Application for Incidental Harassment Authorization for the Non-Lethal Taking of Whales and Seals in Conjunction with a Proposed Seismic Survey in the Beaufort Sea, Alaska, Summer 2008

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Prepared for

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ACRONYMS

µPa	micro Pascal
3D	three-dimensional
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
BLM	Bureau of Land Management
BP	British Petroleum
CFM	cubic feet per minute
Com	Communication
cu in	cubic inches
cu m	cubic meter(s)
dB	decibels
ESA	Endangered Species Act
FN	Field Nyquist
ft	foot/feet
GPS	global positioning system
HP	horsepower
Hz	hertz
IWC	International Whaling Commission
kg	kilogram(s)
km	kilometer(s)
LAUL	line acquisition unit line
LAUX	line acquisition unit crossing
LOA	Letter of Authorization
m	meter(s)
mi	mile(s)
MMMMP	Marine Mammal Monitoring and Mitigation Plan
MMOs	Marine Mammal Observers
MMPA	Marine Mammal Protection Act
MMS	U.S. Department of the Interior, Minerals Management Service
M/V	marine vessel
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSB	North Slope Borough
OBC/TZ	ocean bottom cable/transition zone
OSP	optimum sustainable population
PGS	Petroleum Geo-Services Onshore, Inc.
psi	pounds per square inch
PTS	Permanent Threshold Shift
rms	root mean square
sec	seconds
sq km	square kilometer(s)
sq mi	square mile(s)
TTS	Temporary Threshold Shift
USDOI	United States Department of the Interior
USFWS	United States Fish and Wildlife Service
re 1 µPa-m	relative to one microPascal at one meter distant

1.0 DETAILED DESCRIPTION OF SPECIFIC ACTIVITIES EXPECTED TO RESULT IN THE INCIDENTAL TAKING OF MARINE MAMMALS

1.1 Overview of Activity

PGS Onshore, Inc. (PGS) has been contracted by ENI Petroleum (ENI) to conduct an exploratory three-dimensional (3D) marine seismic survey in the Beaufort Sea of Alaska, utilizing an ocean bottom cable/transition zone (OBC/TZ) technique. The proposed survey is scheduled to occur from July to mid-September 2008. Because the proposed survey is weather and ice dependent, the exact dates of the survey cannot be determined at this time. The proposed survey location is in the Nikaitchuq Lease Block (Figure 1), north of Oliktok Point and covering Thetis, Spy, and Leavitt Islands, and would extend to the 5-kilometer (km) (3-mile [mi]) state/federal water boundary line. The program would not go into federal waters. The water depth in this area ranges from 0 to 15 meters (m) (49 feet [ft]), and a third of the project waters are also shallower than 3 m (10 ft). The total area covered by source or receiver lines is 304.6 square kilometers (sq km) (117.6 square miles [sq mi]); since the islands comprise approximately 1.7 sq km (0.7 sq mi) of this, the total marine area is 303 sq km (117 sq mi). Because of the proposed time and location of the activity, conflicts with subsistence activities would likely be avoided. Operations would be scheduled and located to avoid the bowhead whale (*Balaena mysticetus*) population.

1.2 Three-Dimensional Seismic Survey

The OBC/TZ survey involves deploying cables from small boats, called DIB boats, to the ocean bottom, forming a pattern consisting of three parallel receiver line cables, each a maximum of 17.3 km (10.8 mi) long and spaced approximately 200 m (660 ft) apart. Hydrophones and geophones attached to the cables are used to detect seismic energy reflected back from rock strata below the ocean bottom. The energy is generated from a submerged acoustic source, called a seismic airgun array, that releases compressed air into the water, creating an acoustic energy pulse directed downward toward the seabed. PGS proposes using two shallow water source vessels for this survey. The source vessels will be used sequentially: one vessel will be active while the other travels to its next position. Both source vessels, marine vessel (M/V) *Wiley Gunner* and M/V *Little Joe*, will be equipped with identical airgun arrays with an air discharge volume of 0.014 cubic meters (cu m) (880 cubic inches [cu in]). This airgun array produces an acoustic pressure of 10.5 meters (m) zero to peak or 22.7 bar meters peak to peak. The maximum amplitude is 197 decibels (dB) relative to one microPascal at one meter distant (µPa-m) (peak) at 42 hertz (Hz). These airgun arrays are smaller than most arrays used in seismic programs in either the Beaufort Sea or Chukchi Sea in the past, and are expected to operate at a depth of between 0.91 m and 2.29 m (3 ft and 7.5 ft). Source lines will be spaced approximately 200 m (660 ft) apart. Data acquisition would also require the following instrumentation (instrumentation specifications are included in Appendix A):

- Seismic Recording Equipment
- Line Equipment
- Transducers
- Energy Source Output
- Bathymetry
- Positioning Survey Equipment

1.2.1 Vessel Descriptions

The marine crew would be configured with the following vessels (vessel specifications are included in Appendix A):

- Two airgun source vessels, M/V *Wiley Gunner* and M/V *Little Joe*, would be used. Both vessels are 13 m (44 ft) long, 5.8 m (19 ft) wide, and 3.51 m (11.5 ft) tall with a weight of 18 metric tons (20 tons) (loaded) and a draft of 0.69 m (2.2 ft) with the engines down. These boats are able to maneuver in waters less than 1.2 m (4 ft) deep.
- The recording vessel, M/V *William Bradley*, is a self-propelled barge and has hydraulic gravity spuds that can be lowered in water up to 6 m (20 ft) deep. It would be fitted with a Sercel 408 recording system. The M/V *William Bradley* has a classification of Minor Waters 1, dimensions of 45.7 m (150 ft) long and 11.0 m (36.1 ft) wide, and a draft of 1.23 m (4.03 ft).
- Up to seven shallow-water cable boats (DIB boats) would be available for the survey. The DIB boats are 12.5 m (41 ft) long and 4.3 m (14 ft) wide and have 0.76 m (2.5 ft) draft. The boats are powered by two, 200-horsepower (HP) diesel Volvo Penta engines. The dry weight of each boat is 4.5 metric tons (5 tons) with a working load of 7.7 metric tons (8.5 tons).
- The supply boat M/V *Katmai Spirit* would be used for crew support and supplying marine vessels during the job. The M/V *Katmai Spirit* has dimensions of 12 m (40 ft) long, 5.5 m (18 ft) wide, and 0.6 m (2 ft) draft.
- The Project Manager/Client boat would be available for use by the Project Manager, the client, or other personnel as needed to perform their job tasks. The boat may also be used for crew support and supplying marine vessels as required. The Project Manager/Client boat has dimensions of 7.3 m (24 ft) long, 2.4 m (8 ft) wide, and 0.45 m (1.5 ft) draft. The boat is powered by a 90 HP engine.
- The Mechanic's boat would be used to support maintenance and mechanical support for marine vessels used during the project. The Mechanic's boat has dimensions of 7.9 m (26 ft) long, 2.4 m (8 ft) wide, and 0.45 m (1.5 ft) draft. The boat is powered by twin 90 HP engines.

1.2.2 Seismic Recording Equipment

The seismic recording system scheduled to be housed on the M/V *William Bradley* during the proposed 3D marine seismic survey is a Sercel 408. The system would record data using a tape emulator drive hard drive imbedded into the recorder so that verified IBM 3590 archive tapes can be created at the quality control processing laboratory. Digital records would be formatted in SEG D configuration and traced at three lines of 156 per record for every 2-millisecond periods. The digital filters would be linear or minimum phase, and the anti-alias filters would be high-cut 0.8 Field Nyquist (FN) Stop Band Attenuation greater than 120 dB. Record length would be six seconds (sec) versus a shot point distance of 34 m (110 ft). This Sercel system would be capable of an inter-record delay of equal to or less than 2 sec of overhead. The plotter that would also be housed on the M/V *William Bradley* would be a Veritas V-12.

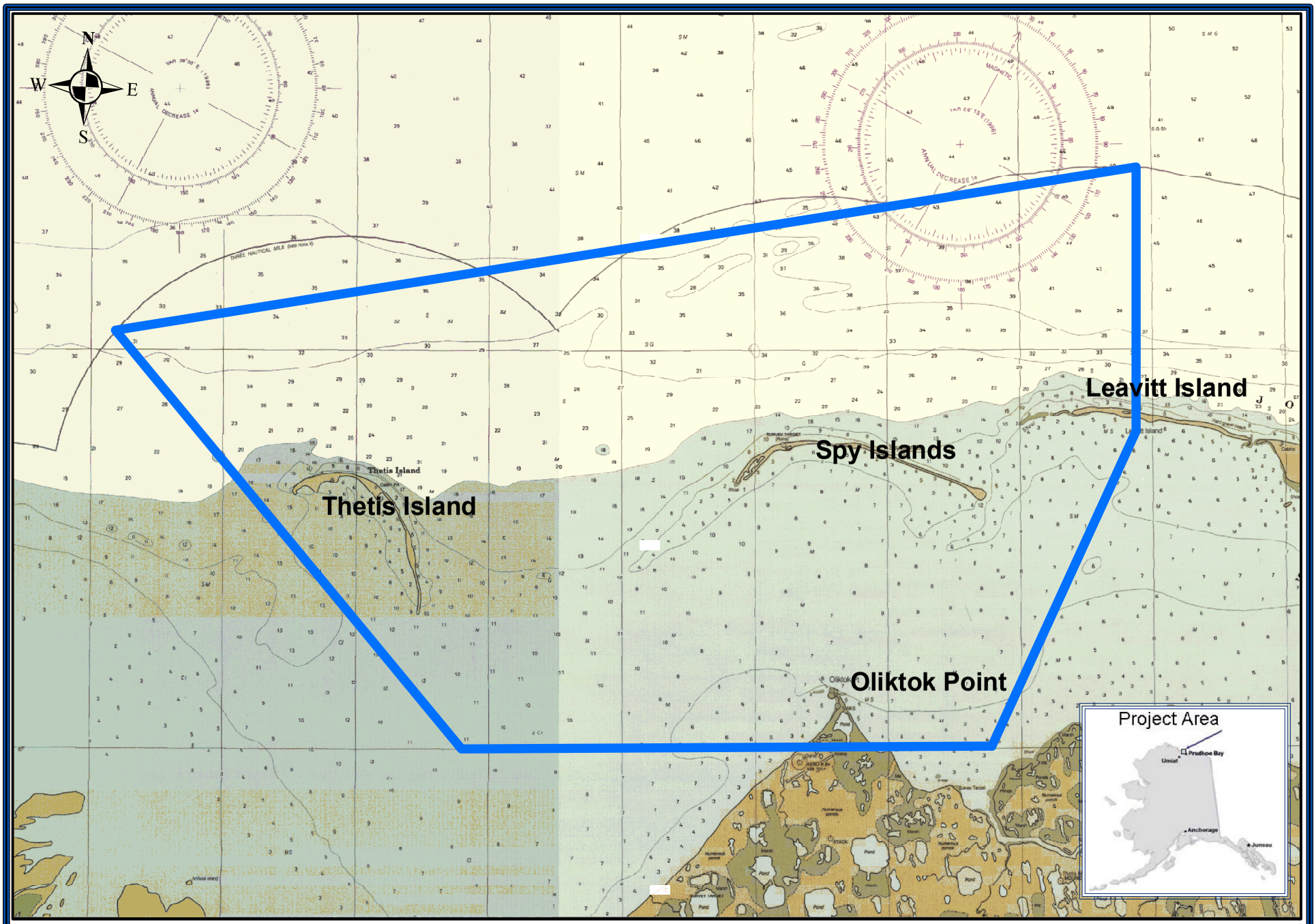
Leavitt Island
Spy Islands
Thetis Island
Oliktok Point
Project Area
Prudhoe Bay
Umiat
Anchorage
Juneau
Legend
Proposed Project Area
PGS Proposed Seismic Survey Project Area
PGS

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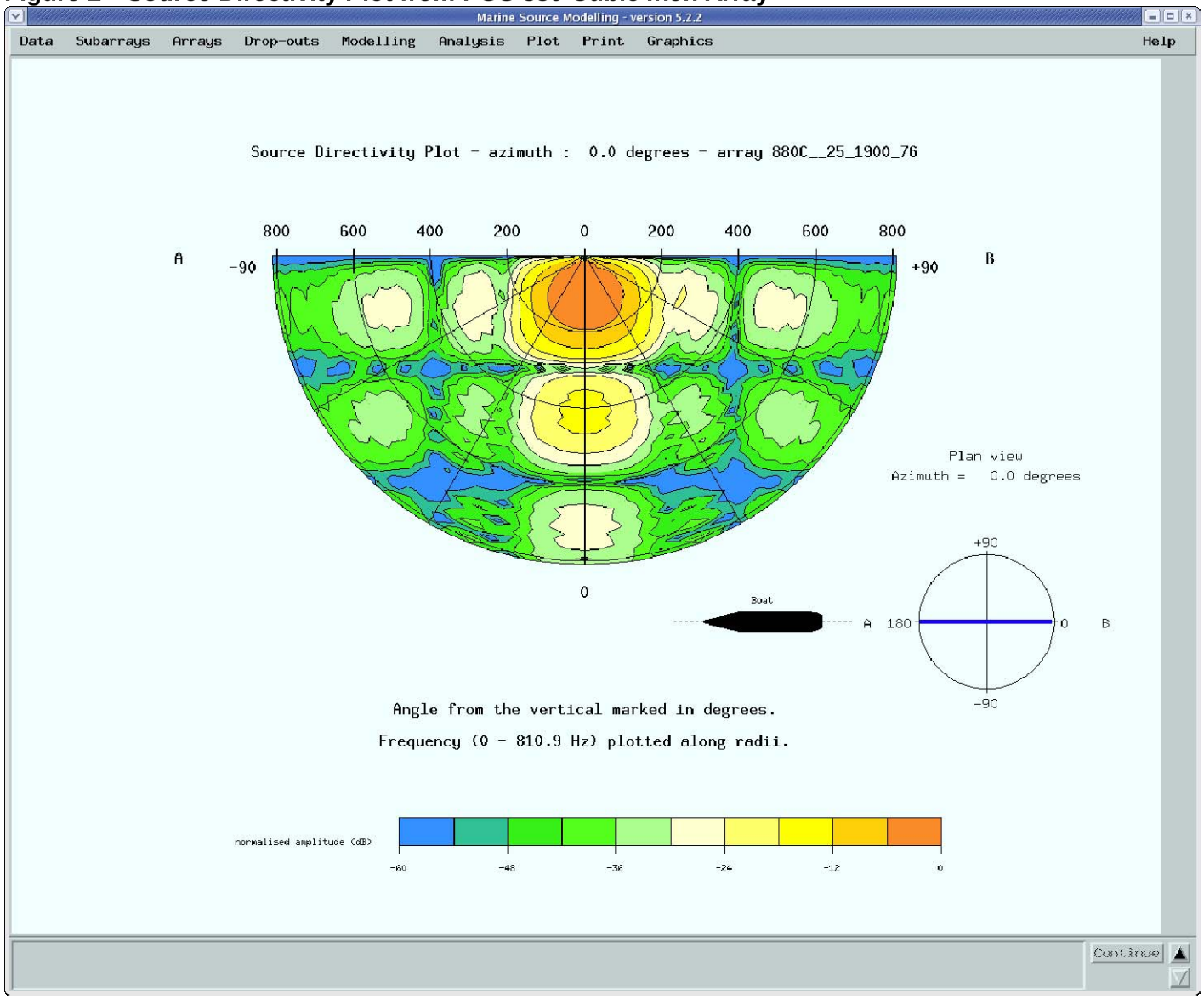
Figure 2 Source Directivity Plot from PGS 880 Cubic Inch Array



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1.2.3 Line Equipment

PGS would have 2400 Sercel FDU Operative Remote Acquisition Units available. The following equipment would also be available:

- 125 Sercel line acquisition unit line (LAUL) repeaters/powers
- 12 Sercel line acquisition unit crossing (LAUX) line interface
- 20 x-line cables
- 1,200 telemetry cables of 67 m (220 ft) each and 1,200 mini cables of 1 m (3.3 ft) each

1.2.4 Transducers

The transducers used during the proposed seismic survey in the Beaufort Sea would be GeoSpace GS-PV1 sensors. The GS30CT geophone has a sensitivity of 2.55 volts (V)/per inch per sec plus or minus 2 percent. The pressure phone has a sensitivity of 6.76 V/bar plus/minus 1.5 dB. The hydrophone crystals are configured for acceleration cancellation.

1.2.5 Energy Source Output

PGS would use an airgun energy source for the proposed data acquisition. A minimum of a 10-airgun array is expected to be used as a single output source. The operating source depth for the guns is a maximum of 2.5 m (8.2 ft). Source centers separation will be from 1.0 m to 1.5 m (3.3 ft to 4.9 ft), and the shot point distance is 34 m (110 ft). The single source volume is 0.014 cu m (880 cu in). Although PGS is proposing to use only a 10-airgun array for acquisition, a 12 airgun array would be placed on each vessel. This would provide two spare airguns at all times. The source layout will be 8 m (26 ft) wide by 6 m (20 ft) long. At a depth of 2.5 m (8.2 ft), the point to point output pressure is plus or minus 22 bar meters, giving a signal/bubble ratio of 10:1.

The power is provided by either a 78 cubic feet per minute (CFM) or 150 CFM diesel air compressor. The air pressure can deliver between 1,750 pounds per square inch (psi) to 1,900 psi. This system will require a 12-sec to 15-sec recycle time. The energy source synchronizing system is a Digital Real Time Long Shot Source Controller.

1.2.6 Bathymetry

Bathymetric equipment would be located on each of the source vessels and the shallow-water cable boats. Bathymetric data would be recorded simultaneously with the seismic data acquisition, by employing Interspace Tech DX 150 (or equivalent) instruments, which can operate in water up to 120 m (400 ft) deep. The digitizer and logger system would be an National Marine Electronic Association standard output to Horizon. PGS would use a Gator INM system and a Gator INS system as source firing controllers. For measures of the depth, temperature, and salinity, a Valeport TS Dip Meter would be used.

1.2.7 Positioning Survey Equipment

To conduct the proposed 3D seismic survey in the Beaufort Sea, PGS would employ a Novatel system and a global positioning system (GPS) mobile receiver with 8 to 12 channels of dual frequency. For the Novatel system, there would be three onshore reference stations and four valid satellites. As a second main system, PGS has available a Trimble 4700 system and a GPS Mobile Receiver, also with 8 to 12 channels of dual frequency. For the Trimble 4700, there

would be two onshore reference stations. PGS will also have 700 active Sonardyne Acoustic transponders available for in-water positioning.

1.3 Mitigation Measures

Communications of vessel operations and transit will occur in accordance with protocols set forth by the Communication (Com) Centers proposed to be operated in Barrow and Deadhorse, Alaska. The use of Com Centers and Call Centers is intended to avoid industry interference with subsistence activities being conducted in the operations area.

The Marine Mammal Monitoring and Mitigation Plan (MMMMP) (Appendix B) will include the use of Marine Mammal Observers (MMOs) on the source vessels to ensure that the seismic arrays are not operated in close proximity to marine mammals. In addition, PGS has offered to hire Inupiat speakers from the potentially affected communities of Barrow and Nuiqsut to perform seismic work on each of the PGS vessels. As part of their duties, the Inupiat speakers will also keep watch for marine mammals and will communicate with the MMOs located on the source vessels.

The proposed activity will avoid concentrations of bowhead whales by operating in very shallow nearshore waters (less than 15 m [49 ft] deep) where bowhead whales rarely occur. In response to discussions with AEWC, PGS has negotiated the following operational windows to further avoid potential impacts to migrating whales. The timing of the proposed survey would be divided into two parts. Data acquisition outside the barrier islands (Thetis Island, Spy Island, and Leavitt Island), the deepest water in the survey area, would be performed first and would be completed by August 5. Data acquisition inside the barrier islands, with maximum water depth of approximately 4.6 m (15 ft), would then be conducted from August 5 through September 15. No data acquisition (air gun activity) would be conducted outside the barrier islands after August 5.

Although seismic operations are proposed to be conducted during the fall whale hunt (after August 25), they would not occur within the areas normally used by hunters from Barrow (Point Barrow) or Nuiqsut (Cross Island). The survey area is 60 km (37 mi) west of Cross Island (and "downstream" of the bowhead whale fall migration) and 260 km (160 mi) east of Point Barrow. During this time, all airgun activity would occur in shallow waters within the barrier islands that are not considered whale habitat. The barrier islands are also expected to act as an obstacle to sounds generated by seismic activities, effectively keeping sound propagation from entering the zone of migration.

1.3.1 Maintaining Safe Radii

The focus of this IHA is for the National Marine Fisheries Service (NMFS) to authorize the incidental "take" of marine mammals by "Level B" harassment, defined as exposure to sound levels of greater than 160 dB for baleen whales and toothed whales and 170 dB for pinnipeds. It does not authorize the "take" of marine mammals by sound levels considered injurious: 180 dB for whales and 190 dB for seals. Injurious "take" is avoided by establishing safety radii and associated zones of influence around the seismic vessels so that noise-generating equipment is shut down if a marine mammal approaches these zones. These zones are determined by calculating the maximum distance to the 180 dB and 190 dB isopleths based on the intensity of sound at source and the expected rate of sound attenuation.

The proposed 880-cu-inch 3D seismic survey equipment generates a relatively low sound source as compared to other seismic sources (Richardson et al. 1995), and is specifically designed to direct sound pressure downwards as shown in Figure 2. Source, peak frequency, and amplitude are presented in Table 3.1-1. Vertical sound propagation is quickly attenuated through interference patterns between the individual guns on the array, which results in less vertical sound propagation than for lesser-volume

seismic arrays not such arrayed. The modeled sound level at source is 192.7 dB re 1 µPa-m root mean square (rms) at frequencies between about 10 Hz and 100 Hz,. The radii distance to the 190-dB isopleth is only a couple of meters, while the distance to the 180-dB isopleth is only about 10 m. Monitoring a 10-m safety radii is impractical. Therefore, PGS is proposing to establish a more conservative 50-m (160-ft) safety radii centered over the array. Establishing a shutdown safety radius of 50 m (160 ft) for all marine mammals, the most conservative estimate for the 180-dB isopleth, should ensure injurious "takes" are avoided. Finally, acoustical field measurements of actual sound propagation from the operating array will be taken at the onset of the survey season. Should these measurements prove that associated sound energy is traveling farther than estimated, the safety zone will be adjusted accordingly.

TABLE 1.3-1
PGS Source Frequency and Amplitude

Source Size (cubic inch)	Peak Frequency (Hz)	Absolute Amplitude (dB re 1 µPa-m)
880	43.9 Hz	196.85

Hz = hertz
dB re 1 µPa-m = relative to one microPascal at one meter distant

PGS does plan to continue conducting seismic surveys after the start of bowhead whale hunt and migration (August 25); however beginning in early August, PGS will move their operations inside the barrier islands, and remain there throughout the bowhead whale hunt and whale migration. Because of the downward sound directionality of the proposed array configuration, the radius to the 12-dB isopleth has been calculated to extend out to only 3 km (1.9 mi). Consequently, the closest 120-dB level sounds that could reach migrating whales is a point 3 km (1.9 mi) north of a line between Spy and Thetis islands. Spy and Leavitt Islands are close enough that sound is not expected to migrate through the gap between them. At this point the water depth is approximately 6 m (20 ft), less than suitable habitat for migrating bowhead whales. Further, much of the sound emanating from inside the barrier islands would be blocked by Spy, Thetis, and Leavitt islands, leaving only a fraction of the survey area inside the barrier islands from which the 120-dB radius could travel to a point 3 km (1.9 mi) north of barrier islands. For this reason, during most of the survey inside the barrier islands it is expected that the 120-dB radii would not extend at all outside the barrier islands.

