UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION FISHERIES

REQUEST FOR A MULTI-YEAR LETTER OF AUTHORIZATION PURSUANT TO SECTION 101 (a) (5) OF THE MARINE MAMMAL PROTECTION ACT COVERING

Taking of Marine Mammals Incidental to Construction of the Knik Arm Crossing Project in Upper Cook Inlet, Alaska

(50 C.F.R. Part 216, Subpart I)

submitted by

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I. NATURE OF THE REQUEST

The Knik Arm Bridge and Toll Authority (KABATA), pursuant to Section 101 (a) 5 of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371.101 (a) (5); 50 C.F.R § 216, Subpart I, requests the National Oceanic and Atmospheric Administration (NOAA) Fisheries to issue a multi-year Letter of Authorization (LoA) for incidental "takes" of marine mammals, primarily beluga whales (*Delphinapterus leucas*), during bridge construction at the Knik Arm crossing during the period 2007 through 2012. Marine mammals other than beluga whales are considered rare in the project area. However, sightings of harbor seals (*Phoca vitulina*), harbor porpoises (*Phocoena phocoena*), Steller sea lions (*Eumetopias jubatus*) and killer whales (*Orcinus orca*) have been reported in Upper Cook Inlet, and the LoA should also address these species in the event that incidental "takes" of them might occur. The LoA sought would allow the incidental, but not intentional, "taking" of marine mammals if this occurs in the course of construction of the bridge located in the Knik Arm of Upper Cook Inlet, Alaska.

Potential "takes" of marine mammals associated with the construction of a Knik Arm crossing are not likely to be lethal or to have long-term negative consequences for the marine mammal populations, and any impact on the marine mammals would be no greater than negligible. Furthermore, there would be no adverse impact on the availability of marine mammals for subsistence purposes. This request has been filed for the purpose of ensuring that there is no question that the activities described herein are conducted in compliance with the MMPA when and if small numbers of marine mammals are "taken" incidentally and unintentionally during the course of bridge construction.

II. INFORMATION SUBMITTED IN RESPONSE TO THE REQUIREMENTS OF 50 C.F.R. § 216.104

Regulations governing the issuance of a multi-year LoA permitting incidental "takes" under certain circumstances are codified at 50 C.F.R. Part 216, Subpart I (216.101 – 216.106). Section 216.104 sets out fourteen specific items that must be addressed in requests for rulemaking pursuant to Section 101(a) (5) of the MMPA. Each of these items is addressed in detail below.

1. OPERATIONS TO BE CONDUCTED

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

A detailed description of the activities that could occur during construction of the Knik Arm crossing is provided in the Draft Environmental Impact Statement included as a supporting document with this submission. This section provides a brief overview of the key activities particularly as related to the potential harassment of marine mammals.

Overview of the Activity

KABATA proposes to construct an 8,180 ft (2,493 m) steel bridge spanning Knik Arm in Upper Cook Inlet. The project area is located north of Anchorage and west of Elmendorf Air Force Base in the southern portion of Knik Arm (Figure 1). The west end of the crossing would be located approximately 3,500 ft (1,067 m) south of the existing Anderson dock. Heading east, the crossing would traverse approximately 1,000 ft (305 m) of intertidal area before reaching the subtidal zone (the area above the mean lower low water [MLLW] level). The crossing would then traverse Knik Arm where water depth ranges from zero ft to 20 ft (6 m) at MLLW in slightly over ½ mile (805 m). At this point the crossing would traverse two channels approximately 50 and 70 ft (15 and 20 m) deep at MLLW before reaching the intertidal area that extends approximately ½ mile to the eastern shoreline of Knik Arm.

The bridge would be used for vehicular traffic. The purposes of the bridge are to provide the following: (1) an efficient connection to move freight and goods between the Port of Anchorage/Ship Creek industrial areas and the Port MacKenzie district, (2) safety and redundant overland routes connecting area airports, military bases, ports and hospitals for emergency response, (3) transportation infrastructure to meet projected local population and economic growth forecasts, and (4) support for economic advancement in the region. "Takes" of marine mammals incidental to the construction of the Knik Arm crossing in Upper Cook Inlet are expected to be authorized under this request for a multi-year LoA.

Causeway Construction

Three alternatives for the crossing alignment have been proposed including the southern, skewed, and perpendicular alignments (Figure 2). A complete description of these alternatives is discussed in the Draft Environmental Impact Statement for the Knik Arm Bridge submitted to NOAA Fisheries with this request. The southern alignment is the preferred alternative. For the southern alignment, causeways approximately 3,600 ft (1,100 m) and 2,100 ft (640 m) in length would be constructed from the east and west shores, respectively. During year one (presently scheduled for 2007), the east and west bridge causeway foundations and abutments would be constructed in April-May following the establishment of access roads. Gravel filling for the east and west causeways will occur simultaneously. Armoring of the causeways will occur concurrently with the gravel filling operation. Construction of the access roads and causeways is scheduled for a double shift, seven days per week, and ten hours per day.

Piling Installation

Pile driving is planned to take place primarily during the ice-free months from April to November of each year. No piling emplacement is currently planned for months when ice is present due to increased cost and personnel safety limitations. However, we request authorization for "takes" that might occur during pile driving at any time of year. Pile driving may begin the first year, but is expected to occur primarily during years 2 and 3 of the proposed 3-year construction program.

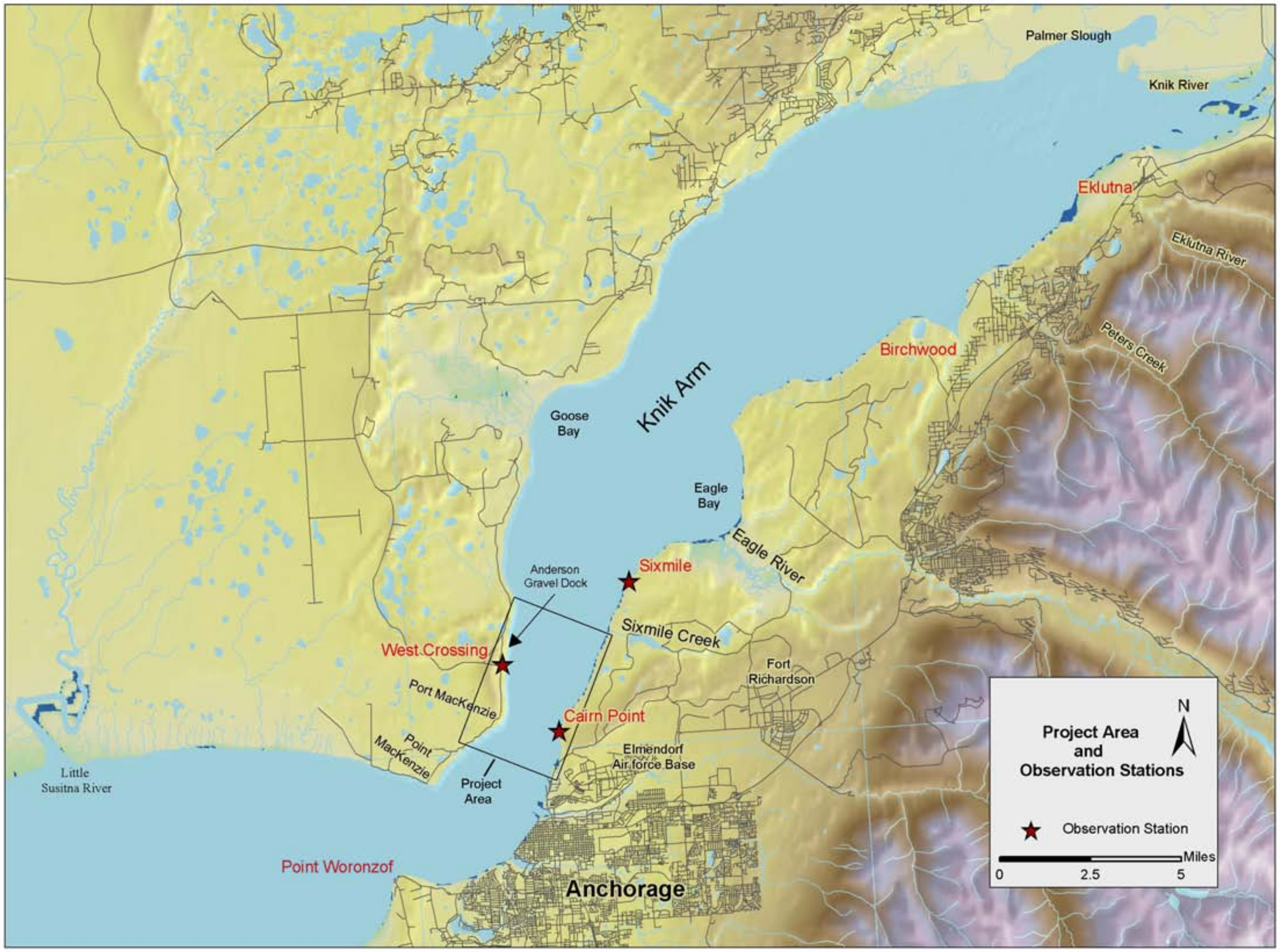

Figure 1. Project area location in southern Knik Arm with location of mitigation monitoring stations indicated by red stars.

