Application for Incidental Harassment Authorization for the Non-Lethal Taking of Whales and Seals in Conjunction with Planned Exploration Drilling Program During 2012 in the Chukchi Sea, Alaska

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List of Acronyms

~	approximate
°	degrees Fahrenheit
°C	degrees Celsius
4MP	Marine Mammal Monitoring and Mitigation Plan
μPa	micropascal
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AHD	acoustic harassment devices
AISC	Alaska Ice Sea Commission
ASL	above sea level
ATOC	Acoustic Thermometry of Ocean Climate
bbl	barrels
BCB	Bering-Chukchi-Beaufort stock (bowheads)
BOEMRE	U.S. Bureau of Ocean Energy Management, Regulation and Enforcement
BOP	blowout preventer
BWASP	Bowhead Whale Aerial Survey Program
CAA	Conflict Avoidance Agreement
CFR	Code of Federal Regulations
CI	Confidence Interval
cm^3	cubic centimeters
CV	Coefficient of Variation
Com Center	Communication and Call Center
COMIDA	Chukchi Sea Offshore Monitoring in Drilling Area
dB	decibel
Discoverer	*Noble Discoverer*
DNV	Det Norske Veritas
EP	Exploration Plan
ESA	Endangered Species Act
Exploration Drilling program	Chukchi Sea Exploration Drilling Program
EWC	Eskimo Walrus Commission
Fennica	Motor Vessel *Fennica*
ft	foot/feet
hr	hour(s)
IHA	Incidental Harassment Authorization
IMP	ice management plan
in.	inch(es)
$in.^3$	cubic inch(es)
Hz	hertz
IUCN	International Union for the Conservation of Nature
km	kilometer(s)
km^2	square kilometer(s)
km/hr	kilometers per hour
LC_{50}	lethal concentration 50 percent
lb	pound(s)

m	meter(s)
mi	square miles
mi	statute mile(s)
min	minute(s)
MLC	mudline cellar
MMPA	Marine Mammal Protection Act
MMO	Marine Mammal Observer
MMS	Minerals Management Service
MONM	Marine Operations Noise Model (JASCO)
M/V	Motor Vessel
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NPDES	National Pollutant Discharge Elimination System
NSB	North Slope Borough
NWAB	Northwest Arctic Borough
OCS	Outer Continental Shelf
ODPCP	Oil Discharge Prevention and Contingency Plan
OSR	Oil Spill Response
OST	Oil Spill Tanker
OSV	offshore supply vessel
POC	Plan of Cooperation
ppm	parts per million
psi	pounds per square inch
PTD	Proposed Total Depth
PTS	Permanent Threshold Shift
RL	Received Level
rms	root mean square
ROV	remotely operated vehicle
SAR	Search and Rescue
Shell	Shell Gulf of Mexico Inc.
SEL	sound exposure level
TAH	total aromatic hydrocarbons
TTS	Temporary Threshold Shift
TK	Traditional Knowledge
U.S.	United States
USFWS	United States Fish and Wildlife Service
VSI	vertical seismic imager
VSP	vertical seismic profile
ZVSP	zero-offset vertical seismic profile

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Executive Summary

As described herein, during the 2012 exploration drilling season, Shell Gulf of Mexico Inc. (Shell) plans to drill up to three exploration wells at three drill sites, and potentially a partial well at a fourth drill site in the Chukchi Sea on Outer Continental Shelf (OCS) leases acquired from the U.S. Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). Shell plans to use the Motor Vessel (M/V) *Noble Discoverer (Discoverer)* drillship to drill the planned wells. The *Discoverer* will be attended by a minimum of eight support vessels for the purposes of ice management, anchor handling, oil spill response (OSR), refueling, and resupply.

The *Discoverer* is an industry-standard, ice-strengthened drillship similar to those routinely used in the Beaufort and Chukchi Seas since the 1980s. During exploration drilling and associated operations, the drillship will emit near continuous non-pulse sounds that ensonify only very limited areas of the ocean bottom and intervening water column. Within the timeframe of exploration drilling operations, Shell may also conduct a particular type of short-duration vertical seismic profile (VSP) survey known as a zero-offset VSP, or ZVSP in each well. The ZVSPs emit pulse sounds that also ensonify very limited areas of the ocean bottom and intervening water column for only approximately 10-14 hours. Typically, a single ZVSP survey will be performed when the well has reached PTD or final depth although, in some instances, a prior ZVSP will have been performed at a shallower depth.

Since the early 1990s, the National Marine Fisheries Service (NMFS) has issued Incidental Harassment Authorizations (IHAs) to industry for the non-lethal taking of small numbers of marine mammals related to the non-pulse, continuous sounds generated by offshore exploration drilling and impulse sounds generated during seismic surveys. Shell requests an IHA pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371 (a) (5), to allow non-lethal takes of whales and seals incidental to the 2012 exploration drilling program, including ZVSP surveys, and related activities.

Shell has calculated the estimated take of marine mammals from both the low-level continuous sound generated during exploration drilling operations, icebreaking, and impulse sound generated during a short-duration ZVSP survey likely to occur at or near the end of each well. It is assumed that any takes that might result from the proposed operations would be temporary and not be of biological significance to marine mammal populations. Any impacts from these sounds to whales and seals would be temporary and result in only short-term displacement of seals and whales from within ensonified zones produced by such sound sources.

For example, an impact analysis of underwater sound generated by the drilling vessel and a very limited amount of icebreaking activities (see Summary Table ES-1) using the average density estimates determined that only 1 bowhead whale and 1 gray whale would be exposed to sounds ≥120 decibels (dB) re 1 micropascal (µPa) root mean square (rms) equaling <1 percent of the population. An even smaller percentage of seal populations in the Chukchi Sea would be exposed to underwater sounds in excess of 120 dB re 1 µPa rms. Marginally more numbers of marine mammals would be exposed to sounds ≥160 decibels (dB) re 1 µPa for the ZVSP surveys (see Table 4-1 for marine mammal populations and Tables 6-4 and 6-7 for estimates of marine mammals exposed to sound from the exploration drilling operations, icebreaking, or ZVSPs associated with this exploration drilling program).

Table ES-1 Summary of Incidental Takes of Marine Mammals

Drilling Vessel – *Discoverer*	Icebreaking	ZVSP
1 Bowhead whale	19 Bowhead whales	5 Bowhead whales
0 Beluga whale	4 Beluga whales	1 Beluga whale
1 Gray whale	14 Gray whales	6 Gray whales
1 Bearded seals	12 Bearded seals	5 Bearded seals
17 Ringed seals	343 Ringed seals	132 Ringed seals
0 Spotted seals	7 Spotted seals	3 Spotted seals

The small numbers of other whale species and seals that may occur in the Chukchi Sea are unlikely to be present around the planned exploration drilling activities. In regard to the subsistence harvest of bowhead whale in the Chukchi Sea, as a consequence of Shell's planned mitigation measures, any effects on the bowhead whale as a subsistence resource also will be negligible.

The organization of this request for IHA follows the organization of Chapter 50 Code of Federal Regulations (CFR) 216.104 (a). The remainder of this document is organized as to follow 50 CFR §216.104 (a) (1)-(14).

Shell relied on guidance in 50 CFR § 216.104, Submission of Requests, to prepare its request for this IHA:

> (a) In order for the NMFS to consider authorizing the taking by United States (U.S.) citizens of small numbers of marine mammals incidental to a specified activity (other than commercial fishing), or to make a finding that incidental take is unlikely to occur, a written request must be submitted to the Assistant Administrator. All requests must include the following information for their activity:

1. A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals

The specific activities that can be expected to result in incidental taking of marine mammals pursuant to the requested IHA are limited to Shell's exploration drilling program and related activities, including ZVSP surveys. Shell has not included the potential impacts arising from a hypothetical oil spill in its consideration of "specified activity" in this IHA application for two reasons.

First, oil spill impacts would not be "substantially similar" to the primarily acoustic impacts that can be expected to result from exploration drilling and the ZVSP surveys. In identifying the "specified activity" at issue in this IHA, Shell has followed the instruction of the U.S. Court of Appeals for the Ninth Circuit in *Center for Biological Diversity v. Kempthorne*, 588 F.3d 701 (9th Cir. 2009). In that case, the court held that, to be consistent with the purpose of the Marine Mammal Protection Act (MMPA), "specified activities" are properly defined so that the "anticipated effects are substantially similar." *Id.* at 709. The activities specified in this IHA application – exploration drilling, ZVSP surveys, and related activities – all have the potential to cause primarily acoustic impacts and thus are substantially similar. In contrast the potential impacts from a spill would be substantially dissimilar from the primarily acoustic impacts for which this IHA is sought.

Second, impacts from speculative events, such as an oil spill, are not properly included in an IHA application. The Ninth Circuit instructed that when determining whether an activity will have a "negligible impact" on the affected marine mammal population, the analysis should focus on "effects that are 'reasonably expected' and 'reasonably likely,' but not those effects that are speculative or uncertain.'" *Id.* at 710-11. Oil spills are highly unlikely events and are not reasonably expected to occur during the course of exploration drilling and ZVSP surveys (*See* [Analysis of the Probability of an "Unspecified Activity" and Its Impacts: Oil Spill; Attachment E of this application). Thus, an analysis of whether the impacts resulting from the "specified activity" will be negligible should not include the impacts from a "speculative" oil spill.

For these reasons, Shell believes that the MMPA and NMFS's regulations implementing that statute instruct that Shell should not seek "authorization" for an action it does not intend to take, and, in fact, has expended substantial resources to prevent. Accordingly, the "specified activities" for which Shell seeks this IHA are restricted to exploration drilling, ZVSP surveys, and related activities.

Exploration Drilling

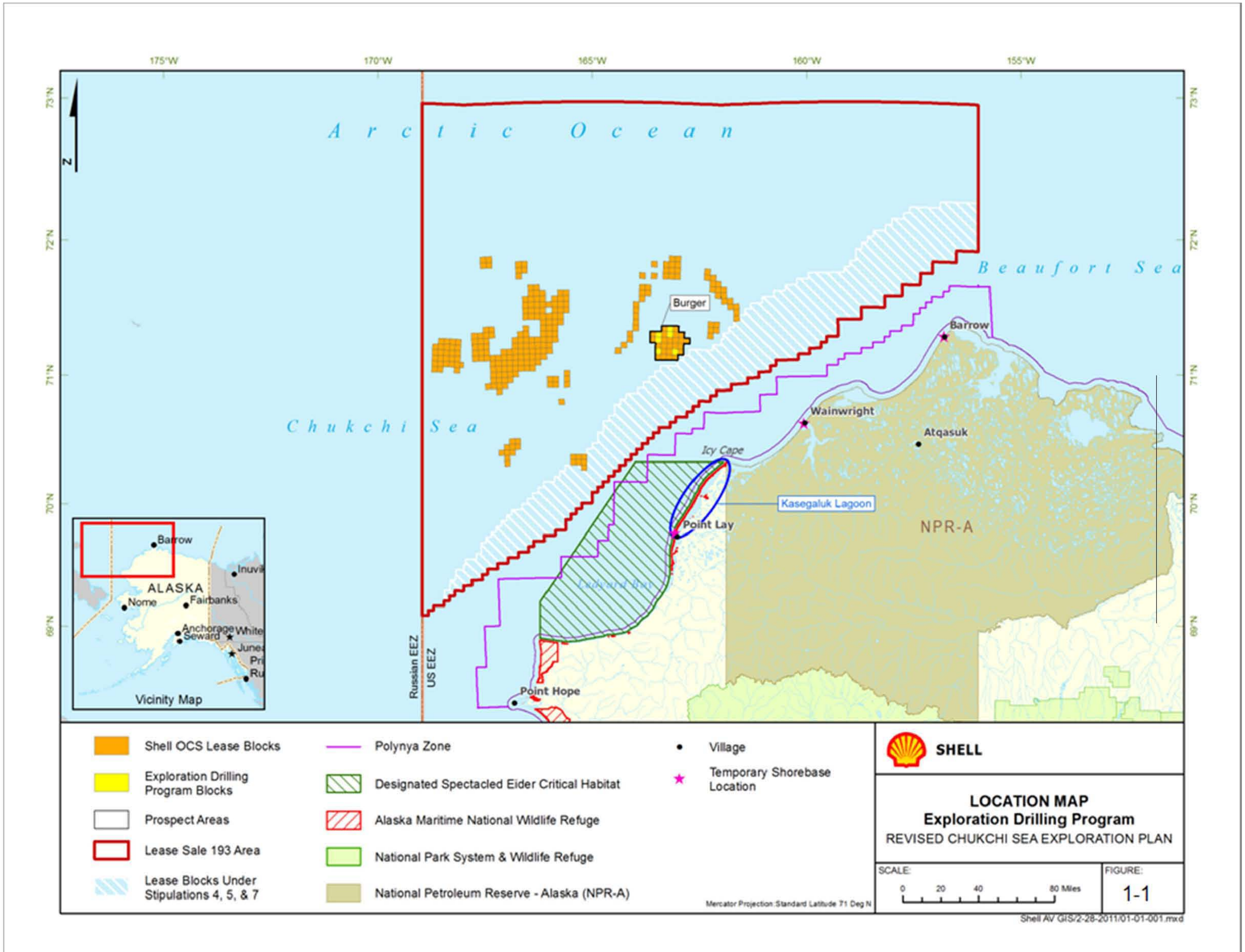
Shell plans to conduct an exploration drilling program on BOEMRE Alaska OCS leases at drill sites greater than 64 miles (mi) [103 kilometers (km)] from the Chukchi Sea coast during the 2012 exploration drilling season (Chukchi Sea Exploration Drilling Program, hereinafter, the *"exploration drilling program")* (Figure 1-1).

The leases were acquired during the Chukchi Sea Oil and Gas Lease Sale 193 held in February 2008. During 2012, the initial year of the exploration drilling program, Shell plans to drill up to three exploration wells at three drill sites, and potentially a partial well at a fourth drill site at the prospect known as Burger (Table 1-1). All wells are planned to be vertical.

Table 1-1 Shell Lease Blocks Covered in the Chukchi Sea Exploration Drilling Program Starting in 2012

Prospect	Area	Protraction	Lease Block	Shell Lease
Burger	Posey	NR03-02	6764	OCS-Y-2280
Burger	Posey	NR03-02	6714	OCS-Y-2267
Burger	Posey	NR03-02	6912	OCS-Y-2321
Burger	Posey	NR03-02	6812	OCS-Y-2294
Burger	Posey	NR03-02	6762	OCS-Y-2278
Burger	Posey	NR03-02	6915	OCS-Y-2324

Figure 1-1 Exploration Drilling Program Location Map



The ice strengthened drillship *Discoverer* will be used to drill the wells. Specifications for the *Discoverer* are included in Attachment A. While on location at the drill sites, the *Discoverer* will be affixed to the seafloor using eight 7-ton Stevpris anchors arranged in a radial array. The underwater fairleads prevent ice fouling of the anchor lines. Turret mooring allows orientation of vessel's bow into the prevailing ice drift direction to present minimum hull exposure to drifting ice. The vessel is rotated around the turret by hydraulic jacks. Rotation can be augmented by the use of the fitted bow and stern thrusters. The hull has been reinforced for ice resistance. Ice-strengthened sponsons have been retrofitted to the ship's hull.

The *Discoverer* is classed by Det Norske Veritas (DNV) as a Mobile Offshore Drilling Unit for worldwide service. It is a "1A1 Ship-Shaped Drilling Unit l" and is capable of performing exploration drilling operations offshore Alaska. The *Discoverer* has been issued with a DNV Appendix to Class stating:

"the structural strength and material quality of the 'Ice Belt' formed by the sponsons below the 8950mm A/B level, have been reviewed against the requirements for the DNV ICE-05 Additional Class Notation and found to meet those requirements (as contained in DNV Rules for Classification of Ships, Pt 5 Ch 1, July 2006) for a design temperature of -15 degrees C."

<u>Vessels</u>

During this exploration drilling program, the *Discoverer* will be attended by a minimum of eight vessels that will be used for ice management, anchor handling, OSR, refueling, resupply, and servicing of the exploration drilling operations (Tables 1-2a and 1-2b). In Table 1-2b, the barges include an accompanying tow/tug vessel, and in one case potentially an anchor handler that together with the barge are counted as one vessel attending the *Discoverer.*

The M/V *Fennica (Fennica)*, or a similar vessel, will serve as the ice management vessel in support of the *Discoverer*. This vessel will enter and exit the Chukchi Sea with the *Discoverer* and will remain at a location approximately 25 mi (40 km) upwind and upcurrent of the drillship when not in use. Any ice management would be expected to occur at a distance of 3-12 mi (5-19 km) upwind/upcurrent of the drillship. The M/V *Tor Viking (Tor Viking)* or a similar vessel will serve as the primary anchor handling vessel in support of the *Discoverer*. The vessel will enter and exit the Chukchi Sea with the *Discoverer* and will remain at a location approximately 25 mi (40 km) upwind and upcurrent of the drillship when not in use. Any ice management would be expected to occur within 0.6-6.0 mi (1.0-9.6 km) upwind from the *Discoverer*.

The planned exploration drilling operations will require two oil spill vessels (OSVs) to resupply the *Discoverer* with exploration drilling materials and supplies from facilities in Dutch Harbor and fuel. The vessels may be vessels such as the *Harvey Spirit*, and the *C-Leader*, or similar offshore supply boats.

Table 1-2a Chukchi Sea Exploration Drilling Program – Proposed Vessel List

Specification	Ice Management Vessel [1]	Anchor Handler [2]	OSV [3]	OSV [4]
Length	380 ft 116 m	275 ft 83.8 m	280 ft 85.3 m	280 ft 85.3 m
Width	85 ft 26 m	59 ft 18 m	60 ft 18 m	60 ft 18 m
Draft	27 ft 8.2 m	20 ft 6.1 m	15.9 ft 4.8 m	19 ft 5.8 m
Accommodations	82 berths	64 berths	37 berths	29 berths
Maximum Speed	16 knots 30 km/hr	16 knots 30 km/hr	13 knots 24 km/hr	13 knots 24 km/hr
Fuel Storage	11,070 bbl 1,760 m^3	7,484 bbl 1,190 m^3	6,233 bbl 991 m^3	7,217 bbl 1,147 m^3

[1] Based on *Fennica,* or similar vessel
[2] Based on *Tor Viking,* or similar vessel
[3] Based on the *Harvey Spirit,* or similar vessel
[4] Based on *C-Leader,* or similar vessel

Oil Spill Response Vessels

The OSR vessels supporting the exploration drilling program include a dedicated OSR barge and an OSR vessel, both of which have associated smaller workboats, an oil spill tanker (OST), and a containment barge (Table 1-2b) . An OSR vessel such as the *Nanuq* will be staged in the vicinity of the drillship when the *Discoverer* is drilling in liquid hydrocarbon bearing zones to immediately respond to a spill and provide containment, recovery, and storage for the initial operational period following a spill event. The *Nanuq* or similar vessel will be paired with an OST such as the *Mikhail Ulyanov* and used to assist refueling the *Discoverer* and support vessels, if necessary. An OSR barge, such as the *Klamath*, or similar vessel and a tug, such as the Crowley *Sea Robin*, will be staged offshore in the vicinity of the drillship. Together with the OSR vessel, it will have sufficient containment, recovery, and storage capacity for the initial operational period in the event of a spill. It will carry a 47-ft (14-m) skimming vessel, three 34-ft (10-m) workboats, four mini-barges, and boom and duplex skimming units for nearshore recovery. An OST such as the *Mikhail Ulyanov* or similar vessel with a minimum liquid storage capacity of 513,000 bbl will be staged such that it would arrive at a recovery site, if needed, within 24 hours of departure from their 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 in the unlikely event of a spill and OSR operations.

An additional barge housing the oil spill containment system will be stationed offshore, where it can be mobilized to a drill site when needed. The barge will be supported by an Invader Class Tug and possibly an anchor handler. The tug tending the OSR containment system barge will either drift or motor under “slow-steam” movement with the barge. An anchor handler is included in this plan only as an additional tending option for the OSR containment system barge, if Shell deems it necessary in advance of the season to anchor the OSR containment system barge. Shell does not assume the OSR containment system barge will be anchored or that the anchor handler is necessary, but includes the option of anchoring the barge and it being also tended by an anchor handler in case that option is chosen.

Table 1-2b Chukchi Sea Exploration Drilling Program – Proposed Oil Spill Response Vessel List

Specification	OSR Vessel [1,2]	OSR Barge [1]		OST [1,4]	Containment Barge [1,5]		
		Barge [3]	Tug [3]		Barge	Tug	Anchor Handler
Length	301 ft 91.9 m	350 ft 106.7 m	126 ft 38.4 m	853 ft 260 m	400 ft 122 m	136 ft 36.5 m	275 ft 83.7 m
Width	60 ft 18.3 m	76 ft 23.1 m	34 ft 10.4 m	112 ft 34 m	100 ft 30.5 m	36 ft 11.1 m	59 ft 18.0 m
Fuel Storage	6,867 bbl (1,092 m^3)	390 bbl (62 m^3)	1,786 bbl (284 m^3)	221,408 bbl (35,200 m^3)	--	3,690 bbl (587 m^3)	7,484 bbl (1190 m^3)
Liquid Storage	12,690 bbl (2,017 m^3)	76,900 bbl (12,226 m^3)	--	543,000 bbl (86,328 m^3)	--	--	--
Accommodations	41	--	6	25	--	10	64 berths
Maximum Speed	16 knots	--	5 knots	16 knots	--	10 knots	16 knots
Workboats	(3) 34 ft work boats	(1) skim boat 47 ft (14 m) (3) work boats 34 ft (10 m) (4) mini-barges	--	--	--	--	--

[1] Or similar vessel
[2] Based on the *Nanuq*
[3] Based on the barge *Klamath* and the tug Crowley *Sea Robin*
[4] Based on the *Mikhail Ulyanov, the* OST will have a minimum storage capacity of 513,000 bbl.
[5] Based on a standard deck barge, Crowley Invader class ocean going tug, and a *Vidar, or Tor Viking*-style anchor handler

Aircraft

Offshore operations will be serviced by helicopters operated out of onshore support base locations. The helicopters are not yet contracted. A Sikorsky S-92 or Eurocopter EC225 capable of transporting 10 to 12 persons will be used to transport crews between the onshore support base and the drillship. The helicopters will also be used to haul small amounts of food, materials, equipment, and waste between vessels and the shorebase. The helicopter will be housed at facilities at the Barrow airport. Shell will have a second helicopter for Search and Rescue (SAR). The SAR helicopter is expected to be a Sikorsky S-61, S-92, Eurocopter EC225, or similar model. This aircraft will stay grounded at the Barrow shorebase location except during training drills, emergencies, and other non-routine events.

A fixed wing propeller or turboprop aircraft, such as Saab 340-B 30-seat, Beechcraft 1900, or deHavilland Dash8 will be used to routinely transport crews, materials, and equipment between the shorebase and hub airports such as Barrow or Fairbanks. A fixed wing aircraft, deHavilland Twin Otter (DHC-6) will be used for marine mammal observer (MMO) flights.

Table 1-2c Chukchi Sea 2012 Exploration Drilling Program – Proposed Aircraft List

Aircraft	Flight Frequency
Aircraft (or similar)	
Sikorsky S-92 or Eurocopter EC225 - crew rotation	Approximately 12 round trips per week between land and offshore vessels throughout the 2012 exploration drilling season
Sikorsky S-61, S-92 or Eurocopter EC225 helicopter – SAR	Trips made only in emergency; training flights
Saab 340-B or Beechcraft 1900 or deHavilland Dash8 (Only 1) – onshore crew/supply trips	Infrequent, up to 4 trips per week from shorebase to hub airports in Barrow, Anchorage, or Fairbanks
deHavilland Twin Otter (DHC-6) – Used for 4MP	Daily, beginning 5-7 days before drilling and ending 5-7 days after drilling ends

The ice reinforced drillship *Discoverer* will move through the Bering Strait and into the Chukchi Sea on or about July 1, and then onto the Burger Prospect as soon as ice and weather conditions allow. Exploration drilling activities will be curtailed on or before 31 October, and the drillship and support vessels will exit the Chukchi Sea at the conclusion of the exploration drilling season.

Vertical Seismic Profile

Shell may conduct a geophysical survey referred to as a vertical seismic profile or ZVSP at each drill site where a well is drilled in 2012. During ZVSP surveys, an airgun array is deployed at a location near or adjacent to the drillship, while receivers are placed (temporarily anchored) in the wellbore. 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 ZVSP 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 will be conducting a particular form of VSP known as the ZVSP, in which the sound source is maintained at a constant location near the wellbore (Figure 1-2). A typical sound source that likely would be used by Shell in 2012 is the ITAGA eight-airgun array, which consists of four 150 cubic inches (in.^{3}) (2,458 cubic centimeters [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. Current specifications of the array are provided in Table 1-3. The airgun array is depicted within its frame or sled, which is approximately 6 ft (2 m) x 5 ft (1.5 m) x 10 ft (3 m) (see photograph below). Typical receivers would consist of a Schlumberger wireline four level vertical seismic imager (VSI) tool, which has four receivers 50-ft (15-m) apart.

Photograph of the ITAGA 8-airgun array in sled

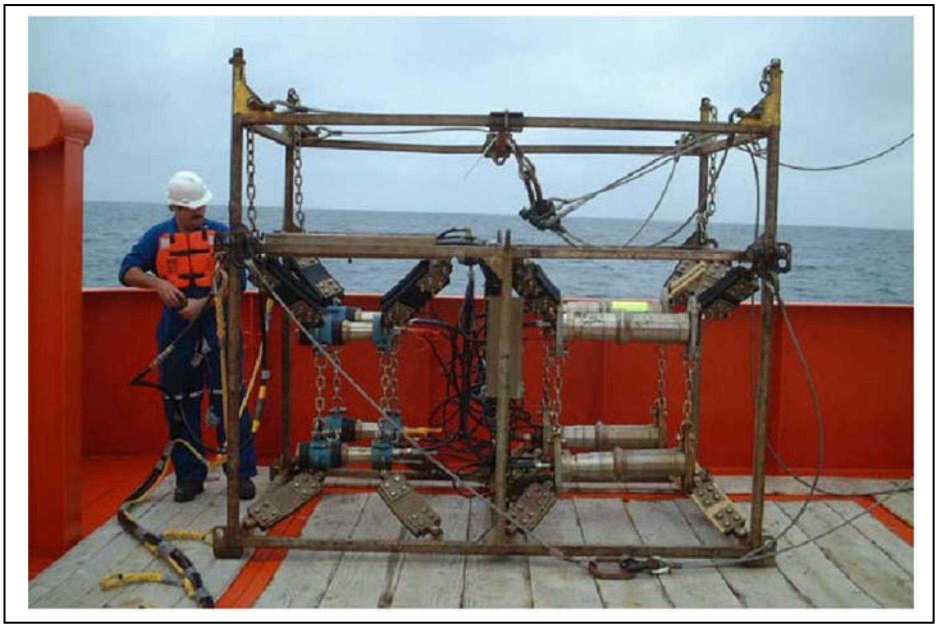


Figure 1-2 Schematic of ZVSP

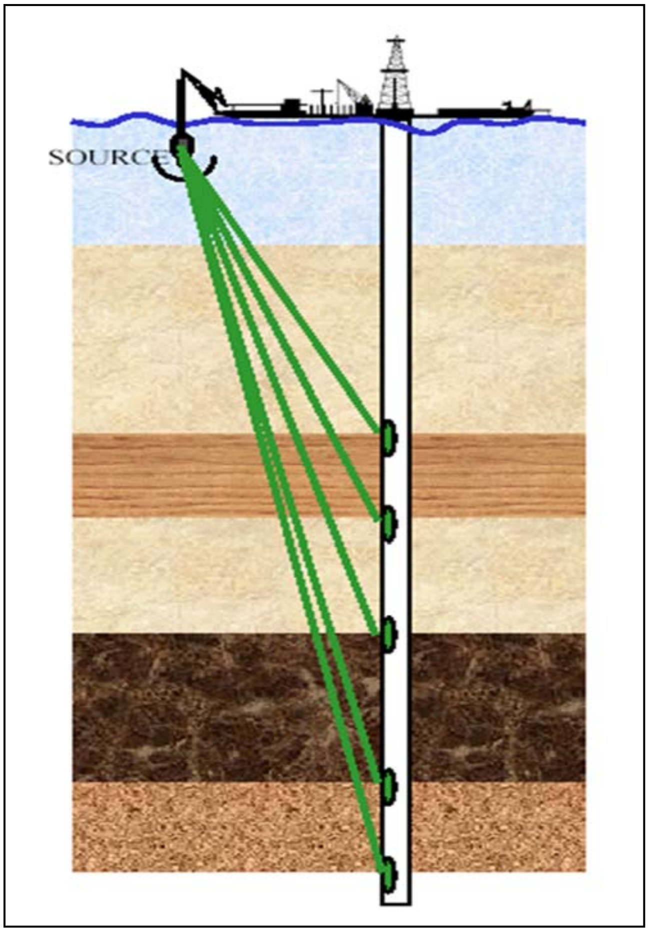


Table 1-3 Sound Source (Airgun Array) Specifications for ZVSP Surveys in the Chukchi Sea in 2012

Source Type	No. Sources	Maximum Total Chamber Size	Pressure	Source Depth	Calibrated Peak-Peak Vertical Amplitude	Zero-Peak Sound Pressure Level
SLB, ITAGA Sleeve Array	8 airguns 4 X 150 in.^{3} (2458 cm^3) 4 X 40 in.^{3} (655 cm^3)	760 in.^{3} 12,454 cm^3	2,000 psi 138 bar	9.8 ft / 3.0 m 16.4 ft / 5.0 m	16 bar @1m 23 bar @1m	238 dB re1µPa @1m 241 dB re1µPa @1m

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 *Discoverer* with a crane (sound source will be 50-200 ft (15-61 m) from the wellhead depending on crane location), to a depth of approximately 10-23 ft (3-7 m) below the water surface. The VSI, with its four receivers will be temporarily anchored in the wellbore at depth. The sound source will be pressured up to 2,000 pounds per square inch (psi) (138 bar), and activated 5-7 times at approximately 20-second intervals. The VSI will then be moved to the next interval of the wellbore and re-anchored, after which the airgun array will again be activated 5-7 times. This process will be repeated until the entire wellbore is surveyed in this manner. The interval between anchor points for the VSI usually is between 200-300 ft (61-91 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.

Ice Management and Forecasting

Shell recognizes the exploration drilling program is located in an area that is characterized by active sea ice movement, ice scouring, and storm surges. In anticipation of potential ice hazards that may be encountered, Shell will implement an IMP (see Attachment B) to ensure real-time ice and weather forecasting to identify conditions that might put operations at risk and modify its activities accordingly. The IMP also contains ice threat classification levels depending on the time available to suspend exploration drilling operations, secure the well and escape from advancing hazardous ice. Realtime ice and weather forecasting will be available to operations personnel for planning purposes and to alert the fleet of impending hazardous ice and weather conditions. Ice and weather forecasting is provided by Shell's Ice and Weather Advisory Center (SIWAC). This center is continuously manned by experienced personnel who rely on a number of data sources for ice forecasting and tracking including:

- Radarsat and Envisat data - satellites with Synthetic Aperture Radar providing all-weather imagery of ice conditions with very high resolution;

- Moderate Resolution Imaging Spectroradiometer - a satellite providing lower resolution visual and near infrared imagery;

- Aerial reconnaissance - provided by specially deployed fixed wing or rotary wing aircraft for confirmation of ice conditions and position;

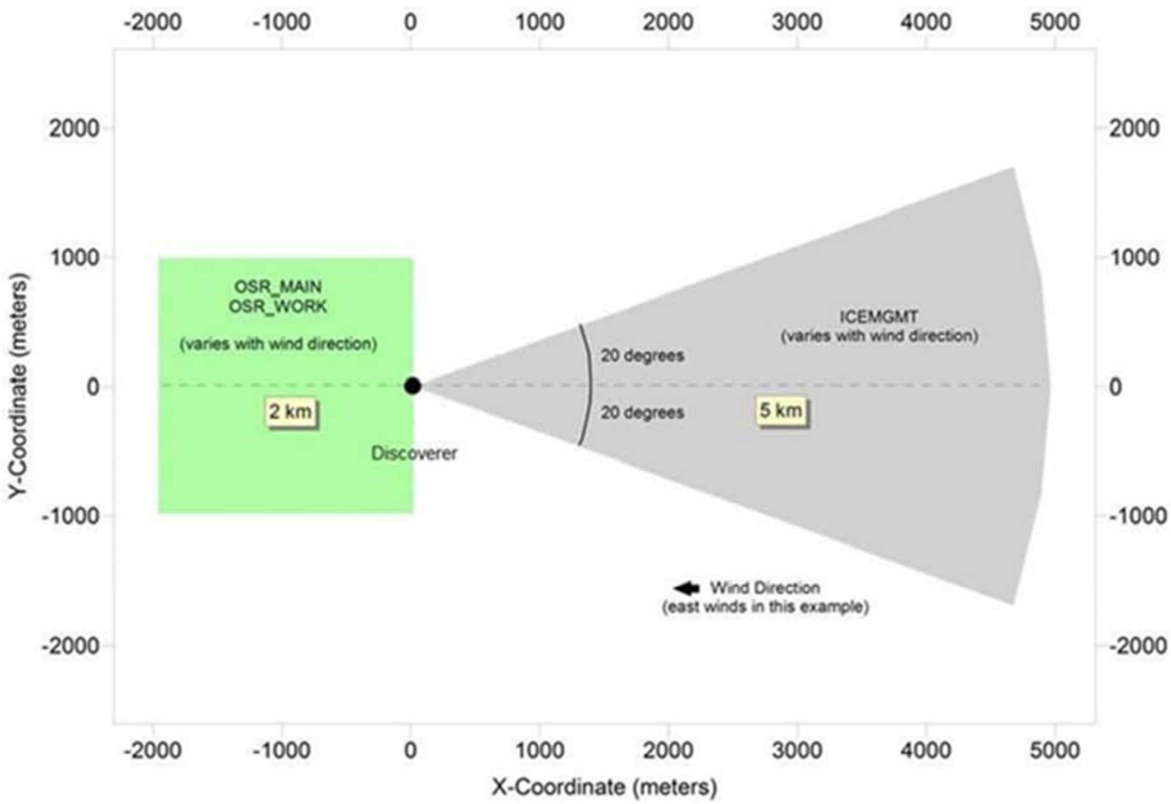
- Reports from Ice Specialists on the ice management vessel and anchor handler and from the Ice Observer on the drillship;

- Incidental ice data provided by commercial ships transiting the area; and
- Information from the National Oceanic and Atmospheric Administration ice centers and the University of Colorado.

Drift ice will be actively managed by ice management vessels, consisting of an ice management vessel and an anchor handling vessel. Ice management for safe operation of Shell's planned exploration drilling program will occur far out in the OCS, remote from the vicinities of any routine marine vessel traffic in the Chukchi Sea, thereby resulting in no threat to public safety or services that occur near to shore. Shell vessels will also communicate movements and activities through the 2012 North Slope Communications Centers. Management of ice by ice management vessels will occur during an exploration drilling season predominated by open water and thus will not contribute to ice hazards, such as ridging, override, or pileup in an offshore or nearshore environment.

The ice-management/anchor handling vessels would manage the ice by deflecting any ice floes that could affect the *Discoverer* when it is drilling and would also handle the *Discoverer's* anchors during connection to and separation from the seafloor. When managing ice, the *Fennica* and *Tor Viking* will generally be operate a 40^{o} arc up to 3.1 mi (4.9 km) upwind originating at the *Discoverer* (Figure 1-3).

Figure 1-3 Ice Management Vessels Configuration for the *Discoverer*



The ice-management/anchor handling vessels would manage any ice floes upwind of the *Discoverer* by deflecting those that could affect the *Discoverer* when it is on location conducting exploration drilling operations. The ice-management/anchor handling vessels would also manage the *Discoverer's* anchors during connection to and separation from the seafloor. The ice floe frequency and intensity are unpredictable and could range from no ice to ice densities that exceed ice-management capabilities, in which case exploration drilling operations would be stopped and the *Discoverer* disconnected from its anchors and moved 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 data regarding historic ice patterns in the area of operations indicate that it will not be required throughout the planned exploration drilling season. 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 *Discoverer* without building up in front of 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 *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.

During Chukchi Sea exploration drilling operations, Shell does not plan to conduct any icebreaking activities; rather, Shell will deploy its support vessels to manage ice as described herein. As detailed in Shell's IMP (see Attachment B), actual breaking of ice will occur only in the unlikely event that ice conditions in the immediate vicinity of operations create a safety hazard for the drilling vessel. In such a circumstance, operations personnel will follow the guidelines established in the IMP to evaluate ice conditions and make the formal designation of a hazardous, ice alert condition, which would trigger the procedures that govern any actual icebreaking operations. Historical data relative to ice conditions in the Chukchi Sea in the vicinity of Shell's planned operations, and during the timeframe for those operations, establish that there is a very low probability (e.g., minimal) for the type of hazardous ice conditions that might necessitate icebreaking (e.g., records of the National Naval Ice Center archives). This probability could be greater at the shoulders of the exploration drilling season (early July or late October); therefore, for purposes of evaluating possible impacts of the planned activities, Shell has assumed limited icebreaking activities for a very limited period of time, and estimated incidental takes of marine mammals (see Section 6) from such activities.

Planned Mitigation

NMFS regulations, which require an operator to implement a Plan of Cooperation (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)). An initial POC was prepared and was submitted to NMFS (and BOEMRE) in May 2009 with an initial Chukchi Sea Exploration Plan (EP). For this IHA application and the revised Chukchi Sea EP submitted to BOEMRE in May 2011, Shell prepared a POC Addendum which updates the initial POC with information regarding proposed changes in the proposed exploration drilling program, and documentation of meetings undertaken to inform the stakeholders of the revised exploration drilling program. The POC Addendum (see Attachment D) builds upon the initial, previous POC.

The *Discoverer* and all support vessels will operate in accordance with the provisions of the POC Addendum and presumed vessel operation mitigation measures included in past IHAs issued to Shell for arctic activities. Shell's POC Addendum will mitigate effects of Shell's planned exploration drilling program where activities would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses. The initial POC and POC Addendum were prepared based upon Shell's experience (recent and past) since the 1980s in the Alaska OCS and in consultation with affected Chukchi Sea communities and marine mammal commissions. During these meetings, Shell focused on lessons learned from prior years' activities and presented mitigation measures for avoiding potential conflicts, which are outlined in the POC Addendum. Shell's POC Addendum addresses the issues of vessel transit, drilling, aerial support, and associated onsite vessel activities. The mitigation measures described in Section 12.3 are intended to minimize any adverse effects on the availability of marine mammals for subsistence uses.

2. The dates and duration of such activity and the specific geographic region where it will occur

Anticipated Duration of this Permit

Shell anticipates that the IHA issued by NMFS for the planned Chukchi Sea exploration drilling program will be valid from the date of issuance through the conclusion of the 2012 exploration drilling season.

Timing of Mobilization and Demobilization of the *Discoverer*

Shell's base plan is for the ice management vessel, the *Fennica* (or similar, primary ice management), the anchor handler M/V *Tor Viking* (or similar, secondary ice management), OSVs, and potentially some of the OSR vessels to accompany the *Discoverer* traveling north from Dutch Harbor through the Bering Strait, on or about 1 July 2012, then into the Chukchi Sea, before arriving on location approximately 4 July. Exploration drilling is expected to be conducted through 31 October 2012. At the end of the exploration drilling season, these support vessels, along with various other support vessels will accompany the *Discoverer* as it travels south out of the Chukchi Sea, through the Bering Strait to Dutch Harbor, Alaska. Subject to ice conditions, alternate exit routes may be considered.

Exploration Drilling

All three, and potentially a forth partial well, will be at Shell's Burger Prospect (Figure 1) in the EP submitted to BOEMRE. Shell has identified a total of six Chukchi Sea EP lease blocks (Table 2-1 and Figure 1-1) on the Burger Prospect. All of the six drill sites listed on Table 2-1 are located more than 64 mi (103 km) off the coast in the Chukchi Sea. During 2012, the *Discoverer* will be used to drill up to three exploration wells and potentially a fourth partial well on four of the six possible leases (Table 2-1). For this exploration drilling program, Shell will mobilize into the Chukchi Sea on or about July 1, and commence exploration drilling at the Burger Prospect as soon as ice, weather, and other conditions allow for safe exploration drilling operations.

Activities associated with the Chukchi Sea exploration drilling program and analyzed herein include operation of the *Discoverer*, associated support vessels, crew change support and resupply. The *Discoverer* will remain at the location of the designated exploration drill sites except when mobilizing and demobilizing to and from the Chukchi Sea, transiting between drill sites, and temporarily moving off location if it is determined ice conditions require such a move to ensure the safety of personnel and/or the environment in accordance to Shell's IMP. The anchor handler and OSR vessels will remain in close proximity to the drillship during exploration drilling operations. The ice management vessel will generally be working upwind/upcurrent of the drillship from 3-12 mi (5-19 km) away. Crew change/resupply vessels will transit to and from the drillship at the estimated frequencies shown in Table 1-2c.

Helicopter flight support will provide crew changes. Fixed-wing aircraft will transport crews to regional hub airports, and to support aerial surveys for the marine mammal monitoring program.

Table 2-1 Drill Site Locations and Water Depths

Drill Site	Approximate Distance from shore (statute miles)	Lease Block No.	Surface Location (NAD 83)		Water Depth
			Latitude (north)	Longitude (west)	Feet/Meters
Burger A	75	6764	71° 18' 30.92"	163° 12' 43.17"	150/45.8
Burger F	76	6714	71° 20' 13.96"	163° 12' 21.75"	149/45.4
Burger J	69	6912	71° 10' 24.03"	163° 28' 18.52"	144/44.0
Burger R	75	6812	71° 16' 06.57"	163° 30' 39.44"	143/43.7
Burger S	78	6762	71° 19' 25.79"	163° 28' 40.84"	147/44.9
Burger V	65	6915	71° 10' 33.39"	163° 04' 21.23"	147/44.7

Shell plans to cease drilling on or before 31 October, after which the *Discoverer* will exit the Alaskan Chukchi Sea. Shell anticipates that the exploration drilling program will require approximately 32 days per well including mudline cellar (MLC) construction. These estimates exclude any downtime for weather or other operational delays. Shell also assumes approximately 10 additional days will be needed for transit, drillship mobilization and mooring, drillship moves between locations, and drillship demobilization.

3. Species and Numbers of Marine Mammals in Area

Marine mammals that occur in the area of the planned exploration drilling activities belong to three taxonomic groups: odontocetes (toothed cetaceans, such as beluga whale and narwhal), mysticetes (baleen whales), and carnivora (pinnipeds and polar bears). Cetaceans and pinnipeds (except Pacific walrus) are the subject of this IHA application to NMFS. The Pacific walrus and polar bear are managed by the U.S. Fish & Wildlife Service (USFWS) are not discussed further in this application.

Marine mammal species under the jurisdiction of NMFS that are known to or may occur in the area of the planned exploration drilling activity include nine cetacean species and four species of pinnipeds. Three of these species, the bowhead, humpback and fin whales, are listed as "endangered" under the Endangered Species Act (ESA). The bowhead whale is more common in the area than the other two species. The fin whale is unlikely to be encountered near the planned activities, but a few sightings in the Chukchi Sea have been reported in recent years. Similarly, humpback whales are not known to regularly occur in the Chukchi Sea; however several humpback sightings were recorded during vessel-based surveys in the Chukchi Sea in 2007 (Reiser et al. 2009a). Two species of seal (ringed seal and bearded seal) have been proposed for listing as "threatened" species under the ESA (NMFS 2010a,b). Both species are common and abundant in the Chukchi Sea.

To avoid redundancy, we have included the required information about the species that are known to or may be present and, insofar as they are known, numbers of these species in Section 4, below.

4. Status, Distribution and Seasonal Distribution of Affected Species or Stocks of Marine Mammals

Sections 3 and 4 are integrated here to minimize repetition.

Marine mammal species under NMFS jurisdiction most likely to occur in the area of the planned exploration drilling activities in the Chukchi Sea include four cetacean species (beluga, bowhead and gray whales, and harbor porpoise), and three pinniped species (ringed, bearded, and spotted seals). Densities of marine mammals in the area of operations are likely to be higher if the ice edge occurs nearby. The marine mammal species that is likely to be encountered most widely (in space and time) throughout the period of the exploration drilling activities is ringed seal. Encounters with bowhead and gray whales are expected to be limited to particular seasons, as discussed below.

Table 4-1 The Habitat, Abundance, and Conservation Status of Marine Mammals Inhabiting the Area

Species	Habitat	Abundance	ESA[1]	IUCN[2]	CITES[3]
Odontocetes Beluga whale (*Delphinapterus leucas*) (Eastern Chukchi Sea Stock)	Offshore, Coastal, Ice edges	3,710[4]	Not listed	NT	–
Beluga whale (Beaufort Sea Stock)	Offshore, Coastal, Ice edges	39,257[5]	Not listed	NT	–
Narwhal (*Monodon monoceros*)	Offshore, Ice edge	Rare[6]	Not listed	NT	–
Killer whale (*Orcinus orca*)	Widely distributed	Uncommon	Not listed	DD	–
Harbor Porpoise (*Phocoena phocoena*) (Bering Sea Stock)	Coastal, inland waters, shallow offshore waters	48,215[4] Common[7]	Not listed	LR-lc	–
Mysticetes Bowhead whale (*Balaena mysticetus*)	Pack ice & coastal	10,545[8] 12,631[9]	Endangered	LR-lc	I
Gray whale (*Eschrichtius robustus*) (eastern Pacific population)	Coastal, lagoons, shallow offshore waters	488[10] 17,500[11]	Not listed	LR-lc	I
Minke whale (*Balaenoptera acutorostrata*)	Shelf, coastal	Rare	Not listed	LR-lc	I
Fin whale (*Balaenoptera physalus*)	Slope, mostly pelagic	Rare	Endangered	EN	I
Humpback whale (*Megaptera novaeangliae*)	Shelf, coastal	Rare	Endangered	LR-lc	I
Pinnipeds Bearded seal (*Erignathus barbatus*)	Pack ice, shallow offshore waters	250,000- 300,000[12] 155,000[13]	Proposed Threatened	LR-lc	–
Spotted seal (*Phoca largha*)	Pack ice, coastal haulouts, offshore	59,214[14]	Arctic pop. segments not listed	DD	–
Ringed seal (*Pusa hispida*)	Landfast & pack ice, offshore	~208,000- 252,000[15]	Proposed Threatened	LR-lc	–
Ribbon seal (*Histriophoca fasciata*)	pack ice, offshore	90-100,000[16]	Not Listed	DD	–

[1] U.S. Endangered Species Act.

[2] Red List of Threatened Species (IUCN 2010). Codes for IUCN classifications: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR = Lower Risk (nt = Near Threatened; lc = Least Concern); DD = Data Deficient
[3] Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2004)
[4] Allen and Angliss (2010)
[5] Beaufort Sea population (IWC 2000, Allen and Angliss 2010)
[6] Population in Baffin Bay and the Canadian arctic archipelago is ~60,000 (DFO 2004); very few enter the Beaufort Sea
[7] Vessel-based observations from Industry activities in 2006–2008 (Haley et al. 2010)
[8] 2001 B-C-B Bowhead population estimate (Zeh and Punt 2005)
[9] 2004 B-C-B Bowhead population estimate (Koski et al. 2010)
[10] Southern Chukchi Sea and northern Bering Sea (Clark and Moore 2002)
[11] North Pacific gray whale population (Rugh 2003 *in* Keller and Gerber 2004) ; see also Rugh et al. (2005)
[12] Alaska population (MMS 1996)
[13] Beringia Distinct Population Segment (NMFS 2010a)
[14] Alaska stock based on aerial surveys in 1992 (Allen and Angliss 2010)
[15] Eastern Chukchi Sea population (Bengtson et al. 2005)
[16] Bering Sea, (Burns 1981a)

Five additional cetacean species—the narwhal, killer whale, minke whale, humpback whale, and fin whale—could occur, but each of these species is uncommon or rare in the project area and relatively few encounters with these species are expected during the exploration drilling program. The narwhal occurs in Canadian waters and occasionally occurs in the Alaskan Beaufort Sea and the Chukchi Sea, but is considered extralimital in U.S. waters and is not expected to be encountered.

4.1 Odontocetes

(a) Beluga (Delphinapterus leucas)

The beluga whale is an arctic and subarctic species that includes several populations in Alaska and northern European waters. It has a circumpolar distribution in the Northern Hemisphere and occurs between 50º and 80ºN latitude (Reeves et al. 2002). It is distributed in seasonally ice-covered seas and migrates to warmer coastal estuaries, bays, and rivers in summer for molting (Finley 1982).

Pod structure in beluga groups appears to be along matrilineal lines, with males forming separate aggregations. Small groups are often observed traveling or resting together. Belugas often migrate in groups of 100 to 600 animals (Braham and Krogman 1977). The relationships between whales within groups are not known, although hunters have reported that belugas form family groups with whales of different ages traveling together (Huntington 2000).

In Alaska, beluga whales comprise five distinct stocks: Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea, Bristol Bay, and Cook Inlet (O'Corry-Crowe et al. 1997). For the planned project, only the Beaufort Sea and eastern Chukchi Sea stocks may be encountered.

The most recent estimate of the ***eastern Chukchi Sea population*** is 3,710 animals (Allen and Angliss 2010). This estimate was based on surveys conducted in 1989–1991. Survey effort was concentrated on the 106 mi (171 km) long Kasegaluk Lagoon where belugas are found during the open-water season. The actual number of beluga whales recorded during the surveys was much lower. Correction factors to account for animals that were underwater and for the proportion of newborns and yearlings that were not observed due to their small size and dark coloration were used to calculate the estimate. The calculation was considered to be a minimum population estimate for the eastern Chukchi Sea stock because the surveys on which it was based did not include offshore areas where belugas are also likely to occur. This population is considered to be stable. It is assumed that beluga whales from the eastern Chukchi stock winter in the Bering Sea (Allen and Angliss 2010).

Although beluga whales are known to congregate in Kasegaluk Lagoon during summer, evidence from a small number of satellite-tagged animals suggests that some of these whales may subsequently range into the Arctic Ocean north of the Beaufort Sea. Suydam et al. (2005a) put satellite tags on 23 beluga whales captured in Kasegaluk Lagoon in late June and early July 1998–2002. Five of these whales moved far into the Arctic Ocean and into the pack ice to 79–80°N latitude. These and other whales moved to areas as far as 685 mi (1,102 km) offshore between Barrow and the Mackenzie River Delta spending time in water with 90 percent ice coverage.

During aerial surveys in nearshore areas ~23 mi (~37 km) offshore in the Chukchi Sea in 2006 and 2007, peak beluga sighting rates were recorded in July. Lowest monthly sighting rates were recorded in September (Thomas et al. 2009). When data from the two years were pooled, beluga whale sighting rates and number of individuals were highest in the band 16-22 mi (26-35 km) offshore. However the largest single groups were sighted at locations near shore in the band within 3 mi (5 km) of the shoreline.

Beluga whales from the eastern Chukchi Sea stock are an important subsistence resource for residents of the village of Point Lay, adjacent to Kasegaluk Lagoon, and other villages in northwest Alaska. Each year, hunters from Point Lay drive belugas into the lagoon to a traditional hunting location. The belugas have been predictably sighted near the lagoon from late-June through mid- to late-July (Suydam et al. 2001a). In 2007, approximately 70 belugas were also harvested at Kivalina located southeast of Point Hope.

Belugas of the eastern Chukchi Sea population could occur in the vicinity of the planned exploration drilling activities throughout the summer months. Based on the results of satellite telemetry data at least some of this stock may also pass the project area during fall migration; however, data from Thomas et al. (2009) suggests the highest concentration of belugas may be expected to occur much closer to shore than Shell’s planned exploration drilling activities.

The ***Beaufort Sea population*** was estimated to contain 39,257 individuals as of 1992 (Allen and Angliss 2010). 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). Beluga whales of the Beaufort Sea stock winter in the Bering Sea, summer in the eastern Beaufort Sea, and migrate in offshore waters of western and northern Alaska (Allen and Angliss 2010). The majority of belugas in the Beaufort Sea stock migrate through the Chukchi Sea and into the Beaufort Sea in April or May, although some whales may pass Point Barrow as early as late-March and as late as July (Braham et al. 1984; Ljungblad et al. 1984; Richardson et al. 1995b). Beluga whales associated with the Beaufort Sea population would be most likely to occur near the planned exploration drilling activities during fall migration through the Chukchi Sea in October.

(b) Narwhal (Monodon monoceros)

Narwhals have a discontinuous Arctic distribution (Hay and Mansfield 1989; Reeves et al. 2002). A large population inhabits Baffin Bay, West Greenland, and the eastern part of the Canadian Arctic archipelago, while much smaller numbers inhabit the Northeast Atlantic/East Greenland area. The IUCN-World Conservation Union lists the species as “near threatened” (IUCN 2010). Aerial surveys of four hunting grounds off the coast of Greenland in 2006 yielded abundance estimates of between 6,024 and 8,368 individuals in each area (Heide-Jørgensen et al. 2010). Innes et al. (2002) estimated a population size of 45,358 narwhals in the Canadian Arctic although little of the area was surveyed. More recent surveys of portions of Baffin Bay in the Canadian High Arctic resulted in a total population estimate of >60,000 individuals (Richard et al. 2010). The Alaskan Beaufort Sea is not defined as a portion of a narwhal population’s range and it is considered extralimital in this region (Reeves et al. 2002). However, there are scattered records of narwhal in Alaskan waters. Thus, it is possible, but very unlikely, that individuals could be encountered in the area of the planned exploration drilling activities in the Chukchi Sea.

(c) Killer Whale (*Orcinus orca*)

Killer whales are cosmopolitan and globally fairly abundant. The killer whale is very common in temperate waters, but it also frequents the tropics and waters at high latitudes. Killer whales appear to prefer coastal areas, but are also found in deep water (Dahlheim and Heyning 1999). The greatest abundance is thought to be within 497 mi (800 km) of major continents (Mitchell 1975) and the highest densities occur in areas with abundant prey. Both resident and transient stocks have been described. These are believed to differ in several aspects of morphology, ecology, and behavior including dorsal fin shape, saddle patch shape, pod size, home range size, diet, travel routes, dive duration, and social integrity of pods (Allen and Angliss 2010).

Killer whales are known to inhabit almost all coastal waters of Alaska, extending from southeast Alaska through the Aleutian Islands to the Bering and Chukchi seas (Allen and Angliss 2010). 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. Killer whales are more common southwest of Barrow in the southern Chukchi Sea and the Bering Sea. Based on photographic techniques, ~100 animals have been identified in the Bering Sea (ADFG 1994). Killer whales from either the North Pacific resident or transient stock could occur in the Chukchi Sea during the summer or fall. The number of killer whales likely to occur in the Chukchi Sea during the planned activity is unknown. MMOs onboard industry vessels in the Chukchi Sea recorded one killer whale sighting in 2006 and two sightings in 2007 (Reiser et al. 2009a).

(d) Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise is a small odontocete that inhabits shallow, coastal waters—temperate, subarctic, and arctic—in the Northern Hemisphere (Read 1999). Harbor porpoises occur mainly in shelf areas where they can dive to depths of at least 722 ft (220 m) and stay submerged for more than 5 minutes (Harwood and Wilson 2001) feeding on small schooling fish (Read 1999). Harbor porpoises typically occur in small groups of only a few individuals and tend to avoid vessels (Richardson et al. 1995a).

The subspecies *Phocoena phocoena vomerina* ranges from the Chukchi Sea, Pribilof Islands, Unimak Island, and the southeastern shore of Bristol Bay south to San Luis Obispo, California. Point Barrow, Alaska, is the approximate northeastern extent of their regular range (Suydam and George 1992), though there are extralimital records east to the mouth of the Mackenzie River in the Northwest Territories, Canada and recent sightings in the Beaufort Sea in the vicinity of Prudhoe Bay during surveys in 2007 and 2008 (Lyons et al. 2009).

Although separate harbor porpoise stocks for Alaska have not been identified, Alaskan harbor porpoises have been divided into three groups for management purposes. These groups include animals from southeast Alaska, Gulf of Alaska, and Bering Sea populations. Harbor porpoises present in the Chukchi Sea belong to the Bering Sea group, which includes animals from Unimak Pass northward. Based on aerial surveys in 1999, the Bering Sea population was estimated at 66,078 animals, although this estimate is likely conservative as the surveyed area did not include known harbor porpoise range near the Pribilof Islands or waters north of Cape Newenhan (~55°N latitude; Allen and Angliss 2010). Suydam and George (1992) suggested that harbor porpoises occasionally occur in the Chukchi Sea and reported nine records of harbor porpoise in the Barrow area in 1985–1991. More recent vessel-based surveys in the Chukchi Sea found that the harbor porpoise was commonly encountered during summer and fall from 2006–2008 (Haley et al. 2010).

Based on recent surveys the harbor porpoise is likely to be one of the most abundant cetaceans encountered throughout the Chukchi Sea and is likely to occur in the vicinity of the planned exploration drilling activities.

4.2 Mysticetes

(a) Bowhead Whale (Balaena mysticetus)

Bowhead whales only occur at high latitudes in the northern hemisphere and have a disjunct circumpolar distribution (Reeves 1980). The bowhead is one of only three whale species that spend their entire lives in the Arctic. Bowhead whales are found in four areas: the western Arctic (Bering, Chukchi, and Beaufort seas) of northeastern Russia, Alaska and northwestern Canada; the Canadian High Arctic and West Greenland (Nunavut, Baffin Bay, Davis Strait, and Hudson Bay); the Okhotsk Sea (eastern Russia); and the Northeast Atlantic from Spitzbergen westward to eastern Greenland. Those four stocks are recognized for management purposes. The largest is the Western Arctic or Bering–Chukchi–Beaufort (BCB) stock, which includes whales that winter in the Bering Sea, and migrate through the Bering Strait, Chukchi Sea, and

Alaskan Beaufort Sea to the Canadian Beaufort Sea, where they feed during the summer. These whales migrate west through the Alaskan Beaufort Sea in the fall as they return to wintering areas in the Bering Sea. Satellite tracking data reported by the Alaska Department of Fish and Game (ADF&G) indicate that most bowhead whales continue migrating west past Barrow and through the northern Chukchi Sea to Russian waters before turning south toward the Bering Sea. Visual and satellite tracking data show that many bowhead whales continue migrating west past Barrow and through the northern Chukchi Sea to Russian waters before turning southeast toward the Bering Sea (Moore et al. 1995; Mate et al. 2000; Quakenbush et al. 2010). Some bowheads reach ~75ºN latitude during the westward fall migration (Quakenbush et al. 2010).

The pre-exploitation population of bowhead whales in the Bering, Chukchi, and Beaufort seas is estimated to have been 10,400-23,000 whales. Commercial whaling activities in the late-1800s and early-1900s may have reduced this population to as few as 3,000 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 14–74 bowheads from 1973 to 1997 (Suydam et al. 1995a). A census in 2001 yielded an estimated annual population growth rate of 3.4 percent (95 percent confidence interval, 1.7–5 percent) from 1978 to 2001 and a population size (in 2001) of ~10,470 animals (George et al. 2004, revised to 10,545 by Zeh and Punt (2005). A photo identification population estimate from data collected in 2004 estimated the population (in 2004) to be 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 percent, 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 Angliss 2010).

The BCB stock of bowhead whales winters in the central and western Bering Sea and many of these whales summer in the Canadian Beaufort Sea (Moore and Reeves 1993). Spring migration through the Chukchi Sea occurs through offshore ice leads, generally from March through mid-June (Braham et al. 1984; Moore and Reeves 1993), well before the onset of the planned exploration drilling activities.

Some bowheads arrive in coastal areas of the eastern Canadian Beaufort Sea and Amundsen Gulf in late May and June, but most may remain among the offshore pack ice of the Beaufort Sea until mid- summer. After feeding primarily in the Canadian Beaufort Sea and Amundsen Gulf, bowheads migrate westward from late August through mid- or late-October. Fall migration into Alaskan waters is primarily during September and October. However, in recent years a small number of bowheads have been seen or heard offshore from the Prudhoe Bay region during the last week of August (Treacy 1993; LGL and Greeneridge 1996; Greene 1997; Greene et al. 1999; Blackwell et al. 2004, 2009a; Greene et al. 2007). Satellite tracking of bowheads has also shown that some whales move to the Chukchi Sea prior to September (Quakenbush et al. 2010).

Bowheads commonly interrupt their migration to feed along the Alaskan Beaufort Sea coast (Ljungblad et al. 1986; Lowry 1993; Landino et al. 1994; Würsig et al. 2002; Lowry et al. 2004) and their stop-overs vary in duration from a few hours to a few weeks (Koski et al. 2002). The nearest of these known feeding areas to the proposed operations in the Chukchi Sea is just east of Pt. Barrow, which is approximately 156 mi (250 km) from the Burger prospect. This location is currently under intensive study as part of the BOWFEST program (BOWFEST 2011).

Westbound bowheads typically reach the Barrow area in mid-September, and remain there until late October (e.g., Brower 1996). However, over the years, local residents report having seen a small number of bowhead whales feeding off Barrow or in the pack ice off Barrow during the summer. Bowhead whales that are thought to be part of the Western Arctic stock may also occur in small numbers in the Bering and Chukchi seas during the summer (Rugh et al. 2003). Thomas et al. (2009) also reported bowhead sightings in 2006 and 2007 during summer aerial surveys in the Chukchi Sea. All sightings were recorded in the northern portion of the study area, north of 70ºN latitude. Autumn bowhead whaling near Barrow normally begins in mid-September to early October, but may begin as early as August if whales are observed and ice conditions are favorable (USDI/BLM 2005). Whaling near Barrow can continue into October, depending on the quota and conditions.

Most spring-migrating bowhead whales would likely pass through the Chukchi Sea prior to the start of the planned exploration drilling activities. However, a few whales that may remain in the Chukchi Sea during the summer could be encountered during the exploration drilling activities or by transiting vessels. More encounters with bowhead whales would be likely to occur during the westward fall migration in late September through October. An ongoing GPS tagging study (Quakenbush et al. 2010) has provided information on fall bowhead movements across the Chukchi Sea. Most bowheads migrating in September and October appear to transit across the northern portion of the Chukchi Sea to the Chukotka coast before heading south toward the Bering Sea (Quakenbush et al. 2009). Some of these whales have traveled well north of the planned operations, but others have passed near to, or through, the proposed project area. In addition to other planned mitigation, Shell will operate in consultation with stakeholders to avoid disturbance to subsistence bowhead whaling activities in the Chukchi Sea, should such a subsistence bowhead hunt occur during the period of Shell's planned 2012 exploration drilling activities.

(b) Gray Whale (Eschrichtius robustus)

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. There are two populations in the North Pacific. A relic population, which survives in the Western Pacific, summers near Sakhalin Island far from the area of the planned exploration drilling activities. The larger eastern Pacific or California gray whale population recovered significantly from commercial whaling during its protection under the MMPA (and ESA until 1994) and numbered about 29,758 ±3,122 in 1997 (Rugh et al. 2005). However, abundance estimates since 1997 indicate a consistent decline followed by the population stabilizing or gradually recovering. Rugh et al. (2005) estimated the population to be 18,178 ±1,780 in winter 2001-2002 and Rugh et al. (2008) estimated the population in winter 2006-2007 to have been 20,110 ±1,766. The eastern Pacific stock is not considered by NMFS to be endangered or to be a strategic stock.

Eastern Pacific gray whales calve in the protected waters along the west coast of Baja California and the east coast of the Gulf of California from January to April (Swartz and Jones 1981; Jones and Swartz 1984). At the end of the calving season, most of these gray whales migrate about 5,000 mi (8,000 km), generally along the west coast of North America, to the main summer feeding grounds in the northern Bering and Chukchi seas (Tomilin 1957, Rice and Wolman 1971, Nerini 1984, Moore et al. 2003, Bluhm et al. 2007). Most gray whales begin the southward migration in November with breeding and conception occurring in early December (Rice and Wolman 1971).

Most summering gray whales have historically congregated in the northern Bering Sea, particularly off St. Lawrence Island in the Chirikov Basin (Moore et al. 2000), and in the southern Chukchi Sea. More recently, Moore et al. (2003) suggested that gray whale use of Chirikov Basin has decreased, likely as a result of the combined effects of changing currents resulting in altered secondary productivity dominated by lower-quality food. Coyle et al. (2007) noted that amplescid amphipod production in the Chirikov Basin had declined by 50 percent from the 1980s to 2002-2003 and that as little as 3-6 percent of the current gray whale population could consume 10-20 percent of the amplescid amphipod annual production. These data support the hypotheses that changes in gray whale distribution may be caused by changes in food production and that gray whales may be approaching or have surpassed the carrying capacity of their summer feeding areas. Bluhm et al. (2007) noted high gray whale densities along ocean fronts and suggested that ocean fronts may play an important role in influencing prey densities in eastern North Pacific gray whale foraging areas. The northeastern-most of the recurring feeding areas is in the northeastern Chukchi Sea southwest of Barrow (Clarke et al. 1989).

Gray whales routinely feed in the Chukchi Sea during the summer. Moore et al. (2000) reported that during the summer, gray whales in the Chukchi Sea were clustered along the shore primarily between Cape Lisburne and Point Barrow and were associated with shallow, coastal shoal habitat. In autumn, gray whales were clustered near shore at Point Hope and between Icy Cape and Point Barrow, as well as in offshore waters southwest of Point Barrow at Hanna Shoal and northwest of Point Hope. The distribution of grays was different during aerial surveys in the Chukchi Sea in 2006 and 2007 (Thomas et al. 2009). In 2006, gray whales were most abundant along the coast south of Wainwright and offshore of Wainwright (Thomas et al. 2007), and in 2007, gray whales were most abundant in nearshore areas from Wainwright to Barrow (Thomas et al. 2009). Gray whales occur fairly often near Point Barrow, but historically only a small number of gray whales have been sighted in the Beaufort Sea east of Point Barrow.

Although they are most common in portions of the Chukchi Sea close to shore, gray whales may also occur in offshore areas of the Chukchi Sea, particularly over offshore shoals. Gray whales are likely to be in the vicinity of the planned exploration drilling activities in the Chukchi Sea and are likely to be one of the most commonly encountered cetacean species, along with the harbor porpoise (Reiser et al. 2011).

(c) Minke Whale (Balaenoptera acutorostrata)

Minke whales have a cosmopolitan distribution at ice-free latitudes (Stewart and Leatherwood 1985), and also occur in some marginal ice areas. Allen and Angliss (2010) recognize two minke whale stocks in U.S. waters: (1) the Alaska stock, and (2) the California/Oregon/ Washington stock. There is no abundance estimate for the Alaska stock. Provisional estimates of minke whale abundance based on surveys in 1999 and 2000 are 810 and 1003 whales in the central-eastern and south-eastern Bering Sea, respectively. These estimates have not been corrected for animals that may have been submerged or otherwise missed during the surveys, and only a portion of the range of the Alaskan stock was surveyed. Minke whales range into the Chukchi Sea, but the level of minke whale use of the Chukchi Sea is unknown. Minke whales have been observed from vessels during previous industry activities in the Chukchi Sea (Haley et al. 2010) and during aerial surveys conducted by the National Marine Mammal Laboratory (NMML) (COMIDA 2011).

(d) Fin Whale (Balaenoptera physalus)

Fin whales are widely distributed in all the world's oceans (Gambell 1985), but typically occur in temperate and polar regions. Fin whales feed in northern latitudes during the summer where their prey include plankton, as well as shoaling pelagic fish, such as capelin *Mallotus villosus* (Jonsgård 1966a,b). The North Pacific population's summering grounds span from the Chukchi Sea to California (Gambell 1985). Three fin whale sightings were made in 2008 from industry vessels and NMFS/NMML survey aircraft in the northern Chukchi Sea off of Ledyard Bay indicating that the range of fin whales may be expanding. Population estimates for the entire North Pacific region range from 14,620 to 18,630, however, reliable estimates are not available (Allen and Angliss 2010). Provisional estimates of fin whale abundance in the central-eastern and southeastern Bering Sea are 3,368 and 683, respectively. No estimates for fin whale abundance during the summer in the Chukchi Sea are available. Reiser et al. (2009a) reported a fin whale sighting during vessel-based surveys in the Chukchi Sea in 2006. Fin whale is listed as "endangered" under the ESA and by the IUCN (2010), and in the North Pacific is classified as a strategic stock by NMFS. Fin whales could be encountered in very low numbers during the exploration drilling activities in the Chukchi Sea.

(e) Humpback Whale (Megaptera novaeangliae)

Humpback whales are distributed in major oceans worldwide but are apparently absent from Arctic waters of the North Pacific (Allen and Angliss 2010). In general, humpback whales spend the winter in tropical and sub-tropical waters where breeding and calving occur, and migrate to higher latitudes for feeding during the summer.