To ensure that marine mammals are detected before they enter the 50 m (164 ft) safety zone, MMOs will be stationed on the seismic vessels and will be on watch 24 hours per day. The MMOs will be provided the authority to initiate a shutdown, and will record all sightings relative to seismic activity. These distances are easily viewable by MMOs stationed on seismic vessels.

1.3.2 Offshore Monitoring

PGS will participate in an offshore monitoring program in cooperation with Pioneer Natural Resources, Inc., (Pioneer) and ENI. This program has been developed in coordination with Shell Offshore, Inc. The program will:

- Characterize in-water sound source levels and spectral content of sound from vessels associated with the project prior to the start of operations.

The offshore monitoring program will also include the following four activities from mid August until mid- to late September:

- Monitor in-water sound near and distant from Pioneer's Oooguruk drill site, ENI's Spy Island drill pad, and vessel operations using four autonomous seafloor acoustic recorders (ASARs).

- Monitor and characterize sounds produced from shallow-depth seismic survey planned by PGS using ASARs and directional autonomous seafloor recorders (DASARs).

- Detect and localize marine mammal vocalizations using an array of DASARs positioned north and northwest of the Pioneer and ENI projects.

- Visually survey the coastal Beaufort Sea from an aircraft to search for bowhead whales and characterize behavior of those animals observed.

2.0 DATES AND DURATION OF PROPOSED ACTIVITY AND SPECIFIC GEOGRAPHICAL REGION

The start date for the planned marine seismic survey is dependent on weather and ice conditions in the Beaufort Sea. It is anticipated that ice will leave the Beaufort Sea as early as July. The proposed survey would begin as soon as ice and weather conditions allow, possibly as soon as July 1. The proposed survey is scheduled to occur from early July to September 15, 2008, depending upon weather conditions. The survey is expected to last for an estimated 75 days of data acquisition, excluding weather days. The marine survey will take place in the Beaufort Sea over the Nikaitchuq Field. It will cover Thetis, Spy, and Leavitt Islands and will extend to the 5-km (3-mi) state/federal waters boundary line (Table 2.0-1). General boundary coordinates located on Figure 1 (Local Datum North America 1927 Zone 4) for the program area are presented in the table.

TABLE 2.0-1
Plane Coordinates

	East (ft)	North (ft)
1	461577.50	6064669.08
2	539032.65	6076921.53
3	539312.42	6056568.08
4	528307.08	6032323.23
5	486992.72	6032323.23

ft = feet

The mobilization of vessels is planned to occur on approximately June 15, 2008, depending on ice and weather conditions. The proposed survey is scheduled to occur from July 1 to September 15, 2008, depending upon weather conditions. The work would be divided into two parts. Data acquisition (use of airguns) outside the barrier islands (Thetis Island, Spy Island, and Leavitt Island) would be performed first and would be completed by August 5. This portion of the work would begin in the east and move toward the west. Data acquisition inside the barrier islands would then be conducted and would be completed by September 15. This portion of the work would also move from east to west. No data acquisition (use of airguns) would be conducted outside the barrier islands after August 5.

Airgun source vessels, M/V *Wiley Gunner* and M/V *Little Joe*, are scheduled to be trucked from Houston, Texas, to the permitted staging area at Oliktok Point via the Dalton Highway (North Slope haul road). The supply boat, M/V *Katmai Spirit*, will be transported overland to the job site from its home port in Anchorage, Alaska. This boat will be used for crew support and resupplying marine vessels. The recording vessel, M/V *William Bradley*, will travel to the proposed program area in mid- to late June from the Canadian Northwest Territories.

3.0 THE SPECIES AND NUMBERS OF MARINE MAMMALS LIKELY TO BE FOUND WITHIN THE ACTIVITY AREA

The species and numbers of marine mammals likely to be found within the Beaufort Sea activity area are listed in Table 3.0-1. Species that are not likely to be found within the Beaufort Sea, or extralimital species (ribbon seal [*Phoca fasciata*], gray whale (*Eschrichtius robustus*) humpback whale [*Megaptera novaeangliae*], minke whale [*Balaenoptera acutorostrata*], fin whale [*Balaenoptera physalus*], North Pacific right whale [*Eubalaena japonica*], harbor porpoise [*Phocoena phocoena*], killer whale [*Orcinus Orca*]), are not included in Table 3.0-1. Species that are managed by the U.S. Fish and Wildlife Service (USFWS) (polar bear [*Ursus maritimus*], Pacific walrus [*Odobenus rosmarus divergens*], and sea otter [*Enhydra lutris*]) are also excluded from Table 3.0-1.

TABLE 3.0-1
List of Species Inhabiting the Proposed Seismic Activity Areas in the Eastern Beaufort Sea and Their Habitats, Conservation Status, and Estimated Populations

Species (Stock)	Habitat	Beaufort Sea Stock and/or ESA Status[1]	Estimated Abundance[2]
Cetaceans			
Bowhead Whale (*Balaena mysticetus*) (Western Arctic Stock)	Pack ice and coastal	ESA listed as Endangered, listed as depleted under MMPA, and classified as a strategic stock	10,545
Beluga Whale (*Delphinapterus leucas*) (Beaufort Sea/Eastern Chukchi Sea)	Offshore, coastal, ice edges	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	39,258/3,710
Pinnipeds			
Ringed Seal (*Phoca hispida*) (Alaska)	Landfast and pack ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	Up to 3.6 million; Currently, no reliable abundance estimate is available for the Beaufort Sea, however, combined with surveys from the Chukchi Sea, approximately 249,000 are estimated.
Spotted Seal (*Phoca largha*)	Pack ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	several thousand and several tens of thousands. An estimate with correction using 1992 data =59,214 seals but is preliminary at best.
Bearded Seal (*Erignathus barbatus*)	Pack ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	Currently, no reliable abundance estimate is available for this stock. Early estimates of the Bering-Chukchi Seas ranged from 250,000 to 300,000.

1. Stocks listed as depleted under the MMPA is described as any stock that falls below its optimum sustainable population must be classified as "depleted," 16 U.S.C. § 1362(1)(A). The numeric threshold for OSP has been interpreted by NMFS and USFWS as being above 0.6 K (i.e. greater than 60% of K, or carrying capacity). In other words, a stock that dropped in numbers to below 60% of K would qualify as "depleted" under the MMPA. The term "strategic stock" is defined as a marine mammal stock: (A) for which the level of direct human-caused mortality exceeds the Potential Biological Removal level; (B) which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the Endangered Species Act of 1973 . . . within the foreseeable future; or (C) which is listed as a threatened species or endangered species under the Endangered Species Act of 1973 . . ., or is designated as depleted under [the MMPA].
2. See text under individual species for population estimate sources.

ESA = Endangered Species Act
K = carrying capacity
MMPA = Marine Mammal Protection Act
NMFS = National Marine Fisheries Service
OSP = Optimum sustainable population

USFWS = U.S. Fish and Wildlife Service

Two cetacean species (bowhead and beluga whale), three species of pinnipeds (ringed, spotted, and bearded seal), and one marine carnivore (polar bear) are known to occur in or near the proposed study area. Other extralimital species that occasionally occur in very small numbers in the central Alaskan Beaufort Sea include the harbor porpoise, killer whale, gray whale, humpback whale, minke whale, fin whale, North Pacific right whale, and ribbon seal. However, because of the rarity of these latter species in the central Beaufort Sea, they are not expected to be exposed to or affected by any activities associated with the areas of proposed seismic work and are not discussed further. Only the bowhead whale is listed as "Endangered" under the Endangered Species Act (ESA).

Species that are managed by the USFWS (polar bear, Pacific walrus, and sea otter) are excluded from further discussion. Within the project activity areas in the Beaufort Sea, only the polar bear is known to occur in significant numbers, and potential incidental "take" of this species will be dealt with under a separate application for a Letter of Authorization (LOA) from the USFWS.

In an effort to reduce redundancy, we have included the required information about these species and abundance estimations (to the extent known) of these species in Section 4.0 below.

4.0 A DESCRIPTION OF THE STATUS, DISTRIBUTION, AND SEASONAL DISTRIBUTION (WHEN APPLICABLE) OF THE AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS LIKELY TO BE AFFECTED BY SUCH ACTIVITIES

The following five species of cetaceans and seals might be expected to occur in the region of the proposed seismic survey activity: bowhead and beluga whales; and ringed, spotted, and bearded seals. These five species are discussed in this section and are the species for which general regulations governing potential incidental "takes" of small numbers of marine mammals are sought. The geographic boundaries and distribution, primary habitats, and population trends and risks are discussed below for each species.

4.1 Bowhead Whale (Balaena mysticetus)

Of the five recognized stocks of bowhead whales, the largest is the Western Arctic stock found in the Bering, Chukchi, and Beaufort Seas (Rugh et al. 2003). The Western Arctic stock is the focus of this IHA. This stock winters in the Bering Sea, migrates across the Chukchi Sea from March through June, and summers in the Canadian Beaufort Sea (Braham et al. 1980, Moore and Reeves 1993).

Bowhead whales are large baleen whales that feed primarily on copepods and euphausids (Lowry 1993; Lowry and Sheffield 2002). In order to satisfy energy requirements, it is likely that bowheads must find areas with above-average concentrations of zooplankton (Lowry 1993). They are long-lived, slow-growing, late-maturing, and reproduce infrequently (Koski et al. 1993). Females become sexually mature at approximately 14.2 m (46 ft) in length; although a few become sexually mature by the time they are 13 m (43 ft) long. It is believed that males become sexually mature between 12 to 13 m (39 and 43 ft); although this needs to be confirmed (Koski et al. 1993). Bowheads mate and calve during spring migration (Nerini et al. 1984); and calving occurs every 3-4 years (Koski et al. 1993). The majority of bowhead whale mating occurs in March and April (International Whaling Commission [IWC] 2004b). Gestation lasts between 12 and 16 months (Nerini et al 1984) and most calving occurs between March and August (Koski et al 1993).

During the spring migration, whales follow open leads through the Chukchi and Beaufort Seas, while they migrate through more open water during the fall migration. The fall migration across the Beaufort Sea begins in about early September and runs to mid-October, while a few whales might be found anywhere within their range during the summer.

The Western Arctic stock was recently estimated at 10,545 and has been growing at an annual rate of about 3.5 percent (Zeh and Punt 2004). Estimating bowhead whale densities in the Alaskan Beaufort Sea is difficult given that the whales are largely migrating through the region and, therefore, the densities are always changing. LGL (2005) provided average and maximum densities for bowhead whales in the Beaufort Sea of 0.0064 and 0.0256 animals per sq km, respectively, based on the work of Moore et al. (2000) and others. However, these numbers greatly overestimate densities in the PGS seismic survey area largely because the survey area is too shallow (less than 15 m [50 ft] deep) to support these densities. Much of the survey area (especially the very shallow [less than 4 m (13 ft) deep] waters inside the barrier islands) is not even recognized as bowhead whale habitat by the U.S. Department of the Interior, Minerals Management Service's (MMS's) Bowhead Whale Aerial Survey Program, and the portion that is recognized as bowhead whale habitat has a sighting-frequency class of only 0.0001 to 0.009 whales per km of effort, which would equate to densities much lower than LGL's. Nonetheless, in an effort to remain conservative and precautionary, the LGL (2005) values are used in the "take" estimates.

The bowhead whale is federally designated as endangered and is an Alaska Species of Special Concern. In the late 19th and early 20th century, the Western Arctic stock of bowhead whales was greatly reduced by commercial whaling from an estimated population of 10,400-23,000 in 1848 to 1,000 to 3,000 near the end of commercial whaling (Woodby and Botkin 1993). The 1993 population was estimated at 8,200, with a 95 percent probability that the population was between 7,200 and 9,400 (Zeh et al.1995; IWC 1996). The Western Arctic Stock is by far the largest of the five remnant populations worldwide but is classified as "depleted" under the Marine Mammal Protection Act (MMPA). The Western Arctic Stock in 2001 numbered an estimated 10,470 (George et al. 2004). Calf counts in 2001 were the highest on record at 121 individuals, lending evidence of a growing population (George et al. 2004). Today, some reports suggest Bering-Chukchi-Beaufort Sea bowhead whales are approaching the lower limit of the historical population size. Others reports suggest removing Bering-Chukchi-Beaufort Sea bowhead whales from the threatened and endangered species list.

4.2 Beluga Whale (Delphinapterus leucas)

Five stocks of beluga whales—Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea, Bristol Bay, and Cook Inlet—occur in Alaska (O'Corry-Crowe et al. 1997, Angliss and Lodge 2004), although only the Beaufort Sea stock and eastern Chukchi Sea stock would possibly be encountered in the survey area. The Beaufort Sea stock summers in the eastern Beaufort Sea and winters in the Bering Sea (Shelden 1994). Like bowhead whales, beluga whales migrate out of the Bering and Chukchi Seas during the spring, following open leads.

Most beluga whales summer far offshore in the pack ice and, therefore, are rarely seen in the central Beaufort Sea during the summer (Hazard 1988, Clarke et al. 1993, Miller et al. 1998, Moore et al. 2000). Small numbers of belugas, however, are sometimes observed near the north coast of Alaska during the westward migration in late summer and autumn (Johnson 1979, Green et al. 2006). The main fall migration corridor of beluga whales is greater than 100 km (62 mi) north of the coast. Some eastern Chukchi Sea stock animals enter the Beaufort Sea in late summer, moving to pack ice areas well offshore as well (Suydam et al. 2001). Aerial and vessel-based seismic monitoring programs conducted in the central Alaskan Beaufort Sea from 1996 through 2001 observed only a few beluga whales migrating along or near the coast (LGL and Greeneridge 1996; Miller et al. 1998, 1999). The majority of belugas

seen during those projects were far offshore. Satellite-linked telemetry data show that some belugas migrate west considerably farther offshore, as far north as 80 degrees (º) N latitude (Richard et al. 1997, 2001, Suydam et al. 2001).

The most recent population estimate for the Beaufort Sea stock is 39,258, which is based on surveys conducted in 1992 by Harwood et al. (1996). This population is not considered by NMFS to be a strategic stock, but the current population trend of the Beaufort Sea stock of beluga whales is unknown (Angliss and Outlaw 2005).

4.3 Ringed Seal (Phoca hispida)

In the North Pacific, ringed seals are found in the southern Bering Sea and range as far south as the Seas of Okhotsk and Japan. Throughout their range, ringed seals have an affinity for ice-covered waters and are well adapted to occupying seasonal and permanent ice. They are year-round residents throughout the Beaufort, Chukchi, and Bering Seas, as far south as Bristol Bay in years of extensive ice coverage. They tend to prefer large floes (greater than 48 m [160 ft] in diameter) and are often found in the interior ice pack where the sea ice coverage is greater than 90 percent (Simpkins et al. 2003). Ringed seals remain in contact with ice most of the year and pup on the ice in late winter to early spring (Smith 1973, Smith and Stirling 1975, Hammill et al. 1991, Lydersen and Hammill 1993).

No estimate for the size of the Alaska ringed seal stock is currently available (Angliss and Outlaw 2005), although past ringed seal population estimates in the Bering-Chukchi-Beaufort area ranged from 1 million to 3.6 million (Frost et al. 1988). Frost and Lowry (1981) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter, indicating about half the population moves into the Chukchi and Bering Seas in the winter. Frost and Lowry (1999) conducted surveys in May, and results indicated that the density of ringed seals in the Alaskan Beaufort Sea is greater to the east of Flaxman Island than to the west. Based on surveys from 1996 through 1999, ringed seal density in fast ice areas between Oliktok Point and Flaxman Island ranged from 0.48 to 0.77 seals per sq km (Frost et al. 2002). Similarly, Moulton et al. (2002) found ringed seal densities ranging from 0.39 to 0.63 seals per sq km near the Northstar development area prior to construction.

In general, ringed seals are widely dispersed as singles or in small groups during the summer open-water period, or they may move into coastal areas (Smith 1987, Harwood and Stirling 1992, Moulton and Lawson 2002, Williams et al. 2004, Green et al. 2007).

Ringed seals are the marine mammal most likely to be encountered during the seismic surveys. The Alaska stock of ringed seals is not classified as a strategic stock by NMFS.

4.4 Spotted Seal (Phoca largha)

Spotted 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). The majority of spotted seals are found in the Bering Sea (especially during the winter) and Chukchi Sea, but small numbers do range into the Beaufort Sea during summer (Rugh et al. 1997, Lowry et al. 1998) where they haulout on islands and spits. Haulout sites include Oarlock Island, Pisasuk River, and the Colville River Delta, which is located near the seismic survey area. Historically, the Colville River Delta and nearby Sagavanirktok River supported as many as 400 to 600 spotted seals, but in recent times, fewer than 20 seals have been seen at any one site (Johnson et al. 1999).

From 2005 to 2007, Green et al. (2005, 2006, 2007) monitored marine mammals from FEX barging activity between Prudhoe Bay and Cape Simpson. The number of spotted seals annually recorded along

the shallow trackline segments coincident with the PGS seismic survey area ranged from 1 to 10. Overall, Green et al. annually recorded between 23 and 54 spotted seals, but the numbers represented only 5 percent of ringed seal numbers.

A reliable abundance estimate for spotted seals is not currently available (Rugh et al. 1995); however, early estimates of the size of the world population of spotted seals were 335,000 to 450,000 animals. The total number of spotted seals in Alaskan waters is not known, but the estimate is most likely between several thousand and several tens of thousands (Rugh et al. 1997). Using maximum counts at known haulouts from 1992 (4,135 seals) and a preliminary correction factor for missed seals developed by the Alaska Department of Fish and Game (ADF&G) (Lowry et al. 1994), an abundance estimate of 59,214 was calculated for the Alaska stock (Angliss and Lodge 2004). There are no density estimates for spotted seals that are relevant to the proposed seismic survey area. However, given Green et al.'s (2005, 2006, 2007) observations that spotted seal numbers represent about 5 percent of ringed seal numbers in the shallow water regions of the central Alaskan Beaufort Sea, a rough density estimate can be calculated by multiplying the more reliable ringed seal densities (Frost et al. 2002) by 5 percent.

The activity associated with the proposed seismic work in the Beaufort Sea are expected to encounter a few spotted seals, especially given the proximity to the Colville River Delta haulout (about 5 km [3 mi]). The Alaska stock of spotted seals is not classified as a strategic stock by NMFS.

4.5 Bearded Seal (Erignathus barbatus)

Bearded seals are associated with sea ice and have a circumpolar distribution (Burns 1981). Bearded seals are predominately benthic feeders and prefer waters less than 200 m (660 ft) in depth.

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly 1988). During winter, they are most common in broken pack ice and in some areas also inhabit shorefast ice (Smith and Hammill 1981). In Alaska waters, bearded seals are distributed over the continental shelf of the Bering, Chukchi, and Beaufort Seas, but they are more concentrated in the northern part of the Bering Sea from January to April (Burns 1981).

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. Between mid-April to late April and June, as the ice recedes, some bearded seals migrate northward through the Bering Strait and spend the summer along the ice edge in the Chukchi Sea (Burns 1967, 1981).

Recent spring surveys along the Alaskan coast indicate that bearded seals tend to prefer areas of between 70 percent and 90 percent sea-ice coverage, and are typically more abundant farther than 37 km (20 nautical mi) offshore, with the exception of high concentrations nearshore south of Kivalina in the Chukchi Sea (Bengtson et al. 2000, Simpkins et al. 2003).

During the summer in the Chukchi Sea, bearded seals are most associated with the pack ice edge near the continental shelf. The nearshore areas of the central and western Beaufort Sea provide somewhat more limited habitat because the continental shelf is narrower and the pack ice edge frequently occurs seaward of the shelf and over waters greater than 200 m (660 ft) in depth. The bearded seals' preferred habitat in the Beaufort Sea during the open-water period is the continental shelf seaward of the scour zone.

No reliable estimate of bearded seal abundance is available for the Beaufort Sea (Angliss and Lodge 2002). Aerial surveys conducted by MMS in fall 2000 and 2001 sighted a total of 46 bearded seals during survey flights between September and October (Treacy 2002a, 2002b), with all but two sightings

recorded east of 147º W, and all sightings were within 74 km (40 nautical mi) of shore. Aerial surveys conducted from 1997 to 2002 in the vicinity of Northstar Island also reported small numbers (up to 15) of bearded seals (Moulton et al. 2003c). Finally, barge-based surveys conducted from 2005 to 2007 by Green et al. (2005, 2006, 2007) between Prudhoe Bay and Cape Simpson recorded between 4 and 35 bearded seals annually. Density estimates were provided by LGL (2005), which were used in this IHA.

Jonah Nukapigak (Nuiqsut hunter, personal communication) recently provided local knowledge regarding bearded seal movements past Thetis Island based on annual summer hunts there. Generally, native hunters sight 50-75 bearded seals and harvest 20 of them annually. While these numbers do not provide a basis for modifying density estimates, they can be used to adjust requested take authorization.

The proposed seismic activity areas may encounter bearded seals during the open-water season; however, the number of bearded seals is expected to be small. The Alaska stock of bearded seals is not classified by NMFS as a strategic stock.

5.0 TYPE OF INCIDENTAL TAKING AUTHORIZATION BEING REQUESTED AND METHOD OF INCIDENTAL TAKING

The type of incidental "takes" requested in this application would be "takes" by noise harassment associated with Level B harassment or disturbance as the result of noise produced by the proposed seismic source vessels, *M/V Wiley Gunner* and *M/V Little Joe*. No serious injuries or lethal "takes" are expected as a result of the proposed activity in the Beaufort Sea (see Section 1.3 on proposed mitigation to avoid injurious "take"). Incidental "takes" by harassment are defined in Section 3 of the MMPA. The overall number of "takes" that will occur during the proposed project will depend mainly upon the proximity of marine mammals to the seismic source vessels during survey activity, the noise level produced during the survey, and the species that is affected.

6.0 BY AGE, SEX, AND REPRODUCTIVE CONDITION (IF POSSIBLE) THE NUMBER OF MARINE MAMMALS (BY SPECIES) THAT MAY BE TAKEN BY EACH TYPE OF TAKING IDENTIFIED IN PARAGRAPH (a)(5) of THIS SECTION, AND THE NUMBER OF TIMES SUCH TAKINGS BY EACH TYPE OF TAKING ARE LIKELY TO OCCUR

PGS seeks authorization for potential incidental "taking" of small numbers of marine mammals under the jurisdiction of NMFS in the proposed region of activity. Species for which authorization is sought are bowhead and beluga whales; and ringed, spotted, and bearded seals. Polar bears and walrus will be covered in a separate LOA application to the USFWS.

The only anticipated impacts to marine mammals associated with noise propagation from seismic profiling work would be temporary and short-term displacement of seals and whales from within ensonified zones produced by such noise sources.

The 3D seismic activity in the proposed area of the Beaufort Sea is not expected to "take" more than small numbers of marine mammals or to have more than a negligible effect on their populations.

6.1 Basis for Estimating Numbers of Marine Mammals That Might Be "Taken by Harassment"

The methods to estimate "take by harassment" and the present estimates of the numbers of marine mammals that might be affected during the proposed seismic acquisition activity in the Beaufort Sea are described below. The bowhead whale, beluga whale, and bearded seal density estimates for the species covered under this IHA are based on the estimates developed by LGL (2005) for the University of Alaska IHA and used here for consistency. The ringed seal density estimates are from Frost et al. (2002). Spotted seal density estimates were derived from Green et al. (2005, 2006, 2007) observations that spotted seals in the Beaufort Sea in the vicinity represent about 5 percent of all phocid seal sightings, and then multiplying Frost et al.'s density estimates times 5 percent.

