sep</td>
<td>Circumpolar in low marshy areas on low arctic tundra, coastal tundra and northern boreal zones of North America and Eurasia; offshore waters</td>
<td>Spring: across ocean and along Atlantic and Pacific coasts, also along inland prairie provinces of Canada; Fall: mostly offshore along spring routes, some travel inland along western North America</td>
<td>Offshore in South China Sea, in Indian ocean and off the coast of Peru</td>
</tr>
</tbody>
</table>

*Potential Impacts* categories: A) Vessel/Aircraft Traffic; B) Commercial Fisheries; C) Oil and Gas Offshore Development; D) Non-oil and Gas Offshore Development; E) Inland Development; F) Hunting; G) Competition with Invasive Species; H) Military Operations
### Table 4.2.4-2
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<th>Species</th>
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<th>Migration Summary</th>
<th>Winter Habitats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Phalarope (Phalaropus fulicaria)</td>
<td>Jul - late Aug / early Sep</td>
<td>Hummocky, moss-sedge tundra interspersed with numerous ponds in western Alaska across coastal Beaufort Sea region to northern Ellesmere Island; offshore waters</td>
<td>Spring: well offshore; Fall: well offshore, flocks concentrate at ice edges and ocean fronts to feed</td>
<td>Offshore of Peru and Chile, West Africa south to Cape Good Hope, possibly South China Sea</td>
</tr>
</tbody>
</table>

- * indicates species listed as "threatened" under Endangered Species Act; uncommon in project area
- † indicates species classified as "Warranted but Precluded" by higher-priority species for listing under Endangered Species Act; uncommon in project area

1 Johnson and Herter 1989
2 Larned et al. 2006

*Potential Impacts* categories: A) Vessel/Aircraft Traffic; B) Commercial Fisheries; C) Oil and Gas Offshore Development; D) Non-oil and Gas Offshore Development; E) Inland Development; F) Hunting; G) Competition with Invasive Species; H) Military Operations
4.2.4.4 Potential Cumulative Impacts on Marine Fish

Potential cumulative effects from the proposed project on marine fish could occur primarily from increased in-water sound from numerous industrial sources including aircraft and from changes to water quality. Fish are unlikely to be directly affected by increases in vessel traffic in the Beaufort Sea. Fish may be affected by indirect impacts from increases in vessel traffic such as noise or pollutant emissions from ships, but direct impacts are unlikely. Other impacts described (Section 4.1.6) are unlikely to have any cumulative effects on fish species using the project area.

Marine Sounds

As described above for marine mammals Shell’s proposed activities beginning in 2012 will introduce industrial sounds into the environment from drilling operations, anchor handling, ice management, ZVSP airgun surveys, and vessel and aircraft traffic. These sounds contribute additively to other industrial and non-industrial sounds in the marine environment of the Beaufort Sea. Fish react to in-water sounds associated with various activities by moving away from strong sounds. If sound in an area increased enough it is possible that fish might abandon use of the area. If that area was preferred habitat population level consequences for those species might occur. Airgun sounds can also affect fish health directly if they are exposed at close range (within a few yards (m) of the sound source).

Current levels of marine sound are not great enough to cause abandonment of habitat at a level that has affected fish populations of any species present in the project area. While it is theoretically possible that impacts could accumulate to that level in the future it would require much greater impacts than those proposed for this project or for potential associated development should Shell be successful in their oil and gas exploration.

Potential Changes in Water and Air Quality

The proposed project will have localized affects on air and water quality in the project area, and these will contribute to a very small degree to changes in air and water quality in the North Slope offshore ecosystems as well as to global phenomena such as climate change. These small impacts will not affect marine fish except potentially through large scale changes such as climate.

4.2.4.5 Potential Cumulative Impacts on Lower Trophic Organisms

Potential cumulative effects from the proposed project on lower trophic organisms could occur primarily from changes to water quality associated with disturbance caused by sediment plumes from MLC construction and vessel mooring and anchoring, and various permitted discharges that may change the temperature or chemical properties of the water column. Additionally, benthic organisms will be impacted by destruction of habitat associated with MLC construction and vessel mooring and anchoring in Camden Bay. Lower trophic organisms are unlikely to be directly affected by increases in vessel traffic in the Beaufort Sea. Lower trophic organisms may be affected indirectly from increases in vessel traffic by pollutant emissions from ships, but direct impacts are unlikely. Other impacts described in Section 4.1.5 such as sound have little impact on these organisms and are unlikely to have any cumulative effects species found in the project area.

Habitat Loss From Construction of MLCs and Mooring of Vessels

A small amount of seafloor habitat will be lost from construction of MLCs and mooring and anchoring of vessels. This habitat loss will be insignificant when compared to the amount of available similar habitat in the Beaufort Sea, but will contribute additively to seafloor habitat loss from other development projects including island and platform construction, subsea pipeline construction and other activities associated with oil and gas and other industrial development. This will affect lower trophic organisms through the
direct destruction and loss of available habitat. The incremental loss added by this project will be so small that it is unlikely to have any effect on populations of these species.

**Potential Changes in Water and Air Quality**

The proposed project will have localized affects on air and water quality in the project area and these will contribute to a very small degree to changes in air and water quality in the North Slope offshore ecosystems as well as to global phenomena such as climate change. These small impacts will not affect lower trophic organisms except potentially through large scale changes such as climate.

### 4.2.5 Cumulative Impacts to Subsistence

Because of the short-term and locally constrained disturbance of exploration drilling, BOEMRE concluded that no long-term permanent effects would result and no harvest areas would become unavailable to subsistence users (MMS 2003, 2007b).

Subsistence impacts from Shell’s planned exploration drilling program within the area of analysis will be minor and temporary, but the local perceptions of subsistence impacts vary (MMS 2003, 2007b, 2007c). Any activity that affects subsistence resources, subsistence use areas, or harvest activity patterns has the potential to affect subsistence users.

In general, bowhead whale and other subsistence resources may avoid areas of exploration drilling during times of active drilling, but this avoidance is temporary. As discussed above, marine mammals can be affected by sound generated by the drilling vessel and support vessels; however, any effects are minimal and temporary because marine mammals tend to naturally avoid vessels. Anticipated impacts are mitigated through the North Slope Inupiat SA program, implementation of Shell’s 4MP, and the movement of all vessels out of the area on 25 August to avoid possible impact to the subsistence whale hunts of Nuiqsut (Cross Island) and Kaktovik. Thus, with respect to the specific activities proposed in the EP, Shell does not expect to impact actual subsistence activities. Aircraft traffic associated with the exploration drilling would be light, restricted, short-term and localized, and not additive to normal commercial or chartered aircraft traffic in the vicinity.

The oil-spill analysis has determined that there is a low chance for an accidental small oil spill during Shell’s proposed activities in both the Beaufort and Chukchi Seas. If a small spill occurred in both seas, they would be separated by a significant distance. 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 three days on the surface of the water. Booms would be on site and predeployed, 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 three 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 Iñupiat of Nuiqsut and Kaktovik in terms of potential effects on health. While the concern about the possible impacts of a large oil spill is very high, the potential of such a large release occurring is quite low. Section 4.4 presents an evaluation of the risks of such a release and the likelihood of occurrence.

NSB residents expressed concerns that oil and gas industry activities have cumulative effects on culturally important subsistence activities. However, in the Beaufort Sea EIS, the MMS concluded that the impacts from exploration activities would be short-term and localized (MMS 2003).

Thus, cumulative impacts on subsistence activities from the revised Camden Bay EP activities are not significant.
4.2.6 Cumulative Impacts to Socioeconomic Resources

Local socioeconomic impacts from Shell’s exploration drilling program within the area of analysis will be minor and temporary. Some increases in employment and wages will occur through hiring by Shell and Shell contractors for various positions. Additional employment and revenues will be generated by providers of the shorebase facilities (Section 4.1.12).

The sociocultural and population effects in Kaktovik and Nuiqsut would be negligible, as there are no shore-based facilities planned for these communities. Effects in Barrow should be minimal as well, because of the large population and small number of anticipated workers.

There is no commercial fishing in federal waters of the Beaufort Sea. Existing harbor and dock facilities in Dutch Harbor will be used for storage of some supplies and refueling/resupply of the drilling vessel and supply vessels. These operations should have no effect on other uses for this harbor such as commercial fishing operations. The transit of the drilling fleet from Dutch Harbor through the Bering Sea will traverse important commercial fishing grounds, but would not be expected to interfere with commercial fishing operations or fishing success. Drilling fleet transit and drilling operations would not be expected to impact other forms of commercial shipping/barging.

There are significant positive cumulative economic impacts anticipated from development of the oil and gas resources of the Beaufort Sea (see also Section 4.1.12). A recent study by Northern Economics, Inc. (NEI) and the Institute for Social and Economic Research (ISER) at the University of Alaska analyzed the positive economic impacts associated with a significant discovery and development of oil and gas resources in the Beaufort Sea (NEI 2011). Over a 50-year period, NEI estimated this scope of development would create an estimated annual average of more than 30,100 new jobs nationwide, with 13,700 in Alaska and 16,400 in the rest of the U.S. (NEI 2011). Employment opportunities cycle with the project phases, from exploration and development, through production and field decline. An estimated $80 billion in new payroll would be paid throughout the United States for these jobs. The sustained job creation increases income and further stimulates domestic economic activity.

A total of more than $97 billion in new government revenue would be generated as well over this 50-year period of development for the oil and gas resources of the Beaufort Sea. Approximately $84.6 billion would go to the federal government, $7.6 billion would go to the State of Alaska, $1.2 billion would go to the North Slope Borough, and $3.7 billion would go to other state governments (NEI 2011). These estimates increase if the long-term average price of oil exceeds $65 per barrel (in 2010 US dollars).

Thus, cumulative impacts on socioeconomic resources from the EP activities are expected to be positive.

4.2.7 Summary

In conclusion, negligible to minor incremental contributions to cumulative effects are expected from the exploration drilling activities proposed in Shell’s revised Camden Bay EP. This conclusion is supported by the cumulative analyses in the Beaufort Sea multiple-sale EIS and subsequent sale EAs, which concluded that the incremental contribution from activities that would reasonably result from an OCS lease sale in the Beaufort Sea Planning Area to overall cumulative impacts would likely be quite small.