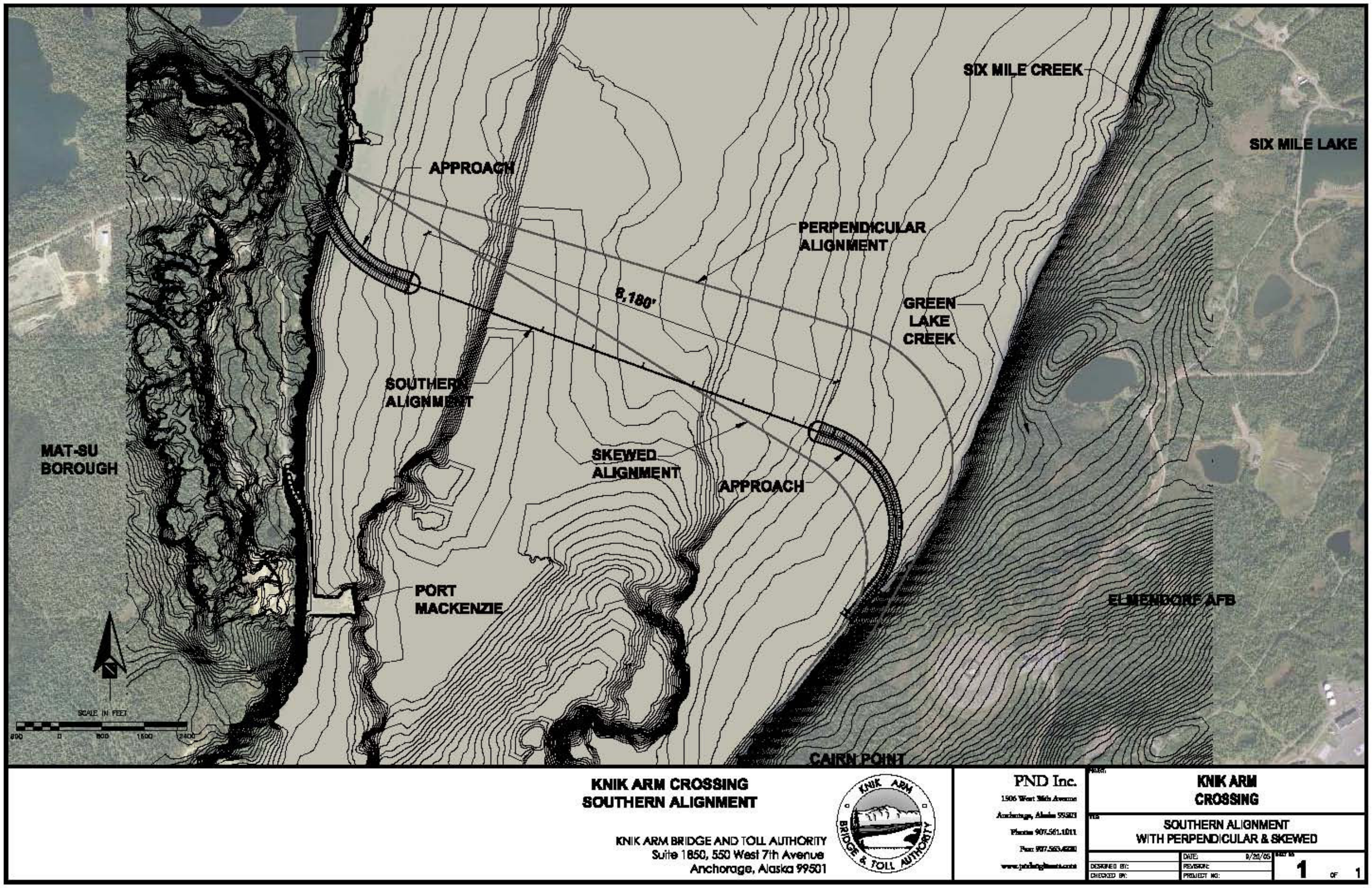

Figure 2. Alignment alternatives for Knik Arm Crossing, Upper Cook Inlet, Alaska. The southern alignment is the preferred alternative

KABATA Request for a Multi-year Letter of Authorization

The bridge design requires approximately 132 pilings at 33 locations with an abutment at each end where the bridge meets the east and west causeways. Water depths at the piling sites range from 60 to 80 feet (18 to 24 m) MLLW. Piles will be constructed of pre-stressed steel, approximately 150 ft (46 m) in length, 4 ft (1.2 m) in diameter, and of 1-2 inches (2.54-5.08 cm) wall thickness. Initially, a vibratory hammer will be used to drive each pile approximately 40% or more of the way to its final position. Impact hammering will be used to drive the pile the remainder of the way or to refusal (i.e., when further impact pile driving is unproductive). Pilings will be driven one or possibly two at a time and are expected to require 1-2 hours of actual impact hammering per pile to install. On any given day approximately 2-4 hours of impact hammering would be expected. Pile driving will require approximately 220 days.

An APE HI400U hydraulic impact hammer or similar equipment would be used to drive piles during the Knik Arm crossing construction. The APE HI400U delivers 30 blows per minute at maximum stroke with a ram weight of 80,000 lb (36,287 kg).

Roadbed Construction and Installation

Construction and installation of the superstructure roadbed is proposed to occur over a 2-year period following placement of piles and installation of support framework. Superstructure installation would occur immediately after completion of construction of support structures for a given section of superstructure, and prior to installation of pilings for subsequent sections. Superstructure construction will involve the use of tug and barge combinations fitted with cranes for lifting and placement of roadbed components.

Vehicles and Heavy Equipment

The following list summarizes the vehicles, vessels and machinery that are expected to be used during crossing construction. Specific vehicles and heavy equipment are mentioned where possible, but alternative equipment may be used in some cases.

Front-End Loader	*Caterpillar 966.* Used for gravel placement, slope grading, truck loading, snow removal (with snow blower attachment). Six or more front-end loaders may be operating simultaneously.
Backhoe	Used for general dirt excavation. Five or more backhoes may be working simultaneously.
Excavator	*Hitachi 3600-5 and EX5500* or similar excavators. Two to six excavators may be operating simultaneously.
Dozer	*D6, D7, D8, D9 and D10 Caterpillar* Two to four dozers will be used for slope grading.
Vibratory Hammer	American Pile Driving (APE) 400LH Hydraulic Hammers. One to two vibratory hammers will be used to initiate driving of pier pilings.

Impact Hammer	APE HI400U Impact Hammer or similar machinery will be used to install support pilings.
Compactor	Three to five self-propelled, steel-wheel vibratory compactors will be used for causeway construction during gravel hauling.
Piling Tug/Barges	Two tug/barge sets to be used for vibratory and impact driving operations. Both may be operating simultaneously.
Material Tug/Barges	Two material barges will be required. One approximately 180' x 60' used to supply sites with materials for pile driving, and one barge 150' x 50' for transporting concrete to fill the pilings.
Fitting Tug/Barges	One fitting barge, 150' x 50' with a 75 ton crane will be used to finish welding piers after pile driving operations move forward.
Roadway Tug/Barge	Support for superstructure roadway construction
Small Vessels/Skiffs	For use in transport of crews, expediting support materials, and as emergency vessels

Abandonment and Reclamation

The bridge will be actively maintained throughout its functional life. Any areas affected by construction activities that are not part of the permanent bridge structure will be returned to as close to a natural state as possible and practicable.

2. DATES, DURATION AND REGION OF ACTIVITY

The date(s) and duration of such activity and the specific geographical region where it will occur.

Overview

KABATA seeks a multi-year LoA for incidental "take" issued by NOAA Fisheries commencing on 1 April 2007. This request is for an LoA for the first year of the crossing construction during 2007 plus additional construction years. KABATA plans to construct the crossing during a 2-3 year construction program; however, potential delays associated with a project of this size and scope may require a longer construction period. Therefore, it is requested that the multi-year LoA cover the period 2007 through 2012 should an additional year or more be required to complete construction of the crossing.