6.2 Exposure Calculations

Specifically, the average and maximum estimates of "take" presented in this IHA were calculated by multiplying the expected average and maximum animal densities provided in Table 6.2-1 by the area of ensonification. The area of ensonification was assumed to be the length of trackline in marine waters multiplied by the radius to the 160-dB and 170-dB isopleths times 2. The 160-dB radii was estimated at about 75 m (246 ft) and the 170-dB radii at 18 m (59 ft). The total length of trackline in marine waters is estimated at 1,280 km (795 ft), including 770 km (478 mi) outside the barrier islands and 510 km (317 mi) inside the barrier islands. The area of ensonification using the 160 dB criteria is 192 sq km (74.1 sq mi) (116 sq km [44.8 sq mi] outside the barrier islands, and 76 sq km [29.3 sq mi] inside), and for the 170 dB criteria is 46 sq km (17.8 sq mi) (28 sq km [10.8 sq mi] outside the barrier islands, and 18 sq km [6.9 sq mi] inside). However, given that none of the area occurs in waters greater than 15 m (49 ft) deep (and half the area is in waters less than 4 m [13 ft] deep), and suitable habitat for migrating bowhead whales has been defined as waters 15 m to 200 m (49 ft to 660 ft) deep (Richardson and Thomson 2002), assuming the survey area outside the barrier islands is suitable habitat for bowhead whales (and the area inside the barrier islands is not) still provides a very conservative estimate of potential "take". The "take" estimates were determined by multiplying the various density estimates in Table 6.2-1 by the ensonification area using the 160 dB criteria for cetaceans and the 170 dB criteria for pinnipeds. The bowhead and beluga density estimates come from LGL (2005) and the ringed seal estimates from Frost et al. (2002). The spotted seal densities were determined by multiplying the ringed seal estimate by 5 percent, a reflection of three years of survey results by Green et al. (2005, 2006, 2007) that showing that spotted seals represented about 5 percent of several thousand phocid sightings in nearshore waters of the Beaufort Sea.

No Level A (injurious) takes following the 180 dB and 190 dB criteria are expected. First, radii to these isopleths are extremely short; about 10 m (33 ft) to the 180 dB and about 2 m (6.6 ft) to the 190 dB (given the 192.7 dB re 1 µPa-m rms source). Calculated take estimates in all cases, except ringed seals, are only a small fraction of an individual (between 0.09 and 0.39 animals). Calculated take estimates for ringed seals ranged between 2 and 4, but these potential takes are mitigated to near zero through the marine mammal monitoring program and the conservative 50-m (164-ft) safety zone. In the event of a seal approaching the 50-m (164-ft) safety zone, the seismic array would be temporarily shutdown well before a seal reached the 2-m (6.6-ft) zone (190 dB criterion) where injurious take would occur. Further, it is unlikely that a seal would approach an active airgun to within 2 m (6.6 ft) in the first place. Consequently, no additional takes are expected, nor additional take authorizations requested, related to Level A take criterion for marine mammals.

Only the area outside the barrier islands was used in the calculations for bowhead whales. These estimates, and the requested authorizations, are shown in Table 6.2-2. There are no density estimates for humpback, minkie, killer, gray or fin whales.

TABLE 6.2-1
Expected Densities of Marine Mammals During the PGS Seismic Surveys

Species	Average Density (number per sq km)	Maximum Density (number per sq km)
Cetaceans		
Bowhead Whale	0.0064[1]	0.0256[1]
Beluga Whale	0.0034[1]	0.0135[1]
Pinnipeds		
Ringed Seal	0.48[2]	0.77[2]
Spotted Seal	0.024[3]	0.039[3]
Bearded Seal	0.0128[1]	0.0226[1]

[1]From LGL (2005), Table 4.
[2]From Frost et al. (2002).
[3]Adapted from Green et al. (2005, 2006, 2007); 0.05 times the ringed seal density estimates.
sq km = square kilometers

TABLE 6.2-2
Estimates of Marine Mammal Exposures to PGS's Proposed Seismic Survey Activity in the Beaufort Sea

Species	Exposures (Average Density)	Exposures (Maximum Density)	Requested "Take" Authorization
Cetaceans			
Bowhead Whale	1	3	3
Beluga Whale	1	3	10[1]
Pinnipeds			
Ringed Seal	22	35	35
Spotted Seal	1	2	6[2]
Bearded Seal	1	2	6[3]
Total			**218**

[1]Take request increased to take into account beluga whale group size.
[2]The take estimate for spotted seals was tripled to account for the presence of a nearby spotted seal haulout (Colville River Delta).
[3]The take estimates for bearded seals was tripled to account for local knowledge regarding bearded seal harvest at Thetis Island.

The requested take authorization for beluga whales was increased to 10. Belugas travel in groups larger that 3; thus, if belugas were to enter inside the 170-dB radii, they would likely do so as a group.

The requested take authorization for spotted seals was tripled to take into account that one of the few spotted seal haulout sites in the Beaufort Sea occurs on the Colville River Delta is only 10 km (6.2 mi) southwest of the survey area. While few seals actually use this site, it is a focal area for these animals possibly leading to multiple harassments of the same seal.

LGL (2005) provided average and maximum density estimates for bearded seals of 0.0128 and 0.0226 per sq km, respectively. Compared to the percentage of bearded seals as a part of all seals recorded by Green et al. (2005, 2006, 2007), these estimates appear very reasonable. However, Jonah Nukapigak (personal communication) has provided local knowledge regarding the annual bearded seal hunt from Thetis Island (inside the survey area). Annually, approximately 50 to 75 bearded seals are sighted and about 20 harvested as they pass Thetis Island during the July and August bearded seal movements. While this information cannot be translated directly to density estimates, it does show that at times bearded seal numbers are high enough to warrant focused harvest from Thetis Island. Consequently we have requested a take authorization that is triple the maximum take estimate calculated using the LGL density estimates to reflect a possible seasonal peak in bearded seal numbers in the project area.

PGS does plan to continue conducting seismic surveys after August 25, the commencement of annual bowhead whale hunt, and the beginning of the fall bowhead migration. The NMFS (K. Hollingshead, pers. comm.) requires take estimates be evaluated out to the 120-dB isopleth for any operation occurring after August 25, unless the operator can show that their sound source would attenuated to less than 120 dB before reaching the normal bowhead whale migration lanes. Because of the downward sound directionality of the proposed array configuration, the radius to the 120-dB isopleth has been calculated to extend out to only 3 km (1.9 mi). Further, beginning in early August, PGS will move their operations inside the barrier islands, and remain there throughout the hunt and whale migration. Consequently, the closest 120 dB level sounds could reach migrating whales is a point 3 km (1.9 mi) north of a line between Spy and Thetis islands. At this point the water depth is approximately 6 m (20 ft), less than suitable habitat for migrating bowhead whales. Further, much of the sound emanating from inside the barrier islands would be blocked by Spy, Thetis, and Leavitt Islands, leaving on a fraction of the survey area inside the barrier islands from which the 120-dB radius could even reach a point 3 km (1.9 mi) north of barrier islands. During most of the survey inside the barrier islands it is expected that the 120-dB radii would not extend at all outside the barrier islands.

However, the 120-dB radius estimate is based on modeling. Actual field measurements of acoustical signatures for the proposed array are planned at the onset of the surveys. Should these measurements determine that the 120-dB radius could extend into the bowhead whale migration corridor, additional mitigation measures will be proposed in conjunction with consultation with NMFS, the NSB, and the Alaska Eskimo Whaling Commission (AEWC).

Because PGS plans to operate inside the barrier islands only during the fall, and these interior habitats typically provide less suitable habitat for marine mammals as compared to outside the barrier islands, no increase in animal densities are expected during the fall seismic survey. Thus, separate take estimates for the fall period were not calculated.

7.0 ANTICIPATED IMPACT OF THE ACTIVITY ON THE SPECIES OR STOCK

7.1 Introduction

The proposed seismic activity that would potentially affect marine mammals through seismic sources include airgun operations. This activity is expected to result in a temporary displacement of whales and seals within the ensonified zones but are not expected to result in significant behavior disruption. Impacts on Beaufort Sea whale and seal populations are likely to be short-term and transitory and temporary displacement should occur only when seismic sounds emit received noise levels greater than 160 dB. Although impacts such as brief behavioral and acoustical alterations may occur, due to a lack of scientific data, it is impossible to determine the level of physical damage on marine mammal hearing mechanisms. To prevent risk of auditory damage, the MMO program and procedures to ramp-up from 80 cu in to 880 cu in prior to seismic data collection, should alleviate significant impact. Further, these activities are not expected to result in a significant impact on species or stocks of marine mammals, and should also not affect the availability of species or stocks for subsistence use.

7.2 Behavioral Response

7.2.1 Bowhead Whale

Bowhead whales will likely show some behavioral changes during airgun activity, but depending on distance from the noise source, overall displacement should be minimal. Bowhead whales in the Beaufort Sea were observed remaining in a location where they were exposed to seismic, dredging, and drilling sounds. Their social and feeding behavior appeared normal as industry-related noises occurred (Richardson et al. 1987). When observed over multiple years, bowhead whales in the same area also did not appear to avoid seismic locations. MMS did not find a statistical difference in the change of direction for bowhead whales traveling during seismic activity when analyzing fall migration data from 1996 to 1998 (MMS 2005). Bowhead and gray whales have appeared unbothered when seismic pulses between 160 dB and 170 dB re 1 µPa were fired from a seismic vessel within a few km of their locality, but tended to avoid the area when levels exceeded 170 dB (Richardson et al. 1997).

Common behavioral responses of marine mammals include displacement, startle, attraction to sound, altered communication sounds, discontinued feeding, disruption to social behaviors, temporary or permanent habitat abandonment, panic, flight, stampede, and in worse cases stranding, and sometimes death (Nowacek et al. 2007; Southall et al. 2007; Gordon et al. 2004). Behavior ranges from temporary to severe and the effects can influence foraging, reproduction, or survival. Response level is based on how habituated or sensitive the individual mammal is and whether or not previous interactions with sound was positive, negative, or neutral (Southall et al. 2007). The common behavioral patterns seen in bowhead whales when seismic operations were operated nearby include displacement, avoidance, and altered respiration (Richardson et al.1999; Ljungland et al. 1988). Whales may also display varied reactions based on the time of the year and activity. Bowhead whales migrating in the fall exhibited avoidance at distances up to 20 km (12 mi) or more, while bowheads feeding during summer displayed more subtle reactions and did not show a strong avoidance at distances past 6 km (3.7 mi) from active airguns (Miller et al. 2005).

It is unclear exactly what causes displacement, but whales have tended to show shorter surface and dive times, fewer blows per surfacing, and longer blow intervals when noise levels were at or above 152 dB and show avoidance of seismic operations within a 20-km (12.4-mi) radius (Ljungbald 1988; Richardson 1999). Bowhead whales may also flee from or show total avoidance of vessels if they are too close. Bowhead whales showed total avoidance at distances of 1.3 km, 7.2 km, 3.5 km, and 2.9 km (0.8 mi, 4.5 mi, 2.2 mi, and 1.8 mi) when sound levels were 152 dB, 165 dB, 178 dB, and 165 dB, respectively (Ljungbald et al. 1988). Based upon McCauley et al., bowhead whales exhibit a behavioral change at 120 dB when migrating. However, other low-frequency cetaceans, including bowhead whales, exhibit behavioral changes at 140 dB to 160 dB when not migrating, and sometimes higher levels (Miller et al. [2005]).

7.2.2 Beluga Whales

Seismic activity is expected to cause temporary displacement of beluga whales, but the impact is not expected to be significant. Belugas have been shown to have greater displacement in response to a moving source (e.g., airgun activity on a moving vessel) and less displacement or behavioral change in response to a stationary source. The presence of belugas has been documented within the ensonified zones of industrial sites near platforms and stationary dredges,

and the belugas did not seem to be disturbed by the activity (Richardson et al. 1995). When drilling sounds were played to belugas in industry-free areas, the belugas only showed a behavioral reaction when received levels were high (Richardson et al. 1997). Beluga whales have been observed to show only an initial scare when drilling noises were played with a received level greater than or equal to 153 dB re 1 µPa. Richardson (1997) suggested that the effect could be a result of belugas having less sensitivity to low-frequency sounds. Other reports suggested that belugas will remain far away from seismic vessels (Miller et al. 2005). A study in the Beaufort Sea observed low numbers of belugas within 10 km to 20 km (6 mi to 12 mi) of seismic vessels (noted in LGL 2006).

7.2.3 Ringed Seals

Ringed seals can be expected to have only short-term and temporary displacement as a result of the proposed PGS project activities. Seals should not be exposed to source levels higher than 190 dB re 1 micro Pascal (µPa) due to the potential for hearing damage. Though ringed seals have density and estimated take higher than other marine mammals in the project area, ringed seals exposed to sound sources as high as 200 dB, displayed only brief orientation and minor behavioral modifications, and only momentary left young (Moulton et al. 2005, Southall 2007, Blackwell 2004). Any behavioral reactions to activities should only be temporary and should also not disrupt reproductive activities. When industrial- related sounds propagated 1 km to 3 km (0.6 mi to 1.9 mi) within ringed seals location, normal behavior such as maintaining active breathing holes and lairs continued, and observed breeding females appeared to be unbothered (Moulton et al. 2005).

In 1998, a total of 252 ringed seals were counted over a period of 1,331 hours, contributing to 98.5 percent of the total pinniped population during this time. Richardson (1999) found sounds produced from both a 16 - 1500 cu in. sleeve gun array and another 8 - 560 cu in. sleeve gun array affected distribution and behavior only when seals were within a few hundred meters of the array and ringed seals remained in the project area during operations. During seismic activities, whales also remained at a mean radial distance of 223 m (731 ft) during seismic operations and 116 m (381 ft) when seismic operations did not occur (Richardson 1999).

Over time, ringed seals may also show less displacement and fewer behavioral changes. In one study, ringed seals remained distant from activities during the first season of seismic activities, but during the second season, were observed at close proximity of the marine vessel. No observable behavioral changes were accounted for with received levels ranging between 170 and 200 dB (Miller et al. 2005).

7.2.4 Spotted Seals

The total number of spotted seals in Alaska is assumed to be tens of thousands and their range sometimes includes the Beaufort Sea (MMS 1996 Rugh et al. 1997). Any impacts on spotted seals should also be minimal as high numbers of spotted seals should not occur in the project area. From July-September 1996, Harris et al. (2001) counted a total of 422 seals in the Beaufort Sea. Of the seals counted, only 0.9 percent were spotted seals. Spotted seal reactions to seismic activities are typically minimal and spotted seals have demonstrated little or no reaction to scare devices even when linked to areas for feeding or reproduction (Harris et al. 2001).

7.2.5 Bearded Seals

In his study during summer 1996, Harris (2001) found bearded seals were 7.3 percent of the total number of seals counted. Though bearded seals are bottom feeders and are usually found in water depths less than 200 m (650 ft), if the rarity of an encounter should occur, bearded seals

like other pinnipeds should demonstrate only minimal displacement and behavioral reaction. Bearded seals did not show reactions to 1,450 cu in to 2,250 cu in airguns when received levels averaged in the range of 170 to 200 dB (Richardson 1999).

7.3 Hearing Impairments

7.3.1 Sound Transmission

Marine mammals rely on sound transmission for foraging, orientation, and predator avoidance (Southall 2007; Au 2000). Marine mammals typically show different reactions to sound based on the species, sex, reproductive status, and previous exposure to sound. Marine mammals have also demonstrated a higher behavioral sensitivity when traveling with their young (MMS 2006). Although various marine mammals hear and vocalize at different frequencies, current criteria set forth by NMFS Level A and B harassment is 180 dB 1 µPa and 160 dB 1 µPa, respectively, for cetaceans; and 170 dB for Level B harassment for pinnipeds (Southall 2007).

Currently, it is presumed that species will remain unaffected by sounds outside of their range of hearing (Southall 2007). Pinnipeds have a different hearing capacity than cetaceans and they lack a specialized active biosonar. Pinnipeds also communicate both in water and air (at 75 Hz to 75,000 Hz in water, and 75 Hz to 30,000 Hz in air) (Southall 2007).

7.3.2 Temporary Threshold Shift and Permanent Threshold Shift

When conducting seismic activities, a Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS) is not expected to occur in marine mammals. When marine mammals located within a vulnerable range are impacted by impulsive noises, the noises can lead to TTS or PTS. When TTS occurs, the result is reversible: hearing in exposed mammals is temporarily affected. A TTS may result in mammals failing to locate predators or prey and the inability to communicate effectively with other individuals of the same species. When the threshold does not return to the original threshold levels, the damage is classified as PTS. It is unknown what level of sound will cause PTS in marine mammals, but it is reasoned to occur at a much greater level than that caused by TTS (NMFS 2005).

TTS and PTS in given species depends upon the frequency sensitivity of that species. Bowhead and gray whales operate at a low frequency, killer whale and beluga at mid frequency, and the harbor porpoise at high frequency (Southall 2005). Finneran (2002) estimated sound levels greater than 192 dB re 1 µPa will lead to a TTS in most cetaceans (NMFS 2005). There are no data identifying the level of sound intensity that causes a TTS in baleen whales, but because most baleen whales show avoidance at certain sound intensities, risk of TTS should be avoided (MMS 2006; Southall 2007). Under prolonged exposure pinnipeds have been shown to exhibit TTS. Kastak et al. (1999) investigated the effects of noise on two California sea lions *(Zalophus californianus)*, one northern elephant seal (*Mirounga angustirostris)* and one harbor seal (*Phoca vitulina*). Kastak et al. (1999) subjected each pinniped to a noise source (100 to 2,000 Hz) for 20 to 22 minutes. Each pinniped showed a threshold shift averaging 4.8 dB *(*harbor seal), 4.9 dB *(*sea lion), and 4.6 dB (northern elephant seal) until the hearing threshold returned to pre-exposure values (under a 12-hour period). PGS mitigation measures such as monitoring by MMOs within the safety zone, and, ramp-up prior to seismic operations, should prevent marine mammals from sound exposure that causes TTS and PTS. Received levels causing injury to seals are unknown and there is no specific data that point to permanent threshold damage (Harris et al 2001).

7.3.3 Masking

Masking is the coverage or reduction of a sound (e.g., marine mammal communications) when a stronger sound (e.g., airgun noises) interferes with that sound (Richardson et al. 1995). Masking is expected to be minimal and to rarely interfere with whale calls. It is presumed, but not yet determined that, like humans, marine mammals in their natural environment have the ability to sort out sounds specific to communication, foraging, and safety while overlapping noises occur (Southall 2007; Madsen 2005a). During 13 days of seismic survey pulses, sperm whales continued normal calls, and vocalization patterns remained undisturbed by received noise levels up to 146 dB re 1µPa (Madsen 2002). Some studies suggest several whale species might alter their vocalization levels to adjust to various levels of background noise (MMS 2006; MMS 1998). Belugas on the St. Lawrence River in Canada adjusted to high noise levels by vocalizing more loudly when exposed to high level sound sources (Scheifele 2005). Some of the smaller odonocetes communicate at frequencies higher than those produced by airguns, so their calls should naturally avoid masking.

Low frequency sounds emitted by airguns overlap with mysticeti communication frequency, but not with the frequencies used by odnotocetes and pinnipeds. Mitigation measures are expected to prevent close unsafe contact between marine mammals and airguns, and the precautionary measures should prevent mysticeti masking and consequently not disrupt communication.

8.0 ANTICIPATED IMPACT OF ACTIVITY ON AVAILABILITY OF SPECIES OR STOCKS OF MARINE MAMMALS FOR SUBSISTENCE USES

8.1 Introduction

Subsistence hunting and fishing is historically, and continues to be, an essential aspect of Alaska Native life, especially in rural coastal villages. The Inupiat people participate in subsistence hunting and fishing activities in and around the Beaufort Sea. The animals taken for subsistence provide a significant portion of the food that will feed the people throughout the year. Along with providing the nourishment necessary for survival, 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.

Only minor, temporary effects from the seismic survey project are anticipated on Native subsistence hunting. PGS does not expect any permanent impacts on marine mammals that will adversely affect subsistence hunting. Mitigation efforts will be implemented to minimize or completely avoid any adverse effects on marine mammals. Additionally, areas being used for subsistence hunting grounds will be avoided. It is anticipated that only minor, temporary displacement of marine mammals will occur.

8.1.1 Subsistence Hunting

Alaska Natives, including the Inupiat, legally hunt several species of marine mammals. Marine animals used for subsistence within the Beaufort Sea region include bowhead whales, beluga whales, ringed seals, spotted seals, and bearded seals. Each village along the Beaufort Sea hunts key subsistence species. Hunts for these animals occur during different seasons throughout the year. Depending upon the success of a village's hunt for a certain species, another species may become a priority in order to provide enough nourishment to sustain the village. Communities

that participate in subsistence activities potentially affected by seismic surveys within the proposed development area are Nuiqsut and Barrow.

Nuiqsut is the village nearest to the proposed seismic activity area. Bowhead whales, beluga whales, ringed seals, spotted seals, and bearded seals are harvested by residents of Nuiqsut. Because the village is 56 km (35 mi) inland (Alaska community Online Database 2008), whaling crews travel in aluminum skiffs equipped with outboard motors to offshore areas such as Cross Island (Funk and Galginaitis 2005). Of the marine mammals harvested, bowhead whales are most commonly harvested. In 1992 an estimated 34,884 kilograms (kg) (76,906 pounds [lbs]) were harvested (ADF&G 2008). Seals are also regularly hunted and may account for up to 3,770 kg (8,310 lbs) of harvest, while beluga whale harvests account for little or none (ADF&G 2008).

Barrow residents' main subsistence focus is concentrated on biannual bowhead whale hunts that take place during the spring and fall. Other animals, such as seals, are hunted outside of the whaling season, but they are not the primary source of the subsistence harvest (URS Corp. 2005).

8.1.2 Bowhead Whales

The bowhead whales that could potentially be affected by seismic activity in the Beaufort Sea come from the Western Arctic stock. The majority of these whales migrate annually during the spring from wintering grounds in the Bering Sea, through the Chukchi Sea, to summer grounds in the Beaufort Sea. During the fall migration, the whales travel back through the Chukchi Sea to their wintering grounds in the Bering Sea. While on their spring migration route, bowhead whales travel through leads in the ice between the shore-fast ice and pack ice.

In a study of approximately 440 bowhead whales between 1989 and 1994 off the coast of Point Barrow, Richardson et al. (1995) documented movements and behaviors in response to playbacks of sounds similar to those produced by site clearance and shallow hazard surveys. Whale behavior in relation to the sound level being received at the whales' locations was observed. It was concluded by the research team that the sounds emitted did not have a biologically significant effect on bowhead movement, distribution, or behavior.

Ten primary coastal Alaskan villages deploy whaling crews during whale migrations of these ten. Nuiqsut has the potential to be affected by the proposed project. Nuiqsut is the village situated closest to the proposed project area. Barrow is located farther from the proposed seismic activity but has the potential to be affected. These two communities are part of the AEWC. The AEWC was formed as a response to the International Whaling Commission's (IWC's) past closure of bowhead whale hunting for subsistence purposes. IWC sets a quota for the whale hunt, and AEWC allocates the quota between villages. Each of the villages within the AEWC is represented by a Whaling Captains' Association. Bowhead whales migrate within the hunting range of whaling crews in the spring (north migration) and the fall (south migration). In the spring, the whales must travel through leads in the ice that tend to occur close to shore. In the fall, the water is much more open, allowing the whales to swim farther from the coast. Whaling crews in Barrow hunt in both the spring and the fall (Funk and Galginaitis 2005).