The activities proposed in Shell's revised Camden Bay EP represent only a small portion of the projected activities originally analyzed for the Beaufort Sea lease sale. The activities described in the EP not only are within the range of activities previously described and analyzed by BOEMRE, but are also within the same offshore geographic and environmental context. There is no scientific or other concrete evidence to conclude that any of the cumulative impacts from the site-specific activities under this EP will be
meaningfully different from the impacts previously identified and described by BOEMRE, or that the drill sites are unique or different in any way. Consequently, because the specific drill sites identified in Shell’s EP are a subset of the area and activities analyzed in BOEMRE’s prior cumulative effects analysis, those analyses and their conclusions of insignificant cumulative impacts apply to the activities described in the EP. Because the incremental contribution of the proposed activities in this EP to cumulative impacts is a fraction of those already analyzed by BOEMRE, the impacts are not significant.

4.3 Lease Stipulations, Permit Requirements, and Mitigation Measures

The Lease Stipulations, permit requirements and mitigation measures that are the foundation for Shell’s revised Camden Bay EP, and the analysis of impacts assessed herein are outlined below.

4.3.1 Lease Stipulations

The leases were obtained under the Beaufort Sea Oil and Gas Lease Sale 195 on March 30, 2005 and the Beaufort Sea Oil and Gas Lease Sale 202 on April 18, 2007. The lease stipulations included for 202 and 195 are the same and address the following items:

- Stipulation No. 1 – Protection of Biological Resources
- Stipulation No. 2 – Orientation Program
- Stipulation No. 3 – Transportation of Hydrocarbons
- Stipulation No. 4 – Industry Site-Specific Bowhead Whale-Monitoring Program
- Stipulation No. 5 – Plan of Cooperation
- Stipulation No. 6 – Pre-Booming Requirements for Fuel Transfers
- Stipulation No. 7 – Lighting of Lease Structures to Minimize Effects to Spectacled and Steller’s Eider

Stipulation No. 1 – Protection of Biological Resources

Stipulation No. 1 – Protection of Biological Resources requires the operator to conduct a biological survey if the lessor determines that biological populations or habitat in the lease area requires additional protection. Based upon this survey the lessor may be required to:

1. Relocate the site of operations;
2. Establish that operations will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist;
3. Operate during times 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 the lessee discovers an area of biological significance during lease operations, they are required notify the lessor and to act to preserve the area until they obtain further direction from the lessor.
Stipulation No. 2 – Orientation Program

Any exploration or development and production plan is required to include a proposed orientation program for all personnel involved in field operations to inform personnel of specific environmental, social, and cultural concerns regarding the project area. The orientation program will identify important resources and provide guidance on how to avoid disturbance of these resources, and will be designed to increase sensitivity on the part of project personnel to values, customs, and lifestyles of communities in the project areas, and to avoid conflicts with existing subsistence and commercial users of resources. Project field personnel are required to attend the program at least once a year and records of attendance must be maintained as long as the site is active.

Stipulation No. 3 – Transportation of Hydrocarbons

Pipelines will be required to transport hydrocarbons if they are technologically feasible, environmentally preferable, rights-of-way can be obtained, and can be laid without net social loss when compared to alternative transportation methods. Upon development of pipeline capacity sufficient to meet transportation needs, no hydrocarbon transportation by surface vessel will be allowed except in cases of emergency.

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

Site-specific monitoring is required for lessees who will be conducting operations during bowhead whale migration. The NSB, AEWC, and State of Alaska will be provided a maximum of 60 days to review and comment on the proposed annual monitoring program. Monitoring will include an assessment of when bowhead whales are in the vicinity of lease operations and what behavior effects operations have on bowhead whales. The program must also provide for the following:

1. Recording and reporting information on the presence and behavioral effects due to operations on other marine mammals;
2. Inviting an AEWC or NSB representative to observe the monitoring program;
3. Coordinating the monitoring logistics beforehand with the MMS BWASP;
4. Submitting daily monitoring results to the MMS BWASP;
5. Submitting a draft report on the results of the monitoring program within 60 days following the completion of the operation which will be distributed to the AEWC, the NSB, the State of Alaska, and NOAA - NMFS; and
6. Submitting a final report on the results of the monitoring program, including a discussion of the results of the peer review of the draft report, which will be distributed to the AEWC, the NSB, the State of Alaska, and the NOAA NMFS.

As part of the required annual monitoring program, lessees must fund an independent peer review of the proposed monitoring plan and the draft report. The results of these peer reviews will be provided for consideration in final approval of the monitoring program and the final report.

In the event the lessee is seeking an LOA for polar bear and Pacific walrus from the USFWS or IHA from the NMFS for whales and seals for incidental take, the monitoring program and review process required under the LOA or IHA may satisfy the requirements of this stipulation. If a LOA and/or IHA is being requested in lieu of the requirements of this stipulation, BOEMRE must be notified and copied on all pertinent submittals and correspondence. BOEMRE will coordinate and advise the lessee if the LOA and/or IHA will meet the stipulation requirements.
Stipulation No. 5 – Plan of Cooperation

BOEMRE Lease Sale Stipulation No. 5 (Attachment A to Appendix H of the EP) 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 No. 5 requires the operator to consult directly with potentially affected North Slope subsistence communities, the NSB, and the AEWC.

Consultation is needed “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 No. 5 also requires the operator to document its contacts and the substance of its communications with subsistence stakeholder groups during the operator’s consultation process. In the event no agreement is reached between the lessee, the AEWC, the NSB, NMFS, or any of the potentially affected subsistence communities, BOEMRE may assemble a representative group to specifically address the conflict and attempt to resolve the issues before making a final determination on the adequacy of proposed mitigation measures.

The requirements of Stipulation No. 5 parallel requirements for receipt of a USFWS LOA or a NMFS IHA. The LOA and IHA provide authorization for the nonlethal harassment of species protected by the MMPA. Both the USFWS and NMFS require an applicant to implement a POC to mitigate the potential for conflicts between the proposed activity and traditional subsistence activities (50 CFR § 18.124(c)(4) and 50 CFR § 216.104(a)(12)). The POC must identify the measures that will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, both USFWS and NMFS require an applicant to communicate and consult with local subsistence communities concerning the proposed activity, potential conflicts with subsistence activities, and means of resolving any such conflicts (50 CFR § 18.128(d) and 50 CFR § 216.104(a) (12) (i), (ii), (iv)).

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

Fuel transfers (excluding gasoline transfers) of 100 bbls or more that take place within three weeks of bowhead whale migration or during bowhead whale migration require pre-booming of the fuel barge(s). The lessee’s oil-spill-contingency plans must include procedures for the pre-transfer booming of the fuel barge(s). Fuel transfers will be performed in accordance to Shell’s Fuel Transfer Procedure, which is included in Section 9.0 of the EP and is included here by reference. All fuel transfers will involve pre-booming to facilitate recovery of the fuel in the unlikely event of a spill.

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

Lessees must adhere to USFWS lighting requirements for all exploration or delineation structures so as to minimize the likelihood that migrating spectacled or Steller’s eiders will strike these structures. These requirements are for locations between the longitude 156° W and longitude 146° W and for activities conducted between May 1 and October 31. BOEMRE encourages operators working east of longitude 146° W to also adhere to these measures because of the potential presence of eiders in this area as well as other migratory birds protected under the Migratory Bird Treaty Act. Lighting must be designed to minimize the radiation of light outward from structures to minimize the likelihood that spectacled or Steller’s eiders will strike those structures. Measures to be considered in lighting design may include:

- Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward
Types of lights
- Adjustment of the number and intensity of lights as needed during specific activities.
- Dark paint colors for selected surfaces
- Low reflecting finishes or coverings for selected surfaces
- Facility or equipment configuration

Additional mitigation measures may be required if additional information indicates that it is warranted. BOEMRE will notify lessees of any changes to lighting requirements.

BOEMRE must be provided with a written statement of the measures proposed to meet the stipulation, including a plan for recording and reporting bird strikes that occur during approved activities with the EP submittal. Lessees are required to report spectacled and/or Steller’s eiders injured or killed through collisions with lease structures to the USFWS Fairbanks Field Office, Endangered Species Branch.

### 4.3.2 Permit Requirements and Permit Stipulations

A number of permits are required to conduct exploration of oil and gas leases and development and production of these leases. Each of the permits would include stipulations that must be adhered to regarding how the lessor would operate in order to mitigate negative impacts. Table 4.3.2-1 includes a list of major permits anticipated to be needed and the types of stipulations anticipated to be included.

<table>
<thead>
<tr>
<th>Permit</th>
<th>Mitigation Measures Expected to be Required</th>
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<tbody>
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<td>IHA for Whales and Seals (NMFS)</td>
<td>• Exclusion zones for whales and seals&lt;br&gt;• Monitoring requirements&lt;br&gt;• Notification requirements&lt;br&gt;• Reporting requirements</td>
</tr>
<tr>
<td>Discharge Permit (USACE)</td>
<td>• Exclusion zones&lt;br&gt;• Notification requirements&lt;br&gt;• Reporting requirements</td>
</tr>
<tr>
<td>LOA for Polar Bear and Pacific Walrus (USFWS)</td>
<td>• Exclusion zones for polar bear and Pacific walrus&lt;br&gt;• Monitoring requirements&lt;br&gt;• Notification requirements&lt;br&gt;• Reporting requirements</td>
</tr>
<tr>
<td>Coastal Consistency Determination (ADNR)</td>
<td>• Monitoring requirements&lt;br&gt;• Reporting requirements</td>
</tr>
<tr>
<td>Geophysical Permit (ADNR)</td>
<td>• Monitoring requirements&lt;br&gt;• Reporting requirements</td>
</tr>
<tr>
<td>Development Permit (NSB)</td>
<td>• Monitoring requirements&lt;br&gt;• Reporting requirements</td>
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</tbody>
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ADNR = Alaska Department of Natural Resources  
G & G = Geological and Geophysical  
IHA = Incidental Harassment Authorization  
LOA = Letter of Authorization  
NMFS = National Marine Fisheries Service  
NSB = North Slope Borough  
USACE = U.S. Army Corps of Engineers  
USFWS = U.S. Fish and Wildlife Service
4.3.3 Mitigation Measures

The permits and authorizations table included in Section 2 of the EP lists the authorizations and necessary permits to conduct the planned exploration drilling program. Shell will adopt the mitigation measures written into these authorizations, and will therefore be working within regulatory requirements.