The project area is located in Knik Arm at the head of Upper Cook Inlet including both the Municipality of Anchorage and the Matanuska-Susitna Borough. The eastern end of the crossing will be located north of Cairn Point adjacent to Elmendorf Air Force

Base, and the crossing will extend across Knik Arm and terminate north of the Port MacKenzie dock (Figures 1, 2, and 3). This is a span of about 2.5 miles (4.0 km) of which 1.5 miles (2.4 km) will cross water at high tide.

3. SPECIES AND NUMBERS OF MARINE MAMMALS IN AREA

The species and numbers of marine mammals likely to be found within the activity area.

Knik Arm including the area of bridge construction is used by several species of marine mammals. The beluga whale is the most abundant marine mammal in the area and harbor seals are occasionally present. Harbor porpoises and killer whales have also been sighted in Knik Arm, but are considered rare and are unlikely to be encountered during bridge construction. There have been no published sightings of Steller sea lions in Knik Arm, but a single adult male was documented in the Susitna Flats area to the southwest (Matthew Eagleton, NMFS, Pers. Comm. 2005). Several marine mammal species have been reported in the project area during recent intensive survey work to determine the level of beluga whale use of the area (Funk et al. 2005a; Ireland et al. 2005). To reduce redundancy, we have included the required information about species and numbers of marine mammals within the project area in Section 4.

4. STATUS AND SEASONAL DISTRIBUTION OF AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS

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.

Beluga whales, harbor seals, Steller sea lions, killer whales and harbor porpoises are the marine mammal species that might occur in the region of the proposed activity. These five species are discussed in this section, and are the species for which a multi-year LoA governing incidental “takes” of small numbers of marine mammals are sought.

Harbor Seal (*Phoca vitulina*)

The Gulf of Alaska stock of harbor seals, which includes Cook Inlet seals, is not classified as a strategic or depleted stock and is not listed under the Endangered Species Act (ESA; Angliss and Lodge 2004). The most recent population estimate for this stock was 29,175 harbor seals in 1998 (Angliss and Lodge 2004). They occasionally forage near river mouths during salmon runs in the summer and fall. Harbor seals occur in Upper Cook Inlet throughout the year, but are only occasionally seen in Knik Arm near the site of the proposed Knik Arm crossing project. In annual marine mammal surveys conducted by NOAA Fisheries from 1994 to 2005, there were 3 sightings of harbor seals in Knik Arm (Unpublished Data, NOAA Fisheries, D. Rugh 2005). Twenty-two sightings of harbor seals were reported during baseline studies in Knik Arm over a 13 month period (LGL, unpublished data). These sightings occurred during October and

September 2004 and June through September 2005. Fourteen of these sightings occurred within the general project area. Two of these sightings were in the general area of the Knik Arm crossing project. The closest established haulout to the Knik Arm crossing project is in the West Forelands approximately 72 miles (116 km) southwest of Point MacKenzie. However, harbor seals have also been reported to haulout intermittently near the Susitna Flats and in Turnagain Arm at Chickaloon Bay (D. Rugh 2005, pers. comm.; NOAA Fisheries, unpublished data). Harbor seals are occasionally killed by subsistence hunters in the Susitna Flats area approximately 24 miles (39 km) southwest of Point MacKenzie (Ron Stanek, Alaska Department of Fish and Game, Pers. Comm. 2005).

Steller Sea Lion (*Eumetopias jubatus*)

The western U.S. stock of Steller sea lions, which includes Cook Inlet animals, is listed as "endangered" under the ESA and "depleted" under the MMPA. The western stock is distributed throughout the Bering Sea, the North Pacific Ocean, and the Gulf of Alaska east to 144°W (Loughlin 1997). The most recent minimum estimate (2001-2002) of this population was 34,779, including pups (Angliss and Lodge 2004). In Cook Inlet, Steller sea lions are found far south of the Knik Arm crossing project site near the entrance to Cook Inlet. Haulouts and rookeries are located near Cook Inlet at Gore Point, Elizabeth Island, Perl Island and Chugach Island. Steller sea lions gather on traditional rookeries from mid-May through mid-July to give birth and breed. They are not known to migrate, but may move great distances on occasion. Typically they move from exposed outer coastal areas used in the summer to more protected areas in the winter. No Steller sea lion rookeries or haulouts are located in the vicinity of the proposed Knik Arm crossing project site and no sightings were reported in Knik Arm during baseline studies of marine mammals in the area (Funk et al. 2005a). It is unlikely that any Steller sea lions will be encountered in the project area during the bridge construction.

Harbor Porpoise (*Phocoena phocoena)*

The Gulf of Alaska stock of harbor porpoises, which includes Cook Inlet animals, is not classified as a strategic or depleted stock and is not listed under the ESA (Angliss and Lodge 2004). In 2000, the minimum population estimate for the Gulf of Alaska stock was 25,536 animals (Angliss and Lodge 2004). Harbor porpoises occur in Cook Inlet throughout the year, but are only occasionally seen in Knik Arm near the site of the proposed Knik Arm crossing project. Four sightings of harbor porpoises were reported during baseline studies in Knik Arm over a 13 month period (LGL, unpublished data). These sightings were during April and May 2005. The number of harbor porpoises using Knik Arm is unknown but appears to be low. On 11 August 2005 a dead harbor porpoise was found floating in the near-shore waters north of Eagle Bay in Knik Arm (Stranding report filed with Barbara Mahoney of the NOAA Fisheries in Anchorage, Alaska).

Killer Whales (*Orcinus orca*)

The Eastern North Pacific Stock of killer whales includes transient and resident killer whales in the Gulf of Alaska and Cook Inlet. The stock is not classified as a strategic or depleted stock and is not listed under the ESA (Angliss and Lodge 2004). The killer whales found in Cook Inlet are included as part of the Eastern North Pacific stock for assessment purposes (Angliss and Lodge 2004). In 2000, the "resident" (i.e. fish consuming) stock minimum population estimate was 723 animals. In 2001, the "transient" (marine-mammal consuming) stock minimum population estimate was 346 animals (Angliss and Lodge 2004). Killer whales occur in low numbers in Upper Cook Inlet. The number of killer whales using Knik Arm is unknown but is suspected to be low. Shelden et al. (2003) reported 11 sightings of killer whales in Upper Cook Inlet from the Susitna Flats east into Turnagain Arm and north into Knik Arm over the last 20 years. Two of these sightings were recorded in the southern portion of Knik Arm. There were no killer whale sightings during two recent marine mammal studies in Knik Arm (LGL, unpublished data)

Beluga Whale (*Delphinapterus leucas*)

Status

In Alaska, Cook Inlet beluga whales are one of five stocks recognized by NOAA Fisheries (Angliss and Lodge 2004): Bristol Bay (est. 1,619), Eastern Bering Sea (est. 7,986), Beaufort Sea (est. 39,258), Eastern Chukchi Sea (est. 3,710), and Cook Inlet (est. 366). The stocks are separated based on summer habitat. Except for the Cook Inlet stock, all Alaskan stocks of beluga whales winter in the Bering Sea (Shelden 1994).

The Cook Inlet stock has been defined as including "*all beluga whales occurring in waters of the Gulf of Alaska north of 58 degrees north latitude including, but not limited to, Cook Inlet, Kamishak Bay, Chinitna Bay, Tuxedni Bay, Prince William Sound, Yakutat Bay, Shelikof Strait, and off Kodiak Island and freshwater tributaries to these waters"* (C.F.R. section 216.15)

In 2000, the Cook Inlet beluga whale stock was listed by the National Marine Fisheries Service (NMFS; 65 FR 34590; 16 U.S.C. 1362) as depleted under the MMPA. The population of Cook Inlet beluga whales is below the Optimum Sustainable Population (OSP) as determined by NOAA Fisheries. NOAA Fisheries defines the OSP as 60% of the carrying capacity (K) of Cook Inlet (K estimated at 1,300), or 780 whales. Cook Inlet beluga whales are also listed by the State of Alaska as a species of special concern.

Seasonal Distribution

Worldwide

Beluga whale distribution is generally circumpolar, ranging from the Arctic to Subarctic waters off the coasts of Alaska, Canada, Russia, and Greenland (50° – 80° N Latitude, Reeves et al. 2002). Beluga whales show a high degree of philopatry to preferred summering areas, often gathering in large numbers seasonally to molt and feed on anadromous fish in the mouths of particular rivers (Caron and Smith 1990; Reeves et al. 2002).