Humpback whales were hunted extensively during the 20th century and worldwide populations may have been reduced to ~10 percent of their original numbers. The International Whaling Commission banned commercial hunting of humpback whales in the Pacific Ocean in 1965 and humpbacks were listed as "endangered" under the ESA and depleted under the MMPA in 1973. Most humpback whale populations appear to be recovering well.

Humpbacks feed on euphausiids, copepods, and small schooling fish, notably herring, capelin, and sandlance (Reeves et al. 2002). As with other baleen whales, the food is trapped or filtered when large amounts of water are taken into the mouth and forced out through the baleen plates. Individual humpback whales can often be identified by distinctive patterns on the tail flukes. They are frequently observed breaching or engaged in other surface activities. Adult male and female humpback whales average 46 and 49 ft (14 and 15 m) in length, respectively (Wynne 1997). Humpbacks have large, robust bodies and long pectoral flippers, which may reach ⅓ of their body length. The dorsal fin is variable in shape and located well back toward the posterior ⅓ of the body on a hump which is particularly noticeable when the back is arched during a dive (Reeves et al. 2002).

Allen and Angliss (2010) reported that at least three humpback whale populations have been identified in the North Pacific. Two of these stocks may be relevant to the planned exploration drilling activities in the Chukchi Sea. The Central North Pacific stock winters in waters near Hawaii and migrates to British Columbia, Southeast Alaska, and Prince William Sound to Unimak Pass to feed during the summer. The Western North Pacific stock winters off the coast of Japan and probably migrates to the Bering Sea to feed during the summer. There may be some overlap between the Central and Western North Pacific stocks.

Humpback whale sightings in the Bering Sea have been recorded southwest of St. Lawrence Island, the southeastern Bering Sea, and north of the central Aleutian Islands (Moore et al. 2002, Allen and Angliss 2010). Recently there have been sightings of humpback whales in the Chukchi Sea and a single sighting in the Beaufort Sea (Green et al. 2007). Reiser et al. (2009a) reported four humpback whales during vessel-based surveys in the Chukchi Sea in 2007 and Haley et al. (2009) reported one humpback whale sighting during 2008 operations. Green et al. (2007) reported and photographed a humpback whale cow/calf pair east of Barrow near Smith Bay in 2007. Small numbers of humpback whales could occur within or near the exploration drilling activities in the Chukchi Sea.

4.3 Pinnipeds

(a) Bearded Seal (*Erignathus barbatus*)

Bearded seals are associated with sea ice and have a circumpolar distribution (Burns 1981b). They have occasionally been reported to maintain breathing holes in sea ice and broken areas within the pack ice, particularly if the water depth is <656 ft (<200 m) (e.g., Harwood et al. 2005). Bearded seals apparently also feed on ice-associated organisms when they are present, and this allows a few bearded seals to live in areas where water depth is considerably greater than 656 ft (200 m) (Cameron et al. 2009). During the summer period, bearded seals occur mainly in relatively shallow areas because they are predominantly benthic feeders (Burns 1981b). No reliable estimate of bearded seal abundance is available for the Chukchi Sea (Allen and Angliss 2010). 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).

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly 1988). During winter, most bearded seals in Alaskan waters are found in the Bering Sea. In the Chukchi and Beaufort seas, favorable conditions are more limited, and consequently, bearded seals are less abundant there during winter. From mid-April to June as the ice recedes, some of the bearded seals that overwintered in the Bering Sea migrate northward through the Bering Strait. During the summer, they are found near the widely fragmented margin of multi-year ice covering the continental shelf of the Chukchi Sea and in nearshore areas of the central and western Beaufort Sea.

In Alaskan waters, bearded seals occur over the continental shelves of the Bering, Chukchi, and Beaufort Seas (Burns 1981b). The Alaska stock of bearded seals may consist of 300,000–450,000 individuals (MMS 1996). Bengtson et al. (2005) reported bearded seal densities in the Chukchi Sea ranging from 0.18 to 0.36 seals/square miles (mi^2) (0.07 to 0.14 seals/square kilometers [km^2]) in 1999 and 2000, respectively. No population estimates could be calculated since these densities were not adjusted for haulout behavior. Bearded seals are common in offshore pack ice, but there have been high bearded seal numbers observed near the shore south of the project area near Kivalina. Haley et al. (2010) reported bearded seal densities ranging from 0.03 to 0.23 seals/mi^2 (0.01 to 0.09 seals/km^2) in the summer and fall, respectively, during vessel-based surveys in the Chukchi Sea. These densities were lower than those reported by Bengtson et al. (2005) but are not directly comparable since the latter densities were based on aerial surveys of seals on sea ice in late May and early June. Bearded seals are likely to be encountered during exploration drilling operations, and greater numbers of bearded seals are likely to be encountered if the ice edge occurs nearby.

(b) Spotted Seal (*Phoca largha*)

Spotted seals (also known as largha seals) occur in the Beaufort, Chukchi, Bering, and Okhotsk Seas, and south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977). They migrate south from the Chukchi Sea and through the Bering Sea in October (Lowry et al. 1998). Spotted seals overwinter in the Bering Sea and inhabit the southern margin of the ice during spring (Shaughnessy and Fay 1977).

An early estimate of the size of the world population of spotted seals was 370,000–420,000, and the size of the Bering Sea population, including animals in Russian waters, was estimated to be 200,000–250,000 animals (Bigg 1981). The total number of spotted seals in Alaskan waters is not known (Allen and Angliss 2010), but the estimate is most likely between several thousand and several tens of thousands (Rugh et al. 1997). During the summer, spotted seals are found in Alaska from Bristol Bay through western Alaska to the Chukchi and Beaufort seas. The ADF&G placed satellite transmitters on four spotted seals in Kasegaluk Lagoon and estimated that the proportion of seals hauled out was 6.8 percent. Based on an actual minimum count of 4,145 hauled out seals, Allen and Angliss (2010) estimated the Alaskan population at 59,214 animals. The Alaska stock of spotted seals is not classified as endangered, threatened, or as a strategic stock by NMFS (Allen and Angliss 2010), although the southern distinct population segment of spotted seals was recently listed as a threatened species, it occurs entirely outside of U.S. waters.

During spring when pupping, breeding, and molting occur, spotted seals are found along the southern edge of the sea ice in the Okhotsk and Bering seas (Quakenbush 1988; Rugh et al. 1997). In late April and early May, adult spotted seals are often seen on the ice in female-pup or male-female pairs, or in male-female-pup triads. Subadults may be seen in larger groups of up to 200 animals. 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 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 69–72ºN latitude. 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).

In the Chukchi Sea, Kasegaluk Lagoon and Icy Cape are important areas for spotted seals. Spotted seals haul out in this region from mid-July until freeze-up in late October or November. Lowry et al. (1998) reported a maximum count of about 2,200 spotted seals in the lagoon during aerial surveys. No spotted seals were recorded along the shore south of Pt. Lay. Based on satellite tracking data, Frost and Lowry (1993) reported that spotted seals tagged at Kasegaluk Lagoon spent 94 percent of the time at sea. Extrapolating the count of hauled-out seals to account for seals at sea would suggest a Chukchi Sea population of about 36,000 animals. Few spotted seals are expected to occur near the planned exploration drilling activities in the Chukchi Sea.

(c) Ringed Seal (*Phoca hispida*)

Ringed seals have a circumpolar distribution and occur in all seas of the Arctic Ocean (King 1983). They are closely associated with ice and, in the summer, they often occur along the receding ice edges or farther north in the pack ice. In the North Pacific, they occur in the southern Bering Sea and range south to the seas of Okhotsk and Japan. 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).

Ringed seals are year-round residents in the Chukchi and Beaufort seas and the ringed seal is the most frequently encountered seal species in the area. During winter, ringed seals occupy landfast ice and offshore pack ice of the Bering, Chukchi and Beaufort seas. In winter and spring, the highest densities of ringed seals are found on stable shorefast ice. However, in some areas where there is limited fast ice but wide expanses of pack ice, including the Beaufort Sea, Chukchi Sea and Baffin Bay, total numbers of ringed seals on pack ice may exceed those on shorefast ice (Burns 1970, Stirling et al. 1982, Finley et al. 1983). Ringed seals maintain breathing holes in the ice and occupy lairs in accumulated snow (Smith and Stirling 1975). They give birth in lairs from mid-March through April, nurse their pups in the lairs for 5–8 weeks, and mate in late April and May (Smith 1973, Hammill et al. 1991, Lydersen and Hammill 1993).

No estimate for the size of the Alaska ringed seal stock is currently available (Allen and Angliss 2010). Past ringed seal population estimates in the Bering-Chukchi-Beaufort area ranged from 1–1.5 million (Frost 1985) to 3.3–3.6 million (Frost et al. 1988). During aerial surveys in 1999, Bengtson et al. (2005) reported ringed seal densities offshore from Shishmaref to Barrow ranging from 1.0 to 9.6 seals/mi^2 (0.4 to 3.7 seals/km^2) and estimated the total Chukchi Sea population at 245,048 animals in 1999. Densities were higher in nearshore than offshore locations. During vessel-based observations from industry activities in the Chukchi Sea, Haley et al. (2010) reported seal densities (assumed to be almost entirely ringed seals) from 0.18 to 1.92 seals/mi^2

(0.07 to 0.74 seals/km^2) in summer and fall, respectively. Ringed seal will likely be the most abundant marine mammal species encountered in the Chukchi Sea during exploration drilling operations.

(d) Ribbon Seal (Histriophoca fasciata)

Ribbon seals are found along the pack-ice margin in the southern Bering Sea during late winter and early spring and they move north as the pack ice recedes during late spring to early summer (Burns 1970, Burns et al. 1981a). Little is known about their summer and fall distribution, but Kelly (1988) suggested that they move into the southern Chukchi Sea, based on a review of sightings during the summer. However, ribbon seals appeared to be relatively rare in the northern Chukchi Sea. During recent vessel-based surveys in 2006-2008 there were only two ribbon seal sightings among the total of 1,390 seal sightings identified to species (Haley et al. 2010). Ribbon seals are expected to be rare in the planned project area.

5. Type of Incidental Take Authorization Requested

Shell requests an IHA pursuant to Section 101(a)(5)(D) of the MMPA for incidental take by harassment of small numbers of cetaceans and pinnipeds during its planned exploration drilling activities in the Chukchi Sea during July–October, 2012.

The operations outlined in sections 1 and 2 have the potential to take marine mammals by "Level B" harassment as a result of sound energy introduced to the marine environment. Sounds that may "harass" marine mammals will include continuous sounds generated by the exploration drilling activities and pulsed sounds generated by the airguns used during the ZVSP activities. The effects will depend on the species of cetacean or pinniped, the behavior of the animal at the time of reception of the stimulus, as well as the distance and received level of the sound (see section 7). Disturbance reactions are likely to vary among some of the marine mammals in the general vicinity of the sound source. No "take" by serious injury is reasonably expected or reasonably likely, given the nature of the specified activities and the mitigation measures that are planned (see Section 11). No lethal takes are expected.

6. Numbers of Marine Mammals That May be Taken

Shell seeks authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of the NMFS in the planned region of activity. Species most likely to be encountered include bowhead and gray whales, beluga, harbor porpoise, and ringed, spotted, and bearded seals. Exposure estimates and requests for takes of ribbon seal, fin whale, humpback whale, killer whale, minke whale, and narwhal are also included, but are minimal because sightings of these species in the Chukchi Sea are rare.

The only anticipated impacts to marine mammals are associated with underwater sound propagation from exploration drilling and ZVSP activities, potential icebreaking activities, and associated support vessels. Impacts would consist of temporary displacement of marine mammals from within ensonified zones produced by such sound sources.

The exploration drilling activities in the Chukchi Sea planned by Shell are not expected to "take" more than small numbers of marine mammals, or have more than a negligible effect on their populations. Discussions of estimated "takes by harassment" are presented below.

All anticipated takes would be "takes by harassment", involving temporary changes in behavior. The mitigation measures to be applied will minimize the possibility of injurious takes. However, there is no specific information demonstrating that injurious "takes" would occur even in the absence of the planned mitigation measures. In the sections below, we describe methods to estimate "take by harassment" and present estimates of the numbers of marine mammals that might be affected during the planned exploration drilling program in the Chukchi Sea. The estimates are based on data obtained during marine mammal surveys in and near the planned exploration drilling sites and on estimates of the sizes of the areas where effects could potentially occur. Adjustments to reported population or density estimates were made to account for seasonal distributions and population increases or declines insofar as possible.

The main sources of distributional and numerical data used in deriving the estimates are described in the next subsection. There is some uncertainty about the representativeness of those data and the assumptions used below to estimate the potential "take by harassment". However, the approach used here is the best available at this time.

Basis for Estimating "Take by Harassment"

"Take by Harassment" is calculated in this section by multiplying the expected densities of marine mammals that may occur near the exploration drilling operations by the area of water likely to be exposed to continuous sounds ≥120 dB re 1 μPa rms during exploration drilling operations or icebreaking activities, and impulsive sounds ≥160 dB re 1 μPa rms created by seismic airguns during ZVSP surveys.

Marine mammal occurrence near the operation is likely to vary by season and habitat, mostly related to the presence or absence of sea ice. This section provides descriptions of the estimated densities of marine mammals and areas of water exposed to the indicated sound levels over the course of the planned operations. There is no evidence that avoidance at received sound levels of ≥120 dB or ≥160 dB rms would have significant biological effects on individual animals or that the subtle changes in behavior or movements would "rise to the level of taking" according to guidance by the NMFS (NMFS 2001). Any changes in behavior caused by sounds at or near the specified received levels would likely fall within the normal variation in such activities that would occur in the absence of exploration drilling operations.

Marine Mammal Density Estimates

Marine mammal density estimates in the Chukchi Sea have been derived for two time periods, the summer period covering July and August, and the fall period including September and October. Animal densities encountered in the Chukchi Sea during both of these time periods will further depend on the habitat zone within which the operations are occurring: open water or ice margin. More ice is likely to be present in the area of operations during the July–August period, so summer ice-margin densities have been applied to 50 percent of the area that may be exposed to sounds from exploration drilling and ZVSP activities in those months. Open water densities in the summer were applied to the remaining 50 percent of the area. Less ice is likely to be present during the September–October period, so fall ice-margin densities have been applied to only 20 percent of the area that may be exposed to sounds from exploration drilling and ZVSP activities in those months. Fall open-water densities were applied to the remaining 80 percent of the area. Since icebreaking activities would only occur within ice-margin habitat, the entire area potentially ensonified by icebreaking activities has been multiplied by the ice-margin densities in both seasons.

As noted above, there is some uncertainty about the representativeness of the data and assumptions used in the calculations. To provide some allowance for the uncertainties, "maximum estimates" as well as "average estimates" of the numbers of marine mammals potentially affected have been derived. For a few marine mammal species, several density estimates were available. In those cases, the mean and maximum estimates were determined from the reported densities or survey data. In other cases only one, or no applicable estimate was available, so correction factors were used to arrive at "average" and "maximum" estimates. In other cases, no applicable estimate (or perhaps a single estimate) was available, so correction factors were used to arrive at "average" and "maximum" estimates. These are described in detail in the following sections.

Detectability bias, quantified in part by *f*(0), is associated with diminishing sightability with increasing lateral distance from the survey trackline. Availability bias, *g*(0), refers to the fact that there is <100 percent probability of sighting an animal that is present along the survey trackline. Some sources below included these correction factors in the reported densities (e.g. ringed seals in Bengtson et al. 2005) and the best available correction factors were applied to reported results when they had not already been included (e.g. Moore et al. 2000).

Cetaceans

Nine species of cetaceans are known to occur in the planned project area in the Chukchi Sea. Only four of these (bowhead and gray whales, beluga, and harbor porpoise) are expected to be encountered during the planned exploration drilling activities. Three of the nine species (bowhead, fin, and humpback whales) are listed as "endangered" under the ESA.

Summer densities of ***belugas*** in offshore waters are expected to be low, with somewhat higher densities in ice-margin and nearshore areas. Aerial surveys have recorded few belugas in the offshore Chukchi Sea during the summer months (Moore et al. 2000). Aerial surveys of the Chukchi Sea in 2008-2009 flown by the NMML as part of the Chukchi Offshore Monitoring in Drilling Area (COMIDA) project have only reported 5 beluga sightings during >8,700 mi (>14,000 km) of on-transect effort, only 2 of which were offshore (COMIDA 2009). One of the three nearshore sightings was of a large group (~275 individuals on July 12, 2009) of migrating belguas along the coastline just north of Peard Bay. Additionally, only one beluga sighting was recorded during >37,900 mi (>61,000 km) of visual effort during good visibility conditions from industry vessels operating in the Chukchi Sea in September-October of 2006-2008 (Haley et al. 2010). If belugas are present during the summer, they are more likely to occur in or near the ice edge or close to shore during their northward migration. Expected densities have previously been calculated from data in Moore et al. (2000b). However, more recent data from COMIDA aerial surveys during 2008-2010 are now available (Clarke and Ferguson *in prep.*). Effort and sightings reported by Clarke and Ferguson (*in prep.*) were used to calculate the average open-water density estimate. Clarke and Ferguson (*in prep*) reported two on-transect beluga sightings (5 individuals) during 11,985 km of on-transect effort in waters 36-50 m deep in the Chukchi Sea during July and August. The mean group size of these two sightings is 2.5. A *f(0)* value of 2.841 and *g(0)* value of 0.58 from Harwood et al. (1996) were also used in the density calculation. The CV associated with group size was used to select an inflation factor of 2 to estimate the maximum density that may occur in both open-water and ice-margin habitats. Specific data on the relative abundance of beluga in open-water versus ice-margin habitat during the summer in the Chukchi Sea is not available. However, belugas are commonly associated with ice, so an inflation factor of 4 was used to estimate the average ice-margin density from the open-water density. Very low densities observed from vessels operating in the Chukchi Sea during non-seismic periods and locations in July-August of 2006-2008 (0.0-0.0003/mi^2, 0.0-0.0001/km^2; Haley et al. 2010), also suggest the number of beluga whales likely to be present near the planned activities will not be large.

In the fall, beluga whale densities in the Chukchi Sea are expected to be somewhat higher than in the summer because individuals of the eastern Chukchi Sea stock and the Beaufort Sea stock will be migrating south to their wintering grounds in the Bering Sea (Allen and Angliss 2010). However, there were no beluga sightings reported during >11,200 mi (>18,000 km) of vessel based effort in good visibility conditions during 2006-2008 industry operations in the Chukchi Sea (Haley et al. 2010). Densities derived from survey results in the northern Chukchi Sea in Clarke and Ferguson (*in prep*) were used as the average density for open-water fall season estimates (see Table 6-2). Clarke and Ferguson (*in prep*) reported 3 beluga sightings (6 individuals) during 10,036 km of on-transect effort in water depths 36–50 m. The mean group size of those three sightings is 2. A *f(0)* value of 2.841 and *g(0)* value of 0.58 from Harwood et al. (1996) were used in the calculation. The same inflation factor of 2 used for summer densities was used to estimate the maximum density that may occur in both open-water and ice-margin habitats in the fall. Moore et al. (2000) reported lower than expected beluga sighting rates in open-water during fall surveys in the Beaufort and Chukchi seas, so an inflation value of 4 was used to estimate the average ice-margin density from the open-water density. Based on the lack of any beluga sightings from vessels operating in the Chukchi Sea during non-seismic periods and locations in September-October of 2006-2008 (Haley et al. 2010), the relatively low densities shown in Table 6-2 are consistent with what is likely to be observed form vessels during the planned operations.

By July, most ***bowhead whales*** are northeast of the Chukchi Sea, within or migrating toward their summer feeding grounds in the eastern Beaufort Sea. No bowheads were reported during 6,640 mi (10,686 km) of on-transect effort in the Chukchi Sea by Moore et al. (2000). Aerial surveys in 2008-2010 by the NMML as part of the COMIDA project reported only 6 sightings during >16,020 mi (>25,781 km) of on-transect effort (Clarke and Ferguson *in prep*). Two of the six sightings were in waters ≤35 m deep and the remaining four sightings were in waters 51-200 m deep. Bowhead whales were also rarely sighted in July-August of 2006-2008 during aerial surveys of the Chukchi Sea coast (Thomas et al. 2010). This is consistent with movements of tagged whales (see ADFG 2010), all of which moved through the Chukchi Sea by early May

2009, and tended to travel relatively close to shore, especially in the northern Chukchi Sea. The estimate of bowhead whale density in the Chukchi Sea was calculated by assuming there was one bowhead sighting during the 7,447 mi (11,985 km) of survey effort in waters 36-50 m deep in the Chukchi Sea during July-August reported in Clarke and Ferguson (*in prep*), although no bowheads were actually observed during those surveys. The mean group size from September–October sightings reported in Clarke and Ferguson (*in prep*) is 1.1, and this was also used in the calculation of summer densities. The group size value, along with a *f(0)* value of 2 and a *g(0)* value of 0.07, both from Thomas et al. (2002) were used to estimate a summer density of bowhead whales (Table 6-1). The CV of group size and standard errors reported in Thomas et al (2002) for *f(0)* and *g(0)* correction factors suggest that an inflation factor of 2 is appropriate for estimating the maximum density from the average density. Bowheads are not expected to be encountered in higher densities near ice in the summer (Moore et al. 2000), so the same density estimates are used for open-water and ice-margin habitats. Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in July-August of 2006-2008 (Haley et al. 2010) ranged from 0.0003-0.0018/mi^2 (0.0001-0.0007/km^2) with a maximum 95 percent confidence interval (CI) of 0.0075/mi^2 (0.0029/km^2). This suggests the densities used in the calculations and shown in Table 6-1 are somewhat higher than are likely to be observed from vessels near the area of planned operations.

During the fall, bowhead whales that summered in the Beaufort Sea and Amundsen Gulf migrate west and south to their wintering grounds in the Bering Sea making it more likely that bowheads will be encountered in the Chukchi Sea at this time of year. Moore et al. (2002; Table 8) reported 34 bowhead sightings during 27,560 mi (44,354 km) of on-transect survey effort in the Chukchi Sea during September-October. Thomas et al. (2010) also reported increased sightings on coastal surveys of the Chukchi Sea during September and October of 2006-2008. GPS tagging of bowheads appear to show that migration routes through Chukchi Sea are more variable than through the Beaufort Sea (Quakenbush et al. 2010). Some of the routes taken by bowheads remain well north of the planned exploration drilling activities while others have passed near to or through the area. Kernel densities estimated from GPS locations of whales suggest that bowheads do not spend much time (e.g. feeding or resting) in the north-central Chukchi Sea near the area of planned activities (Quakenbush et al. 2010). Clarke and Ferguson (*in prep*) reported 14 sightings (15 individuals) during 10,036 km of on transect aerial survey effort in 2008-2010. The mean group size of those sightings is 1.1. The same *f(0)* and *g(0)* values that were used for the summer estimates above were used for the fall estimates (Table 6-2). As with the summer estimates, an inflation factor of 2 was used to estimate the maximum density from the average density in both habitat types. Moore et al. (2000) found that bowheads were detected more often than expected in association with ice in the Chukchi Sea in September-October, so a density of twice the average open-water density was used as the average ice-margin density. Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in July-August of 2006-2008 (Haley et al. 2010) ranged from 0.0008 to 0.0114/mi^2 (0.0003-0.0044/km^2) with a maximum 95 percent confidence interval (CI) of 0.1089/mi^2 (0.0419/km^2). This suggests the densities used in the calculations and shown in Table 6-2 are somewhat higher than are likely to be observed from vessels near the area of planned operations.

Table 6-1 Expected Densities of Cetaceans and Seals in Areas of the Chukchi Sea, Alaska, for the Planned Summer (July–August) Period. Species listed under the U.S. ESA as Endangered are in italics.

	Open Water		Ice Margin	
Species	**Average Density (# / km²)**	**Maximum Density (# / km²)**	**Average Density (# / km²)**	**Maximum Density (# / km²)**
Odontocetes				
Monodontidae				
Beluga	0.0010	0.0020	0.0040	0.0080
Narwhal	0.0000	0.0000	0.0000	0.0001
Delphinidae				
Killer whale	0.0001	0.0004	0.0001	0.0004
Phocoenidae				
Harbor porpoise	0.0011	0.0015	0.0011	0.0015
Mysticetes				
Bowhead whale	0.0013	0.0026	0.0013	0.0026
Fin whale	0.0001	0.0004	0.0001	0.0004
Gray whale	0.0258	0.0516	0.0258	0.0516
Humpback whale	0.0001	0.0004	0.0001	0.0004
Minke whale	0.0001	0.0004	0.0001	0.0004
Pinnipeds				
Bearded seal	0.0107	0.0203	0.0142	0.0270
Ribbon seal	0.0005	0.0020	0.0005	0.0020
Ringed seal	0.3668	0.6075	0.4891	0.8100
Spotted seal	0.0073	0.0122	0.0098	0.0162

Gray whale densities are expected to be much higher in the summer months than during the fall. Moore et al. (2000) found the distribution of gray whales in the planned operational area was scattered and limited to nearshore areas where most whales were observed in water less than 114 ft (35 m) deep. Thomas et al. (2010) also reported substantial declines in the sighting rates of gray whales in the fall. The average open-water summer density (Table 6-1) was calculated from 2008–2010 aerial survey effort and sightings in Clarke and Ferguson (*in prep*) for water depths 118-164 ft (36-50 m) including 54 sightings (73 individuals) during 7,447 mi (11,985 km) of on-transect effort. The average group size of those sightings is 1.35. Correction factors $f(0)$ = 2.49 (Forney and Barlow 1998) and $g(0)$ = 0.30 (Forney and Barlow 1998, Mallonee 1991) were also used in the density calculation. Similar to beluga and bowhead whales, an inflation factor of 2 was used to estimate the maximum densities from average densities in both habitat types and seasons. Gray whales are not commonly associated with sea ice, but may be present near it, so the same densities were used for ice-margin habitat as were derived for open-water habitat during both seasons. Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in July-August of 2006-2008 (Haley et al. 2010) ranged from 0.0055/mi^2 to 0.0208/mi^2 (0.0021/km^2 to 0.0080/km^2) with a maximum 95 percent CI of 0.0874 mi^2 (0.0336 km^2).

In the fall, gray whales may be dispersed more widely through the northern Chukchi Sea (Moore et al. 2000), but overall densities are likely to be decreasing as the whales begin migrating south. A density calculated from effort and sightings (15 sightings [19 individuals] during 6,236 mi (10,036 km) of on-transect effort) in water 118-164 ft (36-50 m) deep during September–October reported by Clarke and Ferguson (*in prep*) was used as the average estimate for the Chukchi Sea during the fall period. The corresponding group size value of 1.26, along with the same *f(0)* and *g(0)* values described above were used in the calculation. Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in July-August of 2006-2008 (Haley et al. 2010) ranged from 0.0068/mi^2 to 0.0109/mi^2 (0.0026/km^2 to 0.0042/km^2) with a maximum 95 percent CI of 0.0720 mi^2 (0.0277 km^2).

Harbor Porpoise densities were estimated from industry data collected during 2006-2008 activities in the Chukchi Sea. Prior to 2006, no reliable estimates were available for the Chukchi Sea and harbor porpoise presence was expected to be very low and limited to nearshore regions. Observers on industry vessels in 2006–2008, however, recorded sightings throughout the Chukchi Sea during the summer and early fall months. Density estimates from 2006-2008 observations during non-seismic periods and locations in July-August ranged from 0.0021/mi^2 to 0.0039/mi^2 (0.0008/km^2 to 0.0015/km^2) with a maximum 95 percent CI of 0.0205/mi^2 (0.0079/km^2) (Haley et al. 2010). The average density from the summer season of those three years (0.0029/mi^2, 0.0011/km^2) was used as the average open-water density estimate while the high value (0.0039/mi^2, 0.0015/km^2) was used as the maximum estimate (Table 6-1). Harbor porpoise are not expected to be present in higher numbers near ice, so the open-water densities were used for ice-margin habitat in both seasons. Harbor porpoise densities recorded during industry operations in the fall months of 2006-2008 were slightly lower and ranged from 0.0075/mi^2 to 0.0029/mi^2 (0.0029/km^2 to 0.0011/km^2) with a maximum 95 percent CI of 0.0242/mi^2 (0.0093/km^2). The average of those three years (0.0018/mi^2, 0.0007/km^2) was again used as the average density estimate and the high value 0.0029/mi^2 (0.0011/km^2) was used as the maximum estimate (Table 6-2).

Table 6-2 Expected Densities of Cetaceans and Seals in Areas of the Chukchi Sea, Alaska, for the Fall (September–October) Period. Species listed under the U.S. ESA as Endangered are in italics.

	Open Water		Ice Margin	
Species	Average Density (# / km^2)	Maximum Density (# / km^2)	Average Density (# / km^2)	Maximum Density (# / km^2)
Odontocetes				
Monodontidae				
Beluga	0.0015	0.0030	0.0060	0.0120
Narwhal	0.0000	0.0000	0.0000	0.0001
Delphinidae				
Killer whale	0.0001	0.0004	0.0001	0.0004
Phocoenidae				
Harbor porpoise	0.0007	0.0011	0.0007	0.0011
Mysticetes				
Bowhead whale	0.0219	0.0438	0.0438	0.0876
Fin whale	0.0001	0.0004	0.0001	0.0004
Gray whale	0.0080	0.0160	0.0080	0.0160
Humpback whale	0.0001	0.0004	0.0001	0.0004
Minke whale	0.0001	0.0004	0.0001	0.0004
Pinnipeds				
Bearded seal	0.0107	0.0203	0.0142	0.0270
Ribbon seal	0.0005	0.0020	0.0005	0.0020
Ringed seal	0.2458	0.4070	0.3277	0.5427
Spotted seal	0.0049	0.0081	0.0065	0.0108

The remaining five cetacean species that could be encountered in the Chukchi Sea during Shell's planned exploration drilling program include the humpback whale, killer whale, minke whale, fin whale, and narwhal. Although there is evidence of the occasional occurrence of these animals in the Chukchi Sea, it is unlikely that more than a few individuals will be encountered during the planned exploration drilling program. Clarke et al. (2011) and Haley et al. (2010) reported humpback whale sightings; George and Suydam (1998) reported killer whales; Brueggeman et al. (1990), Haley et al. (2010) and COMIDA (2011) reported minke whales; and Clarke et al. (2011) and Haley et al. (2010) reported fin whales. Narwhal sightings in the Chukchi Sea have not been reported in recent literature, but subsistence hunters occasionally report observations near Barrow, and Reeves et al. (2002) indicated a small number of extralimital sightings in the Chukchi Sea.

Pinnipeds

Three species of pinnipeds under NMFS jurisdiction are likely to be encountered in the Chukchi Sea during Shell's planned exploration drilling program: ringed seal, bearded seal, and spotted seal. Each of these species, except for the spotted seal, is associated with both the ice margin and the nearshore area. The ice margin is considered preferred habitat (as compared to the nearshore areas) for ringed and bearded seals during most seasons. Spotted seals are often considered to be predominantly a coastal species except in the spring when they may be found in the southern margin of the retreating sea ice. However, satellite tagging has shown that they sometimes undertake long excursions into offshore waters during summer (Lowry et al. 1994, 1998). Ribbon seals have been reported in very small numbers within the Chukchi Sea by observers on industry vessels (Patterson et al. 2007, Haley et al. 2010).

Ringed seal and ***bearded seals*** "average" and "maximum" summer ice-margin densities (Table 6-1) were available in Bengtson et al. (2005) from spring surveys in the offshore pack ice zone (zone 12P) of the northern Chukchi Sea. However, corrections for bearded seal availability, *g(0)*, based on haulout and diving patterns were not available. Densities of ringed and bearded seals in open water are expected to be somewhat lower in the summer when preferred pack ice habitat may still be present in the Chukchi Sea. Average and maximum open-water densities have been estimated as 3/4 of the ice margin densities during both seasons for both species. The fall density of ringed seals in the offshore Chukchi Sea has been estimated as 2/3 the summer densities because ringed seals begin to reoccupy nearshore fast ice areas as it forms in the fall. Bearded seals may also begin to leave the Chukchi Sea in the fall, but less is known about their movement patterns so fall densities were left unchanged from summer densities. For comparison, the ringed seal density estimates calculated from data collected during summer 2006-2008 industry operations ranged from $0.0411/mi^2$ to $0.1786/mi^2$ ($0.0158/km^2$ to $0.0687/km^2$) with a maximum 95 percent CI of $0.3936/mi^2$ ($0.1514/km^2$) (Haley et al. 2010). These estimates are lower than those made by Bengtson et al. (2005) which is not surprising given the different survey methods and timing.

Little information on ***spotted seal*** densities in offshore areas of the Chukchi Sea is available. Spotted seal densities in the summer were estimated by multiplying the ringed seal densities by 0.02. This was based on the ratio of the estimated Chukchi populations of the two species (Table 4-1). Chukchi Sea spotted seal abundance was estimated by assuming that 8 percent of the Alaskan population of spotted seals is present in the Chukchi Sea during the summer and fall (Rugh et al. 1997), the Alaskan population of spotted seals is 59,214 (Allen and Angliss 2010), and that the population of ringed seals in the Alaskan Chukchi Sea is ~208,000 animals (Bengtson et al. 2005). In the fall, spotted seals show increased use of coastal haulouts so densities were estimated to be 2/3 of the summer densities.

Two ***ribbon seal*** sightings were reported during industry vessel operations in the Chukchi Sea in 2006-2008 (Haley et al. 2010). The resulting density estimate of $0.0013/mi^2$ ($0.0005/km^2$) was used as the average density and 4 times that was used as the maximum for both seasons and habitat zones.

As described in earlier sections, the assumed start date of exploration drilling in the Chukchi Sea using the drillship *Discoverer* and associated support vessels is 4 July. Up to four wells (three wells, and one partial well) may be drilled in a drilling season, with an assumed average of 32 days at each drill site (including the partial well drill site, including 7.5 days of MLC excavation at all four drill sites. All four drill sites will be at the Burger Prospect. Exploration drilling operations are expected to be conducted through 31 October 2012.

<u>Area Potentially Exposed to Sounds ≥120 dB or ≥160 dB re 1µPa rms</u>

Estimated Area Exposed to Continuous Sounds ≥120 dB re 1µPa rms from Exploration Drilling Activities

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 results of those measurements were used to model the sound propagation from the *Discoverer* (including a nearby support vessel) at planned exploration drilling locations in the Chukchi and Beaufort seas (Warner and Hannay 2011). Broadband source levels of sounds produced by the *Discoverer* varied by activity and direction from the ship, but were generally between 177 and 185 dB re 1 µPa 1 m (rms) (Austin and Warner 2010). Propagation modeling at the Burger Prospect resulted in an estimated distance of 0.814 mi (1.31 km) to the point at which exploration drilling sounds would likely fall below 120 dB. The estimated 1.31 km distance was multiplied by 1.5 (= 1.22 mi [1.97 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 on the Burger Prospect (Table 6-3). Given this distance or radius, he total area of water ensonified to ≥120 dB rms during exploration drilling at each drill site was estimated to be 4.6 mi^2 (12 km^2).

The acoustic propagation model used to estimate the sound propagation from *Discoverer* in the Chukchi Sea is JASCO Research's Marine Operations Noise Model (MONM). MONM computes received sound levels in rms units when source levels are specified also in those units. MONM treats sound propagation in range-varying acoustic environments through a wide-angled parabolic equation solution to the acoustic wave equation. The specific parabolic equation code in MONM is based on the Naval Research Laboratory's Range-dependent Acoustic Model. This code has been extensively benchmarked for accuracy and is widely employed in the underwater acoustics community (Collins 1993).

Changes in the water column of the Chukchi Sea through the course of the exploration drilling season will likely affect the propagation of sounds produced by exploration drilling activities, so the modeling of exploration drilling sounds was run using expected oceanographic conditions in October which are expected to support greater sound propagation (Warner and Hannay 2011). Results of sound propagation modeling that were used in the calculations of areas exposed to various levels of received sounds are summarized in Table 6-3.

Distances shown in Table 6-3 were used to estimate the area ensonified to ≥120 dB rms around the drillship. As noted above, all exploration drilling activities will occur at the Burger Prospect. The exploration drill sites assumed for the summer of 2012 at the Burger Prospect (Burger A, F, J, and V) are 3.4 to 13 mi (5.5 km to 21 km) from each other and wells will not be drilled simultaneously. Therefore, the area exposed to continuous sounds ≥120 dB at each drill site is not expected to overlap with any other drill site. The total area of water potentially exposed to received sound levels ≥120 dB rms by exploration drilling operations during July–August at two locations is therefore estimated to be 9.42 mi^2 (24.4 km^2). Activities at two additional locations in September–October may expose an additional 9.42 mi^2 (24.4 km^2) to continuous sounds ≥120 dB rms.

Sound propagation measurements will be performed on the *Discoverer* and support vessels in 2012, once these are on location in Chukchi Sea. The results of those measurements will be used during the season to implement mitigation measures as required by the IHA.

Table 6-3 Sound Propagation Modeling Results of Exploration Drilling, Icebreaking, and ZVSP Activities at the Burger Prospect in the Chukchi Sea

Source	Received Level (dB re 1 µPa)	Modeling Results (km)	Used in Calculations (km)
Discoverer	120	1.31	1.97
Icebreaking	120	7.63	9.50
ZVSP	160	3.67	5.51

Estimated Area Exposed to Continuous Sounds ≥120 dB re 1µPa rms from Icebreaking Activities

Measurements of the icebreaking supply ship *Robert Lemeur* pushing and breaking ice during exploration drilling operations in the Beaufort Sea in 1986 resulted in an estimated broadband source level of 193 dB re 1 µPa · m (Greene 1987a; Richardson et al. 1995a). Measurements of the icebreaking sounds were made at 5 different distances and those were used to generate a propagation loss equation [RL=141.4–1.65R–10Log(R) where R is range in kilometers (Greene 1987a); converting R to meters results in the following equation: R=171.4–10log(R)–0.00165R]. Using that equation, the estimated distance to the 120 dB threshold level for continuous sounds from icebreaking is 4.74 mi (7.63 km). Since the measurements of the *Robert Lemeur* were taken in the Beaufort Sea under presumably similar conditions as would be encountered in the Chukchi Sea in 2012, an inflation factor of 1.25 was selected to arrive at a precautionary 120 dB distance of 5.9 mi (9.5 km) for icebreaking sounds. Additionally, measurements of identical sound sources at the Burger and Camden Bay prospects in 2008 yielded similar results, suggestion that sound propagation at the two locations is likely to be similar (Hannay and Warner 2009).

If ice is present, icebreaking 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 exploration drilling season. Icebreaking activities would likely occur in a 40^{o} arc up to 3.1 mi (5 km) upwind of the drilling vessel (see Section 1, Figure 1-3 and Attachment B of this application for additional details). This activity area plus a 5.9 mi (9.5 km) buffer around it results in an estimated total area of 162 mi^2 (420 km^2) that may be exposed to sounds ≥120 dB from icebreaking activities in each season.

Estimated Area Exposed to Impulse Sounds ≥160 dB re 1µPa rms from ZVSP Activities

A typical sound source that would be used by Shell in 2012 is an 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. The ≥160 dB re 1 µPa rms radius for this source was estimated from measurements of a similar airgun source used in the region in 2008 during the BP Liberty seismic survey in the Beaufort Sea.

Preseason estimates of the propagation of airgun sounds from the ITAGA VSP sound source have therefore been estimated based on the measurements of the seismic source reported in BP's 90-day report (Aerts et al. 2008). The BP liberty source was also an eight-airgun array, but had a slightly larger total volume of 880 $in.^3$ (14,421 cm^3). 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 100^{th} 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 10-23 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 airgun source has been increased from 235.4 to 241.4 while the remainder of the equation (–18*LogR – 0.0047*R) has been left unchanged. This equation results in the following estimated distances to maximum received levels: 190 dB = 1719 ft (524 m); 180 dB = 4068 ft (1240 m); 160 dB = 12,041 ft (3670 m); 120 dB = 34,449 ft (10,500 m). The ≥160 dB distance was multiplied by 1.5 (Table 6-3) for use in estimating the area ensonified to ≥160 dB rms around the drillship during ZVSP activities. Therefore, the total area of water potentially exposed to received sound levels ≥160 dB rms by ZVSP operations at two exploration drill sites during each season (summer and fall) is estimated to be 73.67 mi^2 (190.8 km^2).

<u>Potential Number of “Takes by Harassment”</u>

This subsection provides estimates of the number of individuals potentially exposed to continuous sound levels ≥120 dB re 1 μPa rms from exploration drilling and icebreaking activities and pulsed sound levels ≥160 dB re 1 μPa rms by ZVSP activities. The estimates are based on a consideration of the number of marine mammals that might be disturbed appreciably by operations in the Chukchi Sea and the anticipated area exposed to those sound levels.

The number of individuals of each species potentially exposed to received levels of continuous drilling related sounds ≥120 dB or to pulsed airguns sounds ≥160 dB within each season (summer and fall) and habitat zone was estimated by multiplying

- the anticipated area to be ensonified to the specified level in each season (summer and fall) and habitat zone to which that density applies, by
- the expected species density.

The numbers of individuals potentially exposed were then summed for each species across the two seasons and habitat zones. Some of the animals estimated to be exposed, particularly migrating bowhead whales, might show avoidance reactions before being exposed to pulsed airgun sounds ≥160 dB. Thus, these calculations actually estimate the number of individuals potentially exposed to the specified sounds levels that would occur if there were no avoidance of the area ensonified to that level.

The exploration drilling program is planned to occur from July 4 through October 31 as described in the previous section. We have assumed that ZVSP activities may occur at each well drilled. Additionally, we have assumed that more ice is likely to be present in the area of operations during the July–August period, so summer ice-margin densities have been applied to 50 percent of the area that may be exposed to sounds from exploration drilling and ZVSP activities in those months. Open water densities in the summer were applied to the remaining 50 percent of the area. Less ice is likely to be present during the September–October period, so fall ice-margin densities have been applied to only 20 percent of the area that may be exposed to sounds from exploration drilling and ZVSP activities in those months. Fall open-water densities were applied to the remaining 80 percent of the area. Since icebreaking activities would only occur within ice-margin habitat, the entire area potentially ensonified by icebreaking activities has been multiplied by the ice-margin densities in both seasons.

Species with an estimated average number of individuals exposed equal to zero are included below for completeness, but are not likely to be encountered.

Exploration Drilling Activities

Estimates of the average and maximum number of individual marine mammals that may be exposed to continuous sound levels ≥120 dB by exploration drilling activities are shown by season and habitat in Table 6-4. Due to the relatively small estimated ≥120 dB radius around the exploration drilling activities, only a few individuals of any species are estimated to be exposed based on average densities. However, chance encounters with individuals of any species are possible as all listed species are known to occur in the Chukchi Sea. Minimal estimates have therefore been included in the Total (Max) column to account for chance encounters or where greater numbers may be encountered than calculations suggested.

Icebreaking Activities

Estimates of the average and maximum number of individual marine mammals that may be exposed to continuous sound levels ≥120 dB by exploration drilling activities are shown by season and habitat in Table 6-5. Should icebreaking be necessary, it would ensonify a larger area of water to ≥120 dB than the exploration drilling activities or to ≥160 dB by ZVSP surveys and therefore results in the highest number of potential estimated individual exposed to such sounds.

The average and maximum estimates of the number of individual bowhead whales exposed to received sound levels ≥120 dB are 19 and 38, respectively. The average estimates for beluga and gray whales are 4 and 14, respectively (Table 6-5). Few other cetaceans are likely to be exposed to icebreaking sounds ≥120 dB, but maximum estimates have been included to account for chance encounters.

Ringed seals are expected to be the most abundant animal in the Chukchi Sea and the average and maximum estimates of the number exposed to ≥120 dB by potential icebreaking activities are 343 and 568, respectively (Table 6-5). Estimated exposures of other seal species are substantially less than those for ringed seals (Table 6-5).

ZVSP Activities

Estimates of the average and maximum number of individual marine mammals that may be exposed to pulsed airgun sounds at received levels ≥160 dB during ZVSP activities are shown by season and habitat in Tables 6-6. The estimates are somewhat greater than for exploration drilling activities because of the larger ≥160 dB radius around the airguns compared to the estimated ≥120 dB radius around exploration drilling activities (Table 6-3).

The average and maximum estimates of the number of individual bowhead whales potentially exposed to received sound levels ≥160 dB are 5 and 11, respectively. The average estimates for beluga and gray whales are 1 and 6, respectively (Table 6-6). Few other cetaceans are likely to be exposed to airgun sounds ≥160 dB, but maximum estimates have been included to account for chance encounters.

The average and maximum estimated number of ringed seals potentially exposed to ≥160 dB by ZVSP activities are 132 and 218, respectively (Table 6-6). Estimated exposures of other seal species are substantially below those for ringed seals (Table 6-6).

Table 6-4 The number of potential exposures of marine mammals to received sound levels in the water of ≥120 dB rms during planned exploration drilling activities in Summer (July–August) and Fall (September–October) in the Chukchi Sea, Alaska, 2012.

	Number of Individuals Potentially Exposed to Drilling Sounds ≥ 120 dB													
	Summer						Fall							
	Open Water		Ice Margin		Total		Open Water		Ice Margin		Total		Grand Total	
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
Odontocetes														
Monodontidae														
Beluga	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Narwhal	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Delphinidae														
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Phocoenidae														
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Mysticetes														
Bowhead whale	0	0	0	0	0	0	0	1	0	0	1	1	1	5
Fin whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Gray whale	0	1	0	1	1	1	0	0	0	0	0	0	1	5
Humpback Whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Minke whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Pinnipeds														
Bearded seal	0	0	0	0	0	1	0	0	0	0	0	1	1	5
Ribbon seal	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Ringed seal	4	7	6	10	10	17	5	8	2	3	6	11	17	28
Spotted seal	0	0	0	0	0	0	0	0	0	0	0	0	0	5

Table 6-5 The number of potential exposures of marine mammals to received sound levels in the water of ≥120 dB rms during potential icebreaking activities in Summer (July–August) and Fall (September–October) in the Chukchi Sea, Alaska, 2012.

	Number of Individuals Potentially Exposed to Icebreaking Sounds ≥120 dB													
	Summer						Fall							
	Open Water		Ice Margin		Total		Open Water		Ice Margin		Total		Grand Total	
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
Odontocetes														
Monodontidae														
Beluga	0	0	2	3	2	3	0	0	3	5	3	5	4	5
Narwhal	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Delphinidae														
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Phocoenidae														
Harbor porpoise	0	0	0	1	0	1	0	0	0	0	0	0	1	5
Mysticetes														
Bowhead whale	0	0	1	1	1	1	0	0	18	37	18	37	19	38
Fin whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Gray whale	0	0	11	22	11	22	0	0	3	7	3	7	14	28
Humpback Whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Minke whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Pinnipeds														
Bearded seal	0	0	6	11	6	11	0	0	6	11	6	11	12	23
Ribbon seal	0	0	0	1	0	1	0	0	0	1	0	1	0	5
Ringed seal	0	0	205	340	205	340	0	0	138	228	138	228	343	568
Spotted seal	0	0	4	7	4	7	0	0	3	5	3	5	7	11

Table 6-6 The number of potential exposures of marine mammals to received sound levels in the water of ≥160 dB rms during planned ZVSP activities in Summer (July–August) and Fall (September–October) in the Chukchi Sea, Alaska, 2012.

	Number of Individuals Potentially Exposed to VSP Sounds ≥160 dB													
	Summer						Fall							
	Open Water		Ice Margin		Total		Open Water		Ice Margin		Total		Grand Total	
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
Odontocetes														
Monodontidae														
Beluga	0	0	0	1	0	1	0	0	0	0	0	1	1	5
Narwhal	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Delphinidae														
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Phocoenidae														
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Mysticetes														
Bowhead whale	0	0	0	0	0	0	3	7	2	3	5	10	5	11
Fin whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Gray whale	2	5	2	5	5	10	1	2	0	1	2	3	6	13
Humpback Whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Minke whale	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Pinnipeds														
Bearded seal	1	2	1	3	2	5	2	3	1	1	2	4	5	9
Ribbon seal	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Ringed seal	35	58	47	77	82	135	38	62	13	21	50	83	132	218
Spotted seal	1	1	1	2	2	3	1	1	0	0	1	2	3	5

Table 6-7 The total number of potential exposures of marine mammals to received sound levels in the water of ≥120 dB or ≥160 dB rms during proposed exploration drilling, icebreaking, and ZVSP activities in the Chukchi Sea, Alaska, 2012.

Species	Total Number of Individuals Potentially Exposed to Sounds ≥120 dB or ≥160 dB	
	Average	**Maximum**
Odontocetes		
Monodontidae		
Beluga	5	15
Narwhal	0	15
Delphinidae		
Killer whale	0	15
Phocoenidae		
Harbor porpoise	1	15
Mysticetes		
Bowhead whale	25	53
Fin whale	0	15
Gray whale	21	46
Humpback Whale	0	15
Minke whale	0	15
Pinnipeds		
Bearded seal	17	36
Ribbon seal	1	15
Ringed seal	492	814
Spotted seal	10	21

Conclusions

Effects on marine mammals are generally expected to be restricted to avoidance of the area around the planned activities and short-term changes in behavior, falling within the MMPA definition of "Level B harassment".

Cetaceans

Overall, few cetaceans are expected to be exposed to continuous sounds ≥120 dB rms or impulse sounds ≥160 dB rms in the Chukchi Sea during the exploration drilling program, should they show no avoidance of the activities. This is largely a result of the relatively small area expected to be exposed to sounds at these levels. The average estimates suggest 25 bowhead whales may be exposed to sounds at or above the specified levels (Table 6-7). This number is <1 percent of the BCB population of >15,232 assuming 3.4 percent annual population growth from the 2001 estimate of >10,545 animals (Zeh and Punt 2005) which is supported by a 2004 population estimate of 12,631 by Koski et al. (2010). Similarly small numbers of beluga and gray whales may also be exposed to sounds from the exploration drilling program if they do not avoid the area of operations. The small numbers of other whales that may occur in the Chukchi Sea are unlikely to be present around the planned operations but chance encounters may occur. The few individuals would represent a very small proportion of their respective populations.

Pinnipeds

Ringed seal is by far the most abundant species expected to be encountered during the planned operations. The best (average) estimate of the numbers of ringed seals exposed to sounds at the specified received levels during the exploration drilling program is 492 ringed seals which represents <1 percent of the estimated Chukchi Sea population. Fewer individuals of other pinniped species are estimated to be exposed to sounds at the specified received levels, also representing small proportions of their populations. Pinnipeds are unlikely to react to continuous sounds or impulsive sounds until received levels are much stronger than 120 dB rms and 160 dB, respectively. So it is probable that a smaller number of these animals would actually be disturbed.

7. The anticipated impact of the activity on the species or stock:

The reasonably expected or reasonably likely impacts of the specified activities (planned offshore exploration drilling program and brief ZVSP surveys) on marine mammals will be related primarily to acoustic effects. Petroleum development and associated activities in marine waters introduce sound into the environment. The acoustic sense of marine mammals probably constitutes their most important distance receptor system, and underwater sounds could (at least in theory) have several types of effects on marine mammals. Potential acoustic effects relate to sound produced by exploration drilling activity, vessels and aircraft.

7.1 Noise Characteristics and Effects

The effects of sound on marine mammals are highly variable, and can be categorized as follows (based on Richardson et al. 1995a):

1. The sound may be too weak to be heard at the location of the animal, i.e. lower than the prevailing ambient noise level, the hearing threshold of the animal at relevant frequencies, or both.

2. The sound may be audible but not strong enough to elicit any overt behavioral response. This has been demonstrated upon exposure of bowhead whales to low levels of seismic, drilling, dredge, or icebreaker sounds (Richardson et al. 1986; 1990; 1995a,b,).

3. The sound may elicit reactions of variable conspicuousness and variable relevance to the well being of the animal. These can range from subtle effects on respiration or other behaviors (detectable only by statistical analysis) to active avoidance reactions.

4. Upon repeated exposure, animals may exhibit diminishing responsiveness (habituation), or disturbance effects may persist. The latter is most likely with sounds that are highly variable in characteristics, unpredictable in occurrence, and associated with situations that the animal perceives as a threat.

5. Any man made sound that is strong enough to be heard has the potential to reduce (mask) the ability of marine mammals to hear natural sounds at similar frequencies, including calls from conspecifics, echolocation sounds of odontocetes, and environmental sounds such as ice or surf noise.

6. Very strong sounds have the potential to cause temporary or permanent reduction in hearing sensitivity. Effects of non-explosive sounds on hearing thresholds of some marine mammals have been studied. Data are available for two species of odontocetes exposed to a single strong noise pulse lasting one second (Ridgway et al. 1997 and pers. comm.) and for three species of pinnipeds exposed to moderately strong sound for 20-22 minutes (Kastak et al. 1999). Received sound levels must far exceed the animal's hearing threshold for any temporary threshold shift (TTS) to occur. The TTS threshold depends on duration of exposure; the sound level necessary to cause TTS is higher for short sound exposures than for long sound exposures. Received levels must be even higher to risk permanent hearing impairment (probably at least 10 dB above the TTS threshold).

Exploration Drilling Sounds

Exploration drilling will be conducted from a drillship designed for such operations in the Arctic. Underwater sound propagation during the activities 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 hertz (Hz) although tones up to 1,850 Hz were recorded by Greene (1987a) during drilling operations in the Beaufort Sea. At a range of 0.1 mi (0.17 km) the 20-1000 Hz band level was 122-125 dB re 1μPa for the drillship *Explorer I.* Underwater sound levels were slightly higher (134 db re 1μPa) 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 re 1μPa) than from the other two vessels.

Airgun Sounds

A typical eight airgun array used to perform ZVSP surveys in each exploration well would consist of 4×40 in.^{3} (655 cm^3) airguns and 4×150 in.^{3} (2,458 cm^3) airguns. Typically, a single ZVSP survey will be performed when the well has reached PTD or final depth although, in some instances, a prior ZVSP will have been performed at a shallower depth. A typical survey, would last 10–14 hours, depending on the depth of the well and the number of anchoring points, and include firings of up to the full array, plus additional firing of a single 40 in.^{3} (655 cm^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.

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 500–1000 Hz and some energy at higher frequencies (Goold and Fish 1998; Potter et al. 2007).

Aircraft Noise

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

Dominant tones in noise spectra from helicopters are generally below 500 Hz (Greene and Moore 1995). Harmonics of the main rotor and tail rotor usually dominate the sound from helicopters; however, many additional tones associated with the engines and other rotating parts are sometimes present.

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

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

Vessel Noise

In addition to the drillship, various types of vessels will be used in support of the operations including ice management vessels, an anchor handler, OSVs, 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 re 1 μPa at distances ranging from ~1.5 to 2.3 mi (~2.4 to 3.7 km) from various types of barges. MacDonnell et al. (2008) estimated higher underwater sound pressure levels from the seismic vessel *Gilavar* of 120 db re 1 μPa 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. 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.

7.2 Summary of Potential Effects of Exposure to Underwater Sounds from Exploration Drilling

The potential effects of sounds from the proposed exploration drilling activities 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. 1995a). It is unlikely that there would be any cases of temporary or especially permanent hearing impairment, or non-auditory physical effects.

Tolerance

Numerous studies have shown that underwater sounds from industry activities are often readily detectable in the water at distances of many kilometers. Numerous studies have also shown that marine mammals at distances more than a few kilometers away often show no apparent response to industry activities of various types. This is often true even in cases when the sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to underwater sound such as airgun pulses under some conditions, at other times mammals of all three types have shown no overt reactions.

In general, pinnipeds, small odontocetes, and sea otters seem to be more tolerant of exposure to some types of underwater sound than are baleen whales.

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. 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. This practice, however, 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 industrial sounds are based on behavioral observations during studies of several species. Detailed studies have been done on humpback, gray, and bowhead whales, and on ringed seals. Less detailed data are available for some other species of baleen whales, sperm whales, small toothed whales, and sea otters.

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 exploration drilling activities. These subtle behavioral effects were temporary and localized, and occurred at distances up to 1.2-2.5 mi (2-4 km). Safety radii for the proposed exploration drilling activities are expected to be small and are not expected to result in significant disturbance to baleen whales.

Some bowheads appeared to divert from their migratory path after exposure to projected icebreaker sounds. Other bowheads however, tolerated projected icebreaker sound at levels 20 dB and more above ambient sound levels. The source level of the projected sound however, was much less than that of an actual icebreaker, and reaction distances to actual ice breaking may be much greater than those reported here for projected sounds.

Brewer et al. (1993) and Hall et al. (1994) reported numerous sightings of marine mammals including bowhead whales in the vicinity of offshore exploration drilling operations in the Beaufort Sea. One bowhead whale sighting was reported within ~400 m of a drilling vessel although most other bowhead sightings were at much greater distances. Few bowheads were recorded near industrial activities by aerial observers. After controlling for spatial autocorrelation in aerial survey data from Hall et al. (1994) using a Mantel test, Schick and Urban (2000) found that the variable describing straight line distance between the rig and bowhead whale sightings was not significant, but that a variable describing threshold distances between sightings and the rig was significant. Thus, although the aerial survey results suggested substantial avoidance of the operations by bowhead whales, observations by vessel-based observers indicate that at least some 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's Northstar Island. The southern edge of the call distribution ranged from 0.47 to 1.46 mi (0.76 to 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.

Patenaude et al. (2002) reported fewer behavioral responses to aircraft overflights by bowhead compared to beluga whales. Behaviors classified as reactions consisted of short surfacings, immediate dives or turns, changes in behavior state, vigorous swimming, and breaching. Most bowhead reaction resulted from exposure to helicopter activity and little response to fixed-wing aircraft was observed. Most reactions occurred when the helicopter was at altitudes ≤492 ft (≤150 m) and lateral distances ≤820 ft (≤250 m). Restriction on aircraft altitude will be part of the mitigation measures during the proposed exploration drilling activities and likely to have little or no disturbance effects on baleen whales. Any disturbance that did occur would likely be temporary and localized.

Southall et al. (2007 Appendix C) 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 rms. Probability of avoidance and other behavioral effects increased when received levels were 120-160 dB rms. Some of the relevant reviews of Southall et al. (2007) are summarized below.

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).

Malme et al. (1983, 1984) used playback of sound from helicopter overflight and drilling rigs and platforms to study behavioral effects on migrating gray whales. Received levels exceeding 120 dB induced avoidance reactions. Malme et al. (1984) calculated 10%, 50%, and 90% probabilities of gray whale avoidance reactions at received levels of 110, 120, and 130 dB re 1 μPa, respectively.

Malme et al. (1986) observed the behavior of feeding gray whales during four experimental playbacks of drilling sounds (50 to 315 Hz; 21-minutes (min) overall duration and 10% duty cycle; source levels 156 to 162 dB re 1 μPa-m). In two cases for received levels of 100 to 110 dB re 1 μPa, no behavioral reaction was observed. Avoidance behavior was observed in two cases where received levels were 110 to 120 dB re 1 μPa.

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 re 1 μPa range, although there was some indication of minor behavioral changes in several instances.

McCauley et al. (1996) reported several cases of humpback whales responding to vessels in Hervey Bay, Australia. Results indicated clear avoidance at received levels between 118 to 124 dB re 1 μPa in three cases for which response and received levels were observed/measured.

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 to 2,352 ft (563 to 717 m) at received levels (RLs) of 110 to 120 dB re 1 μPa.

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 to 90 Hz band with output of 172 dB re 1 μPa 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.

Finally, 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 re 1 μPa (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.

At least six of 17 groups of beluga whales appeared to alter their migration path in response to underwater playbacks of icebreaker sound (Richardson et al. 1995b). Received levels from the icebreaker playback were estimated at 78-84 dB re 1 μPa in the 1/3-octave band centered at 5,000 Hz, or 8-14 dB above ambient. If beluga whales reacted to an actual icebreaker at received levels of 80 dB, reactions would be expected to occur at distances on the order of 6 mi (10 km). Finley et al. (1990) also reported beluga avoidance of icebreaker activities in the Canadian High Arctic at distances of 22 to 31 mi (35 to 50 km). In addition to avoidance, changes in dive behavior and pod integrity were also noted. Beluga whales have also been report to avoid active seismic vessels at distances of 6-12 mi (10-19 km) (Miller et al. 2005). It is likely that at least some beluga whales may avoid the vicinity of the proposed activities thus reducing the potential for exposure to high levels of underwater sound.

Patenaude et al. (2002) reported that beluga whales appeared to be more responsive to aircraft overflights than bowhead whales. Changes were observed in diving and respiration behavior, and some whales veered away when a helicopter passed at ≤820 ft (≤250 m) lateral distance at altitudes up to 492 ft (150 m). However, some belugas showed no reaction to the helicopter. Belugas appeared to show less response to fixed-wing aircraft than to helicopter overflights.

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 re 1 μPa, while others failed to exhibit such responses for exposure to received levels from 120 to 150 dB re 1 μPa. 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 re 1 μPa before inducing behavioral responses. Below we summarize some of the relevant material reviewed by Southall et al. (2007).

LGL and Greeneridge (1986) and Finley et al. (1990) documented belugas and narwhals congregated near ice edges reacting to the approach and passage of icebreaking ships. Beluga whales responded to oncoming vessels by (1) fleeing at speeds of up to 20 kilometers per hour (km/hr) from distances of 12 to 50 mi (19 to 80 km), (2) abandoning normal pod structure, and (3) modifying vocal behavior and/or emitting alarm calls. Narwhals, in contrast, generally demonstrated a “freeze” response, lying motionless or swimming slowly away (as far as 23 mi/37 km down the ice edge), huddling in groups, and ceasing sound production. There was some evidence of habituation and reduced avoidance 2 to 3 days after onset.

The 1982 season observations by LGL & Greeneridge (1986) involved a single passage of an icebreaker with both ice-based and aerial measurements on 28 June 1982. Four groups of narwhals (n = 9 to 10, 7, 7, and 6) responded when the ship was 4.0 mi (6.4 km away) with received levels of ~100 dB re 1 μPa in the 150- to 1,150-Hz band. At a later point, observers sighted belugas moving away from the source at >12.4 mi (> 20 km) with received levels of ~90 dB re 1 μPa in the 150- to 1,150-Hz band. The total number of animals observed fleeing was about 300, suggesting approximately 100 independent groups (of three individuals each). No whales were sighted the following day, but some were sighted on 30 June, with ship noise audible at spectrum levels of approximately 55 dB re 1 μPa/Hz (up to 4 kHz).

Observations during 1983 (LGL & Greeneridge 1986) involved two icebreaking ships with aerial survey and ice-based observations during seven sampling periods. Narwhals and belugas generally reacted at received levels ranging from 101 to 121 dB re 1 μPa in the 20- to 1,000-Hz band and at a distance of up to 65 km. Large numbers (100s) of beluga whales moved out of the area at higher received levels. As noise levels from icebreaking operations diminished, a total of 45 narwhals returned to the area and engaged in diving and foraging behavior. During the final sampling period, following an 8-hour quiet interval, no reactions were seen from 28 narwhals and 17 belugas (at received levels ranging up to 115 dB re 1 μPa).

The final season (1984) reported in LGL & Greeneridge (1986) involved aerial surveys before, during, and after the passage of two icebreaking ships. During operations, no belugas and few narwhals were observed in an area approximately 17 mi (27 km) ahead of the vessels, and all whales sighted over 12-50 mi (19 to 80 km) from the ships were swimming strongly away. Additional observations confirmed the spatial extent of avoidance reactions to this sound source in this context.

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/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 whalewatching boats ranged from 109 to 129 dB re 1 μPa/Hz. Over a bandwidth of 100 to 6,000 Hz, equivalent broadband source levels were ~157 dB re 1 μPa-m; received levels at a range of 1,476 ft (450 m) were ~104 dB re 1 μPa.

Buckstaff (2004) reported elevated dolphin whistle rates with received levels (RLs) from oncoming vessels in the 110 to < 120 dB re 1 μPa. 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 re 1 μPa/Hz in the 1- to 22-kHz band (broadband received levels ~128 dB re 1 μPa) as opposed to ~65 dB re 1 μPa/Hz in the same band (broadband RL ~108 dB re 1 μPa) 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.

Morton and Symonds (2002) used census data on killer whales in British Columbia to evaluate avoidance of nonpulse acoustic harassment devices (AHDs). Avoidance ranges were about 2.5 mi (4 km). Also, there was a dramatic reduction in the number of days “resident” killer whales were sighted during AHD-active periods compared to pre- and post-exposure periods and a nearby control site.

Monteiro-Neto et al. (2004) studied avoidance responses of tucuxi (*Sotalia fluviatilis*) to Dukane® Netmark acoustic deterrent devices. In a total of 30 exposure trials, ~5 groups each demonstrated significant avoidance compared to 20 pinger off and 55 no-pinger control trials over two quadrats of about 0.2 mi^2 (0.5 km^2). Estimated exposure received levels were ~115 dB re 1 μPa.

Awbrey & Stewart (1983) played back semi-submersible drillship sounds (source level: 163 dB re 1 μPa-m) to belugas in Alaska. They reported avoidance reactions at 985 ft and 4,921 ft (300 m and 1,500 m) and approach by groups at a distance of 3,927 yd (3,500 m) with received levels ~110 to 145 dB re 1 μPa over these ranges assuming a 15 log R transmission loss. Similarly, Richardson et al. (1990) played back drilling platform sounds (source level: 163 dB re 1 μPa-m) 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.

Finally, two 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. Scheifele 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”).

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 re 1 μPa and 55-min duration affected the trained behaviors of a bottlenose dolphin participating in a TTS experiment. Finneran & Schlundt (2004) provided a detailed, comprehensive analysis of the behavioral responses of belugas and bottlenose dolphins to 1-s tones (received levels 160 to 202 dB re 1 μPa) 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 re 1 μPa. 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**—**Pinnipeds generally seem to be less responsive to exposure to industrial sound than most cetaceans. Pinniped responses to underwater sound from some types of industrial activities such as seismic exploration appear to be temporary and localized (Harris et al. 2001, Reiser et al. 2009b).

Blackwell et al. (2004) reported little or no reaction of ringed seals in response to pile-driving activities during construction of a man-made island in the Beaufort Sea. Ringed seals were observed swimming as close as 150 ft (46 m) from the island and may have been habituated to the sounds which were likely audible at distances <1.9 mi (<3.0 km) underwater and 0.3 mi (0.5 km) in air. Moulton et al. (2003) reported that ringed seal densities on ice in the vicinity of a man-made island in the Beaufort Sea did not change significantly before and after construction and drilling activities.

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 re 1 μPa 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.

Jacobs & Terhune (2002) observed harbor seal reactions to AHDs (source level in this study was 172 dB re: 1 μPa-m) deployed around aquaculture sites. Seals were generally unresponsive to sounds from the AHDs. During two specific events, individuals came within 43 and 44 m of active AHDs and failed to demonstrate any measurable behavioral response; estimated received levels based on the measures given were ~120 to 130 dB re 1 μPa.

Costa et al. (2003) measured received noise levels from an Acoustic Thermometry of Ocean Climate (ATOC) program sound source off northern California using acoustic data loggers placed on translocated elephant seals. Subjects were captured on land, transported to sea, instrumented with archival acoustic tags, and released such that their transit would lead them near an active ATOC source (at 3,081 ft [939-m] depth; 75-Hz signal with 37.5- Hz bandwidth; 195 dB re 1 μPa-m max. source level, ramped up from 165 dB re 1 μPa-m over 20 min) on their return to a haulout site. Received exposure levels of the ATOC source for experimental subjects averaged 128 dB re 1 μPa (range 118 to 137) in the 60- to 90-Hz band. None of the instrumented animals terminated dives or radically altered behavior upon exposure, but some statistically significant changes in diving parameters were documented in nine individuals. Translocated northern elephant seals exposed to this particular nonpulse source began to demonstrate subtle behavioral changes at ~120 to 140 dB re 1 μPa exposure RLs.

Kastelein et al. (2006) exposed nine captive harbor seals in a ~80 x 100 ft (~24 × 30 m) enclosure to nonpulse sounds used in underwater data communication systems (similar to acoustic modems). Test signals were frequency modulated tones, sweeps, and bands of noise with fundamental frequencies between 8 and 16 kHz; 128 to 130 [± 3] dB re 1 μPa-m source levels; 1- to 2-s duration (60-80% duty cycle); or 100% duty cycle. They recorded seal positions and the mean number of individual surfacing behaviors during control periods (no exposure), before exposure, and in 15-min experimental sessions (n = 7 exposures for each sound type). Seals generally swam away from each source at received levels of ~107 dB re 1 μPa, avoiding it by ~5 m, although they did not haul out of the water or change surfacing behavior. Seal reactions did not appear to wane over repeated exposure (i.e., there was no obvious habituation), and the colony of seals generally returned to baseline conditions following exposure. The seals were not reinforced with food for remaining in the sound field.