In addition to meeting all regulatory requirements, Shell is committed to other mitigation measures including those that will decrease any potential conflicts between exploration drilling activities and subsistence harvests. For the revised Camden Bay EP exploration drilling program, these mitigation measures include:

Communications

- Shell has developed a Communication Plan and will implement this plan before initiating exploration drilling operations to coordinate activities with local subsistence users, as well as Village Whaling Captains’ Associations, to minimize the risk of interfering with subsistence hunting activities, and keep current as to the timing and status of the bowhead whale hunt and other subsistence hunts. The Communication Plan includes procedures for coordination with Com Centers to be located in coastal villages along the Chukchi and Beaufort Seas during Shell’s proposed exploration drilling activities.

- Shell will employ local SAs from the Beaufort and Chukchi Sea villages that are potentially impacted by Shell’s exploration drilling activities. The SAs will provide consultation and guidance regarding the whale migration and subsistence activities. There will be one per village, working approximately 8 hours per and 40-hour weeks during the drilling seasons. The subsistence advisor will use local knowledge (Traditional Knowledge) to gather data on subsistence lifestyle within the community and to advise in ways to minimize and mitigate potential negative impacts to subsistence resources during the drilling season. Responsibilities include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; coordinating with the Com and Call Center personnel; and advising how to avoid subsistence conflicts. Subsistence advisors will have a handbook that will specify work tasks in more detail.

Aircraft Travel

- Aircraft shall not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, in poor weather (fog or low ceilings) in an emergency situation. Aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft (457 m) in areas of active whaling; such areas to be identified through communications with the Com Centers. Except for airplanes engaged in marine mammal monitoring, aircraft shall use a flight path that keeps the aircraft at least 5 mi (8 km) inland until the aircraft is south of its offshore destination, then at that point it shall fly directly north through the Mary Sachs Entrance to its destination. Shell reserves the option to use an alternate flight route in the event that transit through the Mary Sachs Entrance is unsafe due to weather, other environmental conditions, or in the event of an emergency.

- Aircraft and vessels will not operate within 0.5 mi (0.8 km) of walrus or polar bears when observed on land or ice.

- Shell will also implement non-MMO flight restrictions prohibiting aircraft from flying within 1,000 ft (300 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs and landings or in emergency situations) while over land or sea. This flight will also help avoid disturbance of and collisions with birds.
Vessel Travel

- The *Kulluk* or *Discoverer* and support vessels will enter the Chukchi Sea through the Bering Strait on or after 1 July, minimizing effects on marine mammals and birds that frequent open leads and minimizing effects on spring and early summer bowhead whale hunting.

- Exploration drilling activities at the Sivulliq or Torpedo drill sites are planned to begin on or about 10 July following transit into the Beaufort Sea and run through 31 October, with a suspension of all operations beginning 25 August for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. During the suspension for the whale hunts the drilling fleet will leave the Camden Bay project area and move to an area north of latitude 71° 25’N and west of longitude 146° 4’W. Shell does not plan to anchor during this suspension. Shell will return to resume activities after the subsistence bowhead whale hunts conclude. Exploration drilling activities will be completed by 31 October, depending on ice and weather.

- The drilling support fleet transit route will avoid known fragile ecosystems, including the LBCHU, and will include coordination through Com Centers.

- To minimize impacts on marine mammals and subsistence hunting activities, the drilling vessel and support fleet will transit through the Chukchi Sea along a route that lies offshore of the polynya zone. In the event the transit outside of the polynya zone results in Shell having to break ice (as opposed to managing ice by pushing it out of the way), the drilling vessel and support vessels will enter into the polynya zone far enough so that ice breaking is not necessary. If it is necessary to move into the polynya zone, Shell will notify the local communities of the change in the transit route through the Com Centers. As soon as the fleet transits past the ice, it will exit the polynya zone and continue a path in the open sea toward the Camden Bay drill sites.

- MMOs will be aboard the *Kulluk* or *Discoverer* and all support vessels (see the 4MP in Appendix D of the revised Camden Bay EP).

- When within 900 ft (274 m) of marine mammals, vessels will reduce speed, avoid separating members from a group and avoid multiple changes of direction.

- Vessel speed is to be reduced during inclement weather conditions in order to avoid collisions with marine mammals.

- All vessels must maintain cruising speed not to exceed nine knots while transiting the Beaufort Sea. This measure would reduce the risk of ship-whale collisions.

- Shell will communicate and coordinate with the Com Centers regarding all vessel transit.

Drilling Operations

- Shell will collect all drilling mud and cuttings with adhered mud from all well sections below the 26-in. (20-in. casing) hole section, as well as treated sanitary waste water, domestic wastes, bilge water and ballast water, and transport them outside the Arctic for proper disposal in an EPA-licensed TDS. These waste streams will not be discharged to the ocean.

- Drilling mud will be cooled to mitigate any potential permafrost thawing or thermal dissociation of any methane hydrates encountered during drilling, if such materials are present at the drill site.

- Drilling mud will be recycled to the extent practicable based on operational considerations (e.g., whether mud properties have deteriorated to the point where they cannot be used further) so that the volume of the spent mud is reduced.
Critical operations will not be started if potential hazards (ice floe, inclement weather, etc.) are in the vicinity and there is not sufficient time to complete the critical operation before the arrival of the hazard at the drill site (see COCP in Appendix J of the revised Camden Bay EP).

All casing and cementing programs will be certified by a registered professional engineer.

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

The blowout prevention program will be enhanced through the use of two sets of blind/shear rams, increased frequency of BOP performance tests from 14 days to 7 days, a remotely operated vehicle (ROV) control panel on the seafloor with sufficient pressured water-based fluid to operate the BOP, a containment system that includes treatment and flaring capabilities, capping stack equipment, and a fully-designed relief well drilling plan and provisions for a second relief well drilling vessel (Discoverer or Kulluk) to be available to drill the relief well if the primary drilling vessel is disabled and not capable of drilling its own relief well.

Lighting on the drilling vessel will be shaded and has been replaced with ClearSky lighting. ClearSky lighting is designed to minimize the disorientation and attraction of birds to the lighted drilling vessel to reduce the possibility of a bird collision (see the Bird Strike Avoidance and Lighting Plan in Appendix I of the revised Camden Bay EP).

**Ice Management**

- Ice management will involve preferentially redirecting, rather than breaking, ice floes while the floes are well away from the drill site (see the Ice Management Plan in Appendix K of the revised Camden Bay EP).

- Real time ice and weather forecasting will be from the SIWAC.

**Oil Spill Response**

- The primary OSR vessel will be on standby at all times when drilling into zones containing oil to ensure that oil spill response capability is available within one hour, if needed.

- Shell will deploy an OSR fleet that is capable of collecting oil on the water up to the calculated WCD flowrate of a blowout in the unlikely event that one should occur. The primary OSR vessel will be on standby when drilling into zones containing oil to ensure that oil spill response capability is available within one hour, if needed. The remainder of the OSR fleet will be fully engaged within 72 hours.

- In addition to the OSR fleet, an oil spill containment system will be available for use in the unlikely event of a blowout. The containment system barge will be centrally located in the Beaufort Sea and supported by an Invader Class Tug and possibly an anchor handler. The containment system will be designed for conditions found in the Arctic including ice and cold temperatures. This equipment
will also be designed for maximum reliability, ease of operation, flexibility and robustness so it could be used for a variety of blowout situations.

- Capping stack equipment will be stored aboard one of the ice management vessels and will be available for immediate deployment in the unlikely event of a blowout. Capping stack equipment consist of subsea devices assembled to provide direct surface intervention capability with the following priorities:
  - Attaching a device or series of devices to the well to affect a seal capable of withstanding the MAWP and closing the assembly to completely seal the well against further flows (commonly called “capping and killing”)
  - Attaching a device or series of devices to the well and diverting flow to surface vessel(s) equipped for separation and disposal of hydrocarbons (commonly called “capping and diverting”)

- A polar bear culvert trap has been constructed in anticipation of OSR needs and will be deployed near Point Thomson or Kaktovik prior to drilling.

- Pre-booming is required for all fuel transfers between vessels.

**Air Emissions**

**Kulluk**

- The *Kulluk* will have selective catalytic reduction (SCR) as a nitrogen oxide (NOx) tailpipe emission control on its primary engines, reducing NOx emissions to less than 1.6 g/kW-hr. The primary generators will also have oxidation catalysts installed for control of particulate matter less than 2.5 microns (PM$_{2.5}$), volatile organic compounds (VOC), and carbon monoxide (CO). Oxidation Catalysts are assumed to control engine emissions to 50 percent for PM$_{2.5}$, 80 percent for CO, and 70 percent for VOC.

- The other engines normally used in the drilling activities (the air compressors, the MLC, hydraulic power units (HPU), and cranes) will also have oxidation catalysts as tailpipe control for oxidizing all oxidize-able substances, including PM$_{2.5}$, VOC, and CO. Control of engine emissions is assumed to be 50 percent for PM$_{2.5}$, 80 percent for CO, and 70 percent for VOC.

- Ice management vessels and anchor handlers will have SCR as a nitrogen oxide (NOx) tailpipe emission control, and oxidation catalyst on its primary propulsion and generation engines with the same reduction efficiencies as the Kulluk primary engines.

- ULSD (0.0015 percent) fuel will be purchased for the *Kulluk* and support vessels to reduce sulfur dioxide (SO$_2$) emissions.

**Discoverer**

- Primary generators on the *Discoverer* are retrofitted with selective catalytic reduction devices to reduce NOx emissions to under 0.5 g/kW-hr, and catalytic oxidation devices to reduce CO, VOCs and particulate matter less than 10 microns (PM10).

- 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) and fine particulate matter.

- ULSD (0.0015 percent) fuel will be purchased for the *Discoverer* and support vessels to reduce sulfur dioxide (SO$_2$) emissions.