Bowhead whale hunts in Barrow occur during the spring and fall. In the spring, the whales are hunted along leads that occur when the pack ice starts deteriorating. This tends to occur in Barrow between the first week of April and the first week of June, well before the geophysical surveys will be conducted. The proposed seismic survey is anticipated to start after all the ice melts, in approximately mid-July, and will not affect spring whaling. Fall whaling activities are anticipated to take place east of Point Barrow (BLM 2005). The project area is located 260 km

(160 mi) east of Point Barrow. It is anticipated that the project will not impact the Barrow fall hunt. The Nuiqsut fall whale hunt takes place in the vicinity of Cross Island, ranging from there to approximately 50 km (30 mi) north of the island. The project area is located approximately 60 km (37 mi) west of Cross Island and is too shallow (less than 15 m [50 ft] deep) to support bowhead whales. It is unlikely that the Nuiqsut fall hunt would extend to the project area. Adverse impacts on the subsistence harvest of bowhead whales as a result of the proposed survey are not anticipated.

8.1.3 Beluga Whales

Beluga whales summer in the waters of the Chukchi and Beaufort Seas and winter in the Bering Sea. Living in areas mostly covered in ice, they are associated with leads and polynyas (Haard 1988). Beluga whales can be hunted from the first week in April to July or August. It is common for the Inupiat to refrain from hunting beluga during the spring or fall bowhead whale hunt to prevent scaring the larger whales away from hunting locations. Belugas do not account for a majority of the total subsistence harvest in Barrow or Nuiqsut (ADF&G 2008). Between 1999 and 2003, the annual beluga subsistence "take" was 65 (Frost and Suydam 1995).

8.1.4 Ringed Seals

Ringed seals are distributed throughout the Arctic Ocean. They inhabit both seasonal and permanent ice. An abundance and distribution study conducted in the Beaufort Sea before, during, and after anthropogenic sound-producing construction found that there were only slight changes near construction activities around British Petroleum's (BP's) Northstar oil development that most likely were caused by environmental factors (Moulton et al. 2005). Harris et al. (2001) performed a study using 3D seismic arrays in which the number of seal sightings varied only slightly in periods of no sonar firing, single sonar firing, and multiple-array sonar firing. Seals tended to stay slightly farther away from the vessel at times of full-array sonar firing, but they rarely moved more than 250 m (820 ft) from the vessel. Sonar activity was interrupted when seals came within a certain radius (150 m [492 ft] to 250 m [820 ft]) of the vessel, in accordance with regulations set by NMFS.

Ringed seals are available to subsistence users year-round, but they are primarily hunted in the winter due to the rich availability of other mammals in the summer. In 2000, the annual estimated subsistence "take" from Alaska of ringed seals was 9,567. Because the bulk of the ringed seal hunting will occur outside the time scope of the proposed project, adverse impacts on ringed seals as a result of the proposed survey are not anticipated.

8.1.5 Spotted Seals

Spotted seals in Alaska are distributed along the continental shelf of the Beaufort, Chukchi, and Bering Seas. These seals migrate south from the Chukchi Sea, through the Bering Strait, into the Bering Sea beginning in October. They spend the winter in the Bering Sea traveling east and west along the ice edge (Lowry et al. 1998). Because of the numbers of whales and bearded seals and the opportunities for subsistence harvesting of them, spotted and ringed seals are primarily hunted during winter months in the Beaufort Sea. Since this time frame is outside the scope of the proposed project, subsistence activities involving spotted and ringed seals are unlikely to occur during the survey (BLM 2005). PGS does not anticipate adverse effects to spotted seals as a result of project activities.

8.1.6 Bearded Seals

Bearded seals tend to inhabit relatively shallow water (less than 200 m [660 ft] deep) that does not have much ice. In Alaska they are distributed along the continental shelf of the Bering, Chukchi, and Beaufort Seas. Most bearded seals migrate in the spring from the Bering Sea, through the Bering Strait, and into the Chukchi Sea and spend the summer season along the ice edge. Some bearded seals do not migrate and spend all year in the waters of the Bering and Chukchi Seas. According to a subsistence harvest database, the 2000 annual harvest of bearded seals in Alaska was 6,788 (ADF&G 2000). Bearded seals are an important source of meat and hide for Chukchi Sea villages. They tend to be targeted by subsistence users over ringed and spotted seals because they are very large. This provides a large amount of meat and skins for constructing boats (BLM 2005).

Bearded seals are primarily hunted during July in the Beaufort Sea; however, in 2007 bearded seals were harvested in the months of August and September at the mouth of the Colville River Delta (Smith, personal communication 2008). The proposed project location is not a primary subsistence hunting ground; however, it is occasionally used by residents of Nuiqsut for subsistence hunting of bearded seals. An annual bearded seal harvest occurs in the vicinity of Thetis Island in July through August (J. Nukapigak, Nuiqsut hunter, personal communication 2008). Approximately 20 bearded seals are harvested annually through this hunt.

PGS anticipates that there is not a significant potential for the proposed project to affect the bearded seal subsistence hunt. Mitigation measures will be in place to minimize potential impacts.

9.0 THE ANTICIPATED IMPACT OF THE ACTIVITY UPON THE HABITAT OF THE MAMMAL POPULATIONS AND THE LIKELIHOOD OF RESTORATION OF THE AFFECTED HABITAT

The seismic survey activity proposed will not result in any permanent impact on habitats used by marine mammals or their prey sources. Furthermore, seismic activity will take place in shallow, nearshore waters less than 15 m (49 ft) deep which is not considered to be bowhead whale habitat. No impacts are expected to the ocean floor or anticipated by placing geophones on the ocean floor.

Relative to toothed whale and pinniped prey, a broad discussion on the various types of potential effects of exposure to seismic activity on fish and invertebrates can be found in LGL (2005). This discussion includes a summary of direct mortality (pathological/physiological) and indirect (behavioral) effects. Mortality to fish, fish eggs, and larvae from seismic energy sources would be expected within a few meters (0.5 m to 3 m [1.6 ft to 10 ft]) from the seismic source. Direct mortality has been observed in cod and plaice within 48 hours after they were subjected to seismic pulses 2 m (6.6 ft) from the source (Matishov 1992); however other studies did not report any fish kills from seismic source exposure (La Bella et al. 1996, IMG 2002, Hassel et al. 2003). To date, fish mortalities associated with normal seismic operations are thought to be slight. Saetre and Ona (1996) modeled a worst-case mathematical approach on the effects of seismic energy on fish eggs and larvae, and concluded that mortality rates caused by exposure to seismic energy are so low compared to natural mortality that issues relating to stock recruitment should be regarded as insignificant.

Limited studies on physiological effects on marine fish and invertebrates to acoustic stress have been conducted. No significant increases in physiological stress from seismic energy were detected for various

fish, squid, and cuttlefish (McCauley et al. 2000) or for male snow crabs (Christian et al. 2003). Behavioral changes in fish associated with seismic exposures from project activities are expected to be minor at best. Because only a small portion of the available foraging habitat would be subjected to seismic pulses at a given time, fish would be expected to return to the area of disturbance within anywhere from 15 to 30 minutes (McCauley et al. 2000) to several days (Engas et al. 1996).

Available data indicate that mortality and behavioral changes do occur within very close range to the seismic source; however, the proposed seismic site clearance activity in the Beaufort Sea are predicted to have a negligible effect on the prey resources of the various life stages of fish and invertebrates available to marine mammals. Further, the 880-cu-in array, proposed for this project, produces a relatively low energy pulse (197 dB peak) compared to the seismic systems used in the above studies.

10.0 THE ANTICIPATED IMPACT OF THE LOSS OR MODIFICATION OF THE HABITAT ON THE MARINE MAMMAL POPULATIONS INVOLVED

The effects of the planned seismic activity at each of these locations on marine mammal habitats and food resources are expected to be negligible, as described in Section 9.0. It is estimated that only a small portion of the animals utilizing the areas of the proposed activities would be temporarily displaced. No loss of habitat is anticipated due to laying cable on the ocean floor.

During the period of seismic surveying (July through mid-September), most marine mammals would be dispersed throughout the area. The peak of the bowhead whale migration through the Alaskan Beaufort Sea typically occurs in September. Starting in late August, bowheads may travel in proximity to the seismic surveys and hear sounds from vessel traffic and seismic activity, which might temporarily displace some whales. In addition, feeding does not appear to be an important activity for bowheads migrating through the Chukchi Sea in most years; however, sightings of bowhead whales do occur in the summer near Barrow (Moore and DeMaster 2000), and there are suggestions that certain areas near Barrow are important feeding grounds. In the absence of important feeding areas, the potential diversion of a small number of bowheads away from survey activities is not expected to have any significant or long-term consequences for individual bowheads or their population. Bowheads are not expected to be excluded from any habitat.

The numbers of cetaceans and pinnipeds subject to displacement are very small in relation to abundance estimates for the mammals addressed under this IHA.

The proposed activities are not expected to have any habitat-related effects that would produce long-term effects to marine mammals or their habitat due to the limited extent and very nearshore location of the survey area.

11.0 AVAILABILITY AND FEASIBILITY OF EQUIPMENT, METHODS, AND MANNER OF CONDUCTING ACTIVITY OR OTHER MEANS OF EFFECTING THE LEAST PRACTICABLE ADVERSE IMPACT UPON THE AFFECTED SPECIES OR STOCKS, THEIR HABITAT, AND ON AVAILABILITY FOR SUBSISTENCE USES, PAYING PARTICULAR ATTENTION TO ROOKERIES, MATING GROUNDS, AND AREAS OF SIMILAR SIGNIFICANCE

Several mitigation efforts will be followed in order to cause the minimal adverse impact upon affected species. These include:

- The seismic vessel will remain within 5 km (3 mi) of the coastline and is not expected to pass the state/federal boundary line, avoiding bowhead whale migration routes.
- In response to discussions with AEWC, PGS has negotiated the following operational windows to further avoid potential impacts to migrating whales. The timing of the proposed survey would be divided into two parts. Data acquisition outside the barrier islands (Thetis Island, Spy Island, and Leavitt Island), the deepest water in the survey area, would be performed first and would be completed by August 5. Data acquisition inside the barrier islands, with maximum water depth of approximately 4.6 m (15 ft), would then be conducted from August 5 through September 15. No data acquisition would be conducted outside the barrier islands after August 5.
- Although seismic operations are proposed to be conducted during the fall whale hunt (after August 25), they would not occur within the areas normally used by hunters from Barrow (Point Barrow) or Nuiqsut (Cross Island). The survey area is 60 km (37 mi) west of Cross Island (and "downstream" of the bowhead whale fall migration) and 260 km (160 mi) east of Point Barrow.
- Although, seismic operations are proposed to be conducted during the fall whale migration (after September 1), activities would occur in shallow waters within the barrier islands that are not considered whale habitat. The barrier islands are also expected to act as an obstacle to sounds generated by seismic activities, effectively keeping sound propagation from entering the zone of migration.
- MMOs will be stationed on source vessels to ensure that the seismic arrays are not operated in close proximity to marine mammals and will be actively involved in vessel operations during all survey operations.
- PGS has offered to hire Inupiat speakers to perform seismic work on each of the PGS vessels. As part of their duties, the Inupiat speakers will also keep watch for marine mammals and will communicate with the MMOs located on the source vessels.
- PGS will participate in the Com Centers proposed to be operated in Barrow and Deadhorse. Com Centers enable vessel operators to be aware of and avoid marine mammal and subsistence activity in the area. Communications of vessel operations and transit will occur via telephones, the Internet, and very high frequency (VHF) radios.
- The proposed airgun energy source is relatively small, reducing the ensonified zone and the impacts to marine mammals.

- The airgun source will be acoustically measured from all directions and in varying water depths at the start of operations. Using this information, an avoidance radius will be determined within which any marine mammal sighting will cause an immediate shutdown of the airguns.
- Ramp up and soft start methods will be conducted while seismic operations are initiated. This is intended to alert marine mammals in the area so that they may swim away from the source before the full energy source is employed.
- A shutdown safety radius of 50 m (160 ft) will be monitored and enforced for all marine mammals during operations to ensure that injurious "takes" are avoided. This safety radii will be adjusted accordingly based on the results of the acoustic measurements mentioned above.
- PGS will participate in an offshore monitoring program that will take place from mid-August until mid- to late September in cooperation with Pioneer Natural Resources, Inc., (Pioneer) and ENI and in coordination with Shell Offshore, Inc. which includes:
    - Monitor in-water sound near and distant from Pioneer's Oooguruk drill site, ENI's Spy Island drill pad, and vessel operations using four autonomous seafloor acoustic recorders (ASARs).
    - Monitor and characterize sounds produced from shallow-depth seismic survey planned by PGS using ASARs and directional autonomous seafloor recorders (DASARs).
    - Detect and localize marine mammal vocalizations using an array of DASARs positioned north and northwest of the Pioneer and ENI projects.
    - Visually survey the coastal Beaufort Sea from an aircraft to search for bowhead whales and characterize behavior of those animals observed.

12.0 LOCATION OF PROPOSED ACTIVITY – IN OR NEAR A TRADITIONAL ARCTIC SUBSISTENCE HUNTING AREA AND IMPACT ON AVAILABILITY OF SPECIES OR STOCK OF MARINE MAMMALS FOR ARCTIC SUBSISTENCE USES; APPLICANT MUST SUBMIT A "PLAN OF COOPERATION" OR INFORMATION TO IDENTIFY PLANNED MEASURES TO MINIMIZE ADVERSE EFFECTS ON AVAILABILITY OF MARINE MAMMALS FOR SUBSISTENCE USES

The proposed survey location is in the Nikaitchuq Lease Block north of Oliktok Point, covering Thetis, Spy, and Leavitt Islands, and would extend to the 5 km (3 mi) state/federal water boundary line. The program would not go into federal waters. Due to the location of the proposed project, conflicts with subsistence activities would likely be avoided. PGS anticipates that there is a potential for the proposed project to affect the bearded seal subsistence hunt. Mitigation measures will be in place to minimize potential impacts.

PGS developed a Draft Plan of Cooperation (POC), which included a timeline of meetings set to occur in the communities identified as potentially being affected by the proposed project. These communities are Nuiqsut and Barrow. The Draft POC document was distributed to the communities, subsistence users

groups, NMFS, and USFWS on March 20, 2008. Based upon discussions with communities and subsistence users, PGS has incorporated changes to the project to reduce potential subsistence conflicts. These changes are discussed in Addendum 1 of the Draft POC, which was submitted to the potentially affected communities and subsistence users groups, NMFS, and USFWS on May 7, 2008. Copies will also be available during POC meetings in Barrow on May 8, 2008 and in Nuiqsut on May 9, 2008. A Final POC document including all input from potentially affected communities and subsistence users groups will be provided upon completion of the May POC meetings.

PGS has identified the following groups to be included in the project outreach effort:

- The NSB Planning Commission
- The Alaska Eskimo Whaling Commission
- The Kuukpikmiut Subsistence Oversight Panel, Inc.
- The Alaska Ice Seal Committee
- The Alaska Nanuuq Commission
- The Inupiat Community of the Arctic Slope
- The Village of Nuiqsut
- The Village of Barrow

A pre-application meeting was conducted with the NSB and state and federal agencies to facilitate early identification of key issues and to define an appropriate Plan of Cooperation agenda for the potentially affected subsistence communities.

13.0 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 POPULATIONS 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. GUIDELINES FOR DEVELOPING A SITE-SPECIFIC MONITORING PLAN MAY BE OBTAINED BY WRITING TO THE DIRECTOR, OFFICE OF PROTECTED RESOURCES

The proposed MMMMP is included as Appendix B. It should be noted that all sightings of polar bears will be recorded and reported to the USFWS.

14.0 LEARNING, ENCOURAGING, AND COORDINATING RESEARCH OPPORTUNITIES, PLANS, AND ACTIVITIES RELATING TO REDUCE AND EVALUATE INCIDENTAL "TAKE"

To reduce and evaluate incidental "take", PGS will encourage and coordinate collaborative research opportunities within state, federal, and NSB divisions. Active communication will ensure proper regulatory compliance and build local biological knowledge, and thus, may reduce incidental "take". Contacts such as the USFWS and National Oceanic and Atmospheric Administration (NOAA) can assist with marine mammals or avian interactions and abnormal behavior. To better understand the importance of issues surrounding marine mammals and fisheries within the region, NSB Department of Wildlife Management biologists might also provide input and advice.

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Appendix A
Equipment Specifications

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Recording System Description

Sercel 408UL Recording System

The 408 UL is a large capacity, high-resolution seismic acquisition system. A new approach to combined telemetry, named Seismic Areal Network, provides complete flexibility and the best solution for today's complex operational problems. All components of the 408UL become nodes communicating simultaneously within the recording operation. The 408UL offers advantages such as fewer components, lower power-simple battery management, uncomplicated 4 wire cables, no takeouts, fewer connectors and improved troubleshooting capability.

The 408UL is composed of a Central Control Unit (HCI & CMXL) and Acquisition Units (LAU) with active link cables (FDU-LINKS). Data acquisition is performed by the acquisition units, remotely powered from 12 VDC batteries. The central control unit consists of a Human Computer Interface workstation (HCI) and a control module (CMXL).

Central Control Unit

The Human Computer Interface (HCI) is dedicated to system interaction with the operator, through a fast and comprehensive software package specially designed to ease geophysical operations in the field. The operator controls the complete system through a UNIX based workstation with multiple high-resolution color monitors. A multi-windowing system allows flexible and versatile screen extensions allowing access to all parameter settings. The major functions of the HCI software include:

- Normal operation control (parameter set-up, update and display for the entire system).
- Permanent graphic display of the complete field electronics connected to the control unit, including ancillary units and the shot point. The graphic display allows interactive selection of the spread and energy monitoring prior to and during the shot.
- Preplanning I/O capability; script files can be saved to and/or loaded from auxiliary sources. Shot point set-up and updating is easily accomplished
- Graphic display of planned source and receiver positions, possibly superimposed on a digitized map as well as optional real time tracking of the source position
- Display, analysis and storage of spread tests, automatic log of observer report data
- Printout of all parameters and hard copy of daily production report (customized) using a standard line printer attached to the HCI

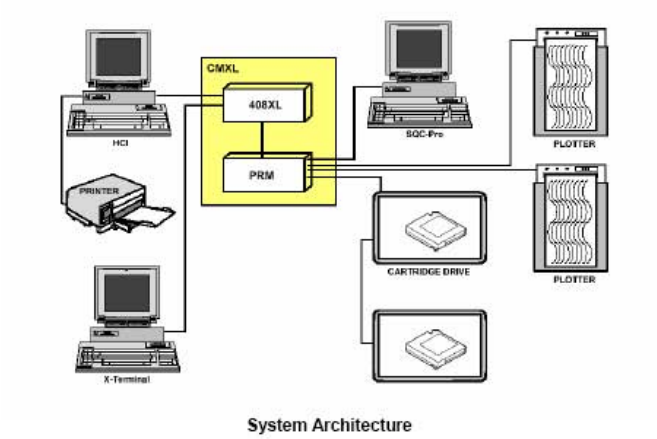
The parameters entered through the HCI are downloaded to the CMXL module. The CMXL consists of a 408XL unit and PRM (processing remote module) processing software. The major functions performed by the 408XL module include:

- Interfacing with the field electronics
- Generating the Firing Order and sensing Time Break.
- Seismic line management and control
- Auxiliary line control
- Collecting the data from the field electronics
- Collecting system status data to be returned to the HCI

The major function of the PRM software include:

- Formatting the data to and from the cartridge drive, the plotter and the SQC-PRO
- Noise editing(Zeroing/Clipping/ Diversity Stack)

Recording System Description



System Architecture

Acquisition Units

The field electronics for wire-line telemetry consist of two major components, Line Acquisition Units (LAUs) and Links including digitizing input points (FDUs)

LAUs

When used to connect adjacent lines an LAU is called an LAUX; when used to connect line sections it is called an LAUL. LAUX and LAUL units are primarily used as interconnecting units within the spread. They are also used by the HCI to control the path of data flow from the acquisition lines to the recorder. LAUs collect, buffer, decimate, filter and compress data received from the FDUs before sending to the CM408. They also synchronize all of the samples to time break, process the FDU instrument tests, and condition and inject power to the FDU links..

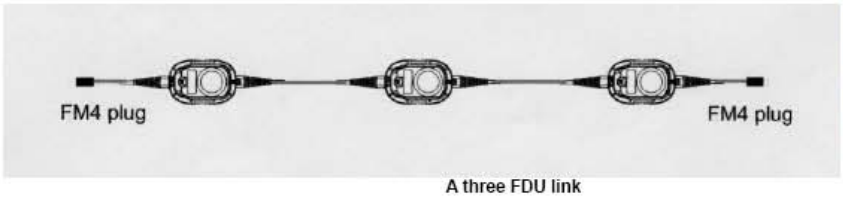
LAUL

LAUX

FDU LINKS

A Link consists of one or more extremely small, lightweight acquisition units (FDU: Field Digitizer Units), connected by a small-diameter custom-length cable with 4-pin hermaphroditic plugs at either end. The Link is handled as one unit including FDU's and cables and can be modified from job to job to offer flexible solutions to meet operational and safety requirements. The FDU operates from the power supplied via the LAU. It converts the analog signal from the sensors into digital data, performs first-stage filtering and relays the data to the LAU via the cable link. The FDU has a controlled gain pre-amp, analog-digital circuitry and a digitally controlled test signal generator built-in. This allows instrument tests without using external oscillators. The FDU's low-distortion, large dynamic range A/D converter achieves ideal seismic response. It is designed with no analog filters eliminating any undesirable phase shifts, preventing unrecoverable errors resulting from incorrect filter settings.

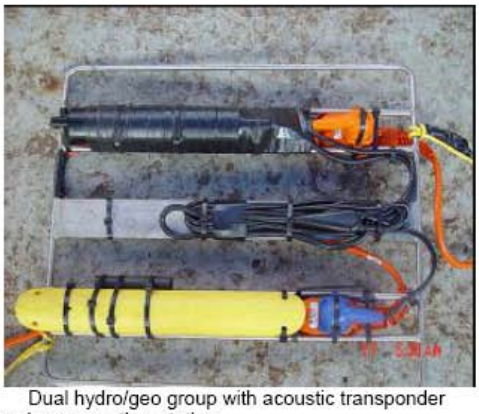
Recording System Description



A three FDU link

PGS Onshore's TZ crews are typically configured with two ground stations per link. The ground stations can either be single hydrophone (2 FDU's per link), dual hydrophone and geophone (4 FDU's per link), or four component (8 FDU's per link) configurations. The number of links between LAU's is a function of FDU power consumption and cable distance. Normal separation of LAU's is 42 ground stations for single hydrophone recording or 30 ground stations for dual sensor recording. Cable distance between ground stations is 75 meters.