Beluga whale distribution shifts seasonally with changes in sea-ice concentration (Gurevich 1980; Wells et al. 1999). Beluga whales generally seem to prefer areas relatively free of sea ice or along ice edges. However, aerial surveys and satellite tracking data demonstrate that they are capable of traveling large distances through areas of high sea-ice concentration (Braham et al. 1984; Suydam et al. 2001).

Cook Inlet

The beluga whale is the most abundant and most frequently observed marine mammal species in the project area. Estimates of the size of the Cook Inlet beluga stock over the last several decades have ranged from 300 to 1,300 whales. Historically, beluga whales were distributed throughout Cook Inlet although in recent years most records have been from areas north of Kalgin Island, particularly the Susitna Flats area, Turnagain Arm and Knik Arm (NMFS 2005a, Figure 3). Based on annual aerial surveys conducted by the National Marine Mammal Laboratory (NMML), the population is currently estimated at 278 individuals (95% confidence limits 194-398; NOAA 2005) and the stock was declared depleted in 2000. Although this current estimate is lower than estimates from 1999-2004, the decrease is not statistically significant.

The project site is located in Knik Arm in the northern portion of upper Cook Inlet (Figure 3). Observations of Cook Inlet beluga whales outside of Cook Inlet and south of the Alaska Peninsula are rare, suggesting that the range of this stock is generally limited to the inlet (Rugh et al. 2000). Historically beluga whales were observed with some consistency throughout upper and lower Cook Inlet. However, based on anecdotal information, their range appears to have contracted over the past 30 years coincident with decreased abundance (Speckman and Piatt 2000).

Factors likely influencing beluga whale distribution within Cook Inlet include prey availability, predation pressure, sea-ice cover and other environmental factors, reproduction, sex and age class, and human activities (Rugh et al. 2000; Kingsley 2002). Seasonal movement patterns and site fidelity of beluga whales in Cook Inlet appear to be closely linked to prey availability, with whale distribution coinciding with salmon (*Onchorynchus* spp.) and eulachon (*Thaleichthys pacificus*) concentrations (Moore at al. 2000).

Aerial Surveys—In summer, Cook Inlet beluga whales display site fidelity to certain concentration areas. They are reliably found in just a few areas each year (Seaman et al. 1988), typically near river mouths and the associated shallow, warm, and low salinity waters (Moore et al. 2000). During annual June-July aerial surveys, most beluga whales were sighted in the Susitna Delta, Chickaloon Bay and Knik Arm (Rugh et al. 2000, 2002). Aerial survey results indicated some inter-annual variability from 1993 to 2005, with the greatest number of whales counted during May-July in the Susitna Delta in most years, but higher counts in Chickaloon Bay and Knik Arm in a few years.

There is less information on beluga whale distribution in Cook Inlet in months other than May-July. During 2001-2002, nine aerial surveys of Cook Inlet spread throughout the year indicated that there were seasonal movements and changes in

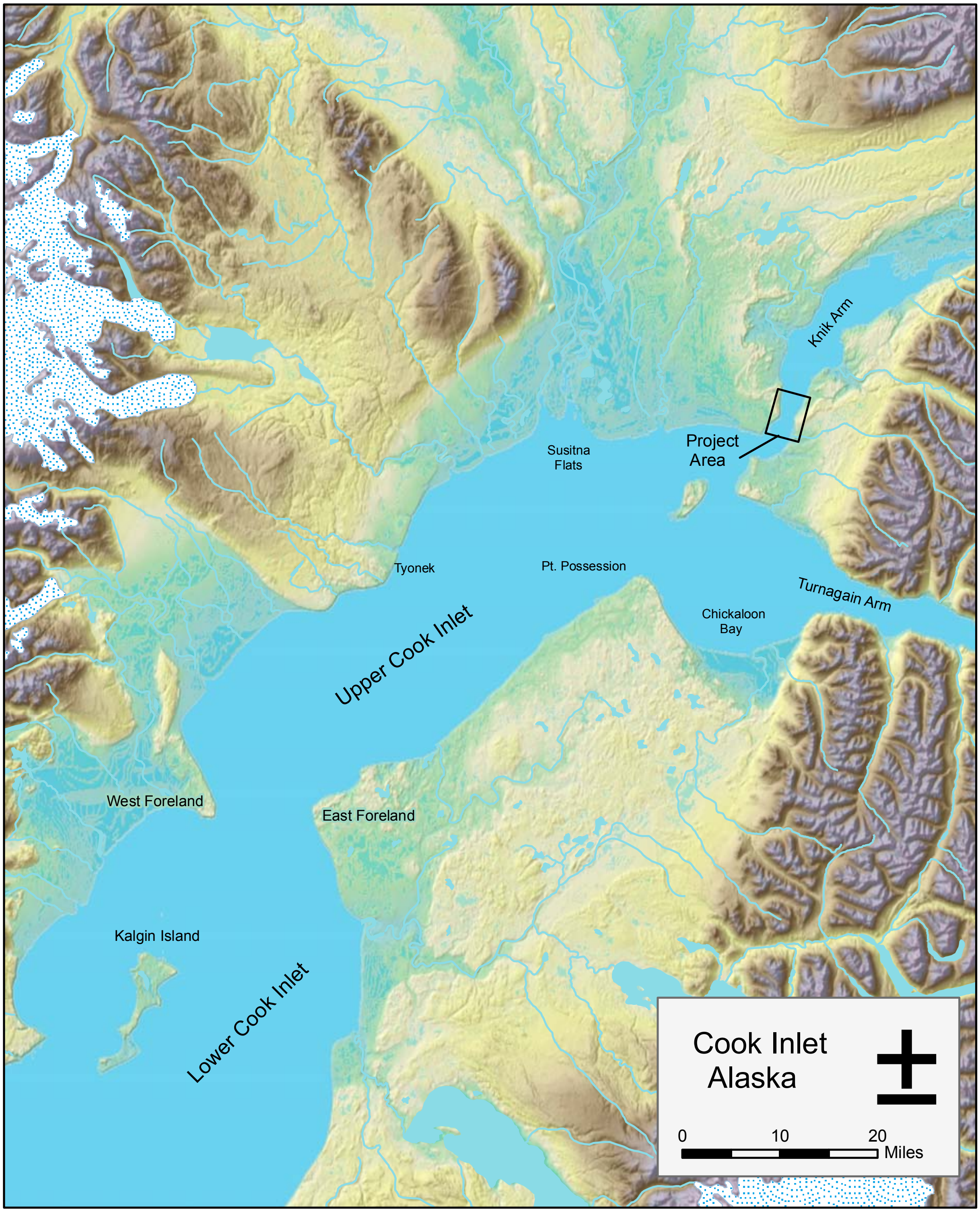

Figure 3. Location of the project area in relation to upper and lower Cook Inlet.

residency patterns (Rugh et al. 2004). Of the 33 beluga whale group sightings during these nine aerial surveys, the greatest proportion occurred in the Susitna and Chickaloon areas in July, in Turnagain Arm in August, in Knik Arm in September, and in the mid-Cook Inlet between Point Possession and Kalgin Island in January through April (Figure 3).

These observations generally agree with less systematic information collected previously indicating that during winter and spring Cook Inlet beluga whales shift their distribution to the south and are more dispersed throughout the upper to middle, and possibly the lower reaches of Cook Inlet (Moore et al. 2000; Angliss and Lodge 2004). Historic records of beluga whales during winter months include sightings in the upper and mid-Cook Inlet during the winters of 1975-1977 (Harrison and Hall 1978; Calkins 1989). Beluga whale sightings in January have also been reported from offshore drilling platforms south of Tyonek (Rugh et al. 2000). In 1997, beluga whales were consistently sighted in the mid-Cook Inlet (10 group sightings, mean group size = 15 whales) during February-March aerial surveys (Hansen and Hubbard 1999). Beluga whales were noted during surveys of lower Cook Inlet during September 1994-1996 (Bennett 1996).

Beluga whales may move seasonally in relation to sea-ice concentration in winter; however, it has been suggested that sea ice may not be the most important factor in seasonal shifts in distribution (Moore et al. 2000). Lower counts of beluga whales during winter aerial surveys may partly represent an artifact of reduced detectability due to the presence of sea ice (Rugh et al. 2004).

Satellite Telemetry.—Data on seasonal movements of beluga whales in Cook Inlet are also available from satellite tracking studies undertaken in recent years (NMFS 2005a). To date, satellite tags have been attached to 18 Cook Inlet beluga whales. A review of the positions from these satellite tagged whales (<http://nmml.afsc.noaa.gov>) indicates seasonal movements between different parts of the upper and central Cook Inlet generally concurring with the results from available aerial survey data.