- Ice management vessels and anchor handlers will have SCR as a nitrogen oxide (NOx) tailpipe emission control, and oxidation catalyst on its primary propulsion and generation engines.
4.4 Analysis of the Probability of a Large or Very Large Oil Spill and Potential Impacts

Probability Analysis of an Oil Spill

While a well blowout (loss of well control) is potentially the most significant concern for generating a large hydrocarbon spill because of the associated spill volume. BOEMRE has estimated the risk is low that a blowout event would impact the Beaufort Sea as a result of exploration drilling. A total of 35 exploration wells have been drilled between 1982 to 2003 in the Chukchi and Beaufort Seas, and there have been no blowouts. In addition, none have occurred from the approximately 98 exploration wells drilled within the Alaskan OCS (MMS 2007a).

The BOEMRE EA prepared for the Beaufort Sea (MMS 2007b) reported that from 1971 through 2005 approximately 13,463 exploration wells were drilled (including 172 in the Pacific OCS, 51 in the Atlantic OCS, and 98 in the Alaska OCS). Sixty-six blowouts were identified for all exploration drilling from 1971 to 2005. No large spills (greater than 1,000 bbl; greater than or equal to 159 m$^3$) occurred during exploration drilling well blowouts from 1971 to 2005. Of the approximately 13,000 wells that were drilled, four spills resulted in crude reaching the environment from blowouts with volumes of 200-, 100-, 11-, and 0.89- bbl (31.8 m$^3$, 16 m$^3$, 1.8 m$^3$, and 0.13 m$^3$, respectively). Another BOEMRE study affirmed that no crude oil spills greater than 100 bbl (16 m$^3$) resulting from blowouts occurred from 1985 to 1999 (Hart Crowser, Inc. 2000). A 2007 report by BOEMRE (Izon et al. 2007) reviewed blowout statistics for the U.S. from 1992 through 2006. This paper did not distinguish between exploration and development wells but reported that the overall frequency of blowouts has diminished since their previous review for the period of 1971 through 1972.

Holand (1997) reported the U.S. Gulf of Mexico OCS exploration blowout frequencies as 0.0059 per well drilled, based on worldwide historical data available from the SINTEF Offshore Blowout Database. 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 percent of the total blowouts, gas/liquid mixtures 14 percent, and uncontrolled liquid flows involved only three percent.

BOEMRE recently analyzed how the Deepwater Horizon event affected prior analysis about the likelihood of an oil spill (BOEMRE 2011).2 It explained that, when preparing such predictive analyses, it used data from past OCS spills. However, from 1985-1999 (the time period used when preparing the Gulf of Mexico analysis), there were no platform or blowout spills greater than 1,000 barrels. Thus, “to allow for conservative future predictions of spill occurrence, a spill number of one was ‘assigned’ to provide a non-zero spill rate for blowouts. Therefore, this spill rate already included the occurrence of the Macondo Event.” (BOEMRE 2011).

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2 This technical analysis builds on and is consistent with BOEMRE’s findings related to the Deepwater Horizon incident, which include the following: “The probability of a catastrophic spill from drilling deepwater exploration and development well[s] remains very low, even remote. The knowledge gained and proactive steps taken since the Macondo well blowout further reduces that probability, the degree to which is still unknown” (BOEMRE 2010a); and “The potential impact of these activities on listed species and their designated critical habitat remains low because it is very unlikely that another high impact oil spill would occur in the [Gulf of Mexico] and because BOEMRE is taking steps to reduce the likelihood of such a spill and to protect listed species and their habitat, including new measures devised in light of the [Deepwater Horizon] incident” (BOEMRE 2010b).
Scandpower (2001) used statistical blowout frequencies modified to reflect specific field conditions and operative systems at the Northstar Development in the Beaufort. The report concluded that the predicted frequency of blowouts when drilling into the oil-bearing zone is 0.000015 per well drilled. This same report estimates that the frequency of oil quantities per well drilled for Northstar for a spill greater than 130,000 bbl (20,668 m³) is 0.00000094 per well. This compares to a statistical blowout frequency of 0.000074 per well for an average development well.

Bercha (2006, 2008) developed a fault tree model to estimate oil spill occurrence rates associated with Arctic OCS locations. Since limited historical spill data for the Arctic exists, Bercha modified the existing base data using fault trees to arrive at oil spill frequencies for future development and production scenarios. For offshore exploration drilling, Bercha (2008) used statistics derived from Holand (1997) for non-Arctic drilling operations and Scandpower’s (2001) blowout frequency assessment for Northstar to estimate the anticipated size and frequency of spills. Based on this historical data, Bercha reported the spill frequency for non-Arctic exploration well drilling as 0.000342 per well for a blowout equal to or in excess of 150,000 bbl (23,848 m³).

In order to model the data variability for Arctic exploration, Bercha applied a numerical simulation approach to develop the probability distribution of 150,000 bbl (23,848 m³) or greater, and arrived at a frequency ranging from a low of 0.00015 per well to a high of 0.000697 per well. The expected value for a blowout of this size was computed to be 0.000394 per well (Bercha 2008). To address causal factors associated with blowouts, Bercha applied adjustments for improvements to logistics support and drilling contractor qualifications that resulted in lower predicted frequencies for Arctic drilling operations. No fault tree analyses or unique Arctic effects were applied as a modification to existing spill causes for exploration, development, or production drilling frequency distributions. For exploration wells drilled in analogous water depths to planned Beaufort Sea wells at 98-197 ft (30-60 m), Bercha (2008), the predicted, adjusted frequency is 0.000612 per well for a blowout sized between 10,000 bbl (1,590 m³) to 149,000 bbl (23,689 m³) and 0.000354 per well for a blowout greater than 150,000 bbl (23,848 m³).

The best available information on blowouts associated with oil and gas operations on Alaska’s North Slope identifies 11 blowouts between 1977 and 2001. These blowouts released either dry gas or gas condensate only; resulting in minimum environmental impact (NRC 2003).

**Volume of an Oil Spill**

Shell’s Beaufort Sea Oil Discharge Prevention and Contingency Plan (ODPCP) (Revision 1) response scenario addresses the potential release of crude oil to the environment by loss of well control during the drilling season. The rate and volume for a very large oil spill (VLOS) were based on the planning scenario worst case discharge (WCD) provided in Section 2.10 (Table 2.10-1). The planning scenario considers a daily release of 16,000 bbl of crude oil for 30 days (480,000 bbl total). This volume exceeds the WCD calculated for the Sivulliq and Torpedo prospects (Section 2 of the revised Camden Bay EP). Shell’s Beaufort Sea ODPCP (Revision 1) demonstrates access to sufficient equipment and personnel needed to respond to a well blowout with this flow rate and total volume. The WCD calculations in the revised Camden Bay EP Table 8.d-2 were calculated in accordance with BOEMRE’s guidance and reflect the total volume of oil that could be released into the environment in the absence of any spill response activities. Because Shell has committed to have a capping stack (capping) and containment system in place for the exploration drilling program, in addition to robust mechanical spill response capabilities, such a scenario is highly unrealistic. Therefore, for purposes of the EIA, Shell further refined the scenario to take into account conservative estimates of its spill response capacity, to more accurately predict how such a spill, when mitigated by Shell’s spill response activities, would affect the environment.
The description of the volume of a VLOS considered in that document reflects the volume of released crude oil from the assumed blowout that might escape containment and recovery and therefore further affect the environment. Based on the WCD planning scenario in Shell’s Beaufort Sea Regional ODPCP (Revision 1), Shell assumes that 90 percent of the total WCD volume (432,000 bbl) will be captured during primary efforts using mechanical recovery and will not further affect the environment. The remaining 10 percent of the WCD volume (48,000 bbl) could escape capture. This volume is much lower than the 180,000 bbl of oil analyzed in the 2003 Final Environmental Impact Statement for the Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 (2003 Multi-Sale Environmental Impact Statement [EIS]).

Of the four wells proposed in the revised Camden Bay EP, the highest calculated WCD is 9,468 bbl of oil per day from Torpedo H, much lower than the 16,000 bbl per day planning WCD. Over a period of 30 days the calculated WCD would be 284,040 bbl of oil, not taking into account that the flow rate would decrease over time. Using the same assumption that 90 percent of the total calculated WCD will be captured using mechanical recovery, only 28,404 bbl of oil would escape capture over the 30-day period. Once again, this volume is much lower than the 180,000 bbl of oil analyzed in the 2003 Multi-Sale EIS.

In the unlikely event that there is a blowout, where a relief well is required and the primary drilling vessel could not drill its own relief well, it could take up to 43 days to mobilize and finish a relief well (Table 2.g-2), depending on the location of the secondary relief well drilling vessel. During these 43 days, it is possible that 40,712 bbl of oil (i.e. 10 percent of 9,468 bbl of oil X 43 days) would escape primary efforts using mechanical recovery. Again, this volume remains much lower than the 180,000 bbl of oil analyzed in the 2003 Multi-Sale EIS.

Of course the volume of oil that could escape capture during an unlikely event such as a blowout could be even less given the capping and containment commitments in Shell’s planned exploration drilling program. Based on guidance from BOEMRE and the Alaska Department of Environmental Conservation, Shell’s Beaufort Sea Regional ODPCP (Revision 1) takes credit for capture and recovery of released oil that is removed only via mechanical recovery means. Shell has not assumed spill response credit (e.g., reduction in oil released to the environment) for the use of the capping stack or the containment system in our oil spill response assets. As is described further below, capping stack deployment and sealing of a blown out well could be completed in as few as seven days. In tandem with mechanical recovery of oil spilled prior to completion, capping would further reduce the WCD volume of oil that escapes capture. Further, the containment system, if needed, would lower the volume of oil that escapes capture when compared to mechanical recovery alone.

In addition to the mechanical recovery, the well-capping and oil spill containment equipment that Shell will have on hand in order to capture and contain the flow of oil from the well unfolds in capping and capping-and-containment scenarios* summarized as follows.