7.3 Summary of Potential Effects of Exposure to Underwater Sounds from Airguns

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 that 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, small odontocetes, and sea otters seem to be more tolerant of exposure to airgun pulses than are baleen whales.

Masking

Masking effects of underwater sounds on marine mammal calls and other natural sounds are expected to be limited. Masking effects of pulsed sounds (even from larger arrays of airguns than proposed in this project) 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; Nieukirk 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). Bowhead whale calls are frequently detected in the presence of seismic pulses, although the number of calls detected may sometimes be reduced in the presence of airgun pulses (Richardson et al. 1986; Greene et al. 1999; Blackwell et al. 2009a). Bowhead whales in the Beaufort Sea may decrease their call rates in response to seismic operations, although movement out of the area might also have contributed to the lower call detection rate (Blackwell et al. 2009a,b). Additionally, there is increasing evidence that, at times, there is enough reverberation between airgun pulses such that detection range of calls may be significantly reduced. In contrast, Di Iorio and Clark (2009) found evidence of increased calling by blue whales during operations by a lower-energy seismic source, a sparker. Masking effects of seismic pulses are expected to be negligible given the low number of cetaceans expected to be exposed, the intermittent nature of seismic pulses and the fact that ringed seals (the most abundant species in the area) are not typically vocal during this period.

Disturbance Reactions

***Baleen Whales*—** Baleen whale responses to pulsed sound have been studied more thoroughly than responses to continuous sound. Baleen whales generally tend to avoid operating airguns, but 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 may react by deviating from their normal migration route. In the case of the 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).

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 to 9.0 mi (4.5 to 14.5 km) from the source. For the much smaller airgun array used during the ZVSP survey, distances to received levels in the 160–170 dB re 1 μPa rms range are estimated to be 1.44-2.28 mi (2.31-3.67 km). 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 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 avoidance occurring out to distances of 12-19 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) corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources. In summer, bowheads typically begin to show avoidance reactions at a received level of about 160–170 dB re 1 μPa rms (Richardson et al. 1986; Ljungblad et al. 1988; Miller et al. 1999).

Malme et al. (1986, 1988) studied the responses of feeding eastern gray whales to pulses from a single 100 in.^{3} (1,639 cm^3) 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 the distribution of feeding Western Pacific gray whales off Sakhalin Island, Russia during a seismic survey (Yazvenko et al. 2007).

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 (Appendix A in Malme et al. 1984). Bowhead whales 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). 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 airgun source are highly unlikely to result in prolonged effects.

***Toothed Whales*—**Few systematic data are 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 and marine mammal observers 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 Osmek 1998; Stone 2003). The beluga may be a species that (at least at times) shows long-distance avoidance of seismic vessels. Aerial surveys during seismic operations in the southeastern Beaufort Sea recorded much lower sighting rates of beluga whales within 6-12 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 6-12 mi (10–20 km) (Miller et al. 2005).

Captive bottlenose dolphins and (of more relevance in this project) 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. 2002, 2005). However, the animals tolerated high received levels of sound (pk–pk level >200 dB re 1 μPa) before exhibiting aversive behaviors.

Reactions of toothed whales to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for mysticetes. A ≥170 dB disturbance criterion (rather than ≥160 dB) is considered appropriate for delphinids (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.

***Pinnipeds*—**Pinnipeds are not likely to show a strong avoidance reaction to the airgun sources that will be used. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds, and only slight (if any) changes in behavior. Ringed seals frequently do not avoid the area within a few hundred meters of operating airgun arrays (Harris et al. 2001; Moulton and Lawson 2002; Miller et al. 2005). However, initial telemetry work suggests that avoidance and other behavioral reactions by two other species of seals 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 present study 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. As for delphinids, a ≥170 dB disturbance criterion is considered appropriate for pinnipeds, which tend to be less responsive than many cetaceans.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. 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). Those criteria have been used in defining the safety (shut down) radii during seismic survey activities in the Arctic in recent years. 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. In summary,

- the 180 dB criterion for cetaceans is probably quite precautionary, i.e., lower than necessary to avoid 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 2005b; D. Wieting in Orenstein et al. 2004). New science-based noise exposure criteria are also proposed by a group of experts in this field, based on an extensive review and syntheses of available data on the effect of noise on marine mammals (Southall et al., 2007) and this review seems to confirm that the current 180 dB and 190 dB are conservative.

Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the exploration drilling activities to avoid exposing them to underwater sound levels that might, at least in theory, cause hearing impairment. In addition, many cetaceans are likely to show some avoidance of the proposed activities. 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 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, 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 industrial sound sources and beaked whales do not occur in the proposed study area. It is unlikely that any effects of these types would occur during the proposed project given the brief duration of exposure of any given mammal, and the planned monitoring and mitigation measures (see below). 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 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. At least in terrestrial mammals, 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 in both terrestrial and marine mammals recovers rapidly after exposure to the noise ends. 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 impulses of sound. [There are, however, recent data on TTS in dolphins caused by multiple pulses of sonar sound—Mooney et al. (2009).]

The distinction between TTS and PTS is not absolute. Although mild TTS is fully reversible and is not considered to be injury, exposure to considerably higher levels of sound causes more "robust" TTS, involving a more pronounced temporary impairment of sensitivity that takes longer to recover. There are very few data on recovery of marine mammals from substantial degrees of TTS, but in terrestrial mammals there is evidence that "robust" TTS may not be fully recoverable, i.e., TTS can grade into PTS (Le Prell *in press*).

The received energy level of a single seismic pulse that caused the onset of mild TTS in the beluga, as measured without frequency weighting, was ~186 dB re 1 $\mu Pa^2 \cdot s$ or 186 dB sound exposure level (SEL) (Finneran et al. 2002).[1] The rms level of an airgun pulse (in dB re 1 μPa measured over the duration of the pulse) is typically 10–15 dB higher than the SEL for the same pulse when received within a few kilometers of the airguns. Thus, a single airgun pulse might need to have a received level of ~196–201 dB re 1 μPa rms in order to produce brief, mild TTS. Exposure to several strong seismic pulses that each has a flat-weighted received level near 190 dB rms (175–180 dB SEL) could result in cumulative exposure of ~186 dB SEL (flat-weighted) or ~183 dB SEL (M_{mf}-weighted), and thus slight TTS in a small odontocete. That assumes that the TTS threshold upon exposure to multiple pulses is (to a first approximation) a function of the total received pulse energy, without allowance for any recovery between pulses.

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 likelihood that baleen whales (especially migrating bowheads) would avoid the exploration drilling and vessel activities 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 to sound suggested that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak et al. 1999, 2005; Ketten et al. 2001; cf. Au et

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[1] If the low-frequency components of the watergun sound used in the experiments of Finneran et al. (2002) are downweighted as recommended by Southall et al. (2007) using their M_{mf}-weighting curve, the effective exposure level for onset of mild TTS was 183 dB re 1 $\mu Pa^2 \cdot s$ (Southall et al. 2007).

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.

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). NMFS is in the process of developing an EIS to establish new sound exposure criteria for marine mammals (NMFS 2005b). New criteria are likely to include a time component in addition to sound pressure level which has been the only metric used previously when developing mitigation measures for industrial sound exposure for marine mammals. Due to the relatively small sound radii expected to result from the proposed exploration drilling and support activities, marine mammals would be unlikely to incur TTS without remaining very near the activities for some unknown time period. Given the proposed mitigation and the likelihood that many marine mammals are likely to avoid the proposed activities, exposure sufficient to produce TTS is unlikely to 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 underwater industrial sound associated with oil exploration can cause PTS in any marine mammal. However, given the possibility that mammals might incur TTS, there has been further speculation about the possibility that some individuals occurring very close to such activities 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.

It is highly unlikely that marine mammals could receive sounds strong enough (and over a sufficient duration) to cause permanent hearing impairment during the proposed exploration drilling program. Marine mammals are unlikely to be exposed to received levels strong enough to cause even slight TTS. 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 drillship may not be sufficient to induce PTS, even if the animals remain in the immediate vicinity of the activity. The planned monitoring and mitigation measures, including measurement of sound radii and visual monitoring when mammals are seen within “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. 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 sufficiently long that significant physiological stress would develop.

Until recently, it was assumed that diving marine mammals are not subject to the bends or air embolism. This possibility was first explored at a workshop (Gentry [ed.] 2002) held to discuss whether the stranding of beaked whales in the Bahamas in 2000 (Balcomb and Claridge 2001; NOAA and USN 2001) might have been related to bubble formation in tissues caused by exposure to noise from naval sonar. However, the opinions were inconclusive. Jepson et al. (2003) first suggested a possible link between mid-frequency sonar activity and acute and chronic tissue damage that results from the formation in vivo of gas bubbles, based on the beaked whale stranding in the Canary Islands in 2002 during naval exercises. Fernández et al. (2005a) showed those beaked whales did indeed have gas bubble-associated lesions as well as fat embolisms. Fernández et al. (2005b) also found evidence of fat embolism in three beaked whales that stranded 62 mi (100 km) north of the Canaries in 2004 during naval exercises. Examinations of several other stranded species have also revealed evidence of gas and fat embolisms (e.g., Arbelo et al. 2005; Jepson et al. 2005a; Méndez et al. 2005). Most of the afflicted species were deep divers. There is speculation that gas and fat embolisms may occur if cetaceans ascend unusually quickly when exposed to aversive sounds, or if sound in the environment causes the destabilization of existing bubble nuclei (Potter 2004; Arbelo et al. 2005; Fernández et al. 2005a; Jepson et al. 2005b). Even if gas and fat embolisms can occur during exposure to mid-frequency sonar, there is no evidence that that type of effect occurs in response to the types of sound produced during the proposed exploratory activities. Also, most evidence for such effects has been in beaked whales, which do not occur in the proposed survey area.

Available data on the potential for underwater sounds from industrial activities to cause auditory impairment or other physical effects in marine mammals suggest that such effects, if they occur at all, would be temporary and limited to short distances. 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 the proposed activities, including most baleen whales, some odontocetes (including belugas), and some pinnipeds, are especially unlikely to incur auditory impairment or other physical effects.

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). Underwater sound from exploration drilling and support activities are less energetic and have slower rise times, and there is no proof that they can cause serious injury, death, or stranding. However, the association of mass strandings of beaked whales with naval exercises and, in one case, an 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. The potential for stranding to result from exposure to strong pulsed sound suggests that caution be used when exposing marine mammals to pulsed or other underwater sound. Most of the stranding events associated with exposure of marine mammals to pulsed sound however, have involved beaked whales, which do not occur in the proposed area. Additionally, the sound produced from the proposed activities will be at much lower levels than those reported during stranding events.

8. The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses

Subsistence hunting continues to be an essential aspect of Inupiat Native life, especially in rural coastal villages. The Inupiat participate in subsistence hunting activities in and around the Chukchi Sea. The animals taken for subsistence provide a significant portion of the food that will last the community through the year. Marine mammals represent on the order of 60-80 percent of the total subsistence harvest. Along with the nourishment necessary for survival, the subsistence activities strengthen bonds within the culture, provide a means for educating the young, provide supplies for artistic expression, and allow for important celebratory events. In this IHA application, Shell specifically discusses the potential impact from the exploration drilling program to subsistence use of the bowhead whale, beluga, and seals, which are the primary marine mammals harvested for subsistence that are also covered under this authorization of incidental take by NMFS.

Bowhead Whale. Most activities associated with Shell's planned exploration drilling program would have no or negligible effects on bowhead whales or on subsistence hunts for bowheads. Sound energy and general activity associated with exploration drilling and operation of vessels and aircraft have the potential to temporarily affect the behavior of bowhead whales. However, as noted above in Section 7, though temporary diversions of the swim path of migrating whales have been documented, the whales have generally been observed to resume their initial migratory route within a distance of 6-20 mi (10-32 km) (Davis 1987; Brewer et al. 1993; Hall et al. 1994). Drilling noise has not been shown to block or impede migration even in narrow ice leads (Davis 1987; Richardson et al. 1991). Any effects on the bowhead whale as a subsistence resource would be negligible.

Observed behavioral effects from sound energy produced by drilling, such as avoidance, deflection, and changes in surface/dive ratios, have generally been restricted to the area ensonified to >160 dB or more although effects have infrequently been observed out to distance ensonified to 120 dB. As indicated above in Table 6-3, areas ensonified to >160 dB or more are limited to the areas within 0.06 mi (0.1 km) of the drillship, and areas expected to be ensonified to >120 dB would be expected to be limited to the areas within 0.913 mi (1.47 km) of the drillship. Shell's proposed drill sites are located more than 64 mi (103 km) from the Chukchi Sea coastline, whereas available mapping of subsistence use areas indicates bowhead hunts are conducted within about 30 mi (48 km) of shore. There is therefore little or no opportunity for the proposed exploration drilling activities to affect bowhead hunts.

Planned vessel traffic between the drill sites and marine support facilities in Wainwright would traverse areas used during bowhead harvests by Wainwright crews. However, bowhead hunts by residents of Wainwright, Point Hope and Point Lay takes place almost exclusively in the spring and are typically curtailed prior to the date Shell would commence the proposed exploration drilling program. From 1984 through 2009, bowhead harvests by these Chukchi Sea villages occurred only between April 14 and June 24 (George and Tarpley 1986; George et al. 1987, 1988 1990, 1992, 1995, 1998, 1999, 2000; Philo et al. 1994; Suydam et al. 1995b, 1996, 1997, 2001b, 2002, 2003, 2004, 2005b, 2006, 2007, 2008, 2009, 2010), while Shell will not enter the Chukchi Sea prior to July 1. Fall whaling by Chukchi Sea villages may occur in the future, particularly if bowhead quotas are not completely filled during the spring hunt, and fall weather is accommodating. A Wainwright whaling crew harvested the first fall bowhead in 90 years or more on October 8, 2010. Shell's mitigation measures, which include a system of subsistence advisors, community liaisons, and Communication and Call Centers (Com Centers), will be implemented to avoid any effects from vessel traffic on fall whaling in the Chukchi.

Aircraft traffic (helicopters and small fixed wing airplanes) between the drill sites and facilities in Wainwright and Barrow would also traverse these subsistence areas. Again, flights to and from Wainwright would take place after the date on which bowhead whaling out of Point Hope, Point Lay, and Wainwright is typically finished for the year. Barrow crews hunt bowheads during the spring and the fall, although most commonly east of Barrow along the Beaufort Sea coast. Aircraft flights between the Barrow air support facilities and Shell's drill sites located approximately 140 mi (227 km) to the west/southwest would traverse areas sometimes used during spring and fall whaling by Barrow crews. Spring whaling by Barrow crews is normally finished before the date that such flights would commence. From 1984 through 2009 whales were harvested in the spring by Barrow crews only between April 23 and June 15 (George and Tarpley 1986; George et al. 1987, 1988, 1990, 1992, 1995, 1998, 1999, 2000; Philo et al. 1994; Suydam et al. 1995b, 1996, 1997, 2001b, 2002, 2003, 2004, 2005b, 2006, 2007, 2008, 2009, 2010), while Shell operations would not commence until early July. During these same years fall bowheads were harvested between August 31 and October 29, so some flights could traverse areas hunted in the fall. However, in the past 35 years, Barrow whaling crews have harvested almost all whales in the Beaufort Sea to the east of Point Barrow (Suydam et al. 2008), indicating that relatively little fall hunting occurs to the west where the flight corridor is located. The most commonly observed reactions of bowheads to aircraft traffic are hasty dives, but changes in orientation, dispersal, and changes in activity are sometimes noted. Such reactions could potentially affect subsistence hunts if the flights occurred near and at the same time as the hunt. Shell has developed and proposes to implement a number of mitigation measures to ensure that any effects on the bowhead whale as a subsistence resource, or effects on bowhead subsistence hunts would be negligible. These mitigation measures, which include minimum flight altitudes, employment of subsistence advisors in the villages, and implementation of a Communications Plan (with operation of Com Centers), are described below in Section 12.3.

Beluga. Beluga typically do not represent a large proportion of the subsistence harvests by weight in the communities of Wainwright and Barrow, the nearest communities to Shell's planned exploration drilling program. Barrow residents hunt beluga in the spring (normally after the bowhead hunt) in leads between Point Barrow and Skull Cliffs in the Chukchi Sea – primarily in April-June, and later in the summer (July-August) on both sides of the barrier island in Elson Lagoon / Beaufort Sea (MMS 2008), but harvest rates indicate the hunts are not frequent. Wainwright residents hunt beluga in April-June in the spring lead system, but this hunt typically occurs only if there are no bowheads in the area. Communal hunts for beluga are conducted along the coastal lagoon system later in July-August.

Belugas typically represent a much greater proportion of the subsistence harvest in Point Lay and Point Hope. Point Lay's primary beluga hunt occurs from mi-June through mid-July, but can sometimes continue into August if early success is not sufficient. Point Hope residents hunt beluga primarily in the lead system during the spring (late March to early June) bowhead hunt, but also in open water along the coastline in July and August. Beluga are harvested in coastal waters near these villages, generally within a few miles from shore. Shell's proposed drill sites are located more than 60 mi (97 km) offshore, therefore proposed exploration drilling in the Burger Prospect would have no or negligible effect on beluga hunts. Aircraft and vessel traffic between the drill sites and support facilities in Wainwright, and aircraft traffic between the drill sites and air support facilities in Barrow would traverse areas that are sometimes used for subsistence hunting of belugas.

Disturbance associated with vessel and aircraft traffic could therefore potentially affect beluga hunts. However, all of the beluga hunt by Barrow residents in the Chukchi Sea, and much of the hunt by Wainwright residents would likely be completed before Shell activities would commence. Additionally, vessel and aircraft traffic associated with Shell's planned exploration drilling program will be restricted under normal conditions to designated corridors that remain onshore or proceed directly offshore thereby minimizing the amount of traffic in coastal waters where beluga hunts take place. The designated traffic corridors do not traverse areas indicated in recent mapping as utilized by Point Lay, or Point Hope for beluga hunts, and avoids important beluga hunting areas in Kasegaluk Lagoon. Shell has developed and proposes to implement a number of mitigation measures to ensure that any effects on the beluga whale as a subsistence resource, or effects on beluga subsistence hunts would be negligible. These mitigation measures, which include minimum flight altitudes, employment of subsistence advisors in the villages, and implementation of a Communications Plan (with operation of Com Centers), are described below in Section 12.3. Therefore, any behavioral responses of avoidance of activity areas by beluga in the Chukchi Sea would have no or negligible effect on the subsistence resource or subsistence hunts for beluga.

Seals. Seals are an important subsistence resource and ringed seals make up the bulk of the seal harvest. Most ringed and bearded seals are harvested in the winter or in the spring before Shell's exploration drilling program would commence, but some harvest continues during open water and could possibly be affected by Shell's planned activities. Spotted seals are also harvested during the summer. Most seals are harvested in coastal waters, with available maps of recent and past subsistence use areas indicating seal harvests have occurred only within 30-40 mi (48-64 km) of the coastline. Shell planned drill sites where exploration activities would occur are located more than 64 statute mi (103 km) offshore, so activities within the Burger Prospect, such as drilling, would have no impact on subsistence hunting for seals. Helicopter traffic between land and the offshore exploration drilling operations could potentially disturb seals and, therefore, subsistence hunts for seals, but any such effects would be minor due to the small number of flights and the altitude at which they typically fly, and the fact that most seal hunting is done during the winter and spring. Any effects on subsistence hunts for seals would be negligible and temporary lasting only minutes after the flight has passed. Any effects on the seals as a subsistence resource, or effects on subsistence hunts for seals would be negligible. These mitigation measures, which include minimum flight altitudes, employment of subsistence advisors in the villages, and implementation of a Communications Plan (with operation of Com Centers), are described below in Section 12.3.

9. Anticipated impact on habitat

Shell's planned exploration drilling program will not result in any permanent impact on habitats used by marine mammals, or to their prey sources. With regard to migrating cetaceans and seals, any effects would be temporary and of short duration at any one place. The primary potential impacts to all marine mammals that are reasonably expected or reasonably likely are associated with elevated sound levels from exploration drilling operations, its support vessels, and aircraft. The effects to habitat of marine mammals by sounds from the planned exploration drilling program are expected to be negligible.

Although evaluation of speculative events such as oil spills is not properly included in the "negligible impacts" analysis, Shell recognizes the agency's interest in these remote risks. Therefore, [as a courtesy] Shell includes with this IHA application an analysis of the highly unlikely, unanticipated impact of a crude oil spill event during this exploration drilling program (Attachment E). This is an analysis of the impacts from a hypothetical, site-specific, very large oil spill scenario created for Shell's regional oil spill response plan (*Chukchi Sea Regional Oil Discharge Prevention and Contingency Plan* [ODPCP] – revised April 2011) which was submitted to BOEMRE contemporaneously with Shell's Chukchi Sea Exploration Plan. Under 30 CFR 254. 26(d) (1) Shell's oil spill response plan must envision a crude oil spill scenario from a worst case discharge lasting 30 days. Attachment E analyzes the impacts from such a site-specific scenario, and presents this analysis in light of the very large crude oil spill impact analyses already conducted for oil and gas exploration activities in the arctic by NMFS (NMFS 2008) and BOEMRE's on-going effort in the Supplemental Environmental Impact Statement for Chukchi Sea Lease Sale 193 (BOEMRE in print). Given that a very large oil spill is a highly unlikely and unanticipated result of Shell's planned exploration drilling program, the analysis is not included within Section 9 of this IHA application which assesses the anticipated impacts of this activity, but provided separately as Attachment E.

9.1 Potential Impacts from Seafloor Disturbance (Mooring and MLC Construction)

There will be some seafloor disturbance or temporary increased turbidity in the seabed sediments during anchoring and emplacement of the MLCs. The amount and duration of disturbed or turbid conditions will depend on sediment material and consolidation and specific activity. The *Discoverer* would be stabilized and held in place with a system of eight 15,400 pounds (lb) (7,000 kg) Stevpris anchors during operations. The anchors from the *Discoverer* are designed to embed into the seafloor. Prior to setting, the anchors will penetrate the seafloor and drag two or three times their length. 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. Anchor depressions commonly exceed the dimensions of the anchor itself.

Each Stevpris anchor may impact an area of 2,027 ft^2 (188 m^2) of the seafloor. Minimum impact estimates from each well or mooring the *Discoverer* by its eight anchors is 16,216 ft^2 (1,507 m^2) of seafloor. This estimate assumes that the anchors are set only once. Shell plans to pre-set anchors at each drill site for whichever drillship is used for exploration drilling. Unless moved by an outside force such as sea current, anchors should only need to be set once per drill site.

Once the *Discoverer* ends operation, the anchors will be retrieved. Over time the anchor scars will be filled through natural movement of sediment. The duration of the scars depends upon the energy of the system, water depth, ice scour, and sediment type. Anchor scars were visible under low energy conditions in the North Sea for five to ten years after retrieval. Scars typically do not form or persist in sandy mud or sand sediments but may last for nine years in hard clays (Centaur Associates, Inc. 1984). Surficial sediments in Shell's Burger Prospect consist of soft sandy mud (silt and clay) with lesser amounts of gravel (Battelle Memorial Institute 2010; Blanchard et al. 2010a,b). The energy regime, plus possible effects of ice gouge in the Chukchi Sea suggests that anchor scars would be refilled faster than in the North Sea.

Excavation of each MLC by the *Discoverer* will displace about 17,128 ft^3 (485 m^3) of seafloor sediments and directly disturb approximately 314 ft^2 (29 m^2) of seafloor. Material will be excavated from the MLCs using a large diameter drillbit. Pressurized air and seawater (no drilling mud used) will be used to assist in the 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.

9.2 Potential Impacts on Habitat due to Sound Generation

Marine Mammals

Shell does not expect any significant or lasting impacts to marine mammals from sound energy created by exploration drilling activities in the Chukchi Sea. Sound is crucial to marine mammals because they use it to navigate, communicate, find open water, avoid predators, and find food. There are a variety of sounds in the Chukchi Sea, especially during the “open water” exploration drilling season, when the area is exposed to the peak level of man-made sound from oil and gas exploration activities and biological research surveys. Sound sources from Shell’s exploration activities that could be heard by marine mammals include the drillship, marine vessels, and support vessels. Sounds that are natural in the marine environment of the Chukchi Sea include sound from ice, surf, subsea landslides, and other animals. Concern has been expressed regarding the presence and intensity of impacts from sound energy on marine mammals. Concerns are mainly aimed at deflection of whales from hunting and migration areas, masking of natural sounds, and physiological damage to marine mammals’ hearing. Based on previous studies regarding sound energy and effects on marine mammals, as well as the preventive mitigation measures planned for the project, Shell does not expect any significant or lasting impacts to marine mammals from sound energy resulting from exploration drilling activities in the Chukchi Sea.

Avoidance behavior in response to sound energy by marine mammals, such as temporary deflection, is the most likely behavioral response expected as a result of Shell’s exploration drilling activities in the Chukchi Sea. Depending upon the sound source, different mitigation measures will be implemented. Mitigation measures have been included in the 4MP that is included as an appendix of this IHA application. That discussion and analysis of Shell’s sound energy mitigation measures is incorporated here by reference.

MMOs will be stationed on all drilling and support vessels to survey inside the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals. For support vessels in transit, if a marine mammal is sighted from a vessel within its respective safety radius, the Shell vessel will reduce activity (e.g. reduce speed) and sound energy level to ensure that the animal(s) are not exposed to sound above their respective safety level. Full activity will not be resumed until all marine mammals are outside of the vessel's exclusion zone and there are no other marine mammals likely to enter the exclusion zone. Regular overflight surveys and support vessel surveys for marine mammals will be conducted to further monitor exploration drilling areas.

Anchored vessels, including the drillship, 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. MMOs use distance as an indicator of the safety radii, which is anticipated to be much smaller than 900 ft (274 m). These measures will reduce the sound energy received by the mammals. Shell will not be operating during the sensitive times such as pupping and molting. These important activities will be over by the time Shell activities start. If seals are hauled out on ice in the vicinity of operations temporary deflection is expected.

While observing the response of beluga whales to icebreakers, Finley and Davis (1984) reported avoidance behavior when ice breaker vessels approached at distances of 22-31 mi (35-50 km). Belugas are thought to have poor hearing below one Hz, the range of most exploration drilling activities, but have shown some behavioral reactions to the sounds. Brewer et al. (1993) observed belugas within 2.3 mi (3.7 km) of the drilling unit *Kulluk* during exploration drilling.

Seals are not expected to be impacted by sound energy from Shell vessel traffic or exploration drilling. This was demonstrated during a study designed to assess ringed seals' reactions to drilling activity (Brewer et al. 1993). After observing the seals approach within 33 ft (10 m) of the drilling unit *Kulluk*, the scientists concluded that they are not disturbed by drilling activity. The same conclusion was reached concerning bearded seals that approached within 656 ft (200 m) of ice breakers (Brewer et al. 1993). In another study involving the drillship *Explorer II*, seals were observed within 115 ft (35 m) of the ship during drilling (Gallagher et al. 1992).

Sound energy introduced into the environment of marine mammals could cause masking (the covering of sound that would otherwise have been heard). Masking can interfere with the detection of important natural sources. Underwater sound could possibly mask environmental sounds (Terhune 1981) or communication between marine mammals (Perry and Renouf 1987). However, in a study conducted by Cummings et al. (1984) in which breeding ringed seals were subjected to recordings of industrial sounds and there were no documented effects on ringed seal vocalizations.

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). At distances greater than 660-1,300 ft (200-400 m), recorded sounds from drilling activities did not affect behavior of beluga whales even though the sound energy level and frequency were such that it could be heard several kilometers away (Richardson et al. 1995b). This exposure resulted in whales being deflected from the sound energy and changing behavior. These brief changes are expected to be temporary and are not expected to affect whale population (Richardson et al. 1991; Richard et al. 1998).

Threatened and Endangered Species

Sound is important to bowhead whales because they use it to navigate, communicate, find open water, avoid predators, and find areas of food abundance. Bowhead whales, along with being endangered, are a key subsistence resource of the Inupiat Eskimos of the North Slope. There is concern regarding potential impacts on the whales due to sound energy produced by exploration drilling activities. Potentially, sounds created by exploration drilling activities could affect behavior, mask whale communication and other environmental sounds, or damage hearing mechanisms. There have been no conclusive studies on the sensitivity of bowhead whale hearing (Richardson et al. 1995b). It is likely that the range of hearing includes the frequency range used in their calls. Most frequencies used by bowhead whales are low (less than 1,000 Hz) (Richardson et al. 1995b). Mitigation measures are in place to minimize or eliminate impacts to the whales and, by extension, subsistence uses of the whales. Shell does not expect any lasting impacts on marine mammals from sound energy created during exploration drilling activities in the Chukchi Sea.

In order to limit the whales' close contact with ice management and other support vessels, MMOs will be stationed on all support vessels to survey inside the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals. If a marine mammal is sighted from a vessel in transit within its respective safety radius, 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 its respective safety levels. Full activity will not be resumed until all marine mammals are outside of the exclusion zone and there are no other marine mammals likely to enter the exclusion zone before the next overflight survey. Regular overflight surveys and support vessel surveys for marine mammals will be conducted to further monitor exploration drilling areas. Anchored vessels, including the drilling unit, 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.

Avoidance behavior in response to sound by marine mammals such as temporary deflection from migration corridors is the most likely behavioral response expected as a result of Shell's exploration activities in the Chukchi Sea. Bowhead whales, likely due to their hearing range, have been reported to react more to low frequency sounds than higher frequency sounds (Richardson et al. 1995b). Davis (1987) studied the responses exhibited by bowhead whales to drilling sound. The only response he saw was avoidance behavior in some whales. Davis (1987) concluded that avoidance behavior was temporary and sound energy from drilling did not impede migration of the whales. Recordings from the drilling ship *Explorer II* were projected in the Canadian Beaufort Sea during the drilling season (Richardson et al. 1985). Changes in behavior in response to the sounds were observed. Some whales showed avoidance behavior, but the deflection away from the sound was considered weak (Richardson et al. 1985). During the same study, Richardson et al. (1985) observed whales between 2.5 mi and 12.4 mi (4 and 20 km) while drilling activity was occurring, and he concluded that the whales were undisturbed. In a similar study where recordings from the drilling unit *Kulluk* were projected, no deflection was seen until sound pressure levels reached 120 dB or higher (Wartzok et al. 1989).

Concern has been expressed that sound energy levels produced by exploration drilling and ice management could cause masking. Masking can interfere with the detection of important natural sound sources. Underwater sound could possibly mask environmental sounds (Terhune 1981) or communication between marine mammals (Perry and Renouf 1987). Effects of sound energy from exploration drilling and ice management will be temporary and localized, and are not expected to significantly impact marine mammals.

Loud sound (higher than 180 dB) could cause temporary (the duration would depend upon the level and duration of noise exposure) or permanent damage to hearing ability (Kryter 1985; Richardson and Malme 1993). Since bowhead whales have been shown to exhibit avoidance behaviors in the presence of lower level sound (115 dB) (Richardson et al. 1990), it is unlikely that they would approach such sound sources close enough to be exposed to sound levels that could be injurious (Richardson and Malme 1993).

Zooplankton

Sound energy generated by exploration drilling activities will not negatively impact the diversity and abundance of zooplankton. The primary generators of sound energy are the drillship and marine vessels. Ice management vessels are likely to be the most intense sources of sound associated with the exploration drilling program (Richardson et al. 1995a). Ice management vessels, during active ice management, may have to adjust course forward and astern while moving ice and thereby create greater variability in propeller cavitation than other vessels that maintain course with less adjustment. The drillship maintains station during exploration drilling without activation of propulsion propellers. Richardson (et al.1995a) reported that the noise generated by an icebreaker pushing ice was 10-15 dB greater than the noise produced by the ship underway in open water. It is expected that the lower level of sound produced by the drillship, ice management vessels conducting icebreaking, or other vessels would have less impact on zooplankton than would 3D 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 units would have lower sound energy output than three-dimensional seismic sound sources (Burns et al. 1993). The drillship *Discoverer* would emit sounds at a lower level than the *Kulluk* and therefore the impacts due to exploration drilling noise 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 the Chukchi Sea.

Benthos

There was no indication from benthic biomass or density that previous drilling activities at the Hammerhead Prospect have had a measurable impact on the ecology of the immediate local area. To the contrary, the abundance of benthic communities in the Sivulliq area would suggest that the benthos were actually thriving there (Dunton et al. 2008).

Sound energy generated by exploration drilling activities will not appreciably affect diversity and abundance of plants or animals on the seafloor. The primary generators of sound energy are the drillship and marine vessels. Ice management vessels are likely to be the most intense sources of sound associated with the exploration drilling program (Richardson et al. 1995a). Ice management vessels, during active ice management, may have to adjust course forward and astern while moving ice and thereby create greater variability in propeller cavitation than other vessels that maintain course with less adjustment. The drillship maintains station during exploration drilling without activation of propulsion propellers. Richardson et al.(1995a) reported that the noise generated by an icebreaker pushing ice was 10-15 dB greater than the noise produced by the ship underway in open water. The lower level of sound produced by the drillship, ice management vessels conducting icebreaking, or other vessels will have less impact on bottom-dwelling organisms than would 3D 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 that might occur as a result of Shell's operations is 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 (USDI/MMS 2007). Impacts from sound energy generated by ice breakers, other marine vessels, and drillship would have less impact, as these activities produce much lower sound energy levels (Burns et al. 1993).

Fish

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.

The impact of sound energy from exploration 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).

Drillship sound source levels during drilling can range from 90 dB within 31 mi (50 km) of the drillship to 138 dB within a distance of 0.06 mi (0.01 km) from the drillship (Greene 1985,1987b). These are predicted sound levels at various distances based on modeled transmission loss equations in the literature (Greene 1987b). Ice management vessel sound source levels can range from 174-184 dB. At these intensity levels, fish may avoid the drilling unit, ice management vessels, or other large support vessels. This avoidance behavior is temporary and limited to periods when a vessel is underway or drilling.

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. 1995b). 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. Cod, herring and other species of fish with swim bladders have been found to be relatively sensitive to sound, while mackerel, flatfish, and many other species that lack swim bladders have been found to have poor hearing (Hawkins 1981, Hastings and Popper 2005). 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).

9.3 Potential Impacts on Habitat from Drilling Muds and Cuttings Waste

<u>General</u>

The National Pollutant Discharge Elimination System (NPDES) General Permit establishes discharge limits for drilling fluids (at the end of a discharge pipe) to a minimum 96-hr Lethal Concentration 50 percent (LC_{50}) of 30,000 parts per million (ppm). Both modeling and field studies have shown that discharged drilling fluids are diluted rapidly in receiving waters (Ayers et al. 1980a, 1980b; Brandsma et al. 1980; NRC 1983; O'Reilly et al. 1989; Nedwed et al. 2004; Smith et al. 2004; Neff 2005). The dilution rate is strongly affected by the discharge rate; the NPDES General Permit limits the discharge of cuttings and fluids to 750 bbl/hr (89 m^3/hr). For example, the EPA modeled hypothetical 750 bbl/hr (89 m^3/hr) discharges of drilling fluids in water depths of 66 ft (20 m) in the Beaufort and Chukchi Sea and predicted a minimum dilution of 1,326:1 at 330 ft (100 m).

Modeling of similar discharges offshore of Sakhalin Island predicted a 1,000-fold dilution within 10 minutes and 330 ft (100 m) of the discharge. In a field study (O'Reilly et al. 1989) of a drilling waste discharge offshore of California, a 270 bbl (43 m^3) discharge of drilling fluids was found to be diluted 183-fold at 33 ft (10 m) and 1,049-fold at 330 ft (100 m). Neff (2005) concluded that concentrations of discharged drilling fluids drop to levels that would have no effect within about two minutes of discharge and within 16 ft (5 m) of the discharge location.

Marine Mammals

The levels of drill cuttings and drilling mud discharges are regulated by the EPA's NPDES General Permit. The impact of the limited amount of drilling mud and cuttings discharges would be localized to the drill sites and temporary. Drilling mud and cuttings discharges could displace marine mammals a short distance from an exploration drilling location.

Gray whales will more than likely avoid exploration drilling activities and not come into close contact with drilling mud or cuttings. However, gray whales are benthic feeders and the area of seafloor that will be covered by discharge will be unavailable to the whales for foraging purposes. This is not expected to impact individual whales or the population, because the areas of disturbance are insignificant compared to the area covered by the whales for foraging. Impacts on beluga whales from the discharge of drilling mud and cuttings are not likely.

It is anticipated that drilling mud and cuttings will only dispense up to 330 ft (100 m) from the drillship in beluga feeding areas. Therefore, it is highly unlikely that beluga whales will come into contact with any drilling discharge and impacts are not expected.

Seals are not expected to be impacted by drilling mud or cuttings. If seals remain within 330 ft (100 m) of the discharge source for an extended period of time, it is possible that physiological effects due to toxins could impact the animal. However, it is highly unlikely that a seal would remain within 330 ft (100 m) of the discharge source for any extended period of time.

Threatened and Endangered Species

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 of discharges to be affected.

The levels of drilling mud and cuttings discharges are regulated by the EPA's NPDES General Permit. The impact of drilling mud and cuttings discharges would be localized and temporary. Drilling mud and cuttings discharges could displace endangered whales (bowhead and humpback whales) a short distance from an exploration drilling location. Effects on the whales present within a few meters of the discharge point would be expected, primarily due to sedimentation. However, endangered whales are not likely to have long-term exposures to drilling mud and cuttings because of the episodic nature of discharges (typically only a few hours in duration).

Seals, including the proposed for threatened listing ringed and bearded seals, are not expected to be impacted by drilling mud and cuttings. If seals remain within 330 ft (100 m) of the discharge source for an extended period of time, it is possible that physiological effects due to toxins could impact the animal. However, it is highly unlikely that a seal would remain within 330 ft (100 m) of the discharge source for any extended period of time.

It is expected that any toxic effects on fish and fish larvae present within a few feet of the discharge point would be negligible and ephemeral.

Zooplankton

Studies by the EPA (2006) and Neff (2005) indicate that though planktonic organisms are extremely sensitive to environmental conditions (e.g., temperature, light, availability of nutrients, and water quality), there is little or no evidence of effects from drilling mud and cuttings discharges on plankton.

More than 30 OCS well sites have been drilled in the Beaufort Sea. The Warthog well was drilled in Camden Bay in 35 ft (11 m) of water (Thurston et al. 1999). The BOEMRE routinely monitored that well site for contaminants and found that it had no accumulated petroleum hydrocarbons or heavy metals (Brown et al. 2001).

The levels of drilling mud and cuttings discharges are regulated by the EPA's NPDES General Permit. The impact by drilling mud and cuttings discharges would be localized and temporary. Effects on zooplankton present within a few meters of the discharge point would be expected, primarily due to sedimentation. However, zooplankton are not likely to have long-term exposures to drilling mud and cuttings because of the episodic nature of discharges (typically only a few hours in duration). Results of a recent study on a historical drill site in Camden Bay (HH-2) showed that movement of drilling mud and cuttings were restricted to within 330 ft (100 m) of the discharge site (Trefry and Trocine 2009).

Fine-grained particulates and other solids in drilling mud and cuttings could cause sublethal effects to organisms in the water column. The responses observed following exposure to drilling mud include alteration of respiration and filtration rates and altered behavior. Zooplankton in the immediate area of discharge from exploration drilling operations could potentially be adversely impacted by sediments in the water column, which could clog respiratory and feeding structures, and they could suffer abrasions. This impact would likely not have more than a short-term impact and not affect population levels of zooplankton.

Benthos

Drilling mud and cuttings discharges are regulated by the EPA's NPDES General Permit. The impact of drilling mud and cuttings discharges would be localized and temporary. Effects on benthic organisms present within a few meters of the discharge point would be expected, primarily due to sedimentation. However, benthic animals are not likely to have long-term exposures to drilling mud and cuttings because of the episodic nature of discharges (typically only a few hours in duration).

Significant heavy metal contamination of sediments and resulting effects on benthic organisms is not expected. The general NPDES permit contains stringent limitations on the concentrations of mercury, cadmium, chromium, silver, and thallium allowed in discharged drilling fluids and cuttings. Additional limitations are placed on free oil, diesel oil, and total aromatic hydrocarbons (TAH) allowed in discharged drilling fluids and cuttings. Discharge rates are also controlled by the permit. Baseline studies at the 1985 Hammerhead drill site (Trefry and Trocine 2009) detected background levels Al, Fe, Zn, Cd and Hg in all surface and subsurface sediment samples. Considering the relatively small area that drilling mud and cuttings sediment will be deposited, no significant impacts on sediment are expected to occur. The expected increased concentrations of Zn, Cd, and Cr in sediments near the drill site due to the discharge are in the range where no or low effects would result.

Studies in the 1980s, 1999, 2000, and 2002 (Brown et al. 2001 in USDI/MMS 2003) also found that benthic organism near drilling sites in the Beaufort have accumulated neither petroleum hydrocarbon nor heavy metals. In 2008 Shell investigated the benthic communities (Dunton et al. 2008) and sediments (Trefry and Trocine 2009) around the Sivulliq Prospect including the location of the historical Hammerhead drill site that was drilled in 1985. Benthic communities at the historical Hammerhead drill site were found not to differ statistically in abundance, community structure, or diversity, from benthic communities elsewhere in this portion of the Beaufort Sea, indicating that there was no long term effect. Because discharges from drilling mud and cuttings are composed of seawater, impacts to benthic organisms will be negligible and restricted to a very small area of the seafloor in the Chukchi Sea.

Fish

The levels of drilling mud and cuttings discharges are regulated by the EPA's NPDES General Permit. The impact of drilling mud and cuttings discharges would be localized and temporary. Drilling mud and cuttings discharges could displace fish a short distance from an exploration drilling location. Effects on fish and fish larvae present within a few meters of the discharge point would be expected, primarily due to sedimentation. However, fish and fish larvae that live in the water column are not likely to have long-term exposures to drilling mud and cuttings because of the episodic nature of discharges (typically only a few hours in duration).

Although unlikely at deeper offshore exploration drilling locations, demersal fish eggs could be smothered if discharges occur in a spawning area during the period of egg production. No specific demersal fish spawning locations have been identified at the Burger well locations. The most abundant and trophically important marine fish, the Arctic cod, spawns with planktonic eggs and larvae under the sea ice during winter and will therefore have little exposure to discharges.

Habitat alteration concerns apply to special or relatively uncommon habitats, such as those important for spawning, nursery, or overwintering. Important fish overwintering habitats are located in coastal rivers and nearshore coastal waters, but are not found in the proposed exploration drilling areas. Important spawning areas have not been identified in the Chukchi Sea.

9.4 Potential Impacts from Ice Management

Ice-management activities include the physical pushing or moving of ice in the proposed exploration drilling area and to prevent ice floes from striking the drilling unit. Ringed, bearded, and spotted seals (along with the ribbon seal and walrus) are dependent on sea ice for at least part of their life history. Sea ice is important for life functions such as resting, breeding, and molting.

These species are dependent on two different types of ice: pack ice and landfast ice. Shell does not expect to have to manage pack ice during the majority of the exploration drilling season. The majority of the pack ice management should occur in the early and latter portions of the exploration drilling season. Landfast ice would not be present during Shell's proposed operations.

The ringed seal is the most common pinniped species in the Chukchi Sea project area. While ringed seals use ice year-round, they do not construct lairs for pupping until late winter/early spring on the landfast ice. Therefore, since Shell plans to conclude exploration drilling on or before October 31, Shell's activities would not impact ringed seal lairs or habitat needed for breeding and pupping in the Chukchi Sea. Ringed seals can be found on the pack ice surface in the late spring and early summer in the Chukchi Sea, the latter part of which may overlap with the start of Shell's planned exploration drilling activities. If an ice floe is managed into one that contains hauled out seals, the animals may become startled and enter the water when the two ice floes meet.

Bearded seals breed in the Bering and Chukchi Seas, but would not be plentiful in the area of the Chukchi Sea exploration drilling program.

Spotted seals are even less common in the Chukchi Sea project area. The ice used by bearded and spotted seals needed for life functions such as breeding and molting would not be impacted as a result of Shell's exploration drilling program since it is unlikely these life functions would occur in the proposed project area, during the time in which drilling activities will take place.

For ringed seals, ice-management would occur during a time when life functions such as breeding, pupping, and molting do not occur in the proposed activity area. Additionally, these life functions normally occur on landfast ice, which will not be impacted by Shell's activity.

Therefore, it is determined that Shell's planned exploration drilling program in the Chukchi Sea is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or on the food sources that they utilize.

9.5 Potential Impacts from Discoverer Presence

The length of the *Discoverer* (514 ft [156.7 m]) is not significant enough to cause large-scale diversions from the animals' normal swim and migratory paths. The *Discoverer's* physical footprint is small relative to the size of the geographic region either would occupy, and will likely not cause marine mammals to deflect greatly from their typical migratory routes.

Any deflection of bowhead whales or other marine mammal species due to the physical presence of the *Discoverer* or its support vessels would be very minor. Even if animals may deflect because of the presence of the drillship, the Chukchi Sea's migratory corridor is much larger in size than the length of the drillship and animals would have other means of passage around the drillship. In sum, the physical presence of the drillship is not likely to cause a significant deflection to migrating marine mammals.

10. Anticipated impact of habitat loss or modification

The effects of the planned exploration drilling program are expected to be negligible. It is estimated that only a small portion of the animals utilizing the areas of the planned program would be temporarily displaced. During the period of the exploration drilling program (July 4-October 31st), most marine mammals would be dispersed throughout the area. The peak of the bowhead whale migration through the Chukchi Sea typically occurs in September and October. Again, some bowheads might be temporarily displaced around the exploration drilling operation during this time. The numbers of cetaceans and seals subject to displacement, if any, would be extremely few in relation to abundance estimates for the mammals addressed under this IHA.

In addition, feeding does not appear to be an important activity by bowheads migrating through the Chukchi Sea in most years. In the absence of important feeding areas, the potential diversion of a small number of bowheads is not expected to have any significant or long-term consequences for individual bowheads or their population. Bowheads, gray, or beluga whales are not predicted to be excluded from any habitat, nor are any seals predicted to be excluded from any habitat by the offshore exploration drilling program.

The planned exploration drilling program is not expected to have any habitat-related effects that would produce long-term affects to marine mammals or their habitat due to the limited extent of the acquisition areas and timing of the program.

11. The availability and feasibility (economic and technological), methods, and manner of conducting such activity or means of effecting the least practicable impact upon affected species or stock, their habitat, and of their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance

Details of the planned mitigations are discussed in the Marine Mammal Monitoring and Mitigation Plan (4MP; Attachment C).

12. Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following

12.1 A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation

Shell has prepared and will implement a POC pursuant to BOEMRE Lease Sale Stipulation No. 5, which requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas activities and the subsistence activities and resources of residents of the North Slope. This stipulation also requires adherence to, and 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 submitted with the initial Chukchi Sea EP that was submitted to BOEMRE in May 2009, and approved on 7 December 2009. Shell has prepared a POC Addendum (Attachment D) which updates the POC with information regarding proposed changes to the proposed exploration drilling program as compared to the initial Chukchi Sea EP. The POC Addendum includes documentation of meetings undertaken to specifically to inform the stakeholders of the revised exploration drilling program and obtain their input. The POC Addendum builds upon the previous POC.

The POC Addendum identifies the measures that Shell has developed in consultation with North Slope subsistence communities to minimize any adverse effects on the availability of marine mammals for subsistence uses and will implement during its planned Camden Bay and Chukchi Sea exploration drilling programs planned to begin in the summer of 2012. In addition, the POC Addendum details Shell's communications and consultations with local subsistence communities concerning its planned 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 the North Slope subsistence communities, as well as the substance of its communications with subsistence stakeholder groups.

The leases within the Burger Prospect were acquired during the Chukchi Sea Oil and Gas Lease Sales 193 held in February 2008. During the 2012 exploration drilling program Shell plans to drill up to three exploration wells, and potentially a fourth partial well, on four leases (Table 1-1).

Shell's Chukchi Sea exploration drilling program is planned for the Burger Prospect in the Chukchi Sea (Figure 1-1). This program is set-out in detail in a revised Chukchi Sea EP submitted to BOEMRE in May 2011 and the impacts of the project, as well as the measures Shell will implement to mitigate those impacts, are analyzed in the Chukchi Sea Environmental Impact Analysis Shell submitted to BOEMRE (Appendix F to the revised Chukchi Sea EP). Shell will implement this POC Addendum, and the mitigation measures set-forth herein, for its Chukchi Sea exploration drilling program.

The potentially affected subsistence communities, identified in BOEMRE Lease Sale Stipulation No. 5, that were consulted regarding Shell's exploration drilling activities include: Barrow, Wainwright, Point Lay and Point Hope. Shell presented its POC for the Chukchi Sea exploration drilling program to these potentially affected subsistence communities during these consultations. Additionally, Shell met with subsistence groups including the AEWC, Inupiat Community of the Arctic Slope (ICAS), and the Native Village of Barrow, and presented information regarding the proposed activities to the North Slope Borough (NSB) and Northwest Arctic Borough (NWAB) Assemblies, and NSB and NWAB Planning Commissions. Several one-on-one meetings were also held throughout the villages.

Beginning in early January 2009 and continuing into 2011, the one-on-one meetings Shell held included representatives from the NSB and NWAB, subsistence-user group leadership, 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 the 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.

Shell continues to meet each year with the commissioners and committee heads of Alaska Beluga Whale Committee, the Nanuuq Commission, Eskimo Walrus Commission (EWC), and Alaska Ice Seal Commission (AISC) jointly in co-management meetings. Shell held individual consultation meetings with representatives from the various marine mammal commissions to discuss the planned Chukchi exploration drilling program. Following the exploration drilling season, Shell will have a post-season co-management meeting with the commissioners and committee heads to discuss results of mitigation measures and outcomes of the preceding season. The goal of the post-season meeting is to build upon the knowledge base, discuss successful or unsuccessful outcomes of mitigation measures, and possibly refine plans or mitigation measures if necessary.

Shell also attended the 2011 Conflict Avoidance Agreement (CAA) negotiation meetings in support of a limited program of marine environmental baseline activities in 2011 surveys taking place in the Beaufort and Chukchi seas. Shell is committed to a CAA process and will demonstrate this by making a good-faith effort to negotiate an agreement every year it has planned activities.

12.2 A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation

In the POC Addendum report (Attachment D), Table 4.2-1 provides a list of public meetings attended by Shell since January 2009 to develop the POC and the POC Addendum. Attachment D, updated to April 2011, also includes sign-in sheets and presentation materials used at the POC meetings held in 2011 to present the revised Chukchi Sea EP. Comment analysis tables for numerous meetings held during 2011 summarize feedback from the communities on Shell 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 Attachment D.

12.3 A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing;

The following mitigation measures, plans and programs, are integral to this POC and were developed during consultation with potentially affected subsistence groups and communities. These measures, plans, and programs to monitor and mitigate potential impacts to subsistence users and resources will be implemented by Shell during its exploration drilling operations in the Chukchi Sea. The mitigation measures Shell has adopted and will implement during its Chukchi Sea exploration drilling operations are listed and discussed below. These mitigation measures reflect Shell's experience conducting exploration activities in the Alaska arctic OCS since the

1980s and its ongoing efforts to engage with local subsistence communities to better understand their concerns and develop appropriate and effective mitigation measures to address those concerns. This most recent version of Shell's planned mitigation measures was presented to community leaders and subsistence user groups starting in January 2009 and has evolved since in response to information learned during the consultation process.

Subsistence Mitigation Measures

To minimize any cultural or resource impacts from its exploration operations, Shell will implement the following additional measures to ensure coordination of its activities with local subsistence users to minimize further the risk of impacting marine mammals and interfering with the subsistence hunt:

Communication

- 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 day and 40-hours per week during the exploration drilling season. 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 exploration 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 Center personnel; and advising how to avoid subsistence conflicts. SAs will have a handbook that will specify work tasks in more detail.

Aircraft Travel

- Aircraft shall not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, in poor weather (fog or low ceilings), or in an emergency situation, while over land or sea to minimize disturbance to mammals and birds. Aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft (457 m) in areas of active whaling; such areas to be identified through communications with the Com Centers.
- Aircraft 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 *Discoverer* and support vessels will enter the Chukchi Sea through the Bering Strait on or after July 1, minimizing effects on marine mammals and birds that frequent open leads and minimizing effects on spring and early summer bowhead whale hunting.
- All vessels transit routes will avoid known fragile ecosystems, including the Ledyard Bay Critical Habitat Unit, and will include coordination through Com Centers.
- To minimize impacts on marine mammals and subsistence hunting activities, the drillship 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 drillship 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 drill sites.
- MMOs will be aboard the *Discoverer* and all support vessels.
- Vessels will not operate within 0.5 mi (0.8 km) of walrus or polar bears when observed on land or ice.
- 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.
- Shell will communicate and coordinate with the Com Centers regarding all vessel transit.
- 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 Bird Strike Avoidance and Lighting Plan, Appendix I, revised Chukchi Sea EP).

Exploration Drilling Operations

- Drilling mud will be cooled to mitigate any potential permafrost thawing or thermal dissociation of any methane hydrates encountered during exploration 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.
- All casing and cementing programs will be certified by a registered professional engineer.
- 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 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 both capping stack equipment and, treatment and flaring capabilities, a fully-designed relief well drilling plan and provisions for a second relief well drilling vessel (*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.

<u>ZVSPs</u>

- Airgun arrays will be ramped up slowly to the required level 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 level will not begin until there has been a minimum of 30 minutes 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-minute lead-in to an array ramp up. If a marine mammal(s) is sighted within the safety zone during the 30-minute 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 minutes: 15 minutes for small odontocetes and pinnipeds, or 30 minutes for baleen whales and large odontocetes.

<u>Ice Management</u>

- Ice management will involve preferentially redirecting, rather than breaking, ice floes while the floes are well away from the drill site.
- Real time ice and weather forecasting will be from the Shell Ice and Weather Advisory Center (SIWAC).

<u>Oil Spill Response</u>

- 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 planning scenario which is greater than 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, oil spill containment equipment will be available for use in the unlikely event of a blowout. The containment 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 as equipment 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:

    1. Attaching a device or series of devices to the well to affect a seal capable of withstanding the maximum anticipated wellhead pressure and closing the assembly to completely seal the well against further flows (commonly called “capping and killing”)
    2. 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 available prior to exploration drilling.
- Pre-booming is required for all fuel transfers between vessels.

13. The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on the population of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding

The planned marine mammal monitoring and mitigation program for the Chukchi Sea exploration drilling program is included as Attachment C and this document addresses the issues in item 13.

14. Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects

Various agencies and programs may undertake marine mammal studies in the Chukchi Sea during the course of the exploration drilling season. It is unclear if these studies might be relevant to Shell's planned exploration drilling program. Shell is prepared to share information obtained during implementation of our marine mammal monitoring and mitigation program with a variety of groups who may find the data useful in their research. A suggested list of recipients includes:

- The NSB Department of Wildlife Management (T. Hepa)
- The USFWS Office of Marine Mammal Management (C. Perham and J. Garlic-Miller)
- The BOEMRE's Bowhead Whale Aerial Survey Program (C. Monnett)
- National Oceanic and Atmospheric Administration, National Marine Mammal Laboratory (Robyn Angliss)
- The Kuukpik Subsistence Oversight Panel
- Alaska Eskimo Whaling Commission (H. Brower -Barrow)
- Beluga Whale Committee (W. Goodwin -Kotzebue)
- Inupiat Community of the Arctic Slope (Martha Ipalook Faulk -Barrow)
- North Slope Science Initiative (J. Payne)
- BOEMRE Field Supervisor (J. Walker)
- Alaska Department of Natural Resources (S. Longan)
- Alaska Department of Fish and Game

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Attachment A
Equipment Specifications for *Discoverer*

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Discoverer Specifications

***DISCOVERER* SPECIFICATIONS**	
TYPE-DESIGN	Drillship - Sonat Offshore Drilling *Discoverer* Class
SHAPE	Monohull with sponsons added for ice-resistance[1]
SHIP BUILDERS & YEAR	Namura Zonshno Shipyard, Osaka, Japan - hull number 355
YEAR OF HULL CONSTRUCTION	1965
YEAR OF CONVERSION	1976
DATE OF LAST DRY-DOCKING	2010

***DISCOVERER* DIMENSIONS**		
LENGTH	514 ft	156.7 m
LENGTH BETWEEN PERPENDICULARS (LBP)	486 ft	148.2 m
BREADTH (MOULDED) OVER SPONSONS	85.3 ft	26.0 m
MAX HEIGHT (ABOVE KEEL)	274 ft	83.7 m
HEIGHT OF DERRICK ABOVE RIG FLOOR	175 ft	53.3 m

***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 7,000 kilograms (kg) each (ea) 15,400 pounds (lb) 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**	
MAX WATER DEPTH	1,000 ft with present equipment (can be outfitted to 2,500 ft)
MAX DRILLING DEPTH	20,000 ft

***DISCOVERER* DRILLING PACKAGE**	
DRAW WORKS	EMSCO E-2,100 - 1,600 horsepower (hp)
ROTARY	National C-495 with 49-$^{1}/_{2}$-in. opening
MUD PUMPS	2 ea Continental Emsco Model FB-1600 Triplex Mud Pumps
DERRICK	Pyramid 170 ft with 1,300,000 lb nominal capacity
PIPE RACKING	BJ 3-arm system
DRILL STING COMPENSATOR	Shaffer 400,000 lb with 18-ft stroke
RISER TENSIONS	8 ea 80,000 lb Shaffer 50-ft stroke tensioners
CROWN BLOCK	Pyramid with 9 ea 60-in. diameter sheaves rated at 1,330,000 lb
TRAVELING BLOCK	Continental - Emsco RA60-6
BOP	Cameron Type U 18.75-in. x 10,000 pounds per square inch (psi)
RISER	Cameron RCK type
TOP DRIVE	Varco TDS-3S, with GE-752 motor, 500 ton
BOP HANDLING	Hydraulic skid based system, drill floor

***DISCOVERER* DISPLACEMENT**	
FULL LOAD	20,253 metric tons (mt)
DRILLING	18,780 mt (Drilling, max load, deep hole, deep water)

***DISCOVERER* DRAFT**		
DRAFT AT LOAD LINE	27 ft	8.20 m
TRANSIT	27 ft (fully loaded, operating , departure)	8.20 m
DRILLING	25.16 ft	7.67 m

***DISCOVERER* HELIDECK**	
MAXIMUM HELICOPTER SIZE	Sikorsky S-92N
FUEL STORAGE	2 ea 720-gallon (gal) tanks

***DISCOVERER* ACCOMODATIONS**	
NUMBER OF BEDS	140
SEWAGE TREATMENT UNIT	Hamworthy ST-10

***DISCOVERER* PROPULSION EQUIPMENT**	
PROPELLER	1 each 15 ft 7-in. (4.75 m) diameter, fixed blade
PROPULSION DRIVE UNIT	Marine Diesel, 6 cylinder, 2 cycle, Crosshead type
HORSEPOWER	7,200 hp @ 135 RPM
TRANSIT SPEED	8 knots max

GENERAL STORAGE CAPACITIES	
SACK STORAGE AREA	33,000 ft^3 (934 m^3)
BULK STORAGE	
Bentonite / Barite	1,132 bbl (180 m^3) - 4 tanks
Bulk Cement	1,132 bbl (180 m^3) - 4 tanks
LIQUID MUD	
Active	1,200 bbl (191 m^3)
Reserve	1,200 bbl (191 m^3)
Total	2,400 bbl (382 m^3)
POTABLE WATER	1,670 bbl / 265.5 m^3 (aft peak can be used as additional pot water tank)
DRILL WATER	5,798 bbl / 921.7 m^3
FUEL OIL	6,497 bbl / 1,033 m^3

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

Attachment B
Ice Management Plan

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Shell Gulf of Mexico Inc.
3601 C Street, Suite 1000
Anchorage, AK 99503

ICE MANAGEMENT PLAN
Chukchi Sea

Submitted to:

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

Submitted by:
Shell Gulf of Mexico Inc.

Table of Contents

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I. INTRODUCTION

SCOPE

A Critical Operations and Curtailment Plan (COCP) will be in place for the Shell Gulf of Mexico Inc. (Shell) Chukchi Sea Exploration Drilling Program. As part of the COCP, this Ice Management Plan (IMP) has been developed. The description of notification of curtailment (an excerpt from the COCP) is presented in Attachment 1.

The IMP addresses the following activities:

- Vessels
- Shell Ice and Weather Advisory Center (SIWAC)
- Ice Alerts and Procedures
- Ice Management Philosophy
- Well Suspension Procedures
- Mooring System Recovery and Release
- Moving onto the Drill Site
- Training

The IMP:

- Defines Roles and Responsibilities
- Establishes Alert Levels; and
- Establishes Responses to Alert Levels.

The IMP facilitates appropriate decision-making and responses to the threat of hazardous ice and procedures set forth in the IMP prevent damage or harm to personnel, assets, or the environment.

Nothing in this document takes away the authority and accountability of the Master(s) of the vessels for the safety of their personnel and vessels and for protection of the environment.

This plan is not a substitute for good judgment.

Guidance Note: This document is not intended to contain detailed procedures. Detailed procedures are contained within the vessel-specific operating manuals.

II. DEFINITIONS

A. Roles and Responsibilities

Responsibilities have been defined for key personnel in section V. In addition to the defined personnel, the following positions have a role in IMP,

Chief Officer /Second Officer/Third Officer	In addition to regular duties will assist the Ice Advisor (IA)
Shell Drilling Superintendent	Shell's Drilling Superintendent is the senior Shell shore-based manager responsible for all Shell well operations offshore Alaska.
Noble Drilling Superintendent	The senior shore-based manager (Alaska). Liaising with the Shell Drilling Superintendent.

B. Definitions and Abbreviations

AHTS	Anchor Handling Tug Supply
API	American Petroleum Institute
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOP	blowout preventer
CFR	Code of Federal Regulations
COCP	Critical Operations and Curtailment Plan
cm	centimeter(s)
Discoverer	Turret-moored Drillship Motor Vessel (M/V) *Noble Discoverer*
DNV	Det Norske Veritas
Fennica	*M/V Fennica*
ft	foot/feet
FTP	file transfer protocol
FY	First-year ice. Sea ice of not more than one winter's growth, developing from young ice; 12 inches (in.) (30 centimeters [cm]) or greater. It may be subdivided into thin FY – sometimes referred to as white ice, medium FY and thick FY.
GFS	Global Forecast System
GIS	Geographic Information System
Hazardous Ice	Ice, which due to its size, stage of development, concentration, set and drift is considered to be a threat to the safety of personnel, the drilling vessel and well operations. Close proximity of an ice feature regardless of its set and drift may be determined to be hazardous ice. Guidance Note: Sea state as well as visibility may influence what is categorized as hazardous ice.
HOS	hang-off sub
HT	Hazard Time. The estimated time it will take for hazardous ice to reach the drill site.
IA	Ice Advisor
IMO	International Maritime Organization
IMP	Ice Management Plan

IMV	Ice management vessel. Any ice class vessel tasked with ice management duties in support of the drilling vessel. This includes the primary ice management vessel (IMV) and the ice class Anchor Handling Tug Supply (AHTS)
in.	inch(es)
Kulluk	conical drilling unit *Kulluk*
LMRP	Lower Marine Riser Package
m	meter(s)
MODU	Mobile Offshore Drilling Unit
MT	Move-off Time. The time required to clear decks on the anchor handler recover all anchors conventionally and move off the drill site in an orderly fashion.
M/V	Motor Vessel
MY	Multi-year ice. OI which has survived at least two summers' melt. Hummocks are smoother than on SY and the ice is almost salt-free. Where bare, this ice is usually blue in color. The melt pattern consists of large interconnecting, irregular puddles and a well developed drainage system.
NOAA	National Oceanic and Atmospheric Administration
OI	Old ice. Sea ice which has survived at least one summer's melt. Topographic features generally are smoother than FY. It may be subdivided into SY and multiyear ice.
OSR	Oil Spill Response
OSV	Offshore Supply Vessel
PIC	Person in Charge
RP	Recommended Practice
SAR	Synthetic Aperture Radar
Shell	Shell Gulf of Mexico Inc.
SIWAC	Shell Ice and Weather Advisory Center located in Anchorage. The center develops forecasts from various sources, and disseminates same.
Support Vessels	Includes all vessels defined in this plan (IMV/OSR/AHTS/OSV).
SY	Second-year ice. OI which has survived only one summer's melt. Thicker than FY, it stands higher out of the water. In contrast to MY, summer melting produces a regular pattern of numerous small puddles. Bare patches and puddles are usually greenish-blue.
ST	Secure Time. The time required to secure the well, disconnect the Lower Marine Riser Package (LMRP) from the blowout preventer (BOP), recover and secure the riser.
TD	total depth
T-Time	Total Time. The sum of ST + MT.
Tor Viking	*M/V Tor Viking*
U.S.	United States
USCG	United States Coast Guard
VMT	Vessel Management Team. This team is headed by the Vessel Master and includes the Shell Drilling Foreman, Noble Drilling Superintendent, Drilling Vessel IA and the Chief Engineer.

III. VESSELS COVERED BY IMP

- Drillship - Motor Vessel (M/V) Noble *Discoverer (Discoverer)*
- Primary Ice Management Vessel (IMV) - the *M/V Fennica* (or similar)
- Secondary Ice Management Vessel and Anchor Handler – the M/V *Tor Viking* (or similar) –

<u>Drillship *Discoverer*</u>

The *Discoverer* is a true, self-contained drillship. Station keeping is accomplished using the turret-moored, 8-point anchor system. The underwater fairleads prevent ice fouling of the anchor lines. Turret mooring allows orientation of vessel's bow into the prevailing ice drift direction to present minimum hull exposure to drifting ice. The vessel is rotated around the turret by hydraulic jacks. Rotation can be augmented by the use of the fitted bow and stern thrusters.

The hull has been strengthened for ice resistance. Ice-strengthened sponsons have been retrofitted to the ship's hull.

The *Discoverer* is classed by Det Norske Veritas (DNV) as a Mobile Offshore Drilling Unit (MODU) for worldwide service. It is a "1A1 Ship-Shaped Drilling Unit l" and is capable of performing drilling operations offshore Alaska. The *Discoverer* has been issued with a DNV Appendix to Class stating:

> "*the structural strength and material quality of the 'Ice Belt' formed by the sponsons below the 8950mm A/B level, have been reviewed against the requirements for the DNV ICE-05 Additional Class Notation and found to meet those requirements (as contained in DNV Rules for Classification of Ships, Pt 5 Ch 1, July 2006) for a design temperature of -15 degrees C*."

The *Discoverer* will comply with the requirements of 30 CFR Part 250.417, the IMO, the USCG and DNV. All drilling operations will be conducted under the provisions of 30 CFR Part 250 Subpart D, API RP 53, 65 Part 2 and 75 and other applicable regulations and notices including those regarding the avoidance of potential drilling hazards and safety and pollution control. Such measures as inflow detection and well control, monitoring for loss of circulation and seepage loss, and casing design will be the primary safety measures. Primary pollution prevention measures are the contaminated and non-contaminated drain systems, the mud drain system, and the oily water processing system.

Structurally, this is comparable to Canmar drillships used safely and successfully in exploration campaigns in the Beaufort and Chukchi Seas into the 1990s.

Additional specifications on the drillship are provided in Attachment 2.

Drillship Principal Dimensions

Dimension	*Discoverer*	
Length Overall	514 ft	156.7 m
Draft	27 ft	8.2 m
Width	85 ft	26 m

Ice Management Vessels

Ice management support to the drillship will be provided by the *Fennica* (or similar) and *Tor Viking* (or similar). The drillship will be supported by these IMVs from the beginning of the campaign until the vessel departs the area. A description of these vessels is provided in Attachment 2.

Ice Management Vessel Principal Dimensions

Dimension	*Fennica*	*Tor Viking*
Length Overall	380 ft (116 m)	275 ft (83.7 m)
Draft	27 ft (8.4 m)	20 ft (6.0 m)
Width	85 ft (26 m)	59 ft (18.0 m)

Primary Ice Management Vessel

The *Fennica* (or similar vessel) is designated as the primary IMV. The *Fennica* is classed by the DNV as +1A1. Designed for the management, maintenance and service of offshore oil wells, the 380-ft (116-m) *Fennica* is a multipurpose vessel specialized in marine construction and icebreaking. *Fennica* is equipped with diesel-electric propulsion systems and their innovative combination of capabilities, based on extensive design and engineering work, facilitates use of these systems in arctic conditions.

Secondary Ice Management Vessel / Anchor Handler

Tor Viking is designated as the secondary IMV and anchor handler. Designed for the management, anchor handling, and maintenance and service of offshore oil wells, the 275-ft (83.7-m) *Tor Viking* is a multipurpose vessel specialized in marine construction and icebreaking.