The greatest proportions of whales with active satellite tags were reported in Susitna during spring-early summer (April-July), in Knik Arm in late summer-fall (Aug-Oct), in Chickaloon Bay and Turnagain Arm during late fall (Nov), and in the central Inlet during the winter (Dec-Mar). Satellite tagged whales represent a limited sample, both in terms of total sample size and with respect to the seasonal timing and geographic location of tagging. Most of the tagged whales were captured in Knik Arm in late July-early September (n = 13), although five animals were captured and tagged in the Susitna area, in one case during May (<http://nmml.afsc.noaa.gov>). Consequently, with limited transmitter life, sample sizes are small for the months from January through July (n = 1-4), and sampling may be biased geographically toward Knik Arm. Nevertheless, these data provide valuable insights into seasonal movement patterns of individuals, indicating that whales captured in Knik Arm and Susitna during the summer and fall, move out of these areas, occupying Chickaloon Bay, Turnagain Arm, and central Cook Inlet at other times of year. However, a small number of winter satellite locations were recorded within Knik Arm. Kernel probability analyses of beluga whale ranging behavior based on these satellite tracks (50% area use) show a similar seasonal pattern (NMFS 2005a).

Land and Boat Based Observations.—Land- and boat based observations were obtained during baseline studies of habitat use by beluga whales in Knik Arm and adjacent areas during 2004-2005 (Funk et al. 2005b, Ireland et al. 2005). These studies documented beluga whale movement patterns and activity in Knik Arm in general with detailed observations in and around the area proposed for construction of a Knik Arm crossing. Observations were conducted daily from July 2004 through July 2005 and included 1,899 observation sessions averaging 6 hours in length for a total of over 14,000 hours of land-based monitoring effort. In addition, 140 boat surveys were conducted representing 748 hours of additional observation.

Results of the Funk et al. (2005a) study indicated strong seasonal patterns of beluga whale use of Knik Arm. In general, sighting rates of beluga whales in Knik Arm were low from December through July (Figure 4). Sighting rates were highest during late summer and fall (mid-August through mid-November), peaking during September (Markowitz et al. 2005a). Sighting rates during spring and early-to-mid summer were higher than winter but they were low compared to late summer and fall.

Limited data from boat surveys concurred with those from shore-based stations regarding patterns of beluga whale use of Knik Arm during fall versus summer. During boat surveys most whale sightings in Knik Arm occurred during fall, with relatively few whales encountered during summer surveys. Sighting rates in Knik Arm per hour of survey effort and per mile surveyed during summer 2005 were roughly 10% of those during fall 2004. There was evidence of a shift in distribution from Knik Arm in fall to Susitna in summer. Encounter rates during boat surveys were higher in Knik Arm than in the Susitna River area in the fall and higher in Susitna than in Knik Arm in summer.

During fall, beluga whales using Knik Arm generally remained north of the area proposed for construction of a Knik Arm crossing. On a few occasions, whales were seen transiting the narrows between Cairn Point and Port Mackenzie through the area proposed for construction of the Knik Arm crossing. However, no large groups of whales were seen moving into or out of Knik Arm during either land-based or boat-based surveys in the August through October 2004 period.

The numbers of whale groups sighted decreased dramatically during November 2004. The whales returned to Knik Arm sporadically during the spring and summer 2005.

Extreme tidal fluctuations influenced the available habitat and the movement of beluga whales in Knik Arm (Funk et al. 2005b). As the tide flooded, beluga whales typically moved from areas near Sixmile Creek and Eagle Bay past Birchwood toward the northern reaches of Knik Arm (Figure 1). As the tide ebbed the whales returned to areas near Eagle Bay and Sixmile Creek where they remained during the lower portions of the tidal cycle.

During the low tide period beluga whales remained in Eagle Bay most of the time. However, 62% of the whales sighted during boat based surveys during September and October 2005 moved out of Eagle Bay toward the Sixmile Creek area at some time during low tide period (Ireland et al. 2005). On average, whales spent less than three hours in the Eagle Bay/Sixmile Creek areas before they headed north into upper Knik Arm on the leading edge of the flooding tide, often as one large group. The southern portion of the Sixmile Creek area (3.2 km north of the bridge site) was used most frequently during September when the greatest numbers of beluga whales were present in Knik Arm (Ireland et al. 2005).

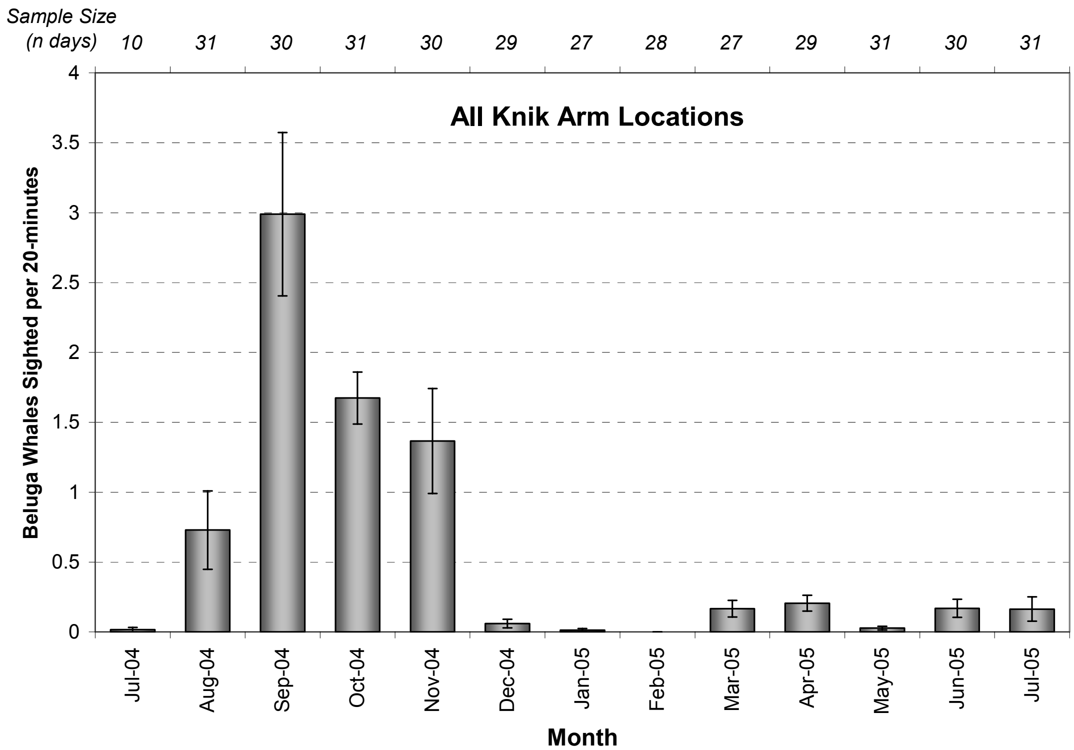

Figure 4. Beluga whale sighting rate by month during baseline studies in Knik Arm. Data are from Funk et al. (2005).

Sighting rates in the bridge crossing corridor were generally lower than elsewhere in Knik Arm. On average, including the high whale use months of fall, one group of approximately 5 beluga whales was sighted within 0.3 miles (500 m) of the bridge site every 33 to 70 hours. As in other parts of Knik Arm, sighting rates were highest in the fall, lower in spring and lowest in the winter. Sighting rates in summer (May through July) and winter (November through January) were very low, with roughly one group sighted within 2.5 miles (4 km) of the proposed bridge alignment every 30 hours of observation effort. During all seasons, sighting rates in the planned bridge corridor were highest at low tide when whales, limited by water depths in the northern part of Knik Arm, are forced to remain in Eagle Bay and areas to the south. Most beluga whales observed in the crossing corridor were adults transiting or diving, suggesting that the area is not important for resting, feeding or protecting young (Markowitz et al. 2005b).

5. TYPE OF INCIDENTAL "TAKE" AUTHORIZATION REQUESTED

> *The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death, and the method of incidental taking.*

KABATA requests issuance of a multi-year LoA to authorize non-lethal incidental "take" by harassment during its planned construction of a bridge across Knik Arm. Marine mammal injury or mortality during routine construction and operational activities on the project is very unlikely and it is anticipated that all "takes" will be level B "takes" by harassment. However, KABATA requests that the LoA authorizes a very small number (1-2 animals) of incidental, non-intentional injurious "takes" in the unlikely event that they might occur. Should a Level A "take" involving serious injury or death of a whale occur, construction activities would be suspended pending notification of NMFS and review the conditions under which construction activity could resume.