- Mechanical recovery is initiated via the vessel of opportunity skimming system and oil spill response (OSR) vessel pre-positioned to respond within one hour of the beginning of uncontrolled well flow.
- The pre-positioned OSR barge arrives on site of the blowout well with 2½ hours and also begins skimming and collecting oil.
- OSR tanker arrives within the 24 hours of the onset of the uncontrolled flow event, and is able to take recovered fluids.
- The capping stack, carried on one of the ice management vessels, is deployed within 5-7 days from the onset of the uncontrolled flow event, and if successful may stop the flow of oil within this
timeframe—therefore sealing the flow of oil into the environment well in advance of the planning response.

- If the capping stack does not seal the flow, then the containment system, which also arrives within the 5-7 day timeframe, is deployed and is positioned to begin oil recovery/containment on the 8th day after the uncontrolled well flow begins.

* Actual time is dependent on configuration of the blowout well, weather, ice and sea conditions and other factors. These are rough estimates and are highly variable. They are used to demonstrate a timeline in one unlikely scenario only developed to outline Shell’s capping and containment process if a loss of well control event was to occur. This timeline in no way indicates a guarantee of the time required to conduct capping operations in an actual blowout event.

The containment system, combined with the mechanical recovery, will further reduce the amount of oil that escapes capture.

Impact Analysis of an Oil Spill

Oil and gas exploration activities, such as those proposed in Shell’s Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Beaufort Sea, Alaska for Flaxman Island Blocks 6559, 6610 & 6658 and Beaufort Sea Lease Sales 195 & 202 (“revised Camden Bay EP”) carry a risk of an oil spill. Various events could cause a spill, ranging from a hose rupture to the extreme example of a loss of well control (blowout). However, the most likely spill to occur during the activities in the revised Camden Bay EP would be a spill of approximately 48 bbl resulting from a refueling operation (Shell Camden Bay EIA 2010). This conclusion is consistent with BOEMRE’s prior findings when analyzing the likelihood of various kinds of spill impacts. Accordingly, this EIA evaluates the impacts of a 48 bbl spill on existing environmental resources.3 These impacts will not be significant. As analyzed for each potentially affected resource throughout Section 4 above, the impacts of a 48 bbl spill resulting from a refueling operation are expected to be localized and fleeting.

While not a reasonably expected impact of this exploration project, BOEMRE has analyzed the impacts of a VLOS in the Beaufort Sea, defined by BOEMRE as a spill of 150,000 bbl or more. BOEMRE analyzed the impacts of a 180,000 bbl spill in the 2003 Final Environmental Impact Statement for the Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 (2003 Multi-Sale Environmental Impact Statement (EIS)). As discussed below, BOEMRE concluded that such a spill would be rare, but that, if it occurred, it could have significant impacts on certain environmental resources. As part of that analysis, BOEMRE analyzed potential trajectories of a spill and considered the impacts of a spill in various ice conditions.

The VLOS analysis in the 2003 Multi-Sale EIS properly informs the analysis of the revised Camden Bay EP. The Ninth Circuit has approved of the use of existing NEPA analyses on spill impacts when the analysis covers the area at issue.4 Applying the impacts analysis in the 2003 Multi-Sale EIS to the activities in the revised Camden Bay EP provides a site-specific analysis of the potential impacts of a VLOS resulting from the revised Camden Bay EP. Although the oil spill resulting from the Deepwater Horizon incident has brought heightened attention to oil spill—and especially VLOS—issues, there is no new information related to the site-specific impacts of this project that requires additional analysis.

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3 This approach is consistent with the approach approved by the Ninth Circuit in Edwardsen v. U.S. Dep’t of the Interior, in which the agency did not include a worst case scenario analysis regarding oil spill trajectories. 268 F.3d 781, 785 (9th Cir. 2001) (“Moreover, an EIS need not include a worst-case scenario. See Robertson v. Methow Valley Citizen’s Council, 490 U.S. 332, 354 (1989). See also Mandelker, NEPA Law and Litigation § 10.07[3] at 10-39.”).

4 Id. at 785-86 (upholding the approval of the BP Northstar project which relied on analysis of oil spill impacts in the NEPA documents related to Lease Sale 170, which covered the same area as the project).
existing analysis of VLOS impacts in the Beaufort Sea in the 2003 Multi-Sea EIS, as properly applied to the revised Camden Bay EP, evaluates the reasonably foreseeable impacts from a VLOS resulting from this operation.

Impacts of a Very Large Oil Spill

In its 2003 Multi-Sale EIS, MMS analyzed the likelihood of a spill, the fate of spilled oil without cleanup and the most likely trajectories of spills of various sizes that could result from oil exploration and development on the proposed leased areas (MMS 2003). This analysis included an evaluation of the impacts of a VLOS, which BOEMRE defined as greater than 150,000 barrels of oil.\(^5\) For the purposes of the analysis, the agency evaluated the impacts of a hypothetical 180,000 barrel spill in a nearshore area on areas identified by the agency as sensitive resources.\(^6\) BOEMRE analyzed the behavior of spilled crude oil in open water, solid ice, and broken ice. For each scenario, BOEMRE evaluated the impacts of the spill on environmental resources.\(^7\) The agency concluded that impacts to some resources were likely to be significant in the unlikely event of a very large oil spill. However, the agency also noted the mitigating role that oil spill response activities could have on these potential impacts.

In its 2003 Multi-Sale EIS, MMS noted the following impacts resulting from a very large 180,000 barrel oil spill. MMS considered the impact of a VLOS on threatened and endangered species, including bowhead whales. MMS estimated a VLOS during summer had a 35 percent chance of contacting important bowhead whale habitat within 30 days. The probability of oil contacting whales, however, is likely to be considerably less than the probability of it contacting bowhead whale habitat. If bowhead whales were contacted, available data shows baleen whales are unlikely to experience serious direct effects from oil exposure. While lethal effects for some individuals are possible, most individuals exposed to spilled oil are expected to experience temporary nonlethal effects from, for example, oiling of the skin and inhalation of hydrocarbon vapors.\(^8\)

A VLOS could have potentially lethal impacts on marine mammals, including pinnipeds, polar bears and beluga whales, because of absorption, inhalation or ingestion of toxic hydrocarbons. About 67 percent of the oil likely would contact offshore seal and polar bear ice-front habitat. Several thousand walruses and seals and as many as 128 polar bears (assuming a high population density) could be exposed to oil. Assuming all contacted individuals died, this loss could take these marine mammal populations more than one or two generations to recover (up to approximately 15 years). Beluga whales might encounter spilled oil during the spring migration and summer, but few if any whales are likely to be adversely affected, with fewer than 20 individuals lost (population recovery in 1 year).\(^9\)

MMS found that a VLOS would impact water quality by increasing the concentration of hydrocarbons in the water column in a large area greatly above background levels. For example, a very large spill to open water during summer could increase concentrations above the 1.5 ppm acute toxic criterion during the first several days in an area of a hundred square miles. Oil could exceed the 0.015 ppm chronic criterion for several months or more in an area of approximately 5,000 mi\(^2\) (12,950 km\(^2\)), before dispersion and

\(^5\) Id. at IV-227.

\(^6\) Id. at IV-228.

\(^7\) See id. at IV-230 to IV-247.

\(^8\) Id. at IV-233 to IV-234. BOEMRE’s analysis also considered the impacts of a VLOS on spectacled and Steller’s eiders, which are potentially significant for these small populations. See id. at IV-234 to IV-236. BOEMRE also analyzed the potential impacts on other marine and coastal birds. Depending on season and distribution, a VLOS could cause the loss of potentially thousands of waterfowl. Id. at IV-236 to IV-238.

\(^9\) Id. at IV-238 to IV-239.
dilution reduced oil concentrations below the chronic criterion. MMS estimated only limited affects on lower trophic-level organisms given their distribution and seasonal factors. For example, MMS estimated there would be no impacts on subtidal marine plants because they live below the zone where toxic concentrations of oil are expected to occur. Lethal and sublethal effects are expected on marine invertebrates in the intertidal and subtidal zones. Plankton species would also be impacted by a spill, but because of their wide distribution, large numbers and rapid rate of regeneration, there would be only a temporary, local effect on the plankton community resulting from a very large oil spill. MMS estimated a very large oil spill would have no measurable effects on fish in winter, due to their low numbers and wide distribution. A VLOS during summer could affect fish in nearshore waters, although MMS estimated the likelihood of a VLOS occurring and contacting nearshore areas as very low (< 0.5%). If such a spill did occur, some marine and migratory fish could be harmed or killed, but mortality due to oil exposure is seldom observed outside the laboratory because the zone of lethal toxicity is very small and short lived, and fish in the immediate area typically avoid that zone.

Finally, MMS analyzed the impact of a VLOS on air quality. MMS concluded a spill’s effects on air quality would be low. A VLOS could cause an increase in gaseous hydrocarbon concentrations, which could affect onshore air quality. Any effects would be localized and temporary, and concentrations of criteria pollutants would likely remain well within Federal air-quality standards.

MMS continued to refine its impacts analysis in subsequent EAs it prepared in advance of lease sales held pursuant to the 2003 Multi-Sale EIS. For example, by the time it prepared its EA of Proposed OCS Lease Sale 202 Beaufort Sea Planning Area (“Lease Sale 202 EA”) in 2006, MMS had updated its analysis with refined information to estimate that the likelihood of one or more large spills (defined by MMS to mean > 1,000 bbl) had increased from the 8-10 percent likelihood estimated in the 2003 Multi-Sale EIS to 20 percent in the Lease Sale 202 EA (MMS 2006). The EA further stated that in the absence of any clean-up activities, it assumed that after 30 days in open water or broken ice, 27-29 percent of oil evaporates, 4-32 percent disperses, and 28-65 percent remained. After 30 days under landfast ice, the EA assumed that nearly 100 percent of oil remains in place and unweathered.

The VLOS Impacts Analysis of the 2003 Multi-Sale EIS is Applicable to Shell’s Current EP.