Guidance Note: IMVs supporting the drilling vessel may be deployed to assist other vessels, as operations and ice conditions dictate. Diverting ice management resources away from the drilling vessel may require a curtailment of activities. This decision shall be made jointly by the Shell Drilling Foremen and the Master on the drilling vessel. The onshore Shell Drilling Superintendent (in consultation with the Noble Drilling Superintendent) will endorse the plan or set priorities if agreement cannot be reached at the field level.

IV. SHELL ICE AND WEATHER ADVISORY CENTER

SIWAC is an integrated forecasting service staffed 24/7 by industry-leading specialists under Shell contract in Anchorage, Alaska. SIWAC's primary function is to provide current and forecast ice and weather conditions directly to field operations and planning managers during the operational season. SIWAC provides information to decision makers and field principals to help them minimize risks when operating in the presence of ice. To provide quality and accurate information, SIWAC depends on skilled forecasters, subscription and public satellite imagery, numerical models, field observations, Geographic Information System (GIS) software tools, and a robust communication network.

SIWAC ICE DATA INPUTS

Ice forecasts are developed and issued daily. The Lead Ice Analyst compiles available data from subscription, specialized, and public services in ArcMAP (GIS Software) such as:

- MDA RadarSat 2 imagery
- MODIS satellite
- Canadian Ice Services
- National Ice Center
- Contract weather services
- Field observations
- IceNav images

Data Transmission

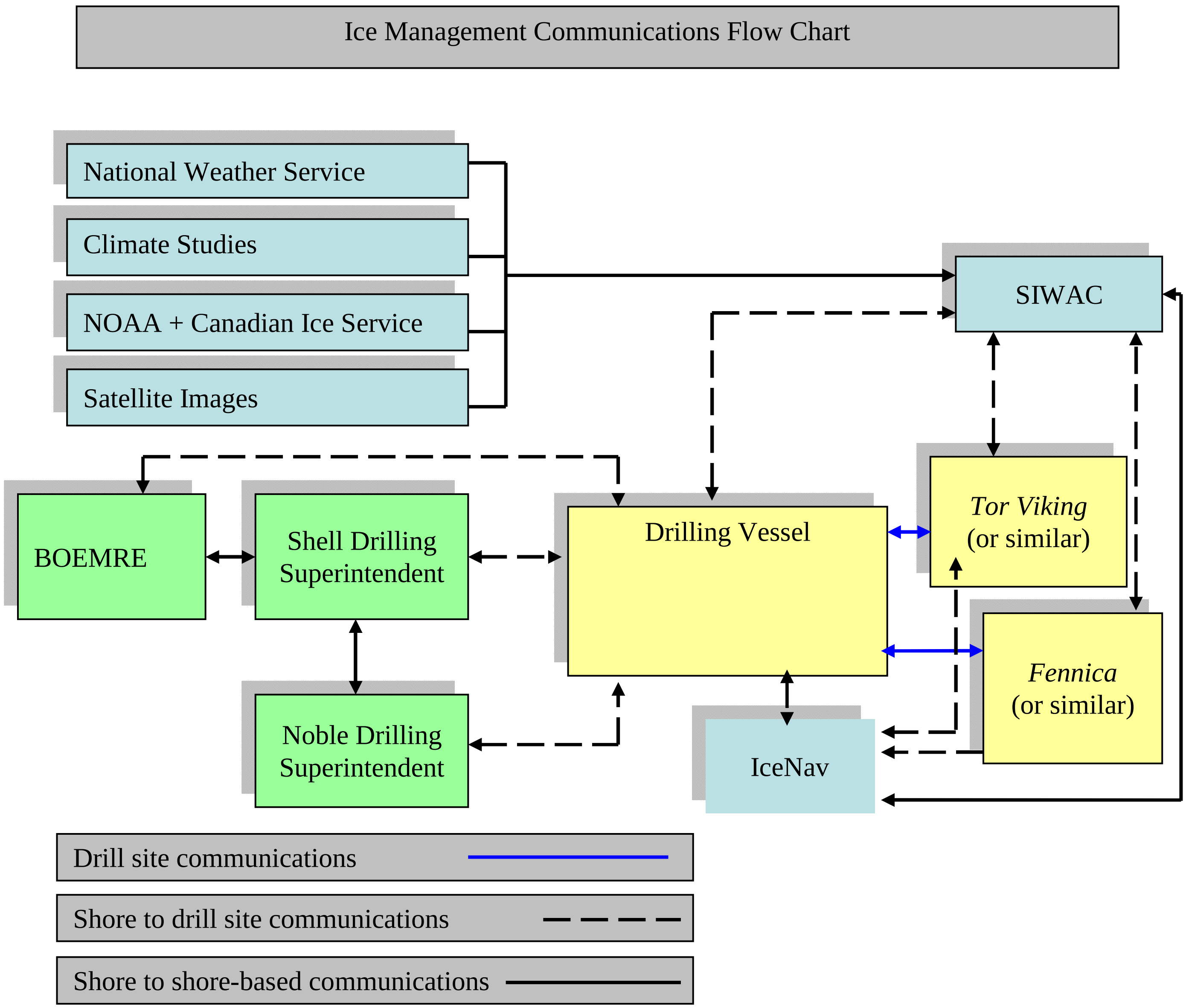
Effective communication of SIWAC ice and weather guidance and reciprocal feedback and field observations requires a robust and capable data network. The drilling vessel and IMVs are equipped with high-speed data and voice satellite service that has been proven to perform well in the U.S. Chukchi and Beaufort Seas.

Data, including satellite imagery and observations, are relayed through a file transfer protocol (FTP) site between SIWAC and the field vessels using automated processes. This keeps both the field and forecasters continuously refreshed with the latest information. In addition, SIWAC maintains a secure website that allows direct, on demand access to all forecast reports and data products.

Additional information about SIWAC is in Attachment 3.

Ice Information Flow Chart

NOTE: The following graphic, Ice Management Communications Flow Chart, depicts the constant two-way communication that would occur between the various components of the system.



NOAA = National Oceanic and Atmospheric Administration
BOEMRE = Bureau of Ocean Energy Management, Regulation and Enforcement

Guidance Note: Additional information regarding ice may be requested by the Master of the drilling vessel. Any means appropriate to the circumstances shall be used to provide this information. Where this information is to be obtained by aerial reconnaissance, the Shell Drilling Foreman will liaise with Shell Logistics to provide the appropriate resources.

V. ICE ALERT LEVELS AND PROCEDURES

These procedures define five Alert Levels that are linked to the time that hazardous ice is forecast to be at the drilling vessel location, and the time required to secure the well and move the drilling vessel off location if it becomes necessary. Roles, responsibilities and actions required are specified according to the Alert Level.

Ice Alert Levels

ALERT LEVEL	TIME CALCULATION	STATUS
Green	(HT – T-Time) is greater than 24 hours	Normal operations
Blue	(HT – T-Time) is greater than 12 hours and less than 24 hours	Initiate risk assessment. Validate secure times and move times.
Yellow	(HT – T-Time) is greater than 6 hours and less than 12 hours	Limited well operations in line with COCP. Commence securing well.
Red	(HT – MT) is less than 6 hours	Well-Securing Operations Completed. Commence anchor recovery operations.
Black	Drill site evacuated	Move drilling vessel to a safe location.

HT = Hazard Time
MT = Move-off Time
T-Time = Total Time

Guidance Note: If HT becomes greater than T-Time at any time, well securement and drill site evacuation contingency plans will be implemented.

Ice Alert Roles and Responsibilities

The following table summarizes roles, responsibilities and actions required for each Ice Alert Level.

Alert	Drilling Vessel Master	Drilling Vessel IA	IMV IA (Shell)	IMV Master	Noble Drilling Superintendent	Shell Drilling Foreman
ROLES AND RESPONSIBILITIES FOR ALL ALERT LEVELS	The Drilling Vessel Master is the person in charge (PIC) of the drilling vessel. He is the final authority in regards to safety of the vessel, crew and complement. All changes of Alert level are issued by the Master. The responsibility to evacuate the drill site in response to a hazard rests with the Master Evaluates information from SIWAC, IAs and Vessel Management Team (VMT) Establishes Ice Alert Level and directs ice management operations. Establishes MTs in conjunction with the IMV Masters. Ensure Alert Level status is broadcast to fleet and internally throughout drilling vessel at intervals dependent on Alert Level or at change of alert Level	Collates and evaluates information from the SIWAC, IMV IAs and VMT Advises Master in establishing Ice Alert Level. Correlates Secure Time (ST) with information from rig operations. Establishes HT and MT in conjunction with IMVs and drilling vessel and advises Master and VMT. Works in conjunction with IAs on IMVs to develop and establish effective ice management strategies and advises Drilling Vessel Master. Ensures current ice drift is broadcast to fleet and liaises with SIWAC	The IA is Shell's representative onboard the IMVs and is the primary contact for all communications with the Drilling Vessel Master. He advises the IMV Master in executing the ice management strategies. Works in conjunction with Master of IMVs to determine the local ice conditions and hazardous ice. Works in conjunction with Drilling Vessel IA and Master of IMVs to develop and implement effective ice management strategies. Provides feedback on effectiveness of strategy and reports any anomalies pertaining to ice.	The Master is the PIC of the IMVs. He is the final authority in regards to safety of the vessel, crew and complement. Evaluates advice from the SIWAC and IA (drilling vessel & IMVs). Works in conjunction with IA on drilling vessel and IA of IMVs to develop and execute effective ice management strategies within the capability of the vessel. Provides feedback on effectiveness of the strategy to the IA on the IMVs. Reports to IMVs IA any condition which inhibits vessel performance	The Noble Drilling Superintendent is the on-site supervisor responsible for all rig functions and drilling-related operations aboard the drilling vessel. Establishes ST & informs VMT of ST and well conditions. Validates drilling team is aware of their duties under present Ice Alert Level. Validates well secure contingency plans	The Drilling Foreman is the senior on-site Shell supervisor with responsibility for overseeing drilling and well operations and for initiating spill response as the On-site Incident Commander for spills originating from the well site. Validates well ST in conjunction with the Rig Superintendent. Informs Drilling Vessel Master and Noble Drilling Superintendent regarding ongoing & upcoming critical operations and curtailment plans. Communicates status of well and Ice Alert level to Shell shore-based management Under the authority of the Shell Drilling Superintendent the Shell Drilling Foreman may raise the Ice Alert Level at any time, He may order the suspension of drilling operations, securing of the well.

Alert	Condition	VMT Comms Frequency	Drilling Vessel Master	Drilling Vessel IA	IMV IA (Shell)	IMV Master	Noble Drilling Superintendent	Shell Drilling Foreman
Green	(HT – T-Time) is greater than 24 hours	Every 24 hours, or more frequently as needed	Discharges duties as per accountabilities	Discharges duties as per accountabilities	Discharges duties as per accountabilities	Discharges duties as per accountabilities	Discharges duties as per accountabilities	Discharges duties as per accountabilities
Blue	(HT – T-Time) is greater than 12 hours and less than 24 hours	Every 12 hours, or more frequently as needed	Ensures readiness to execute contingency plans. Ensures primary IMV is available to execute Ice Management strategies for the given ice regime. Ensures anchor handling tug supply (AHTS) IMV readiness to manage ice and anchor handling operations.	Establish Ice Management Strategies in conjunction with IMVs and IA onboard IMVs.	Establishes Ice Management Strategies in conjunction with IMV Master and Drilling Vessel IA Validate readiness of IMV to execute ice management strategy	Executes Ice Management Strategies in conjunction with IA on IMVs Establishes and states readiness of IMV to execute ice management strategy	Establishes ST and assesses upcoming well operations for changes to ST Informs VMT of ST and well conditions Validates securing contingency plans Evaluates ongoing & upcoming stage of drilling program with regard to ST and COCP	Validates ST in conjunction with the Rig Superintendent Informs Drilling Vessel Master and Noble Drilling Superintendent regarding ongoing & upcoming COCP Reports Alert changes to Shell shore-based management
Yellow	(HT – T-Time) is greater than 6 hours and less than 12 hours	Every 6 hours, or more frequently as needed	Directs ice management operations Establishes and Validates MT Establishes departure strategy Ensures Alert status is broadcast to fleet and internally at 1-hour intervals or at change of Alert Level	Establishes HT & advises Master & VMT Works in conjunction with IA on IMVs to initiate ice management strategies Ensures current ice drift is broadcast to fleet	Implements ice management strategies as directed by Drilling Vessel Master in conjunction with IMV Master Provides feedback on effectiveness of strategy	Executes ice management strategies as directed by Drilling Vessel Master and IA on IMV Provides feedback on effectiveness of the strategy	Commences securing well in accordance with agreed upon plan, informs VMT of progress	Monitors Well Securing Operations and effectiveness of ice management operations Communicates overall drilling vessel status to Shell shore management
Red	(HT – MT) is less than 6 hours	Every hour	Initiates departure plans following confirmation from Rig Superintendent that lower marine riser package (LMRP) has been retrieved and secured and guide wires are released Ensures Alert Level status is broadcast to fleet and internally Directs IMV and AHTS activities	Assess effectiveness of Ice Management Strategy in line with ongoing operations, Assist Drilling Vessel Master as needed Ensures current ice drift is broadcast to fleet during anchor recovery operations	Continues to implement ice management strategies in support of drilling vessel and anchor recovery operations	Executes ice management strategies and or activities associated with releasing the drilling vessel from moorings as directed by Drilling Vessel Master and IMV IA	Confirms well is secured and that LMRP is disconnected, retrieved & secured Commences securing drill floor for departure from site	Monitors rig securing operations and departure plan Communicates status to Shell shore management Organizes additional support as needed for site departure operations (for example logistics)
Black	Drill site evacuated	As needed	Directs IMV support operations leading to safe departure from drill site to pre-agreed safe area Complies with all regulatory reporting requirements (internal and external) Works with VMT and IA and IMVs to establish further course of action	Continues to monitor ice conditions. Works in conjunction with IA on IMVs during transit Provides Master of Drilling Vessel and VMT with information to aid further decision making	Advises IMV Master on operations leading to safe transit from drill site to pre-agreed safe area Provides information to Drilling Vessel Master to aid further decision making	Works under direction of the Drilling Vessel Master and IMV IA during transit	Confirms drill floor and associated areas are secured and ready to depart drill site Provides information to Master and VMT to aid further decision making	Informs Shell shore management of evacuation Complies with all regulatory reporting requirements (internal and external) Provides information to Master and VMT to aid further decision making

VI. ICE MANAGEMENT PHILOSOPHY

An effective IMP is designed to enable execution of the exploration program, with the appropriate barriers in place to manage and mitigate against risks that are specific to exploration drilling operation in offshore Alaska (in this case, threat of ice). Additionally, the IMP identifies the "top" event caused by the failure of barriers and addresses the procedures to deal with consequences of escalation.

The "top" event, for the purpose of the IMP, is a yellow alert level that triggers the commencement of well suspension operations. This section addresses the activities associated with ice management as a barrier to the top event.

The strategy to prevent the top event is to have the following elements as effective barriers:

- proper equipment,
- skilled people,
- appropriate information, and
- work processes.

The key elements identified above are discussed herein.

Proper Equipment

- The IMVs will be capable IMVs, with the appropriate ice strengthening, and have been contracted to support the exploration campaign.
- IceNav: The drilling vessel and IMVs will be outfitted with IceNav Equipment (Enhanced radar imaging of ice)
- *Tor Viking* (or similar vessel) is a high specification anchor handling vessel and will be the primary anchor handling vessel.
- *Fennica* (or similar vessel) designated as the primary IMV has anchor handling capability and could be used to supplement *Tor Viking* if needed.

Skilled People

- The drilling vessel and IMVs will carry specialist IA, in addition to the regular crew complement.
- The drilling vessel and the *Fennica* (or similar vessel) will have two IAs onboard providing 24/7 coverage.
- The IAs supporting the exploration campaign will have documented experience of having performed ice management activities associated with supporting exploration activities.
- SIWAC will be staffed with world-class industry-acknowledged experts in weather, satellite and Ice Synoptic analysis.
- IMVs will have crews with ice management experience.

Appropriate Information

A multi-layered, systematic approach is taken to provide relevant information from SIWAC with a feedback loop from the vessels using:

- Wide Area Satellite Imagery
- High Resolution Satellite Imagery
- Meteorological Buoys
- Field Observation
- Numerical Models
- Local Radar
- Vessels are outfitted with Fit-for-Purpose Data and Communications link.

Work Processes

A systematic approach for risk mitigation is adopted by developing effective work processes.

- Development of effective ice management strategies based on available information (global and local)
- Deployment of assets to deliver strategy
    - Threat sectors identified
    - Assess manageability of ice feature
    - Appropriate management of ice feature (breaking/deflecting)
    - Primary IMV deployed at an effective perimeter to reduce floes to manageable size in advance of HT
- Scheduled VMT meetings (frequency dictated by Alert levels)
- Planning/Coordination meetings with specific focus on Ice Alert Levels

VII. WELL SUSPENSION PROCEDURES.

Effectiveness of the IMP depends on accurately establishing HT, ST and MT. Secure Time is time taken to secure the well, disconnect and retrieve the LMRP.

As part of securing the well, well suspension procedures will be established. These procedures will supplement the detailed well securing procedures that will be contained within the Rig Operations Procedures and will be specific to securing the well in response to the threat of hazardous ice.

Return to the drill site following exit due to the threat of hazardous ice is covered in Section IX.

Examples of well suspension options and procedures are presented in Attachment 4.

A. Well Suspension Options

Securing and suspending the well can be accomplished by several means. The base case is to suspend the well by plugging, (mechanical or cement). The chosen option or combination thereof will be dependent upon well conditions, environmental conditions, and (or) equipment limitations. Shell will employ the most effective suspension procedure under the specific circumstances at the time.

Relevant information associated with well suspension will be documented in the daily drilling reports. The BOEMRE field representative will be apprised, and relevant records will be submitted to BOEMRE.

Potential well suspension options are listed in the following table.

	Mechanical Plugging	Drillpipe Hang-off	Pull Out of Hole	Shearing Drill Pipe	Dropping String
Time Required / Preference	Requires most time. Is the base case procedure for securement.	Less time than plugging	Potentially less time depending upon position in hole.	Least amount of time ;Stuck pipe contingency	Comparable to shearing drillpipe. Contingency to cope with mechanical hoisting failure
Provides Wellbore Isolation	Yes	Yes (blind/shears closed)	Yes (blind/shears closed)	Yes (blind/shears closed)	Yes (blind/shears closed)
Hang-off Sub (HOS) Required	No	Yes (Emergency Drill Pipe Hang-off Tool)	No	No	No
Packers / Bridge Plug Required	Yes	No	No	No	No
Potential to Leave String in Hole	Yes, if suspended below packer.	Yes	No	Yes, but access to pump through sheared string is questionable.	String in hole but requires fishing trip and overshot to circulate
Remarks	Mechanical plugs are preferred method in cased hole.	In this case no downhole plugging has been assumed.	This method is acceptable in situations where casing has been run and cemented, but not drilled out yet. Pipe can be pulled and blind/shears closed without further containment.	Contingency for stuck pipe situation	Contingency to cope with mechanical hoisting failure
Advantages	Provides complete wellbore isolation. Equipment readily available.	Provides wellbore isolation via blind/shear rams. Equipment readily available. Can be done in a timely manner. Leaves kill string in place for potential well control requirements.	Requires less time in situations where casing has been run but not drilled out, or if already out of the hole as noted above, for logging or changing BHA.	Quickest way to secure the well and prepare for move-off	Next to shearing, quickest way to prepare rig for move-off. Also leaves the top of the string in the hole undamaged and ready for recovery or circulating via overshot and packoff
Disadvantages	Takes longer. Packers require additional tripping. Cementing requires mixing / pumping time and introduces potential for contamination.	No downhole wellbore isolation.	Not a preferred method with open hole conditions because no pipe is left in the hole for potential well control methods. No downhole wellbore isolation.	Potential to leave a deformed pipe profile complicating fishing and circulating operations	No downhole isolation is accomplished. Requires fishing trip to reestablish downhole circulation

VIII. MOORING SYSTEM RELEASE/ RECOVERY

A. Conditions Present to Initiate Mooring System Release and Recovery

This section addresses mooring system release and recovery if ice conditions have triggered an Ice Alert Level of yellow and escalated to a red. The following discussion assumes the well has been secured and all recoverable well-related equipment has been retrieved.

B. Release Options

Mooring system release /recovery can be accomplished by several means. The base case is to recover moorings in the conventional manner. The selection of a specific release option and the execution of the procedures rest with the Drilling Vessel Master who informs the VMT. Potential options are listed in the table below.

Mooring System Release/ Recovery

	Conventional Anchor Retrieval	Rig Anchor Release (RAR)	Running off Wires
Time Required / Preference	Requires most time. Is the base case procedure for retrieval	Less time than conventional recovery	Contingency plan if RARs fail to activate.
Advantages	System is intact. Ready for redeployment	Reduced MT	None
Disadvantages	None	Increased redeployment time. Requires back up equipment. Potential loss of buoys. Relies on activation by acoustic release.	Complicates redeployment. High potential for seabed fouling. Potential to compromise system.

IX. MOVING ONTO OR RETURNING TO THE DRILL SITE

The authority to move on to or return to the drill site will be issued by the Shell Drilling Superintendent with the concurrence of the Rig Manager. Relevant regulatory authorities will be notified in accordance with the requirements.

Upon authorization, the final decision to move on to or return to the drill site is dependent upon the Drilling Vessel Master and the VMT who are able to assess the various parameters properly with input from the IMV Masters and IA to determine the practicality of the decision.

X. TRAINING

All personnel will be made aware of their roles and responsibilities within this IMP through a training session on each vessel. This training will include a table-top exercise, which will be executed prior to beginning operations to provide exposure to and test communications and procedures of the COCP and the IMP. Participants at the table-top exercise will include:

- Shell and Drilling leadership
- Rig Crews (both Drilling and Marine Operations staff)
- Oil Spill Response (OSR) representative
- SIWAC representatives
- BOEMRE operations representatives
- IMVs
- IAs
- Alaska Logistics (Marine and Aviation) Representatives

Observations from the table-top exercise will be documented.

XI. ATTACHMENTS

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Attachment 1 – Extract from Critical Operations Curtailment Plan

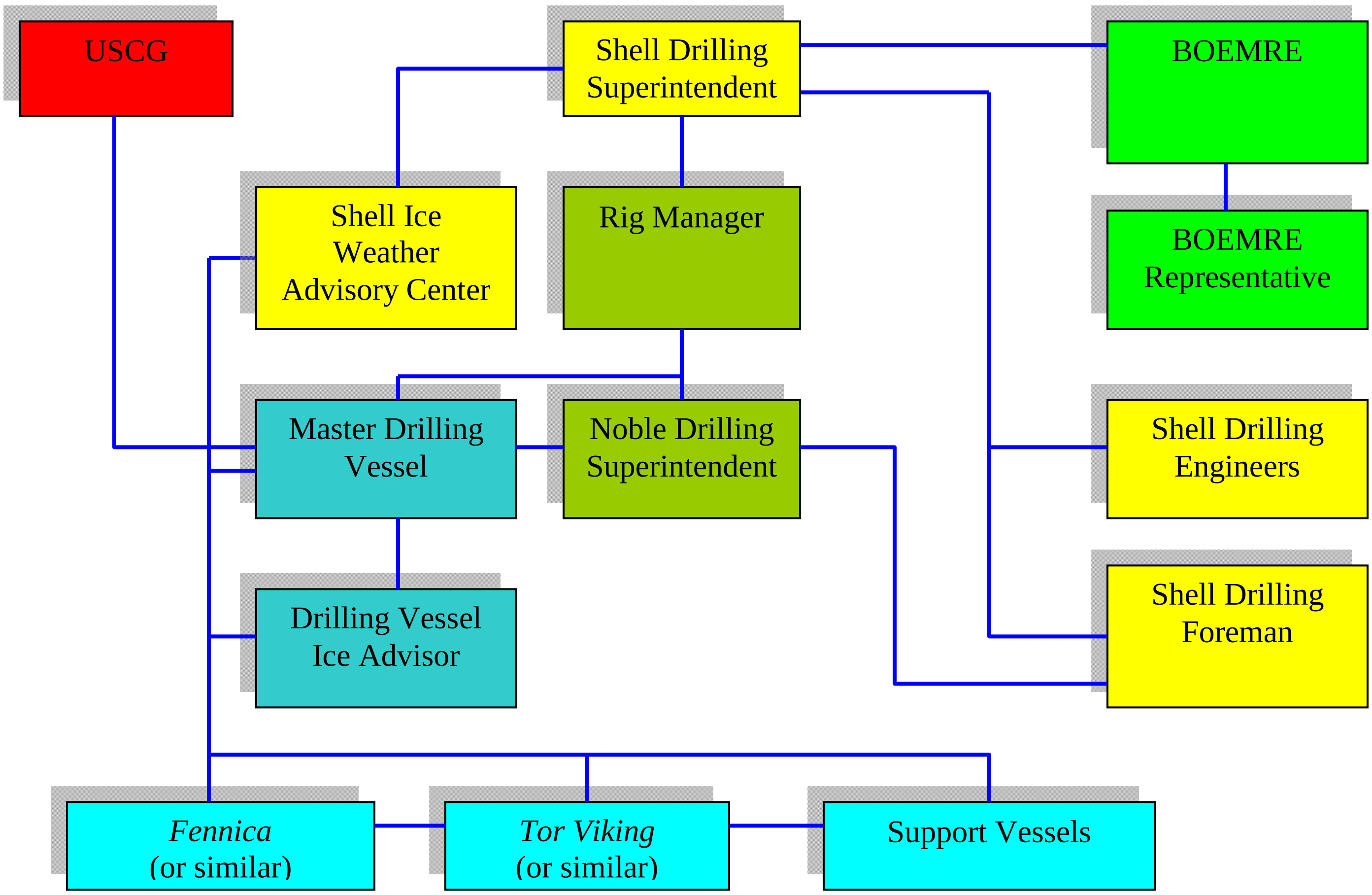
Per Section 10 of the COCP:

Notification of the decision for curtailments requiring the rig to disconnect from the well and depart location will be made as soon as practical, but not to interfere with the safety of the crew, environment, or vessel. This notification will be made either verbally to a representative on site or by telephone to a BOEMRE representative on duty; the notification may also be made in written form through the use of fax or email.

All operations curtailment decisions will be documented on the Shell Daily Operations Report. This information will be conveyed to BOEMRE on a weekly basis via the Well Activity Report and at the end of the well operations as part of the End of Operations Report.

The following flow chart depicts notifications in the event of curtailment.

Curtailment Notification Flow Chart (Attachment 1 continued)



Attachment 2 - Vessel Descriptions

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Discoverer Specifications

***DISCOVERER* SPECIFICATIONS**	
TYPE-DESIGN	Drillship - Sonat Offshore Drilling *Discoverer* Class
SHAPE	Monohull with sponsons added for ice-resistance[1]
SHIP BUILDERS & YEAR	Namura Zonshno Shipyard, Osaka, Japan - hull number 355
YEAR OF HULL CONSTRUCTION	1965
YEAR OF CONVERSION	1976
DATE OF LAST DRY-DOCKING	2010

***DISCOVERER* DIMENSIONS**		
LENGTH	514 ft	156.7 m
LENGTH BETWEEN PERPINDICULARS (LBP)	486 ft	148.2 m
WIDTH	85 ft	26 m
MAXIMUM (MAX) HEIGHT (ABOVE KEEL)	274 ft	83.7 m
HEIGHT OF DERRICK ABOVE RIG FLOOR	175 ft	53.3 m

***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 7,000 kilograms (kg) each (ea) 15,400 pounds (lb) ea
ANCHOR LINES	Chain Wire Combination
SIZE/GRADE	2.75-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**		
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)		
DRAW WORKS	EMSCO E-2,100 - 1,600 horsepower (hp)	
ROTARY	National C-495 with 49 ½ -in. opening	
MUD PUMPS	2 ea. Continental Emsco Model FB-1600 Triplex Mud Pumps	
DERRICK	Pyramid 170 ft. with 1,300,000 lb nominal capacity	
PIPE RACKING	BJ 3-arm system	
DRILL STING COMPENSATOR	Shaffer 400,000 lb with 18-ft (5.5 m) stroke	
RISER TENSIONS	8 ea. 80,000 lb Shaffer 50-ft (15.2 m) stroke tensioners	
CROWN BLOCK	Pyramid with 9 ea. 60-in. (1.5 m) diameter sheaves rated at 1,330,000 lb	
TRAVELING BLOCK	Continental - Emsco RA60-6	
BLOWOUT PREVENTOR (BOP)	Cameron Type U 18 ¾ -in. (48 cm) x 10,000 pounds per square in. (psi)	
RISER	Cameron RCK type, 21-in. (53 cm)	
TOP DRIVE	Varco TDS-3S, with GE-752 motor, 500 ton	
BOP HANDLING	Hydraulic skid based system, drill floor	
***DISCOVERER* DISPLACEMENT**		
FULL LOAD	20,253 metric tons (mt)	
DRILLING	18,780 mt (Drilling, max load, deep hole, deep water)	
***DISCOVERER* DRAUGHT**		
DRAFT AT LOAD LINE	27 ft	8.20 m
TRANSIT	27 ft (fully loaded, operating , departure)	8.20 m
DRILLING	25.16 ft	7.67 m
***DISCOVERER* HELIDECK**		
MAXIMUM HELICOPTER SIZE	Sikorsky 92N	
FUEL STORAGE	2 ea. 720-gallon tanks	
***DISCOVERER* ACCOMODATIONS**		
NUMBER OF BEDS	140	
SEWAGE TREATMENT UNIT	Hamworthy ST-10	
***DISCOVERER* PROPULSION EQUIPMENT**		
PROPELLER	1 ea 15 ft 7-in. (4.8 m) diameter, fixed blade	
PROPULSION DRIVE UNIT	Marine Diesel, 6 cylinder, 2 cycle, Crosshead type	
HORSEPOWER	7,200 hp @ 135 revolutions per minute (RPM)	
TRANSIT SPEED	8 knots	

GENERAL STORAGE CAPACITIES	
SACK STORAGE AREA	934 cubic meters (m^3)
BULK STORAGE	
Bentonite / Barite	180 m^3 - 4 tanks
Bulk Cement	180 m^3 - 4 tanks
LIQUID MUD	
Active	1,200 barrels (bbl)
Reserve	1,200 bbl
Total	2,400 bbl
POTABLE WATER	1,670 bbl / 265.5 m^3 (aft peak can be used as add. pot water tank)
DRILL WATER	5,798 bbl / 921.7 m^3
FUEL OIL	6,497 bbl / 1,033 m^3

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

***Fennica* Specifications**

FINSTASHIP OFFSHORE

Powerful, high-tech, multipurpose vessels for global underwater oil field construction

Designed for the management, maintenance and service of offshore oil wells, the 97-metre Botnica is a multipurpose vessel specialised in marine construction and icebreaking, as are the 116-metre vessels Fennica and Nordica. They are equipped with diesel-electric propulsion systems and their innovative combination of capabilities, based on extensive design and engineering work, facilitates their use in both arctic and tropical conditions. All three of these multipurpose vessels are highly advanced, powerful and extremely well designed and built.

Unique technology for demanding conditions

These vessels are ideal for offshore operations. The working deck is about 1,000 m², making it exceptionally large and level for ships of this length. The deck was designed for fast equipment changes. Depending on the ship, such equipment may range from simple deck cranes to a 160-tonne pedestal active heave compensated crane, or from deepwater installation equipment to pipe-laying systems, under-water machinery control or the towing and installation of large pipelines.

With their 15,000 kW power output and 230-tonne bollard pull, the Nordica and the Fennica are ideal for seabed ploughing and towing, and they are also fully equipped for anchor-handling operations. The ships' main engine and generator solution makes it possible to perform heavy-duty maintenance tasks without affecting their operating ability.

Both the Fennica and the Nordica are also equipped with a stern roller.

Accurate, safe and highly suitable

The Botnica's moon pool and the large size of its working deck make this ship highly suitable for a variety of offshore operations. Different types of special tools and structures can be installed on the working deck. The attributes of the Botnica, a class 3 DP ship, are in keeping with the strict rules and stipulations demanded in oil well management, as well as the requirements on oil fields set by the Norwegian Maritime Directorate.

The multipurpose icebreakers are equipped with Kongsberg Simrad's Dynamic Positioning (DP) system, which has five independent control units operating their main propellers and three bow thrusters. Even in a sector in which ocean vessels equipped with DP systems are a normal sight, these vessels have performed their tasks exceptionally well in terms of manoeuvrability and accuracy. Their unusual asymmetrical and spacious navigation bridge was designed with an eye to the requirements placed on the ship's multiple applications, both on the open sea and in icebreaking and towing operations.

The vessels have a separate deck for the clients' use, with cabins and offices and a separate data network. The high quality facilities accommodate a total of 45-47 guests, depending on the ship.

Fennica

Dimensions

Length	116.00 m
Beam	26.00 m
Draught	8.40 m max.
Built	1993
Max. speed	16 knots

Class
DnV + 1A1 – Tug Supply Vessel – SF – EO – Icebreaker polar – 10, Dynpos, AUTR, Helideck

Dynpos
Simrad ADP 702

Accommodation
82 persons
24 cabins for client use (47 persons)
Client's offices: 1 operation centre on 4th bridge deck, 1 x 20 m² office

Helideck
Superpuma or similar

Deck
Working deck area 1090 m²
Anchor handling/winch
Aquamaster TAW 3000/3000 E

Machinery
Main engines
2 x Wärtsilä Diesel, Vasa 16V 32, each 6000 kW
2 x Wärtsilä Diesel, Vasa 12V 32, each 4500 kW
Generators
ABB Strömberg Drives
2 x HSG 1120 MP8, power 8.314 kVA, Volt 6.3 KV, speed750 rpm
2 x HSG 900 LR8, power 6.235 kVA, Volt 6.3 KV, speed 750 rpm
Propellers
2 x HSSOL 18/1654, output 7.500 kW each, ABB Strömberg Drives
2x Aquamater-Rauma US ARC 1, 7500 kW each,
FP propellers, variable RPM
Bow thrusters
3 x Brunvoll FV-80 LTC-2250, VP propellers 1.050 kW each

Bollard pull 234 tons

Crane(s) (optional)

Stb	30 tons/38 metre jib
Port	15 tons
A-frame	120 tons

Navigation Equipment
Robertson ECDIS Navigation System
Doppler speed log
Loran C
GPS
Fiber optic gyros
Differential GPS Gyro.
Navintra Ecdis
Direction finder
Echo sounder
Facsimile recorder

Communication Equipment
1 x Skanti TRP 8400D MF/HF SSB, including all GMDSS requirements
1 x Watch receiver
1 x Aero VHF. Helicopter communication
6 x VHF
1 x Navtex receiver
1 x Inmarsat B satellite comm. system
VSAT online satellite comm. system
3 x UHF walkie-talkie
3 x VHF walkie-talkie
2 x Freefloat EPRIB, 121,5 and 406 MHz
2 x Distress transponders, 96 Hz
Call signal OJAD

Nordica

Dimensions

Length	116.00 m
Beam	26.00 m
Draught	8.40 m max.
Built	1994
Max. speed	16 knots

Class
DnV + 1A1 – Tug Supply Vessel – SF – EO – Icebreaker polar – 10, Dynpos, AUTR, Helideck

Dynpos
Simrad ADP 702

Accommodation
82 persons
24 cabins for client use (47 persons)
Client's offices: 1 operation centre on 4th bridge deck, 1 x 20 m² office

Helideck
Superpuma or similar

Deck
Working deck area 1090 m²
Anchor handling/towing winch
Aquamaster TAW 3000/3000 E

Machinery
Main engines
2 x Wärtsilä Diesel, Vasa 16V 32, each 6000 kW
2 x Wärtsilä Diesel, Vasa 12V 32, each 4500 kW
Generators
ABB Strömberg Drives
2 x HSG 1120 MP8, power 8.314 kVA, Volt 6.3 KV, speed750 rpm
2 x HSG 900 LR8, power 6.235 kVA, Volt 6.3 KV, speed 750 rpm
Propellers
2 x HSSOL 18/1654, output 7.500 kW each, ABB Strömberg Drives
2x Aquamater-Rauma US ARC 1, 7500 kW each,
FP propellers, variable RPM
Bow thrusters
3 x Brunvoll FV-80 LTC-2250, VP propellers 1.050 kW each

Bollard pull 234 tons

Main crane (optional)

Lifting capacity	160 T/9 m 30 T/32 m
Main winch	Active Heave Compensated Constant Tension
Heave amplitude	+ 3,5 m double part + 7 m single part
Operating depth	500 m–160 T (double part) 1000 m–80 T (single part)
Aux winch	10 T, 33 m, Constant Tension
Tugger winches	2 x 4 T Constant Tension
Port	15 tons

A-frame (optional) 120 tons

Navigation Equipment
Navintra ECDIS Navigation System
Doppler speed log
Loran C
GPS
Fiber Optic Gyros
Differential GPS Gyro.
Direction finder
Echo sounder
Facsimile recorder

Communication Equipment
1 x Skanti TRP 8400D MF/HF SSB, including all GMDSS requirements
1 x Watch receiver
1 x Aero VHF. Helicopter communication
6 x VHF
1 x Navtex receiver
1 x Inmarsat B satellite comm. system
VSAT online satellite comm. system
3 x UHF walkie-talkie
3 x VHF walkie-talkie
2 x Freefloat EPRIB, 121,5 and 406 MHz
2 x Distress transponders, 96 Hz
Call signal OJAE

Botnica

Dimensions

Length	96.70 m
Beam	24.00 m
Draught	7.2 to 8.5 m
Built	1998
Max. speed	15 knots

Class
DnV + 1A1 – Supply Vessel – SF – EO – Icebreaker Ice – 10,
Dynpos AUTRO, RPS
NMD Mobile offshore Units, DP UNIT, with equipment class 3

Dynpos
Simrad SDP22 + SDP12 backup
2 x HIPAP combined SSBL/MULBL hydroacoustic system
2 x Seatex DPS DGPS combined GPS/Glonass

Accommodation
72 persons
24 cabins for client use (45 pers.)
2 x client's office

Helideck
Superpuma or similar

Deck
Working deck area 1000 m²

Machinery
Main engines
12 x Caterpillar 3512B, 1257 kW, 1500 rpm
Main generators
6 x ABB-AMG 560, 2850 kVA, 3,3 kV 3 N, 50 Hz
Emergency generators
1 x Caterpillar 3406, 200 kW, 400 V, 3 N, 50 Hz
Main propulsion
Stern 2 x 5000 kW Azipod, FP
Bow thrusters
3 x Brunvol tunnel, variable pitch á 1150 kW

Bollard pull 117 tons

Crane(s) (optional)
1 x Hydralift, 160 tons
1 x 15 tons

Main cranes

Lifting capacity	160 T/9 m 30 T/32 m
Main winch	Active Heave Compensated Constant Tension
Heave amplitude	+ 4 m double part + 8 m single part
Operating Depth	550 m–160 T (double part) 1100 m– 80 (single part)
Aux winch	10 T, 33 m, Constant Tension

Moonpool 6.5 x 6.5 metres

Navigation and communication equipment
GMDSS
Inmarsat B
VSAT online satellite comm. system
Call signal OJAK

FINSTASHIP

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Phone +47 3701 2260, fax +47 3701 2862
e-mail: maritime@gdv.no
www.gdv.no

Tor Viking Specifications

AHTS/Icebreaker Tor Viking II- Main Characteristics
Design: KMAR 808 AHTS/ ICEBREAKER (Now; MOSSMAR)
Classification: DnV,+1A1, SUPPLY, SF, TUG ICEBREAKER ICE-10, DK(+) EO HELDK-SH DYNPOS-AUTR HL(2,8) W1-OC
Built / Delivered: Havyard Leirvik, Norway - 03/2000
Registered / Flag: Skärhamn, Sweden

Dimensions
Length Over All (LOA): 83.70 metres
Length between p.p.: 75.20 metres
Breadth, moulded: 18.00 metres
Depth, moulded: 8.50 metres
Draught (scantling): 7.20 metres
Draught (design): 6.00 metres
Freeboard (design): 2.50 metres
Dead Weight: 2,528 tonnes
Light Ship: 4,289 tonnes
Gross: 3,382 tonnes
Net: 1,145 tonnes

Capacities
Dry Bulk: 283 m 3 in 4 tanks - totalling 10,000 ft 3
Pot Water: 724 m 3
Drill Water / Ballast: 1,205 m 3
Brine: 400 m 3 – SG 2.5
Oil Based Mud: 612 m 3 – SG 2.8
Base Oil: 242 m 3
Fuel Oil: 1,190 m 3 Marine Gas Oil (Diesel)
Urea: 94 m 3
Diesel Overflow: 21 m 3 with alarm
Diesel Service / Settling: 2 x 20 m 3
Deck Load: Abt 1,350 ts
Deck Area: 603 m 2 / 40.20 m x 15.0 m
All products in dedicated tanks – no dual purpose tanks

Propulsion
Main Engine: MAK 18,300 BHP - 4 eng (father/son) 2 x 3,840 kW + 2 x 2,880 kW = 13,440 kW
Thrusters: Bow 1,200 BHP in tunnel (Electr) + 1,200 BHP 360 deg retractable = 2,400 BHP: Stern 1,200 BHP in tunnel
Bollard Pull: Bollard Pull: 202 continuous (DnV certified) / Abt. 210 max pull
Speed/Consumption: 16 knots – Abt. 42.7 MT / 24 hrs at 6.0 metres draught , 12 knots – Abt. 25.0 MT

Towing & Anchorhandling Equipment
AHT Winch: Brattvaag towing/anchorhandling winch 400 ts pull / 550 ts brake holding caps
AHT Drum: One of 1,400 mm dia. x 3,750 dia x (1,250 mm + 1,250 mm) length
Wire Capacity: 2 x 1,900 metres of 77 mm wire or 2 x 1,650 metres of 83 mm wire
AH Drum: One of 1,400 mm dia. x 3,750 mm dia. x 3,000 mm length
Wire Capacity: 4,100 metres of 83 mm wire
Winch Control: TOWCON 2000 Automatic Control with printer
Pennant Reels: One off 2 x 1,500 m of 77 mm wire or 2 x 1,300 m of 83 mm wire capacity
: One off 3,400 m of 77 mm wire or 1 x 3,100 m of 83 mm wire capacity
Large Reel Inner Core: 1,500 mm dia
Cable Lifters: 2 x 76 mm and 2 x 84 mm onboard
Chain Lockers: 2 x 129 m 3 / giving abt 2 x 6,000 ft of 3 inch chain
Shark Jaws: 2 pairs of Karm Forks arranged for chain up to 165 mm dia / 750 ts SWL
Inserts for handling of 65, 75, 85, 100, and 120 mm dia. wire/chain
Stern Roller: One of 3,5 metres dia. x 6.0 metres length – SWL 500 ts
Guide Pins: 2 pairs Karm Fork Hydraulic pins – SWL 170 ts

Deck Equipment
Capstans: 2 x 15 ts pull
Tugger Winches: 2 x 15 ts pull
Smit Brackets: One bracket on B Deck Forward – SWL 250 ts
Cranes: 1 hydraulic crane on fore cargo deck giving 6 / 12 ts at 20/10 m arm (360 degr) : 1 telescopic crane on aft cargo deck giving 1.5 / 3 ts at 15/10 m arm (360 degr) : 1 hydraulic crane on for-castle deck for stores etc
Windlass: 1 hydraulic windlass / mooring winch. 2 declutch-able drums 46 mm K3 chain

Accommodation: Accommodation of a total of 23 persons, including crew.
All accommodation equipped with air-condition and humidification facilities.

Dynamic Positioning
The vessel is equipped with Kongsberg Simrad SDP 21 Redundant DP System – GreenDP

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Attachment 3 – Shell Ice and Weather Advisory Center

Operational Support Overview

Safe and efficient offshore operations in the Arctic are contingent upon quality and timely ice and weather forecasts. Using state-of-the art satellite technology, large areas of the Beaufort and Chukchi Seas are monitored remotely by the SIWAC to track and forecast movement of ice and make estimates of ice type and concentration.

Synthetic Aperture Radar (SAR) instruments on board the RADARSAT 2 satellite are contracted to acquire necessary images of sea ice over areas of interest several times per week. These images are transmitted to ground stations, processed, and made available for analysis within hours of acquisition. Interpretation of the ice edge and features are performed by experienced specialists using powerful mapping software to produce ice charts that are considerably more detailed than those available from national ice centers. These charts are then distributed to operational personnel and planning managers.

Knowing the location and composition of the ice at any given moment is a valuable tool. However, it is important to forecast how the ice may change over time. A complementary component of ice forecasting is quality weather information. Weather conditions in the Arctic are among the most severe on the planet and can change dramatically over a short time. The National Weather Service does not provide measurements and forecasts that sufficiently resolve the conditions over small areas or short time spans in the Arctic offshore. Therefore, dedicated meteorologists with Arctic forecasting experience are employed full time to produce accurate snapshots of the current conditions and reliable forecasts of weather conditions into the future.

Using the Global Forecast System (GFS) numerical weather model as a starting point, the meteorologists produce a high resolution grid in proprietary modeling software of weather parameters, such as atmospheric pressure, wind speed, and wave height that have been corrected based on local observations and weather instrumentation from Shell's vessels at sea, meteorological buoys, and coastal weather stations. The result is a model that accurately reflects current and forecast weather conditions over short distances in the Beaufort and Chukchi Seas, making marine operations and vessel transits safer and more responsible. Without this innovative forecast effort, weather products from other sources tend to describe the average or general conditions that one could expect over large areas, such as the entire U.S. Beaufort Sea, which results in reports of local conditions rarely matching what is forecast for the specific areas of operations.

The wind vectors, a set of points indicating the speed and direction of the wind distributed over the Beaufort and Chukchi Seas, and other output from the weather model are applied to the ice charts in the mapping software. This allows the ice analyst to assess the effect of wind and weather systems on the future movement and development of the ice.

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Attachment 4 – Well suspension Options and Contingencies

In all the following well suspension scenarios, the assumption is that a determination has been made by the Shell Drilling Superintendent, the Shell Drilling Foreman, the Drilling Superintendent, the Drilling Vessel Master and the VMT that a hazard exists and the well should be suspended. The Shell Drilling Foreman and the Drilling Superintendent in conjunction with the Shell Drilling Engineer and the Shell Drilling Superintendent will have analyzed the trip time, borehole stability, well control issues, operational parameters, depth of hole, and time available to decide upon the contingency steps most appropriate for well securement, and a detailed procedure will have been worked up. The Shell Drilling Foreman then presents the procedure to the BOEMRE Field Representative aboard the drilling vessel for comment and concurrence.

Well Suspension Scenario 1 – Mechanical Plugging

1. After determining that the well should be suspended under the assumptions described above, the Shell Drilling Foreman orders the Noble Drilling Superintendent to stop all normal drilling operations and to commence circulating the hole.
2. The driller completes circulating at minimum a full “bottoms up.”
3. The drilling assembly is pulled out of the hole and a mechanical packer suitable to the last casing or liner size is made up on the bottom of the drill string.
4. The packer is tripped in the hole, set approximately 200 ft above the last casing or liner shoe depth and pressure tested.
5. Depending on actual water depth, sufficient pipe is pulled to enable having the end of the string 200 ft above the top of the packer when hung off in the wellhead via the hang-off sub (HOS).
6. A full-opening safety valve and an inside blowout preventer (BOP) are made up in the top of the drill pipe, and one additional joint is added above these valves. The HOS is installed in the top of this joint. (The full opening safety valve is left in the *open* position.)
7. The HOS assembly is run in the hole on drill pipe to land the HOS in the wellhead bowl.
8. The proper hydraulic fluid volume to actuate the BOP stack is confirmed by the Subsea Engineer and the system operating pressure is checked. Pipe rams in the BOP are closed on the HOS profile. The drill pipe is backed out from the HOS and the landing string is pulled from the riser. The blind/shear rams are closed and locked above the HOS. BOP failsafe valves are all left in the closed position.
9. The master bushings are removed and the riser spider is installed.
10. The diverter handling tool is made up and the diverter assembly is laid down.
11. The riser landing joint is made up into the slip joint inner barrel. The slip joint inner barrel is collapsed and the inner barrel is locked.
12. BOP stack functions are blocked, and the LMRP connector is unlocked.

13. The LMRP is pulled off the top of the BOP with the block motion compensator and riser tensioners.
14. Once the Shell Drilling Foreman has ascertained that the LMRP is released from the BOP, he advises the Drilling Vessel Master that he is free to initiate (or continue) mooring recovery and departure procedures.
15. The drill crew and Subsea Engineer pull the landing joint to surface. The landing joint, slip joint and riser are then layed down and the LMRP is secured on deck.
16. The Drilling Vessel Master confirms with the IA that the Ice Alert Level has reached "red" status (ice hazard is due to arrive within 6 hours of completing anticipated mooring recovery time). The Drilling Vessel Master advises the Drilling Superintendent to have the Subsea Engineer shear guidelines loose from the top of the BOP guideposts and to retrieve the lines to surface.
17. The drill floor and moonpool area are cleared and inspected in preparation for mobilizing the drilling vessel.
18. All decisions and supporting facts are recorded on the Daily Report and issued to the BOEMRE, SIWAC, and the normal distribution list.

Well Suspension Scenario 2 – Drillpipe Hang-off

1. After determining that the well should be suspended, the Shell Drilling Foreman orders the Drilling Superintendent to stop all normal drilling operations and to commence circulating the hole.
2. The driller completes circulating at minimum a full "bottoms up."
3. A pill of heavy, kill-weight drilling mud is mixed and spotted at total depth (TD), then the rig pulls the bottomhole assembly back into the casing such that the bit will be at least 200 ft above the shoe when the pipe has been hung off on the BOP rams.
4. After pulling the proper distance into the casing, a full-opening safety valve and an inside BOP are made up in the top of the drillpipe. (The full opening safety valve is left in the *open* position.) One additional joint of drillpipe is added above these valves and all connections made up properly.
5. Drill pipe is added to the top of the single, but the connection at the hang-off point is not fully tightened.
6. The drill string is lowered back into the well with the loose connection positioned just above a pipe ram.
7. The proper hydraulic fluid volume to actuate the BOP stack is confirmed by the Drilling Superintendent and the system operating pressure is checked. Pipe rams in the BOP just below the loose drill pipe connection are closed. The drill string is lowered until all string weight is resting on the closed pipe ram. The loose connection is backed off and the remaining drill pipe is pulled from the riser. The blind/shear rams are closed and locked above the backed off drill pipe. BOP failsafe valves are all left in the closed position.
8. Proceed with steps 9 through 18 as indicated in Scenario 1 above.

Well Suspension Scenario 3 – Pull Out of Hole:

It is assumed the wellbore is isolated from the formation (i.e., a casing string has been run and cemented, but not yet drilled out). A drilling assembly has been run in the hole to the top of cement.

1. After determining that the well should be suspended, the Shell Drilling Foreman orders the Drilling Superintendent to pull out of the hole.
2. After pulling out of the hole, the proper hydraulic fluid volume to actuate the BOP stack is confirmed by the Drilling Superintendent and the system operating pressure is checked.
3. The blind/shear rams are closed and locked. BOP fail-safe valves are left in the <u>*closed*</u> position.
4. Proceed with steps 9 through 18 as indicated in scenarios 1 and 2 above.

Well Suspension Scenario 4 – Shearing Drill Pipe

It is assumed the drill string is stuck and unable to be pulled from the hole.

1. After determining that the well should be suspended, the Shell Drilling Foreman orders the Drilling Superintendent to circulate at minimum a full "bottoms up" (assuming circulation is possible).
2. While circulating, the Drilling Superintendent and the Toolpusher calculate the location of the drill string tool joints below the rotary.
3. Once circulation is completed the proper hydraulic fluid volume to actuate the BOP stack is confirmed by the Drilling Superintendent and the system operating pressure is checked.
4. Pipe rams are closed under the nearest connection.
5. The drill string is slacked down until all string weight is resting on the closed ram or the string weight has been transferred to the point at which pipe is stuck.
6. The blind/shear rams are closed, shearing the drill string above the hang-off point. The blind/shear rams are locked closed. BOP fail-safe valves are left in the <u>*closed*</u> position.
7. The cut section of drill string is pulled to surface.
8. Proceed with steps 9 through 18 as indicated in scenarios 1 and 2 above.

Well Suspension Scenario 5 – Dropping String

It is assumed that there has been a failure to the rig's hoisting capability; for example, failure of the drawworks to be able to pick up or position the string by lifting, and an approaching hazard has been identified. (Dropping the string is normally associated with being unable to shear the pipe across the shear rams, whether it is in the form of drill collars or heavywall casing, etc., and comes into play more often with a dynamically positioned vessel in a "drive off" situation.) Under most all circumstances with encroaching ice (barring mechanical failure), there is adequate time to trip drill collars out of the hole if across the stack or to install a crossover and run casing past the stack on drill pipe and then utilize a conventional hang-off tool.)

1. After determining that the well should be suspended and the string dropped because of a mechanical failure, the Shell Drilling Foreman orders the Drilling Superintendent to circulate at minimum a full bottoms up (if circulation is possible).
2. Once circulation is completed the proper hydraulic fluid volume to actuate the BOP annulars is confirmed by the Drilling Superintendent and the system operating pressure is checked.
3. Operating pressure for both annulars is increased to maximum, and both annulars are closed.
4. The string is slacked down until all string weight is supported by the closed annular elements.
5. Elevators are unlatched.
6. Opening pressure is applied to the annulars, releasing their hold upon the string and allowing it to fall downhole.
7. The blind/shear rams are closed and locked. BOP failsafe valves are left in the closed position.
8. At this point, the BOP stack functions are blocked, and the LMRP connector is unlocked. The LMRP is pulled off the top of the BOP with the riser tensioners alone, allowing it to clear the BOP sufficiently to enable moving off location.
9. Note that in this circumstance the LMRP may be left hanging until the hoisting capabilities of the rig have been restored. Movement off location will thus have to take water depth into consideration and clearance between the bottom of the LMRP and the seabed.
10. Once hoisting capabilities have been restored, proceed beginning with step 9 in the scenarios above to get the diverter and slip joint layed down and the LMRP secured on deck.

Attachment C
Marine Mammal Monitoring and Mitigation Plan (4MP)

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MARINE MAMMAL MONITORING AND MITIGATION PLAN

for

Exploration Drilling of Selected Lease Areas in the Alaskan Chukchi Sea

Shell Gulf of Mexico Inc.

May 2011

REVISED AUGUST 2011

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Tables

ACRONYMS & ABBREVIATIONS

°C	degrees Celsius
°T	degrees True North
µPa	micropascal(s)
4MP	Marine Mammal Monitoring and Mitigation Plan
AEWC	Alaska Eskimo Whaling Commission
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
dB	decibel
CDs	compact discs
cm^3	cubic centimeter(s)
Com Center	Communications and Call Center
Discoverer	Motor Vessel *Noble Discoverer*
GPS	Global Positioning System
ft	feet
ft^2	square feet
Hz	Hertz
in^3	cubic inch(es)
IHA	Incidental Harassment Authorization
JASCO	JASCO Applied Sciences
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
lb	pound(s)
Leq	sound energy equivalent level
LOA	Letter of Authorization
m	meter(s)
m^2	square meter(s)
mi	mile(s)
mi^2	square mile(s)
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
M/V	Motor Vessel
NMFS	National Marine Fisheries Service
Noble	Noble Corporation
NSB	North Slope Borough
NVD	night-vision device
psi	pounds per square inch
rms	root mean squared
Shell	Shell Gulf of Mexico Inc.
USB	universal serial bus
USFWS	U.S. Fish and Wildlife Service
VSI	vertical seismic imager
VSP	vertical seismic profile
ZVSP	zero-offset vertical seismic profile

INTRODUCTION

Shell Gulf of Mexico Inc. (Shell) will conduct a Marine Mammal Monitoring and Mitigation Plan (4MP) for exploration drilling activities in the Chukchi Sea during the 2012 exploration drilling season. The 4MP developed for Shell's exploration drilling program supports protection of the marine mammal resources in the area, fulfills reporting obligations to the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS), and establishes a means for gathering additional data on marine mammals for future operations planning.

Shell plans to conduct exploration drilling within existing lease holdings in the Chukchi Sea. Exploration drilling will be conducted from the drillship Motor Vessel (M/V) *Noble Discoverer* (*Discoverer*) owned and operated by Noble Corporation. The drillship is an ice-strengthened drilling vessel designed, engineered and constructed to safely operate in arctic waters like the Chukchi Sea. In addition to the drillship, several support vessels will be used. The support vessels will include tugs and barges, a primary ice management vessel, an anchor handler/ice management vessel, and oil spill response vessels.

At, or near the end of each well, a zero-offset vertical seismic profile (ZVSP) likely will be conducted. During ZVSP surveys, an airgun array is deployed adjacent to the drillship, while receivers are placed (temporarily anchored) in the wellbore. The sound source (airgun array) is fired repeatedly, and the reflected sonic waves are recorded by receivers (geophones) located in the wellbore. The survey will last 10-14 hours as the receivers are moved through the length of the wellbore and the airguns are fired 5-7 times after each movement. The purpose of the ZVSP 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's 4MP is a combination of active monitoring of the area of operations and the implementation of mitigation measures designed to minimize project impacts to marine resources. Monitoring will provide information on the numbers of marine mammals potentially affected by the exploration operations and facilitate real time mitigation to prevent injury of marine mammals by industrial sounds or activities. These goals will be accomplished by conducting vessel-based, aerial, and acoustic monitoring programs to document the potential reactions of marine mammals in the area to the various sounds and activities and to characterize the sounds produced by the exploration drilling activities, support vessels, and ZVSP.

Aerial monitoring and reconnaissance of marine mammals in coastal areas of the Chukchi Sea and recordings of ambient sound levels and vocalizations of marine mammals along the Chukchi Sea coast will be used to interpret potential impacts to marine mammals in subsistence use areas. Acoustic measurements will be made to establish safety radii for real time mitigation, if necessary, around the activities. These measurements will be used to determine the sound levels produced by various equipment and to establish any safety and disturbance radii if necessary. An initial sound source analysis will be supplied to NMFS within 120 hours of completion of the measurements, if possible. A detailed report will be issued to NMFS as part of the 90-day report following the end of the exploration drilling season. Shell will continue to measure the sound propagation of the drillship at various times or throughout the exploration drilling program. Sound energy from support vessels will also be measured. Bottom-founded hydrophones will also be placed in a large array across the Chukchi Sea to collect information on the use of the region by marine mammals and additional information on the propagation of sounds from human activities.

VESSEL-BASED MARINE MAMMAL MONITORING PROGRAM

Introduction

The vessel-based operations of Shell's 4MP are designed to meet the requirements of the Incidental Harassment Authorization (IHA) and the Letter of Authorization (LOA) which Shell requested from the NMFS and the USFWS, respectively, and to meet any other stipulated agreements between Shell and other agencies or groups. The objectives of the program will be to ensure that disturbance to marine mammals and subsistence hunts is minimized, that effects on marine mammals are documented, and to collect data on the occurrence and distribution of marine mammals in the project area.

The 4MP will be implemented by a team of experienced marine mammal observers (MMOs). These MMOs will be trained, experienced field observers, including both biologists and Inupiat personnel. The MMOs will be stationed aboard the drillship and associated support vessels throughout the exploration drilling period. The duties of the MMOs will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the exploration drilling operations; initiating mitigation measures when appropriate; and reporting the results. Reporting of the results of the vessel-based monitoring program will include the estimation of the number of marine mammal "takes" as defined by the NMFS and stipulated in the IHA.

The vessel-based operations of Shell's 4MP will be required to support the vessel based exploration drilling activities in the Chukchi Sea. The dates and operating areas will depend upon ice and weather conditions, along with Shell's arrangements with agencies and stakeholders. The *Discoverer* and associated support vessels will transit through the Bering Strait into the Chukchi Sea on or about July 1, arriving on location at the Burger Prospect as soon as ice and weather conditions allow. Exploration drilling will then commence on or about July 4, as ice, weather, and other conditions allow for safe exploration drilling operations, and may last until October 31. Vessel-based monitoring for marine mammals will be done throughout the period of exploration drilling operations to comply with provisions in the anticipated IHA and LOA from NMFS and USFWS, respectively.

The vessel-based work will provide:

- the basis for real-time mitigation, if necessary, as required by the various permits that Shell receives;
- information needed to estimate the number of "takes" of marine mammals by harassment, which must be reported to NMFS and USFWS;
- data on the occurrence, distribution, and activities of marine mammals in the areas where the exploration drilling program is conducted;

- information to compare the distances, distributions, behavior, and movements of marine mammals relative to the drillship at times with and without exploration drilling activity;
    - a communication channel to coastal communities including Inupiat whalers; and
    - employment and capacity building for local residents, with one objective being to develop a larger pool of experienced Inupiat MMOs.

The 4MP will be operated and administered consistent with monitoring programs conducted during seismic and shallow hazards surveys in 2006–2010 or such alternative requirements as may be specified in the IHA and LOA received from NMFS and USFWS, respectively for this project. Any other agreements between Shell and agencies or groups such as BOEMRE, the North Slope Borough (NSB), and the Alaska Eskimo Whaling Commission (AEWC) will also be fully incorporated. All MMOs will be provided training through a program approved by NMFS, USFWS (if so stipulated) and Shell, as described in the MMO section of this 4MP. At least one observer on each vessel will be an Inupiat who will have the additional responsibility of communicating with the Inupiat community and (during the various subsistence harvests) directly with Inupiat hunters and whalers. Details of the vessel-based marine mammal monitoring program are described below.

Mitigation Measures During Exploration Drilling Activities and Zero-Offset Vertical Seismic Profile Surveys

Shell's planned exploration drilling program incorporates both design features and operational procedures for minimizing potential impacts on marine mammals and on subsistence hunts. The design features and operational procedures of the mitigation measures have been described in the IHA (Section 12 of the IHA application to which this 4MP is appended) and LOA applications submitted to NMFS and USFWS respectively, and are not repeated in entirety here. Survey design features include:

- timing and locating exploration drilling and support activities to avoid interference with the annual subsistence hunting by the peoples of the Chukchi villages;
- conducting pre-season acoustic modeling to establish the appropriate safety zones and behavioral or disturbance radii;
- vessel-based monitoring to implement appropriate mitigation if necessary, and to determine the effects of project activities on marine mammals;
- acoustic monitoring of drillship and vessel sounds and marine mammal vocalizations; and
- seismic activity mitigation measures during performance of ZVSP surveys.

The potential disturbance of marine mammals during operations will be minimized further through the implementation of several vessel-based mitigation measures (see Section 12 of the IHA application to which this 4MP is appended) if mitigation becomes necessary.

Safety and Disturbance Zones

Under current NMFS guidelines (e.g., NMFS 2000), "safety radii" for marine mammals around industrial sound sources are customarily defined as the distances within which received pulse levels are ≥180 decibels (dB) re 1micropascal (µPa) root mean squared (rms) for cetaceans and ≥190 dB re 1 µPa (rms) for pinnipeds. These safety criteria are based on an assumption that sound energy received at lower levels will not injure these animals or impair their hearing abilities, but that higher received levels might have some such effects. Disturbance or behavioral effects to marine mammals from underwater sound may occur after exposure to sound at distances greater than the safety radii (Richardson et al. 1995). NMFS assumes that marine mammals exposed to underwater impulsive sounds at received levels ≥160 dB (rms) have the potential to exhibit behavioral reactions great enough to meet the definition of "harassment" in the MMPA. For continuous sounds NMFS has established a similar disturbance threshold at ≥120 dB (rms).

Exploration Drilling Activities

Expected safety and disturbance radii based on sound propagation from the drillship *Discoverer* were modeled by JASCO Applied Sciences (JASCO) at the three potential drill sites (JASCO 2009). Changes in the water column of the Chukchi Sea through the course of the exploration drilling season will likely affect the propagation of sounds produced by drilling activities, so models were run for expected oceanographic conditions in July and October to bracket the seasonal variability. These radii will be used for mitigation purposes, should they be necessary, until direct measurements are available early during the exploration drilling activities. Shell will measure the received levels of underwater sound versus distance and direction from the sound sources using calibrated hydrophones. The acoustic data will be analyzed as quickly as reasonably practicable in the field and used to verify (and if necessary adjust) the safety and disturbance radii.

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 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). Broadband source levels of sounds produced by the *Discoverer* varied by activity and direction from the ship, but were generally between 177 and 185 dB re 1 µPa @ 1 m rms (Austin and Warner 2010). Propagation modeling at the Burger prospect resulted in an estimated distance of 0.814 miles (mi) (1.31 kilometers [km]) to the point at which drillings sounds would likely fall below 120 dB. The estimated 0.814 mi (1.31 km) distance was multiplied by 1.5 (= 1.22 mi [1.97 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 on the Burger prospect. 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 is estimated to be 4.6 square miles (mi^2) (12 square kilometers [km^2]). As noted above, broadband source levels from the *Discoverer* generally were close to 180 dB rms (Austin and Warner 2010). Source levels by definition are measured at a 1 m distance. Therefore the 180 dB rms distance is 1 m. The distance to which sounds ≥160 are expected to propagate are estimated to be less than 33 feet (ft) (10 meters [m]) from the vessel and were not included in modeling results.

The source levels noted above for exploration drilling activities are not high enough to cause a temporary reduction in hearing sensitivity or permanent hearing damage to marine mammals.

Consequently, mitigation as described for seismic activities including ramp ups, power downs, and shut downs should not be necessary for exploration drilling activities, but will be employed during the ZVSP survey described below. Shell plans to use MMOs onboard the drillship and the various support vessels to monitor marine mammals and their responses to industry activities and to initiate mitigation measures should in-field measurements of the operations indicate conditions represent a threat to the health and well-being of marine mammals.

ZVSP Surveys

The sound source likely to be used by Shell for the ZVSP survey in 2012 will be similar to the ITAGA eight-airgun array, which consists of four 150 cubic inches (in.^{3}) (2,458 cubic centimeters [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. A similar airgun source was used in the region in 2008 during the BP Liberty seismic survey. Preseason estimates of the propagation of airgun sounds from the ITAGA vertical seismic profile (VSP) sound source have been estimated based on the measurements of the seismic source reported in BP's 90-day report (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} (14,421 cm^3). 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 10-23 ft [3-7 m]). The lower 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 has been increased from 235.4 to 241.4 while the remainder of the equation (-18*LogR – 0.0047*R) has been 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).

MMOs on the drillship will initially use these estimated safety radii for monitoring and mitigation purposes. An acoustics contractor will perform direct measurements of the received levels of underwater sound versus distance and direction from the ZVSP array using calibrated hydrophones. The acoustic data will be analyzed as quickly as reasonably practicable (within 5 days) in the field and used to verify (and if necessary adjust) the safety distances. The mitigation measures to be implemented will include pre-ramp up watches, ramp ups, power downs and shut downs as described below.

Ramp Ups

A ramp up of an airgun array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns firing until the full volume is achieved. The purpose of a ramp up (or "soft start") is to "warn" cetaceans and pinnipeds in the vicinity of the airguns and to provide the time for them to leave the area and thus avoid any potential injury or impairment of their hearing abilities.

During the proposed ZVSP surveys, the operator will ramp up the airgun arrays slowly. Full ramp ups (i.e., from a cold start when no airguns have been firing) will begin by firing a single airgun in the array. A full ramp up will not begin until there has been a minimum of 30 minutes of observation of the safety zone by MMOs to assure that no marine mammals are present. The entire safety zone must be visible during the 30-minute lead-in to a full ramp up. If the entire safety zone is not visible, then ramp up from a cold start cannot begin. If a marine mammal(s) is sighted within the safety zone during the 30-minute 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 minutes: 15 minutes for small odontocetes and pinnipeds, or 30 minutes for baleen whales and large odontocetes.

Power Downs and Shut Downs

A power down is the immediate reduction in the number of operating energy sources from all firing to some smaller number. A shut down is the immediate cessation of firing of all energy sources. The arrays will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable safety zone of the full arrays, but is outside the applicable safety zone of the single source. If a marine mammal is sighted within the applicable safety zone of the single energy source, the entire array will be shut down (i.e., no sources firing).

Marine Mammal Observers

Vessel-based monitoring for marine mammals will be done by trained MMOs throughout the period of exploration drilling operations to comply with expected provisions in the IHA and LOA that Shell receives. The observers will monitor the occurrence and behavior of marine mammals near the drillship and support vessels during all daylight periods during the exploration drilling operation, and during most periods when exploration drilling is not being conducted. MMO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the exploration drilling operations; and documenting “take by harassment” as defined by NMFS.

Number of Observers

A sufficient number of MMOs will be onboard each vessel to meet the following criteria:

- 100 percent monitoring coverage during all periods of exploration drilling operations in daylight;
- maximum of four consecutive hours on watch per MMO; and
- maximum of approximately 12 hours on watch per day per MMO.