Single hydrophone group with acoustic transponder



Dual hydro/geo group with acoustic transponder

Note: For this survey PGS is offering a 2C phone with transponder every other station

408UL Applicability

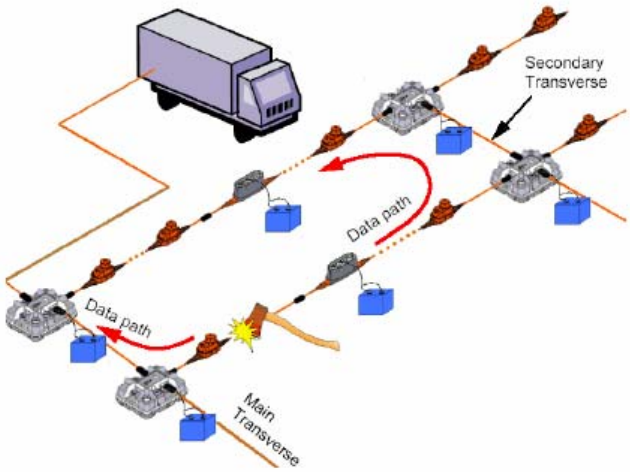
The 408 UL is rated by Sercel to withstand water depths of up to 15 meters. PGS Onshore has developed a specially modified cable head that allows for deployment of the standard FDU to water depths exceeding **40** meters. The specially modified cables have the static guard functionality removed in order to provide enhanced water block capability, since the static circuitry is not required for wet deployment. The 408UL cables, commonly known as WPSR, are water blocked and contain a Kevlar braid bonded within the outer jacket. They provide superior tensile strength while maintaining lightweight portability.

Multipath

One of the most important features of the 408UL system is its ability to continue recording in the event of a line failure. Adding additional LAUX's and Transverse cables to the seismic spread enables data to be re-routed, continuing the flow to the recorder in the event of a broken line or a failed Acquisition Unit.

Recording System Description

Multipath with LAUXs



Peripheral Equipment

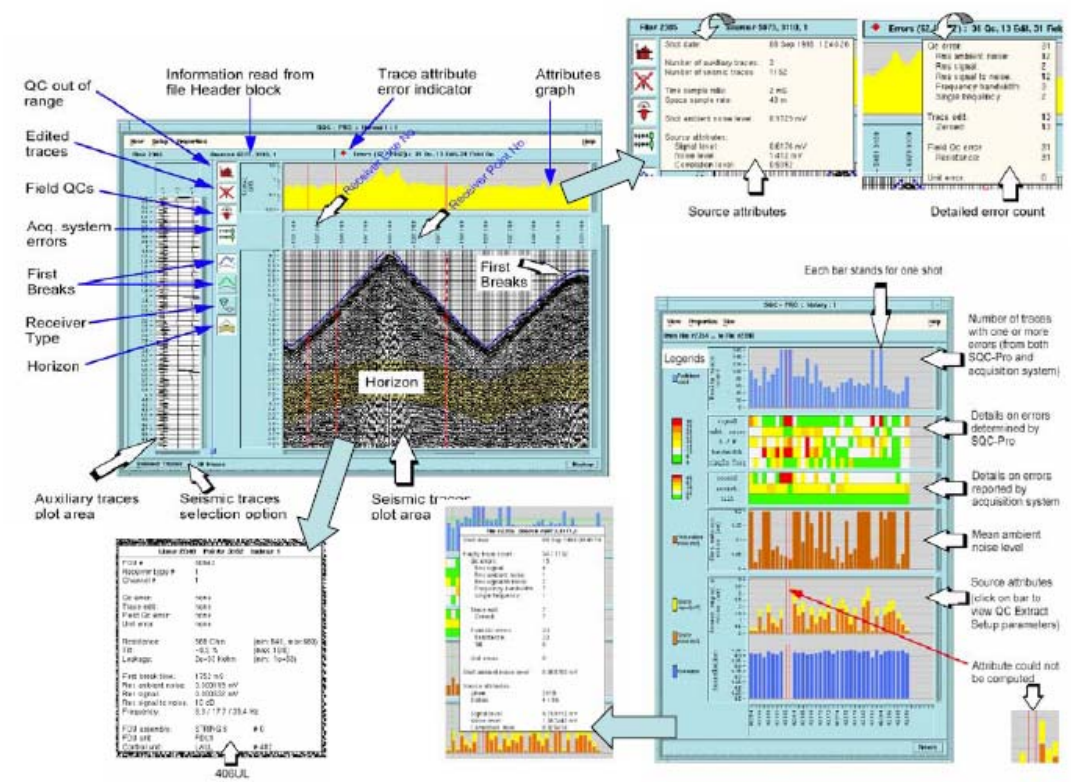
Tape Drives:
TED hard drives in recorder creating verified archive IBM 3590 tapes in QC/infield processing

Plotter:
Versatec V-12 plotter provides a paper record of the acquired seismic data, either in read-after-write or in play-back mode.

SQC-PRO (Real-time Quality Control)
SQC-PRO is an optional hardware and software package which can be implemented on-line with the standard 408UL data acquisition system to offer a powerful integrated tool for real time QC of seismic data without slowing down production rates. SQC-PRO is directly interfaced with all the 408UL acquisition modules through the READ or WRITE sockets of the acquisition module. In addition to the high-resolution seismic record display with enhanced AGC, filtering and equalization, SQC-PRO provides the following attribute displays :

- ambient noise
- seismic trace energy
- signal-to-noise ratio
- seismic trace frequency analysis
- shot gather F-K analysis
- geophone group resistance
- geophone group tilt
- detailed QC of any trace
- theoretical and picked first break arrival displays

Recording System Description



Analysis can be made over a fixed time range or windowed based on target move-out velocity. Any calculated attribute can be exported in SEG ADF file format for analysis in other software packages.

Test Equipment

Line Tester

When a LAUL and its associated set of LINKs is deployed in the field, a 408UL Line Tester may be plugged into the LAUL to completely test the set of LINKs. A full set of instrument tests (noise, distortion, phase, gain, CMRR) and geophone group tests (tilt, group resistance, leakage, noise) are performed and analyzed. Results are displayed on the Line Tester screen. The 408UL Line Tester may also be connected to a LAUX to test the local spread in the field.

Quick Tester

The Quick Tester allows to control power-up and transmission for link fault location by checking the power voltage as well as the transmission on cables. It requires live spread.With a weight of only 0.8Kg, it is a very useful and portable tool.

TMS 408

The TMS 408 is made of a PC connected to a testing unit (TMU408). It tests power transmission and leakage on Line ports of LAUs. The TMS408 performs also polarity, instrument, power and transmission tests on FDUs.

Recording System Description

System Specifications

Maximum Channels per Module:	10.800 @ 2ms/8s
Sample Rates:	4, 2, 1, 0.5, 0.25 msec
A/D Resolution:	24 bits
Full Scale Input Levels:	1.6 V RMS (at G1600 gain) 400 mV RMS (at G400 gain)
Low Cut Filter:	None
High Cut Filter:	0.8 x Nyquist (linear or minimum phase) (-3 dB point at 0.8 f_n with slope of 370 dB/octave)
Recording System / Filter Delay:	Zero

"WILLIAM BRADLEY" SPECIFICATIONS

Port of Registry:
Edmonton, AB

Official #:
810639

Classification:
Minor Waters 1

Year Built:
1991

Registered Tonnage:
Gross:337.75 T
Net: 222.86 T

Dimensions:
Length overall: 45.7 M
Breath Molded: 11.0 M
Depth Moulded: 2.13 M
Design Draft: Fwd 4.03 Ft
Aft 4.03 F**t**

Principal Capacities:
Fuel Oil: 22,700 Lts @ 95%
Lube Oil: 204 Lts.
Freshwater: 3,405 Lts

Accommodation:
1 Single Cabins
1 Triple Cabin

Crew:
4 persons

Propulsion:
(2) Caterpillar 3408 diesel 950 HP driving (2) white Gill 360º steering jet drives
Speed: 8 Knots

Auxiliary Power:
(2) Duetz 30 KW Gen sets

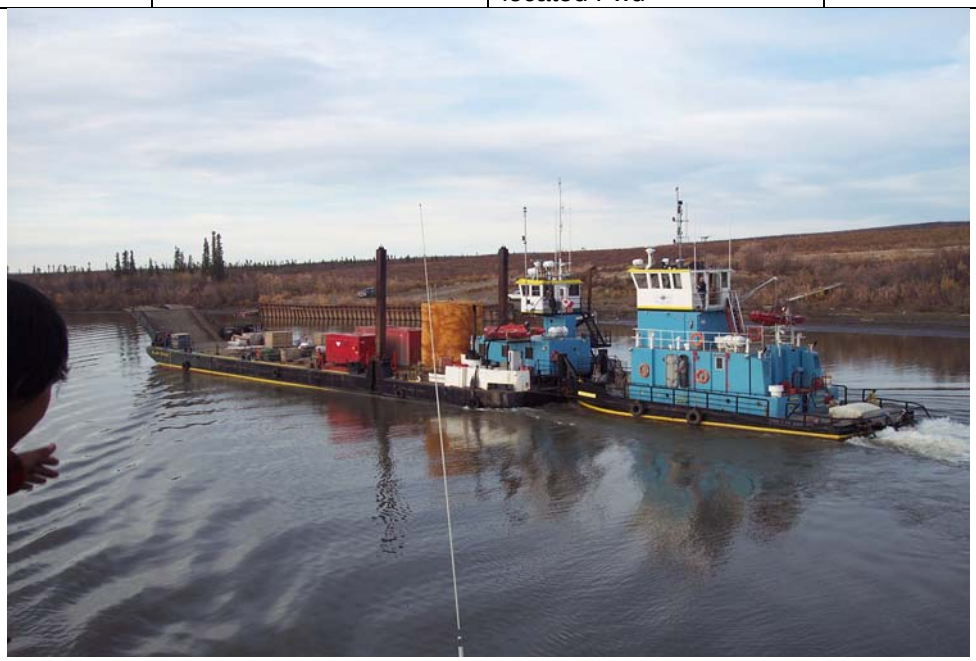
Navigation & Communication Equipment:

GPS Furuno SC-50
48 mi Furuno FR 8252 Mobile Phone
Cellular Phone
(1) Incandescent Searchlight
(1) Xenon Searchlight
SSB Radio

Deck Equipment:
Tow Winch
(2) Drum hand winches Capacity -75' of 1" wire
Anchor windlass
RIBO 420 Emergency boat c/w outboard, cradle & davit
(1) 300 Amp Rectifier Welder
(1) 4" Blackmere Pump
(1) 24' x 24' Hydraulic Ramp
(2) Hydraulic anchor winches 1 located Aft, & 1 located Fwd

Lifesaving:
(1) 420 RIBO Emergency Rescue Boat c/w outboard, cradle & davit.
Lifebuoys, lifejackets, survival suits, pyrotechnics

Firefighting:
CO2 system
Fire Extinguishers
fire hoses c/w fog nozzles(1) Emergency Fire Pump



AMERICAN MARINE CORPORATION

Katmai Spirit

Aluminum Catamaran

Year Built:	1994
Home Port:	Anchorage, Alaska
Dimensions:	40' X 18' X 2'
Main Propulsion:	Twin Mercruiser D 7.3l/270 Turbo AC V8 diesel engines
Drives:	Mercruiser Bravo Three outdrive units with hydraulic tilt and trim
Hull:	Welded aluminum (type 5086) 1/4' bottom, sides and decking 3/16", cabin 1/8"
Speed:	17 knots
Fuel Capacity:	400 Gallons *Water Capacity: 150* Gallons
Electrical:	Northern Lights 6kw diesel
Engine Cooling:	Fresh water cooled heat exchangers
Electronics:	Furuno 1721 16 mile radar, Furuno RP100 plotter, Furuno FCV-522 color video sounder Colt CB transceiver, Northstar 800 Loran, VH transeiver, compass
Deck Layout:	Large open deck aft, deckhouse midshps with elevated wheelhouse and small foredeck Midships in the deckhouse are six bench seats with seating for 24 Deck Configuration Modifications Project Specific
Safety Gear:	Bilge and Engine Alarms, Smoke Detectors, Fire Extinguishers, Fire Pumps, Survival Suits, 18 Man Life raft and EPIRB
Accomodations:	6 bench seats, galley, head, 4 berths
Area of Operations:	Oceans, Coastwise, Lakes, Bays and Sounds

For further information please contact the American Marine Corporation office nearest you:

6000 "A" Street	65 N. Nimitz Hwy.	1500 S. Barracuda St.
Anchorage, AK 99518	Pier 14	Berth 270/271
Phone (907) 562-5420	Honolulu, HI 96817	Terminal Island, CA 90731
Fax (907) 562-5426	Phone (808) 545-5190	Phone (310) 547-0919
	Fax (808) 538-1703	Fax (310) 547-0031

Vessel Specifications

DIB

Shallow Water Cable Boat

PGS Onshore reserves the right to alter specifications without prior notice.

Vessel Specifications

VESSEL SPECIFICATIONS

Name	DIB
Function	Shallow Water Cable Boat
Flag	N/A
Port of Registry	N/A
Owner	PGS
Year/Site of Construction	2002 / Houston
Classification	N/A
Official Number	N/A
Call Sign	N/A
Length	41 ft (12.5 m)
Beam	14 ft (4.2 m)
Draft	2.6 ft (0.8 m)
Dry Weight	5.0 tons
Working Load	8.5 tons
Cruising Speed	18 knots
Cruising Range	N/A
Fuel Consumption (shooting / transit)	150 gallons per day / N/A
Endurance	1 days
Fuel Capacity	0.6 cubic meters (160 gallons)
Freshwater Capacity	N/A
Accommodation Capacity	0
Life Rafts	2 x 10 persons
Main engines	2 x Volvo Penta AD41-P
Propulsion	2 x 3 blade propellers
Total Horsepower	2 x 200 HP
Gear	
Main Generators	Run off main engines
Emergency Generator	
Clean Power / UPS	
Auxiliary Machinery	
Navigation:	
Gyro Compass	N/A
Auto Pilot	N/A
Radar	JRC JMA-1010
GPS	Trimble DSM
Ships Fathometer	Standard Horizon DS-100
Communications:	
VHF Crew Radios	Motorola GM300
VHF Marine Radios	1 x Sailor RT-4822

Vessel Specifications

SEISMIC EQUIPMENT

Cable Handling Equipment:	
Bow Puller	Yes
Deck Handler	Manual
Stern Squirter	Yes
Line Checker	Yes

NAVIGATION EQUIPMENT

Navigation System:	Concept Systems GATOR is a UNIX-based integrated navigation system designed for OBC surveys. The software is based on a client/server model in which the central data server acts as the information bank and data broker for all GATOR software processes or nodes. The system offers real time coverage monitoring, vessel tracking, and source/recording system synchronization.
Vessel Navigation:	Differential GPS using RTCM corrections will be provided from a Wide Area Differential Network. The RTCM corrections will be calculated by the recording vessel and rebroadcast to the other boats that comprise the crew.
Source Tracking:	A GPS antenna is located approximately 2m forward of the sensor deployment location
Survey Fathometer:	Standard Horizon DS-100
Digital Compass:	KVH Sailcomp 103A

Wiley Gunner/Little Joe – 880 cubic in gun source

General Specification

Dimensions	44ft long x 19 ft wide x 11.5 ft tall
Weight	20 tons loaded
Draft	27 inches with engines down
Hull	All steel construction
Propulsion	Triple 225 horsepower Johnson outboards
Cabin	Full size with AC/heat for up to 6 people
Safety gear	4 x 600 gal bilge pumps and all equipment required as per Coast Guard regulations
Ancillary Equipment	Depth sounder, magnetic compass, GPS
Gun Controller	Real Time Long Shot Gun controller
Gun Type	Bolt guns, varying sizes depending upon array
Compressor	75 CFM @ 2000 psi air cooled diesel engine compressor
Generator	17,500-watt Honda with 6,500 watt in standby

Project Manager/Client Boat

PGS Onshore reserves the right to alter specifications without prior notice.

Dimensions:	7.3 m (24 ft) long
	2.4 m (8 ft) wide
	0.45 m (1.5 ft) draft
Main Propulsion:	90 HP engine

Mechanic's Boat

PGS Onshore reserves the right to alter specifications without prior notice.

Dimensions:	7.9 m (26 ft) long
	2.4 m (8 ft) wide
	0.45 m (1.5 ft) draft
Main Propulsion:	twin 90 HP engines

Geo Space LP
HYDROPHONES

GS-PV1-S

GS-PV1-S

- **Completely molded unit with waterblock eliminates water entry**
- **Less exposed leader wire**
- **Minimal sensitivity change from 1-656 ft.**
- **Higher geophone and hydrophone output**
- **Anchor slots for tie wrap or other material to facilitate taping unit to cable**

The GS-PV1-S Dual Sensor minimizes ghosting by combining pressure sensing (hydrophone) and velocity sensing (geophones) into a single unit.

For ocean bottom cable applications, combining the output of geophones and a hydrophone is now a widely accepted technique for reducing ghosting. To overcome the disadvantages of using two separate sensors, Geo Space now offers both pressure sensing and motion sensing in one unit. To achieve vertical orientation, the geophones are gimbal mounted and positioned adjacent to the hydrophone with all elements in a single waterproof enclosure. Boot guard available for added protection.

Specifications

Velocity Sensor
2 each GS-30CT:
Natural Frequency 10 Hz ± 2%
Sensitivity 2.55 volts/in/sec ± 2%
Damping .70 ± 2% (.686 to .714)
DC Resistance 3677 ohms ± 4%

Pressure Sensor
Natural Frequency 10 Hz ± 15%
Sensitivity 6.76 volts/bar ± 1.5 dB
Sensitivity change at operational depth less than 3 dB
Damping .70 typical (.60 to .80)
DC Resistance 871 ohms ± 5%

Operational Depth: 1 - 656 ft.

Dual Sensor Physical Dimensions
Length: 14.25 in (36.20 cm)
Diameter: 2.50 in (6.35 cm)
Weight: 4.50 lb (2.04 Kg)

Consult the factory for information on customizing geophone and hydrophone parameters to your required specifications. Specifications @ 25°C, atmospheric pressure. Specifications are subject to change without notice.

Parameters

GENERALS			
Area & Block/Permit	Nikaitchuq		
Geometry	Orthogonal Cross-Array 3D		
Shooting Method	Airgun		
Bin Size	55ft x 55ft (~17m x 17m)		
Max Far Offset	9670ft (~2947.5m)		
Max inline offset	8525ft (~2598.5m)		
Max Cross-line offset	4565ft (~1391.5m)		
Source Density	1562 to 1635 SP/mi2 depending on option		
Receiver Density	388 to 391 RP/mi2 depending on option		
Patch aspect ratio	0.54 (max crossline offset/max inline offset)		
Fold of Coverage	78th		
Acquisition Direction	Receiver Lines	30°-210° or 90°-270°	
	Source Traverse	120°-300° or 0°-180°	
Acquisition Layout			
Spread	Number of Receiver lines	3	
	Group Interval	110 ft (~34 m)	
	Line Separation	660 ft (~204 m)	
	Line active Length	17050 ft (~5196.8 m)	
	Number of live stations per line	156	
	Total Number of live Stations	468	
	Receiver Type	OBC	
Shooting Template	Number of Source line	1	
	Shot Point Interval	110 ft (~34 m)	
	Shooting configuration	Split spread	
	Source Line Separation	660 ft (~204 m)	
	Source line length	7920 ft (~2414 m)	
	Number of SP per line	72	
Geometry Move-up	In Line Move-up	660 ft (~204 m)	
	Cross Line Move-up	1980 ft (~204 m)	
	Number of receiver line overlap	0 lines	
	In line Fold	13th	
	Cross line Fold	6th	
Operative parameters			
Recording	Minimum Listening time	3s	
	Sample rate	2ms	
	Recording Instrument	24 bit	
	Recording Low Cut Filter	Out	
	Recording High Cut (anti alias) Filter	¾ Ny.F.	

SURVEY STATISTICS	
Full fold area	About 205 Km2
Number of Receiver Lines	Dependent on option chosen
Number of Shot Lines	Dependent on option chosen
Total Receivers stations	Max 41363
Total shot points	Max 175849
Number of swaths	Dependent on option chosen
Coverage Factor (full fold area/total number of shots)	About 0,00069 mi2
Estimated daily production	1500 to 2250 SP/day
Estimated shooting duration	90 to 120 days
Estimated survey duration	3 to 4 months

DATA ACQUISITION EQUIPMENT

Seismic recording system

No.	Item requested	*PGS offer*
1.	Manufacturer/type	Sercel 408
2.	Magnetic tape driver (Manufacturer/type & No.)	TED hard drive tape emulator in recorder, creating verified IBM 3590 archive tapes at the QC processing lab
3.	Digital recording format	SEG D
4.	Number of traces / record	3 lines of 156
5.	Sampling rate	2 msec
6.	Type of digital filters (zero, linear or minimum phase)	Linear or minimum phase
7.	Anti-alias filters	High cut 0.8 FN Stop Band Attenuation >120 dB (above Nyquist)
8.	Low Cut filters	None
9.	Record length Vs. Shot point distance	3 sec vs 110 ft
10.	Maximum recording system re-cycle time	System is capable of inter record delay of equal to or less than 2 seconds of overhead.
11.	Plotter characteristics & model	Veritas V-12

Line Equipment

No.	Item requested 2C Option	*PGS offer*
1.	No. of operative Remote Acquisition Units	2400 Sercel FDU available
2.	No. of units for: i) Repeater/power ii) Line Interface iii) Other (also indicate type for each)	 i)125 Sercel LAUL ii)12 Sercel LAUX iii)12 x-line cables
3.	No. of repeater units	0
4.	No. of telemetry cables in operating conditions	1200 + 1200 mini cables
5.	Telemetric cables length – take out spacings	220 ft

Transducers

No.	Item requested 2C Option	*PGS offer*
1.	Sensor manufacturer, type and model	GeoSpace GS-PV1
2.	Sensitivity for each component of the sensor	GS30CT geophone 2.55 V/in/sec +/-2% Pressure phone 6.76 V/bar +/-1.5 dB
3.	Components of the sensor and their main technical characteristics (brief description of the main manufacturer's features)	Hydrophone crystals are configured for acceleration cancellation. Schematic can be provided if requested.

ENERGY SOURCE EQUIPMENT

Marine source

Source type and main requirements

No.	Item requested	*PGS offer*
1.	Source type and manufacturer	Airgun
2.	No. of single sources	Minimum 10 gun array
3.	Maximum Single Source output	Maximum 12 gun array
4.	Operating Source Depth	Min 2.5 meters
5.	Source centres separation	1 to 1.5 meters
6.	Shot point distances	110 ft

Source Synchronising and Pressuring Systems

Synchronising system

No.	Item requested	*PGS offer*
1.	Type & manufacturer	Digital Real time Long Shot Source Controller
2.	Main system characteristics - No. of near field (and shuttle monitoring) sensors - No. of available shooting lines - No. of gun depth monitoring - Other main system function:	TB sensors on each gun N/A Cable controlled gun depth monitoring

Pressuring system

No.	Item requested	***PGS offer***
1.	Compressor type & manufacturer	75 or 150 CFM diesel compressor
2.	Operating system pressure	1750 to 1900 psi max.
3.	No. of units and litres per minute capacity	1
4.	Minimum re-cycle time of the system	12 to 15 sec

Single Source lay-out

No.	Item requested	***PGS offer***
1.	Single Source volume (lt. or i^3)	880 c.i.
2.	No. of sub-arrays	Single gun arrays
3.	No. of guns per sub-array	10 guns total 5 guns per side +2 spare
4.	Geometry of the source (in-and across line dimensions)	8 mt wide x 6 mt long
5.	P-P Output Pressure (Bar*m)	+/- 22 bar-m @ 2.5 mt depth
6.	Signal/Bubble Ratio	10:1

AUXILIARY SUPPLIES

Bathymetry survey

Echo-sounder survey

No.	Item requested	*PGS offer*
1.	System manufacturer, type and model	Interspace Tech DS 150 or equivalent
2.	Operating frequencies and water depths	Up to 400ft
3.	Digitiser and Logger system description:	NMEA output to Horizon

Source firing controller (Encoder/Decoder)

No.	Item requested	*PGS offer*
1.	Manufacturer/Model	*Gator INM System*
2.	Number of units always operative, including transceiver	*1*

No.	Item requested	*PGS offer*
1.	Manufacturer/Model	*Gator INS system*
2.	Number of units always operative	*1 per gun boat*

Other operational needs

At least once a week, the measurements of water velocity will be taken with the following meter:

No.	Item requested	*PGS offer*
1.	DTS (Depth–Temperature–Salinity) meter type and model	Valeport TS Dip Meter

Gravity survey (when optional service is provided)

Instrumentation

No.	Item requested	*PGS offer*
1.	Gravimeter manufacturer, type and model	Lacoste & Romberg Model S Gravity Meter
2.	Instrument sensitivity (mGal)	Resolution : 0.01 mGal Repeatability: <1.00 m Gal in field
3.	Analogue paper recorder manufacturer, type and model	Not supplied
4.	Digital recorder manufacturer, type and model	Air-Sea Gravity system II
5.	Land Gravimeter manufacturer, type and model Instrument sensitivity (mGal)	Lacoste & Romberg Model G Gravity Meter Resolution: .0005 mGal Repeatability : .01 to .02 mGal

POSITIONING SURVEY EQUIPMENT

The field crew shall be provided with all necessary equipment, data, and means as necessary to carry out the positioning survey and produce the geodetic and cartographic documentation at the crew site providing the following minimum survey equipment.