The detailed impacts analysis of the 2003 Multi-Sale EIS provides decision-makers with useful information on the anticipated impacts of a VLOS from a given project. For example, when MMS prepared its EA of the Shell Offshore Inc. 2010 Outer Continental Shelf Lease Exploration Plan for Camden Bay, Alaska (“2010 Camden EA”), the agency referred back to the overall analysis prepared in the 2003 Multi-Sale EIS and determined that the potential impacts from a very large spill in the vicinity of Shell’s proposed operations were “statistically similar” to the impacts and contacts modeled in the 2003 Multi-Sale EIS (BOEMRE 2010c). BOEMRE then applied the previous analysis to determine the likelihood of spilled oil reaching various key environmental areas from the proposed activity site in various time windows, both in the summer and winter (BOEMRE 2010c). In this way, BOEMRE was able to narrow the range of possible impacts from those identified in the 2003 Multi-Sale EIS to the more likely impacts if a spill were to occur from the proposed activities. The results of that analysis are the same for the current program and are listed in the following tables, which summarize the probable

10 Id. at IV-230 to IV-231.
11 Id. at IV-231 to IV-232.
12 Id. at IV-232.
13 Id. at IV-245. The 2003 Multi-Sale EIS also analyzed the impacts of a VLOS on terrestrial mammals, vegetation and wetland habitats as well as socio-economic impacts, particularly the impacts on subsistence activities and resources. See id. at IV-239 to IV-245.
14 Id. at 14-15.
trajectories of a summer spill greater than 1,000 barrels, without any spill response activities, over time periods of 3, 15, and 30 days.

Table 4.4-1  Summer Conditional Probabilities that an Oil Spill Greater than or Equal to 1,000 bbl (Greater than or Equal to 159 m³) Starting at Launch Area 15 Will Contact a Particular Land Segment or Environmental Resource Area in 3 Days

<table>
<thead>
<tr>
<th>ID</th>
<th>Land Segment Name</th>
<th>% Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>Point Hopson and Sweeney, Staines River</td>
<td>1</td>
</tr>
<tr>
<td>43</td>
<td>Brownlow Point, Canning River</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>Environmental Resource Area Name</th>
<th>% Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Stockton Islands</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Maguire Islands</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Flaxman Islands</td>
<td>1</td>
</tr>
<tr>
<td>74</td>
<td>Cross Island ERA</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4.4-2  Summer Conditional Probabilities that an Oil Spill Greater than or Equal to 1,000 bbl (Greater than or Equal to 159 m³) Starting at Launch Area 15 Will Contact a Particular Land Segment or Environmental Resource Area in 10 Days

<table>
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<tr>
<th>ID</th>
<th>Land Segment Name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>Point Brower, Prudhoe Bay</td>
<td>1</td>
</tr>
<tr>
<td>41</td>
<td>Bullen Point, Point Gordon, Reliance Point</td>
<td>1</td>
</tr>
<tr>
<td>42</td>
<td>Point Hopson and Sweeney, Staines River</td>
<td>2</td>
</tr>
<tr>
<td>43</td>
<td>Brownlow Point, Canning River</td>
<td>2</td>
</tr>
<tr>
<td>44</td>
<td>Collinson Point, Konganevik Point</td>
<td>1</td>
</tr>
<tr>
<td>45</td>
<td>Anderson Point, Sadlerochit River</td>
<td>1</td>
</tr>
<tr>
<td>46</td>
<td>Arey Island, Barter Island</td>
<td>1</td>
</tr>
<tr>
<td>47</td>
<td>Kaktovik</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>Environmental Resource Area Name</th>
<th>% Probability</th>
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</thead>
<tbody>
<tr>
<td>3</td>
<td>Thetis and Jones Islands</td>
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<tr>
<td>4</td>
<td>Cottle and Return Islands, West Dock</td>
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</tr>
<tr>
<td>5</td>
<td>Midway Islands</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Cross and No Name Islands</td>
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<td>7</td>
<td>Endicott Causeway</td>
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<tr>
<td>8</td>
<td>McClure Island</td>
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<td>9</td>
<td>Stockton Islands</td>
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<tr>
<td>11</td>
<td>Maguire Islands</td>
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<tr>
<td>14</td>
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<tr>
<td>15</td>
<td>Arey and Barter Islands, Bernard Spit</td>
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<tr>
<td>16</td>
<td>Jago and Tapkaurak Spits</td>
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<td>71</td>
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<td>Cross Island ERA</td>
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<td>83</td>
<td>Kaktovik ERA</td>
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Table 4.4-3  Summer Conditional Probabilities that an Oil Spill Greater than or Equal to 1,000 bbl (Greater than or Equal to 159 m³)
Starting at Launch Area 15 Will Contact a Particular Land Segment or Environmental Resource Area in 30 Days

<table>
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<th>Land Segment Name</th>
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<td>37</td>
<td>Milne Point, Simpson Lagoon</td>
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<tr>
<td>38</td>
<td>Kuparuk River</td>
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</tr>
<tr>
<td>39</td>
<td>Point Brower, Prudhoe Bay</td>
<td>1</td>
</tr>
<tr>
<td>41</td>
<td>Bullen Point, Point Gordon, Reliance Point</td>
<td>1</td>
</tr>
<tr>
<td>42</td>
<td>Point Hopson and Sweeney, Staines River</td>
<td>2</td>
</tr>
<tr>
<td>43</td>
<td>Brownlow Point, Canning River</td>
<td>3</td>
</tr>
<tr>
<td>44</td>
<td>Collinson Point, Konganevik Point</td>
<td>1</td>
</tr>
<tr>
<td>45</td>
<td>Anderson Point, Sadlerochit River</td>
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</tr>
<tr>
<td>46</td>
<td>Arey Island, Barter Island</td>
<td>2</td>
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<tr>
<td>47</td>
<td>Kaktovik</td>
<td>4</td>
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<tr>
<td>48</td>
<td>Griffin Point, Oruktalik Lagoon</td>
<td>2</td>
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<tr>
<td>49</td>
<td>Angun Point, Beaufort Lagoon</td>
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<th>ID</th>
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<td>Maguire Islands</td>
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<td>Anderson Point Barrier Islands</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Arey and Barter Islands, Bernard Spit</td>
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<td>16</td>
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<td>Angun and Beaufort Lagoons</td>
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<td>69</td>
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<td>Simpson Lagoon</td>
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<td>72</td>
<td>Gwyder Bay</td>
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<td>Cross Island ERA</td>
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<tr>
<td>75</td>
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<tr>
<td>76</td>
<td>Water over Boulder Patch 2</td>
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<td>81</td>
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<tr>
<td>83</td>
<td>Kaktovik ERA</td>
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</tbody>
</table>

This analysis remains applicable for the revised Camden Bay EP. OCSLA anticipates and instructs that BOEMRE evaluate exploration and development in the OCS in a staged manner, building its analysis over the course of the lease sale, exploration, and development. The statute’s limited time period in which to approve or deny EPs indicates Congress’s intent that the agency use the environmental analysis underlying the lease sale to the extent appropriate. There is no reason not to use this approach here. The revised Camden Bay EP proposes activities that will take place within the area analyzed in the 2003 Multi-Sale EIS. Thus, any analysis of potential VLOS impacts arising from the revised Camden Bay EP properly should look to the analysis in the 2003 Multi-Sale EIS. Further, the revised Camden Bay EP proposes drill sites in the vicinity as those proposed in the 2010 Camden Bay EP approved by BOEMRE and upheld by the Ninth Circuit. Having once analyzed the VLOS impacts related to wells in these...
locations by using the 2003 Multi-Sale EIS framework, it is reasonable to take the same approach for the revised Camden Bay EP. There is no new information indicating that this approach, and the analytical framework created by the 2003 Multi-Sale EIS, is incomplete, dated or otherwise insufficient. To the contrary, additional information regarding the potential size of a “worst case” spill arising from the proposed activities, developed using new guidance from the agency in response to the Deepwater Horizon incident, indicate that such a spill would be well within the range of spills analyzed by the agency in the 2003 Multi-Sale EIS.

The drill sites proposed have worst case discharge scenarios comparable to, albeit notably lower than, the scenarios used in the 2003 Multi-Sale EIS. For example, using BOEMRE’s revised “Worst Case Scenario” guidelines, Shell calculated and reported in response to NTL-06 that, if a well control event occurred at the Sivulliq N exploration well, the most oil that would be released in a single day would be 860 bbl, on the first day.\(^{15}\) Modeling indicates that oil released from the well would decrease steadily to 556 bbl/day on the 38th day (when the relief well, if necessary, would be finished). This modeling assumes no bridging over of the well, although the wet sands formations above the oil-bearing zone and prior experiments with Hammerhead wells in the area indicate that bridging over would likely occur.\(^{16}\) If the well did bridge over the worst case discharge would fall to approximately 20 percent of the modeled amounts.\(^{17}\)

Shell has continued to refine its analysis since that submission and has determined that the worst case discharge scenarios for the proposed drill sites are as follows: Sivulliq G (594 bbl/day), Sivulliq N (918 bbl/day), Torpedo H (9,468 bbl/day), Torpedo J (5,824 bbl/day).

**Shell’s Oil Spill Response Strategies Will Mitigate the Impacts of a Spill.**

Shell has an extensive response system in place that would minimize the amount of oil reaching the environment.\(^{18}\) Shell will deploy state-of-the-art subsea blow-out preventer devices to stop all flow from the well immediately upon a well control event occurring. If that system fails, Shell will have a secondary system which will be capable of either (i) stopping the flow from the well, or (ii) capturing the flow from the well and diverting it to the surface for proper disposal. Shell anticipates that it can stop the flow from the well within 15 days of deploying this secondary system. Shell is also ready to intervene with containment devices as necessary to capture the oil below the surface to prevent interference with sea ice. If subsurface efforts are not successful at capturing and containing all oil, Shell has surface response vessels that will conduct clean-up operations. Shell also is prepared to drill a relief well, if necessary, with its primary drilling vessel (whether that be the Kulluk or Discoverer), but if the primary drilling vessel is disabled, Shell will have the other drilling vessel on standby to drill the relief well. In the event the primary drilling vessel is not available to drill the relief well, Shell anticipates that it would take a maximum of 43 days from the time the secondary drilling vessel is mobilized for it to drill a relief well at the Torpedo Prospect where the wells will be drilled slightly deeper than Sivulliq where the maximum number of days for a relief well is 38. The time to drill a relief well would be substantially shorter if the primary drilling vessel is able to drill it. Thus, even if a large spill were to occur, the impacts identified in the 2003 Multi-Sale EIS would not necessarily follow because Shell’s spill response capabilities would minimize the amount of oil reaching the environment.