MMO teams will consist of trained Inupiat and field biologist observers. An experienced field crew leader will be a member of every MMO team aboard the drillship and each support vessel during the exploration drilling program. The total number of MMOs aboard may decrease later in the season as the duration of daylight decreases assuming NMFS does not require continuous nighttime monitoring. Inupiat MMOs will also function as Native language communicators with hunters and whaling crews and with the Communications and Call Centers (Com Centers) in Native villages along the Chukchi Sea coast.

Crew Rotation

Shell anticipates that there will be provision for crew rotation at least every three to six weeks to avoid observer fatigue. During crew rotations detailed hand-over notes will be provided to the incoming crew leader by the outgoing leader. Other communications such as email, fax, and/or phone communication between the current and oncoming crew leaders during each rotation will also occur when possible. In the event of an unexpected crew change Shell will facilitate such communications to insure monitoring consistency among shifts.

Observer Qualifications and Training

Crew leaders and most other biologists serving as observers in 2012 will be individuals with experience as observers during one or more of the 2006–2010 monitoring projects for Shell or recent experience with other operators in Alaska or the Canadian Beaufort.

Biologist-observers will have previous marine mammal observation experience, and field crew leaders will be highly experienced with previous vessel-based marine mammal monitoring projects. Resumés for those individuals will be provided to NMFS so that NMFS (and USFWS if so stipulated) can review and accept their qualifications. All observers will be trained and familiar with the marine mammals of the area. A MMO handbook, adapted for the specifics of the planned Shell exploration drilling program will be prepared and distributed beforehand to all MMOs (see below).

Most observers will also complete a two-day training and refresher session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2012 exploration drilling season. Any exceptions will have or receive equivalent experience or training. The training session(s) will be conducted by marine mammalogists with extensive crew-leader experience during previous vessel-based seismic monitoring programs.

Primary objectives of the training include:

- review of the marine mammal monitoring plan for this project, including any amendments adopted, or specified by NMFS or USFWS in the IHA or LOA, by BOEMRE, or other agreements in which Shell may elect to participate;
- review of marine mammal sighting, identification, (photographs and videos) and distance estimation methods, including any amendments specified by NMFS or USFWS in the 2012 IHA or LOA;
- review of operation of specialized equipment (reticle binoculars, night vision devices, and global positioning system [GPS] system);
- review of, and classroom practice with, data recording and data entry systems, including procedures for recording data on mammal sightings, exploration drilling and monitoring operations, environmental conditions, and entry error control. These procedures will be implemented through use of a customized computer database and laptop computers; and
- review of specific tasks of the Inupiat communicator.

MMO Handbook

A MMO Handbook will be prepared for Shell's monitoring program. The Handbook will contain maps, illustrations, and photographs as well as copies of important documents and descriptive text and are intended to provide guidance and reference information to trained individuals who will participate as MMOs. The following topics will be covered in the MMO Handbook:

- summary overview descriptions of the project, marine mammals and underwater sound energy, the 4MP (vessel-based, aerial, acoustic measurements, special studies), the NMFS IHA and USFWS LOA and other regulations/permits/agencies, the Marine Mammal Protection Act (MMPA);
- monitoring and mitigation objectives and procedures, including initial safety radii,
- responsibilities of staff and crew regarding the 4MP;
- instructions for ship crew regarding the 4MP;
- data recording procedures: codes and coding instructions, common coding mistakes, electronic database; navigational, marine physical, and exploration drilling data recording, field data sheet;
- use of specialized field equipment: reticle binoculars, Big-eye binoculars, night vision devices (NVDs), laser rangefinders;
- reticle binocular distance scale;
- table of wind speed, Beaufort wind force, and sea state codes;
- data storage and backup procedures;
- list of species that might be encountered: identification, natural history;
- safety precautions while onboard;
- crew and/or personnel discord; conflict resolution among MMOs and crew;
- drug and alcohol policy and testing;
- scheduling of cruises and watches;
- communications;
- list of field gear provided;
- suggested list of personal items to pack;
- suggested literature, or literature cited; and
- copies of the NMFS IHA and USFWS LOA will be made available.

Monitoring Methodology

The observer(s) will watch for marine mammals from the best available vantage point on the drillship and support vessels. Ideally this vantage point is an elevated stable platform from which the MMO has an unobstructed 360-degree view of the water. The observer(s) will scan systematically with the naked eye and 7×50 reticle binoculars, supplemented with Big-eye binoculars and night-vision equipment when needed (see below). Personnel on the bridge will assist the MMO(s) in watching for pinnipeds and whales. New or inexperienced MMOs will be paired with an experienced MMO or experienced field biologist so that the quality of marine mammal observations and data recording is kept consistent.

Information to be recorded by MMOs will include the same types of information that were recorded during previous monitoring projects (e.g., Moulton and Lawson 2002). When a mammal sighting is made, the following information about the sighting will be carefully and accurately recorded:

- species, group size, age/size/sex categories (if determinable);
- physical description of features that were observed or determined not to be present in the case of unknown or unidentified animals;
- behavior when first sighted and after initial sighting;
- heading (if consistent), bearing and distance from observer;
- apparent reaction to activities (e.g., none, avoidance, approach, paralleling, etc.);
- closest point of approach and behavioral pace;
- time, location, speed, and activity of the vessel, sea state, ice cover, visibility, and sun glare; on support ships the distance and bearing to the drillship will also be recorded; and
- positions of other vessel(s) in the vicinity of the observer location.

The ship's position, speed, water depth, sea state, ice cover, visibility, and sun glare will also be recorded at the start and end of each observation watch, every 30 minutes during a watch, and whenever there is a change in any of those variables.

Distances to nearby marine mammals will be estimated with binoculars (Fujinon 7×50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon.

Observers may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water. However, previous experience showed that a Class 1 eye-safe device was not able to measure distances to seals more than about 230 ft (70 m) away. The device was very useful in improving the distance estimation abilities of the observers at distances up to about 1,968 ft (600 m)—the maximum range at which the device could measure distances to highly reflective objects such as other vessels. Humans observing objects of more-or-less known size via a standard observation protocol, in this case from a standard height above water, quickly become able to estimate distances within about ±20 percent when given immediate feedback about actual distances during training.

Monitoring At Night and In Poor Visibility

Night-vision equipment ("Generation 3" binocular image intensifiers, or equivalent units) will be available for use when needed. However, past experience with NVDs in the Beaufort Sea and elsewhere indicates that NVDs are not nearly as effective as visual observation during daylight hours (e.g., Harris et al. 1997, 1998; Moulton and Lawson 2002).

Specialized Field Equipment

Shell will provide or arrange for the following specialized field equipment for use by the onboard MMOs: reticle binoculars, Big-eye binoculars, GPS unit, laptop computers, night vision binoculars, and possibly digital still and digital video cameras.

Field Data-Recording, Verification, Handling, and Security

The observers on the drillship and support vessels will record their observations onto datasheets or directly into handheld computers. During periods between watches and periods when operations are suspended, those data will be entered into a laptop computer running a custom computer database. The accuracy of the data entry will be verified in the field by computerized validity checks as the data are entered, and by subsequent manual checking of the database printouts. These procedures will allow initial summaries of data to be prepared during and shortly after the field season, and will facilitate transfer of the data to statistical, graphical or other programs for further processing. Quality control of the data will be facilitated by (1) the start-of-season training session, (2) subsequent supervision by the onboard field crew leader, and (3) ongoing data checks during the field season.

The data will be backed up regularly onto compact discs (CDs) and/or universal serial bus (USB) disks, and stored at separate locations on the vessel. If possible, data sheets will be photocopied daily during the field season. Data will be secured further by having data sheets and backup data CDs carried back to the Anchorage office during crew rotations.

In addition to routine MMO duties, observers will be encouraged to record comments about their observations into the “comment” field in the database. Copies of these records will be available to the observers for reference if they wish to prepare a statement about their observations. If prepared, this statement would be included in the 90-day and final reports documenting the monitoring work.

Both Inupiat and trained-biologist observers will be encouraged to record comments about their observations into the “comment” field in the marine mammal sightings database. Observer training will emphasize the use of “comments” for sightings that may be considered unique or not fully captured by standard data codes.

In addition to the standard marine mammal sightings forms, a specialized form was developed for recording traditional knowledge and natural history observations. MMOs will be encouraged to use this form to capture observations related to any aspect of the arctic environment and the marine mammals found within it. Examples might include relationships between ice and marine mammal sightings, marine mammal behaviors, comparisons of observations among different years/seasons, etc. Copies of these records will be available to all observers for reference if they wish to prepare a statement about their observations for reporting purposes. If prepared, this statement would be included in the 90-day and final reports documenting the monitoring work.

Field Reports

Throughout the exploration drilling program, the observers will prepare a report each day or at such other interval as required summarizing the recent results of the monitoring program. The reports will summarize the species and numbers of marine mammals sighted. These reports will be provided to NMFS, USFWS, BOEMRE, and Shell as required.

Reporting

The results of the 2012 vessel-based monitoring, including estimates of "take by harassment", will be presented in the 90-day and final technical report(s). Reporting will address the requirements established by NMFS in the IHA, and USFWS in the LOA (if so stipulated).

The technical report(s) will include:

- summaries of monitoring effort: total hours, total distances, and distribution of marine mammals through study period for sea state, and other factors affecting visibility and detectability of marine mammals;
- analyses of the effects of various factors influencing detectability of marine mammals: sea state, number of observers, and fog/glare;
- species composition, occurrence, and distribution of marine mammal sightings including date, water depth, numbers, age/size/gender categories (when discernable), group sizes, and ice cover; and
- analyses of the effects of exploration drilling operations:
    - sighting rates of marine mammals during periods with and without exploration drilling activities (and other variables that could affect detectability),
    - initial sighting distances versus drilling state,
    - closest point of approach versus drilling state,
    - observed behaviors and types of movements versus drilling state,
    - numbers of sightings/individuals seen versus drilling state,
    - distribution around the drillship and support vessels versus drilling state, and
    - estimates of "take by harassment".

Data will be visualized by plotting sightings relative to the position of the drillship. We will also overlay the sightings data with acoustic data that indicates the sound levels associated with the exploration drilling activity and with maps of call locations determined by the seafloor recorders. Additionally, sightings data will be incorporated into animations of the call locations around the exploration drilling activity. Seafloor recorders used in the Chukchi Sea do not have the ability to localize calls. Larger groups of recorders, however, can localize calls using arrival times of the calls captured on several nearby recorders.

Shell will consider requests for data collected during the marine mammal monitoring only after the data have been put through a quality control/quality assurance program. Such requests may include incorporating the data with other companies' data and/or integrating the raw data with data from other marine mammal studies.

ACOUSTIC MONITORING PLAN

Exploration Drilling Sound Measurements

Objectives

Exploration drilling sounds are expected to vary significantly with time due to variations in the level of operations and the different types of equipment used at different times onboard the drillship. The goals of these measurements are:

- to quantify the absolute sound levels produced by exploration drilling and to monitor their variations with time, distance and direction from the drillship.
- to measure the sound levels produced by vessels operating in support of exploration drilling operations. These vessels will include crew change vessels, tugs, ice-management vessels, and spill response vessels.
- to measure the sound levels produced by an end-of-hole ZVSP survey using a stationary sound source.

Equipment

The drillship, support vessels, and ZVSP sound measurements will be performed using one of two methods, both of which involve real-time monitoring. The first method would involve use of bottom-founded hydrophones cabled back to the drillship (Figure 1). These hydrophones weigh approximately 88 pounds (lb) (40 kilograms) with a footprint of approximately 2.7 square feet (ft^2) (0.25 square meters [m^2]) and would be positioned between 1,640 ft (500 m) and 3,281 ft (1,000 m) from the drillship, depending on the final positions of the anchors used to hold the drillship in place. Hydrophone cables would be fed to real-time digitization systems on board. In addition to the cabled system, a separate set of bottom-founded hydrophones (Figure 2) may be deployed at various distances from the exploration drilling operation for storage of acoustic data to be retrieved and processed at a later date.

As an alternative to the cabled hydrophone system (and possible inclusion of separate bottom-founded hydrophones), the second (or alternative) monitoring method would involve a radio buoy approach deploying four spar buoys 4-5 mi (6-8 km) from the drillship. Additional hydrophones may be deployed closer to the drillship if necessary to better determine sound source levels. Monitoring personnel and recording/receiving equipment would be onboard one of the support vessels with 24-hour monitoring capacity. The system would allow for collection and processing of real-time data similar to that provided by the cabled system but from a wider range of locations. Processing would provide real-time localization of sound sources including seals and whales.

Sound level monitoring with either method will occur on a continuous basis throughout all exploration drilling activities. Both types of systems will be set to record digital acoustic data at sample rate 32 kilohertz (kHz), providing useful acoustic bandwidth to at least 15 kHz. Both the hydrophone systems use Reson TC4032 hydrophones with sensitivity -170 dB re V/µPa. These systems are capable of measuring absolute broadband sound levels between 90 and 180 dB re μPa. The long duration recordings will capture many different operations performed from the drillship. Retrieval of these systems will occur following completion of the exploration drilling activities.

These recorders will provide a capability to examine sound levels produced by different exploration drilling activities and practices and possibly to develop real time noise reduction measures. This system will not have the capability to locate calling marine mammals and will indicate only relative proximity. The system will be evaluated during operations for its potential to improve MMO observations through notification of MMOs on vessel and aircraft of high levels of call detections and their general locations.

The deployment of exploration drilling sound monitoring equipment will occur as soon as possible once the drillship is on site at any of the prospects where Shell intends to drill an exploration well. Retrieval of these systems will occur following completion of the exploration drilling activities. The long duration recordings will capture many different operations performed at the drillship. Accurate activity logs of exploration drilling operations and nearby vessel activities will be maintained to correlate with these acoustic measurements.

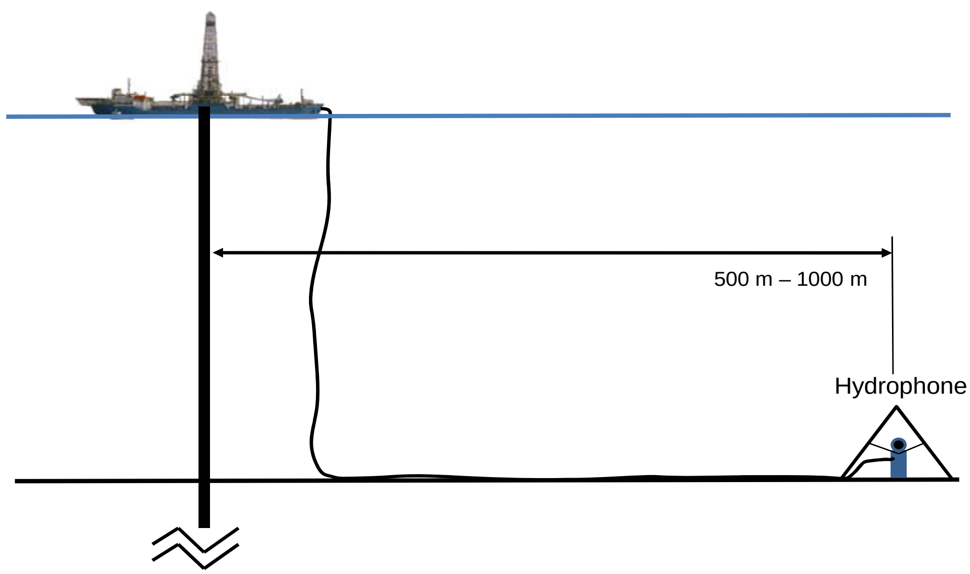


Figure 1. Cabled hydrophone method for real time monitoring of drilling sound energy.

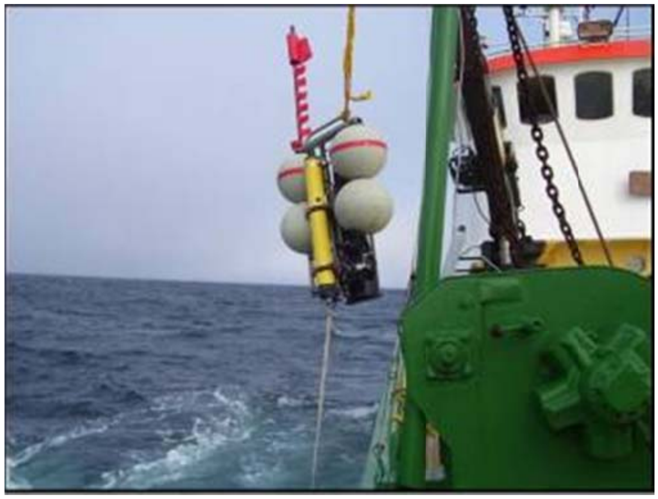


Figure 2. Hydrophone recording system being deployed at sea. The hydrophone system is an autonomous recorder with very high recording resolution. Acoustic data is stored internally on a hard-drive.

Vessel Sounds Monitoring

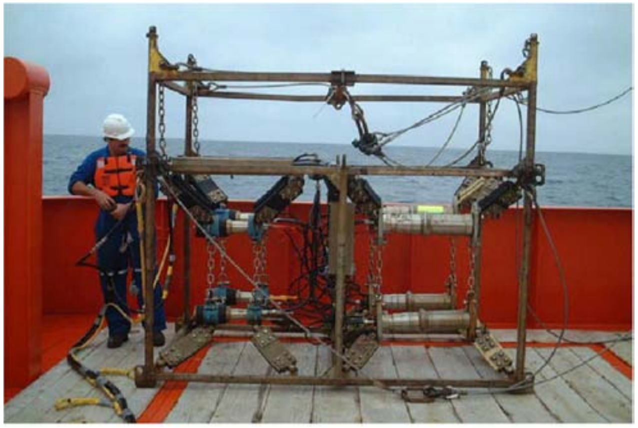
Sound produced by the vessels supporting exploration drilling operations will be recorded by the drilling sounds monitoring equipment. Logs of vessel position and activity will be used to determine the time varying contribution of each vessel to the overall sound level measurements. Additional dedicated measurements of vessel source levels will be obtained by having the vessels perform sail-pasts of the monitoring locations. These dedicated measurements will provide sound level versus distance from the respective vessels and will also be processed to compute source levels in 1/3-octave bands referenced to 3 ft (1.0 m) range.

Zero Offset Vertical Seismic Profiling Sounds Monitoring

Sounds produced by the ZVSP survey at, or near the end of each well will be recorded using the drilling sounds monitoring equipment. During ZVSP 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 drillship, while receivers are placed (temporarily anchored) in the wellbore. 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 in a string, 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 ZVSP 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.

During the ZVSP, the sound source is maintained at a constant location near the wellbore (Figure 3). A typical sound source that likely would be used by Shell in 2012 is the ITAGA eight-airgun array, which consists of four 150-in.^{3} (2,458-cm^3) airguns and four 4-in.^{3} (66-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. Current specifications of the array are provided in Table 1. The airgun array is depicted within its frame or sled, which is approximately 6 ft (2 m) x 5 ft (1.5 m) x 10 ft (3 m), in the photograph below. 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.



Photograph of ITAGA 8-airgun Array in Sled

Table 1 Typical Sound Source (Airgun Array) Specifications for ZVSP Surveys

Source Type	Number of Sources	Max Total Chamber Size	Pressure	Source Depth	Calibrated Peak-Peak Vertical Amplitude	Zero-Peak Sound Pressure Level[1]
ITAGA Sleeve Array	8 airguns (4) 150 in.^{3} (2,458 cm^3) (4) 40 in.^{3} (655 cm^3)	760 in.^{3} 12,454 cm^3	2,000 psi 138 bar	9.8 ft / 3.0 m 16.4 ft / 5.0 m	16 bar @1m 23 bar @1m	238 dB 241 dB

[1] dB re1μPa @1m

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 drillship *Discoverer* with a crane (sound source will be 50-200 ft / 15-61 m from the wellhead depending on crane location), to a depth of approximately 10-23 ft (3-7 m) below the water surface. The VSI with its four receivers will be temporarily anchored in the wellbore at depth. The sound source will be pressured up to 2,000 pounds per square inch (psi) (138 bar), and activated 5-7 times at approximately 20-second intervals. The VSI will then be moved to the next interval of the wellbore and re-anchored, after which the airgun array will again be activated 5-7 times. This process will be repeated until the entire wellbore is surveyed in this manner. The interval between anchor points for the VSI is usually between 200-300 ft (61-91 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.

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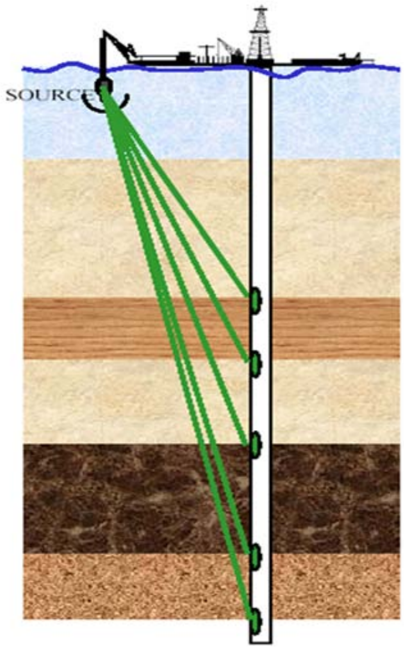

Figure 3. Schematic of ZVSP

Acoustic Data Analyses

Exploration drilling sound data will be analyzed to extract a record of the frequency-dependent sound levels as a function of time. Figure 4 shows the results of this type of analysis. These results are useful also for correlating measured sound energy events with specific survey operations and capturing marine mammal vocalizations. The analysis provides absolute sound levels in finite frequency bands that can be tailored to match the highest-sensitivity hearing ranges for species of interest. For example, bowhead hearing is thought to be most acute in the 100 Hertz (Hz) - 1000 Hz frequency range that corresponds with the blue dotted line in the upper plot of Figure 4.

The analyses will also consider sound level integrated through 1-hour durations (referred to as sound energy equivalent level Leq (1-hour). Figure 5 (upper) shows an example of a Leq analysis of hydrophone data. Similar graphs for long time periods will be generated as part of the data analysis performed for indicating exploration drilling sound variation with time in selected frequency bands.

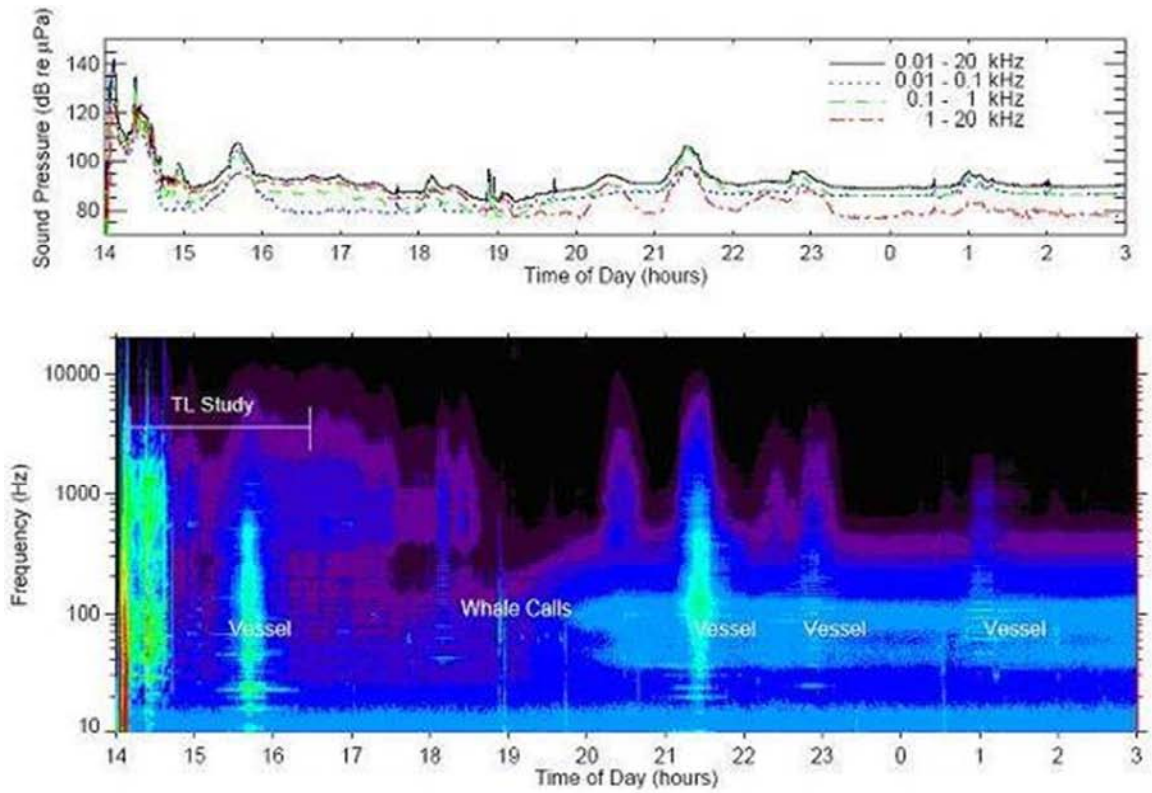

Figure 4. Lower: spectrogram of sound level measurements obtained from a hydrophone recording system. Upper: broadband and selected band level variation with time.

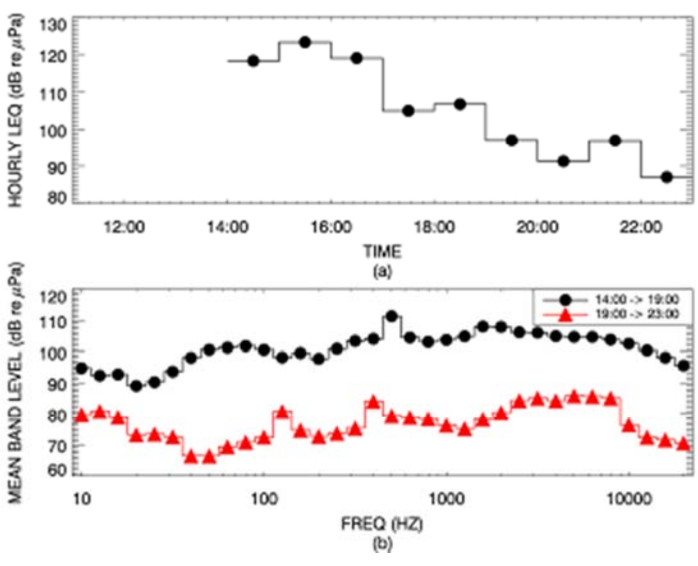

Figure 5. Upper: 1-hour Leq levels that will be calculated from acoustic measurements for use in correlating with bowhead whale deflection data.

Reporting of Results

Acoustic sound level results will be reported in the 90-day and comprehensive reports for this program. The results reported will include:

- sound source levels for the drillship and all exploration drilling support vessels;
- spectrogram and band level versus time plots computed from the continuous recordings obtained from the hydrophone systems;
- hourly sound energy equivalent (Leq) levels at the hydrophone locations; and
- correlation of exploration drilling source levels with the type of exploration drilling operation being performed. These results will be obtained by observing differences in exploration drilling sound associated with differences in the drill rig activity as indicated in detailed drillship logs.

JOINT MONITORING PROGRAM

This section describes studies that were undertaken in the Chukchi Sea from 2006 through 2010, will be undertaken again in 2011, and will be conducted during exploration drilling operations in 2012. Shell plans to conduct aerial surveys consistent with the previous 2006–2008 and 2010 programs along the Chukchi Sea coast. Additionally, an acoustic net array similar to the one deployed in 2010 is planned for 2011 and 2012 will be used to monitor industry and marine mammal sounds across the Chukchi Sea and along coast. Additional recorders will be deployed in the area around prospects where Shell intends to drill.

Chukchi Sea Coastal Aerial Survey

Nearshore aerial surveys of marine mammals in the Chukchi Sea were conducted over coastal areas to approximately 23 mi (37 km) offshore in 2006–2008 and 2010 in support of Shell's open-water marine survey exploration activities. These surveys provided data on the distribution and abundance of marine mammals in nearshore waters of the Chukchi Sea. Shell plans to conduct an aerial survey program in the Chukchi Sea in 2012 that will be similar to the previous programs.

Alaskan Natives from villages along the east coast of the Chukchi Sea hunt marine mammals during the summer and Native communities are concerned that offshore oil and gas exploration activities may negatively impact their ability to harvest marine mammals. Of particular concern are potential impacts on the beluga harvest at Point Lay and on future bowhead harvests at Point Hope, Point Lay, Wainwright and Barrow. Other species of concern in the Chukchi Sea include the gray whale, bearded, ringed, and spotted seals, and walrus. Gray whale and harbor porpoise are expected to be the most numerous cetacean species encountered during the proposed aerial survey, although harbor porpoise are difficult to detect from aircraft. Beluga whales may occur in high numbers early in the season. The ringed seal is likely to be the most abundant pinniped species. The current aerial survey program will be designed to collect distribution data on cetaceans but will be limited in its ability to collect similar data on pinnipeds.

Objectives

The aerial survey program objectives in 2012 will be:

- to collect data on the distribution and abundance of marine mammals in coastal areas of the eastern Chukchi Sea; and
- to collect and report data on the distribution, numbers, orientation and behavior of marine mammals, particularly beluga whales, near traditional hunting areas in the eastern Chukchi Sea.

Survey Considerations

With agreement from hunters in the coastal villages, aerial surveys of coastal areas to approximately 23 mi (37 km) offshore between Point Hope and Point Barrow will begin in early to mid-July and will continue until exploration drilling operations in the Chukchi Sea are completed. Weather and equipment permitting, surveys will be conducted twice per week during this time period. In addition, during the 2012 exploration drilling season, aerial surveys will be coordinated in cooperation with the aerial surveys funded by BOEMRE and conducted by NMFS and any other groups conducting surveys in the region.

Survey Procedures

Transects will be flown in a saw-toothed pattern between the shore and 23 mi (37 km) offshore as well as along the coast from Point Barrow to Point Hope (Figure 6). This design will permit completion of the survey in one to two days and will provide representative coverage of the nearshore region. Saw-tooth transects were designed by placing transect start/end points every 34 mi (55 km) along the offshore boundary of this 23 mi (37 km) wide nearshore zone, and at midpoints between those points along the coast. The transect line start/end points will be shifted along both the coast and the offshore boundary for each survey based upon a randomized starting location, but overall survey distance will not vary substantially. The coastline transect will simply follow the coastline or barrier islands. As with past surveys of the Chukchi Sea coast, coordination with coastal villages to avoid disturbance of the beluga whale subsistence hunt will be extremely important. “No-fly” zones around coastal villages or other hunting areas established during communications with village representatives will be in place until the end of the hunting season.

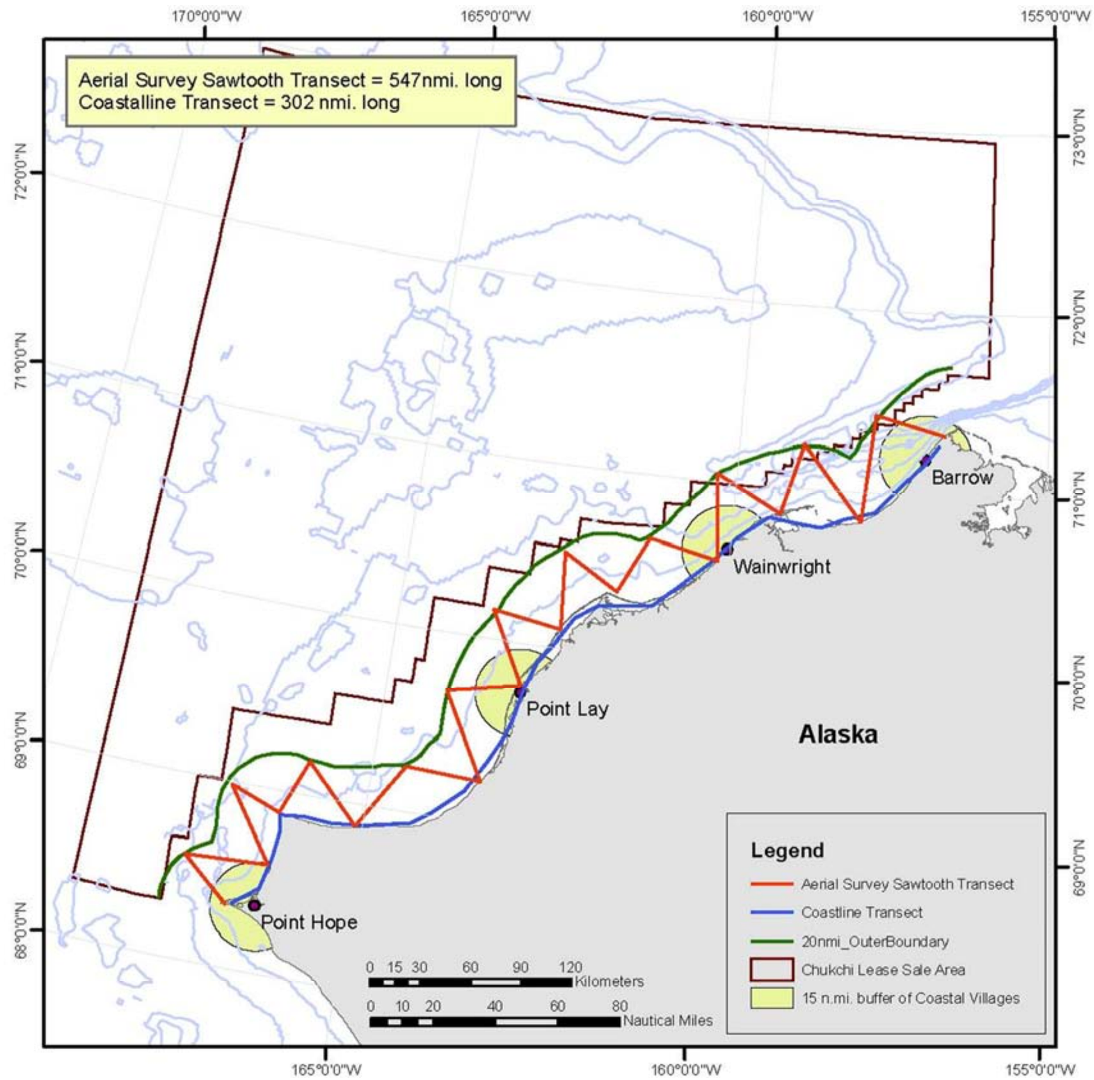

Figure 6. Aerial survey transects location and general pattern for the eastern Chukchi Sea, 2012. Specific transect start-/end-points will be altered randomly from survey to survey, and hunting areas will be avoided when hunting is occurring.

Standard aerial survey procedures used in previous marine mammal projects (by Shell as well as by others) will be followed. This will facilitate comparisons and (as appropriate) pooling with other data, and will minimize controversy about the chosen survey procedures. The aircraft will be flown at 110–120 knots ground speed and usually at an altitude of 1,000 ft (305 m). In accordance with anticipated stipulations in the LOA, survey aircraft will be flown at 1,500 ft (457 m) over the Ledyard Bay spectacled eider habitat after 1 July. Aerial surveys at an altitude of 1,000 ft (305 m) do not provide much information about seals but are suitable for bowhead, beluga, and gray whales. The need for a 1,000+ ft (305+ m) cloud ceiling will limit the dates and times when surveys can be flown. Selection of a higher altitude for surveys would result in a significant reduction in the number of days during which surveys would be possible, impairing the ability of the aerial program to meet its objectives.

The surveyed area will include waters where belugas are normally available to subsistence hunters. If large concentrations of belugas are encountered during the survey, the survey may be interrupted to photograph the groups to obtain better counts of the number of animals present. If whales are photographed in lagoons or other shallow-water concentration areas, the aircraft will climb to ~10,000 ft (3,048 m) altitude to avoid disturbing the whales and causing them to leave the area. If whales are in offshore areas, the aircraft will climb high enough to include all whales within a single photograph; typically about 3,000 ft (914 m) altitude. When in shallow water, belugas and other marine mammals are more sensitive to aircraft overflights and other forms of disturbance than when they are offshore (see Richardson et al. 1995 for a review). They frequently leave shallow estuaries when over flown at altitudes of 2,000–3,000 ft (610-904 m), whereas they rarely react to aircraft at 1,500 ft (457 m) when offshore in deeper water. Additionally, if large groups of other marine mammals are encountered on the surveys, such as the large aggregations of walruses seen in 2007 and 2010, we will attempt to photograph the animals and provide location information to interested stakeholders.

Two primary observers will be seated at bubble windows on either side of the aircraft and a third observer will observe part-time and record data the rest of the time. All observers need bubble windows to facilitate downward viewing. For each marine mammal sighting, the observer will dictate the species, number, size/age/sex class when determinable, activity, heading, swimming speed category (if traveling), sighting cue, ice conditions (type and percentage), and inclinometer reading to the marine mammal into a digital recorder. The inclinometer reading will be taken when the animal's location is 90° to the side of the aircraft track, allowing calculation of lateral distance from the aircraft trackline.

Transect information, sighting data and environmental data will be entered into a GPS-linked computer by the third observer, and simultaneously recorded on digital voice recorders for backup and validation. At the start of each transect, the observer recording data will record the transect start time and position, ceiling height (ft), cloud cover (in 10ths), wind speed (knots), wind direction degrees True North (°T) and outside air temperature degrees Celsius (°C). In addition, each observer will record the time, visibility (subjectively classified as excellent, good, moderately impaired, seriously impaired or impossible), sea state (Beaufort wind force), ice cover (in 10ths) and sun glare (none, moderate, severe) at the start and end of each transect, and at 2-minute intervals along the transect. This will provide data in units suitable for statistical summaries and analyses of effects of these variables (and position relative to the drillship) on the probability of detecting animals (Davis et al. 1982; Miller et al. 1999; Thomas et al. 2002). The data logger will automatically record time and aircraft position (latitude and longitude) for sightings and transect waypoints, and at pre-selected intervals along the transects.

Coordination with Other Aerial Surveys

The BOEMRE, the NMFS, the NSB, or other organizations may also conduct aerial surveys in the Chukchi Sea during the exploration drilling season. Shell will consult with any groups or organizations conducting aerial surveys along the eastern Chukchi Sea coast regarding coordination during the exploration drilling season. The objectives will be:

- to ensure aircraft separation when both crews conduct surveys in the same general region;

- to coordinate the 2012 aerial survey projects in order to maximize consistency and minimize duplication; and
- to maximize consistency with previous years' efforts insofar as feasible.

Analysis of Aerial Survey Data

During the field program, preliminary maps and summaries of the daily surveys will be provided to NMFS as normally required by the terms of the IHA. While in the field data will be checked for entry errors and files will be backed up to CDs or portable memory drives. Reporting of results will focus on the distribution of the observed species along the coast and the seasonal timing (if any) of the observed species.

Acoustic "Net" Array in Chukchi Sea

Background and Objectives

The acoustic "net" array used during the 2006–2010 field seasons is again proposed for 2011 and 2012 in the Chukchi Sea was designed to accomplish two main objectives. The first was to collect information on the occurrence and distribution of marine mammals (including beluga whale, bowhead whale, and walrus) that may be available to subsistence hunters near villages located on the Chukchi Sea coast and to document their relative abundance, habitat use, and migratory patterns. The second objective was to measure the ambient soundscape throughout the eastern Chukchi Sea and to record received levels of sounds from industry and other activities further offshore in the Chukchi Sea.

Technical Approach

The net array configuration used in 2007–2010 is again proposed for 2011 and 2012. The basic components of this effort consist of 30 hydrophone systems placed widely across the U.S. Chukchi Sea and a prospect specific array of 12 hydrophones capable of localization of mammal calls. The net array configuration will include hydrophone systems distributed at each of the four primary transect locations: Cape Lisburne, Point Hope, Wainwright and Barrow. The systems comprising the regional array will be placed at locations shown in Figure 7. These offshore systems will capture exploration drilling sounds, if present, over large distances to help characterize the sound transmission properties in the Chukchi Sea. They will also provide a large amount of information related to marine mammals in the Chukchi Sea.

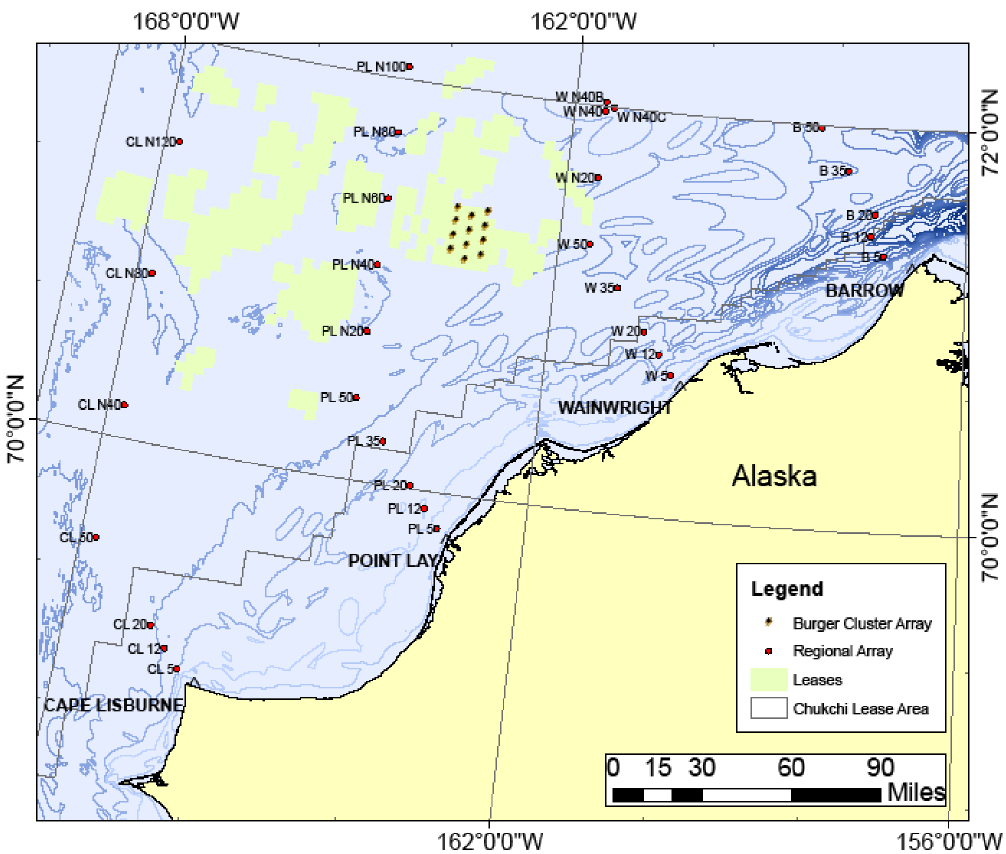

Figure 7. Deployment locations of Hydrophones in acoustic arrays in the eastern Chukchi Sea, Alaska 2012. Depiction of hydrophone array at Burger is not scaled correctly based on description below (12 km by 18 km)

The regional acoustic monitoring program, will be augmented in 2012 by an array of additional acoustic recorders to be deployed on a grid pattern over a 7.2 mi (12 km) by 10.8 mi (17.4 km) area extending over several of Shell's lease blocks near locations of highest interest for exploration drilling in 2012. The cluster array will operate at a sampling frequency of 16 kHz, which is sufficient to capture vocalizations from bowhead, beluga, walrus, gray whale, fin whale, humpback, killer whale and most other marine mammals known to be present in the Chukchi Sea. The cluster deployment configuration was defined to allow tracking of vocalizing animals that pass through the immediate area of these lease blocks. Maximum separation between adjacent recorders is 3.6 mi (5.8 km). At this spacing we expect that individual whale calls will be detected on at least 3 different recorders when the calling animals are within the boundary of the deployment pattern. Bowhead and other mysticete calls should be detectable simultaneously on more than 3 recorders due to their relatively higher sound source levels compared to other marine mammals. In calm weather conditions, when ambient underwater sound levels are low, we expect to have detection of most other marine mammal calls on more than three recorders. The goal of simultaneous detection on multiple recorders is to allow for triangulation of the call positions, which also requires accurate time synchronization of the recorders. When small numbers of whales are vocalizing Shell hopes to be able to identify and track the movements of specific individuals within the deployment area. It will not be possible to track individual whales if many whales are calling due to abundant overlapping calls. In this case analyses will show the general distribution of calls in the vicinity of the recorders.

Analysis and Reporting

The Chukchi Net Arrays and Cluster Array, deployed for up to 3 months, will produce an extremely large dataset comprising several Terabytes of acoustic data. The analyses of these data require identification of marine mammal vocalizations. Because of the very large amount of data to be processed, the analysis methods will incorporate automated vocalization detection algorithms. While the hydrophones used in the net array are not directional, and therefore not capable of accurate localization of detections, the number of vocalizations detected on each of the sensors may provide a measure of the relative spatial distribution of some marine mammal species, assuming that vocalization patterns are consistent within a species across the spatial and geographic distribution of the hydrophone array. These results may therefore provide information such as timing of migrations and routes of migration for belugas and bowheads.

A second purpose of the Chukchi net array is to monitor the amplitude of exploration drilling sounds reaching the near-shore region. It is expected that sounds from exploration drilling activities will be detectable on hydrophone systems when ambient sound energy conditions are low. The exploration drilling sound levels at recorder locations will be quantified and reported.

Analysis of all acoustic data will be prioritized to address the primary questions. The primary data analysis questions are to (a) determine when, where, and what species of animals are acoustically detected on each recorder (b) analyze data as a whole to determine offshore distributions as a function of time, (c) quantify spatial and temporal variability in the ambient sound energy, and (d) measure received levels of exploration drilling survey events and drillship activities. The detection data will be used to develop spatial and temporal animal detection distributions. Statistical analyses will be used to test for changes in animal detections and distributions as a function of different variables (e.g., time of day, season, environmental conditions, ambient sound energy, and exploration drilling or vessel sound levels).

COMPREHENSIVE REPORT ON INDUSTRY ACTIVITIES AND MARINE MAMMAL MONITORING EFFORTS IN THE BEAUFORT AND CHUKCHI SEAS

Following the 2012 exploration drilling season a comprehensive report describing the acoustic, vessel-based, and aerial monitoring programs will be prepared. The comprehensive report will describe the methods, results, conclusions and limitations of each of the individual data sets in detail. The report will also integrate (to the extent possible) the studies into a broad based assessment of industry activities and their impacts on marine mammals in the Chukchi Sea. The report will help to establish long term data sets that can assist with the evaluation of changes in the Chukchi Sea ecosystems. The report will attempt to provide a regional synthesis of available data on industry activity in offshore areas of northern Alaska that may influence marine mammal density, distribution and behavior.

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Attachment D
Plan of Cooperation (POC) Addendum

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Plan of Cooperation Addendum
Revised Chukchi Sea Exploration Plan
OCS Lease Sale 193
Chukchi Sea, Alaska

May 2011
Revised August 2011

Prepared by

Shell Gulf of Mexico Inc.
3601 C Street, Suite 1000
Anchorage, AK 99503

Table of Contents

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ACRONYMS & ABBREVIATIONS

4MP	Marine Mammal Monitoring and Mitigation Plan
ABWC	Alaska Beluga Whale Committee
AEWC	Alaska Eskimo Whaling Commission
ASRC	Arctic Slope Regional Corporation
bbl	barrel(s)
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOP	blowout preventer
CAA	Conflict Avoidance Agreement
CFR	Code of Federal Regulations
COCP	Critical Operations and Curtailment Plan
Com Centers	Communication and Call Centers
Discoverer	drillship M/V *Noble Discoverer*
dB	decibel(s)
EA	Environmental Assessment
EIA	Environment Impact Assessment
EP	Exploration Plan
EWC	Eskimo Walrus Commission
ft	foot/feet
ICAS	Inupiat Community of the Arctic Slope
IHA	Incidental Harassment Authorization
IMP	Ice Management Plan
km	kilometer(s)
LCMF	LCMF Incorporated, a division of Ukpeagvik Iñupiat Corporation
LOA	Letter of Authorization
m	meter(s)
MAWP	Maximum anticipated wellhead pressure
mi	mile(s)
min	minutes
MMO	Marine Mammal Observer
MMS	Department of the Interior, Minerals Management Service
M/V	Motor Vessel
NMFS	National Marine Fisheries Service
NSB	North Slope Borough

NSBSD	North Slope Borough School District
NWAB	Northwest Arctic Borough
OCS	Outer Continental Shelf
ODPCP	Oil Discharge Prevention and Contingency Plan
OSR	oil spill response
POC	Plan of Cooperation
revised Chukchi Sea EP	Revised Chukchi Sea Exploration Plan, OCS Lease Sale 193, Chukchi Alaska
ROV	remotely operated vehicle
SA	subsistence advisor
Shell	Shell Gulf of Mexico Inc.
UIC	Ukpeagvik Iñupiat Corporation
USFWS	United States Fish and Wildlife Service
WCD	worst case discharge

1.0 INTRODUCTION

Shell Gulf of Mexico Inc. (Shell) seeks to revise its Chukchi Sea Exploration Plan (EP). The initial Chukchi Sea EP was submitted to the former U.S. Department of the Interior, Minerals Management Service (MMS) now Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) in May of 2009. In this initial EP, Shell identified seven blocks (Posey Area Blocks 6713, 6714, 6763, 6764, 6912 and Karo Area Blocks 6864 and 7007) of interest in three prospects (Burger, Southwest Shoebill, and Crackerjack), that contained five potential drill sites (Burger C, F, J, Southwest Shoebill C, and Crackerjack C). The initial Chukchi Sea EP consisted of an exploration drilling program, which would have been conducted during the 2010 exploration drilling season, and included the drilling of an exploration well at up to three of the above-referenced five potential drill sites during the 2010 exploration drilling season using the drillship *Frontier Discoverer* now known as the Motor Vessel (M/V) *Noble Discoverer* (*Discoverer*).

The initial Chukchi Sea EP was deemed submitted by BOEMRE on 20 October 2009. BOEMRE subsequently prepared and distributed an Environmental Assessment (EA) of the proposed exploration drilling program as detailed in the EP, issued a Finding of No Significant Impact National Environmental Policy Act, and approved the Chukchi Sea EP on 7 December 2009. Shell was not able to conduct the exploration drilling program in 2010 or 2011 since the exploration drilling activities were postponed when BOEMRE suspended all exploration drilling activities in the Arctic following the Deepwater Horizon incident in the Gulf of Mexico. Pursuant to an initial Chukchi Sea EP, Shell plans to conduct an exploration drilling program beginning in the summer of 2012 at some of the same drill sites within some of the same prospects using the same drillship. Shell has prepared a Revised Chukchi Sea Exploration Plan, OCS Lease Sale 193, Chukchi Alaska (revised Chukchi Sea EP) accordingly and has submitted it to BOEMRE for approval.

BOEMRE Lease Sale Stipulation No. 5 (see Attachment A), 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 United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) regulations, which require an operator to implement a Plan of Cooperation (POC) to mitigate the potential for conflicts between the proposed activity and traditional subsistence activities (50 Code of Federal Regulations [CFR] § 18.124(c)(4) and 50 CFR § 216.104(a)(12)). A POC was prepared and was submitted with the initial Chukchi Sea EP. The following POC Addendum updates the POC with information regarding proposed changes in the proposed exploration drilling program, and documentation of meetings undertaken to inform the stakeholders of the revised exploration drilling program. The POC Addendum builds upon the previous POC.

The POC Addendum identifies the measures that Shell has developed in consultation with North Slope communities and subsistence user groups and will implement during its planned Chukchi Sea 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 revised Chukchi Sea EP exploration drilling program beginning in the summer of 2012, 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 the North Slope communities, as well as the substance of its communications with subsistence stakeholder groups. Tables summarizing Shell's communications, and responses thereto, are included in Attachment B. This POC Addendum may be further 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's Chukchi Sea exploration drilling program, which is planned for the Burger Prospect in the Chukchi Sea (Figure 1), is set-out in detail in the revised Chukchi Sea EP and the impacts of the project, as well as the measures Shell will implement to mitigate those impacts, are analyzed in the Environmental Impact Analysis (EIA), Revised Chukchi Sea Exploration Plan, OCS Lease Sale 193, Chukchi Sea Alaska. Shell will implement this POC, and the mitigation measures set-forth herein, for its Chukchi Sea exploration drilling program.

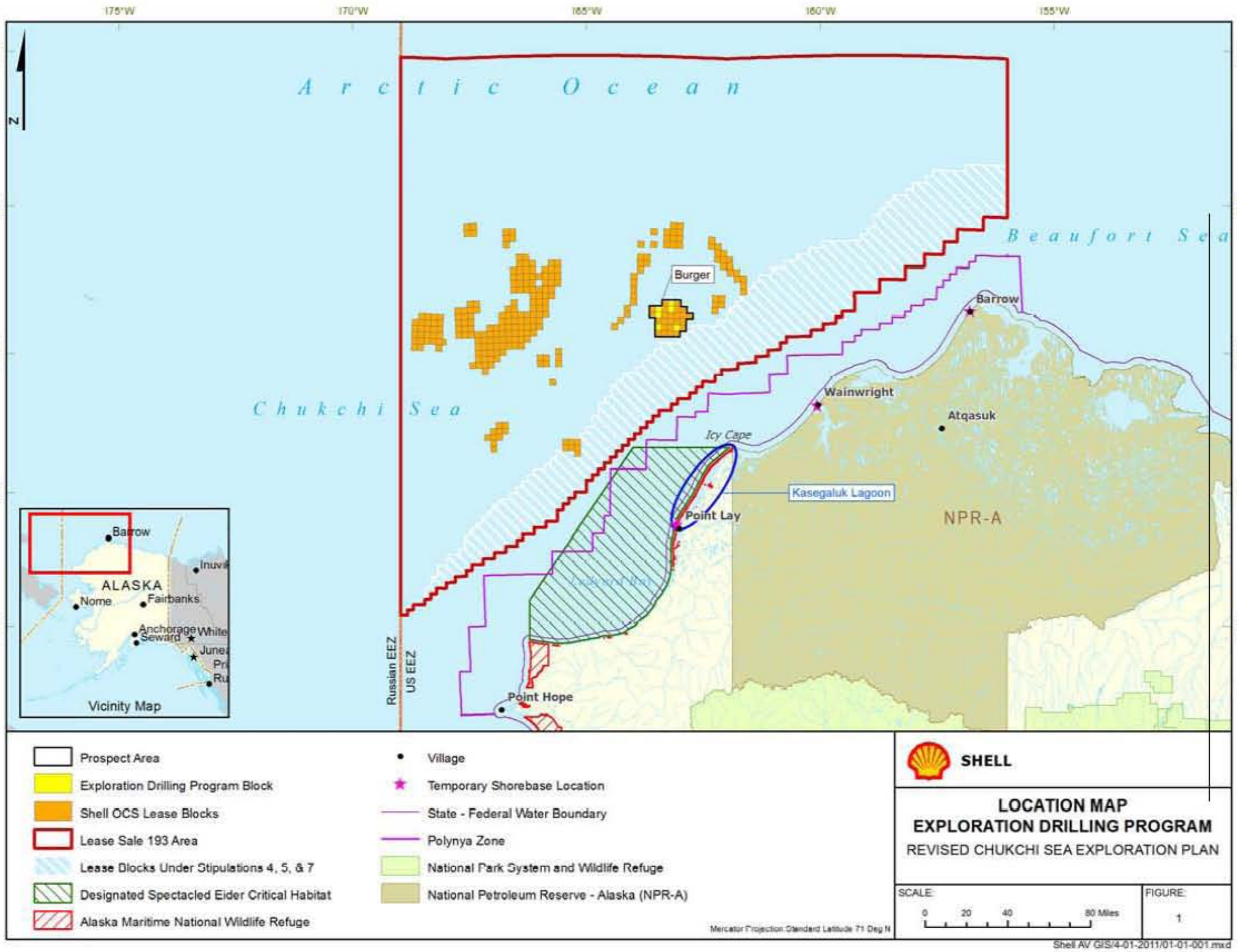
2.0 POC LEASE STIPULATION AND REGULATORY REQUIREMENTS

BOEMRE Lease Sale Stipulation No. 5 (in Attachment A) requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas activities, and subsistence resources and 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 North Slope Borough (NSB), the Alaska Eskimo Whaling Commission (AEWC), and co-management groups including the Alaska Beluga Whale Committee (ABWC), Alaska Eskimo Walrus Commission (EWC), Ice Seal Commission, and Nanuuq Commission.

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.

The requirements of Stipulation No. 5 parallel requirements for receipt of a USFWS Letter of Authorization (LOA) and a NMFS Incidental Harassment Authorization (IHA). The LOA and IHA provide authorization for the nonlethal harassment of species protected by the Marine Mammal Protection Act. 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)).

Figure 1 Location Map Exploration Drilling Program



3.0 MEASURES IN PLACE

The following mitigation measures, plans and programs, are integral to this POC and were developed during consultation with potentially affected subsistence groups, communities, and the NSB. These measures, plans, and programs will be implemented by Shell during its exploration drilling operations in the Chukchi Sea to monitor and mitigate potential impacts to subsistence users and resources. These measures are documented in the following sections:

- Revised Chukchi Sea EP Mitigation Measures
- Exploration Drilling Marine Mammal Monitoring and Mitigation Program (4MP)
- Interaction and Avoidance Plan for Polar Bear and Pacific Walrus

3.1 Revised Chukchi Sea EP Mitigation Measures

The mitigation measures Shell has adopted and will implement during its revised Chukchi Sea EP exploration drilling operations are listed and discussed below. These mitigation measures reflect Shell's experience conducting exploration activities in Alaska since 2006 and its ongoing consultations with local subsistence communities to better understand their concerns and develop appropriate and effective mitigation measures to address those concerns. Shell's planned mitigation measures have been presented to community leaders and subsistence user groups starting in 2009 and have evolved since in response to comments and concerns expressed during the consultation process. Some mitigation measures appear under more than one sub-heading below, since they are pertinent to more than one "category" of mitigation measures.

3.1.1 Subsistence Mitigation Measures

To minimize any cultural or resources impacts to subsistence beluga whaling or walrus hunting activities from its operations, exploration drilling activities will not take place in the Chukchi Sea until on or about July 4, in each drilling season. Shell will implement the following measures to ensure coordination of its activities with local subsistence users and to minimize further the risk of impacting marine mammals and interfering with the subsistence hunt.

Communication, Vessel and Aircraft Travel:

- To minimize impacts on marine mammals and subsistence hunting activities, the drillship and support vessels traversing north through the Bering Strait will transit through the Chukchi Sea along a route that 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 drillship 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 Communication and Call Centers (Com Centers). As soon as the fleet transits past the ice, it will exit the polynya zone and continue in the open sea toward the Chukchi Sea drill sites.
- Vessels underway will alter course to avoid impacts to marine mammals including possible collisions, stampeding, and exclusion from access to critical resources.
- There will be no transit before July 1 in the Bering Strait to minimize effects on spring and early summer bowhead whale hunting.
- Shell has developed a Communication Plan (see Attachment C) and will implement it before initiating exploration drilling operations to coordinate activities with local subsistence users as

well as Village Whaling Associations in order to minimize the risk of interfering with subsistence hunting activities, and keep current as to the timing and status of the bowhead whale migration, as well as the timing and status of other subsistence hunts. The Communication Plan includes procedures for coordination with Com Centers to be located in coastal villages along the Chukchi and Beaufort Seas during Shell's proposed activities.

- Shell will fund the operation of Com Centers in the coastal villages to enable communications between Shell operations and vessels, local subsistence users, and Subsistence Advisors (SAs), thereby notifying the subsistence community of any vessel transit route changes and avoiding conflicts with subsistence activities.
- Shell will employ local SAs from the Beaufort Sea and Chukchi Sea villages to provide consultation and guidance regarding the whale migration and subsistence hunt. The SAs will use local knowledge (Traditional Knowledge) to gather data on subsistence lifestyle within the community and provide advice on ways to minimize and mitigate potential negative impacts to subsistence resources during the exploration drilling season. Responsibilities include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; and advising how to avoid subsistence conflicts. They will work approximately 8 hours per day and 40-hour weeks through each exploration drilling season. SAs must be from a native village located on the North Slope, speak and understand Inupiaq and must have knowledge of subsistence practices for the area. After the initial recruitment and selection of potential candidates, the hiring process will consist of a two-part interview. During the first interview a full description of the job will be given including the schedule, type of work, conditions, and requirements (including drug testing, orientation, and specialized training). The second interview will assess the candidate's previous employment, subsistence hunting experience, communication skills and ensure they have good social skills. Each SA will be based out of their home village and will be given a SA handbook. The SA handbook will give an overview of the program, program objectives, discusses recruitment, hiring, and certification, and details the SAs responsibilities. The handbook will also include several forms that the SA will be using along with a Traditional Knowledge Questionnaire and subsistence use maps. The handbook will provide the SA with: the information needed to identify situation they are to be alert for, their responsibilities and their authorities.
- Aircraft shall not operate below 1,500 feet (ft) (457 meters [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.
- Shell will also implement non-marine mammal observer (MMO) flight restrictions prohibiting aircraft from flying 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.

Exploration Drilling Operations:

- Drilling muds will be recycled (used from one well to the next) to the extent practicable based on operational considerations (e.g., whether mud properties have deteriorated to the point where they cannot be used further), to reduce discharges from the operations. At the end of the season, excess water based fluids, approximately 1,500 barrels (bbl), will be pre-diluted to a 30:1 ratio with seawater and then discharged.

- Drilling muds will be cooled to mitigate any potential permafrost thawing or thermal dissociation of any methane hydrates encountered during exploration drilling if such materials are present at the drill site.
- Lighting on the drillship 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 drillship to reduce the possibility of a bird collision (Bird Strike Avoidance and Lighting Plan in Appendix I of the revised Chukchi Sea EP).

3.1.2 Marine Mammal Mitigation Measures

Marine mammal mitigation measures will focus on the utilization of MMOs to ensure that exploration drilling and support vessel activities do not disturb marine mammal resources and avoid unreasonable interference with the subsistence hunt of those resources. MMOs will be stationed on all exploration drilling and support vessels to monitor the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals. For vessels in transit, if a marine mammal is sighted from a vessel within its respective safety radius, the Shell vessel will reduce activity (e.g., reduce speed and/or change course) and noise level to ensure that the animal is not exposed to sound above their respective safety levels. Full activity will not be resumed until all marine mammals are outside of the exclusion zone and there are no other marine mammals likely to enter the exclusion zone. Regular overflight surveys and support vessel surveys for marine mammals will be conducted to further monitor prospect areas. Shell will also implement flight restrictions prohibiting aircraft from flying below 1,500 ft (457 m) altitude (except during takeoffs and landings, in emergency situations, or for MMO overflights), further reducing the likelihood of impacts.

Anchored vessels 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 noise conditions.

For complete MMO protocol refer to the 4MP for Exploration Drilling of Selected Lease Areas in the Alaskan Chukchi Sea (revised Chukchi Sea EP, Appendix D).

In addition to the use of MMOs, Shell will implement the following measures to avoid disturbances to marine mammals that potentially could rise to the level of incidental take, and ensure coordination of its activities with local subsistence users to minimize further the risk of impacting marine mammals and interfering with the subsistence hunt:

Vessel and Aircraft Travel:

- 4MP protocol;
- Aircraft will not operate within 1,500 ft (457 m) of whale groups;
- Aircraft and vessels will not operate within 0.5 miles (mi) (.8 kilometers [km]) of walruses or polar bears when observed on land or ice;
- When within 900 ft (274 m) of marine mammals, vessels will reduce speed, avoid separating members from a group and avoid multiple course changes;
- Vessel speed to be reduced during inclement weather conditions in order to avoid collisions with marine mammals;

- 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 to its destination;
- 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;
- The *Discoverer* and support vessels will enter the Chukchi Sea through the Bering Strait on or after July 1, minimizing effects on marine mammals and birds that frequent open leads and minimizing effects on spring and early summer bowhead whale hunting. All transit will be coordinated and collaborated with Com Centers as practicable.

Exploration Drilling Operations:

- During zero-offset vertical seismic profiles (Section 2.4 of EIA, Appendix F, revised Chukchi Sea EP), airgun arrays will be ramped up slowly 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. A ramp up to the required level will not begin until there has been a minimum of 30 minutes (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 decibel (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 odontocete.

3.1.3 Mitigation Measures for Operations and Oil Spill Prevention and Response

BOEMRE has concluded that the probability of a large oil spill occurring during an exploration drilling project is extremely remote. Nevertheless, as required by both federal and state regulations, Shell has developed and will implement a comprehensive Oil Discharge Prevention and Contingency Plan (ODPCP) during its exploration drilling operations, in addition to other operations plans including the Ice Management Plan (IMP) and Critical Operations and Curtailment Plan (COCP). The ODPCP will be reviewed and approved by both state and federal regulators to ensure that Shell has the spill response resources necessary to respond to any spill that might occur. While the probability of a spill is very remote, Shell will dedicate all necessary resources to respond to any spill that might occur. In addition to the maintenance and implementation of its ODPCP, Shell will implement the following additional measures to further minimize the risk of a spill that might impact marine mammals and interfere with the subsistence hunt:

- All vessels transit routes will avoid known fragile ecosystems, including the Ledyard Bay Critical Habitat Unit, and will include coordination through Com Centers.

- Shell has developed and will implement an IMP to ensure real-time ice and weather forecasting to identify conditions that might put operations at risk and modify its activities accordingly. The IMP also contains ice threat classification levels depending on the time available to suspend exploration drilling operations, secure the well and escape from advancing hazardous ice (IMP, revised Chukchi Sea EP, Appendix K).
- Ice management will involve preferentially redirecting, rather than breaking, ice floes while the floes are well away from the drill site (IMP, revised Chukchi Sea EP, Appendix K).
- Real time ice and weather forecasting will be from the Shell SIWAC.
- Shell has developed and will implement a COCP, which establishes protocols to be followed in the event potential hazards, including ice, are identified in the vicinity of the exploration drilling operations (e.g., ice floes, inclement weather, etc.). Like the IMP, the COCP threat classifications are based on the time available to prepare the well and escape the location. The COCP also contains provisions for not initiating certain critical operations if there is insufficient time available before the arrival of the hazard at the drill site (see the COCP Appendix J of the revised Chukchi Sea EP).
- Shell has engineered each of its exploration wells (including hole sizing, mud program, casing design, casing cementing depth, hole sizing, and wellhead equipment, etc.) specifically to minimize the risk of uncontrolled flows from the wellbore due to casing or other equipment failures.
- Shell will deploy an oil spill response (OSR) fleet that is capable of collecting oil on the water up to the worst case discharge (WCD) planning scenario which is greater than 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.
- 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..
- The blowout prevention program will be enhanced through the use of two sets of blind/shear rams, increased frequency of blowout preventer (BOP) performance tests from 14 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 both capping equipment and treatment and flaring capabilities, a fully-designed relief well drilling plan and provisions for a second drilling vessel, the conical drilling unit *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.
- 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 as equipment 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 available prior to commencing the exploration drilling operations.
- Pre-booming is required for all fuel transfers between vessels (the Fuel Transfer Plan is located in Appendix M of the revised Chukchi Sea EP).

3.2 Exploration Drilling Marine Mammal Monitoring and Mitigation Program

Under 50 CFR 218.108, NMFS requires any holder of an IHA in Arctic waters to complete monitoring and reporting requirements established in the IHA and published regulations. Additionally, the USFWS requires all applicants for LOAs to conduct monitoring under 50 CFR 18.128. To meet these requirements, a 4MP was developed for the exploration drilling program as detailed in the revised Chukchi Sea EP. The 4MP is designed to avoid, minimize, and mitigate potential adverse impacts to marine mammal subsistence resources that may result from offshore activities. The 4MP is available from NMFS and is included in Appendix D of the revised Chukchi Sea EP. The 4MP for the exploration drilling program includes the following provisions:

- MMOs will be required to support the transit and operations in the Chukchi Sea. The shipboard MMO program is designed to provide real time observations of marine mammals by trained observers from individual vessels to document exposure to industrial activities. MMOs will be present on vessels to monitor for the presence of marine mammals, assist maintenance of marine mammal safety radii around vessels, monitor and record avoidance or exposure behaviors, and communicate with the Com Centers and local subsistence hunters by marine radio. The experience and abilities of the NSB residents in sighting and identifying marine mammals during Shell’s exploration programs contributed significantly to the success of Shell’s previous monitoring and mitigation program.
- Manned Aerial Program – aerial surveys to collect information in the Chukchi Sea regarding distribution and abundance of bowhead whales and other marine mammals.
- Acoustic Recorders – a combination of recorder technology, such as pop-up or Directional Autonomous Seafloor Acoustic Recorder buoys, to monitor wide area distribution of marine mammals, specifically bowhead whales, in relation to Shell’s proposed activities.
- Sound Modeling – of vessels utilized for seismic and exploration drilling activities.
- Sound Source Verification – field measurement sound propagation profiles for the drillship and support vessels utilized by Shell in the planned exploration drilling program in the Chukchi Sea.