Positioning equipment for 3D survey

Main system(s)

PGS shall propose the onshore reference stations lay out for each system and perform an accurate radio frequency scouting to avoid any possible interference when surveying.

1ST MAIN POSITIONING

No.	Item requested	*PGS offer*
1.	System type	Novatel
2.	GPS Mobile Receiver – manufacturer and type (Eight-to-twelve channels dual frequency)	Novatel
3.	Number of mobile units	As required
4.	Number and Locations of the on shore reference stations	3
5.	Minimum number of LOP' s valid Satellites for all Fixes	4

2ND MAIN POSITIONING

No.	Item requested	*PGS offer*
1.	System type	Trimble 4700

2.	GPS Mobile Receiver – manufacturer and type (Eight-to-twelve channels dual frequency)	Trimble 4700
3.	Number of mobile units	As required
4.	Number and Locations of the on shore reference stations	2
5.	Minimum number of LOP' s valid Satellites for all Fixes	4

Shot-Receiver positioning equipment

In water positioning system(s)

The following system(s) will be provided as follow

No.	Item requested	*PGS offer*
1.	Active positioning buoys type and no. of available units	N/A
2.	Active source-receiver positioning type and no. of available units	N/A
3.	Active receiver positioning type and no. of available units	Sonardyne Acoustic transponder, 700 available

COMMUNICATION SYSTEMS

Field communications

No.	Item requested	*PGS offer*
1.	Manufacturer & model	Motorola or equivalent
2.	Number of available frequency channels	Minimum 12
3.	Antenna output power (w)	5 to 50 watts

Long distance communications (telephone /radio /fax /satellite)

Phone, fax radio and internet communication will be available on crew.

Telephone communication

No.	Item requested	*PGS offer*
1.	No. of telephone line(s) and cell phone unit(s)	1 on crew, 2 in Deadhorse. Cell phones for management and recorder
2.	No. of PSTN or ISDN phone line(s) at the Crew Office	1 on crew and 1 in Deadhorse

Internet communication

No.	Item requested	*PGS offer*
1.	Dedicated Internet site for any communication and information exchange regarding the Survey between both PGS and ENI head office	1 on crew and 1 in Deadhorse

Real Time Remote Control System for Multi Boat operations

No.	Item requested	*PGS offer*
1.	Manufacturer & model/type	*Gator System*
2.	Number of units available for PGS use	*1 node per boat*
3.	Locations where installed	*Controlled from recorder vessel*
4.	Characteristics and standard protocol	*Available upon request*
5.	Hardware and Software description GATOR ™ is indicated as a reference. Any software with similar performances is acceptable	*Gator system*
6.	Description of implemented functionality and performances	*See attached details*

HARDWARE AND SOFTWARE SYSTEMS

3D Binning and Spatial attribute analysis QC system (for 3-D only)

Hardware

No.	Item requested	PGS offer
1.	Platform/Clock/Environment	Same as 10.1
2.	RAM (Mbytes)	Same as 10.1
3.	Hard disk (internal and external)	Same as 10.1
4.	Video monitor	Same as 10.1
5.	Tape drives: 3590, Exabyte	Same as 10.1
6.	Additional drives: floppy disk, CD R/W, DVD +R/W (option)	Same as 10.1
7.	Plotter	Same as 10.1
8.	Printer	Same as 10.1
9.	Other	

Software

No.	Item requested	PGS offer
1.	Software package name. Reflex™ is indicated as a reference. Any software with similar performances is acceptable.	ProMax
2.	Software package characteristics Enclose list with the characteristics and specifications	Integrated QC and Processing software

Seismic quality control system(s)

Hardware

No.	Item requested	PGS offer
1.	Platform/Clock/Environment	*Dell/Windows XP OS*
2.	RAM (Mbytes)	*7 Gbyte*
3.	Hard disk (internal and external)	*3 x 146 GByte*
4.	Video monitor	*20 or 24 inch*
5.	Tape drives: 3590, Exabyte	*LTO/3590*
6.	Additional drives: floppy disk, CD R/W, DVD +R/W (option)	*CD/Floppy*
7.	Plotter	*Part of Promax hardware*
8.	Printer	*HP Deskjet or similar*
9.	Other	

No.	Item requested	PGS offer
1.	Software package names	Office/Adobe/Ultraedit/Stratus /SPS Tools
2.	Software package characteristics Enclose list with characteristics and specifications	Standard software packages

Positioning and subsidiary data system

Hardware

No.	Item requested	PGS offer
1.	Platform/Clock/Environment	Dell/ Linux OS
2.	RAM (Mbytes)	4
3.	Hard disk (internal and external)	200
4.	Video monitor	19 inch
5.	Tape drives: 3590, Exabyte	N/A
6.	Additional drives: floppy disk, CD R/W, DVD ±R/W (option)	DVD RW
7.	Plotter	MP 1055 cm
8.	Printer	HP Deskjet or similar
9.	Other	

Softwares

The system must fully process the positioning data with data output in SPS or an equivalent U.K.O.O.A. format

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No.	Item requested	*PGS offer*
1.	Software package name for subsidiary data computation	*Gator*
	Software package characteristics Enclose list with characteristics and specifications	*Integrated Nav and Data Management*
2.	Software package name for Satellite Fix computation The package shall be suited for DGPS and rGPS fix computation in dynamic, static and kinematic mode.	*Gator*
	Software package characteristics Enclose list with characteristics and specifications	*Integrated Nav and Data Management*
3.	Software package name for pre-post plotting of the seismic lines and contour maps.	*GPSeismic*
	Software package characteristics Enclose list with characteristics and specifications	*Seismic Positioning QC*
4.	Software package name for production of geo-referred map and subsidiary data posting (in shot and receiver domain) with appropriate DB support.	*ESRI ArcView 9.2*
	Software package characteristics Enclose list with characteristics and specifications	*GIS package*

TRANSPORTATION MEANS

Offshore Mean		***Number of PGS offer***
Recording boats/vessels (specify type)		1 – "William Bradley"
Cable/receiver boats/vessels (specify type)		5 – DIB Boats
Shooting boats (specify type and use)		1 or 2 depending on option chosen "Wiley Gunner and/or Little Joe"
Supporting boats/vessels (specify type and use)		1 – "Katmai Spirit" for crew support and supply form shore
Onshore Mean		***Number of PGS offer***
Field support vehicles (specify type and use)		1 – F250 for Expeditor
Camp logistic vehicles (specify type and use)		1- F250 Project Manager
Client representative's vehicles (specify type)		N/A

Offshore Means Specifications

No.	Item requested	*PGS offer*
1.	Name	William Bradley
2.	Port of Registry	Edmonton Alberta
3.	Owner	Horizon North
4.	Classification	Minor Waters I
5.	Call Sign	810639
6.	Built and/or Rebuilt (Year)	1991
7.	Length (m)	45.7 m
8.	Beam (m)	11.0 m
9.	Draught (m):	4.03 ft
10.	Gross tonnage	337.75 T
11.	Net tonnage	222.86 T
12.	Cruising speed (kn)	8 knots
13.	Endurance surveying (No. of days)	30 days
14.	Accommodations (No. of persons / No. of cabins)	4/ 1 single 1 triple
15.	Engine(s) (No./Type-Power)	2 x Cat 3408 Diesel
16.	Propeller(s) (No./Type-Power)	Jet drives
17.	Generator(s) (No./Type-Power)	2 x 30 KW Duetz
18.	Bow Thruster(s) (No./Type-Power)	
19.	Autopilot(s) (No./Type-Power)	
20.	Gyrocompass(es) (No./Type-Power)	Yes
21.	Radar(s) (No./Type-Power)	Furuno FR 8252
22.	Fresh water capacity (m^3)	3,405 L
23.	Fresh water maker (Ton/Day)	
24.	Incinerator (Type)	

25.	Safety Maritime Regulation Compliance The following item might be used as reference for reporting equipment list of the vessel. • Helideck type and size • Fire fighting system(s) (specify No., type & use per system) • Portable fire extinguisher(s) (specify No., type & use per unit) • Lifeboat(s) (specify No. per persons and type) • Life-raft(s) (specify No. per persons and type) • Lifebuoy(s) (specify No. per persons and type) • Lifejacket(s) (specify No. and type) • Survival suit(s) (specify No. and type) • No. of hooks to prevent swivelling when loading by crane • Nets and any other safety tool for external load operations • First-aid kit available at the Loading Zone • Windsocks at the Base and the Loading Zones	See attached brochure
No.	**Item requested**	***PGS offer***
26.	Name	Katmai Spirit
27.	Port of Registry	Anchorage, Alaska
28.	Owner	American Marine
29.	Classification	
30.	Call Sign	
31.	Built and/or Rebuilt (Year)	1994
32.	Length (m)	40 ft
33.	Beam (m)	18 ft
34.	Draught (m):	2 ft
35.	Gross tonnage	
36.	Net tonnage	
37.	Cruising speed (kn)	17 knots
38.	Endurance surveying (No. of days)	3 days
39.	Accommodations (No. of persons / No. of cabins)	4 berths
40.	Engine(s) (No./Type-Power)	2 x Mercruiser Turbo Diesel engines
41.	Propeller(s) (No./Type-Power)	Mercruiser Bravo Three outdrive units
42.	Generator(s) (No./Type-Power)	Northern lights 6 Kw diesel
43.	Bow Thruster(s) (No./Type-Power)	N/A
44.	Autopilot(s) (No./Type-Power)	N/A
45.	Gyrocompass(es) (No./Type-Power)	Yes
46.	Radar(s) (No./Type-Power)	Furuno 1721 radar
47.	Fresh water capacity (m^3)	150 gallons
48.	Fresh water maker (Ton/Day)	
49.	Incinerator (Type)	

50.	Safety Maritime Regulation Compliance The following item might be used as reference for reporting equipment list of the vessel. • Helideck type and size • Fire fighting system(s) (specify No., type & use per system) • Portable fire extinguisher(s) (specify No., type & use per unit) • Lifeboat(s) (specify No. per persons and type) • Life-raft(s) (specify No. per persons and type) • Lifebuoy(s) (specify No. per persons and type) • Lifejacket(s) (specify No. and type) • Survival suit(s) (specify No. and type) • No. of hooks to prevent swivelling when loading by crane • Nets and any other safety tool for external load operations • First-aid kit available at the Loading Zone • Windsocks at the Base and the Loading Zones	See attached brochure

No.	**Item requested**	***PGS offer***
51.	Name	Wiley Gunner/Little Joe
52.	Port of Registry	Fouchon Louisiana
53.	Owner	Geo Marine
54.	Classification	N/A
55.	Call Sign	N/A
56.	Built and/or Rebuilt (Year)	
57.	Length (m)	44 ft
58.	Beam (m)	11.8 ft
59.	Draught (m):	2 ft 3 in
60.	Gross tonnage	20 T
61.	Net tonnage	18 T
62.	Cruising speed (kn)	10 knots
63.	Endurance surveying (No. of days)	1 to 2 days
64.	Accommodations (No. of persons / No. of cabins)	None
65.	Engine(s) (No./Type-Power)	3 x 225 Hp Johnson outboards
66.	Propeller(s) (No./Type-Power)	3 x 3 blade props
67.	Generator(s) (No./Type-Power)	17.5 Kw Honda
68.	Bow Thruster(s) (No./Type-Power)	N/A
69.	Autopilot(s) (No./Type-Power)	N/A
70.	Gyrocompass(es) (No./Type-Power)	Yes
71.	Radar(s) (No./Type-Power)	Yes
72.	Fresh water capacity (m^3)	N/A
73.	Fresh water maker (Ton/Day)	N/A
74.	Incinerator (Type)	N/A

75.	Safety Maritime Regulation Compliance The following item might be used as reference for reporting equipment list of the vessel. • Helideck type and size • Fire fighting system(s) (specify No., type & use per system) • Portable fire extinguisher(s) (specify No., type & use per unit) • Lifeboat(s) (specify No. per persons and type) • Life-raft(s) (specify No. per persons and type) • Lifebuoy(s) (specify No. per persons and type) • Lifejacket(s) (specify No. and type) • Survival suit(s) (specify No. and type) • No. of hooks to prevent swivelling when loading by crane • Nets and any other safety tool for external load operations • First-aid kit available at the Loading Zone • Windsocks at the Base and the Loading Zones	See attached brochure

No.	**Item requested**	***PGS offer***
76.	Name	DIB boats
77.	Port of Registry	N/A
78.	Owner	PGS Onshore
79.	Classification	N/A
80.	Call Sign	N/A
81.	Built and/or Rebuilt (Year)	2002/2007
82.	Length (m)	41 ft
83.	Beam (m)	14 ft
84.	Draught (m):	2 ft 6 in
85.	Gross tonnage	6 T
86.	Net tonnage	5 T
87.	Cruising speed (kn)	18 knots
88.	Endurance surveying (No. of days)	1 day
89.	Accommodations (No. of persons / No. of cabins)	None
90.	Engine(s) (No./Type-Power)	2 x Volvo Penta Ad-41
91.	Propeller(s) (No./Type-Power)	2 x 3 blade props
92.	Generator(s) (No./Type-Power)	Run off main engines
93.	Bow Thruster(s) (No./Type-Power)	N/A
94.	Autopilot(s) (No./Type-Power)	N/A
95.	Gyrocompass(es) (No./Type-Power)	N/A
96.	Radar(s) (No./Type-Power)	JMA 1010 or equivalent
97.	Fresh water capacity (m^3)	N/A
98.	Fresh water maker (Ton/Day)	N/A
99.	Incinerator (Type)	N/A

100.	Safety Maritime Regulation Compliance The following item might be used as reference for reporting equipment list of the vessel. • Helideck type and size • Fire fighting system(s) (specify No., type & use per system) • Portable fire extinguisher(s) (specify No., type & use per unit) • Lifeboat(s) (specify No. per persons and type) • Life-raft(s) (specify No. per persons and type) • Lifebuoy(s) (specify No. per persons and type) • Lifejacket(s) (specify No. and type) • Survival suit(s) (specify No. and type) • No. of hooks to prevent swivelling when loading by crane • Nets and any other safety tool for external load operations • First-aid kit available at the Loading Zone • Windsocks at the Base and the Loading Zones	See attached brochure

MINIMUM CREW ORGANIZATION

Minimum personnel

No.		Technical personnel			Offered No. of persons by PGS
1.	**K**	*Onshore Co-ordinator*			1
2.	**K**	*Party chief*			1
3.	**K**	*Assistant Party Chief (provided also for the shooter vessel)*			1
4.	**K**	*Quality supervisor*			1
5.	**K**	*HSE Officer (position might be covered by marine mate)*			1
6.	**K**	*Senior electronic engineer (hardware expert)*			1
7.	**K**	*Senior Recording system operators*			2
8.		*Junior Recording/Streamer system operators*			2
9.	**K**	*Senior navigators*			2
10.		*Junior navigators (provided also for the shooter vessel)*			4
11.	**K**	*Senior source technician*			1
12.		*Junior source technicians (provided also for the shooter vessel)*			3
13.	**K**	*QC Expert supervisor for 3D survey only (positioning and seismic software expert)*			1
14.	**K**	*Seismic data processing expert analyst*			0
15.	**K**	*QC seismic data and processing operator*			1
16.	**K**	*Positioning data processing expert analyst*			1
17.		*Positioning data processing analyst*			0
18.		*Onboard gravity data technician*			1
19.		**Marine personnel :** *Number and positions according to Ship Flag security regulations for each provided vessel under the CONTRACT*			6
		Labor and seismic personnel			45
		TOTAL NUMBER OF PERSONNEL			75

Appendix B
Marine Mammal Monitoring
and
Mitigation Plan

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Marine Mammal Monitoring and Mitigation Plan

May 2008

Prepared by

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

3900 C Street, Suite 601
Anchorage, Alaska 99503

Tetra Tech EC
19803 North Creek Parkway
Bothell, Washington 98011

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List of Appendices

ACRONYMS

3D	three-dimensional
cu	cubic
dB	decibel(s)
ENI	ENI Petroleum
ft	foot/feet
Hz	hertz
IHA	Incidental Harassment Authorization
km	kilometer(s)
m	meter(s)
mi	mile(s)
MMO	Marine Mammal Observer(s)
M/V	marine vessel
NMFS	National Marine Fisheries Service
OBC/TZ	ocean bottom cable/transition zone
PGS	PGS Onshore, Inc.,
re 1 μPa-m	relative to one microPascal at one meter distant
rms	root mean square
sq km	square kilometer(s)
sq mi	square mile(s)

1.0 INTRODUCTION

PGS Onshore, Inc. (PGS) has been contracted by ENI Petroleum (ENI) to conduct a three-dimensional (3D) marine seismic survey in State of Alaska waters of the Beaufort Sea. Because the lease sale area is inhabited by marine mammals, PGS is applying for an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS) for small takes of marine mammals as authorized under the Marine Mammal Protection Act.

Section 13 of the IHA application stipulates that the applicant provide "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 populations 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." This Marine Mammal Monitoring and Mitigation Plan was developed to meet the obligation of Section 13.

2.0 PROJECT OVERVIEW

The purpose of the proposed 3D marine seismic survey is to gather information to evaluate the project area for oil and gas development. The 3D seismic survey will be conducted utilizing a low impact ocean bottom cable/transition zone (OBC/TZ) technique. The OBC/TZ survey involves deploying cables from small boats to the ocean floor, forming a pattern consisting of three parallel cables. A source boat equipped with seismic airgun arrays would release compressed air into the water, creating an acoustic energy pulse directed toward the cables on the seafloor. Hydrophones and geophones attached to the cables would be used to detect seismic energy reflected from rock strata below the ocean bottom. Digital records of the data received by hydrophones and geophones would be recorded by equipment housed on the receiver vessel, marine vessel (M/V) *William Bradley*.

PGS proposes using two source vessels for the data acquisition. The source vessels will be used sequentially: one vessel will be active while the other travels to its next position. Both source vessels, M/V *Wiley Gunner* and M/V *Little Joe* will be equipped with identical gun arrays. These airgun arrays are smaller than most arrays used in the past for seismic programs in either the Beaufort or Chukchi Sea (880 cubic inch).

The proposed survey location is in the Beaufort Sea in the Nikaichuq Unit north of Oliktok Point and covering Thetis, Spy, and Leavitt Islands. It would extend to the 5 kilometer (km) (3 mile [mi]) state/federal water boundary line. The program would not go into federal waters. The total area covered by source or receiver lines is 304.6 square kilometers (sq km) (117.6 square miles [sq mi]) and includes 1.70 sq km (0.658 sq mi) of island coverage and 303.0 sq km (117.0 sq mi) of marine coverage. The water depth in this area ranges from zero to 15 meters (m) (49 feet [ft]); and a third of project waters are also shallower than 3 m (10 ft).

In order to obtain adequate coverage, the receiver lines with geophones would extend over the islands (Thetis, Spy, and Leavitt Islands) within the project area as well as over the tip of Oliktok Point approximately every 200 m (660 ft). Receiver cables would be hand-laid in shallow water and where they cross land to mitigate damage to vegetation and the land surface or ocean bottom. Receiver lines would remain in place for several days (up to one week) before being removed by hand.

No airgun pulses would occur in waters shallower than 1.2 m (4 ft) or on land. To make up for the lack of data acquisition on land and within waters shallower than 1.2 m (4 ft), additional airgun pulses would be scheduled in the area immediately surrounding the 1.2 m (4 ft) shallow water area.

It is anticipated that ice will leave the project area as early as July. The proposed survey would begin as soon as ice and weather conditions allow, possibly as soon as July 1. The proposed survey is scheduled to occur from early July to September 15, 2008, depending upon weather conditions. The work would be divided into two parts. Data acquisition outside the barrier islands (Thetis Island, Spy Island, and Leavitt Island) would be performed first and would be completed by August 5. This portion of the work would begin in the east and move toward the west. Data acquisition inside the barrier islands would then be conducted and would be completed by September 15. This portion of the work would also move from east to west. No airgun activity would be conducted outside the barrier islands after August 5.

3.0 MITIGATION

PGS's proposed operations can prevent injury to marine mammals or reduce the chances of harassment by either avoiding areas where marine mammals occur or shutting down noise-generating operations while marine mammals are present.

3.1 Avoidance

The bowhead whale spring migration and the associated spring whaling hunts by the villages of Barrow, Point Hope, Wainwright, and Point Lay occur in open leads from about March to June, well before the early-July start date of the proposed open-water survey. Although seismic operations are proposed to be conducted during the fall whale hunt (after August 25), they would not take place within the areas normally used by hunters from Barrow (Point Barrow) or Nuiqsut (Cross Island). The survey area is 60 km (37 mi) west of Cross Island (and "downstream" of the bowhead whale fall migration) and 260 km (160 mi) east of Point Barrow.

The proposed activity will take place in very shallow nearshore waters (less than 15 m [49 ft] deep). Although bowhead whales have been rarely observed in waters less than 15 m (49 ft) deep, the great majority of the migration occurs in waters 15 m to 200 m (49 ft to 660 ft) deep. In fact, nearly half the survey area occurs inside the barrier islands (Thetis, Spy, and Leavitt), where water depths are less than the shallowest water depth (4.5 m [15 ft]) recorded for a bowhead whale sighting by the U.S. Department of the Interior, Minerals Management Service's Bowhead Whale Aerial Survey Program survey team. Thus, the seismic program avoids bowhead whales by operating in habitats largely unsuitable for these animals.

The proposed survey would be divided into two parts. Data acquisition (use of airguns) outside the barrier islands (Thetis Island, Spy Island, and Leavitt Island), the deepest part of the survey area, would be performed first and would be completed by August 5. Data acquisition inside the barrier islands, with a maximum depth of approximately 4.6 m (15 ft), would then be conducted from August 5 through September 15. No data acquisition (use of airguns) would be conducted outside the barrier islands after August 5.

The project is scheduled to avoid the annual subsistence beared seal hunt from Thetis Island in July.

Although seismic operations are proposed to be conducted during the fall Bowhead whale migration (after September 1), activities would take place in shallow waters within the barrier islands that are not considered whale habitat. The barrier islands are also expected to act as an obstacle to sounds generated by seismic activities.