The construction activities outlined in Sections 1 and 2 of this request and described in detail in the Draft Environmental Impact Statement submitted with this request have the potential to disturb or displace small numbers of marine mammals. These potential "takes" would constitute Level B harassment (behavioral disturbance) as defined in the 1994 amendments to the MMPA. No take by serious injury or death is likely, given the planned monitoring and mitigation procedures (Sections 11 and 13). These measures are designed to minimize the possibility of injury to marine mammals and to reduce disturbance caused by construction activities.

Sounds and non-acoustic stimuli will be generated by vehicle traffic, vessel operation, roadbed construction, filling, and vibratory and impact pile driving. The sounds generated from construction operations and associated activities will be detectable underwater and/or in air some distance away from the area of activity. The distance will depend on the nature of the sound source, ambient noise conditions, and the sensitivity of the receptor to the sound (Richardson et al. 1995). Animals that hear the sound will not necessarily react to it. However, at times, some of these sounds are likely to be strong enough to cause localized avoidance or other disturbance reactions by small numbers of marine mammals. Harassment will potentially result when marine mammals near the activity react in a non-trivial manner to the sounds generated. The type and significance of behavioral reaction is likely to depend on the activity of the animal at the time it receives the stimulus, as well as the distance from the sound source and the level of the sound relative to ambient conditions. Noise from pile driving, in particular, may result in marine mammals near the activity changing their behaviors or activities. In addition to disturbance, some limited masking of whale calls or other sounds potentially relevant to whales could occur. Vessel traffic is also known to cause avoidance reactions by beluga whales at certain times (Richardson et al. 1995). However, Cook Inlet belugas are regularly sighted in and around the Port of Anchorage (NMFS 2005a) passing near or under vessels (Blackwell and Greene 2002), and they appear to have high tolerance to vessel traffic. It is anticipated that belugas exposed to repetitious construction sounds from the proposed construction activities will, after initial exposure to these sounds, tolerate them as they have learned to tolerate vessel traffic.

Harbor seals, beluga whales, and harbor porpoises could be exposed to vessel or construction noise and to other stimuli associated with the planned construction. No other species of marine mammal is expected to be present near the planned activities. It is remotely possible that a very small number of killer whales and/or Steller sea lions might be present. Construction activities are expected to occur seasonally and incidental harassment "takes" of marine mammals could potentially occur intermittently when construction occurs. Although KABATA is requesting a 5-year duration of the proposed authorization (approximately April 2007 through April 2012), construction activities are expected to occur seasonally over a two- to three-year period and the nominal plan would not involve operations over the full five-year period. Beluga whales and harbor seals will likely be in the area throughout this period to some extent. Based on sighting rates and telemetry studies, few beluga whales are likely to be in the project area between December and late May, they will be present infrequently from May through July, and highest numbers will occur in August through November (Rugh et al. 2004, NMFS 2005a, Funk et al. 2005a). Only a few harbor seals have been reported near the planned construction site (LGL unpublished data). With the monitoring and mitigation measures that are planned (see Sections 11 and 13), it is very unlikely that any marine mammal will be injured or killed.

6. NUMBERS OF MARINE MAMMALS THAT MAY BE "TAKEN"

> *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 [section 5], and the number of times such takings by each type of taking are likely to occur.*

The material for Sections VI and VII has been combined and presented in reverse order to minimize duplication between sections.

7. ANTICIPATED IMPACT ON SPECIES OR STOCKS

> *The anticipated impact of the activity upon the species or stock of marine mammals.*

Introduction

Both acoustic and non-acoustic activities associated with the proposed construction of the Knik Arm crossing could have impacts on marine mammals. The bridge construction and associated activities in marine waters will introduce sound into the environment. The hearing ability of marine mammals constitutes their most important distance receptor system, and construction sounds could (at least in theory) have several types of effects on marine mammals which are discussed in this section. Acoustic effects could result from sound produced by vehicles, vessels, and aircraft, as well as sounds produced during bridge construction activities such as impact pile driving. Pile driving is expected to produce the greatest level of construction-related noise and is more likely to impact marine mammals than other anthropogenic sound sources.

Potential non-acoustic effects could result from the physical presence of personnel, structures and equipment. Structures, such as causeways and pilings, have the potential to alter benthic habitats locally although these structures would not be likely to obstruct movements of beluga whales or other marine mammals. It is possible, though very unlikely, that a beluga whale or a harbor seal might be injured or killed by a vessel strike or that construction activities may result in the stranding of one or more beluga whales.

Noise Characteristics and Effects

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

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

(2) The noise may be audible but not strong enough to elicit any overt behavioral response. This has been demonstrated upon exposure of various species, including beluga whales, to low levels of seismic, drilling, dredge, or icebreaker sounds.

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

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

(5) Any man-made noise that is strong enough to be heard has the potential to reduce (mask) the ability of marine mammals to hear natural sounds at similar frequencies. Important natural sounds could include calls from conspecifics or predators, echolocation sounds of odontocetes, and environmental sounds such as ice or surf noise. However, with intermittent (pulsed) noise, such as that from impact hammers, other sounds are likely to be audible between the noise pulses, reducing the importance of the masking.

(6) Very strong sounds have the potential to cause temporary or permanent reduction in hearing sensitivity. Effects of non-explosive sounds on hearing thresholds of marine mammals have received very little study. However, some data are now available for two species of odontocetes, including the beluga whale, exposed to a single strong noise pulse or tonal sound (Ridgway et al. 1997, Finneran et al. 2000, 2002, 2005) and for three species of pinnipeds exposed to moderately strong sound for extended periods (Kastak et al. 1999). Received sound levels must far exceed the animal's hearing threshold for there to be any temporary threshold shift (TTS). The TTS threshold

depends on the duration of exposure. The sound level necessary to cause TTS is higher for short sound exposures than for long sound exposures. Received levels must be even higher for there to be risk of permanent threshold shift (PTS).

Sensitivity of Marine Mammal Hearing

Pinnipeds may respond to sound both in air and in water (Kastak et al. 2004). Harbor seals hear well in water at frequencies from 1 to 60 kHz and can detect sound levels as weak as 60-85 dB re 1 µPa, depending on frequency, within that band. Harbor seals also hear well in air and had lower thresholds than California sea lion and elephant seal (Kastak and Schusterman 1998). Kastak and Schusterman (1998) reported low frequency (100 Hz) sound detection thresholds at 65.4 dB for harbor seal. Harbor seal hearing sensitivity diminishes as frequency diminishes below 1 kHz, but they can detect strong sounds at frequencies at least as low as 100 Hz (Kastak and Schusterman 1998). For pinnipeds, TTS thresholds associated with exposure to brief pulses (single or multiple) of underwater sound have not been measured. Initial evidence from prolonged exposures suggested that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak et al. 1999, 2005; Ketten et al. 2001; *cf*. Au et al. 2000). However, more recent indications are that TTS onset in the most sensitive pinniped species studied (harbor seal) may occur at a similar sound exposure level as in odontocetes (Kastak et al. 2004).

Odontocetes such as the beluga whale, killer whale and harbor porpoise can hear very strong sounds at frequencies down to 40-75 Hz but they have low sensitivity at these frequencies (~130-140 dB re 1 µPa). Odontocetes have very good high-frequency hearing in the 80-150 kHz range, and make use of these high frequencies for echolocation. The frequencies with highest sensitivity, as recorded for seven species of odontocetes, were between ~8 and 90 kHz (reviewed in Richardson et al. 1995).

Beluga whales are one of the most studied of all the odontocetes in terms of hearing abilities. They are known to hear a wide range of frequencies although their greatest sensitivity is around 10-100 kHz (Richardson et al. 1995), well above sounds produced by most industrial activities (<100 Hz) recorded in Cook Inlet (Blackwell and Greene 2002). Awbrey et al. (1988) reported average hearing thresholds for captive beluga whales of 65 and 120.6 dB re 1 µPa at frequencies of 8 kHz and 125 Hz, respectively. Finneran et al. (2000) measured masked hearing thresholds of approximately 120 dB re 1 µPa for a captive beluga whale at three frequencies between 1.2 and 2.4 kHZ. However, beluga whales have some limited hearing ability down to ~35 Hz, where their hearing threshold is about 140 dB re 1 µPa (Richardson et al. 1995 and references therein). Thresholds for pulsed sounds will be higher, depending on the specific durations and other characteristics of the pulses (Johnson 1991, 1992).