3.3 Interaction and Avoidance Plan for Polar Bear and Pacific Walrus

Shell has prepared an interaction and avoidance plan for polar bear and Pacific walrus to meet the requirements of 50 CFR 18.128 for holders of LOAs issued by the USFWS. The plan outlines procedures for mitigating potential impacts to polar bear and Pacific walrus, as well as monitoring program requirements. A copy of the plan for Shell's exploration drilling activities outlined in the EP has been sent to the USFWS. Measures in the plan, which cover all Shell activities associated with the revised Chukchi Sea EP are summarized below.

- New polar bear dens, identified by industry, local residents, and regulatory agencies are reported annually and will be incorporated into project plans to ensure both bear and worker safety. Bear dens discovered during operations will be reported to the designated USFWS representatives.
- Trash will be collected and separated so that all food-associated waste is placed in an appropriate bear-resistant dumpster.
- Hazardous wastes, if generated, would be transported off-site for disposal at an approved facility.
- Employees will be prohibited from directly feeding animals or deliberately leaving food for polar bears and other animals.
- If a polar bear is observed, all on-site personnel will be alerted so that work activities can be altered or stopped to avoid interactions. Personnel will contact the designated USFWS representative whenever a polar bear is sighted. Depending on the distance between the polar bear and the activities this may mean retreating to the safety of vehicles, emergency shelter, temporary buildings, or other safe haven.
- When a polar bear is observed, a designated bear watcher will be assigned to ensure continuous monitoring of the bear's movements. The On-Scene Shell Supervisor will be contacted before any bear hazing activities. Trained polar bear hazers and bear guards will support field operations.
- Exploration drilling and support vessels will observe a 0.5 mi (.8 km) exclusion zone around any bear observed on land or ice during transit.
- Aircraft will maintain 1,500 ft (457 m) minimum altitude within, 0.5 mi (.8 km) of a hauled-out polar bear or Pacific walrus.
- Ice management mitigation measures, such as "ice scouting," will use radar, satellite imagery, observations from support vessels by trained Ice Specialists, and reconnaissance flights to monitor ice movement in areas near the prospect area prior to and during exploration drilling operations. These measures will provide an early warning of bears in the vicinity so appropriate measures can be taken to limit polar bear/human interference.
- Polar bear monitoring, reporting, and survey activities will be conducted in accordance with those outlined in 73 Federal Register 33212.
- Exploration drilling and support vessels will observe a 0.5 mi (.8 km) exclusion zone around Pacific walrus observed on land or ice during transit.

4.0 AFFECTED SUBSISTENCE COMMUNITY MEETINGS

Affected subsistence communities that were consulted regarding Shell's revised Chukchi Sea EP include: Barrow, Wainwright, Point Lay and Point Hope. Kotzebue, Kivalina, and Kiana were also visited by Shell to communicate planned offshore activities beginning in the summer of 2012. Additionally, Shell met with subsistence groups including the AEWC, the Nanuuq Commission, the Eskimo Walrus Committee, the Beluga Commission, the Ice Seal Commission, and the Native Village of Barrow, and presented information regarding the proposed activities to the NSB and Northwest Arctic Borough (NWAB) Assemblies, and NSB and NWAB Planning Commissions. Several one-on-one meetings were also held throughout the villages.

4.1 Consultation with Community Leaders

Beginning in early January 2009, Shell held one-on-one meetings with representatives from the NSB and NWAB, 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.

4.2 Community Meeting Summaries

Table 4.2-1 provides a list of public meetings attended by Shell while developing this POC beginning in 2009 through 2011. Attachment B presents sign-in sheets and presentation materials used at the POC meetings held in 2011 to present the revised Chukchi Sea EP. Comment analysis tables for numerous meetings held during 2011 summarize feedback from the communities on Shell 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 Attachment B.

Table 4.2-1 Meeting Dates and Locations

2009	Meeting Location	Meeting Attendees – Position
12-13 January	Barrow	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
21 January	Point Hope	Steve Oommittuk - Mayor of Point Hope
21 January	Barrow	Charlie Hopson – Whaling Captain, LCMF employee, and AEWC alternate commissioner in Barrow Adeline Hopson – NSB Assembly Member Deano Oleuman – NSB Assembly Member
21 January	Barrow	Ray Koonuk – AEWC Commissioner and Point Hope Whaling Captain
21 January	Barrow	George Edwardson – ICAS President Juanita Smith – ICAS Natural Resource Director
21 January	Point Hope	Rex Rock Sr. – NSB Assembly Member and Tikigaq Corporation President
27 January	Kotzebue	Jackie Hill – Maniilaq Association Representative
27 January	Kotzebue	Martha Whiting – Mayor of the NWAB
27 January	Kotzebue	NWAB Assembly Meeting
27 January	Kotzebue	Chuck Greene, EJ Doll Garoutte, Walter Sampson, Gladys Pungowiyi - NANA Representatives
2 February	Barrow	NSB Assembly Workshop
2 February	Barrow	Plan of Cooperation Public Meeting
3 February	Barrow	Janice Meadows – AEWC Executive Director
3 February	Barrow	Vera Williams – Native Village of Barrow Realty Director Joseph Sage – Native Village of Barrow Wildlife Director
4-5 March	Anchorage	AEWC 2009 CAA Negotiations
24 March	Point Hope	Plan of Cooperation Public Meeting
25 March	Kotzebue	Plan of Cooperation Public Meeting
25 March	Kotzebue	NSB/NWAB Joint Planning Commission Meeting
26 March	Wainwright	Plan of Cooperation Public Meeting

Table 4.2-1 Meeting Dates and Locations

2 April	Barrow	ICAS Monthly Meeting
20 April	Barrow	Native Village of Barrow Meeting
22 April	Point Lay	Plan of Cooperation Public Meeting
23 April	Kivalina	Community Meeting
2010	**Meeting Location**	**Meeting Attendees – Position**
14 January	Barrow	ICAS Monthly Meeting
15 January	Anchorage	Eugene Brower – Barrow Whaling Captains Association President
22 January	Anchorage	George Oleuman – Deputy Mayor Eugene Brower – NSB Assembly President Taqulik Hepa – NSB Wildlife Director Bessie O'Rouke – NSB Law Department Marvin Olson – NSB Director Public Works Dan Forster – NSB Planning Director
24 February	Barrow	Plan of Cooperation Public Meeting
25 February	Point Hope	Plan of Cooperation Public Meeting
26 February	Barrow	Edward Itta – Mayor of the NSB
1 March	Wainwright	Plan of Cooperation Public Meeting
2 March	Kotzebue	Community Meeting
5 March	Point Hope	Plan of Cooperation Public Meeting
1 April	Point Lay	Plan of Cooperation Public Meeting
8 April	Barrow	Martha Whiting – Mayor of the NWAB Walter Sampson – NWAB Assembly President
30 April	Barrow	Edward Itta – Mayor of the NSB
1 June	Barrow	NSB Assembly Meeting
1 June	Point Lay	Point Lay Community Meeting
2 June	Barrow	Barrow Community Meeting
8 June	Barrow	Utqiagvik Agviqsiuqtit Aganangich Meeting
8 June	Barrow	Barrow Whaling Captains Association Meeting
24 June	Barrow	NWAB/NSB Joint Planning Commission Meeting
19 July	Barrow	Edward Itta – Mayor of the NSB
30 July	Kotzebue	NWAB Assembly Meeting
3 August	Barrow	NSB Assembly Meeting
7 September	Barrow	NSB Assembly Meeting
24 September	Barrow	Plan of Cooperation Public Meeting
8 November	Anchorage	Alaska Beluga Whale Committee Meeting
6 December	Anchorage	Alaska Beluga Whale Committee Members Ice Seal Committee Members Alaska Nanuuq Commission Members Eskimo Walrus Commission Members
2011	**Meeting Location**	**Meeting Attendees – Position**
27 January	Barrow	Barrow Whaling Captains Association Meeting
27 February – 2 March	Dutch Harbor	Edith Vorderstrasse – UIC UMIAQ General Manager Ray Koonuk, Sr. – Whaling Captain Christopher Oktollik – Whaling Captain John Long, Jr. – Native Village of Point Hope Council Member Joseph Frankson – Whaling Captain Franklin Sage – Native Village of Point Hope Council Member Caroline Cannon – Native Village of Point Hope President 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

Table 4.2-1 Meeting Dates and Locations

		▪ 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
23 March	Wainwright	Plan of Cooperation Public Meeting
23 March	Wainwright	Rossman Peetok – AEWC Commissioner for Wainwright Jason Ahmaogak – Wainwright Whaling Captain
25 March	Point Lay	Plan of Cooperation Public Meeting
28 March	Point Hope	Plan of Cooperation Public Meeting
29 March	Kiana	Community Meeting
30 March	Kotzebue	Community Meeting
31 March	Kivalina	Community Meeting
2 April	Nome	Vera Metcalf – Eskimo Walrus Commission Charlie Johnson – Alaska Nanuuq Commission
5 April	Barrow	NSB Assembly Meeting
7 April	Kotzebue/ Anchorage (Teleconference)	Willie Goodwin – Alaska Beluga Whale Committee
8 April	Anchorage	John Goodwin – Ice Seal Committee
15 April	Anchorage	Vera Metcalf – Eskimo Walrus Commission
25 April	Savoonga	Community Meeting
26 April	Shishmaref	Community Meeting
27 April	Gambell	Community Meeting

Notes:

ASRC = Arctic Slope Regional Corporation
CAA = Conflict Avoidance Agreement
ICAS = Inupiat Community of the Arctic Slope

LCMF = LCMF Incorporated, A subsidiary of Ukpeagvik Iñupiat Corporation
NSBSD = North Slope Borough School District
UIC = Ukpeagvik Iñupiat Corporation

4.3 Project Information and Presentation Materials

To present consistent and concise information regarding the planned exploration drilling program as detailed in the revised Chukchi Sea EP, Shell prepared presentation materials (listed below and attached in Attachment B) for meetings with stakeholders across the North Slope.

Revised Chukchi Sea EP Exploration Drilling Presentation Summary

- Summary of Shell's Science Accomplishments
- Summary and explanation of Shell's Proposed 2012-13 EP
- Summary of Shell's proposed drill sites for the revised Chukchi Sea EP

4.4 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 phone 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.

After each meeting, comment cards were gathered and compiled in a comment analysis table. A separate comment analysis table was completed for each POC meeting, the NSB Assembly Meeting, and each community meeting. These tables are included in Attachment B.

5.0 CONCLUSION

As discussed in Section 4, and detailed in the documents attached here, 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 and 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 conflicts and to notify the communities of any changes in its planned operations. The 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).

Attachment A
OCS Lease Sale 193 Stipulations

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Leasing Activities Information

MMS

U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

Final
Lease Stipulations
Oil and Gas Lease Sale 193
Chukchi Sea
February 6, 2008

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

Stipulation No. 1. Protection of Biological Resources. If previously unidentified biological populations or habitats that may require additional protection are identified in the lease area by the Regional Supervisor, Field Operations (RS/FO), the RS/FO may require the lessee to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The RS/FO shall give written notification to the lessee of the RS/FO's decision to require such surveys.

Based on any surveys that the RS/FO may require of the lessee or on other information available to the RS/FO on special biological resources, the RS/FO may require the lessee to:

(1) Relocate the site of operations;
(2) Establish to the satisfaction of the RS/FO, on the basis of a site-specific survey, either that such operations will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist;
(3) Operate during those periods of time, as established by the RS/FO, that do not adversely affect the biological resources; and/or

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

If any area of biological significance should be discovered during the conduct of any operations on the lease, the lessee shall immediately report such finding to the RS/FO and make every reasonable effort to preserve and protect the biological resource from damage until the RS/FO has given the lessee direction with respect to its protection.

The lessee shall submit all data obtained in the course of biological surveys to the RS/FO with the locational information for drilling or other activity. The lessee may take no action that might affect the biological populations or habitats surveyed until the RS/FO provides written directions to the lessee with regard to permissible actions.

Stipulation No. 2. Orientation Program. The lessee shall include in any exploration plan (EP) or development and production plan (DPP) submitted under 30 CFR 250.211 and 250.241 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the RS/FO. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. This guidance will include the production and distribution of information cards on endangered and/or threatened species in the sale area. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence activities and pertinent mitigation.

The program shall be attended at least once a year by all personnel involved in onsite exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) and all supervisory and managerial personnel involved in lease activities of the lessee and its agents, contractors, and subcontractors.

The lessee shall maintain a record of all personnel who attend the program onsite for so long as the site is active, not to exceed 5 years. This record shall include the name and date(s) of attendance of each attendee.

Stipulation No. 3. Transportation of Hydrocarbons. Pipelines will be required: (a) if pipeline rights-of-way can be determined and obtained; (b) if laying such pipelines is technologically feasible and environmentally preferable; and (c) if, in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts. The lessor specifically reserves the right to require that any pipeline used for transporting production to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to recommendations of any Federal, State, and local governments and industry.

Following the development of sufficient pipeline capacity, no crude oil production will be transported by surface vessel from offshore production sites, except in the case of an emergency. Determinations as to emergency conditions and appropriate responses to these conditions will be made by the RS/FO.

Stipulation No. 4. Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources. A lessee proposing to conduct exploration operations, including ancillary seismic surveys, on a lease within the blocks identified below during periods of subsistence use related to bowhead whales, beluga whales, ice seals, walruses, and polar bears will be required to conduct a site-specific monitoring program approved by the RS/FO, unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with appropriate agencies and co-management organizations, determines that a monitoring program is not necessary. Organizations currently recognized by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) for the co-management of the marine mammals resources are the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, the Ice Seal Commission, and the Nanuk Commission. The RS/FO will provide the appropriate agencies and co-management organizations a minimum of 30 calendar days, but no longer than 60 calendar days, to review and comment on a proposed monitoring program prior to Minerals Management Service (MMS) approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced.

The monitoring program will be designed to assess when bowhead and beluga whales, ice seals, walruses, and polar bears are present in the vicinity of lease operations and the extent of behavioral effects on these marine mammals due to these operations. In designing the program, the lessee must consider the potential scope and extent of effects that the type of operation could have on these marine mammals. Experiences relayed by subsistence hunters indicate that, depending on the type of operations, some whales demonstrate avoidance behavior at distances of up to 35 miles. The program must also provide for the following:

(1) Recording and reporting information on sighting of the marine mammals of concern and the extent of behavioral effects due to operations;
(2) Coordinating the monitoring logistics beforehand with the MMS Bowhead Whale Aerial Survey Project and other mandated aerial monitoring programs;
(3) Inviting a local representative, to be determined by consensus of the appropriate co-management organizations, to participate as an observer in the monitoring program;
(4) Submitting daily monitoring results to the RS/FO;
(5) Submitting a draft report on the results of the monitoring program to the RS/FO within 90 days following the completion of the operation. The RS/FO will distribute this draft report to the appropriate agencies and co-management organizations;
(6) Allowing 30 days for independent peer review of the draft monitoring report; and
(7) Submitting a final report on the results of the monitoring program to the RS/FO within 30 days after the completion of the independent peer review. The final report will include a discussion of the results of the peer review of the draft report. The RS/FO will distribute this report to the appropriate agencies and co-management organizations.

The RS/FO may extend the report review and submittal timelines if the RS/FO determines such an extension is warranted to accommodate extenuating circumstances.

The lessee will be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program for bowhead whales. The lessee may be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program for other co-managed marine mammal resources. This peer review will consist of independent reviewers who have knowledge and experience in statistics, monitoring marine mammal behavior, the type and extent of the proposed operations, and an awareness of traditional knowledge. The peer reviewers will be selected by the RS/FO from experts recommended by the appropriate agencies and co-management resource organizations. The results of these peer reviews will be provided to the RS/FO for consideration in final MMS approval of the monitoring program and the final report, with copies to the appropriate agencies and co-management organizations.

In the event the lessee is seeking a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) for incidental take from NMFS and/or FWS, the monitoring program and review process required under the LOA or IHA may satisfy the requirements of this stipulation. The lessee must advise the RS/FO when it is seeking an LOA or IHA in lieu of meeting the requirements of this stipulation and must provide the RS/FO with copies of all pertinent submittals and resulting correspondence. The RS/FO will coordinate with the NMFS and/or FWS and will advise the lessee if the LOA or IHA will meet these requirements.

The MMS, NMFS, and FWS will establish procedures to coordinate results from site-specific surveys required by this stipulation and the LOA's or IHA's to determine if further modification to lease operations are necessary.

This stipulation applies to the following blocks:

NR02-06, Chukchi Sea:
6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey:
6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert
6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island
6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West
6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal
6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow
6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright
6002-6006, 6052, 6053

NS04-08, (Unnamed)
6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

This stipulation applies during the time periods for subsistence-harvesting described below for each community.

Subsistence Whaling and Marine Mammal Hunting Activities by Community

Barrow: Spring bowhead whaling occurs from April to June; Barrow hunters hunt from ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area. Fall whaling occurs from August to October in an area extending from approximately 10 miles west of Barrow to the east side of Dease Inlet. Beluga whaling occurs from April to June in the spring leads between Point Barrow and Skull Cliff; later in the season, belugas are hunted in open water around the barrier islands off Elson Lagoon. Walrus are harvested from June to September from west of Barrow southwestward to Peard Bay. Polar bear are hunted from October to June generally in the same vicinity used to hunt walrus. Seal hunting occurs mostly in winter, but some open-water sealing is done from the Chukchi coastline east as far as Dease Inlet and Admiralty Bay in the Beaufort Sea.

Wainwright: Bowhead whaling occurs from April to June in the spring leads offshore of Wainwright, with whaling camps sometimes as far as 10 to 15 miles from shore. Wainwright hunters hunt beluga whales in the spring lead system from April to June but only if no bowheads are in the area. Later in the summer, from July to August, belugas can be hunted along the coastal lagoon systems. Walrus hunting occurs from July to August at the southern edge of the retreating pack ice. From August to September, walrus can be hunted at local haulouts with the focal area from Milliktagvik north to Point Franklin. Polar bear hunting occurs primarily in the fall and winter around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.

Point Lay: Because Point Lay's location renders it unsuitable for bowhead whaling, beluga whaling is the primary whaling pursuit. Beluga whales are harvested from the middle of June to the middle of July. The hunt is concentrated in Naokak and Kukpowruk Passes south of Point Lay where hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon where they are hunted. If the July hunt is unsuccessful, hunters can travel as far north as Utukok Pass and as far south as Cape Beaufort in search of whales. When ice conditions are favorable, Point Lay residents hunt walrus from June to August along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 miles offshore. Polar bear are hunted from September to April along the coast, rarely more than 2 miles offshore.

Point Hope: Bowhead whales are hunted from March to June from whaling camps along the ice edge south and southeast of the point. The pack-ice lead is rarely more than 6 to 7 miles offshore. Beluga whales are harvested from March to June in the same area used for the bowhead whale hunt. Beluga whales can also be hunted in the open water later in the summer from July to August near the southern shore of Point Hope close to the beaches, as well as areas north of the point as far as Cape Dyer. Walruses are harvested from May to July along the southern shore of the point from Point Hope to Akoviknak Lagoon. Point Hope residents hunt polar bears primarily from January to April and occasionally from October to January in the area south of the point and as far out as 10 miles from shore.

This stipulation will remain in effect until termination or modification by the Department of the Interior after consultation with appropriate agencies.

Stipulation No. 5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence-Harvesting Activities. Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities. This stipulation applies to exploration, development, and production operations on a lease within the blocks identified below during periods of subsistence use related to bowhead whales, beluga whales, ice seals, walruses, and polar bears. The stipulation also applies to support activities, such as vessel and aircraft traffic, that traverse the blocks listed below or Federal waters landward of the sale during periods of subsistence use regardless of lease location. Transit for human safety emergency situations shall not require adherence to this stipulation.

This stipulation applies to the following blocks:

NR02-06, Chukchi Sea:
6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey:
6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert
6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island
6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West
6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal
6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow
6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright
6002-6006, 6052, 6053

NS04-08, (Unnamed)
6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

Prior to submitting an exploration plan or development and production plan (including associated oil-spill response plans) to the MMS for activities proposed during subsistence-use critical times and locations described below for bowhead whale and other marine mammals, the lessee shall consult with the North Slope Borough, and with directly affected subsistence communities (Barrow, Point Lay, Point Hope, or Wainwright) and co-management organizations to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts. Organizations currently recognized by the NMFS and the FWS for the co-management of the marine mammals resources are the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, the Ice Seal Commission, and the Nanuk Commission. Through this consultation, the lessee shall make every reasonable effort, including such mechanisms as a conflict avoidance agreement, to assure that exploration, development, and production activities are compatible with whaling and other marine mammal subsistence hunting activities and will not result in unreasonable interference with subsistence harvests.

A discussion of resolutions reached during this consultation process and plans for continued consultation shall be included in the exploration plan or the development and production plan. In particular, the lessee shall show in the plan how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. The lessee shall also include a discussion of multiple or simultaneous operations, such as ice management and seismic activities, that can be expected to occur during operations in order to more accurately assess the potential for any cumulative affects. Communities, individuals, and other entities who were involved in the consultation shall be identified in the plan. The RS/FO shall send a copy of the exploration plan or development and production plan (including associated oil-spill response plans) to the directly affected communities and the appropriate co-management organizations at the time the plans are submitted to the MMS to allow concurrent review and comment as part of the plan approval process.

In the event no agreement is reached between the parties, the lessee, NMFS, FWS, the appropriate co-management organizations, and any communities that could be directly affected by the proposed activity may request that the RS/FO assemble a group consisting of representatives from the parties to specifically address the conflict and attempt to resolve the issues. The RS/FO will invite appropriate parties to a meeting if the RS/FO determines such a meeting is warranted and relevant before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

The lessee shall notify the RS/FO of all concerns expressed by subsistence hunters during operations and of steps taken to address such concerns. Activities on a lease may be restricted if the RS/FO determines it is necessary to prevent unreasonable conflicts with local subsistence hunting activities.

In enforcing this stipulation, the RS/FO will work with other agencies and the public to assure that potential conflicts are identified and efforts are taken to avoid these conflicts.

Subsistence-harvesting activities occur generally in the areas and time periods listed below.

Subsistence Whaling and Marine Mammal Hunting Activities by Community

Barrow: Spring bowhead whaling occurs from April to June; Barrow hunters hunt from ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area; fall whaling occurs from August to October in an area extending from approximately 10 miles west of Barrow to the east side of Dease Inlet. Beluga whaling occurs from April to June in the spring leads between Point Barrow and Skull Cliff; later in the season, belugas are hunted in open water around the barrier islands off Elson Lagoon. Walrus are harvested from June to September from west of Barrow southwestward to Peard Bay. Polar bear are hunted from October to June generally in the same vicinity used to hunt walruses. Seal hunting occurs mostly in winter, but some open-water sealing is done from the Chukchi coastline east as far as Dease Inlet and Admiralty Bay in the Beaufort Sea.

Wainwright: Bowhead whaling occurs from April to June in the spring leads offshore of Wainwright, with whaling camps sometimes as far as 10 to 15 miles from shore. Wainwright hunters hunt beluga whales in the spring lead system from April to June but only if no bowheads are in the area. Later in the summer, from July to August, belugas can be hunted along the coastal lagoon systems. Walrus hunting occurs from July to August at the southern edge of the retreating pack ice. From August to September, walruses can be hunted at local haulouts with the focal area from Milliktagvik north to Point Franklin. Polar bear hunting occurs primarily in the fall and winter around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.

Point Lay: Because Point Lay's location renders it unsuitable for bowhead whaling, beluga whaling is the primary whaling pursuit. Beluga whales are harvested from the middle of June to the middle of July. The hunt is concentrated in Naokak and Kukpowruk Passes south of Point Lay where hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon where they are hunted. If the July hunt is unsuccessful, hunters can travel as far north as Utukok Pass and as far south as Cape Beaufort in search of whales. When ice conditions are favorable, Point Lay residents hunt walruses from June to August along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 miles offshore. Polar bears are hunted from September to April along the coast, rarely more than 2 miles offshore.

Point Hope: Bowhead whales are hunted from March to June from whaling camps along the ice edge south and southeast of the point. The pack-ice lead is rarely more than 6 to 7 miles offshore. Beluga whales are harvested from March to June in the same area used for the bowhead whale hunt. Beluga whales can also be hunted in the open water later in the summer from July to August near the southern shore of Point Hope close to the beaches, as well as areas north of the point as far as Cape Dyer. Walruses are harvested from May to July along the southern shore of the point from Point Hope to Akoviknak Lagoon. Point Hope residents hunt polar bears primarily from January to April and occasionally from October to January in the area south of the point and as far out as 10 miles from shore.

Stipulation No. 6. Pre-Booming Requirements for Fuel Transfers. Fuel transfers (excluding gasoline transfers) of 100 barrels or more will require pre-booming of the fuel barge(s). The fuel barge must be surrounded by an oil-spill-containment boom during the entire transfer operation to help reduce any adverse effects from a fuel spill. The lessee's oil spill response plans must include procedures for the pre-transfer booming of the fuel barge(s).

Stipulation No. 7. Measures to Minimize Effects to Spectacled and Steller's Eiders During Exploration Activities. This stipulation will minimize the likelihood that spectacled and Steller's eiders will strike drilling structures or vessels. The stipulation also provides additional protection to eiders within the blocks listed below and Federal waters landward of the sale area, including the Ledyard Bay Critical Habitat Area, during times when eiders are present.

(A) General conditions: The following conditions apply to all exploration activities.

(1) An EP must include a plan for recording and reporting bird strikes. All bird collisions (with vessels, aircraft, or drilling structures) shall be documented and reported within 3 days to MMS. Minimum information will include species, date/time, location, weather, identification of the vessel, and aircraft or drilling structure involved and its operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Lessees are advised that the FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.

(2) The following conditions apply to operations conducted in support of exploratory and delineation drilling.

(a) Surface vessels (e.g., boats, barges) associated with exploration and delineation drilling operations should avoid operating within or traversing the listed blocks or Federal waters between the listed blocks and the coastline between April 15 and June 10, to the maximum extent practicable. If surface vessels must traverse this area during this period, the surface vessel operator will have ready access to wildlife hazing equipment (including at least three *Breco* buoys or similar devices) and personnel trained in its use; hazing equipment may located onboard the vessel or on a nearby oil spill response vessel, or in Point Lay or Wainwright. Lessees are required to provide information regarding their operations within the area upon request of MMS. The MMS may request information regarding number of vessels and their dates of operation within the area.

(b) Except for emergencies or human/navigation safety, surface vessels associated with exploration and delineation drilling operations will avoid travel within the Ledyard Bay Critical Habitat Area between July 1 and November 15. Vessel travel within the Ledyard Bay Critical Habitat Area for emergencies or human/navigation safety shall be reported within 24 hours to MMS.

(c) Aircraft supporting drilling operations will avoid operating below 1,500 feet above sea level over the listed blocks or Federal waters between the listed blocks and the coastline between April 15 and June 10, or the Ledyard Bay Critical Habitat Area between July 1 and November 15, to the maximum extent practicable. If weather prevents attaining this altitude, aircraft will use pre-designated flight routes. Pre-designated flight routes will be established by the lessee and MMS, in collaboration with the FWS, during review of the EP. Route or altitude deviations for emergencies or human safety shall be reported within 24 hours to MMS.

(B) Lighting Protocols. The following lighting requirements apply to activities conducted between April 15 and November 15 of each year.

(1) Drilling Structures: Lessees must adhere to lighting requirements for all exploration or delineation drilling structures so as to minimize the likelihood that migrating marine and coastal birds will strike these structures. Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration or delineation drilling structures to minimize the likelihood that birds will strike those structures. These requirements establish a coordinated process for a performance-based objective rather than pre-determined prescriptive requirements. The performance-based objective is to minimize the radiation of light outward from exploration/delineation structures while operating on a lease or if staged within nearshore Federal waters pending lease deployment.

Measures to be considered include but need not be limited to the following:

- 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; and
- Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational, and management approaches that could be applied to their specific facilities and operations to reduce outward light radiation. Lessees must provide MMS with a written statement of measures that will be or have been taken to meet the lighting objective, and must submit this information with an EP when it is submitted for regulatory review and approval pursuant to 30 CFR 250.203.

(2) Support Vessels: Surface support vessels will minimize the use of high-intensity work lights, especially when traversing the listed blocks and federal waters between the listed blocks and the coastline. Exterior lights will be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather (such as rain or fog), otherwise they will be turned off. Interior lights and lights used during navigation could remain on for safety.

For the purpose of this stipulation, the listed blocks are as follows:

NR02-06, Chukchi Sea:
6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey:
6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert
6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island
6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West
6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal
6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow
6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright
6002-6006, 6052, 6053

NS04-08, (Unnamed)
6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

Nothing in this stipulation is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

Attachment B
Communication and Consultation with North Slope Subsistence Stakeholders

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Issues	Comments	Shell Response	Mitigation Measures*
Credible Science: Baseline Studies	You mentioned the word catastrophe, what's the closest fault line?	There are not active faults in this area but it is a requirement of the BOEMRE that we conduct shallow hazard surveys to ensure that we do not drill through a fault. All of the planned wells are located a good distance away from all faults in the area, and each of those faults is dormant. They have not moved in several million years.	N/A
Baseline Studies	I want to see that-90 foot drop, that hole in the ocean floor. I read a lot of literature of Shell and it's not all exactly what you guys say.	That's why we are having these discussions.	N/A
Biological Environment	What's the polynya zone?	It's an area near the shore where there are open leads along the Chukchi Sea coast with currents where there is a lot of food. The whales follow these currents in the open areas to get their food source.	N/A
Traditional Knowledge	Some large blocks of ice blocked ice from moving from Greenland some time ago.		I
Operational Impacts: Discharge	Can you explain "Cutting after 20" casing"? What is casing?	Casing is the pipe that transmits the cuttings to the surface and keeps the hole from caving in. Cuttings are small chips of rock that the bit grinds up. We capture the cuttings and drilling mud in containers instead of discharging them into the sea. We transport those out of the Arctic for disposal.	K
Drilling	Because of that the amount of drilling, does Shell feel like the expert now because of that?	Shell doesn't just rely on our own internal expertise, we work with people all over the world. We work with all kinds of people even those in communities and with Subsistence Advisors, etc.	E and L
Health & Safety	If one does encounter an emergency will there be Search and Rescue equipment?	Yes. We will have a dedicated helicopter stationed in Barrow to perform search and rescue and evacuation operations.	J

Issues	Comments	Shell Response	Mitigation Measures*
Health & Safety	Can you describe what kind of infrastructure you envision for those programs?	We have a big white hangar in Barrow you may have seen. We will be using this for our air operations for the Chukchi Sea and for search and rescue operations. In Deadhorse, we have a base that is associated with the other infrastructure there for supporting operations in Prudhoe Bay. In the Chukchi Sea we will have a small marine operations station in Wainwright.	J
Health & Safety	What are the minimum guidelines for Shell flying helicopters here? My point is that there were people doing impact contract, due to fog and the minimum safety reason, since you say you're going to have the SAR and with these kinds of deadlines, you will not be able to monitor the ice.	We use the same acronyms for two things. SAR for Synthetic Aperture Radar and for Search and Rescue. We are required to follow the FAA guidelines for aircraft operations including not flying if conditions are below flight minimums. It is no different for our air operations than for anyone else.	J
Ice Management and Monitoring	What is your plan if ice is coming suddenly?	We have a Critical Operations and Curtailment Plan, that includes ice. We have the real time satellite imaging, radar and ice management vessels doing real time ice reconnaissance. The main ice management vessel works from 3-25 miles away from the drill site. The anchor handler works from the drilling vessel to about 5 miles out so we have far and near ice information. If they think we will not be able to manage the ice we will stop drilling, secure the well to make it leak-proof, recover the moorings and move offsite.	I
Ice Management and Monitoring	Has Shell monitored Ellesmere Island ice? It was in the news quite a few years back.	Our ice monitoring is in the area we are operating. We also use the NOAA Ice Center and they are tracking it on a more global basis. Our monitoring is more intensive during our season. The dominant currents in the Arctic tend to move ice toward the ice. If large floes of multi-year ice are entering our area of operation we will be able to track them in a highly detailed manner for several days before they would impact us.	I

Issues	Comments	Shell Response	Mitigation Measures*
Ice Management and Monitoring	BP documented some ice that got stuck in shallow areas a couple years ago.	We are evaluating ice gouging in our lease areas on a yearly basis. This information is really important for development. Our platform must be able to resist the ice and maintain position in the ice all the time we are drilling and producing wells. It is evident that ice frequently grounds on shallow areas like Hanna Shoal and remains there well into the season. These are substantial pieces of ice. We survey the ice by airplane prior to the season and track ice on a daily basis during operations.	I
Ice Management and Monitoring	I have concerns about ice slamming against the platform.	The way we've developed our platforms are conical. They shear the ice and the ice goes around them.	I
Ice Management and Monitoring	The ice that we have up here and the broken pieces that are underneath the water surface will affect you. Your anchor points and your structure underneath. You need to study the glacier ice. There are big pieces of ice that you can't see.	The way we've developed our platforms are conical. They shear the ice and the ice goes around them.	I
Ice Management and Monitoring	I would like to see your plan in place to understand when and how the decisions are made to pack up and move. I want to see on paper who will make the call and it would be very important to get that together. Some days the ice is flat and over night there could be a lot of ridges.	It has to be on paper. We will resubmit our Ice management plan from previous submissions. We are required by the BOEMRE to submit what is called the Critical Operations and Curtailment Plan. Part of this involves hazardous ice that could threaten the drilling vessel. This Ice Management Plan outlines our procedures, and both the state and BOEMRE must approve it before we can drill.	I and L
Ice Management and Monitoring	Do you consider State of Alaska and Federal Government to be experts? If an iceberg came and knocked off the blow out preventer below the seafloor, what would you do? Based on his questions, there is ice that looks invisible and it could come	We must submit our plans to the state and the federal government for approval and issuing permits. They do have expertise in dealing with arctic operations. Shell has also operated in the Arctic for a long time, and we are experts in drilling oil and gas wells in the Arctic. We also need input from the local residents along the coast since you know more about this specific area than anyone. That's one of the reasons we're here: to get your input. The color of the ice is irrelevant to the	I and L

Issues	Comments	Shell Response	Mitigation Measures*
	and cause a problem.	radars that we use for mapping.	
Ice Management and Monitoring	Can you see the thickness of the ice with the satellite? What kind of danger if you can't determine the thickness of the ice?	No, but there are characteristics that tell us when it is multi-year ice and single-year ice. The multi-year ice is constantly tracked. You can tell by the density of it, but we are tracking and we look at subsequent images the direction of the movement.	I
Ice Management and Monitoring	Taking pictures of the water and the currents, if the wells start producing, they will be under the ice seven months out of the year and that's my concern. We need to know which way the currents are going during that time of the season. There is somewhere the currents are going and it will help you track oil, so we can catch it. Especially in the areas where you are.	We have been studying currents for many years, and the trends for oil slick migration (sometimes, toward Russia far offshore in the Chukchi Sea) are important as we plan for response options, anticipate tracking needs, stage shoreline protection equipment, etc.	H and I
Ice Management and Monitoring	There's a different signal that comes back with high-density ice with your ice monitoring methods?	Yes. We can tell from the return radar signals whether it is more dense, meaning multi-year ice, and less dense, meaning first-year ice.	I
Ice Management and Monitoring	On the eastern side of the Beaufort, the ice was all on your tracts. Can you explain that?	There are some heavy ice years, if we can't get out there we can't drill. We have the history of ice accumulations in previous years, and we are aware that there have been years when the ice was very severe. If it is that bad, we simply will not be able to drill that year. That's part of the risk of doing exploration drilling in the Arctic and we accept that risk.	I
Ice Management and Monitoring	Interested in Marine Mammal Observer data from last year. Made point when looking at ice maps that historically there was much more ice than what we are seeing today.	We have the history of ice accumulations in previous years, and we are aware that there have been years when the ice was very severe. If it is that bad, we simply will not be able to drill that year. That's part of the risk of doing exploration well drilling in the Arctic and we accept that risk.	I

Issues	Comments	Shell Response	Mitigation Measures*
Ice Management and Monitoring	I've never seen the ice in the Beaufort Sea that big. I think mother nature was trying to communicate to us. That we have to be very cautious. That ice will keep coming back.	If that is the case we will not get out there to drill. That is a risk we just have to understand and accept.	I
Oil Spill Prevention & Response	At any given time will they have oil spill containment?	We will have an oil spill barge and additional vessel very near the drilling vessel so that we can respond to a spill within 1 hour. There will also be an arctic tanker and a containment vessel that can reach the drilling vessel in a matter of a few days with capping and containment capability.	H and L
Oil Spill Prevention & Response	How often will you be changing your pipes (casing)? Cause that's what caused the GOM spill.	It had to do with a BOP and riser. New regulations require that we have to fully inspect and recertify the entire BOP stack every three to five years.	L
Oil Spill Prevention & Response	What year was your boom manufactured? Are they obsolete? How often do you replace them?	Most of the booms were designed in the last ten to fifteen years. They don't really become obsolete. In the GOM you heard of booms failing. Some of the booms, especially in the shoreline protection mode, were not used properly. The first ones were developed in the early 1970s. They evolved over the last 30-40 years. The life expectancy of a boom depends on how they are being used, and under what kind of conditions. They can get punctured or damaged if used around heavy debris, floating branches, etc.	H
Oil Spill Prevention & Response	That 21-foot Packman boat – is that a standard vessel?	Yes, and it is very reliable for shallow-water transport of equipment, boom handling and anchoring, etc.	H
Oil Spill Prevention & Response	Are those booms made for different types of water, like cold or hot water and ice conditions and so on?	There are different kinds of booms for very specific needs – open ocean, shallow-water, shoreline, river/stream, etc. They are constructed for different purposes, different currents, different degrees	H

Issues	Comments	Shell Response	Mitigation Measures*
		of ice exposure, etc.	
Oil Spill Prevention & Response	Do you have booms that can recover oil under ice? Do boats tow the booms? How will oil be recovered in ice?	It would not be practical to use booms under ice as they could get snagged under the ice, miss oil trapped in the cavities of the under-ice surface, etc. We have other tactics for dealing with oil under ice, including the possible exposure of the oil with vessels, tipping of ice cakes to encourage flow to surrounding water, allowing oil to become entrained within the ice and then accessed later on, etc.	H
Oil Spill Prevention & Response	Do you monitor currents for the boom?	Yes. We are doing a lot of scientific studies on currents right now. There are instruments that are deployed, like upward looking sonar buoys sitting on the sea floor that map the water and currents by sending a sonar signal upward and collecting the reflected data that show currents, temperature differences and salinity. There's a lot of information being gathered in research and traditional knowledge.	H and I
Oil Spill Prevention & Response	Based on the GOM, the boom had water nearshore that went over the top and the waves were not even that big. What is the height of the boom?	Some of the booms in the GOM were used inappropriately in the nearshore/shoreline environment where breaking waves could splash oil over and under the boom. They should be used in relatively quiet water areas - that's what small shoreline protection booms are intended for. All booms have limitations for effective containment when the wind and seas become excessive.	H
Oil Spill Prevention & Response	Will the containment and capping system be ready by 2012?	Yes, it's being developed now and it will be deployed and ready to go for May, 2012.	L
Oil Spill Prevention & Response	The part where the three yellow caps, what kind of suction device will it be using for the containment (containment system slide)?	Our first option would allow for us to latch back onto the wellhead and shut off the flow like what happened on the BP Macondo blowout in the Gulf of Mexico. That's how BP shut off the flow in that well – by capping. The second option, if that connection wasn't available, would be to use one of those domes to collect the oil underwater and pipe it aboard the vessel. Each dome has a pump that will push the oil into separation vessels on the containment vessel where the oil, water and gas will be pulled off. The gas will be flared. The oil will either be collected and offloaded into the tanker or incinerated. The water will be released back into the sea.	L

Issues	Comments	Shell Response	Mitigation Measures*
Oil Spill Prevention & Response	In the 80's when you went out and I wasn't aware and I was actually shocked. We have to tend to those old wells.	Those wells were fully capped.	N/A
Vessel Logistics	Are you constructing a large icebreaker?	Yes, it's a hundred feet longer than the Nanuq. The Nanuq will be in the Chukchi and the new vessel called Hull 247 will be in the Beaufort Sea.	N/A
Vessel Logistics	Between the two drilling locations, will there be traffic between the two locations? Will there be ships going back and forth regularly?	Each drillship will come with its own assets and shouldn't require any transport unless there is an emergency. We will have a shore base in each area with an air operations base between the two seas in Barrow.	A, B, C, D, E, and J
Vessel Logistics	Will there be maritime infrastructure?	No. We will utilize West Dock only. We will have no other marine operations bases in the Beaufort Sea.	N/A
Permits: Process	Offshore development must be done in a way that benefits the local people; in sense of caring for the resources and communities. They are being asked to take the risks but not necessarily getting the benefits. At what point does tribal sovereignty play a role in relation to federal government? How far offshore does this reach? The state is limited to 3 miles, so does sovereignty extend as far as federal?	Thank you for your comment.	N/A
Quality	Based on the fact that there was some secret drilling out there before. How do we trust you people? That drilling that took place.	We have to get permits and we are here. I am not sure what the regulatory regime was at that time in the mid-1980s and early-1990s. We are here in Barrow talking about our plans to be sure you know what we are planning to do. This question was a follow on to a comment that was made that we drilled in the 1980s and 1990s and people in Pt. Hope had no memory of that drilling. This historic drilling	N/A

Issues	Comments	Shell Response	Mitigation Measures*
		was not secret. It was subject to similar permitting and public disclosure and discussion that we have today. The point of the original comment is that the drilling in the 1980s and 1990s did not leave lasting memories of problems or damage.	
Quality of Engagement: Positive/Feedback	Very impressed by Kulluk Visit. 120 photos taken. Copied to CD (got a copy).	Thank you for your comment.	N/A
Positive/Feedback	Just hired on at UMIAQ for spill response, big supporter	Thank you for your comment.	H
Value Proposition: Jobs	I would enjoy joining an oil response team in near future for offshore drilling		N/A

Notes:

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2011 Proposed Mitigation Measures

A-Communication Plan for avoiding conflicts with subsistence users.
B-Collaboration and Communication with Whaling Associations
C-Plan of Cooperation (will work to obtain a CAA)
D-Will honor 2010 Camden blackout dates for Nuiqsut and Kaktovik whaling.
E-Subsistence Advisors based in Chukchi and Beaufort Sea Villages and Kotzebue
F-Marine Mammal Observers
G-Robust Marine Mammal Monitoring Protocol
H-Oil Spill Response Fleet on standby 24/7 near drilling location
I-Real time Ice and Weather Forecasting
J-Crew change by helicopter and collaboration on routes to and from shore base
K-Zero discharge of: drilling fluids and cuttings after the 26-in casing; gray and treated black waters; bilge and ballast waters
L-Enhanced blowout prevention and mitigation measures (i.e., second set of blind shear rams, increased frequency of BOP testing, redundant ROV hot stab panel, capping stack and containment system, and relief well plan with designated standby relief well drilling unit).

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Issues	Comments	Shell Response	Mitigation Measures*
Credible Science: Baseline Studies	Will the North Slope Science Agreement be affected by the next NSB Mayoral election?	No, it will not. It is separate from politics and is managed by the Wildlife Department. Mayor Itta signed the original document, but the initiative will not be run by the mayor's office. The Wildlife Department will.	N/A
Operational Impacts: Discharge	How will the mitigation (zero discharge) in the Chukchi Sea, will it be comparable to the Beaufort Sea too?	We have chosen zero discharge in the Beaufort because our operations are so much closer to shore. The Chukchi program is many miles from shore unlike the Beaufort Sea well sites.	N/A
Health & Safety	Can we use your boats for whaling?	We will commit our vessels to help anyone who gets into trouble. This is a normal part of marine operations in the open ocean. If you get in trouble during whaling we will be available to help. You can get in touch with our vessels through the Com Centers.	A and B
Oil Spill Prevention & Response	Can you clean oil in broken ice?	Yes, we have had opportunities to clean up oil during small spills and field trials in ice; however, because we have never had a significant spill in the Arctic, we have not tested our large recovery systems under such conditions.	H and K
Oil Spill Prevention & Response	How many times have you cleaned oil on ice?	Numerous times. I have personally cleaned oil in ice 15-18 times over the past 25 to 30 years; but these experiences have, once again, been of relatively small size. Thankfully, we have not had to experience such spill events, and therefore depend upon controlled field trials and tank tests. Generally, efficiencies with some of the latest skimmer designs show efficiencies that are in the 70-80% range. It all comes down to our ability to access the oil when it is mixed with ice.	H and K
Oil Spill Prevention & Response	Will you have a shut-off valve below the surface to stop a flow?	Yes. We have blow out preventers that are located in a mudline cellar below the seafloor. (In a meeting following the presentation, Michael and others were shown a video animation of how the mudline cellar is constructed and how the BOP stack is protected to prevent damage to these valves so they are available to shut off flow from the well if necessary).	K
Oil Spill Prevention & Response	How long will it take to connect the containment system?	It won't be immediate. If you remember the Macando incident, there were damaged risers in the way and had to be removed. It took nearly a month for that debris to be cleared. We will have a crane on site for that purpose so it will probably take 2-3 days maximum to get the	H and K

Issues	Comments	Shell Response	Mitigation Measures*
		capping device in place.	
Oil Spill Prevention & Response	In the meantime will you have equipment to contain the oil in the water?	Yes, we will. We will have skimmers and booms to start gathering to pick it up.	H and K
Oil Spill Prevention & Response	How many oil spill response boats will you have?	We'll have at least six vessels with advanced skimming capability offshore, and many smaller boats that could assist with nearshore and shoreline containment/recovery operations.	H
Oil Spill Prevention & Response	Has this equipment been tested in ice conditions?	Yes, both in actual spills, controlled field trials, and large tank tests with oil.	H and K
Oil Spill Prevention & Response	Are you able to contain the lighter oil that comes up from a spill?	Yes, we have skimmers that can handle a range of oil viscosities from very light low viscosity material to oil and emulsions that could take on the consistency of mayonnaise to something almost as viscous as peanut butter.	H and K
Vessel Logistics	The platform you showed us in ice – does that come in pieces?	Probably 2 pieces with the production and drilling equipment in one piece called "topsides" that sits on top of a base called a "jacket."	N/A
Permits: Process	Obama just announced that he was going to allow drilling in the Arctic. Can that happen without anyone in the communities knowing about it?	We cannot drill without permits and part of those requirements are that we come to the communities and talk about our plans and incorporate those comments into our Exploration Plans.	C
Quality of Engagement: Positive/Feedback	Know that the captain whaler are getting mad not get much whale this year. So that we young elder stand up and let you get the answer. So that why lot's of items pass on. And we take over. So be happy. We young elder take over the oldest Elder, and God bless you all and keep on praying or read bible John 3:16 from: Sister in Christ.	Thank you for your comment.	N/A

Issues	Comments	Shell Response	Mitigation Measures*
Positive/Feedback	In favor of oil drilling. Running out of oil and need more.	Thank you for your comment.	N/A
Threat to Subsistence: Marine Mammals	The whales run 60-70 miles offshore there too.	There are some that migrate out there, but for the most part the whale migration expands once the whales pass Barrow. One group goes to the north and ends up in Russian water. Others scatter throughout the Chukchi Sea. In the Beaufort Sea, the entire bowhead whale population travels closer to shore in a corridor that is about 10 miles wide. It turns out that our drilling operations there are very close to the center of that corridor. The whale hunters there have asked that we suspend operations to avoid disruptions to their fall hunts. We will be so far from the shoreline in the Chukchi Sea that we should not impact many whales at all.	A, G, C, D, E, F, and G
Value Proposition: Jobs	Will the money from the Science Program create any temporary jobs?	It is possible – we will get direction from the steering committee and some of the projects may involve local residents participating in field work.	N/A
Jobs	If you have an oil spill will you hire local people?	Yes. Most spills that I've ever worked on have included a heavy reliance upon the expertise and knowledge of the local community.	H
Jobs	Do local oil spill responders need special certification?	Not, necessarily "certification"; however, they do need some training like HAZWOPER. It might be the 40-hour course or it might be as little as 24 hours depending on what the duty of the individual is during the response.	H
Jobs	Do local oil spill responders have to pass a drug test?	Yes.	N/A

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Operational Impacts: GOM Macondo	Why did it take so long in the GOM? Won't that happen here?	Our oil spill response fleet will be on site within an hour. BP's had to be mobilized from long distances.	H and K
GOM Macondo	How did those deaths occur and could that have been prevented?	That was a sequence of errors that broke every level of prevention.	H and K
Oil Spill Prevention & Response	Our water is much colder. How do you plan to handle that for oil spill response?	Our technology has to be designed for the service and we have practiced using this equipment in cold weather climates around the world.	H and K
Oil Spill Prevention & Response	What will the containment boom do in our currents?	In 120 feet of water the oil will come to the surface very quickly and we have learned to work with the ice, not against it.	H and I
Oil Spill Prevention & Response	How big is the rope mop skimmer?	It is 20 feet across, 20 feet above the water and has 100 feet of mop.	H
Oil Spill Prevention & Response	What if the oil is trapped under the ice?	New ice will grow and entrap the oil and then we can track it. In the spring, the ice will migrate to the surface of the ice where it can be skimmed or burned.	H and I
Oil Spill Prevention & Response	Were all the oils spills you have worked on Shell's?	No, they weren't Shell's.	H and K
Oil Spill Prevention & Response	Location of domes, quantities, how many response vessels per drilling platform.	It's not about the quantity of ships, but the quality and appropriate use of ships. We have much more storage capacity than is needed based on current understandings of potential recovery.	H and K
Oil Spill Prevention & Response	Where are you planning to drill and how far from this community?	92 miles from Pt. Lay.	NA
Permits: Process	How many companies and agencies are involved?	Coast Guard, BOEMRE, NSB, ADEC, UIC, Alaska Clean Seas.	H
Process	Do you have a permit?	Some activities have yet to happen because there isn't a permit, but many things are already in place because much planning has to be done beforehand.	H and K

Notes:

*Mitigation Measures are only assigned to applicable comments.
"Not applicable" (N/A) is used to designate comments that do not require mitigation measures as a course of action. See Mitigation Measures Index definitions according to assigned letter.

2011 Proposed Mitigation Measures

A-Communication Plan for avoiding conflicts with subsistence users.
B-Collaboration and Communication with Whaling Associations
C-Plan of Cooperation (will work to obtain a CAA)
D-Will honor 2010 Camden blackout dates for Nuiqsut and Kaktovik whaling.
E-Subsistence Advisors based in Chukchi and Beaufort Sea Villages and Kotzebue
F-Marine Mammal Observers
G-Robust Marine Mammal Monitoring Protocol
H-Oil Spill Reponse Fleet on standby 24/7 near drilling location
I-Real time Ice and Weather Forecasting
J-Crew change by helicopter and collaboration on routes to and from shore base
K-Enhanced blowout prevention and mitigation measures (i.e., second set of blind shear rams, increased frequency of BOP testing, redundant ROV hot stab panel, capping stack and containment system, and relief well plan with designated standby relief well drilling unit).

Issues	Comments	Shell Response	Mitigation Measures*
Credible Science: Baseline Studies	There was a question about mitigation and baseline. A seismic program that lasted nine years running from the Canadian border to the Chukchi Sea. Every square inch was analyzed. In 1989, we noticed a lot of seals were sinking from malnutrition. We didn't know what it was from. We accused Red Dog Mine. It wasn't until a couple years ago that we learned about this nine year seismic program that resulted in skinny seals. Now we are going into the third and fourth year of seismic again. There are over 5,000 environmental studies that were done. I would like to see the data and see what the rate of recovery from that data is. Our tomcod has disappeared from our ocean around us. That is what our seals eat. They partially came back last year a little bit. I believed that was mentioned before. Why don't you answer the question before? How do we deal with trying to understand the impact of seismic over the years. NMFS is trying to list them as endangered at the same time they give authorization. I'm confused. How do you take this into consideration? Have you thought about the recovery of these animals from these activities? There's another series of seismic to come. But there was no explanation from NMFS or NOAA when they have questions from years ago. That's part of our food chain, we rely on those seals and they rely on those fish. Is this part of our mitigation?	We do conduct a very large and significant monitoring system of marine mammals and we talk about baseline studies, that benthic, plankton, in the mud on the bottom. We are looking at all of those. For our 4MP, we have recorders that are out there as well, we have airplanes out there, MMO's on every vessel. We've learned a lot over the last three years. The animals tend to move away from activities when there are activities that make noise. They move away for a period of time. Seals react less and bowheads react more. Bowheads get quiet and when the noise stops they will vocalize again. They will move away from noise to protect themselves. They move away and then they go back. I think it's important and it's part of the reason why Shell has entered into this agreement with the NSB, to hear the concerns from the people in the villages and shape science to their concerns. We are getting better and better to reacting and understanding concern. I wasn't here in the 80's and 90's. We have Subsistence Advisors in each of the communities to hear these kinds of things too.	E and G
Baseline Studies	Your studies are done on the areas where you've done seismic after?	We've done seismic at some of these locations. In the Beaufort Sea, we did the studies before the seismic there in some of the locations. Some of the areas we've done studies. For example to answer your question, we did seismic in Burger, we did not do seismic in Hammerhead.	N/A

Issues	Comments	Shell Response	Mitigation Measures*
Baseline Studies	That sounds like you are at least looking at it.	Thank you for your comment.	N/A
Baseline Studies	It could mean a case in 15 years?	It would mean a case in 30-50 years. Based on wells that we've drilled here we've seen 3-4 times less pressure than Macondo.	N/A
Baseline Studies	The formation out there is different than Cape Lisburne?	Some of the Lisburne. I don't know much about that and it doesn't seem to be an issue with what we're doing. There is nothing wrong or particularly difficult about where we're drilling.	N/A
Baseline Studies	Can you acknowledge what type of current is there? A whirlpool or	We've been doing several things. We've for the last three years had instruments that have been out all year round. Measuring currents even under the ice. We've deployed a met-ocean buoy that measures the currents. We've worked Oceanic.	N/A
Baseline Studies	Have there been any fluctuations of ice in that area? I've seen publications of the National Science Foundation that we can compare with that data in the past few years.	We're required to do ice gouging studies. We're getting an understanding how frequently ice gouges occur for 15-20 and even100's of years and looking at detail.	N/A
Baseline Studies	And you have that kind of ice gouge data available?	Yes.	N/A
Baseline Studies	How about the NS is known for having fluctuating pressures?	We don't share that opinion. There are other areas that have unknown pressures and fluctuations. Typically when you drill in an area that has been drilled before, and you can run into that. That will not be our case.	N/A
Baseline Studies	Have there been any studies on radioactive plankton?	I don't know. I'm sure there have been oceanographic studies in the 60-70's when they were doing nuclear testing.	N/A

Issues	Comments	Shell Response	Mitigation Measures*
Baseline Studies	There are 90 wells in the McKenzie Delta. How many of them were Shell's and what is your experience with them?	Not sure, that would have been operated by our Canadian Group.	N/A
Biological Environment	How deep down at the seafloor will you be drilling?	It's at 120 feet to seafloor.	N/A
Biological Environment	Is this for every hole you drill and how many will that be?	Yes. In the Chukchi Sea drill possibly three and in the Beaufort Sea it's two wells each year.	N/A
Biological Environment	Can you explain how they are the same temperature all year around?	Have you ever gone swimming and it was warm at the surface until you go deeper and you suddenly hit a layer that is cold? Water forms layers called thermoclines that may be warmer or colder and they don't tend to mix unless they are stirred by the wind. So, even if it is very cold on the surface deeper layers may not be that cold because of layering and a lack of mixing.	N/A
Biological Environment	Is there any ice on the ocean bottom?	No, not at those water depths.	N/A
Traditional Knowledge	If you're talking shallow waters in the upper part of the world, there was a lot of land before and it eroded and there is ice coming in. There is erosion along the coast of Alaska.	Thank you for your comment.	C and E
ENGO Opposition: Partnerships	(Question is directed to Earl Kingik) Who brought you here? There's a company here to talk to the community. I haven't seen you for a long time and every time there is industry here you are here. We all don't have jobs and it takes money to travel. You said you were going to follow them around.	I work for Alaska Wilderness League. I work for a Liaison Member to DC to educate our Congress and our House of Representatives to … We cannot let people to push us around anymore. Our aunties and uncles told us to protect our way of life and culture. It was good to see someone from Point Hope go out and do a little tally and say you are invited to tonight's meeting. Maktak or money? Lots of people say maktak. We have a hard time and we want to protect our way of life. Our language is disappearing. Our culture is disappearing. I am here because I love my people.	N/A

Issues	Comments	Shell Response	Mitigation Measures*
Offshore Education: Technology	I'm concerned about Santa Barbara. How was that plugged and was that plugged at all? My understanding is that the ground tore.	1969, it was a completely different type of location. I typically know about the seeps that they had and the shallow wells. Natural seeps are found in that area of California. The Santa Barbara event drove changes in the design and hardware that is installed on wells to prevent that type of incident.	K
Technology	How would you cap that Santa Barbara well?	The Santa Barbara well was handled by the operator in coordination with the regulator.	K
Technology	Can you explain what happened to that?	Unocal was the operator, you have land movement and shifting in the area that damaged the subsea of the casing itself. It is also a heavier type oil. It was pretty close to shore. It was in 1969, lots of regulations were changed.	K
Technology	How did they stop the flow at Santa Barbara?	It required well intervention.	K
Technology	What does a formation mean?	More of a solid than a rock.	N/A
Technology	What is a rig?	It's our drilling ship.	N/A
Technology	After that you will be able to develop, for sale?	It will be 10-15 years to development. We're only doing exploration. We drill, look at the results of the wells and look at the project to see if it is supportable. From 7-10 years to develop the project from that. 10 to 15 years. It's a long time away from producing.	N/A
Operational Impacts: Discharge	I understand that the there is no pollution discharge in the Beaufort Sea, is there one in the Chukchi Sea?	Shell has committed to a zero discharge of muds and cuttings and sanitation in the Beaufort Sea. That is our choice; we have not gone to that in the Chukchi Sea. We don't have a zero-discharge policy in the Chukchi Sea today. We have a zero harmful discharge in both seas.	N/A

Issues	Comments	Shell Response	Mitigation Measures*
Discharge	Why is there zero discharge in the Beaufort Sea and zero harmful in the Chukchi Sea?	All of the discharge is not harmful. In the Beaufort Sea it is so close to the shore. It is not in the path of the migrating mammals and their food source in the Chukchi Sea.	N/A
Discharge	What is your discharge in three weeks? Zero harmful discharge is million gallons and barrels.	EPA allows 18,000 barrels a day, per well. Our discharge is less than 1% per well.	N/A
Discharge	Each day it will be 2,970 gallons per a day for three wells and it will be 30 days. That will still be a lot. Times three wells. The wells are drilled one at a time. How much discharge will you do per a day per a well? You said 180 barrels a day. It's pretty close to a million.	The way the drillrig works, it will set up in the Chukchi Sea and it will move to another well and drill. At any given time, there will not be more than one well in the Beaufort Sea. If there was more time it would.	N/A
Discharge	Are you including, the sanitation, the oil?	No oil, but treated discharge.	N/A
Discharge	When you flush it where does the drilling muds and cuttings go?	We went back to those wellsites and sampled the mud from those sites and the animals from those sites. You can tell that a well was drilled there. The main reason is because something that's used in this mud called Barite. Barite is a non-toxic agent that comes from the ground and it's put in the mud to make it heavy. Has anyone ever had a digestive tract x-ray? You drink barium, it's used medically, it's non-toxic. We've looked for toxic things in the mud and the animals and . . .	N/A
Discharge	Will you dump your mud off the ships?	There will be some residual chloride, but they will be diluted. Typically we are not dumping whole mud off of the ship. The mud that enters the water is separated on a Shell shaker, the mud gets reused and recycled and it is clinging and goes overboard.	N/A
Discharge	What did you say?	A community member is calculating the discharge total.	N/A

Issues	Comments	Shell Response	Mitigation Measures*
GOM Macondo	Keep in mind, NSB only has 3-5 miles. The ICAS could do the same thing in terms of a science agreement. Work with tribes and work together and it will be easier. Man makes mistakes. Look at Japan. I seen the GOM and how bad it is. We are not ready yet. We will not be ready when time comes. That little boy (pointing at a boy in the audience) might be in charge of oil spill response and my granddaughter might be the president of Shell Oil.	I know you were there. It was very heartbreaking. I'm from the GOM and it was hard to watch. You prevent what happens. It was human error, it could have been prevented. There are no guarantees and there are risks. There are risks to everything. We would like to show you our capping and containment systems.	K
GOM Macondo	Explain how you have ice at the bottom and the temperature is the same as the GOM.	We have instruments that are constantly recording the temperatures. When the air is really cold at the surface, but at the bottom it does not change much. The currents are coming from the Bering Sea and the Pacific Ocean. Even though you get a cold surface temperature. Ice floats, so there would not be ice on the bottom of the ocean. There could be gas hydrates, which are frozen methane because of the high pressure. Since there is no sunlight that penetrates to the deep ocean, there is nothing to warm the water, so it is very cold at deep depths but it doesn't freeze.	N/A
Ice Management and Monitoring	Can you imagine that kind of weather with a couple hundred piles of ice?	It would not happen here.	I
Ice Management and Monitoring	What kind of winds and how fast is that ice traveling (Sakhalin platform in ice video)?	That's real time.	I
Ice Management and Monitoring	What if you have had 90 foot seas?	You won't have that here. It is 15 years away at the soonest. You have to design a structure with engineers that have arctic experience.	I
Ice Management and Monitoring	I want to share a story, where we have a big storm and the ice covered the whole village of Point Hope. You should not underestimate the power of the ice flow.	Thank you for your comment.	I

Issues	Comments	Shell Response	Mitigation Measures*
Ice Management and Monitoring	Have you ever considered using NOAA for ice monitoring?	We do use NOAA resources like the MODIS information. We also use the NOAA Ice Center. But we also do a lot of processing that they don't do because we need more detail than they do. NOAA is very interested in getting the information that we have generated to improve their data set.	I
Ice Management and Monitoring	Where is T-3 it's a large piece of ice that ran ashore five years ago and it broke itself free? It's multiyear ice that has a flow station on it?	There are several ice islands that are in circulation in the Arctic. We are helping to fund drift buoys that are keeping track of where they are.	I
Ice Management and Monitoring	Can we have access to your ice monitoring? It would be very helpful to our whaling.	Yes. There will be a website.	I
Mitigation Measures	What is the meaning of mitigation? I want to know this in Inupiat?	The definition to minimize to lower or decrease any impacts that would occur because we are here.	A, B, C, D, E, F, and G
Oil Spill Prevention & Response	How long will the transit will that take. If you have an accident in the Beaufort Sea and you have to travel from the Chukchi Sea?	Three days. But there will be oil spill response vessels and equipment there with each drillship. We have very big vessels with those drillships. Some of the people in this room went to see one of the drillships and one of the oil spill response vessels.	H and K
Oil Spill Prevention & Response	Are the wells there already?	Yes, they were permanently capped.	H and K
Oil Spill Prevention & Response	You mentioned your BOP will be tested every seven days. Have you started and do you know if they will work in our arctic environment?	When the wells were drilled in the late 80's and 90's they worked fine.	K
Oil Spill Prevention & Response	What is the water temperature difference, and how do the divers dive in the winter?	We are only going to be doing it in open water. We would not be doing it when we have ice or solid ice. At the surface it is much different. In the GOM at 5,000 feet below the sea level it is only 1 degree or so different.	H and K

Issues	Comments	Shell Response	Mitigation Measures*
Oil Spill Prevention & Response	How will you handle divers in the development?	Water temperature is about one degree or so different. The BOPs work in Sakhalin and the North Sea.	K
Oil Spill Prevention & Response	We've heard about many oil spills off Norway.	The recent oil spill in Norway wasn't from drilling. It was from a cargo ship. It was fuel onboard the cargo ship.	H and K
Oil Spill Prevention & Response	That's going to the seafloor at 120 feet for the same water temperature?	Yes.	N/A
Oil Spill Prevention & Response	You are talking about drilling in 2012, how long before you get to the bottom and put out the BOP, will it be twenty days?	To get to where we put in the BOP it will be ten days.	K
Oil Spill Prevention & Response	How long after that will you finally get the oil?	Roughly twenty more days.	K
Oil Spill Prevention & Response	For five years, every time they come they keep bringing different people. Kind of a waste of our time listening to you guys coming here to talk about BOP, prevention taking place, by that time most of us will be gone. If we are a body to give you authority, we will be no less. We wouldn't be thinking about our children and grandchild, they will be observing this after we're gone. Most of us. I would never say, "Hey come and do it now." You say you have safeguards, I cannot say yes to it myself. I am more less going to kill my children and grandchildren. Industry would come and develop and I would be killing my children and grandchildren.	Thank you for your comment.	H and K

Issues	Comments	Shell Response	Mitigation Measures*
Oil Spill Prevention & Response	How do you address the rubber seal in the pipe, that for some reason was to tighten and when they pulled the pipe out it tore the seal. And it came out of the rig? How will you address that? Is there some sort of preventative measure?	They have a diverter that was capturing. The biggest reason that failed, they should have recognized that they had gas above the riser.	K
Oil Spill Prevention & Response	What do you have to detect or monitor that?	To catch that influx get into the riser. That's much easier to do in shallower water. They were in 5,000 feet of water. Shell Layers of Prevention slide. We have instrumentation that would detect that immediately to hold those formation fluids back. The third thing we have is mechanical barriers. On phase four we have a capping and containment system. Our biggest priority is to not let the influx enter the well and happen. We do not plan to get any oil out of these wells.	K
Oil Spill Prevention & Response	If it did leak and it exploded, that oil is going to move fast and it will spread. What type of mitigation or agreement is there to address Pt. Barrow? It's going to hit them before it hits us. Will they come over here to do their whaling?	We have a 25 million dollar good neighbor policy. It is administered by Wells Fargo Bank it is available for immediate use for any kind of verifiable. When you take that money it does not prevent you from taking legal action. You can still participate in a class action suit. You could still take legal action you want.	H and K
Oil Spill Prevention & Response	Where will the Barrow whalers go whaling?	You're presupposing the oil will go to Barrow. I can't do that.	A, B, C, D, E, F, and G
Oil Spill Prevention & Response	Where would the Barrow whalers go?	We don't discuss that in the CAA negotiation. It's never come up with the Barrow Whaling Captains Association.	C
Oil Spill Prevention & Response	What's going to happen to those Barrow whalers? That question was never answered. You're always welcome cousin to come, but we've never really seen it. When was that agreement signed?	We just signed another agreement February of 2011.	C

Issues	Comments	Shell Response	Mitigation Measures*
Oil Spill Prevention & Response	Don't those currents go to Barrow?	Part of it. There's a canyon off of Barrow that is like a bathtub drain. The coastal current will come along the coast and towards Barrow. What's out at Burger, the Hannah Shoal pushes the water to the east and west of it. Jack you mentioned a good point about oil in the Gulf that spread through the water column and did not come to the surface because of the extreme depths. Since our water depths are so shallow in the Chukchi and Beaufort, oil will not spread through the water column and pop in another area. It will all surface near the drilling area where our response fleet will be able to capture it. Our first line of defense is the have spill response vessels.	H and K
Oil Spill Prevention & Response	I would like to thank my Tikigagmiut. It's important for our people, our community, our whaling captains. We have to remember what our elders said. Pete, the majority of us have bad hearing, we don't know what they're really talking about. You heard that elder it has to be in place. I make a recommendation you hire a venue and we would like you to hold your meeting at the Qalgi. Our city government needs money too. I would honor what our elder said. And the meeting was just starting too. I myself, a Tikigagmiut, hunter, Qagmaktuuq. I would say "No development." You show me where those oil spill response crews will come from. They will have two ships. I don't believe it will take three days to get from the Chukchi Sea to the Beaufort Sea. It is less than that. I took a kayak trip. It's good to see you in here, trying to protect our way of life. Pete heard me many times. I speak for these people, our people, the culture that I love the most. We don't know what is going happen with radiation with animals that is contaminated from Japan. The two year Pollock, we got many more. Those adult fish spend time here and go back to Bristol Bay	Thank you for your comment	H and K