3.2 Safety Radius

The focus of the IHA is for the NMFS to authorize the incidental take of marine mammals by "Level B" harassment which is defined as exposure to sound levels of greater than 160 decibels (dB) for baleen whales and 170 dB for toothed whales and pinnipeds. It does not authorize the "take" of marine mammals by sound levels considered injurious: 180 dB for baleen whales and 190 dB for toothed whales and pinnipeds. Injurious "take" is avoided by establishing a safety radius and an associated zone of influence around the seismic vessels and arrays so that noise-generating equipment is shut down at the approach of a marine mammal to these zones. These zones are determined by calculating the maximum distance to the 180 dB and 190 dB isopleths based on the intensity of sound at source and the expected rate of sound attenuation.

The proposed 880-cubic (cu)-inch 3D seismic survey equipment generates a relatively low dB sound source compared to other seismic sources (Richardson et al. 1995) and is specifically designed to direct sound pressure downwards as shown in Figure 2 of the IHA. Vertical sound propagation is quickly attenuated through interference patterns between the individual guns on the array, which results in less vertical sound propagation than for lesser-volume seismic arrays not such arrayed. The modeled sound level at source is 192.7 dB re 1 μPa-m (relative to one microPascal at one meter distant) root mean square (rms) at frequencies between about 10 Hz and 100 Hz. The distance to the 190 dB isopleth is only a couple of meters, while the distance to the 180 dB isopleth is only about 10 m. Monitoring a 10-m safety radius is impractical. Therefore, PGS is proposing to establish a conservative 50-m (160-ft) safety radius centered over the array. Establishing a shutdown safety radius of 50 m (160 ft) for all marine mammals, the most conservative estimate for the 180-dB isopleth, should ensure injurious "takes" are avoided. Finally, acoustical field measurements of actual sound propagation from the operating array will be taken at the onset of the survey season. Should these measurements prove that associated sound energy is traveling farther than estimated, the safety zone will be adjusted accordingly.

To ensure that marine mammals are detected before they enter the 50-m (160-ft) safety zone, Marine Mammal Observers (MMOs) will be stationed on the seismic vessels and will be on watch 24 hours per day. The MMOs will be provided with the authority to initiate a shutdown and will record all sightings relative to seismic activities. This distance is easily viewable by MMOs stationed on seismic vessels. In addition, PGS has offered to hire Inupiat speakers from the potentially affected communities of Barrow and Nuiqsut to perform seismic work on each of the PGS vessels. As part of their duties, the Inupiat speakers will also keep watch for marine mammals and will communicate with the MMOs located on the source vessels.

Ramp-up and soft-start methods will be conducted while seismic operations are initiated. This is intended to alert marine mammals in the area so that they may swim away from the source before the full energy source is employed. PGS will ramp-up airguns from 80-cu-inch to 880-cu-inch prior to seismic data collection,

4.0 MONITORING

As stipulated in Section 13 of the IHA application, monitoring and reporting are necessary requirements of the IHA. PGS will meet this requirement by using two techniques: use of MMOs and participating in an acoustics monitoring plan through ENI.

4.1 Marine Mammal Monitoring

PGS's approach to monitoring is to station two or more MMOs aboard each seismic vessel to document the occurrence of marine mammals near the vessel, to help implement mitigation requirements, and to record the reactions of marine mammals to the survey. At least one MMO, if not all, will be an Inupiat trained in collecting marine mammal data. Each MMO will, while on duty, scan the area of operation (using 8 to 10 power binoculars) for marine mammals, recording the species, location, distance from survey vessel, and behavior (and associated weather data) of all that are seen. Observer watches will last no more than 4 consecutive hours, and no observer will watch more than 12 total hours in a 24-hour day. Observation will occur while survey operations are conducted. (Use of a night-scope for fall monitoring will be explored prior to the fall field season.) Most importantly, however, each MMO will determine that the safety radius is "clear" of marine mammals prior to operating the high-energy sound equipment, and each will have the authority to suspend active side-scan sonar or sleeve gun operations should a marine mammal be observed approaching the safety radius. The NMFS will be provided with weekly reports of the marine mammal observations as long as the onboard communication systems allow this.

In addition to the marine mammal monitoring to be performed by the MMOs located on source vessels, PGS has offered to hire Inupiat speakers to perform seismic work on each of the PGS vessels. As part of their duties, the Inupiat speakers will also keep watch for marine mammals and will communicate with the MMOs located on the source vessels.

A final report will be prepared to describe the field operations, locations, and reactions of the marine mammals observed and the number of animals potentially "taken." A Level B harassment "take" will be defined as any baleen whale observed within the 160 dB isopleth while equipment was operating and any toothed whale or pinnipeds observed within the 170 dB isopleth. Estimating the distances of these isopleths from the sound source is dependent on the sound attenuation model used. A very conservative "10 Log *R*" cylindrical rate of spread model was used in the associated IHA to develop a conservative estimate safety radius and a conservative estimate of take. Using the same model (and assuming a 187-dB rms energy level at source) would result in the estimated distance to the 160-dB isopleths at about 500 m (1600 ft), and 170 dB isopleths at about 50 m (160 ft). These distances, coupled with actual behavioral observations of marine mammals, will be used to evaluate take in the data analysis.

Any animal overtly reacting to the presence of the survey operation, while high-energy sound sources are not operating, will be duly recorded and later evaluated as a possible take unrelated to sound.

The final report will be prepared by a marine mammal biologist familiar with marine mammal/oil exploration issues, and will be provided to the NMFS within 90 days of the end of the field season.

4.2 Offshore Monitoring

PGS will participate in an offshore monitoring program in cooperation with Pioneer Natural Resources, Inc., (Pioneer) and ENI in coordination with Shell Exploration and Production Company. The Offshore Monitoring Plan developed by Pioneer and ENI is included as Appendix A of this document. The program will:

- Characterize in-water sound source levels and spectral content of sound from vessels associated with the project at the start of project operations.

The offshore monitoring program will also include the following four activities from mid-August until mid- to late September:

- Monitor in-water sound near and distant from Pioneer's Oooguruk drill site, ENI's Spy Island drill pad, and vessel operations using four autonomous seafloor acoustic recorders (ASARs).

- Monitor and characterize sounds produced from shallow-depth seismic survey planned by PGS using ASARs and directional autonomous seafloor recorders (DASARs).

- Detect and localize marine mammal vocalizations using an array of DASARs positioned north and northwest of the Pioneer and ENI projects.

- Visually survey the coastal Beaufort Sea from an aircraft to search for bowhead whales and characterize behavior of those animals observed.

5.0 REFERENCES

Greene, C.R., Jr. 1997. *Physical acoustics measurements*. (Chap. 3, 63 p.) *In*: W.J. Richardson (ed.), 1997. Northstar Marine Mammal Marine Monitoring Program, 1996. Marine mammal and acoustical monitoring of a seismic program in the Alaskan Beaufort Sea. Rep. TA2121-2. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc., Anchorage, AK, and U.S. Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 245 p.

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700 G Street, Suite 600
Anchorage, Alaska 99501

Eni US Operating Co. Inc.
101 West Benson, Suite 201
Anchorage, Alaska, 99503-3974

Oooguruk and Nikaitchuq Development Projects

Offshore Monitoring Plan, 2008

May 1, 2008

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LIST OF FIGURES

1.0 Introduction

This document describes an Offshore Monitoring Plan (Plan) to monitor in-water sounds and bowhead whales in the vicinity of two drillsites in the nearshore Alaskan Beaufort Sea near Oliktok Point during the open-water period of 2008. It is a revised version of a draft plan submitted to the North Slope Borough (NSB) February 15, 2008. Changes to the Plan are a result of feedback from NSB scientists and permitting staff and from collaborative efforts among several industry operators. The Plan outlined below represents an integrated monitoring program among Pioneer Natural Resources Alaska, Inc. (Pioneer), Eni US Operating Co. Inc. (Eni), and PGS Onshore, Inc. (PGS) in cooperation with Shell Offshore, Inc (Shell).

2.0 General Project Descriptions and Locations

Pioneer Natural Resources Alaska, Inc. and Eni US Operating Co. Inc. will perform construction and/or drilling operations during the 2008 open water season at their respective offshore drilling pads at the east side of Harrison Bay in the Alaskan Beaufort Sea. Pioneer will continue installation of facilities and development drilling on its Oooguruk drillsite (ODS). The ODS is located in 4 to 6 feet of water approximately 2.5 miles north of the Colville River Delta, 2.1 miles northwest of the Kuparuk River Unit, and 8.9 miles west of Oliktok Dock (Figure 1).

Eni will continue with construction activities of its offshore Spy Island drilling pad (SID) which is part of their Nikaitchuq Development. The SID located immediately south of Spy Island in 2 to 6 feet of water and 3.8 miles north of Oliktok Point, and 14.8 miles northwest of Pioneer's ODS (Figure 1). Gravel was transported to SID over an ice road during the winter of 2007-2008. The gravel will be reworked during the open-water season using bulldozers and excavators to build the artificial pad. The perimeter slopes of the pads will be protected with gravel-filled bags similar to the system employed at Pioneer's ODS in 2006. Eni will also be performing construction work this coming summer and initiating drilling on its onshore drill pad at Oliktok Point starting later this fall.

In addition to the Pioneer and Eni drillsite activities described above, seismic and shallow hazard surveys are planned by Eni for the Nikaitchuq Development area. PGS (under contract to Eni) plans to conduct a shallow-depth ocean-bottom cable seismic survey of the Nikaitchuq Unit in the vicinity of Spy and Thetis islands (Figure 1) during the open-water period of 2008. This survey is intended to better delineate shallow oil deposits that Eni will attempt to reach from its drilling program. Shell has proposed to conduct shallow-hazard site surveys north and northwest of SID from mid September through October 2008. Although they will have a separate monitoring plan, work by Pioneer and Eni have been designed to complement the monitoring activities by Shell.

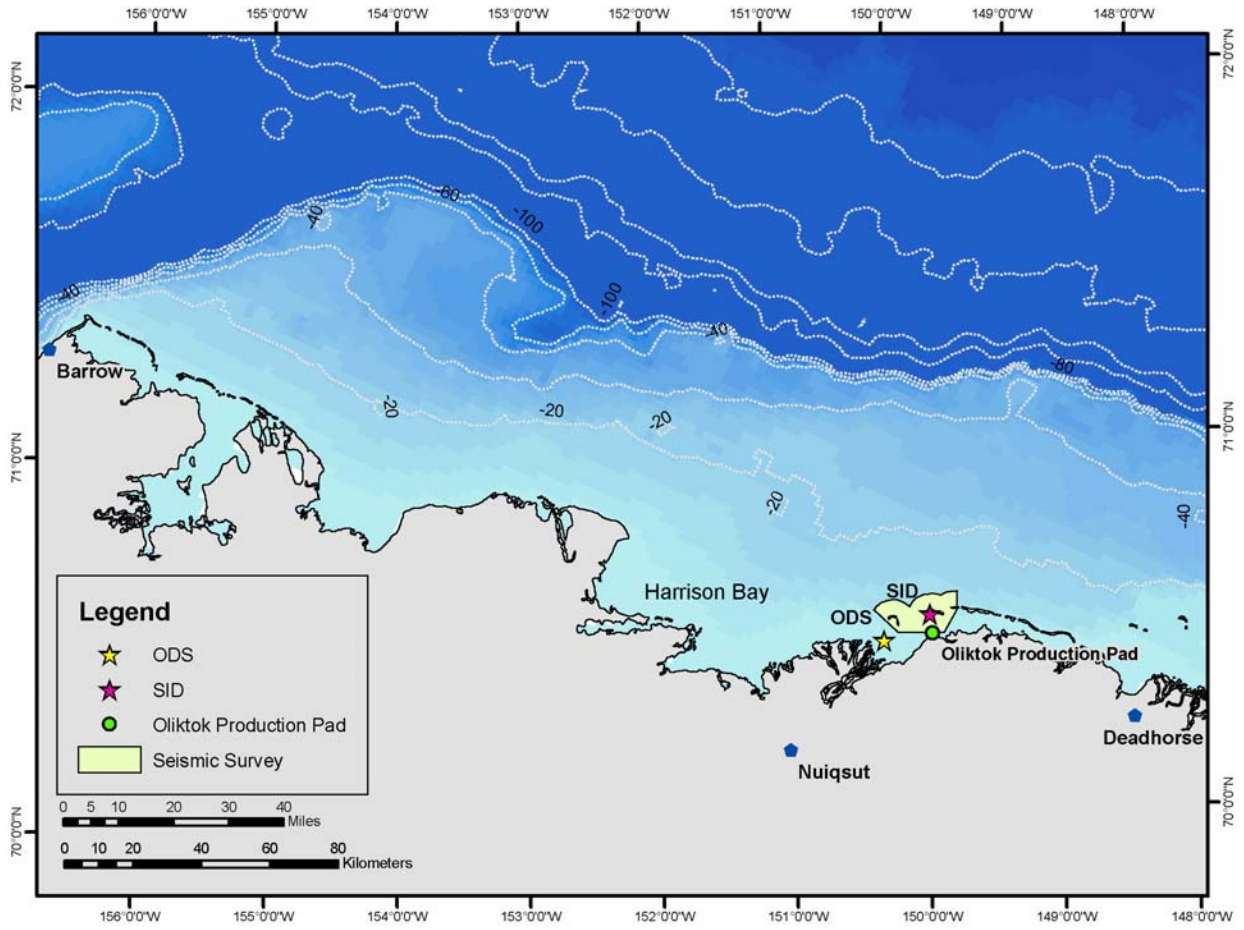

Figure 1. Map showing the location of Pioneer's Oooguruk Drillsite (ODS) and Eni's Spy Island Drillsite (SID), the Oliktok Production Pad, and the proposed seismic survey in the nearshore Alaskan Beaufort Sea.

3.0 Purpose/Scope

This Plan has been developed to facilitate compliance with North Slope Borough (NSB) and National Marine Fisheries Service (NMFS) regulations. It is intended to facilitate collaboration among industry operators' scientists and NSB scientists, and to provide information and guidance for Pioneer, Eni, and PGS employees and contractors. This Plan will be implemented jointly between Pioneer and Eni. The work will be performed by LGL Alaska Research Associates, Inc. (LGL), Greeneridge Sciences, Inc., (Greeneridge) and JASCO Research Ltd. (JASCO) under the direction of Pioneer and Eni, and in collaboration with PGS and Shell. Subcontractors to Greeneridge include Scripps Institution of Oceanography and WEST, Inc.

Offshore monitoring plans were implemented by Pioneer for the Oooguruk project in 2006 and 2007 and resulting reports were reviewed by NSB. Comments received from NSB included a task to address data limitations, which have been incorporated in the development of the 2008 Plan. The 2008 Plan includes five components:

1) Monitor in-water sound near and distant from ODS, SID, and vessel operations using four autonomous seafloor acoustic recorders (ASARs).

2) Characterize in-water sound source levels and spectral content of sound from vessels associated with the projects.

3) Monitor and characterize sounds produced from a shallow-depth seismic survey planned for Nikaitchuq in the areas inshore and offshore of Thetis and Spy islands using ASARs and directional autonomous seafloor recorders (DASARs).

4) Detect and localize marine mammal vocalizations using an array of DASARs positioned north and northwest of the Pioneer and Eni projects.

5) Visually survey the coastal Beaufort Sea from an aircraft to search for bowhead whales and characterize behavior of those animals observed.

Pioneer and Eni will coordinate this acoustic and bowhead whale monitoring with Shell. Monitoring and mitigation for the seismic survey (e.g., marine mammal observers) will be directed by PGS and its subcontractors and outside the scope of this monitoring plan.

4.0 Regulatory Requirements

Regulatory requirements for the Pioneer and Eni projects, including construction, drilling, and production are addressed under NSB ordinances. The NSB Land Use Permit RZ06-002 (Ordinance Serial No. 75-6-50) issued to Pioneer for the rezoning of the project area outlines specific requirements for an offshore monitoring program. The NSB Ordinance for the Nikaitchuq project has similar requirements to Pioneer's ordinance for an offshore monitoring program. Ordinance 75-6-50 stipulates that the Offshore Monitoring Program (Program) contain the following:

- Include a design developed with the NSB and Alaska Eskimo Whaling Commission (AEWC) for a site-specific noise monitoring plan emphasizing noise propagation to the east, north, and west. Such monitoring may require the imposition of seasonal restrictions on vessel traffic and aircraft to minimize adverse noise impacts to bowhead whales and other marine mammals.
- Be in place prior to any open-water activities.
- Document all noise sources and associated noise levels projected into the water or from the air to the water's surface by all construction and operation activities associated with the Oooguruk Project, including but not limited to any boat traffic, pipeline construction and drillsite activity.
- Examine and document the frequency spectrums and received levels of the noise from construction and operation activities at various distances from the drillsite.
- Assess and report on the distribution of bowhead whales within 15-20 miles of the island during fall migration.
- Include a design basis report, annual report and final report. These reports will take into account existing data from all sources.

- All reports must be submitted to the NSB Planning Department in Barrow.

Additionally, a peer review process is also outlined in the Ordinance and includes:

- Prior to implementation, the Program design must undergo peer review and the design must be modified as needed to be responsive to the peer reviewers' comments and the comments of the Administrator.
- All Program reports must undergo peer review and must be modified as needed to be responsive to peer reviewers' comments and the comments of the Administrator.
- Peer reviewers include, but are not limited to representatives of the NSB, AEWC, members of the Scientific Advisory Committee as assigned by the Mayor, and/or NSB consultants.

Regulatory requirements for the PGS seismic survey are covered under the Marine Mammal Protection Act and the associated Incidental Harassment Authorization (IHA; 50 CFR 216.105) issued by the NMFS.

5.0 Sources of In-water Sounds

5.1 Pioneer

Potential sound-generating operations planned by Pioneer during the 2008 open water season include maintenance of the slope protection along the perimeter of the ODS, installation of facilities, and development drilling. The primary source of underwater sound will be the barging and vessel activity required to transfer personnel and materials between Oliktok Point and the ODS. Low frequency sound from heavy equipment performing perimeter maintenance and drilling on the ODS is also expected to be transmitted into the water. Low-level underwater sound from bag placement and helicopter noise was detected at 1- mile north of the ODS in 2006 (Zykov et al. 2008a).

5.2 Eni

Eni's offshore operations in 2008 will include development of a drillsite near Spy Island (SID, Figure 1). The sound-generating activities and equipment to be used for Eni' operations will be similar to those discussed above for Pioneer's work at the ODS in 2006. Eni's activities will include crew boat operations and tug and barge traffic between Oliktok Point and the SID. Reworking of the gravel at the SID will require heavy equipment operations using bulldozers and excavators. There are currently no plans to routinely use helicopters to support the summer operations. The primary underwater sound source will be limited tug and barge traffic transporting equipment and construction materials to the SID. Some low frequency noise from heavy equipment operations on the SID itself may be transmitted through-ground into the sea. The proximity and shape of Spy Island directly north of the SID will substantially shield barge noise from propagating further north offshore, and this is especially the case when the barges are alongside the pad. Additionally, Leavitt and Pingok Islands will physically block sound propagating further offshore in the northeast direction.

5.3 PGS

A shallow-depth, ocean-bottom cable (OBC) seismic survey is planned for the area over a ~60-day period beginning early July (Figure 1). A total of 12 support vessels will be associated with the seismic survey including two source vessels that will be each outfitted with an 880 cubic inch airgun array. The current schedule for the seismic survey is to acquire data from areas offshore of the barrier islands prior to August 5th and then complete the program on areas inshore of the barrier islands from early August through mid September. Sounds produced from the air gun arrays will be captured on seafloor recorders and characteristics of these sounds will be reported as part of this Plan.

6.0 Methods

6.1 Sound-Source Verification (SSV) of Vessels and Seismic Airgun Arrays

Vessels – In-water sounds from support vessels associated with the Pioneer and Eni projects will be measured and source levels determined. Primary vessels may include crew boats, and tugs and barges. A total of 12 vessels will be associated with the PGS seismic survey, many of these relatively small, outboard powered skiffs. Between all three operations, we expect to measure sounds from 18 to 20 vessels.

Most measurements will be made using JASCO Research's Ocean Bottom Hydrophones (OBH) in early July with methods used previously (Zykov et al. 2008b; Laurinolli et al. 2008)). Measurements will be made with a single OBH system positioned in 15 to 30 feet of water with the vessel sailing along a line from 10 to 25 km away to directly over the OBH. The sail past is conducted at normal operating speed of the vessel. Some vessel measurement may be performed using the ASARs stationed near ODS and SID (instead of the OBHs).

Seismic Airguns – Sound source measurements will be made of the two PGS airgun array at two locations, inside and outside the barrier islands in early July and prior to seismic data acquisition. Both airgun array configurations will be measured at each location, leading to 4 separate measurements. The measurements will be made using four OBH systems (Figure 2). These recorders sample at 48 kHz using a high-resolution 24-bit digitization systems. They can record autonomously for up to 3 days per deployment. The distances to the important sound level thresholds will vary strongly with operating water depth. In the shallowest depths of near 4 feet, sounds will be rapidly attenuated and the distances will be relatively small. The survey area outside the barrier islands reaches depths that support much better sound propagation, and Eni expects the 120 dB distance could be as great as 10-20 km (6 to 12 miles). The OBH placement should be made to correspond with the best pre-field estimate of the 190, 180, 160 and 120 dB re uPa (rms) thresholds. JASCO will consider previous SSV measurements near BP's Liberty prospect in similar water depths, combined with modeling to estimate the appropriate distances prior to the SSV measurements.

Figure 2. A picture of an ocean-bottom hydrophone (OBH) used to measure sound levels of vessels and seismic air guns.

The OBH deployment configuration distances will be determined as discussed above. The optimal deployment configurations will be determined for both the inside barrier island and outside barrier island locations. The OBHs will be deployed and seismic vessels asked to shoot along pre-defined test tracks. The test tracks will be oriented in at least two directions to capture the directivity characteristics of the airgun arrays; airgun arrays typically produce greater sound energy perpendicular to the tow direction than in line with the tow direction.

6.2 Acoustic Monitoring of Drillsite Activities and Marine Mammal Vocalizations

Acoustic measurements of drillsite activities and marine mammal vocalizations in 2008 will be performed using Greeneridge's autonomous seafloor recorders. For monitoring the near-drillsite sounds, four omnidirectional ASARs (Greene et al. 1997) will be used, which sample at a rate of 5 kHz and have an acoustic bandwidth of 10 to 2200 Hz. The ASARs can record ambient and anthropogenic sounds and vocalizations from bowhead whales, beluga whales, seals, and walrus.

For the whale-call acoustic array, five directional DASARs (Greene et al. 2004; Figure 3) will be used, which have an acoustic bandwidth of 10 to 450 Hz. In addition to bowhead whale calls, the DASARs will also detect and record industrial sounds including those produced by vessels and seismic air guns. Regarding the ability to detect ultra-low frequency sounds that might be produced from drilling, the DASAR and the ASAR can record sounds as low as 1 or 2 Hz but at reduced sensitivity relative to frequencies above 10 Hz. The DASARs will be modified versions of units (DASAR "b") that were used for Shell's 2007 Beaufort Sea Monitoring Program and will be identical to those proposed for monitoring BP Exploration's

Northstar Island (Northstar) and Shell's five DASAR arrays in 2008. The modification involves a new version of the sensor (a three-channel device). In total, nine recorders will be used for Pioneer/Eni in 2008; four ASARs will be deployed in vicinity of the ODS and SID and five DASARs will be located approximately 8 to 12 miles north of the drillsites in 30 to 50 feet of water (Figure 4).