\(^{15}\) *Id.* at 1, 21. A bridge over refers to the collapse of a well bore during a loss of well control, in which rock, sand, clay and other materials obstruct the well and stop the blow out.

\(^{16}\) *Id.* at 2, 23-24.

\(^{17}\) *Id.* at 23.

\(^{18}\) Shell’s *Beaufort Sea Regional Oil Discharge Prevention and Contingency Plan* provides a full description and timeline of Shell’s response capabilities (Shell 2011).
5.0 CONSULTATION

In preparation for its revised Camden Bay exploration drilling program, Shell has 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. Shell’s ongoing consultation efforts are guided by requirements from various federal agencies. BOEMRE, NMFS, and USFWS, in particular, require a POC to document consultation held between Shell and the potentially affected subsistence stakeholders. These requirements focus on the development of conflict avoidance measures between Shell and potentially affected subsistence user groups and individuals. Additionally, Shell has, and will continue to, engage with all relevant federal, state, and local agencies in regards to permitting requirements, appropriate mitigation and status of operations. Consultation with interested residents of the North Slope Borough Communities is documented in Shell’s Camden Bay Plan of Cooperation (Plan of Cooperation Addendum Revised Outer Continental Shelf Lease Exploration Plan Camden Bay) and summarized below, Shell has consulted, and/or will consult, with: BOEMRE, NMFS, USFWS, EPA, interested members of Congress (including the members of the Alaska Congressional Delegation), the State of Alaska (including the Governor’s Office, the ADNR (including, ADEC, and ADF&G, and the NSB).

5.1 Plan of Cooperation

BOEMRE Lease Sale Stipulation No. 5 requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas exploration activities and subsistence resources and activities. This stipulation also requires adherence to USFWS and NMFS regulations, which require an operator to implement a POC to mitigate the potential for conflicts between the proposed activity and traditional subsistence activities (50 CFR § 18.124(c)(4) and 50 CFR § 216.104(a)(12)). A POC was prepared and was submitted with the initial Camden Bay EP. The following is a summary of the POC Addendum which updates the POC with information regarding proposed changes in the proposed exploration drilling program, and documentation of meetings undertaken specifically to inform the stakeholders of the revise exploration drilling program and obtain their input. The POC Addendum builds upon the previous POC.

The POC identifies the measures that Shell has developed in consultation with North Slope communities and subsistence user groups and will implement during its planned Camden Bay exploration drilling program to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, the POC details Shell’s communications and consultations with local communities concerning its proposed exploration drilling program beginning in the summer of 2012, potential conflicts with subsistence resources and hunting activities, and means of resolving any such conflicts (50 CFR § 18.128(d) and 50 CFR § 216.104(a)(12)). Shell has documented its contacts with North Slope communities, as well as the substance of its communications with subsistence stakeholder groups. The addendum may be supplemented, as appropriate, to reflect additional engagements with local subsistence users and any additional or revised mitigation measures that are adopted as a result of those engagements. Shell will implement the POC addendum, and the mitigation measures set forth in the document, for its Camden Bay exploration program.

5.1.1 Affected Subsistence Community Meetings

Affected subsistence communities that were consulted regarding Shell’s planned drilling activities in Camden Bay include: Barrow, Nuiqsut, and Kaktovik. Shell conducted POC meetings in the Chukchi Sea communities of Wainwright, Point Lay and Point Hope to discuss a planned Chukchi Sea exploration drilling program, while also describing the mobilization of Camden Bay exploration drilling program vessels through the Chukchi Sea to and from the Beaufort Sea. Additionally, Shell met with subsistence
groups including the AEWC, the Nanuuq Commission, the Eskimo Walrus Committee, the Beluga Commission, the Ice Seal Commission, and presented information regarding the proposed activities to the NSB and Northwest Arctic Borough (NWAB) Assemblies, and NSB and NWAB Planning Commissions.

Beginning in early January 2009, Shell held one-on-one meetings with representatives from the NSB, subsistence-user group leadership, the Inupiat Community of the Arctic Slope (ICAS), and Village Whaling Captain Association representatives. These meetings took place at the convenience of the community leaders and in various venues. Meetings were held starting on 12 January 2009 and have continued to date. Shell’s primary purpose in holding individual meetings was to inform key leaders, prior to the public meetings, so that they would be prepared to give appropriate feedback on planned activities.

Table 5.1.1-1 provides a list of public meetings attended by Shell while developing this POC, beginning in 2009 through 2011. Comment analysis tables for numerous meetings held during 2011 summarize feedback from the communities on Shell’s planned activities beginning in the summer of 2012. These comments analysis tables, with responses from Shell and corresponding mitigation measures pertinent to the comment are included in the POC.

<table>
<thead>
<tr>
<th>Year</th>
<th>Meeting Location</th>
<th>Meeting Attendees – Position</th>
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<tbody>
<tr>
<td>2009</td>
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<tr>
<td>12-13 January</td>
<td>Barrow</td>
<td>Harry Brower – Whaling Captain, AEWC Chairman and Assistant Director of the NSB Wildlife Department Edward Itta – Whaling Captain and Mayor of the NSB Eugene Brower – Whaling Captain, ASRC Board Member and President of the NSB Assembly Anthony Edwardsen – Whaling Captain and President of UIC Andy Mack – NSB Assistant to the Mayor Harold Curran – NSB Chief Administrative Officer Robert Suydam – NSB Wildlife Department Biologist Cheryl Rosa – NSB Wildlife Department Research Biologist Craig George – NSB Wildlife Department Biologist</td>
</tr>
<tr>
<td>21 January</td>
<td>Point Hope</td>
<td>Steve Ooomittuk - Mayor of Point Hope</td>
</tr>
<tr>
<td>21 January</td>
<td>Barrow</td>
<td>Charlie Hopson – Whaling Captain Representative, LCMF employee, and AEWC alternate commissioner in Barrow Adeline Hopson – NSB Assembly Member Deano Oleuman – NSB Assembly Member</td>
</tr>
<tr>
<td>21 January</td>
<td>Barrow</td>
<td>Roy Koonuk – AEWC Commissioner and Point Hope Whaling Captain</td>
</tr>
<tr>
<td>21 January</td>
<td>Barrow</td>
<td>George Edwardson – ICAS President Juania Smith – ICAS Natural Resource Director</td>
</tr>
<tr>
<td>21 January</td>
<td>Point Hope</td>
<td>Rex Rock Sr.; NSB Assembly Member and Tikiqag Representative</td>
</tr>
<tr>
<td>27 January</td>
<td>Kotzebue</td>
<td>Jackie Hill – Maniilaq Association Representative</td>
</tr>
<tr>
<td>27 January</td>
<td>Kotzebue</td>
<td>Martha Whiting – Mayor of the NWAB</td>
</tr>
<tr>
<td>27 January</td>
<td>Kotzebue</td>
<td>NWAB Assembly Meeting</td>
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<td>Chuck Greene, EJ Doll Garoutte, Walter Sampson, Gladys Pungowiyi - NANA Representatives</td>
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<td>Kaktovik</td>
<td>Fenton Rexford NSB Assembly Member and Native Village of Kaktovik Executive Director</td>
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<td>Kaktovik</td>
<td>Carla Sims – Kaktovik Vice Mayor</td>
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<td>2 February</td>
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<td>NSB Assembly Workshop</td>
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<td>Janice Meadows – AEWC Executive Director</td>
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<td>3 February</td>
<td>Barrow</td>
<td>Vera Williams – Native Village of Barrow Realty Director</td>
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### Table 5.1.1-1 Meeting Dates and Locations

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<thead>
<tr>
<th>Date</th>
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<th>Meeting Type</th>
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<td>ICAS Monthly Meeting</td>
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<td>Taquilik Hepa – NSB Wildlife Director</td>
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<td>Bessie O’Rouke – NSB Law Department</td>
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<td>Marvin Olson – NSB Director Public Works</td>
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<td>Walter Sampson – NWAB Assembly President</td>
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<td>Utqiagvik Aqiqsiuqtit Aganangich Meeting</td>
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<td>Nuiqsut</td>
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<td>Ice Seal Committee Members</td>
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<td>Alaska Nanuuq Commission Members</td>
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<td>Eskimo Walrus Commission Members</td>
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<td>2011</td>
<td>Meeting Location</td>
<td>Meeting Attendees – Position</td>
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<tr>
<td>27 January</td>
<td>Barrow</td>
<td>Barrow Whaling Captains Association Meeting</td>
<td></td>
</tr>
</tbody>
</table>
| 27 February – 2 March | Dutch Harbor | Edith Vorderstrasse – UIC UMIAQ Consulting Division Manager  
John Long, Jr. – Native Village of Point Hope Council Member  
Joseph Frankson – Whaling Captain  
Franklin Sage – Native Village of Point Hope Council Member  
Luke Koonook, Sr. – Elder and Whaling Captain  
Alzred Oomittuk – City of Point Hope Council Member  
Bessie Kowunna – Shell Point Hope Community Liaison, Tikigaq Board Member, and City Council Member  
Theodore Frankson – Native Village of Point Hope Staff  
Aaron Oktollik – AEWC Commissioner for Point Hope and Whaling Captain  
Carl Brower – Whaling Captain  
Dora Leavitt – City of Nuiqsut Council Member  
Thomas Napageak – City of Nuiqsut Mayor and Whaling Captain  
Edgar Kagak – Wainwright Health Board  
Oliver Peetook – City of Wainwright Vice Mayor  
Sandra Peetook – City of Wainwright Council Member  
Joseph Kaleak – AEWC Commissioner for Kaktovik and Whaling Captain  
George Tagarook – NSB Fire Department Fire Chief and Whaling Captain |
| 28 February – 3 March | Dutch Harbor | William Tracey, Sr. – NSB Planning Commissioner and Point Lay Fire Chief  
Marie Tracey – NSB Village Liaison  
Emma Ahvakana – NWAB Assembly Member  
Enoch Mitchell – Noatak IRA President  
Ronald Moto, Sr. – Nana Board Member and City of Deering Mayor  
Cole Schaeffer – Kikiktagruk Inupiat Corporation President & CEO  
Nellie Wesley – NWAB Planning Commission EPA Assistant  
Anthony Edwardsen – UIC President/CEO  
Troy Izat – Tikigaq Corporation COO  
Susan Harvey – Harvey Consulting, LLC and Consultant to the NSB  
Thomas Nageak – Barrow Whaling Captain and NSB Cultural Resource Specialist  
Roy Nageak Jr. – Native Village of Barrow Natural Resource Technician  
Michael Shults – Barrow City Council  
Mary Sage – NSBSD School Board Member, Ilisagvik College Board Member, and Native Village of Barrow Council Member  
Robert Suydam – NSB Wildlife Biologist  
Qaiyaan Opie – ICAS Environmental Director  
Lloyd Leavitt – City of Barrow Council Member  
Robert Nageak – City of Barrow Council Member  
Johnny Aiken – AEWC Executive Director  
Harry Brower, Jr. – AEWC Chairman |
| 7-8 March | Anchorage        | Arctic Open Water Meeting                                                                    |
| 21 March | Barrow           | Plan of Cooperation Public Meeting                                                           |
| 22 March | Kaktovik         | Plan of Cooperation Public Meeting                                                           |
| 23 March | Wainwright       | Plan of Cooperation Public Meeting                                                           |
| 24 March | Nuiqsut          | Plan of Cooperation Public Meeting                                                           |
| 24 March | Nuiqsut          | Isaac Nukapikag – AEWC Commissioner for Nuiqsut  
Herbert Ipalook – President of the Nuiqsut Whaling Captains Association  
Thomas Napageak – Nuiqsut Whaling Captain  
Carl Brower – Nuiqsut Whaling Captain  
Eli Nukapikag – Nuiqsut Whaling Captain |
Table 5.1.1-1 Meeting Dates and Locations