Issues	Comments	Shell Response	Mitigation Measures*
	and make more eggs. No activity until you say we can all be protected. I'm a Tikigagmi. We are having problems, we have to be ready for radiation. There might be only three people that come, but they have to make a report. This makes my heart feel. You have an interest in our way of life.		
Oil Spill Prevention & Response	You actually know if the oil is heavier or lighter? What is worse for a blowout?	It's not a function of the type of oil, it's the pressure, the depth. The deeper the water depth the more issues you have access. Working on top of a 500-foot building opposed to a 120 foot building.	H and K
Oil Spill Prevention & Response	How long would it to take to make that decision to cap your well and move offsite?	In the worst case scenario it would take approximately 30 days to drill a relief well, however the capping operation would be much less.	H and K
Oil Spill Prevention & Response	We're talking about the BOP and we're talking about both safety's not working?	Yes, that is correct, but the likelihood of that happening is extremely low.	H and K
Oil Spill Prevention & Response	What's the first safety of the BOP?	We have the levels of prevention.	H and K
Oil Spill Prevention & Response	You said you'll drill three wells in the Chukchi Sea? That's not counting Conoco and the others?	That's correct. We don't know what their plans are.	N/A
Oil Spill Prevention & Response	So will there be companies planning to drill too?	Thank you for your comment.	N/A
Oil Spill Prevention & Response	If they had a spill would your equipment be available to them too?	We are talking to the federal government. We are discussing that they should have their own equipment.	H and K

Issues	Comments	Shell Response	Mitigation Measures*
Oil Spill Prevention & Response	I would like that an oil spill response would be a huge priority. I would think that you would work together.	We've raised the bar pretty high in OSR and the other companies should follow. If they want to go to the same high quality, we would be more than likely to discuss and share with them. I cannot promise anything.	H and K
Oil Spill Prevention & Response	Why can't work with the North Slope Borough? We in other communities when don't even see any of the contracts. Are the wells earthquake resistant? Due to global warming.	Thank you for your comment.	N/A
Oil Spill Prevention & Response	If there is an oil spill would you stop an oil spill by another company?	Let's say Crowley a company delivering fuel runs aground, we would turn around and help them. In regards to stopping our drill, we would have to assess. We do pick up oil as a routine day of business.	H and K
Seismic	I noticed reference to the Sakhalin Island, they were dealing with seismic at that same time. Those animals didn't have a place to go. It's a blanket inventory. We need to see where that seismic went on, to understand. We didn't' know of all the seismic activity. We don't know what the rate of recovery is from this 3-D. There are exemptions from seismic activity. They're exempted from input. There's no recourse. No slowing down or taking another look at a significant impact. There's always a no-finding-of-significant-impact. I don't think Shell was involved, but it was done. And those impacts are there. We have concern of preserving and that our freezers remain at the same level not due to a lack of our knowledge. So that our recovery can take place. We don't want you to have such a big headache. The more that we state info. the less time we have to argue about it. I don't like arguing.	Thank you for your comment.	N/A

Issues	Comments	Shell Response	Mitigation Measures*
Seismic	One question I've been wondering it has to do with the affect on plankton from seismic activity. They are probably disintegrated at impact. Will it change their eating habits or ability to reproduce? You're dragging this machine along the whole ocean, it's been brought up but it is important and we need to find out.	It has been studied in experimental situations where they have an airgun in an enclosed area. Anything within 7 feet can be impacted, but beyond 6-7 feet there is not a noticeable effect. There is a global current that comes into the Chukchi Sea from the Bering. This is one of only a few ways that water enters the Arctic. The plankton that occur in the Chukchi Sea are essentially brought in from the Bering and grow and develop there. So, there is essentially a conveyor belt of plankton constantly moving through the system. If there were impacts they would be very short term as the system replenishes itself.	N/A
Seismic	Will it affect the feeding ground near Greenland?	The waters around Greenland are a mixture of Arctic outflow that mixes with currents coming up from the south. It is very similar, in that the plankton are constantly refreshed and grow rapidly during the open water periods.	N/A
Vessel Logistics	There is going to be a ship in the Beaufort Sea and in the Chukchi Sea and they both will be drilling? And there will be a big storm and they both will get in trouble. What will you have then?	The likelihood is that it will not happen.	I
Vessel Logistics	How far is the drilling rig from shore?	204 miles from Point Hope, 78 from Wainwright and 92 from Point Lay.	N/A
Vessel Logistics	How many icebreakers do you have and will you use? Are they American or are they foreign?	Each drilling vessel has one ice management vessel that is foreign flagged.	N/A

Permits: Process	Do you have all your permits that are required to do offshore activities? Are you sure oil spill response will work? In the past, you just went right in there and started planning without our people. You have to get an IHA, CAA, and Clean Air is a big issue. Do you have all your permits in place? The government might say no, our people might say no. I want to make sure for my people here that you have your permits.	One of the ways we get permits is to come talk to you. There is not a federal agency that would issue a permit, if we didn't come talk to you. We don't have all our permits. We are here because you live on the Chukchi Sea. The federal government and Shell are here to make sure we are acting appropriately.	A, B, C, D, E, F, G, H, I, J, and K
Process	We're having this exploration up here in Alaska, but offshore exploration is not happening on the East or West Coast of the U.S. The eastern states like Rhode Island, the west coast said no. The U.S. Government honored that. Who said yes? We said no. We see this and they honor that and they won't touch. Is it the governor, the senator, the congressman. Those states they say no, they are not drilling over there. Who is saying yes? What's going on now? What did the U.S. Government honor the governor, State of Alaska, Tribes? What's the difference? Do you understand what I'm asking?	First of all, why the Chukchi Sea and Beaufort Sea, the scientist in the industry and government believe there is oil there. Today we discussed onshore, I would love to drill onshore, it would be much easier. We don't want to make things difficult. If we thought it was prospective, but the oil onshore is small quantity. The USGS looked at all the prospective areas. There is no further leasing on the West coast there is oil being produced. When one looks at those areas, the amount of oil is small in comparison to what we see in Alaska. I recognize the people in Point Hope, not all people, in other villages as well. We don't always get the same reception. The people of Wainwright, they're ok with what's been said. When they do polls in Alaska, three of every four people is in favor. That's the way it's worked. It's very important to us. There will never be a time in our lives where all people will agree with us. We can be responsible and drill our wells and work in an exploration process and to development process. We will never be successful, if we don't work with the communities. We will continue to come back and explain until we get a better understanding.	N/A
Process	In 2008, we had a lease sale on the Chukchi Sea. I protested the lease sale cause not even one cent will go to the State of Alaska. We won't even get any money. If you will give money to the State of Alaska and NSB and will you give money to the impacted communities? You gave how many millions to the NSB and State of Alaska? Can I have a big Seattle Seahawks stadium?	The money given to the Borough is meant to be shared with the communities. Concerned residents come to the committee and determine science. Shell is working with congressman Young and Senators Murkowski and Begich. All Borough communities will see significant amounts of revenue through property tax. The pipelines will come onshore and we will continue to pay property tax and put money into the economy that way. We will continue to work with ASRC and Tikigaq to put money in the hands of Alaskans, the Alaskans in this room. That's what we're trying to do.	N/A

Process	NSB can't tax federal waters?	That is correct, but the NSB gets property taxes for pipelines and other facilities onshore.	N/A
Process	Who owns the OCS?	The Federal government.	N/A
Quality	The feds and industry don't have enough scientists and they are not ready.	Thank you for your comment.	N/A
Quality of Engagement: Feedback	To the young people, I want it on the record that we do have experts. I count 5-6 elders here.	Thank you for your comment.	N/A
Insufficient	I want to make sure that you honor the elders request and redo this meeting and because of their hearing issues. Many of them have hearing issues. They don't like to be told to sit here. We respect our elders. If you come into our community you must respect our community. Do an orientation to your staff. You don't disrespect our community. I will always oppose. I say it even now. I would never risk my food I eat.	We will hold another meeting with the proper equipment.	N/A
Insufficient	Is there a recorder? Does Shell have a recorder?	No we don't have one with us, we have staff recording comments and questions.	N/A
Insufficient	I'm an elder here. I tell you all to bring the proper equipment and stuff like that when you are going to hold a meeting. I can't hear nothing. I can't hear good. I just hear mumblings. Get prepared first and talk to us. I would like to postpone this meeting until it's done with a PC system. Nothing wrong with that. You need loud speakers and stuff like that and we want the documents before ahead of time so we can review it. We so move.	We would be happy to come back later and keep going on with the meeting.	N/A
Insufficient	You guys are rich and could come back and forth.	The next time we come we will come with speakers and microphone. Because we have people here right now.	N/A
Insufficient	This is a second meeting that I've heard this complaint. This is what was said in Dutch Harbor.	Thank you for your comment.	N/A

Insufficient	There's no deal. I said it all ready.	We apologize for not having a microphone system. The principal just notified us that their system is down. We will bring a microphone with speakers in the future. There are many people here that have questions and comments and we are going to continue with the meeting.	N/A
Insufficient	Is this part of a POC that is required for your license? What evidence do you have that was asked as questions?	We've never been asked for a recorder and we can bring a recorder. We can send you a copy of the EP that documents all of these questions, our responses and the mitigation measures.	C
Insufficient	A recorder shows what questions have been asked. What is provided to the Feds and the POC is drawn up by your employee. We don't even review what is recorded. It is indisputable. There's something wrong with this. We always hear "We will get back to you." It's time to get beyond this arguing stuff. We need to get beyond this guessing game. I just wonder why you do this time after time without a recorder? It is so simple.	Thank you for your comment.	N/A
Insufficient	Jack has a very good point. You're taking us in circles and we do need answers. I agree with him. Our elders are the ones that need to hear this, we look for guidance from them. We need microphones.	Thank you for your comment.	N/A
Insufficient	All the last meetings that I've attended with industry, we've always had this problem. We have entities with recorders and loud speakers and microphones. If they were offered to be rented, I'm sure they would let you utilize these things. I've been to meetings where people have been able to talk right into a microphone. All you have to do is pay for it and utilize it.	Thank you for your comment.	N/A
Insufficient	Bring microphone system to the next community meeting.	Thank you for your comment.	N/A

Insufficient	Bring a recorder to the next meeting and send a copy of the transcript to the residents.	Thank you for your comment.	N/A
Insufficient	Use simple words in your PowerPoint and oral presentation.	Thank you for your comment.	N/A
Insufficient	I have trouble with the long words. Simple words would give us more understanding. Next time delete it and put simple words.	I will do that.	N/A
Positive/Feedback	Thank you for being here for the community. We've always had someone from the outside protecting our way of life. I have never heard of anyone that has come to explain how you will clean up oil spills in the ocean.	Earl said is it money or is it maktak. The question is do I need to choose? Instead we want people to say "Can I have both?" We want to work with the community for economic justice, where we're supporting people in their current lifestyles. Can I have both and can I take part in this and go forward? This is what we would want you to think about.	N/A
Positive/Feedback	I would like to thank you for continuing the meeting when an elder continued to tell you to stop or end the meeting. I know that this meeting helped inform me. The more meetings to inform our people the closer it will get to begin drilling.	Thank you for your comment	N/A
Positive/Feedback	First all I would like to thank Shell for visiting our community to try and explain your future operating plans and apologize for the few single minded who cannot go beyond their beliefs to even try to understand what is more than likely inevitable for Alaska's future. I worked last summer for ASRC as a Marine Mammal Observer both for Statoil and Shell and from my experience; I believe this can and will be done safely and efficiently as long as the planning is there. I look forward to possibly working again for Shell and will most definitely be a part of the operation for the long run. Thank you.	Thank you for your comment	N/A

Positive/Feedback	We thank you for doing this and helping it come together. There are protocols and guidelines. We need to do it along with Conoco and Statoil, it's better that way. We don't like to work by ourselves either. We don't know how many wells are being done by ConocoPhillips and Statoil. I don't know.	I appreciate you saying you appreciate all the good work that Shell, Conoco and Statoil have done together. We are really proud of our science program. It will have a lot of value in understanding potential impacts and climate change. We are closer now to understanding how this ecosystem works. We have a lot of information that we can provide to you. I need to differentiate between exploration drilling and development. Exploration takes place in three months and number of years and 5,000 studies and ½ billion dollars. Development will require more work. The NSB will be a big help in incorporating the Traditional Knowledge. They will help in knowing what science we need. If we are ever successful.	N/A
Positive/Feedback	That's a good question. That's why we need these meetings to answer our questions.	Thank you for your comment.	N/A
Positive/Feedback	It's not just maktak. It's all the marine mammals in the sea.	Thank you for your comment.	N/A
Protocol	Where there any follow-ups or actions that came up from the last meeting? You should start off each meeting by going through them before with the community.	We document each of the comments and questions and they get put into tables organized in topical order with the comment/question and the response and if there is a mitigation measure that needs to take place it is recorded.	C
Threat to Subsistence: Marine Mammals	How do the animals get Barite in their system?	We've taken very detailed samples. We've gone back and looked and it was done 20 years ago. Today it is even more strict. If we discharge, we discharge much less.	N/A
Value Proposition: Development	Com Centers	Is it your preference that we build our own structure?	A
Development	No. I have no preference.	Our preference would be that we use an existing structure and pay a contract to a local organization.	N/A
Jobs	We want to be included.	Thank you for your comment.	C, E and F

Jobs	What are the Tikigaq contracts?	Waste disposal and compliance.	N/A
Revenue Sharing	When you start drilling, is there any way that Shell can set up shares for the project to the people other than the corporations? Some of the native corporations do not give back to the shareholders. If our people can get shares for the areas that are being drilled, this would be a good way to give back to our people. A lot of times, we don't see any of the money so this would be a good way to give back to the people. For those enrolled in the native village.	Thank you for your comment.	N/A

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Issues	Comments	Shell Response	Mitigation Measures*
Cost/Access to Energy: Cost/Access to Energy	Does North Slope oil cost more than other places?	Yes – I can't answer why fuel prices are high in rural Alaska. There have been lots of questions about Native Alaskan populations and we want Native Alaskans to be a significant part of our operations. In Brunei, where I worked before I came here, they had 95% local hire. We call this economic justice. There is a lot of discussion about environmental justice but longer term economic justice is just as important.	N/A
Operational Impacts: GOM Macondo	How did the big spill in Mexico affect everything?	It was a catastrophe for the oil and gas industry. We were very close to drilling last year and had conducted over 450 stakeholder engagements and the more we spoke with communities, the more people felt comfortable with Shell. The president put a moratorium on offshore drilling and the fallout from that accident has continued to follow us. We have to show what we can do not just talk.	H and K
GOM Macondo	The biggest fear people have is a repeat of the GOM accident.	We hear that a lot, people are fearful of oil spill and we have a spill response program to talk about tonight. And one of the most important things is prevention.	H and K
Oil Spill Prevention & Response	Will you have a team ready in case of spill and if you do, do you provide training?	Yes all the personnel have to be trained; We sent some of our personnel from up here to work on the BP spill and they gained experience.	H and K
Oil Spill Prevention & Response	What if you have a spill at the end of the season?	Our equipment can work in a certain amount of ice. We will attempt the capping and containment first and we should be able to control the well before ice becomes too much of a problem.	H and K
Oil Spill Prevention & Response	The ice might help with containment.	Yes the ice can actually help corral the oil.	H and K
Oil Spill Prevention & Response	Are the man made islands safer than the platform?	We really can't use man made islands in water depths higher than 20 feet so when we find production we use what is called concrete gravity based structures.	H and K
Quality of Engagement: Positive/Feedback	This is an excellent presentation very thorough.	Many of the people that helped in the Gulf were from Alaska were from the NANA Region.	N/A
Threat to Subsistence: Marine Mammals	What about whaling season – are you going to stop drilling during the whaling season?	We will have blackout dates in the Beaufort Sea on August 24th and move our drilling rig and boats far offshore and wait until whaling is finished. In the Chukchi, we will continue to work because it is very far offshore.	A, B, C, D, E, F, and G

Issues	Comments	Shell Response	Mitigation Measures*
Value Proposition: Jobs	Do you have any Native people working for you?	We don't have many jobs available because we have not been able to move our program forward, but if we have a drilling program, there will be many jobs and we want Native Alaskans to have most of them.	E and F
Revenue Sharing	Can you give a projection of how Shell's success would affect the NWAB?	There isn't revenue sharing in the OCS but we looked at impacts to the state and nation over 50 years. We found that regionally there would be 4 Billion dollars revenue from taxation and other benefits but the biggest benefit is jobs resulting in $145 billion over that timeframe. It would also impact the whole country.	N/A
Workforce Development	One of the benefits is employment and career opportunities and professional careers. At what time does Shell imagine a project that caters to NWAB and NSB people? There should be a mechanism that kicks in that helps this region because there aren't enough people to fill these jobs. As an Alaskan, I'd like to see this benefit Alaskans first.	Shell has started a program called Avante Guard which certifies teacher's aides with UAA to give them the credentials they need to become professional teachers. We are also working with a group called Polar Pairs which is an exchange program with teachers in Aberdeen. We also support ANSEP. I took a call from Kotzebue about jobs for roustabouts and I also hope there will be jobs in engineering, geologists. We are also trying to attract Native Corporations to build capacity to work offshore. We don't have a large pie now without a drilling program but we want to provide jobs. We have identified that 5^{th} graders are the people that will take advantage of the jobs we will have to offer. The longer we wait, the further out that target moves.	N/A

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Issues	Comments	Shell Response	Mitigation Measures*
Quality of Engagement: Positive/Feedback	A suggestion was made that a good time for Shell to come to Kotzebue would be the Trade Fair on the 8th and 9th of July which is also the Manilaaq annual meeting.	Thank you for your comment.	N/A
Positive/Feedback	Another suggestion was made for Shell to participate in the Spring Clean Up by donating bikes. Sponsors get a lot of publicity.	Thank you for your comment.	N/A

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Issues	Comments	Shell Response	Mitigation Measures*
Operational Impacts: Oil Spill Prevention & Response	Have you used the capping and containment system in the Arctic?	We have used this equipment in many other places but we will fully test the equipment here before it is used.	K
Oil Spill Prevention & Response	Will you test the equipment during bad weather?	Yes we will test the equipment during all conditions we could imagine but if the weather gets too bad, we will suspend operations.	I, H, and K
Oil Spill Prevention & Response	How would you deal with an oil spill in ice?	We have equipment that is designed to operate in ice.	I, H, and K
Permits: Timing	You said there wouldn't be any activities in 2011. Is your decision related to HB 210?	No we made our decision before that bill was introduced.	N/A

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Issues	**Comments**	**Shell Response**	**Mitigation Measures***
Operational Impacts: Discharge	Will Shell also do the zero harmful discharge in the Chukchi where whales migrate like the Beaufort Sea?	We will not do zero volume discharge, we will be doing a zero harmful discharge of our muds and cuttings. We have looked back at the past wells from the 80's and 90's and have not found any significant change to the ocean flora, etc.	L
Quality of Engagement: Positive/Feedback	When will Shell host more meetings in Wainwright? I've been hearing back from youth there that they see the potential opportunity for careers. I would like to see Shell involved with the schools.	Shell experts would like to come out the village schools and work with youth. We would be able to do that.	N/A
Positive/Feedback	Shell is getting close to developing a partnership with NSB. I have concern about having two rigs working at the same time. There are some challenges there. I continue to see OSPR, discharge, air etc. as issues that will continue to come up in your programs.	Thank you for your comment.	K and L
Value Proposition: Workforce Development	Wants us to expand our job opportunities outside of Marine Mammal Observers and Subsistence Advisor's and Communication and Call Center Operators.	Thank you for your comment.	N/A

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K-zero discharge of: drilling fluids and cuttings after the 26-in casing; gray and treated black waters; bilge and ballast waters

L-Enhanced blowout prevention and mitigation measures (i.e., second set of blind shear rams, increased frequency of BOP testing, redundant ROV hot stab panel, capping stack and containment system, and relief well plan with designated standby relief well drilling unit).

Science Accomplishments:

Aspects of the Shell science program that reflect input and requests from the North Slope Borough

Acoustic program in both the Chukchi and Beaufort

- Initiated in 2006 with CPAI & GXT
- Continued since that date with > $10 million expended
- Despite setbacks, this is one of the biggest acoustic monitoring programs globally
- Generated greater understanding of many marine mammal species including walrus and bowhead movements

Chukchi Sea aerial program

- 2006-2010 conducted aerial surveys within 25 miles of the Chukchi coast
- About $10 million expended to date
- The first to document walrus haulouts on the Alaska Chukchi coast
- Documented downcoast (Barrow to Wainwright) movement of migrating bowheads

Chukchi Sea Baseline studies

- 2008- 2010 added an extensive baseline program with CPAI, COMIDA, and others
- Includes – birds, mammals, plankton, benthos, contaminants, fishes, physical parameters
- Initiated following Mayor Itta's letter asking for baseline science
- > $15 million expended to date
- Greater clarity of the ecological drivers of the Chukchi ecosystem

Historic exploration well site evaluation

- Returned to Hammerhead (Beaufort) site in 2008
- Returned to Burger/Klondike (Chukchi) sites in 2009
- Evaluated contaminants issues and biological community structure

Cumulative impacts analysis

- Since 2006 Shell has taken the lead in documenting all industry activities and the results of all industry monitoring efforts in the offshore
- The reports have taken a multi-year/multi-activity approach reporting total ensonification areas and reporting on multiple activities.

Air monitoring stations

- 2008-2010 air monitoring stations at Reindeer Island and Wainwright

EXPLORATION PLAN

SHELL'S GOALS

To demonstrate that Shell does not cause undue or serious damage to the human, marine, or coastal environment, conforms to sound conservation practices, and is prepared to conduct exploration that is safe.

WHY PREPARE AN EXPLORATION PLAN?

To discuss and explain the various operative activities associated with drilling.

WHO REVIEWS THE EXPLORATION PLAN?

The North Slope Borough, potentially impacted communities, AEWC, marine mammal management groups, tribes, State of Alaska, and the federal government.

WHAT IS INCLUDED IN THE EXPLORATION PLAN?

- Description of drilling vessels, and associated vessels and equipment
- Location and timing of operations
- Proposed type and amount of discharges
- Oil spill prevention and response measures
- Analysis of direct and indirect environmental impacts
- Mitigation measures
- Health and safety measures
- Geologic information assessment of any hazards to drilling
- Permit applications

Exploration Plan Details

- Two EPs – Camden Bay EP in the Beaufort Sea and a Chukchi Sea EP
- Both are two year plans – starting in 2012
- Up to 2 wells per year in the Beaufort Sea
- Up to 3 wells per year in the Chukchi Sea, plus future well site work
- Noble Discoverer drillship and Conical Drilling Unit Kulluk
- Oil Spill Response capabilities on standby 24/7
- Crew change by helicopter – routes determined through coordination and communication
- Real time ice and weather forecasting
- Shorebase in Deadhorse, Barrow and Wainwright
- Robust marine mammal monitoring protocol
- Communications Plan to avoid conflicts with subsistence users
- Subsistence Advisors

SHELL'S GOALS IN ALASKA'S BEAUFORT & CHUKCHI SEAS OUTER CONTINENTAL SHELF

ENGAGEMENT PHILOSOPHY

Engage local residents and regulatory bodies to understand issues and concerns before design work is initiated

Utilize knowledge gained in design and operational feasibility studies, for example minimizing or mitigating the impact of a development.

Being a "good neighbor" to the residents of the North Slope, and all areas we operate within the state of Alaska.

COMMITMENT TO NORTH SLOPE RESIDENTS

Integrate cultural and environmental protection considerations into the planning, design, construction and operational phases of our potential oil and gas activities.

Improve communication to ensure full and meaningful dialogue with residents.

Consult with NSB and NWAB staff and village residents during the planning and design stages in order to blend traditional and contemporary local knowledge with exploration technology in an appropriate manner.

SHELL'S GOALS IN ALASKA'S NORTH SLOPE

To find and develop commercial hydrocarbon resources in the Beaufort and Chukchi OCS.

To support the community in benefiting from any potential offshore development both economically and socially.

To respect and enhance the way of life of the residents of the North Slope Borough and Northwest Arctic Borough.

OBJECTIVES

Discuss the possible infrastructure needed to make Beaufort and Chukchi OCS development a reality, should it occur.

Review the potential social and economic benefits associated with increased infrastructure and development of Shell leases in the Beaufort and Chukchi OCS.

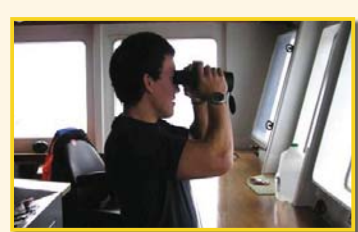
Discuss future engagement with the residents of the North Slope Borough and Northwest Arctic Borough.

EXPERIENCE & COMMITMENT

Shell has experience in Arctic and other ice-covered offshore regions. Traditional knowledge and assistance goes a long way in helping to ensure success.

POTENTIAL BENEFITS: JOBS & CAREERS

- Direct and indirect
- Local business contracting opportunities
- Workforce development and training



POSSIBLE INFRASTRUCTURE NEEDS

Sakhalin

WHY IS OFFSHORE INFRASTRUCTURE REQUIRED?

Many leases are more than 15 miles from shore

Longest land based reach to offshore sites is approximately 8 miles

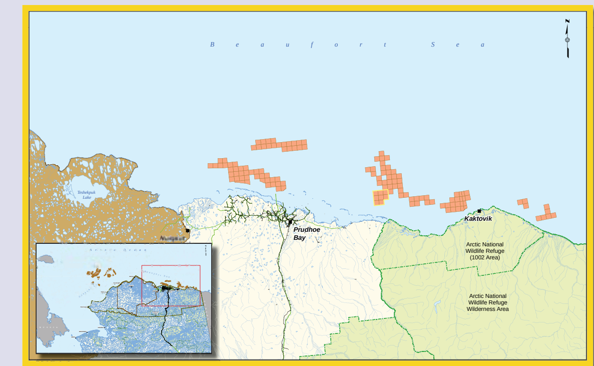
POTENTIAL BENEFITS: REVENUE

- Tax base from pipelines & support bases to address declining revenues
- Extending the life of TAPS and the pipeline tax base
- Additional infrastructure which could make other onshore fields economic and increase revenue

SOCIAL & CULTURAL INVESTMENTS

- Socio-economic studies
- Marine mammal studies
- Environmental studies
- Additional social and cultural investments

BEAUFORT SEA INFRASTRUCTURE: INITIAL DEVELOPMENT FOCUS



Camden Bay:
Initial focus is the 1985 discovery of Hammerhead/Sivulliq.

- 14 to 18 miles offshore
- Water depth 100 feet

Development of Sivulliq is dependent upon factors including:

- Seismic results
- Appraisal drilling results

CHUKCHI SEA INFRASTRUCTURE: INITIAL EXPLORATION FOCUS

The first public sale of leases in the Chukchi Sea since 1991 took place on February 6, 2008.

The Chukchi Sea Shelf is believed to hold up to 30 billion barrels ($4.8x10^9$ m^3) of oil and gas reserves.

- Lease blocks are more than 50 miles offshore
- Water depth 130-200 feet

ADDRESSING CHALLENGES THROUGH RESEARCH & DEVELOPMENT

Platform & vessel noise reduction to minimize impact to marine mammals

Production platform structure design to withstand ice loading

Oil spill prevention and response for development infrastructure

Vessel and platform re-supply

Offshore pipeline installation beyond landfast ice

Evacuation and rescue

FUTURE ENGAGEMENT: THE WAY FORWARD

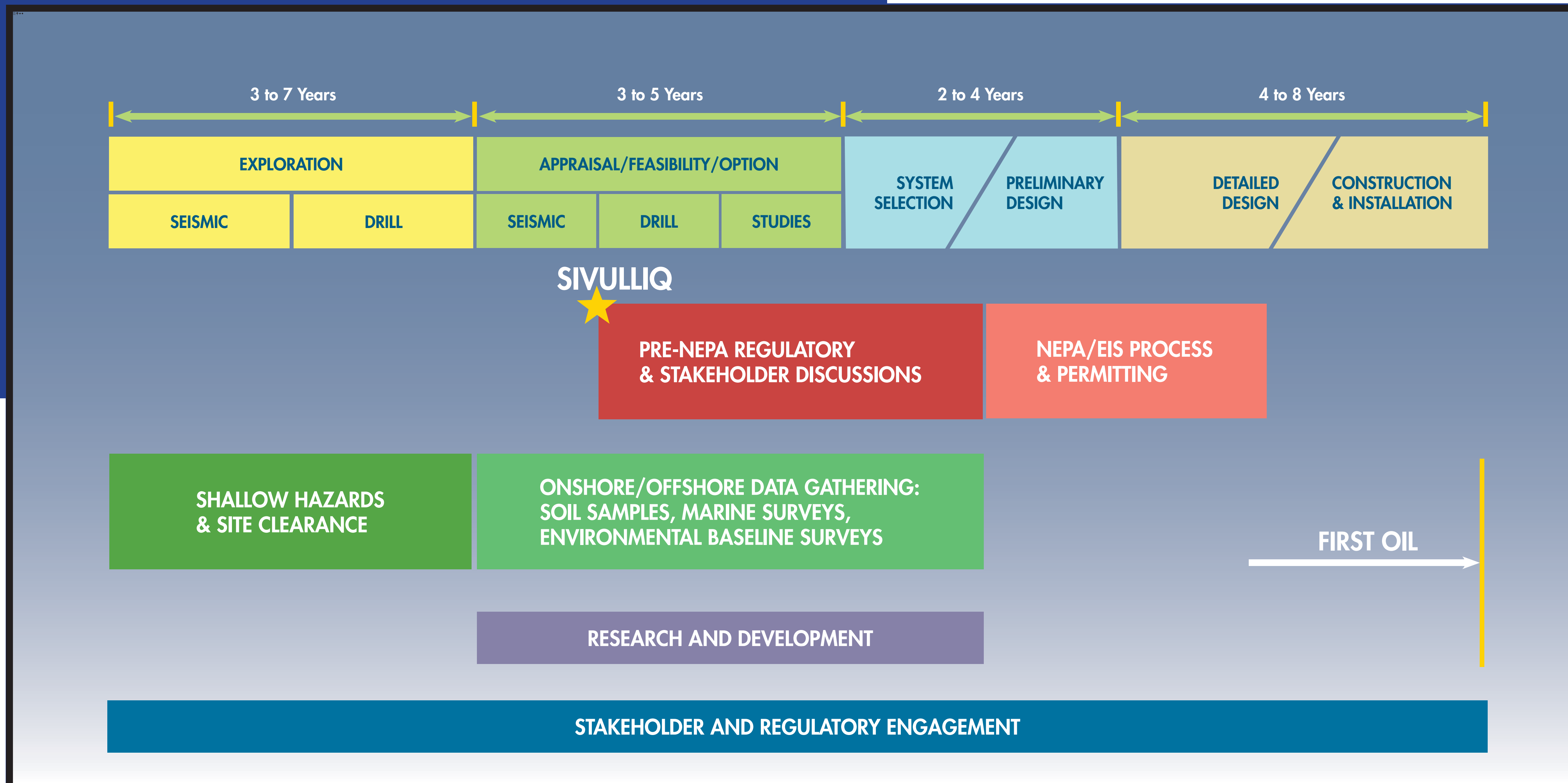
To succeed in meeting mutual goals, we must move forward together based on mutual respect and open dialogue:

- Discuss ideas on ways to engage, consult and work together;
- Validate our understanding of your concerns;
- Discuss issues, potential impacts and potential solutions & mitigation measures;
- Share ideas and feedback on economic development.

"It is clear, that substantial involvement of all potentially affected parties including Alaska Natives is a prerequisite for a successful approach to the development of Arctic OCS Oil and Gas."

–Environmental Information for Outer Continental Shelf Oil and Gas Decisions In Alaska by the National Research Council

Typical Offshore Development Timeline



Shell Camden Bay and Chukchi Sea Program Update

March 2011

Shell In Alaska

- 2011 Program
- 2012-2013 Proposed Exploration Plans

2011 Program

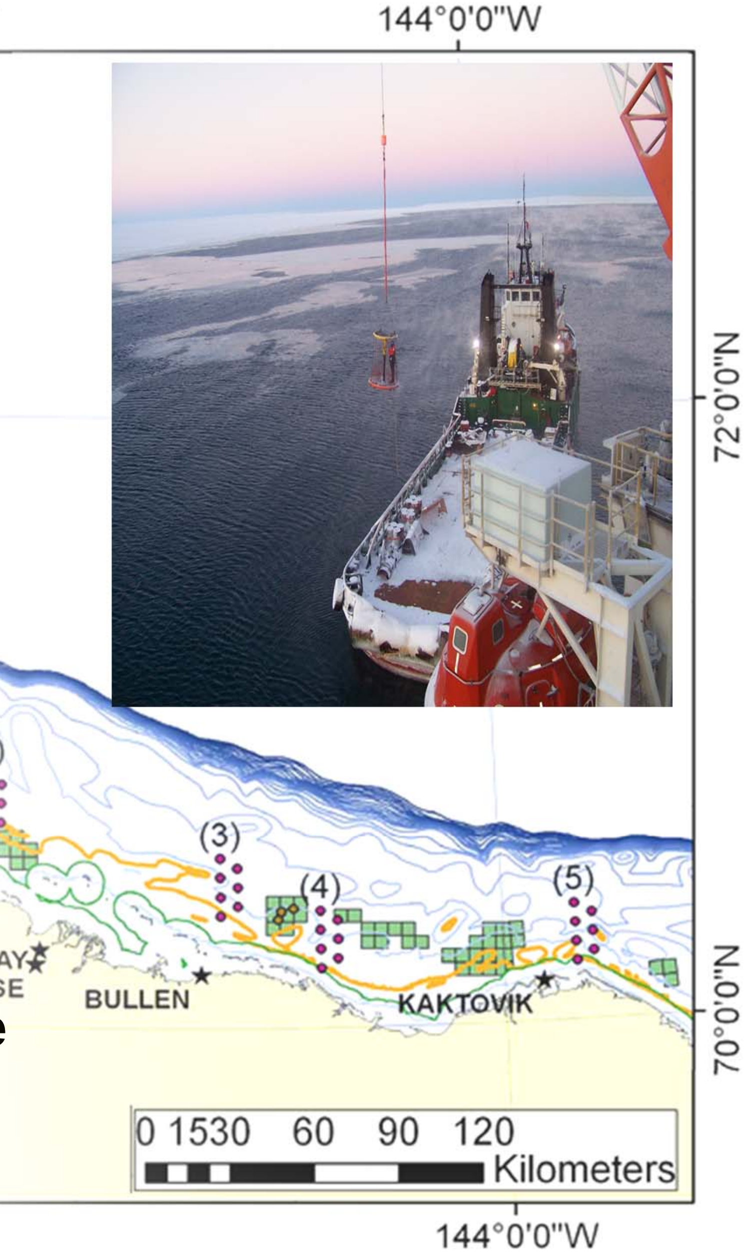
2011 Shell Proposed Operations

- **Shell 2011 program**:
  - Marine mammal monitoring to support operations
  - Non Shell operated Ecological science data gathering (offshore and onshore)
  - Com Centers and Subsistence
  - Advisors in Coastal Villages of North Slope:
    - Point Lay, Point Hope, Wainwright, Barrow, Deadhorse, Kaktovik, Nuiqsut

Science

Baseline Science Supports Exploration In Alaska

- **$500 Million and growing (Shell $50M)**
  - 5000 independent scientific studies since1973
  - 6 years of marine mammal monitoring
  - Tagging studies – walrus and seals
  - First air quality station in OCS – Beaufort
  - Ongoing offshore, nearshore, and onshore ecological characterization studies
  - Traditional knowledge studies
  - Health impact assessments



- **Up to $5 million annual science initiative with North Slope Borough**

Offshore, nearshore, onshore studies

- Marine Mammal
- Acoustic Recorders
- Ice & Metocean Buoys
- UAV Monitoring
- Stereo Photography
- Upward Looking Sonar
- Benthic Studies
- Sediment chemistry
- Current Meter
- Hydrology & Habitat Assessment
- Coastal Stability Studies
- Traditional Knowledge
- Bird Observations
- Fisheries Sampling
- Zooplankton
- Physical Oceanography

NSB Collaborative Science Agreement

- Objective: To enable community members in coastal villages of the Chukchi and Beaufort Seas to participate and prioritize science being conducted related to the potential effects and impacts of oil and gas exploration and development in the outer continental shelf (OCS).
- Signed Sept. 24, 2010
- Funded annually by Shell for an initial term of five years, and administered by the NSB Mayor's Office
- 14-Member Steering Committee
  - Coastal Villages
  - NSB Wildlife Department and Mayor's Office
  - Independent Scientists
  - Shell

2012-13 Proposed Exploration Plans

Chukchi and Beaufort Seas

2012-13 Proposed Operations

- Drill up to three wells per year in Chukchi Seas during open water drilling season (July-October)

- Drill up to two wells per year in Beaufort Sea during open water drilling season (July-October)

- Continuation of Shell's long-term ecological characterization offshore and onshore

Mitigation

Mitigation Shell has committed to

- Communication Plan for avoiding conflicts with subsistence users
- Collaboration and Communication with Whaling Associations, Walrus, Nanuq and Seal Commissions
- Capping and Containment system
- Commitment to hire Subsistence Advisors
- Marine Mammal Observers on all vessels
- Robust Marine Mammal Monitoring Protocol
- Real time Ice and Weather Forecasting
- Crew change by helicopter and collaboration on routes to and from operations
- Deadhorse, Wainwright and Barrow shore bases
- No transiting, including within polynya zone, without communicating
- Relief rig capabilities

Prevention and Response

Commitments

- **Prevention Is the First Priority and Can Be Accomplished**
- **BOP – testing and enhancements**
  - **Testing every 7 days instead of every 14 days**
  - **Use of second set of shear rams**
  - **Sub-sea remote operating panel relocation**
  - **ROV/Diver options on and near site**

- **Arctic Cap and Containment System**
- **Full OSR capabilities for each sea**
- **Second rig relief well capability**

Alaska Arctic Cap and Containment System

New and Traditional Oil Spill Contingency Planning

Shell Oil Spill Response Goals

- Immediate Onsite Response
- Latest Technology
- Flexible Environmental Response Capability
- Sustained Response

Arctic Response Options

Offshore:

Mechanical

In-situ Burning

Dispersants
(under select conditions)

Nearshore:

Mechanical

In-situ Burning

Onshore:

Mechanical

In-situ Burning







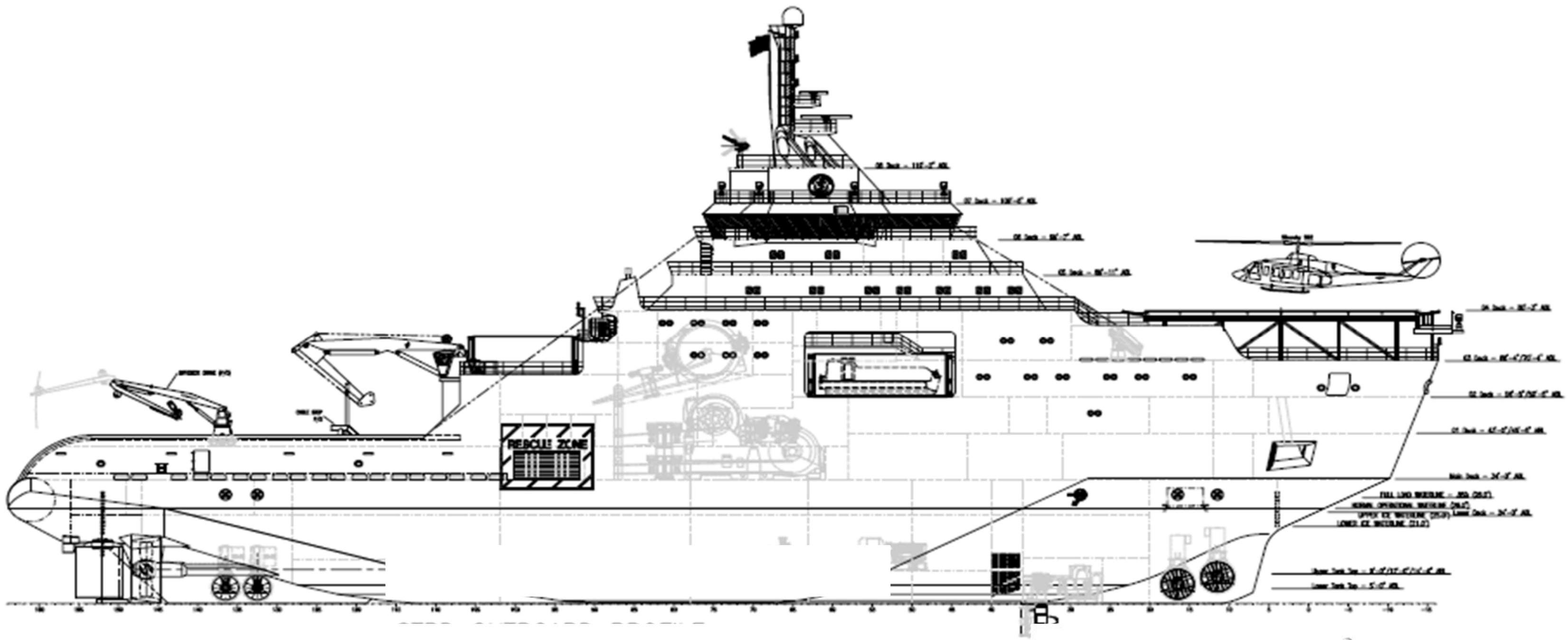

Nanuq

- Multi-Purpose Vessel
  - Spill Response;
  - Onsite Command Center;
  - Anchor Handling;
  - Ice Management; and
  - Supply
- Ice Class A1 Vessel
- Dynamic Positioning Capability
- Full support for up to 41 crew and responders
- 2 Lamor LSC-5 Brush Skimmers & Power Packs
- Staging and Deployment of Boom-tending Work Boats
- Onboard storage: >12,000 bbl
- Rapid Transit for lightering recovered oil
- High Volume, Viscous Oil Lightering capability

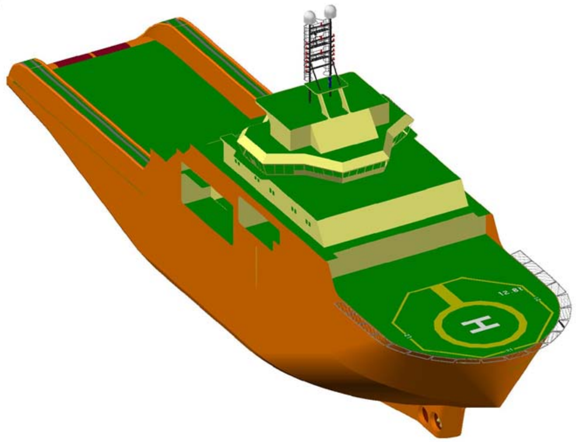
Arctic Endeavor

- Dedicated Oil Spill Response Barge with Tug Assist
- Ice Strengthened
- Onboard Field Command and Communications Center
- 2 Lamor LSC-5 Brush Skimmers & Power Packs
- Staging and Deployment of Boom-tending Work Boats and 249-bbl barges
- Staging and Deployment of 47’ Skimmer with built-in Brush Skimmers
- Onboard storage: >18,000 bbl
- High Volume, Viscous Oil Lightering capability

Hull 247



- Length Overall – 360’ (110m)
- Beam – 80’ (24.4m)
- Draft – 26’ (normal)
- Anchor Handling Backup
- Polar Ice Classed
- High POB for contingency response
- Storage Capacity: 8,000 bbl



Mechanical Recovery

Lamor Brush

TransRec 150

Ocean Buster

47’ Kvichak w/ brush skimmer

Small Over-the-Side Skimmers

Rope Mop skimmer

Harsh Weather Operations

Brent 'B' production platform photographed in stormy weather.

The photograph shows the ferocity of the wind and waves during a storm in the North Sea. Winds of more than 100 mph produced waves reaching up to the **underside of the deck which is 75 ft above sea level**. Platform on calm day shown at bottom.

Ice Against Platform Legs - video

Thank You

END OF PRESENTATION

Attachment C
Chukchi Sea Communication Plan

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COMMUNICATION PLAN
EXPLORATION DRILLING PROGRAM
CHUKCHI SEA, ALASKA

The following Communication Plan will be used during each exploration drilling season to coordinate activities with local subsistence users, including the Alaska Eskimo Whaling Commission (AEWC), Alaska Eskimo Walrus Commission (AWC), Alaska Nanuuq Commission (ANC), Alaska Beluga Whale Committee (ABWC), Ice Seal Committee (ICS), and village Whaling Captains Associations (WCA). Each planned drilling season in the Chukchi Sea will begin with transit through the Bering Strait into the Chukchi Sea on or after July 1, then on location at a drill site on or about July 4 and end on or about October 31.

The Communications Plan will be implemented in two phases. Phase I describes the guidelines already in place to ensure proper communication during the drilling season. Phase II describes what to do in the event Shell Gulf of Mexico Inc. (Shell) activities potentially affect subsistence activities and how to keep subsistence user groups informed of Shell activities. Phase I and II are designed to minimize the potential for interference of Shell activities with subsistence activities and resources and to keep operators up-to-date regarding the timing and status of the beluga and bowhead whale migrations in the Chukchi Sea as well as the timing and status of other subsistence hunts.

Drilling program operations will be performed in compliance with all applicable permits and authorizations, including the Plan of Cooperation, Letter of Authorization per U.S. Fish & Wildlife Service, Incidental Harassment Authorization per National Marine Fisheries Service and Lease Stipulation 5 from Lease Sale 193 per Bureau of Ocean Energy Management, Regulation and Enforcement.

PHASE I

- Shell will fund the operation of Communication and Call Centers (Com Centers) in the coastal villages to enable communications between Shell operations and vessels, local subsistence users, and Subsistence Advisors (SAs), thereby notifying the subsistence community of any vessel transit route changes and avoiding conflicts with subsistence activities.
- Marine Mammal Observers (MMOs) will be onboard exploration drilling-related vessels with responsibilities to: monitor for the presence of marine mammals, assist with the maintenance of marine mammal safety radii around vessels, monitor and record avoidance or exposure behaviors, and communicate with the Com Centers and local subsistence hunters by marine radio.
- If a conflict arises with offshore activities, the MMOs will immediately contact the vessel captain and the Com Centers. The Com Centers will then contact Shell's simultaneous operations emergency response team. If avoidance is not possible, the next phase will

include communication between a Shell representative and a representative from the impacted subsistence hunter group(s) to resolve the issue and plan an alternative course of action by either industry or the subsistence groups.

- Shell will employ local SAs from the Chukchi Sea villages to provide consultation and guidance regarding the affected species migration, the subsistence hunt, and other subsistence activities. The SAs will work approximately 8 hours per day and 40-hour weeks through each drilling season. Responsibilities of the SAs will include: reporting any subsistence concerns or conflicts, within 4 hours if the conflict appears imminent, to the Com Centers (who will then contact Shell's simultaneous operations emergency response team); coordinating with subsistence users to advise on location and timing of Shell's activities; reporting subsistence-related comments, concerns, and information to Shell staff; and, advising Shell how to avoid subsistence conflicts and subsistence users. A SA handbook will be developed and provided to each SA. The handbook will outline contact numbers, communication procedures, and communication timelines for reporting and communicating potential conflict situations.
- Helicopter traffic flight restrictions will be in place to prohibit aircraft from flying within 1,500 ft (457 m) of marine mammals or below 1,500 ft (457 m) altitude, (except during takeoffs and landings, in emergency situations or for MMO overflights), while over land or sea. If flights need to deviate from this path due to emergency landings or other unavoidable reasons, the new flight information will be immediately shared, as outlined by Shell Health, Safety, Security and Environment requirements, with Com Centers so area subsistence users can be notified.
- Regular overflight surveys and support vessel surveys for marine mammals will be conducted to further monitor prospect areas and identify areas currently being used for subsistence activities to avoid potential conflicts with users.
- To minimize impacts on marine mammals and subsistence hunting activities, the drillship and support vessels traversing north through the Bering Strait will transit through the Chukchi Sea along a route that 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 move into the polynya zone far enough so that ice breaking is not necessary. If it is necessary for any vessel to move into the polynya zone, Shell will notify the local communities of the change in the transit route through the Com Centers.

PHASE II

All guidelines in Phase I will be adhered to in addition to the following:

- If potential conflicts are identified between Shell activities and subsistence activities; the Com Center Action Plan will be used to manage the issue.
- Shell will continue with engagements and regular communications with the AEWC, AWC, ANC, ABWC, ISC, and the WCAs of Barrow, Wainwright, Point Lay and Point Hope once transiting of vessels begins through Chukchi Sea, during drilling activities, and during mobilization from the Chukchi Sea.

Attachment E
Analysis of the Probability of an "Unspecified Activity" and Its Impacts: Oil Spill

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4.3 Analysis of the Probability of a Very Large Oil Spill and Potential Associated Impacts

To prepare for an unlikely, unplanned well control event, Shell's revised Chukchi Sea EP considers a worst case discharge (WCD) planning scenario based upon a site-specific calculated WCD following the guidance of BOEMRE's NTL-06 and 30 CFR 250.213 (g). The site-specific WCD is built upon the characteristics of prospective hydrocarbon-bearing reservoirs through the proposed total depth of the wells to be drilled at the Burger prospect in the revised Chukchi Sea EP. The legacy Burger #1 well supplied most of the reservoir characteristics and conditions required as input to calculate a WCD; thus there is much less uncertainty in the results of this calculation than for an undrilled prospect with speculative reservoir and subsurface conditions. This site-specific WCD calculation, which follows BOEMRE's NTL-06 guidance, resulted in a WCD estimate of 23,100 bopd. Based on this calculated value, Shell has elected to plan for a WCD of 25,000 bopd. This WCD is used in a corollary very large oil spill (VLOS) impacts analysis prepared for the revised Chukchi Sea EP. This VLOS scenario assumes the WCD event; however, unlikely, has occurred and the robust response assets of Shell's Chukchi Sea Regional Exploration ODPCP are onsite in the Chukchi Sea, in response mode within one hour, and beginning recovery of released oil from the WCD event. Shell's WCD and VLOS scenario also includes consideration of the deployment of Shell's oil spill response assets in Alaska, including the availability of both primary and secondary relief well drilling vessels, both in Alaska, and Shell’s capping stack and containment system. In Shell's WCD scenario, the greatest length to which a WCD event extends is 38 days as described in the revised Chukchi Sea EP.

BOEMRE's very large oil spill (VLOS) analysis being prepared for the supplemental EIS for Chukchi Sea OCS Lease Sale 193 uses BOEMRE's own hypothetical blowout and very large discharge (VLD) from a hypothetical candidate prospect with maximized geological characteristics for the highest flow rate for the entire Chukchi Sea OCS Lease Sale Planning Area, rather than being site-specific to the Burger Prospect. Characteristics of BOEMRE’s WCD scenario bear little resemblance to Shell's proposed activities. While subsurface characteristics at the Burger Prospect have been previously determined by exploration drilling, subsurface characteristics of BOEMRE’s WCD scenario are speculative. Subsurface characteristics of BOEMRE’s WCD scenario were not observed in the Burger #1 well and cannot reasonably be expected to be encountered by further exploration drilling to the same objective horizon at a similar depth as the prior exploration well. BOEMRE's VLD scenario assumes an initial flow rate of > 60,000 bopd, a rate 2.6 times higher than the 23,100 bopd calculated for Shell's Burger Prospect. BOEMRE's VLD analysis includes no assumptions for effective oil recovery, collection, or containment, or potential capping of the WCD well occurring during the entirety of a WCD event. BOEMRE’s VLD analysis assumes in the best case the hypothetical blowout well is controlled by Day 39 with a relief well drill and kill, and in the worst case assumes 74 days is required because the operator does not have a relief well drilling vessel in the Alaska theatre at the time of the WCD event (unlike Shell's revised Chukchi Sea EP), but must wait 30 days before the relief well rig arrives. Shell’s revised Chukchi Sea EP includes both primary and secondary relief well drilling vessels which could control a Burger Prospect blowout in 34 to 38 days, respectively. Furthermore, since BOEMRE’s hypothetical VLD scenario assumes such an overtly high initial flow rate, even in their best case for timing to kill the blowout (39 days), it assumes more than double the cumulative oil (1,384,000 bbl) has been released in to the environment compared to the amount of Shell’s site-specific analysis (34 days; 603,564 bbl). All of these factors lead to a cumulative oil discharge from BOEMRE's VLD that is being considered in the VLOS in BOEMRE's SEIS that greatly exceeds Shell's WCD analysis, conducted pursuant to BOEMRE's own NTL-06 guidance and promulgating regulation, with respect to oil spill rate and total volume, release duration, and length of time for relief well drill and kill.

Oil and gas exploration activities, such as those proposed in Shell's revised Chukchi Sea EP, carry the 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, as discussed in Section 2.10, the most likely spill to occur during the activities in the revised Chukchi Sea EP would be a spill of approximately 48 bbl resulting from a refueling operation. This conclusion is consistent with BOEMRE's prior findings when analyzing the likelihood of various kinds of spill impacts. Accordingly, the impacts of a 48 bbl spill on existing environmental resources were evaluated in Section 4.1. As analyzed for each potentially affected resource throughout Section 4.1 above, the impacts of a 48 bbl spill resulting from a refueling operation are expected to be localized and fleeting, and would not be significant.

A VLOS is defined by BOEMRE as a release of 150,000 bbl or more. A VLOS is not a reasonably foreseeable effect of this planned exploration project. However, BOEMRE (MMS 2003a) has analyzed the impacts of a VLOS in the Arctic Ocean in several overarching NEPA documents. In its *Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 Final Environmental Impact Statement* (2003 Multi Sale EIS), BOEMRE analyzed the impacts of a 180,000 bbl VLOS from a hypothetical blowout in the Beaufort Sea. BOEMRE concluded that such a spill would be rare, but that, if it occurred, it could have significant impacts on certain environmental resources. BOEMRE analyzed potential trajectories of a spill and considered the impacts of a spill in various ice conditions.

In its *Chukchi Sea Oil and Gas Lease Sale 126 Final Environmental Impact Statement* (Lease Sale 126 EIS), BOEMRE (MMS 1990b) assessed the potential impacts of a VLOS in the Chukchi Sea consisting of a 160,000 bbl crude oil spill from a hypothetical pipeline in the Chukchi Sea, and multiple large crude oil spills of 22,000 bbl. BOEMRE (MMS 2007b) also recently analyzed potential impacts associated with possible large 4,600 bbl crude oil spills from pipelines in the Chukchi Sea in its *Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea* (Lease Sale 193 EIS).

The detailed impact analyses of the 2003 Multi-Sale EIS, Lease Sale 126 EIS, and Lease Sale 193 EIS provide decision-makers with useful information on the anticipated impacts of a VLOS from a given project, and the analyses are directly applicable to the revised Chukchi Sea EP. Application of the impact analyses in the 2003 Multi-Sale EIS, Lease Sale 126 EIS, and Lease Sale 193 EIS, to the activities in the revised Chukchi Sea EP provides a site-specific analysis of the potential impacts of a VLOS resulting from the revised Chukchi Sea EP. The Ninth Circuit has approved of the use of existing NEPA analyses on spill impacts when the analysis covers the area at issue. When BOEMRE prepared its EA of the Shell Gulf of Mexico Inc. Exploration Plan 2010 Exploration Drilling Program Chukchi Sea, Alaska (2010 Chukchi Sea EA), the agency incorporated the analysis in the 2003 Multi-Sale EIs by reference, stating that there were no site-specific anomalies associated with the Chukchi Sea drill site locations. Drill sites in the revised Chukchi Sea EP are in the same general area (launch area) as the drill sites evaluated in the EA for the 2010 Chukchi Sea EP (Table 1.a-1). Although the oil spill resulting from the Macondo 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. The existing analyses of VLOS impacts in these NEPA documents illustrate the reasonably foreseeable impacts from a VLOS resulting from this exploration drilling program, and are incorporated by reference in the impact analysis provided below.

The following subsections:

- provide a discussion and analysis of the probability associated with a VLOS;
- describe the location, volume, timing of a possible VLOS;
- describe the fate and affect of the possible VLOS;
- provide an analysis of the probabilities of the VLOS reaching offshore and coastal resources; and
- provide an analysis of the potential effects the VLOS could potentially have on physical, biological, and socioeconomic resources

4.3.1 Probability of a VLOS Occurring

A well blowout (loss of well control) is of greatest concern with regard to oil spill risk analysis due to the potential for a large release of liquid hydrocarbons; however, BOEMRE (MMS 2003a) has concluded that the risk is low of a blowout event occurring and impacting the environment. No blowouts have occurred as a result of the 98 exploration wells drilled within the Alaskan OCS to date (MMS 2007a). Thirty-five of these exploration wells were drilled in the Chukchi and Beaufort Seas from 1982 to 2003. 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).

The EA BOEMRE prepared for the Beaufort Sea (MMS 2007a) 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 [159 m^3]) occurred during exploration drilling well blowouts from 1971 to 2005. But only four of these blowouts resulted in crude oil reaching the environment, with volumes of 200, 100, 11, and 0.8 bbl (31.8, 16, 1.8, 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).

Looking at data specific to Alaska and the Arctic OCS, 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 for Northstar of a spill greater than 130,000 bbl (20,668 m^3) 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. Because 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 m^3).

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 m^3) 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

[2] The wells planned under this revised Chukchi Sea EP are not deepwater wells. Nevertheless, 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).

production drilling frequency distributions. For exploration wells drilled in analogous water depths to the planned Chukchi Sea exploration wells, at 143-150 ft (43.7-45.8 m), Bercha (2008) predicted an adjusted frequency of 0.000612 per well for a blowout sized between 10,000 bbl (1,590 m^3) to 149,000 bbl (23,689 m^3) and 0.000354 per well for a blowout greater than 150,000 bbl (23,848 m^3). Based on these data, the risk of a blowout resulting in the release of a VLOS associated with Shell's exploration drilling program is extremely low.

4.3.2 Characteristics of a Possible VLOS

It is important to note two differences between the following analysis and BOEMRE's oil spill impact analyses included in prior NEPA documents. First, this analysis addresses a release, which while extremely unlikely, could possibly occur from one of the wells planned in this revised Chukchi Sea EP. The rate and total volume that are assessed are based on the best available information regarding the oil and gas potential specifically of the planned wells, whereas BOEMRE analyzes releases from hypothetical wells from different areas and geological formations. Second, the following analysis incorporates a realistic oil spill scenario, including immediate response and containment as planned in this Chukchi Sea EP, while BOEMRE's analyses do not consider containment or cleanup. The VLOS considered in this impact analysis is based on a subsea release of crude oil resulting from a blowout of an exploration well, with the following additional assumptions.

Location and Timing

Shell has identified six drill sites within the Burger Prospect. A well at one of these drill sites, the Burger J drill site, has been identified as having the highest calculated WCD flow rate and total volume. For this analysis we assume a crude oil blowout at the Burger J drill site. The location of the Burger J drill site is indicated in Figure 1.0-1 and Figure 2.0-1. The drill site is located more than 64 mi (103 km) from shore in a water depth of approximately 150 ft (45.8 m).
The exploration drilling program outlined in the revised Chukchi Sea EP commences in early July and ceases on or before 31 October. For this impact analysis we assume a date of 1 August for the blowout scenario.

Volume

Regardless of the discharge source, or the low probability of a VLOS occurring, Shell's Chukchi Sea ODPCP response scenario must address the potential immediate release of crude oil to the environment by a loss of well control during the exploration drilling season. The rate and volume for the VLOS were based on the planning scenario WCD provided in the Section 2.10 of the revised Chukchi Sea EP, which considers a release of crude oil at 25,000 bopd (3,975 m^3/day) for 30 days, totaling 750,000 bbl (119,237 m^3) of oil. This volume exceeds the calculated WCD for the Burger J drill site. Shell's ODPCP demonstrates access to sufficient equipment and personnel needed to respond to a well blowout with this flow rate and total volume.

Description of the volume of the VLOS considered in this impact analysis was further refined by considering the volume of the released crude oil from the assumed blowout that might escape containment and recovery and therefore further affect the environment. The blowout scenario developed for oil spill response planning and the ODPCP and provided in Section 8.0(d) of the revised Chukchi Sea EP. Based on the WCD planning blowout scenario in Shell's regional ODPCP, we assume no containment and recovery for the first hour, 90 percent containment and recovery for the following five days, and 95 percent containment and recovery for the remainder of the event. Considering the above-described efficiencies, the total volume of crude oil that would be released, escape containment and recovery, and spread on the water surface over the 34 days is estimated to be 55,000 bbl.

Crude Oil Characteristics

For this analysis we assumed the release (VLOS) would be a crude oil with an API gravity of 30. This is a medium weight crude and typical of an Alaska North Slope crude oil.

Spreading of the VLOS

As soon as the oil is released into environment it would begin to spread and its properties would start to change though processes collectively known as weathering. Some of the oil would disperse into the water column while still rising to the surface. Once on the surface the oil would spread across the surface forming a slick, and the oil in the slick would be subject to additional dispersion and to evaporation as well as other weathering processes. NOAA's ADIOS 2 oil weathering model was used to predict behavior of Alaska North Slope oil with an API gravity of 30 under the environmental conditions specified in the ODPCP, which include an average 10 knots wind, and an August air temperatures of 34 to 46 ºF (1 to 8 ºC). ADIOS 2 incorporates a database with the characteristics of more than a thousand crude oils and refined products, and provides quick estimates of the expected characteristics and behaviors of oil spilled into the marine environment. The modeling results indicate that the VLOS would lose up to 25 percent of its volume due to evaporation. An additional 5 percent would likely be removed by dispersion of oil into the water column, but a much higher dispersion rate would occur in higher wind and wave conditions than were assumed, or in the case of a turbulent blowout with high gas concentrations.

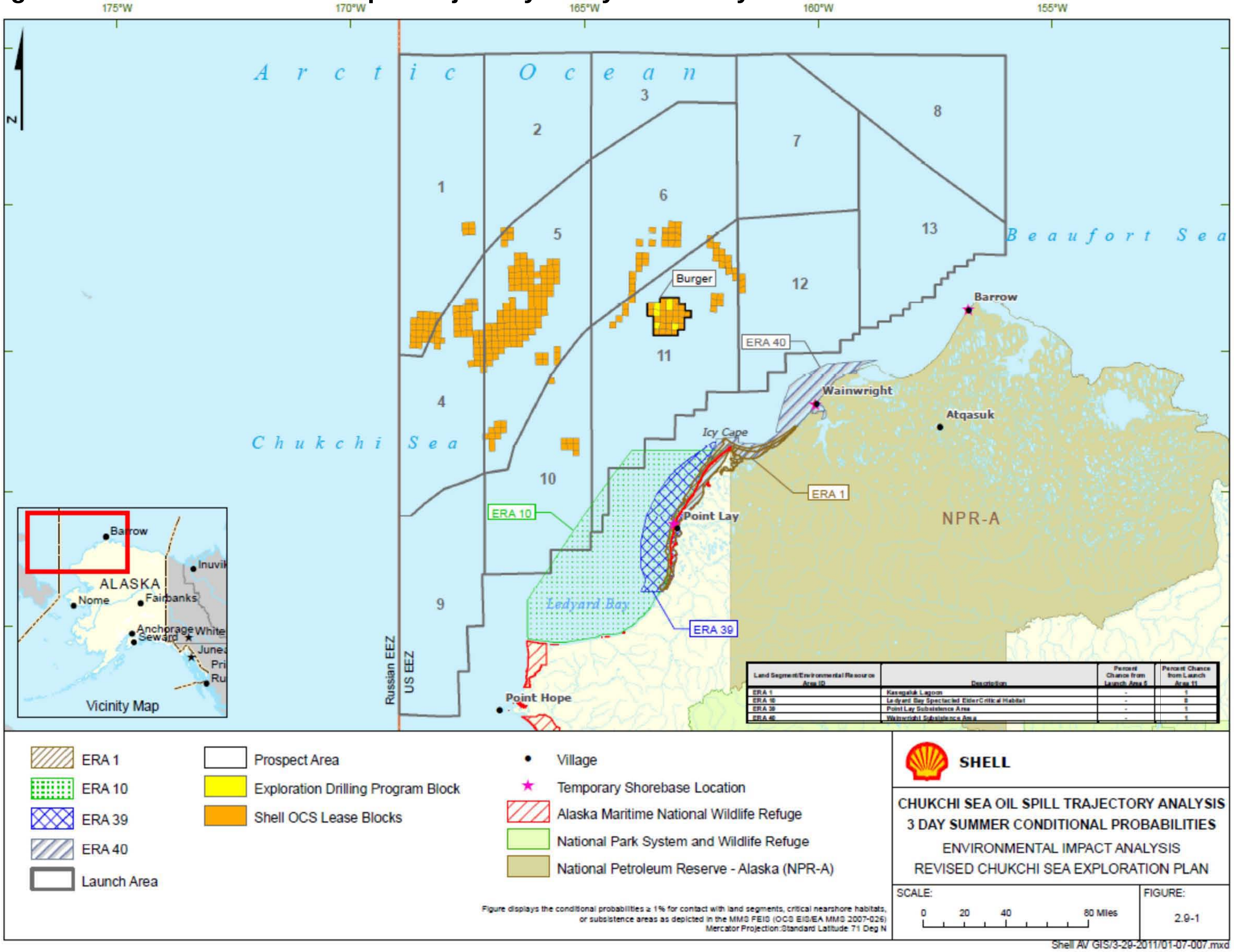
This volume would not spread uniformly; thickness would vary greatly throughout the slick. A portion of this oil may emulsify. The oil slick would also likely not be continuous, breaking into patches and windrows under the influence of waves or zones of convergence and divergence. In this case separate smaller oil slicks with variable thickness would be separated by areas of open water. An average thickness of an Alaska North Slope oil slick released under open water in arctic conditions was assumed to range from 0.01-0.1 in. (0.025-0.25 cm). Using an average thickness of 0.01 in. (0.025 cm) and therefore an average coverage of 6.5 bbl/ac of oil, we conservatively estimated the VLOS oil slick would encompass about 9,000 ac (36.4 km^2). With 30 percent loss due to evaporation and dispersion, the oil volume remaining on the surface after the 34 days required to drill a relief well and kill flow would be approximately 38,200 bbl (6,073 m^3).

Potentially Affected Areas

The Lease Sale 193 EIS (MMS 2007b), includes an analysis of how and where offshore oil spills would move within the Chukchi Sea using a computer trajectory simulation model. Simulations were performed using a computer model called the Oil Spill Risk Analysis (OSRA). The simulation model uses wind, ice, and ocean-current information for winter and summer seasons and annual conditions derived from a variety of sources including field and satellite observations and calculated conditions. Ocean current data used for trajectory modeling is based upon BOEMRE's annual means analysis of Haidvogel et al. (2001) coupled ice-ocean model. Thousands of trajectory simulations were run for hypothetical spill launch locations distributed through the Lease Sale 193 Area. The trajectory runs simulate the movement of oil without consideration of oil spill containment, control, or recovery actions. The trajectory model provides conditional probabilities that oil spilled from a hypothetical launch area will contact a specific land segment or environmental resource area within a given time frame.