Figure 3. Two photographs of DASARs readied for deployment near Northstar Island in the Alaskan Beaufort Sea.

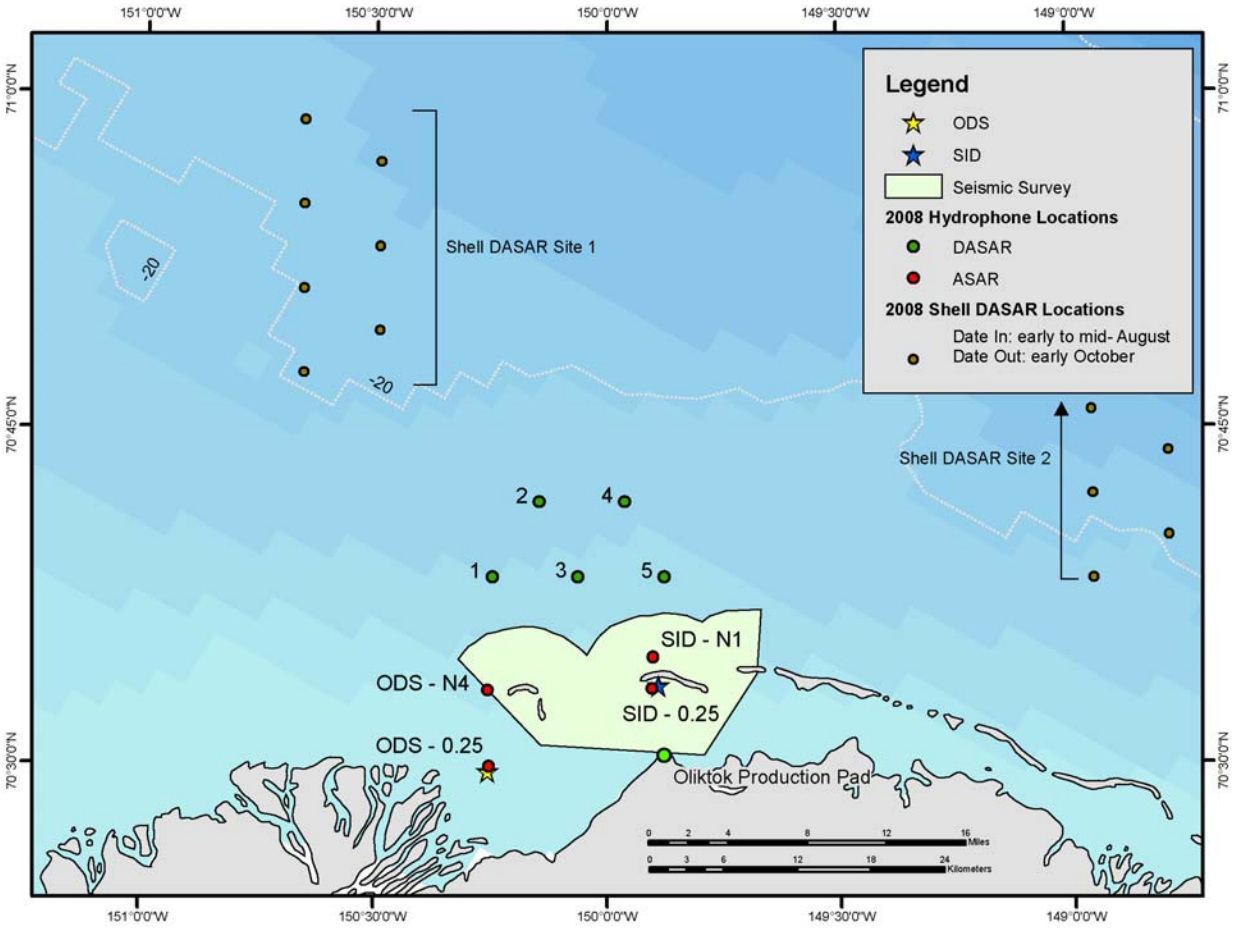

Figure 4. Proposed locations of DASARs and ASARs near Oooguruk and Spy Island drillsites, 2008.

The acoustic recorders will be deployed/retrieved using a workboat supplied by Pioneer/ Eni. Recorders will be retrieved from a tag line and the grapple method. The recorders will be

deployed in mid August and then allowed to record as along as possible into September, taking weather factors (sea state and ice formation) into account. The NSB Wildlife Department will be informed prior to removing the recorders.

The four ASARs will be placed near the two drillsites to monitor sounds produced from drilling (ODS only), vessel (ODS and SID), and construction activities (primarily SID). Figure 5 provides a finer scale resolution of the acoustic recorders in the vicinity of ODS and SID than in Figure 4. One ASAR will be placed approximately 0.25 mile from each of ODS and SID. One ASAR will be placed 4 miles north of ODS and one 1 mile north of SID. Similar to the nearby Shell DASAR Site 1 and Site 2 arrays, the DASARs will be spaced 7 km (4.3 miles) from each other and will detect marine mammal vocalizations to the north and south of the array out to 10 to 15 km (6 to 9 miles) from any one recorder.

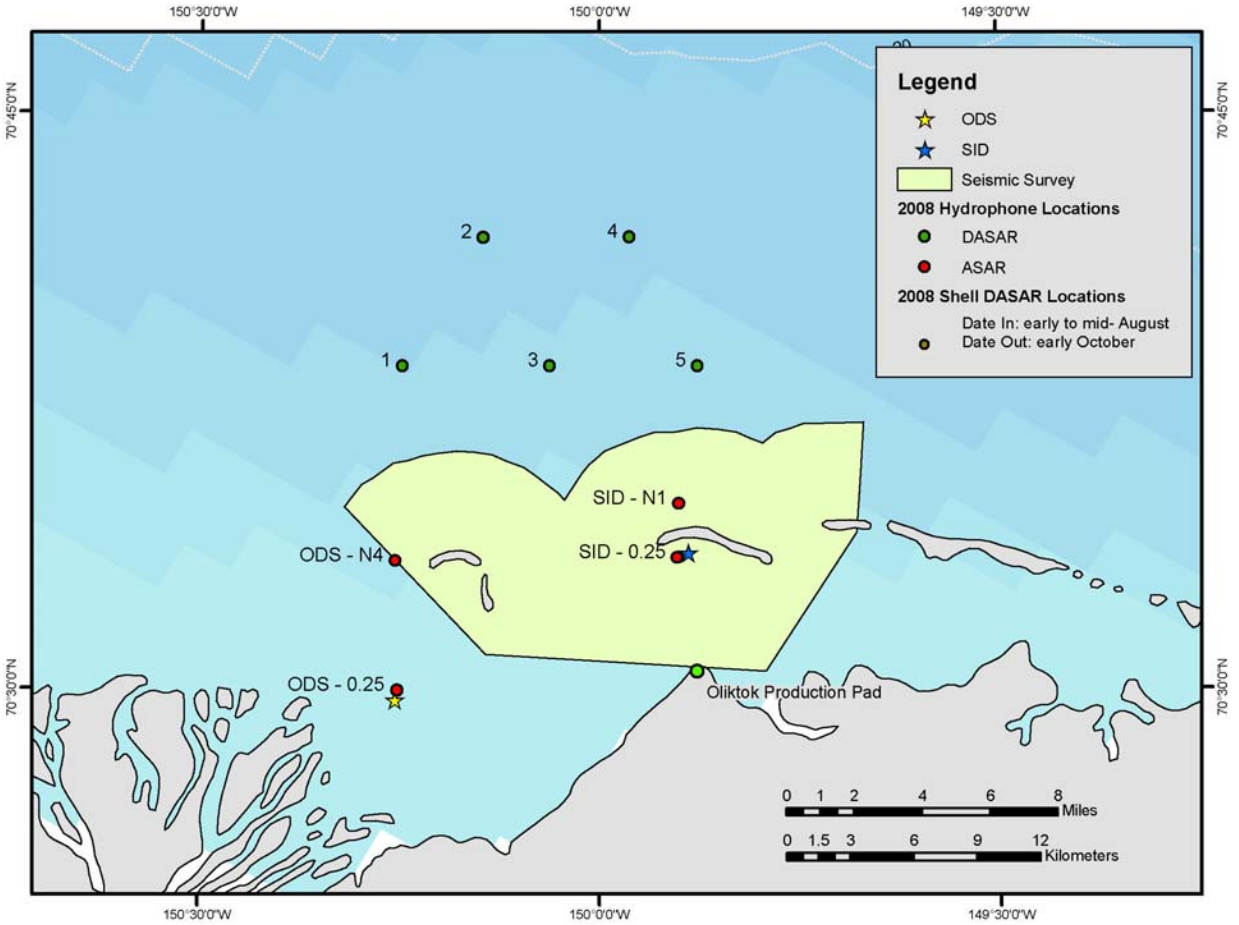

Figure 5. Fine-scale view of the proposed locations of the Pioneer-Eni ASARs and DASARs near Oooguruk and Spy Island drillsites, 2008.

The acoustic data collected during the summer 2008 near ODS and SID will be suitable to compute sound levels received from:

1. Heavy equipment and machinery operating on the drillsites.
2. Small vessels and crew change vessels operating around the ODS and SID and between Oliktok Point and the ODS.
3. Loaded and empty barges traversing to and from Oliktok Point and ODS and SID.

4. The process of holding the barges in place at the drillsites while offloading equipment and supplies.

An important aspect to characterizing sounds and correlating them to specific activities will be to maintain an accurate record of all sound-producing activities in the project areas. Time-referenced information of vessel movements and construction activities at and around the drillsites will be required in order to interpret acoustic sound level data. This is especially important in order to determine whether measured sound levels are generated by activities at or near the drillsites. To acquire detailed position information from key sources of in-water sounds, Pioneer/Eni proposes to place GPS units capable of logging position data on selected project vessels during the open-water period. The vessel logs and GPS position data will be used to verify (or exclude) various sources of anthropogenic sounds that are detected on the acoustic recorders and to associate any visual observations of marine mammal behavior from aerial surveys with project activities. Pioneer/Eni will also maintain logs of equipment inventory and associated daily activities at ODS and SID and the drilling activity at ODS.

6.2.1 Near-Drillsite ASARs

After equalization (see *Equalization Process* in Blackwell et al. 2006c), data collected by the near-drillsite ASARs will be used to determine the sound spectrum (1-Hz intervals) for a one-minute (min) period about every five minutes. This provides ~288 spectral measurements per 24-hr day per ASAR. To derive each of these 1-min spectra, a series of 119 one-second-long data segments, overlapped by 50% and thus spanning 1 min, will be analyzed. For each minute analyzed, the 119 resulting 1-Hz spectra will be averaged to derive a single averaged spectrum spanning the frequency band from 1 to 2200 Hz for the 1-min period.

These narrowband results will be used to determine the corresponding broadband (10–2200 Hz) and one-third octave band levels averaged over 1 min. This provides a measurement of the sound level in each band, averaged over a 5-min period, for each 4.37-min interval. These data provide an essentially continuous record of the levels of low-frequency underwater sounds 0.25 miles from ODS and SID during the study period. The narrowband and one-third octave data will also be summarized to derive "statistical spectra" showing, for each frequency or one-third octave band, the levels exceeded during various percentages of the 1-min samples. For each of the frequency cells or one-third octave bands in the spectra, the values will be sorted from smallest to largest, and the minimum, 5th-percentile, 50th-percentile, 95th-percentile, and maximum values for that frequency cell determined.

Industrial Sound Index.—For direct comparisons to BP's long-term acoustic monitoring results from Northstar, the two ASAR recorders from near the drillsites will be used to define an "Industrial Sound Index" or ISI for SID and ODS. The ISI will be constructed by adding together the sound levels in one-third octave bands that appear to be dominated by industrial components. A detailed rationale for the selection of particular one-third octave bands is presented in Blackwell (2003). The ISI for Northstar from previous years is defined as the sum of the mean square pressures in the one-third octave bands centered at 31.5, 40, 50, 63, and 80 Hz, the "5-band ISI" (Blackwell 2003; McDonald et al. 2008). Total mean-square sound pressure level (SPL) in the five one-third octave bands considered are then computed as

$$ISI = 10 \cdot \log_{10} \cdot \left(10^{\frac{dB_{31.5}}{10}} + 10^{\frac{dB_{40}}{10}} + 10^{\frac{dB_{50}}{10}} + 10^{\frac{dB_{63}}{10}} + 10^{\frac{dB_{80}}{10}} \right),$$

where $dB_{31.5}$, dB_{40}, dB_{50}, dB_{63}, and dB_{80} are SPLs in the corresponding five one-third octaves (Richardson et al. 1995, p. 30). The result is the sound pressure in the (approx.) 28 to 90 Hz band.

6.2.2 Array DASARs

Whale call data from all five DASARs will be analyzed together with data from the 7 DASARs from Shell's Site 1 array (i.e. creating a single 12-DASAR dataset) using an automated procedure developed by Aaron Thode from Scripps. To verify call detections and locations from the automated processing, a subset of the data will be analyzed in the same way as they have been in the past for BP's Northstar array (Richardson et al. 2008) and Shell's 2007 analysis (Blackwell et al. 2008). Whale calls will be tallied on all DASARs by examining all DASAR records simultaneously, minute by minute, to count calls and to determine call types. A spectrogram will be produced of each call (or suspected call). Based on viewing the spectrogram and simultaneously listening to the call with headphones, analysts will classify all calls as *simple calls* of various types, or as *complex calls*. The call classification is based on descriptions by Clark and Johnson (1984) and Würsig and Clark (1993):

- ***Simple calls*** are frequency modulated (FM) tonal calls or "moans", generally in the 50–300 Hz range. We distinguish (1) ascending or up calls, "/"; (2) descending or down calls, "\"; (3) constant calls, "–"; and (4) ∪-shaped and ∩-shaped inflected calls.
- ***Complex calls*** are infinitely varied and included pulsed sounds, squeals, growls with abundant harmonic content, and combinations of two or more simple and complex segments. Subcategories of complex calls cannot be discerned consistently, so all subcategories are pooled.

To provide information on ambient sound levels away from ODS and SID, data recorded by one DASAR in the array will be analyzed the same way as data from the near-drillsite ASARs (see above).

6.3 Acoustic Monitoring of Seismic Survey and Ambient Sounds

We will use an automated process developed by A. Thode of Scripps to detect airgun pulses in the DASAR data and compute the instantaneous peak pressure, the sound pressure level (room-mean-square), the sound exposure level and the pulse duration. Background sound levels (between the pulses) are also characterized using this automated procedure. These measurements provide time series for the entire study period, expected to be from four to six weeks beginning in mid August. Vessel sounds will be noted and their levels included in the background time series (Blackwell et al. 2008).

6.4 Aerial Surveys to Assess Bowhead Whale Distribution

Working with NSB scientists in 2006, Pioneer developed an aerial survey program to assess the distribution of bowhead whales within 15-20 miles (24 to 32 km) of the Pioneer operation during fall whale migration. These surveys were done in 2006 and 2007 and were conducted with two dedicated observers from a Bell 412 helicopter (Reiser et al. 2008; Williams et al. 2008).

For 2008, we propose to collaborate with Shell to expand the temporal coverage of their aerial survey program, which is otherwise planned to start ~7 September. These surveys are to be performed in support of Shell's shallow-hazard surveys being planned from mid September 2008 through October 2008. We will to expand the duration of these surveys to start August 25 and be conducted along the survey tracklines outlined in Figure 5.

Conditions permitting, surveys will be conducted 3 or more days per week beginning August 25 and continuing through as far into October as Shell continues its operation (~mid-to-late October). The surveys will be conducted from a de Havilland Twin Otter following similar protocols used by Shell in the Beaufort Sea in 2006 and 2007. Survey tracklines will be spaced 5 miles apart and will run approximately 40 miles in a north-south direction. Surveys will be conducted in good survey conditions (i.e., favorable weather and sea state). Four trained and experienced surveyors seated in the rear of the aircraft will make observations from the right and left side of the airplane. The airplane will be operated by two pilots in the front seats who will also survey the area ahead of the aircraft.

Standard aerial survey procedures used by LGL and others in many previous marine mammal projects will be followed, including those surveys completed for Shell in the Alaskan Beaufort Sea in 2006 (Thomas et al. 2007) and 2007 (Lyons et al. 2008). Following these procedures will facilitate comparisons and (as appropriate) pooling of our results with other datasets (e.g., sighting rates, whale group size and composition). The aircraft will be flown at 100 to 110 knots ground speed and at an altitude of 1500 ft. Aerial surveys at altitude 1500 ft do not provide much information about seals but are suitable for both bowhead and beluga whales. The need for a 1500 ft cloud ceiling will limit the dates and times when surveys can be flown. The surveys will follow a GPS-referenced tracklines as outlined in Figure 5.

For each marine mammal sighting, the observer will note 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. An inclinometer reading (angle from horizontal) will be taken when the animal's location is at right angle (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 data logger.

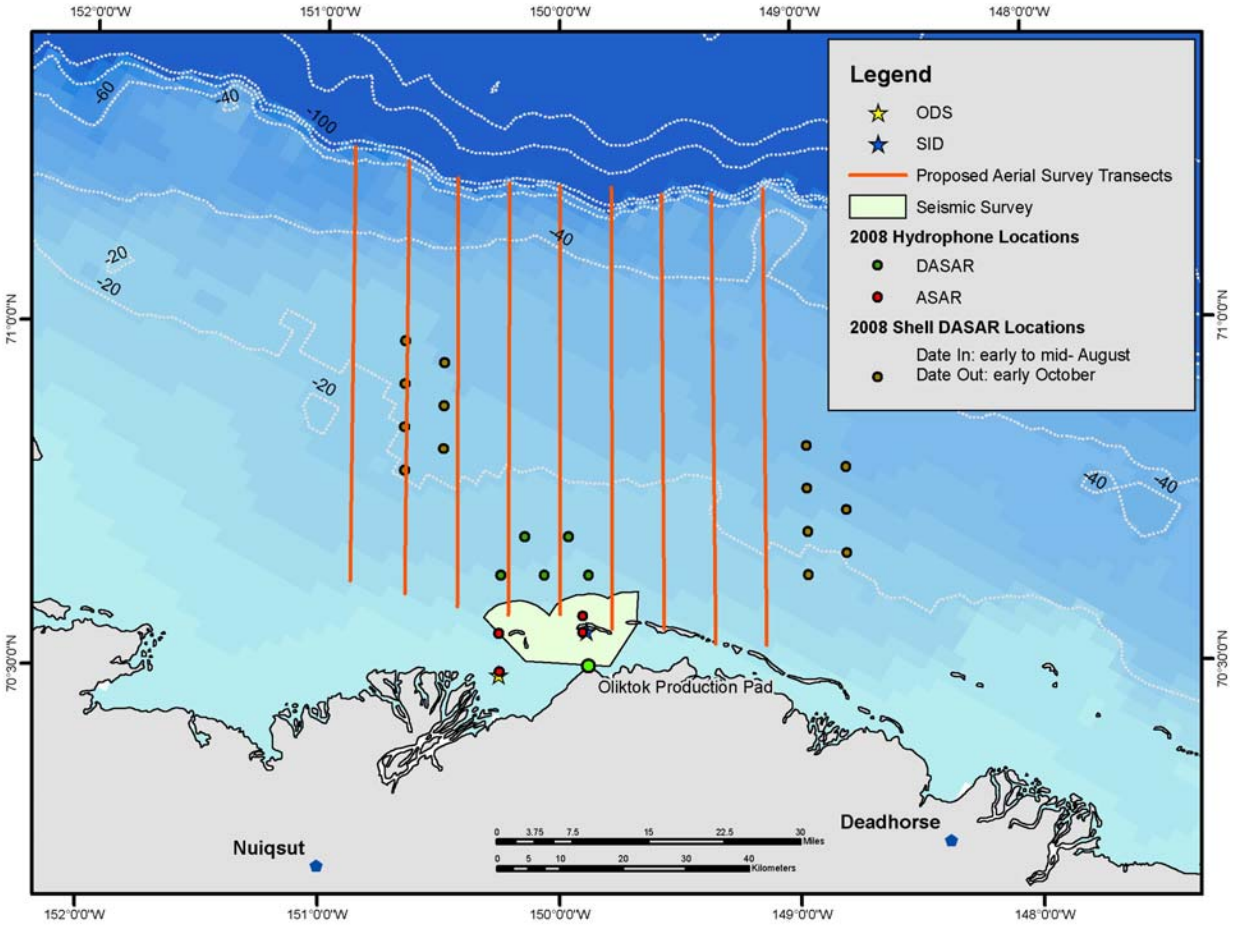

Figure 6. Aerial survey route, drillsites (ODS and SID), and the DASAR arrays for the Pioneer and Eni Offshore Monitoring Plan, 2008.

At the start of each transect the front seat observer will record the transect start time and position, ceiling height (feet), cloud cover (in 10ths), wind speed (knots), wind direction and outside air temperature. 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 min intervals along transect. This will provide data in units suitable for statistical summaries and analyses of effects of these variables (and position relative to drillsite) on the probability of detecting marine mammals.

A 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. The primary data logger will be a laptop computer with Garmin Mapsource (ver 6.9) data logging software. Mapsource automatically stores the time and aircraft position at pre-selected intervals (typically at 6 seconds for straight-line transect surveys) and stores the records to a file as they are obtained. If the computer or data logger malfunctions, the file is terminated and a new file is started when the program is restarted. This prevents loss of already-recorded data. A second laptop computer will log the aircraft position and altitude using a custom written software program (Visual Basic, ver 5.0) as a back-up to the primary data logger. The altitude input will be from the aircraft's radar altimeter.

Weather, ice, and sightability data will be recorded systematically during all surveys. Percent ice cover and severity of sun glare will be recorded by each primary observer for every

2-minute interval along transects. Ice observations during aerial surveys will be mapped when ice is present and satellite imagery will be used, where available, to document ice conditions adjacent to the survey area. These are standard practices for surveys of this type, and are necessary in order to interpret factors responsible for variations in sighting rates.

7.0 Analysis and Reporting

NSB scientists have urged oil industry operators to collaborate and integrate research and monitoring and associated work products. Toward this end, we propose to integrate the analyses from the multi-faceted 2008 effort into two documents.

Offshore Monitoring Report: A single, standalone document will be prepared that provides results from the Pioneer/Eni offshore monitoring program in 2008. This report will contain 5 chapters: 1) introduction and details of the project activities, 2) vessel sound source measurements, 3) acoustic measurements of sounds from drillsite, vessel, and seismic activities, 4) acoustic monitoring of the bowhead whale migration based on the DASAR array data, and 5) a summary of the aerial survey results. This document will be of similar scope and level of detail as the BP Northstar annual report (e.g., Aerts and Richardson 2008).

A draft offshore monitoring report will be presented to the NSB for peer review by February 20, 2009. Comments from reviewers will be addressed as part of the final report, which will be provided prior to the 2009 Open-water meeting hosted by NMFS, which is usually held in April of each year.

Contribution to Industry Joint Monitoring Report: Detailed analyses of the whale call locations from the DASAR array and the aerial survey results will be included in separate chapters of the industry-wide Joint Monitoring Program report for 2008. The DASAR and aerial data provided by the Pioneer/Eni offshore monitoring will be part of a larger dataset, which will be analyzed as part of the Shell program. LGL Alaska will lead in the preparation of this joint monitoring report, as they have in each of the last two years (Funk et al. 2007; Ireland et al. 2008). LGL will work with the acoustics team (Greeneridge, JASCO, Scripps, and WEST) to put the 2008 sound measurements information, whale call data, and aerial survey data into context relative to what has been learned from previous acoustic and bowhead whale studies in the central Alaskan Beaufort Sea.

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