Sounds from Vibratory and Impact Pile Driving

Pile driving in or near water is known to produce strong underwater sound pressure levels (SPLs; Richardson et al. 1995, Würsig et al. 2000). As part of baseline research for this request for a multi-year LoA, Blackwell (2005) measured in-water sound produced from impact and vibratory pile-driving during construction activities at the Port MacKenzie dock in August 2004 (Table 1). Two 36 in (91 cm) diameter steel pipes, 150 feet (46 m) long, were driven 40–50 feet (12–15 m) into the seabed. Blackwell (2005) characterized these construction sounds in terms of their broadband and one-third octave band levels and gathered information on transmission loss by repeated measurements of the same type of sound at different distances from the source. The received sound level at any specific distance from pile driving depends on the depth of the water in which the piles are driven (shallower water attenuates sound faster), the density or resistance of the substrate, the physical properties and dimensions of the pipe, and the type of pile driver that is used. Actual SPLs from pile driving during construction of the Knik Arm crossing will vary from the Port MacKenzie measurements due to differences at the crossing site in tidal height, bathymetry, distance to the shoreline, and construction materials and equipment. The pile driving equipment that is anticipated to be used for the Knik Arm crossing construction will likely produce greater SPLs than those measured by Blackwell (2005) for the Port MacKenzie dock. However, the Port MacKenzie measurements provide a first approximation of the received sound levels at various distances from the source that might be expected during Knik Arm bridge construction. Blackwell (2005) presented received sound levels as a function of distance using values for mean peak levels, SPL, and sound exposure levels (SELs; Figure 5). SPL is a measurement of the average pressure of a sound, while the duration of exposure is included in the SEL values which are a measure of the sound energy.

Impact Criteria

The criteria for establishing underwater sound exposure levels for marine mammals are being reviewed by NOAA Fisheries in an Environmental Impact Statement (NMFS 2005b; 70 FR 1871-1875). There are no current guidelines on permissible (safe) levels of sound exposure for cetaceans, pinnipeds, or other vertebrates to continuous underwater sounds, such as those produced by a vibratory pile driver. Regarding pulsed sounds, such as those produced by impact pile drivers, NOAA Fisheries has specified that cetaceans should not be exposed to pulsed sound with SPLs exceeding 180 dB re 1 µPa rms (NMFS 2000a). Here “rms” refers to average pressure over the duration of a single pulse. More recently NMFS (2005a) suggested that during the use of multiple pulse sources (such as pile driving), beluga whales exposed to a single pulse with peak pressure of ≥230 dB re 1 µPa would theoretically be injured. The SPL value of such a pulse averaged over the duration of the pulse would probably be around 220 dB re 1 µPa (rms), while the pulse energy (SEL) would be approximately 205 dB re 1 $\mu Pa^2 \cdot s$. The area surrounding the noise source where these SPLs could occur is termed the **zone of hearing loss, discomfort and injury** (Richardson et al. 1995).

Table 1. Variables associated with vibratory and impact pile driving using deep and shallow hydrophones at the Port MacKenzie dock in 2004. Data are from Blackwell (2005). The steel piles were 150 ft (~46 m) long, 36 in (91 cm) in diameter, with a thickness of 1 in (2.54 cm). During the recordings, water depth around the pipes was tide-dependent, in the range 33–56 ft (10–17 m).

	Deep hydrophone (10 m or 33 feet)	**Shallow hydrophone (1.5 m or 5 feet)**
Vibratory pile driving		
Mean SPL (rms) at 56 m[(1)]	164 dB re 1 μPa	162 dB re 1 μPa
Sound propagation loss	22 dB/decade[(2)]	29 dB/decade[(2)]
Dominant frequency range	400–2500 Hz	
Peaks or tones	15 Hz and multiples thereof	
Impact pile driving*		
Mean SPL (rms) at 62 m[(3)]	189 dB re 1 μPa	190 dB re 1 μPa
Mean instantaneous peak pressure at 62 m[(3)]	206 dB re 1 μPa	204 dB re 1 μPa
Mean sound exposure level at 62 m[(3)]	178 dB re 1 $\mu Pa^2 \cdot s$	180 dB re 1 $\mu Pa^2 \cdot s$
Sound propagation loss	16–18 dB/decade[(2)]	21–23 dB/decade[(2)]
Dominant frequency range	100–2000 Hz	
Peak frequencies	350–450 Hz	

(1) Average of several 8.5-sec samples
(2) that is, dB per tenfold change in distance
(3) Average of several individual pulses

* The sound recordings at Port MacKenzie were of a Delmag D62-22 impact pile driver with a 13.5-ton (12,280 kg) hammer with maximum net impact energy of 223 kJ and 79,200-161,640 ft lbs of energy per blow.

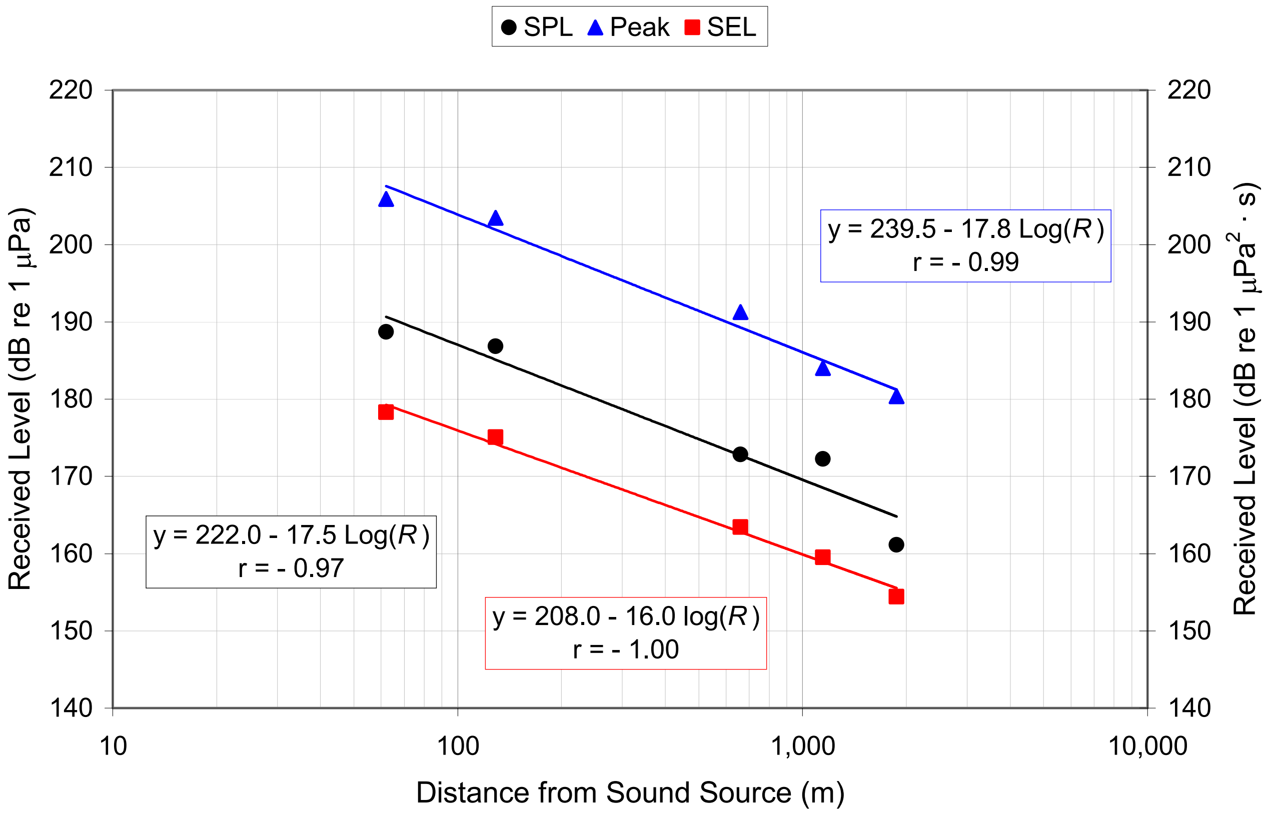

Figure 5. Underwater sound measurements from pile driving at the Port MacKenzie dock (Blackwell 2005) expressed as mean peak sound levels, mean sound pressure levels (SPL), and mean sound exposure levels (SEL).

Displacement, altered habitat use, altered diving intervals, and interrupted or altered behavior may result from exposure to noise at received levels less than 180 dB re 1 µPa rms (Richardson et al. 1995). Underwater pulsed sounds at received levels between 150 and 160 dB re 1 µPa rms have been shown to elicit behavioral responses in some marine mammals (Richardson et al. 1995). Informal NMFS guidelines assume that disturbance (harassment) is likely to occur at received levels ≥160 dB re 1 µPa rms (NMFS 2005a). However, more recent observations of odontocetes and pinnipeds have indicated that exposure to a SPL of 170 dB re 1 µPa rms may be a more appropriate sound level at which behavioral responses are initiated in these groups (Harris et al. 2001; LGL 2005). The area surrounding a sound source where marine mammals show observable behavioral responses is termed the **zone of responsiveness** (Richardson et al. 1995).