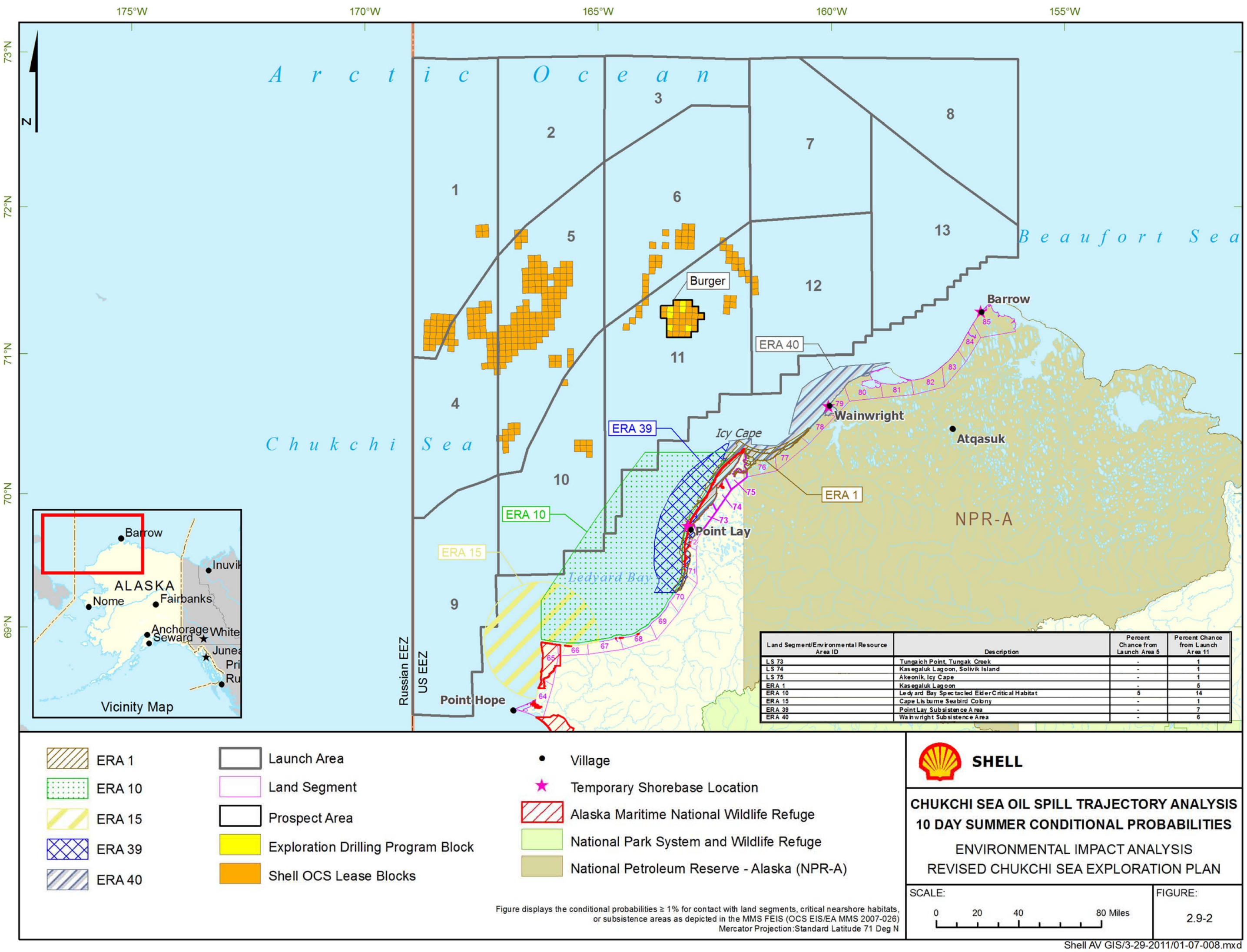
Conditional probabilities derived from the OSRA model are expressed as the chance of a ≥1,000 bbl (≥159 m^3) spill originating from Launch Areas (LA) 1 − 13 contacting Environmental Resource Areas (ERAs) or Land Segments (LS) with given time frames (3, 10, 30, 60, 180, and 360 Days). The assumed site of the VLOS release is located in LA 11 (Figures 4.3-1 through 4.3-3). The summer conditional probabilities as estimated by BOEMRE (MMS 2007b) for the spill reaching land and Environmental Resources Areas (ERAs) within 3 days, 10 days and 30 days are presented in Table 3.0-4. The locations of the LA and ERAs are indicated in Figures 4.3-1 through 4.3-3. These time frames are presented because this would be the critical period when response resources are mobilized and containment and recovery operations implemented to counteract a major oil spill.

Figure 4.3-1 Chukchi Sea Oil Spill Trajectory Analysis – 3 Day Summer Conditional Probabilities



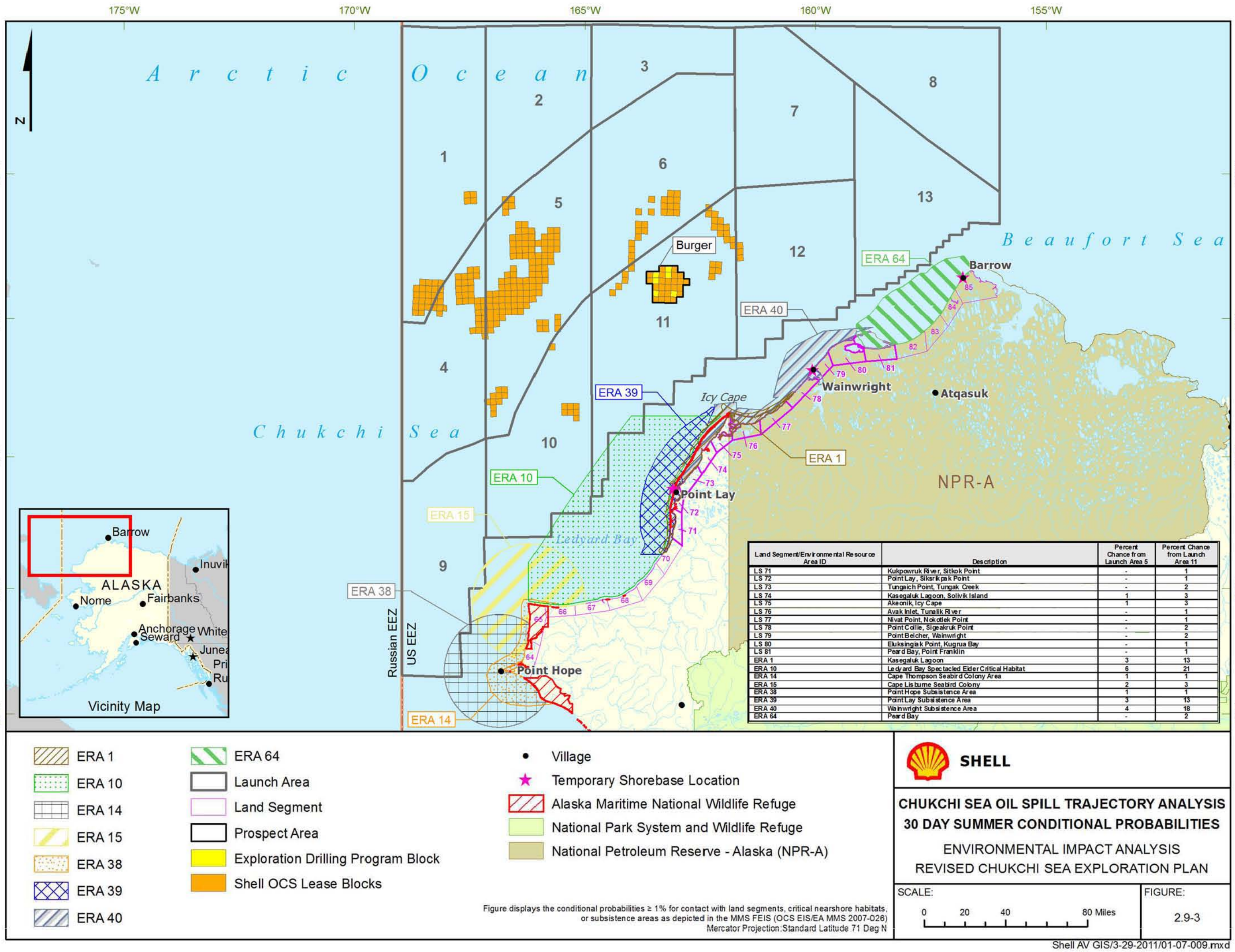
Land Segment/Environmental Resource Area ID	Description	Percent Chance from Launch Area 5	Percent Chance from Launch Area 11
ERA 1	Kasegaluk Lagoon	-	1
ERA 10	Ledyard Bay Spectacled Eider Critical Habitat	-	8
ERA 39	Point Lay Subsistence Area	-	1
ERA 40	Wainwright Subsistence Area	-	1

Figure 4.3-2 Chukchi Sea Oil Spill Trajectory Analysis – 10 Day Summer Conditional Probabilities



Land Segment/Environmental Resource Area ID	Description	Percent Chance from Launch Area 5	Percent Chance from Launch Area 11
LS 73	Tungaich Point, Tungak Creek	-	1
LS 74	Kasegaluk Lagoon, Solivik Island	-	1
LS 75	Akeonik, Icy Cape	-	1
ERA 1	Kasegaluk Lagoon	-	5
ERA 10	Ledyard Bay Spectacled Eider Critical Habitat	5	14
ERA 15	Cape Lisburne Seabird Colony	-	1
ERA 39	Point Lay Subsistence Area	-	7
ERA 40	Wainwright Subsistence Area	-	6

Figure 4.3-3 Chukchi Sea Oil Spill Trajectory Analysis – 30 Day Summer Conditional Probabilities



Land Segment/Environmental Resource Area ID	Description	Percent Chance from Launch Area 5	Percent Chance from Launch Area 11
LS 71	Kukpowruk River, Sitkok Point	-	1
LS 72	Point Lay, Siksrikpak Point	-	1
LS 73	Tungaich Point, Tungak Creek	-	2
LS 74	Kasegaluk Lagoon, Solivik Island	1	3
LS 75	Akeonik, Icy Cape	1	3
LS 76	Avak Inlet, Tunalik River	-	1
LS 77	Nivat Point, Nokotlek Point	-	1
LS 78	Point Collie, Sigeakruk Point	-	2
LS 79	Point Belcher, Wainwright	-	2
LS 80	Eluksingiak Point, Kugrua Bay	-	1
LS 81	Peard Bay, Point Franklin	-	1
ERA 1	Kasegaluk Lagoon	3	13
ERA 10	Ledyard Bay Spectacled Eider Critical Habitat	6	21
ERA 14	Cape Thompson Seabird Colony Area	1	1
ERA 15	Cape Lisburne Seabird Colony	2	3
ERA 38	Point Hope Subsistence Area	1	1
ERA 39	Point Lay Subsistence Area	3	13
ERA 40	Wainwright Subsistence Area	4	18
ERA 64	Peard Bay	-	2

Table 4.3-1 Summer Conditional Probabilities of a Large Spill Starting at Launch Area 5 or Launch Area 11 Contacting Certain Land Segments and Environmental Resource Areas [1]

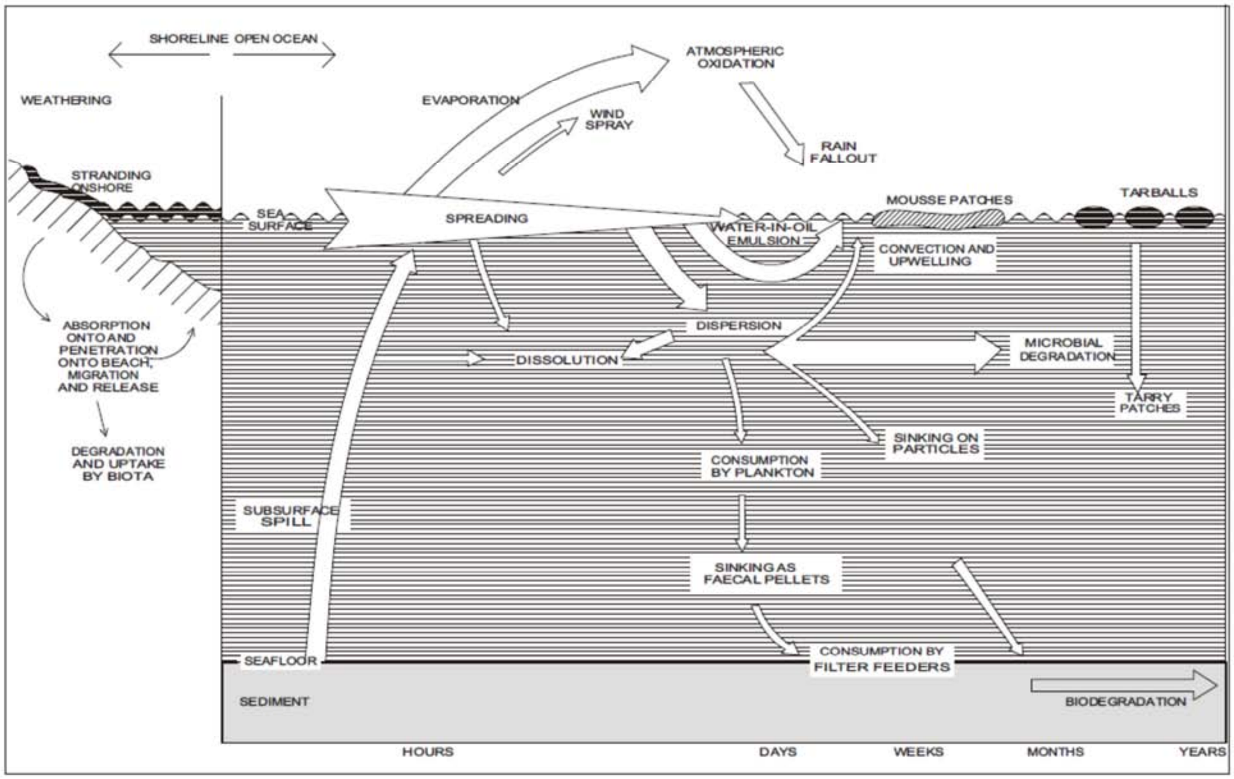
ID [3]	Resource	3 Days (%) [2]	10 Days (%) [2]	30 Days (%) [2]
		LA 11	LA 11	LA 11
Land	Land	-	5	19
LS 71	Kukpowruk R. - Sitkok Pt.	-	-	1
LS 72	Pt Lay – Sisrikpak Pt.	-	-	1
LS 73	Tungaich Pt - Tungak Creek	-	1	2
LS 74	Kasegaluk Lagoon - Solivik Island	-	1	3
LS 75	Akeonik - Icy Cape	-	1	3
LS 76	Avak Inlet - Tunalik R.	-	-	1
LS 77	Foggy Is. Bay	-	-	1
LS 78	Nivat Pt – Nokotlek Pt	-	-	2
LS 79	Pt Belcher - Wainwright	--	-	2
LS 80	Eluksinglak Pt - Kugrua Bay	-	-	1
LS 81	Peard Bay - Pt Franklin	-	-	1
ERA 1	Kasegaluk Lagoon	1	5	13
ERA 10	LBCHU	8	14	21
ERA 14	Cape Thompson bird colonies	-	-	1
ERA 15	Cape Lisburne bird colonies	-	1	3
ERA 38	Pt Hope Subsistence Area	-	-	1
ERA 39	Pt Lay Subsistence Area	1	7	13
ERA 40	Wainwright Subsistence Area	1	7	18
ERA 64	Peard Bay	-	-	2

[1] Source : MMS 2007b
[2] Probability of <0.5 % denoted by (-);
[3] LS = Land Segment, ERA = Environmental Resource Area, LA = Launch Area Burger Prospect in LA 11.

Behavior and Fate

Discussions of the behavior and fate of crude oils in the Arctic Ocean are provided by BOEMRE in the Multi-Sale EIS, the Lease Sale 193 EIS, and the Lease Sale 126 EIS, and are summarized and applied to the VLOS as follows. The generalized fate of summer oil spills in the Arctic is portrayed in Figure 4.3-4. Once released at the wellhead, natural processes would begin to physically, chemically, and biologically aid the degradation of the oil (NRC 2003). The physical processes involved include evaporation, emulsification, and dissolution, while the primary chemical and biological degradation processes include photo-oxidation and biodegradation (i.e., microbial oxidation).

After the VLOS spreading would begin. The oil would spread horizontally in elongated patterns oriented in the direction of the wind. The resulting slick would likely spread non-uniformly with thin sheens of and thick patches (Elliott 1986, Elliot, Huford and Penn 1986, Galt et al. 1991). The VLOS slick would remain relatively thick in the cold waters of the Chukchi Sea due to the increased viscosity (MMS 2008a).



Source: After MacKay, 1985, and Rasmussen, (1985).

Figure 4.3-4 Fate of Oil Spills in the Arctic Ocean during Sumer from MMS 2003

Evaporation would commence immediately with the lighter, more volatile components evaporating first. Evaporation of these lighter components could reduce the spill volume by 30-40 percent, with a 25 percent reduction occurring in the first 24 hours (NAS 1985). Wind and higher temperatures, if they were to occur, would speed the evaporation process. The presence of any ice would slow evaporation (S.L. Ross Environmental Research Ltd. and Dickens Assoc. Ltd. 1987).

The VLOS would also be subject to dispersion from wind, waves, current, and potentially ice. Dispersion is an important component of the weathering of the released crude oil as it breaks the oil slick up into small oil particles (0.5 µm to several mm), which are then transported into the water column. Local sea state largely determines the dispersion rate, with high sea states facilitating rapid dispersion (Mackay 1985). Emulsions may form, by the incorporation of water droplets in the oil; Alaska North Slope crude has been shown to readily form emulsions (MMS 2008a)

The process whereby hydrocarbon molecules become dissolved in the water column is called dissolution. The process is largely restricted to low-molecular compounds such as benzene, toluene, and xyelene, which are among the most toxic components of crude oil. However, the evaporation process is much more rapid than dissolution; the majority of these toxic components are evaporated rather than dissolved into the water (MMS 2008a).

Most of the oil droplets dispersed into the water column would eventually be degraded by bacteria, or deposited on the seafloor, depending on sedimentation loads and rates in the water column, water depth, sea state, oil properties, and planktonic communities.

The persistence formula used by BOEMRE in the Lease Sale 193 EIS indicates that most of the oil on the surface of the sea would persist as a slick for about 50 days. Emulsions and tar balls would persist much longer. The tarballs would eventually sink or contact land, but as much as 16 percent of the VLOS volume could persist as tarballs through 1,000 days (MMS 1990b citing Butler et al. 1976 and Jordan and Payne 1980). Oil that reaches the coast could persist much longer. Persistence in coastal areas, if contact occurs, will depend on the type of shoreline contacted. The sensitivity of shoreline habitats and the estimation of behavior and persistence of oil on intertidal habitats are based on the dynamics of the coastal environment as well as the substrate type and grain size.

4.3.3 Potential Impacts Associated with a Crude Oil Spill

Historical data demonstrate that the probability of a VLOS occurring during exploration drilling is extremely remote. Therefore, the potential impacts of such an event were not analyzed in Section 4.1 as potential direct or indirect impacts of the planned exploration drilling program, but are analyzed in the following sections.

BOEMRE has provided multiple analyses of the potential effects of large or very large oil spills in the Alaska OCS. In its 2003 Multi-Sale EIS, BOEMRE 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 2003a). For the purpose of 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. 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. 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 Lease Sale 126 EIS, BOEMRE (MMS 1990b) reached the following conclusions regarding the impacts that might result from a hypothetical very large 160,000 bbl VLOS from a pipeline in the Chukchi Sea:

- Overall effect of a VLOS on lower trophic organisms and fish would be very low.
- Overall effect of a VLOS on birds would be moderate.
- Overall effect of a VLOS on polar bears and pinnipeds would be low.
- Overall effect of a VLOS on gray whales, bowhead whales, and belugas would be very low.
- Overall effect of a VLOS on archaeological resources would be very low.
- Overall effect of a VLOS on socioeconomics and subsistence use would be very high.

Shell’s analysis tiers to, and incorporates the results of these BOEMRE analyses. The results of BOEMREs analyses are summarized below, and are discussed in light of site-specific information for the possible VLOS detailed above, which is based on the timing and location and Shell's proposed exploration drilling program.

Potential Impacts of the VLOS on Air Quality

In the open water conditions of the Chukchi Sea, these VOCs would be carried with the prevailing winds and would be rapidly dispersed. In its assessment of a 180,000 bbl VLOS from a hypothetical nearshore blowout in the Beaufort Sea, BOEMRE (MMS 2003a) concluded that there would be an increase in VOCs in the atmosphere that could affect onshore air quality, but added that any effects would be temporary and that concentrations of criteria pollutants would likely remain within federal air quality standards (NAAQS). The assumed VLOS for this analysis would occur more than 64 mi (103 km) offshore, which would indicate a much lower probability of impacting onshore air quality. The VLOS would result in moderate short-term air quality impacts offshore near the drill site, but would likely result in little or no impact on onshore air quality.

Potential Impacts of the VLOS on Water Quality

Water quality and other oceanographic characteristics of the Chukchi Sea are described in Section 3.2. The northeastern Chukchi Sea is relatively pristine due to the remoteness, active ecological system, and the limited presence of human (anthropogenic) inputs (MMS 2008a). Rivers that flow into the Chukchi Sea remain relatively unpolluted by human activities, but can carry suspended sediment particles with trace metals and hydrocarbons. The loading of these constituents to the marine environment is relatively low, and as a result the water quality in the nearshore is also expected to only be slightly affected locally by both anthropogenic and natural sources (MMS 2008a).

Water quality would be not only potentially impacted by the oil, gas, and their respective components in the VLOS, but also to some degree from cleanup and mitigation efforts (such as from increased vessel traffic).

Impacts to Offshore Water Quality

During the initial phase of the assumed blowout, immediate water quality impacts would occur mainly from the disturbance of sediments, and release and suspension of sediment, oil, and natural gas (methane) in the water column. Once the oil surfaces, evaporation of lower molecular weight aromatics (C5 – C9) would occur within the first few days significantly lowering the potential for dispersion and dissolution of these more toxic constituents into the water column. Natural physical processes (e.g., wind, waves, current) would disperse a small percent of the oil (assumed 5 percent) into smaller particles that would mix in the euphotic zone of the water column by dispersion and dissolution resulting in the contamination of the water column with increased concentrations of petroleum hydrocarbons. The initial concentrations would be diluted over time and with distance from the drill site.

The concentrations of hydrocarbons in surface waters under several very large oil spills have been measured. Hydrocarbon concentrations in surface waters under the slick resulting from the *Argo Merchant* varied greatly with measured concentrations ranging up to 0.25 ppm (Gross and Mattson 1977 in Teal and Howarth 1984). Concentrations of 0.003-0.02 ppm were measured under the slick produced by the *Amoco Cadiz* spill (Marchand al. 1979 in Teal and Howarth 1984). Measured volatile liquid hydrocarbon concentrations at the Ixtoc spill ranged from 0.4

ppm near the blowout to 0.06 ppm at a distance of 10.0 km (Boehm and Fiest 1980 in Teal and Howarth 1084). Hydrocarbon concentrations under the slick produced by the *Exxon Valdez* in Prince William Sound ranged from 0.001-0.006 ppm 21-41 days after the incident (MMS 2003a).

In its assessment of a hypothetical 180,000 bbl VLOS from a blowout in the Beaufort Sea, BOEMRE predicted that hydrocarbon concentrations in the water beneath the resulting slick (0.11 ppm after 30 days) would exceed the 1.5 ppm acute toxicity criterion for the first several days, and exceed the 0.015 chronic toxicity criterion for one to several months; however, they noted that the predicted concentrations (0.11 ppm at 30 days) were greater than those observed in Prince William Sound 21-41 days after the *Exxon Valdez* spill. Hydrocarbon concentrations that might occur in the upper 33 ft (10 m) of the water column beneath the slick resulting from a 160,000 bbl VLOS from a hypothetical pipeline in the Chukchi Sea were predicted by BOEMRE to be 0.15 ppm, declining to 0.13 ppm after 10 days and 0.09 ppm after 30 days.

Measured hydrocarbon concentrations under above-referenced actual very large oil spills, as well as modeled hypothetical very large oil spills in the Chukchi and Beaufort Seas, indicate that the VLOS would likely result in concentrations of hydrocarbons in the upper 33 ft (10 m) of the water column under the slick, that exceed acute toxicity criteria for the first few days and could exceed chronic toxicity criteria for a month or more. In time, biodegradation processes would act on the smaller fractions of oil to further reduce their surface water concentration directly (in the water column) or indirectly through increased affinity with suspended particulate matter and eventual settlement. Higher molecular weight hydrocarbons (i.e., C11-C15+) would persist for a longer period of time (in days) and water-in-oil emulsions of these constituents would slow the biodegradation process. Diminished surface water quality would be expected in the upper water column within the boundaries of the oil slick as it moves away from the wellhead on a trajectory influenced by wind and currents.

Despite localized water quality impacts, it is unlikely that a spill of this magnitude would cause significant long-term degradation of the quality of Chukchi Sea water. BOEMRE categorized the water quality impacts of the 160,000 bbl spill from a hypothetical spill in the Chukchi Sea as moderate locally, but low regionally (MMS 1990b).

Potential Impacts of the VLOS on Sediment Quality

An assessment of sediment quality in the region is provided in Section 3.3. Sediment quality in the Chukchi Sea is considered good. Concentrations of hydrocarbons in the Burger Prospect area have been shown to be well within the range of non-toxic background concentrations reported in other studies of Alaskan and Arctic coastal and shelf sediments.

Offshore Sediment Quality

Seafloor sediments in the Burger Prospect consist largely of sandy mud with lesser amounts of gravel. In this type of offshore sediment, the assumed subsea blowout would re-suspend and disperse large quantities of sediments within a relatively large radius of the blowout site. Initial settlement of re-suspended sediment could result in burial of both infaunal (living in the sediment) and epifaunal (living on sediment) organisms, and interfere with sessile invertebrates that rely on filter-feeding organs.

Some of the oil released into the water column would attach to suspended sediment and settle out quickly in the vicinity of the wellhead. Sediment quality surrounding the wellhead is likely to be diminished temporarily until natural degradation reduces the concentration of petroleum hydrocarbons in the sediment. However, in the short term sediment quality and toxicity, as these relate to organism exposure, are likely to be of less concern than the risk of sediment burial by settling oil/sediment mixtures. Over the long term, concentrations of petroleum hydrocarbons are expected to readily degrade by sediment microbial activity.

Oil from the VLOS would reach the seafloor under the slick by several mechanisms. Oil droplets dispersed into the water column would adsorb to suspended particulate water that occurs naturally, and subsequently be deposited on the seafloor as the particulate matter sinks. This would likely represent a very small fraction of the oil in the VLOS given the water depths at the drill site and surrounding areas, and the low sediment loads and sedimentation rates reported for the Chukchi Sea. Oil may also be uptaken by zooplankton with subsequent incorporation with their fecal pellets, which then fall to the seafloor. Oil has fairly consistently been found in the gut and fecal pellets of zooplankton in the areas impacted by very large oil spills (Conover 1971; Johansson 1980; Teal and Howarth 1984). Oil can also reach the seafloor of the slick reaches shallow coastal waters where it is mixed with sediments by wave action, and subsequently transported offshore via density currents (Teal and Howarth 1984). Resulting contamination would be expected to be very low; often the hydrocarbons are detectable only in the benthic organisms, not in the sediments (Teal and Howarth 1984). However, perhaps as much as 5.0 percent of the oil could reach the benthic environment over a very large area (Teal and Howarth 1984).

Nearshore and Onshore Sediment Quality

The trajectory analysis indicates there is a 19 percent chance that the slick from the VLOS would reach the coastline and adjacent nearshore waters within 30 days. Although exposed rocky shores are present, sand gravel beaches are the most common onshore habitats along the Arctic Alaskan coast bordering the Chukchi Sea (Taylor 1981). In these “high-energy” environments, the substrates are typically unstable, porous, and subject to intense wave action from extreme tides and storms. If the slick were to reach gravel beach habitats oil could easily become buried or sequestered, making treatment or removal difficult. Early response and cleanup of oil that makes landfall on these types of beaches would be critical to the long term sediment quality of habitats along the shoreline. However, there is relatively little risk of exposure to organisms in this type of environment when compared to others (EPA 1999).

If not adequately addressed at landfall, oil could remobilize and transport elsewhere as beaches undergo normal processes of seasonal gain and loss of unconsolidated sediment. Sheltered rocky shorelines and scarps are examples of other shoreline types in Alaska that oil could collect upon landfall or if remobilized. BOEMRE (2010) concluded that the fate of oil in this type of environment that is not readily contained could persist through the processes of sequestration, remobilization, and transport for tens of years.

In Alaska, major rivers that flow into the Chukchi Sea are the Kivalina, the Kobuk, the Kokolik, the Kukpowruk, the Kukpuk, the Noatak, the Utukok, the Pitmegea, and the Wulik. In the event of a catastrophic spill, tidal exchange between these and other river systems flowing into the Chukchi Sea could transport oil into lower-energy environments, such as sheltered tidal flats and salt- and brackish-water marsh systems. Both systems provide heavily vegetated habitats with plentiful food and cover for many species of birds, mammals, fish, and invertebrates, in addition to serving as nursery areas for sensitive life history stages. Typically these inland systems have slower water movement, longer water exchange rates, and sediments dominated by mixtures of silt and sand. Thus, oil settling in sediments of these sensitive habitats could result in much higher impacts to aquatic life than in other higher energy onshore and offshore habitats. If impacted by oil, sediments within marshes could take years to recover (EPA 1999).

Potential Impacts of the VLOS on Lower Trophic Organisms

Planktonic and benthic communities of the northeastern Chukchi Sea and the Burger Prospect specifically are described in detail in Section 3.4. Phytoplankton, zooplankton, and benthic organisms found in the area of the Burger Prospect are similar to the communities found over large portions of the northeastern Chukchi Sea. Few especially important or sensitive benthic resources are found in the region. Some kelp beds have been identified in the Peard Bay area, the Skull Cliffs area northeast of Peard Bay, and in an area about 16 mi (25 km) southwest of Wainwright. These resources are located more than 70 mi (113 km) from the drill site where the assumed blowout would occur.

<u>Effects on Lower Trophic Organisms in the Offshore Environment</u>

The assumed oil spill is unlikely to have a significant effect on phytoplankton. The generation time of the phytoplankton (9-12) hours is so fast that rapid replacement of the cells from adjacent waters will prevent a major effect on the surrounding phytoplankton community even if many cells are contacted by oil in the open ocean, (MMS 2003a). Additionally, the potential for contact of the phytoplankton with oil is reduced because hydrocarbons tend to float on or near the surface of the sea, whereas most phytoplankton are found lower in the water column. In their assessment of potential large offshore oil spills in the Beaufort Sea, BOEMRE (MMS 2003a) concluded that recovery of phytoplankton communities may require less than two days. This conclusion was based on the lack of reported adverse effects of oil spills on phytoplankton (NRC 1985), lack of reported differences in phytoplankton biomass and productivity between areas contaminated with large oil spills (e.g., *Tsesis* spill, Johansson et al. as cited in NRC 1985), and other studies that have also demonstrated an absence of substantial effects on phytoplankton following oil spills (MMS 2003a).

Zooplankton includes copepods, euphausiids, mysids, and amphipods as well as the planktonic egg and larval stages of fish and marine invertebrates such as those of polychaetes, mollusks, crustaceans, and echinoderms (meroplankton). The effects of petroleum-based hydrocarbons on zooplankton have been observed in the field at spill sites and have been tested in the laboratory. The ability of planktonic animals to metabolize and detoxify hydrocarbons varies widely among species as does their vulnerability to dispersed and dissolved hydrocarbons in the water column. For zooplankton, lethal hydrocarbon concentrations range from about 0.05-10 ppm; sublethal crude oil concentrations range from about 1 ppm to < 0.05 ppm (NRC 1985). Examples of sublethal effects include: lowered feeding and reproductive activity altered metabolic rates, and community changes (MMS 2003a). Whether effects are lethal or sublethal depends on exposure time, hydrocarbon toxicity, the species, and the developmental stage involved with larvae and juveniles typically more sensitive than adults.

Field observations of zooplankton communities at oil spills have shown that the communities were adversely affected but the effects are short lived (Johansson et al. 1980, as cited in NRC 1985). Adverse effects on zooplankton organisms include direct mortality, external contamination by oil, tissue contamination by aromatic constituents, inhibition of feeding, and altered metabolic rates (MMS 2003a). However, because of their wide distribution, large numbers, short generation time, and high fecundity, zooplankton communities exposed to oil spills appear to recover (NRC 1985). Where flushing rates and water circulation are reduced, the effects of an oil spill would probably be greater and the recovery of zooplankton biomass and standing stocks will take somewhat longer (MMS 2003a).

Marine invertebrates have been shown to be more affected by polycyclic aromatic hydrocarbons while under ultraviolet radiation (Pelletier et al. 1997). This phototoxicity was more obvious with heavy oils, such as Liberty crude, than with light diesel oil. Copepods, a major component of zooplankton, show increased vulnerability to oil toxicity in the presence of ultraviolet radiation (Shirley and Duesterloh 2001). However, Gibson et al. (2002, as cited in MMS 2003a) concluded that ultraviolet radiation influences on food-web process in the Arctic Ocean are likely to be small relative to the effects caused by variation in the concentrations of natural ultraviolet radiation-absorbing compounds that enter the Arctic basin from river runoff. Pelletier et al. 1997 had also noted that ultraviolet light would not penetrate turbid coastal water.

In general, oil spill effects on zooplankton depend on the amount of sunlight, wind speed and duration, air and water temperature, and oil composition (MMS 2003a). However, using data gleaned from the weathering of Prudhoe Bay crude oil, it is expected that for oil spills in the Beaufort Sea, within 10 days of a winter spill, 10 percent of the oil would have evaporated, 57 percent would remain on the surface, and 32 percent would be dispersed into the water column. The dispersed and dissolved oil in the water column is that fraction most likely to adversely affect zooplankton and the surface oil and evaporates should rarely contact the plankton that mostly live beneath the water's surface.

Hydrocarbon concentrations in the water column during and immediately following an oil spill are conservatively assumed to be initially harmful, exceeding 0.1 ppm, to both phyto- and zooplankton, but only for 5 days (Meyer 1990). By one week after the Exxon Valdez oil spill, concentrations of hydrocarbons in the water column were already well below the levels known to be toxic and even below levels that cause sublethal effects in plankton (MMS 2003a).

The likelihood of zooplankton populations being adversely affected by an oil spill would be greatest during the summer in the coastal band of high production. However, it would still likely affect a small portion of the zooplankton population. For example, BOEMRE (MMS 2003a) estimated that less than one percent of the plankton, in the Beaufort Sea OCS would experience sublethal and/or lethal effects from a very large oil spill, while a 10 percent inter-annual variability that has been observed in the populations of zooplankton prey of bowhead whales (Griffiths and Thomson, 2002). Zooplankton recovery from an oil spill would be expected to take about one week in open water (MMS 2003a).

If oil were spilled under the ice and trapped directly beneath it, most epontic organisms living there would probably be killed. This trapped oil would probably become encapsulated within the ice. If oil on, in, or under the ice were released during breakup, this oil would continue to affect the plankton community.

The VLOS would likely not have a great effect on lower trophic organisms at regional population level for the above described reasons. BOEMRE (MMS 2003a) concluded that large numbers of planktonic organism would be destroyed or suffer sublethal effects due to the hypothetical 180,000 bbl VLOS from a blowout in the Beaufort Sea, but that recovery would be complete within 1-2 weeks due to rapid regeneration and flushing. In its assessment of the effects of a 160,000 bbl VLOS from a hypothetical pipeline spill in the Chukchi Sea, BOEMRE also concluded that the effects on lower trophic organisms would be moderate locally, but very low regionally..

Effects on Lower Trophic Organisms in the Nearshore Environment

Many benthic invertebrate species are food items for high food-web species, such as marine fishes, birds, and mammals. Hence, any significant effect on benthic-level organisms would also affect higher trophic levels. Benthic marine plants and animals are most affected by oil that has been incorporated into the bottom sediments through wave action (MMS 2003a). In marine environments that have distinct intertidal and subtidal floral and faunal communities, the most persistent effects occur when intertidal and shallow subtidal benthic communities are directly contacted by oil. This effect is aggravated in areas with restricted circulation, such as in embayments.

The Chukchi Sea coast is composed primarily of tundra cliffs and gravel beaches but includes a few marshes and tidal flats (Research Planning, Inc. 2002). Even in the marshes, there would not be well developed communities because of the winter ice. The persistence of oil in arctic marshes and tidal flats is discussed in the Beaufort Sea multiple-sale EIS; it concludes that oil would persist on such shorelines for more than a decade (MMS 2003a). Oil has persisted in the tidal and subtidal sediments of Prince William Sound for about one and a half decades (MMS 2004) and in the marsh sediments of New England for about three and half decades (Peacock et al. 2005).

If a large oil spill occurred offshore, the probabilities of such a spill reaching estuaries and saltmarshes along the Chukchi Sea would be very low. When spills take place in open water, however, the potential for a quick response is higher. *In situ* booming and skimming operations would be effective means to prevent oil spills from reaching sheltered bays where estuaries and saltmarshes typically are found. Due to the low tidal range typical in such environments, stranded oil would be subject to low rates of abrasion and dispersal by littoral processes. Oil deposition above the level of normal wave activity may occur, if the spill takes place during a storm surge. In such case, oil stranded in emergent vegetation is expected to persist for long periods due to the low rates of dispersion and degradation. Impacts would include the destruction of emergent vegetation, if slick oil sinks into the root system (Owens et al. 1983). Effects of offshore oil spills on saltmarsh vegetation and wetlands above the tideline are not assessed in this section.

The annual predominance of shorefast ice prevents marine plant life and most fauna from living along most of the Chukchi Sea shoreline, leaving macrophytes living only above the tideline or below a depth of about 6.0 ft (2.0 m). Kelp beds are found in a few locations in the northeastern

Chukchi Sea. Kelp beds are known to occur in the center of Peard Bay, offshore of Skull Cliffs located 12.4 mi (20 km) northeast of Peard Bay, and in an area about 16 mi (25 km) southwest of Wainwright. Most of what is known about the effect of crude oil on marine plants and shoreline substrates has come largely from observations following oil spills (MMS 2003a). One example is the Exxon Valdez spill. Dean et al. (1996) studied the subtidal macroalgae, including the kelp *Laminaria*, population in Prince William Sound, one year after the spill. They found no differences in the total density, biomass, or percentage cover of macroalgae between oiled and control sites. In summary, the benthic plants in heavily oiled areas recovered to pre-spill conditions within three years even though oil has persisted in the shoreline sediments for more than a decade (MMS 2003a). In contrast to Prince William Sound, the Chukchi Sea does not have a traditional intertidal zone.

The amount and toxicity of oil reaching subtidal marine plants is expected to be so low as to have no measurable effect on them (MMS 2003a). The most likely type of oil that could reach these marine plants in the subtidal zone (most are in 5 to 10 meters depth) would be highly dispersed oil having no measurable toxicity occurring as a result of heavy wave action and vertical mixing (MMS 2003a).

The dominant marine invertebrates in the Chukchi Sea area include gastropods, mollusks, annelids, echinoderms, and crustaceans. Crude oil can be lethal to marine invertebrates from either a short-term exposure to high hydrocarbon concentrations or a long-term exposure to lower concentrations. Laboratory studies indicate that oil concentrations ranging from 1-4 ppm can be lethal to adult and larval crab and shrimp after 96 hours of exposure (Starr et al. 1981, MMS 2003a). Large oil spills have resulted in the mortality of bivalves (Teal and Howarth 1984), an important member of the food chain as they are food items for many species of marine birds, fish, and mammals. Effects on bivalves can be immediate but declines in abundance may continue for years (Thomas 1976).

Because petroleum hydrocarbons are less dense than water, it is expected that some of the spilled oil will eventually drift into shallow water where it will contact the shoreline. The benthic marine invertebrates most likely to come into contact with oil from an offshore oil spill are those that seasonally live along the affected shore. Because of the amount of time that will elapse before the oil reaches shallow water (several days), the most toxic hydrocarbon fractions should have evaporated (MMS 2003a). However, recent studies have shown that oil is extremely persistent in shoreline sediments (MMS 2004). Twelve years after the Exxon Valdez oil spill, 778 bbl of slightly-weather oil remained in the intertidal subsurface sediments (Peterson et al. 2003, Short 2004). Ballachey et al. (2004) demonstrated that Exxon Valdez oil has persisted on the Prince William Sound shoreline through 2003, 14 years after the spill. Peterson et al. (2003) and Ballachey et al. (2004) have also described some long-term effects on the attached intertidal organisms, such as kelp and mussels, and on the animals that consume them, such as fish and birds. Their studies indicate that the oil that becomes buried in shoreline sediments remains toxic (MMS 2004). Kelp beds are known to occur in at least three locations along the northeastern Chukchi Sea coast. The probability of oil from the VLOS reaching these locales is relatively low (about 1.0 percent).

The predominance of shorefast ice along the shoreline of the Beaufort Sea excludes all but seasonal shoreline invertebrate fauna down to a water depth of about 6 ft (2 m). In the absence of attached intertidal organisms, the trophic effects seen Prince William Sound are not expected to occur. Subtidal organisms living deeper than about 6.0 ft (2.0 m) would not be expected to come into contact with the surface oil, and the highly dispersed oil that they may come into contact with is expected to have no measurable toxicity as a result of heavy wave action and vertical mixing (MMS 2003a).

Potential Impacts of the VLOS on Fish

Fish resources of the northeastern Chukchi Sea and the Burger Prospect specifically, are described in Section 3.5. Fish of greatest importance due to their predominance in terms of numbers or prominence on the food chain include arctic cod, saffron cod, sculpin, capelin, and herring.

Effects on Fish in the Offshore Environment

Petroleum is toxic to fish. Most fish demonstrate acute toxicity to oil in the range of 1-10 ppm; however, some studies have demonstrated oil induced, sub-lethal effects at concentrations as low as 0.245-0.265 ppm, including reduced growth, feeding efficiency, and larval swimming speed. Lasting effects were not observed after exposure to concentrations of 0.600 ppm or less. However, larvae exposed to concentrations of 4.1 ppm or more did not recover feeding ability within 24 hours after placement in clean water.

Chronic exposures of fish to crude oil at 0.50-0.10 ppm for 12 or 13 weeks have induced dramatic histological modifications of the bronchial tissue that would severely affect respiration, osmoregulation, and resistance to disease. Impacts caused by petroleum spills are due primarily to the more soluble, lower molecular-weight aromatic and aliphatic components. However mean concentrations in water depths 3 to 10 m (10 to 33 ft) below oil slicks have been shown to be on the order of 1-15 ppb. Furthermore, the maximum concentrations reported under the oil slicks were less than 2,000 ppb (McAuliffe 1987).

Fish assimilate (and void) hydrocarbons primarily through the gills when exposed to the water soluble fraction but may also take on hydrocarbon burdens by feeding on oil particles or oil-contaminated prey. Teal and Howarth (1984) reviewed and summarized observed impacts on shellfish and finfish as a result of the large spills associated with the *Florida*, *Arrow*, *Argo Merchant*, Bravo, *Tsesis*, *Amoco Cadiz*, and Ixtoc I offshore oil spills (Table 4.3-2).

Table 4.3-2 Observed Effects of Large Oil Spills on Fish

Effect	***Florida***	***Arrow***	***Argo Merchant***	***Bravo***	***Tsesis***	***Cadiz***	**Ixtoc I**
Egg/larvae death	0	0	+	0	+	0	0
Decreased spawning	0	0	0	0	+	0	0
Mortalities in adults	0	0	0	0	0	+	0
Decreased growth	0	+	0	0	0	+	0
Contaminated finfish	+	0	_	+	_	+	0
Decreased recruitment	0	0	0	0	0	+	0
Decreased catch	+	0	0	0	0	+	0

[1] Source: Adapted from Teal and Howarth 1984
[2] Key: + = observed effects, - = not observed or observed only occasionally, 0 = no pertinent observations, or data collected but interpretation ambiguous.

Observations at oil spills around the world, including the Exxon Valdez spill in Prince William Sound, consistently indicate that free-swimming fish are rarely at risk from oil spills. Fish move away from spilled oil and this behavior explains why there has never been a commercially important fish-kill on record following an oil spill (MMS 2003b).

Large numbers of fish eggs and larvae have been killed by oil spills. However, fish over-produce eggs on an enormous scale and the majority of them die at an early stage as food for predators. Even a high death toll from an oil spill has no detectable effects on adult populations that are exploited by commercial fisheries. This has been confirmed during and after the Torrey Canyon spill off England and the Argo Merchant spill off Nantucket. In both cases a 90 percent death rate of fish eggs and larvae for pilchard and pollock respectively was observed in the affected area but was found to have no impact on regional commercial fisheries (Baker et al. 1991).

Seasons of low and high susceptibility to impacts can be defined for any species. Oil spill impact levels are most affected by the timing and location of the spill. These two factors, along with winds and currents, which modify spill location, seem to determine whether or not any impact occurs. Spills of significant volumes of petroleum during the spawning season could result in significant mortality to fish eggs and larvae. However, such impacts are generally not great in regards to the total fish population as fish produce large numbers of eggs and larvae over broad areas of the water body.

Prediction of the effects of offshore oil spills on fisheries is subjective at best. The magnitude is determined by the exact combination of biological, physical, and chemical factors at the time of the spill. Adult finfish tend to avoid contaminated areas, however this behavior is not universal. Oil spills that occur in offshore waters can be expected to contact some fish eggs and larvae at any season; however the number of eggs and larvae will vary with the season. Oil spill impacts are more severe for early life stages because the toxicity threshold is lower and because eggs and larvae are unable to avoid oiled waters. The significance of the impact is not generally great because petroleum concentrations in the water below the slick are usually less than the reported toxic concentrations.

No special spawning areas are noted in the vicinity of the Burger Prospect. Many of the most abundant marine fish species in the northeastern Chukchi Sea, including the arctic cod, which typically represents over 90 percent of the fish captured during fish studies in the Chukchi Sea, spawn under the ice during the winter and diadromous fish spawn in freshwater or brackish water near the shoreline. Therefore little or no effect on eggs of these species would be expected.

Effects on Fish in the Nearshore Environment

Important fish species in the nearshore environment include capelin, herring, pink salmon, chum salmon, and Dolly Varden. Seven streams along the northeastern Chukchi Sea coast have been documented as having small runs of anadromous fish, including pink salmon, chum salmon, coho salmon, and Dolly Varden (Johnson and Daigneault 2008). Effects of oil on these species while in the marine environment would be similar to that described above for other fish species. Oil reaching the spawning areas in the rivers would have greater effect, with lethal and sublethal effects on fish spawning in coastal areas and river mouths, such as capelin, herring, and pink salmon.

Conclusions Regarding Effects of the VLOS on Fish

The VLOS would have the most effect on early life stages of fish and fish in nearshore waters if reached by oil from the VLOS. Offshore, the VLOS would result in destruction of fish larvae and eggs, but would have little effect on regional fish populations.

BOEMRE (MMS 1990b) concluded that the impact of a 160,000 bbl spill from a hypothetical pipeline spill on fish would be very low. The agency also stated that the greatest effect on fish would occur if the oil reached Peard Bay or the Wainwright area. Trajectory analyses indicate a one percent chance of oil reaching Peard Bay and two percent chance of reaching landfall near Wainwright.

BOEMRE also concluded in its assessment of a 180,000 bbl VLOS from a hypothetical nearshore blowout in the Beaufort Sea that little mortality would occur offshore, and in nearshore waters the effects would be mostly sublethal consisting of changes in growth, feeding, fecundity, and temporary displacement. Some fish in the immediate area of the spill would occur but measureable effects on fish populations would not be expected.

Potential Impacts to Birds

BOEMRE provided a detailed analyses of the effects of a large oil spill on birds in the Chukchi Sea in their EIS for Chukchi Sea Lease 193 (MMS 2007b), and analyses of the effects of a very large spill on birds in the Beaufort Sea for Oil and Gas Lease sales 186, 195, and 202 (MMS 2003a). The following summarizes effects of oil spills on birds as found in these documents, with the addition of site-specific information. Crude oil can potentially affect birds by direct contact with consequent covering of the skin or feathers, inhalation of vapors, ingestion of oil or contaminated prey, consequent reductions in food sources, and by displacement from important feeding or molting areas.

Direct contact with an oil spill is often fatal to birds as their feathers become fouled and matted, with a consequent loss in water repellency, thermal insulation, buoyancy, and ability to fly or forage (Fry and Lowenstine 1985). Effects range from sublethal to lethal. Preening of the oiled feathers often results in significant feather loss that accelerates the loss of body heat. Metabolic rates are increased in an effort to thermoregulate, and oiled birds usually reduce their food intake, resulting in “accelerated starvation.” Ingestion or inhalation of oil usually accompanies the preening efforts and can result in secondary toxicological effects. Sublethal effects can lead to such things as immune-suppression, with a consequent increase in susceptibility to disease.

Toxicological effects can result from the ingestion oil directly, through preening, or through the ingestion of contaminated prey. The effects vary with the type of oil, the amount of oil, and the age and species of bird. Toxicity can be acute with rapid development of physiological abnormalities and organ or tissue damage, or it can produce long-term effects in exposed adults, chicks exposed to oil or contaminated food, or chicks hatched from eggs which were exposed (Fry et al. 1985). Mortality and developmental effects have been observed in avian embryos associated with very small quantities of oil. Birds contaminated with oil during the nesting period typically exhibit decreases in egg production, fertility, and egg hatchability. Exposed chicks often show reduced survival and growth rates. Chick mortality due to nest abandonment by oil-contaminated adults has also been demonstrated. Oil ingestion frequently results in ulceration and hemorrhage of the gastrointestinal tract, and inhibition of digestive and absorptive capabilities.

Oiling can also result in irritation of mucosal tissues leading to ulceration of the cornea and moist surfaces of the mouth. Aspiration pneumonia often occurs when birds inhale oil droplets during preening, and severe and fatal kidney damage has been documented. Toxic destruction of red blood cells with subsequent anemia, and a lowering of immune system function may also result.

The extent to which the oil affects an individual bird differs according to the species, the life stage of the bird, the type of oil involved, the length of time between oil release and contact with the bird, and the length of time of contact with the oil. Direct oiling of true seabirds is often minor; many of these birds are often merely stained due to their foraging behaviors (Vermeer and Vermeer 1975).

Bird species which spend a great deal of time swimming on the water surface and those which congregate into large flocks are considered to be the most vulnerable. The magnitude of bird mortality and other population effects following an oil spill vary with the size of the local bird population at the time of the spill, foraging behavior of the species involved, and the level of aggregation at the time of the spill, rather than the quantity of oil spilled and its persistence in the environment (Burger 1993).

Effects on Birds in the Offshore Environment

Marine birds are found in relatively low densities in offshore waters of the northeastern Chukchi Sea. Divoky (1987) reported average densities of 23-71 birds/mi^2 (9-28 birds/km^2) and maximum densities of 615-2,255 birds/mi^2 (238-870 birds/km^2). Baseline studies conducted in the Burger Prospect resulted in estimated average densities of 46-119 birds / mi^2 (2-46 birds/km^2) (Gall and Day 2009, 2010). The most abundant species observed during the studies were crested auklet, least auklet, thick-billed murre, glaucous gull, blacklegged kittiwake, short-tailed shearwater, northern fulmar, and Pacific loon. Bird species such as alcids (auklets, murres, puffins), waterfowl (eiders, long-tailed ducks) and loons that spend more time on the water surface and are concentrated in dense flocks have greater vulnerability to such impacts. Others like the larids (gulls, kittiwakes) and tubenoses (shearwaters and fulmars) may be less affected. A 9,000-ac (36.4 km^2) oil slick could potentially oil hundreds to about 2,000 birds, most of which would be the above-referenced species, depending on the interaction of timing and location. We assume that most of the oiled birds would die.

Effects on Birds in the Nearshore Environment

The effect of an oil spill from a blowout on birds would depend on if, where, and when it contacts nearshore waters and the shoreline. Bird density in total, and for most species, is greater in nearshore waters. Common eiders, king eiders, long-tailed ducks, and Pacific and red-throated loons are more abundant in these nearshore waters. Important coastal avian habitats along the northeastern Chukchi Sea coast include Peard Bay where large numbers of shorebirds stage, Kasegaluk Lagoon and Ledyard Bay where large numbers of waterfowl and other waterbirds stage and molt, and Cape Lisburne where there are large seabird nesting colonies. Trajectory analyses (Table 3.0-1) indicate a relatively low probability (<5 percent) of contact with Peard Bay and the Cape Lisburne/Cape Thompson area, but a greater probability of contact with Kasegaluk Lagoon (19 percent) and the LBCHU (21 percent) critical habitat area (CHA) within 30 days. Kasegaluk Lagoon supports relatively rich and diverse bird populations dominated by black brant, long-tailed ducks, glaucous gulls, arctic terns, and shorebirds (Johnson et al. 1993). About 15-49 percent of the total Pacific Flyway population of black brant was observed there in 1989-1991 (Johnson et al. 1993). Waterfowl such as Pacific and red-throated loons, white-fronted goose, long-tailed duck, surf scoter, common eider, and northern pintail would be the most vulnerable and greatly affected species if oil reached this area. Shorebirds are abundant at this locale but are considered to be much less vulnerable to oil spills than many other species (Vermeer and Vermeer 1975).

Effects on Threatened and Endangered Birds

The Steller's eider and the spectacled eider are both listed as threatened species and are found in and along the northeastern Chukchi Sea. Additionally the Kittlitz's murrelet and yellow-billed loon are candidate species and are also found in these coastal and offshore waters. Kittlitz's murrelets, yellow-billed loons, and spectacled eiders are found in offshore waters of the Chukchi Sea and have been documented in very low densities in the Burger Prospect area (Gall and Day 2009, 2010). Small numbers of these species could be affected by a spill in offshore waters. The spectacled eider, Steller's eider, and yellow-billed loon are more common in nearshore waters but still found in low densities.

The LBCHU was established as a unit of critical habitat for the spectacled eider. Most of the female spectacled eiders nesting on the North Slope and about half the males as well as others molt in Ledyard Bay where they are found in large groups. They are flightless for a period of several weeks making them vulnerable to oil spills. A 1995 survey recorded the presence of over 33,000 spectacled eiders in the area. If the oil reached this area during the peak of molting, a relevant portion of the North Slope breeding population of spectacled eiders could be oiled. BOEMRE trajectory analyses indicate there is a 21 percent chance that oil released from the Burger Prospect area reaching the LBCHU within 30 days (Table 4.3-1).

Conclusions Regarding Effects of the VLOS on Birds

The assumed oil spill would have the greatest affect on alcids such as the crested auklet and thick-billed murre in offshore waters, with possible loss of hundreds to thousands of birds. In nearshore waters, where bird density is greater, higher numbers of birds would be affected, with gulls, terns, loons, and sea ducks and other waterfowl being the most affected. Effects would be greatest if quantities of oil reached Kasegaluk Lagoon, however the lagoon is largely protected by barrier islands with few ingress locations for the oil. The long-term effects of oil spill mortality to these species are uncertain. Mortalities to species that have large populations and would experience losses of a few to a few hundred individuals would be difficult to distinguish at a population level.

In their evaluation of the effects of a 180,000 bbl VLOS from a hypothetical blowout in the Beaufort Sea, BOEMRE (2003) concluded that it is reasonable to consider that long-term regional population-level effects would occur should several thousand sea ducks perish as a result of an oil spill. The recovery period is difficult to determine because of the uncertainty associated with the current health of the population of long-tailed ducks and eiders, but recruitment of new individuals is expected to be low and intensified by generally low productivity. Populations of species such as long-tailed ducks and common and king eiders, which are thought to be currently declining, may require several generations to recover if at all (MMS 2002b).

The greatest potential impact would occur if the oil spill reached the large bird colonies in the Cape Lisburne or Cape Thompson areas, or portions of the LBCHU, as a large portion of the North Slope breeding population of the threatened spectacled eider would likely be there at that time. The trajectory analyses indicate a very small probability (1-3 percent) of reaching the bird colonies, but an 18 percent chance that it could reach the LBCHU. USFWS (2007) concluded in their BO for Lease Sale 193 that it is unlikely that exploration / development would occur in the Lease Sale 193 Area and an oil spill would occur and the spill would occur in a location and time where it would reach large numbers of eiders, and concluded that the lease sale would not jeopardize the continued use of the species.

Potential Impacts of the VLOS on Mammals

The literature on the effects of oil spills on marine mammals in arctic and subarctic areas has been reviewed and synthesized by Geraci and St. Aubin (1982, 1985, 1990), Richardson et al. (1989), and others. Assessments of the likely impact of an oil spill on marine mammals in the Alaskan Arctic, including the Chukchi Sea and the Beaufort Sea have been conducted by BOEMRE, USFWS, National Marine Fisheries Service (NMFS), and others. BOEMRE provided a detailed analyses of the effects of a large oil spill on marine mammals in the Chukchi Sea in their EIS for Chukchi Sea Lease 193 (MMS 2007b), and analyses of the effects of a very large spill on marine mammals in the Beaufort Sea for Oil and Gas Lease sales 186, 195, and 202 (MMS 2003a).

The following section summarizes information presented in the reviews and assessments referenced above, and provides a site specific assessment of potential effects of the assumed crude oil spill on marine mammals. Marine mammals found in the northeastern Chukchi Sea include the pinnipeds, ringed seal, bearded seal, spotted seal, and walrus; the cetaceans beluga whale, killer whale, harbor porpoise, bowhead whale, gray whale, fin whale, minke whale, and humpback whale; and the polar bear. Killer whales, fin whales, and humpback whales are extralimital in this area and would be found in such low numbers, if at all, that any impacts would be minor and little species-specific analysis is warranted. Impacts can be categorized into thermoregulatory effects due to contact, toxoicological effects due to contact, ingestion, or inhalation, and effects due to changes in food availability. These impact categories are discussed below.

Thermoregulatory Effects

Contact with oil has been found to negatively impact the ability of some animals to thermoregulate by matting and wetting the hair with a consequent loss of insulation. However, marine mammals found in the Lease Sale 193 Area, including whales, seals, and walrus, use a thick layer of blubber as insulation rather than hair or fur. It has been shown that contact with oil would have little or no effect on species that use a blubber layer for insulation (Kooyman et al. 1976, Geraci and Smith 1976). Within two to four weeks of birth, oiling of the fur can be detrimental to newborn seal pups as the pups use special thick fur called “lanugo” to keep them warm until they can build up enough blubber. Oiling of fur in this case could cause heat loss and hypothermia (St. Aubin 1988). However, the assumed crude oil release would occur in August long after pups are born and have shed their lanugo coat.

Toxicological Effects – Contact, Ingestion, and Inhalation

The epidermis of whales has been found to be largely impenetrable by oil (Geraci and St. Aubin 1985) but eyes and mucous membranes could be affected when contact with oil is made. Oil 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 found no tissue damage to ringed seals after being immersed in oil-covered water for 24 hours (Geraci and Smith 1976).

Aromatics and other toxic molecules from oil that are ingested can enter the bloodstream via the intestinal wall and be transferred 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 ingestion of 0.26 gal (1.0 liter) of crude oil by a seal that was 110 lb (50 kg) would be required in order to see these effects. Ingestion of oil over time has the potential to cause long-term effects on phocids (St. Aubin 1988). Crude oil 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, it is unlikely that they would feed on prey contaminated by oil. Therefore, ingestion of oil is highly unlikely by walrus. Baleen whale prey could also carry contaminants that could be ingested by whales (Wursig 1990). However, Caldwell and Caldwell (1982) fed small amounts of hydraulic oil to dolphins for three months, and found no detectable effects in the dolphins. These studies indicate that, if ingestion of oily material occurred, effects on whales, seals and walrus would likely be minimal. Ingestion of oil by marine mammals is unlikely and not expected because of the low probability of a large liquid hydrocarbon spill.

The respiratory system of marine mammals in the area, if any, could be compromised by the inhalation of vapors from a large liquid hydrocarbon spill. Other effects of vapor inhalation could potentially include neurological disorders and liver damage (Geraci 1990). Toxins could affect seals, walrus or whales if they inhaled from vapors rising from the oil directly after the spill occurs.

Effects on Marine Mammals in the Offshore Environment

Marine mammals are found in relatively low densities in offshore waters of the northeastern Chukchi Sea (Table 4.3-3). Given the low number of past observations killer whales, harbor porpoises, minke whales, and ribbon seals in the area, it is unlikely that oil would contact individuals of these species, but oil could possibly contact very small numbers. Beluga whales, gray whale, ringed seals, bearded seals, spotted seals, and walrus are considered common; however, based on densities of marine mammals in the northeastern Chukchi Sea calculated from agency and industrial surveys (IHA Appendix C of the revised Chukchi Sea EP), relatively few of these marine mammals would be contacted by a 9,000-ac (36.4-km^2) oil slick. Most of the contacted animals would be ringed seals, the most abundant marine mammal in the region. Greater numbers of marine mammals such as walrus could be contacted if the slick approached areas of pack ice where walrus congregate.

Table 4.3-3 Estimated Summer-Fall Marine Mammal Densities in the Northeastern Chukchi Sea [1]

Species	[1] Marine Mammal Density mi^2 (km^2)				[2] Individuals Contacted
	Open Water		Ice Margin		
	Avg	Max	Avg	Max	
Beluga whale	0.042 (0.016)	0.084 (0.032)	0.084 (0.032)	0.168 (0.032)	2.36
Killer whale	0.000 (0.000)	0.001 (0.000)	0.000 (0.000)	0.001 (0.000)	0.01
Harbor porpoise	0.000 (0.000)	0.003 (0.001)	0.000 (0.000)	0.003 (0.001)	0.04
Bowhead whale	0.045 (0.017)	0.090 (0.035)	0.090 (0.035)	0.180 (0.070)	1.27
Fin whale	0.000 (0.000)	0.001 (0.000)	0.000 (0.000)	0.001 (0.000)	0.00
Gray whale	0.016 (0.006)	0.032 (0.012)	0.016 (0.006)	0.032 (0.012)	0.45
Humpback whale	0.000 (0.000)	0.001 (0.000)	0.000 (0.000)	0.000 (0.00)	0.00
Minke whale	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.001 (0.000)	0.01
Bearded seal	0.028 (0.011)	0.053 (0.020)	0.037 (0.014)	0.070 (0.027)	0.98
Ribbon seal	0.001 (0.001)	0.005 (0.002)	0.001 (0.001)	0.005 (0.002)	0.07
Ringed seal	0.637 (0.246)	1.054 (0.407)	0.849 (0.328)	1.406 (0.543)	19.77
Spotted seal	0.013 (0.005)	0.021 (0.008)	0.017 (0.007)	0.028 (0.011)	0.39

[1] Shell IHA application, Appendix C
[2] Based on the maximum density at ice margin

Any whales that were to contact the oil would likely experience only nonlethal effects from skin contact, inhalation of vapors, ingestion of oil-contaminated prey, baleen fouling, temporary reduction in food resources, or temporary displacement (NMFS 2008).

Effects on Marine Mammals in the Nearshore Environment

The effect of an oil spill from a blowout on marine mammals would be dependent on the particular areas that are exposed to the released oil. One of the more important areas for marine mammals during the time when such a release could occur is Kasegaluk Lagoon. A number of documented spotted seal haulouts are located on spits associated with passes along the barrier islands in front of Kasegaluk Lagoon. Frost et al. (1993) reported the use of three haulouts along Kasegaluk Lagoon by anywhere from a few to over 1,000 spotted seals in August-November. Kasegaluk Lagoon is also an important for belugas, which apparently frequent the lagoon waters for molting, however this use by belugas seems to be restricted to July. Oil reaching these areas would likely result in a substantial increase in the number of animals oiled. BOEMRE trajectory analyses indicate that there is a 3-13 percent chance of oil released from the Burger Prospect, reaching these areas within 30 days (Table 4.3-1). Effects would be similar to those described above.

Effects on Threatened and Endangered Whales

Threatened and endangered species of marine mammals found in the northeastern Chukchi Sea include the bowhead whale, the fin whale, humpback whale, and polar bear. Ringed seal, bearded seal, and walrus are candidate species but are discussed above.

Fin whales and humpback whales are rare in the Chukchi Sea. There have been very few recent sightings of fin or humpback whales in the Chukchi Sea. Reiser et al. (2009) reported four humpback whale sightings and one fin whale sighting in the Chukchi Sea in 2007 and Haley et al. (2009) reported one humpback whale sighting during 2008, while conducting monitoring surveys for industry over large portions of the northeastern Chukchi Sea. Green et al. (2007) reported and photographed a humpback whale cow/calf pair east of Barrow near Smith Bay in 2007. Three fin whale sightings were made in 2008 from industry vessels and NMFS/National

Marine Mammal Laboratory (NMML) survey aircraft in the northern Chukchi Sea off of Ledyard Bay indicating that the range of fin whales may be expanding. Reiser et al. (2009) reported a fin whale sighting during vessel-based surveys in the Chukchi Sea in 2006. It is possible that a small numbers of humpback whales could be contacted by an oil spill in the northeastern Chukchi Sea, but unlikely. Densities (Appendix C revised Chukchi Sea EP, Table 4.3-3) of these whales are thought to be less than 0.00004/mi^2 (0.0002/km^2). At these densities, a 9,000-ac (36.4-km^2) oil slick would contact less than 0.015 fin or humpback whales. Because the northeastern is at the edge of the range, or outside of the range of these species, the temporary effects on habitat would not be substantial for these species.

Bowhead whales are found regularly throughout the northeastern Chukchi but at relatively low densities. They migrate northward through the Chukchi Sea in the spring, before a spill could occur. They are found in relatively low densities throughout the Chukchi during summer and fall. Much of the bowhead whale population migrates from the Beaufort Sea through the Chukchi Sea to the Bering Sea in September-October. This fall migration could be exposed to the oil slick, but occurs across a broad area of the Chukchi Sea. Densities (Appendix C revised Chukchi Sea EP, Table 4.3-3) in the area of Shell's Burger Prospect are on the order of 0.007-0.027/mi^2 (0.017-0.070/km^2). At these densities 0.6-2.5 bowhead whales could contact the oil associated with a 9,000-ac (36.4-km^2) oil slick.

Any whales that were to contact the oil would likely experience only nonlethal effects from skin contact, inhalation of vapors, ingestion of oil-contaminated prey, baleen fouling, temporary reduction in food resources, or temporary displacement (NMFS 2008).

Effects on Threatened and Endangered Whales

Threatened and endangered species of marine mammals found in the northeastern Chukchi Sea include the bowhead whale, the fin whale, humpback whale, and polar bear. Ringed seal, bearded seal, and walrus are candidate species but are discussed above.

Effects on Polar Bears

Polar bear density is relatively low in the northeastern Chukchi Sea during the time period of the assumed spill; however the VLOS could contact some polar bears. Polar bears are extremely sensitive to both external contact with oil and ingestion of oil (MMS 1990b).

Conclusions Regarding Effects of the VLOS on Marine Mammals

Based on estimated densities of marine mammals in the northeastern Chukchi Sea, a relatively small number of marine mammals would be contacted by oil from the VLOS. The literature indicates that cetaceans may not be very sensitive to oil and no lethal effects would be expected. Whale deaths directly attributable to oil contact have not been reported. The literature also indicates that seals and walrus species found in the northeastern Chukchi Sea may be resistant to the effects of petroleum; however, some of these animals fouled in oil may die. Polar bears are thought to be extremely sensitive to oil contact and ingestions, and we assume polar bears oiled by contact would die, but that this would be a small number or bears.

In its evaluation of the effects of a 160,000 bbl VLOS in the Chukchi Sea, BOEMRE (MMW 1990) concluded that the effect on seals, walrus, and polar bears would likely be low and sublethal, and that the effects on beluga, gray whales and bowhead whales would be very low.

In the evaluation of the 180,000 bbl VLOS in the Beaufort, BOEMRE (2003) assumed that all young ringed and bearded seals, and all polar bears contacted by oil would die, and that few if any belugas or bowhead whales would be adversely affected.

Impacts of the VLOS on Subsistence, Community Health, Socioeconomics, and Environmental Justice

Effects on subsistence, socioeconomics, environmental justice, and archaeology could occur as a result of a VLOS as assumed in this section.

Potential Impacts on Subsistence

Access to subsistence resources, subsistence hunting, and the use of subsistence resources could be affected by changes in subsistence resource availability or desirability. The animals commonly hunted by Natives in Chukchi Sea coastal communities are bowhead and beluga whales, walrus, seals, polar bears, freshwater and marine fishes, waterfowl, and seabirds. As discussed above, direct and indirect effects on marine mammals, freshwater and marine fish, and most birds are expected to be minor, localized, and short term and have no regional population effects. Although subsistence resources are migratory by nature and dispersed throughout large ranges or habitat, subsistence activities are concentrated in time and location. The potential for impacts due to the VLOS considered in this section, therefore, would be dependent on the spill trajectory, the time of year and the location of various spill response activities. Disturbance due to spill response and cleanup activities offshore could cause marine mammals to avoid areas where they are normally harvested or to become more wary and difficult to hunt.

In the unlikely event that oil reaches the shoreline, sections of coast would also not be used by subsistence users for some time following a spill. The duration of avoidance by subsistence users would vary depending on the volume of the spill, the effectiveness of spill response containment and recovery, the persistence of unrecovered oil in the environment, and the extent of impact on ecological resources important for subsistence. A VLOS, as described in this section, may hinder the harvest of subsistence resources or cause suspensions of subsistence activities for a period longer than a single harvest season, especially for the communities of Barrow, Wainwright, Point Lay, and Point Hope.

Potential Impacts on Community Health

Contamination and the perception of contamination may result in reduced or abandoned harvests and changes in traditional diets that would have some nutritional consequence. In addition, concern about the effects of consuming tainted food and concerns about availability of subsistence resources may increase levels of social stress. Users may resume hunting activities following some period of time. The duration of avoidance by subsistence users would vary depending on their confidence in assurances that resources were safe to eat. Due to the nature of Inupiat culture, however, it is anticipated that impacted subsistence users would be invited to share harvesting and processing of subsistence products with unaffected communities.

Potential Impacts on Socioeconomics

Disruption of subsistence-harvest resources, such as that created by a VLOS analyzed in this section, would have predictable and manageable consequences to several sociocultural aspects of life in Northern Alaska (Luton 1985). Subsistence users may experience more costs if users travel farther than normal to hunt. A VLOS could also affect the local cash economy by creating additional employment during the duration of the spill response and subsequent restoration.

Environmental Justice

An unlikely VLOS that significantly impacts subsistence harvest areas such as fishing areas nearshore or marine mammal migration areas offshore could result in impacts under Environmental Justice; that is, a disproportionately high adverse impact on Alaskan Natives.

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