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 March</td>
<td>Point Lay</td>
<td>Plan of Cooperation Public Meeting</td>
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<tr>
<td>28 March</td>
<td>Point Hope</td>
<td>Plan of Cooperation Public Meeting</td>
</tr>
<tr>
<td>29 March</td>
<td>Kiana</td>
<td>Community Meeting</td>
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<tr>
<td>30 March</td>
<td>Kotzebue</td>
<td>Community Meeting</td>
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<tr>
<td>31 March</td>
<td>Kivalina</td>
<td>Community Meeting</td>
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<tr>
<td>2 April</td>
<td>Nome</td>
<td>Vera Metcalf – Eskimo Walrus Commission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Charlie Johnson – Alaska Nanuuq Commission</td>
</tr>
<tr>
<td>5 April</td>
<td>Barrow</td>
<td>NSB Assembly Meeting</td>
</tr>
<tr>
<td>7 April</td>
<td>Kotzebue/</td>
<td>Willie Goodwin – Alaska Beluga Whale Committee</td>
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<tr>
<td></td>
<td>Anchorage (Teleconference)</td>
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<tr>
<td>8 April</td>
<td>Anchorage</td>
<td>John Goodwin – Ice Seal Committee</td>
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<tr>
<td>15 April</td>
<td>Anchorage</td>
<td>Vera Metcalf – Eskimo Walrus Commission</td>
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<tr>
<td>25 April</td>
<td>Savoonga</td>
<td>Community Meeting</td>
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<tr>
<td>26 April</td>
<td>Shishmaref</td>
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<tr>
<td>27 April</td>
<td>Gambell</td>
<td>Community Meeting</td>
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Notes:
ASRC = Arctic Slope Regional Corporation
LCMF = LCMF Incorporated, a subsidiary of Ukpeagvik Inupiat Corporation
NSBSD = North Slope Borough School District
UIC = Ukpeagvik Inupiat Corporation

5.1.2 Project Information and Presentation Materials

To present consistent and concise information regarding the planned exploration drilling program, Shell prepared presentation materials (listed below and included in the POC) for meetings with stakeholders across the North Slope.

Camden Bay Exploration Drilling Presentation Summary

- Summary of Shells Science Accomplishments
- Summary and explanation of Shell’s proposed revised Camden Bay EP
- Summary of Shell’s drilling discharge mitigation program
- Summary of Shell’s proposed drill sites for the revised Camden Bay EP

5.1.3 Meeting Process

Prior to Shell’s public meetings, communities were contacted to determine an optimal meeting date and subsequently notified by public advertising. Meeting notices and flyers were sent to each city council and Native council for public posting well in advance of the meeting dates. Public notices were also published in the Arctic Sounder, the local paper that serves most of the North Slope region, and announcements were made on the local radio station KBRW 680 AM and KOTZ 720 AM.

Community meetings are designed to allow the public to voice their concerns and speak one-on-one with project experts. Kiosks manned by subject matter experts were set-up in communities where this form of communication is deemed acceptable to facilitate direct communications, and comment cards supplied for each station. Comment cards with a Shell return address were left with the communities and a toll free telephone number and e-mail address were provided in case questions arose after the meeting. Food was provided and door prizes were given out to create a friendly environment and encourage attendance. Every effort was made to ensure the maximum amount of feedback was received and that all questions were addressed and answered to the fullest extent possible.
5.2 Consultation Plan Forward

Stakeholders have been provided information relevant to the project and have been invited to offer input on potential environmental, social, and health impacts, as well as proposed mitigation and conflict avoidance measures. Shell is seeking alignment with stakeholders and, where appropriate and feasible, will incorporate the recommendations of stakeholders into project planning.

As required by applicable lease sale stipulations, as well as anticipated IHA and LOA stipulations, Shell will continue to meet with the affected subsistence communities and users to resolve any conflicts and to notify the communities of any changes in its planned operations. This POC may be supplemented, as appropriate, to reflect additional engagements with local subsistence users and any additional or revised mitigation measures that are adopted as a result of those engagements. Shell respectfully submits that this POC meets its obligations under Stipulation No. 5, as well as the POC requirements established by applicable USFWS and NMFS regulations (50 CFR 216.104, 50 CFR 18.124 and 128).
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Revised Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska


Environmental Impact Analysis
Revised Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska

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## 7.0 LIST OF PREPARERS

<table>
<thead>
<tr>
<th>Preparer’s Name</th>
<th>Preparer’s Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Macrander</td>
<td>Alaska Environmental Team Leader</td>
</tr>
<tr>
<td>Steve Ellsworth</td>
<td>Wildlife Biologist</td>
</tr>
<tr>
<td>William Sears</td>
<td>Regulatory Assistant</td>
</tr>
<tr>
<td>Walter Sandel</td>
<td>Senior Regulatory Affairs Specialist</td>
</tr>
<tr>
<td>Geoff Merrell</td>
<td>Incident Command Coordinator</td>
</tr>
<tr>
<td>Greg Horner</td>
<td>Regulatory Assistant/Principal Scientist</td>
</tr>
<tr>
<td>Erling Westlien</td>
<td>Environmental Engineer</td>
</tr>
<tr>
<td>Cara Wright</td>
<td>Technical Editor</td>
</tr>
<tr>
<td>Kelly Poston</td>
<td>Technical Editor</td>
</tr>
<tr>
<td>John Shepard</td>
<td>Alaska Exploration Evaluation Leader</td>
</tr>
<tr>
<td>Doug Collins</td>
<td>Staff Geologist</td>
</tr>
<tr>
<td>Robert Scheidemann</td>
<td>Alaska Principal Regional Geologist</td>
</tr>
<tr>
<td>Robert Foster</td>
<td>Alaska Principal Regional Geologist</td>
</tr>
<tr>
<td>Les Skinner</td>
<td>Senior Wells Engineer</td>
</tr>
<tr>
<td>Michael Roffall</td>
<td>Senior Staff Reservoir Engineer</td>
</tr>
<tr>
<td>Nicole St. Amand</td>
<td>Environmental Compliance Analyst</td>
</tr>
<tr>
<td>Lucy Jean</td>
<td>Environmental Engineer</td>
</tr>
<tr>
<td>Pauline Ruddy</td>
<td>Regulatory Manager</td>
</tr>
<tr>
<td>Lev Yampolsky</td>
<td>Logistics Planner</td>
</tr>
<tr>
<td>Michelle Malerich</td>
<td>Project Scientist</td>
</tr>
<tr>
<td>Dale Funk</td>
<td>Marine Biologist</td>
</tr>
<tr>
<td>Craig Reiser</td>
<td>Marine Biologist</td>
</tr>
<tr>
<td>Wayne Leighty</td>
<td>Commercial Regulatory Analyst</td>
</tr>
<tr>
<td>Marcus Oder</td>
<td>GIS Analyst</td>
</tr>
</tbody>
</table>

### Preparer’s List (previous plans)

<table>
<thead>
<tr>
<th>Preparer’s Name</th>
<th>Preparer’s Title</th>
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<tbody>
<tr>
<td>Alec Bray</td>
<td>Geologist</td>
</tr>
<tr>
<td>Barbara Bohn</td>
<td>Geophysicist</td>
</tr>
<tr>
<td>Ian Voparil</td>
<td>Marine Oceanographer</td>
</tr>
<tr>
<td>Caren Mathis</td>
<td>Planner</td>
</tr>
<tr>
<td>Stacey Aughe</td>
<td>Marine Biologist</td>
</tr>
<tr>
<td>Jana Lage</td>
<td>Geologist</td>
</tr>
<tr>
<td>Meghan Larson</td>
<td>Environmental Scientist</td>
</tr>
<tr>
<td>Valli Peterson</td>
<td>Fisheries Biologist</td>
</tr>
<tr>
<td>Spencer Rearden</td>
<td>Wildlife Biologist</td>
</tr>
<tr>
<td>Shawna Rider</td>
<td>Anthropologist</td>
</tr>
<tr>
<td>Michelle Russell</td>
<td>Regulatory Specialist</td>
</tr>
<tr>
<td>Jennifer Tobey</td>
<td>Anthropologist</td>
</tr>
<tr>
<td>Wayne Wooster</td>
<td>Air Quality / Environmental Engineer</td>
</tr>
<tr>
<td>William Sears</td>
<td>Geologist</td>
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<td>Robert Watkins</td>
<td>Oil Spill Planning and Response Specialist</td>
</tr>
<tr>
<td>Clara Crosby</td>
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</tr>
<tr>
<td>Stephane Descombes</td>
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