NMFS (2000a) concluded that cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding 180 and 190 dB re 1 µPa (rms), respectively. These sound levels are ***not*** considered to be the levels above which TTS might occur. Rather, they are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before TTS measurements for marine mammals started to become available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. For odontocetes exposed to single short pulses, the TTS threshold appears to be, to a first approximation, a function of the energy content of the pulse (Finneran et al. 2002). Given the available data, the received level of a single pulse might need to be ~210 dB re 1 µPa rms (~221–226 dB pk–pk) in order to produce brief, mild TTS. Exposure to several pulses at received levels near 200–205 dB (rms) might result in slight TTS in a small odontocete, assuming the TTS threshold is (to a first approximation) a function of the total received pulse energy. TTS data that are now available imply that, at least for dolphins, TTS is unlikely to occur unless the dolphins are exposed to pulses much stronger than 180 dB re 1 µPa rms (Schlundt et al. 2000; Finneran et al. 2005).

Effects of Pile Driving on Beluga Whales

The manner in which sound from activities such as pile driving may affect beluga whales depends on the SPL of the sound, but also on numerous other factors. The SPL at the location where the sound is received by a whale depends on the distance of the whale from the sound source as well as the water depth and bathymetry. How a particular SPL from a pile driver will affect beluga whales or other marine mammals also will depend on the frequency range of the sound and the hearing ability of the animal in that frequency range. The level of background noise can also affect marine mammal ability to hear man-made sound. If the received level of a man-made noise is lower than that of the background noise, the man-made noise is not detectable by the marine mammal.

Blackwell (2005) measured underwater sounds during pile driving activity at the Port MacKenzie dock. At the recording station closest to the sound source (~203 ft or 62 m), SPLs of ≥ 160 dB re 1 µPa were recorded at a frequency range of approximately 55 to 20,000 Hz, although the dominant frequency range was 100-2,000 Hz (Table 2). At the farthest station from the sound source (~6135 ft or 1870 m), SPLs of ≥ 160 dB re 1 µPa were recorded at a frequency range of approximately 200 to 900 Hz. Beluga whale hearing extends to at least 50 Hz but is most sensitive at higher frequencies between approximately 10,000 to 100,000 Hz. A sound source must be much stronger for belugas to hear at lower as opposed to mid-range and higher frequencies. Based on the sound measurements recorded during pile driving at the Port MacKenzie dock, the frequency of the sound available at the farthest station would be below the range at which beluga whale hearing is most sensitive, and only a portion of the sound at the near station would be within the range of greatest hearing sensitivity.

Received mean SPLs from impact pile driving at the Port MacKenzie dock exceeded 180 dB, 170 dB, and 160 dB re 1 µPa rms within approximately 820 ft (250 m), 3071 ft (927 m), and 11,450 ft (3,490 m) of the source, respectively (Blackwell 2005). The actual pile-driving SPLs resulting from construction activities for the Knik Arm crossing would vary depending on the type of pile-driving equipment used and the size of the piles. In contrast, Blackwell (2005) reported mean SPLs of 160 dB re 1 µPa rms within ~200 ft (61 m) from the source during vibratory pile driving at the Port MacKenzie dock. However, as noted above, the appropriate impact criteria for more-or-less continuous sound such as that from vibratory pile driving are different than those for pulsed sounds, and not well defined.

Background noise levels are relevant in estimating how far away sounds from a specific source will be detectable, and how prominent they will be at any closer distance. Blackwell (2005) reported background noise levels of 115–133 dB re 1 µPa on a broadband basis over the frequency range 10-20,000 Hz. These are quite high values (*cf.* C. Greene's Chapter 5 *in* Richardson et al. 1995). Some of these background levels were measured in strong tidal currents while the recording vessel was tied up at the dock, resulting in a large contribution of flow noise. Blackwell and Greene (2002) made recordings of background levels in Cook Inlet in 2001 in areas with and without industrial noise. Broadband (10-20,000 Hz) values for ambient underwater sound at 8 locations in Knik Arm and Cook Inlet ranged from less than 95 dB re 1 µPa at Birchwood in Knik Arm to approximately 120 dB re 1 µPa for locations near Elmendorf AFB and north of Point Possession during the incoming tide. The values obtained without strong currents in the Port MacKenzie pile-driving study (115–118 dB re 1 µPa), were comparable to the values obtained in Cook Inlet in 2001. However, the values obtained in the absence of impact pile driving (125–132 dB re 1 µPa), i.e., while the tide was incoming or outgoing, were somewhat higher than the 2001 measurements.

Underwater industrial sounds must have levels equal to or greater than both the ambient noise levels at the corresponding frequencies and the hearing threshold of the animal at that frequency in order to be reliably detected by that animal. Sounds generally need to be at least ~20-30 dB stronger than the detection thresholds and/or ambient noise levels to elicit notable changes in the behavior or distribution of animals that are sensitive to those sounds. Animals that are frequently exposed to certain types of sound will sometimes tolerate sound levels as much as ~40-60 dB above ambient or detection levels before they change their behavior or distribution. Apparent indifference to strong sounds, often occurs when the sounds are familiar and when the animals have learned that the sound is not associated with any negative consequences. This learning process is called habituation. When it occurs, sound levels that animals will tolerate depend on past experience with the type of sound involved.

In assessing potential effects of man-made noise on marine mammals it is important to estimate the radius or zone of influence within which acoustic effects are expected (Richardson et al. 1995). The most extensive zone is the zone of audibility within which a marine mammal may hear the noise. The zone of responsiveness is smaller than the zone of audibility and is the region within which the animal reacts behaviorally or physiologically. The zone of potential auditory effects is the area near the noise source where the received sound level is high enough to cause discomfort or tissue damage to auditory or other systems.

Zone of Audibility

The maximum possible radius of influence of a man-made noise on a marine mammal is the distance from the noise source at which the noise can barely be heard. This distance is determined by either the hearing sensitivity of the animal or the background noise level. Many man-made sounds, such as pile driving, are composed primarily by low-frequency components. Beluga whales are not highly sensitive to these low-frequency sounds and the maximum radius of audibility of will likely depend on the hearing ability of the whale rather than the ambient (background) noise level. Although beluga whales may be able to hear a man-made noise within the zone of audibility, these noises probably have few or no deleterious effects at such distances.

Zone of Responsiveness

The zone of responsiveness is the area around a sound source (pile driving) within which beluga whales show observable behavioral responses to that sound. The distance at which a response becomes evident may vary among individual whales or whale groups. The most common beluga response to pile-driving noise would likely be avoidance. Avoidance responses may be strong if whales move rapidly away from the source, or weak if whale movement is only slightly deflected away from the source. However, SPLs from pile driving have been known to injure or kill fish (CalTrans 2001; Longmuir and Lively 2001). The presence of dead or injured salmon or eulachon could act as an attractant for beluga whales that feed on these species. Other potential beluga responses to pile-driving noise may include changes in behavior, dive intervals, and respiration rates. Stress caused by sound exposure may also result in physiological changes in beluga whale blood chemistry (Romano et al. 2004) although the long-term and/or population effects of these changes are unclear.

Underwater sounds associated with pile driving during the construction of a Knik Arm crossing may be detectable by beluga whales and of high enough intensity to cause changes in beluga whale behavior or distribution. Effects on beluga whales could include temporary (TTS) or perhaps permanent (PTS) auditory impairment at close range, temporary displacement from habitat, altered direction of movement, changes in resting or feeding cycles, alertness, changes in vocal behavior and changes in swimming or diving behavior. The reactions of individual beluga whales may vary depending upon multiple factors, which make it difficult to predict the reaction distance from a noise source for individual whales or the noise level that will always result in a reaction. Few studies have quantified whale reactions to noise exposure and these studies have involved individual or small numbers of animals. No studies have determined population level impacts.

Noise from pile driving could potentially displace whales from areas of pile-driving activity. Areas in upper Knik Arm frequented by whales at high tide are about 15 miles from the crossing project area and it is unlikely that whales in those areas would be displaced by pile driving sounds and thereby excluded from habitat or (theoretically) exposed to greater risk of stranding. However, whales using the Eagle Bay and Sixmile Creek areas during receding and lower portions of the tidal cycle could potentially be displaced farther up the inlet by pile driving sounds and in turn exposed to greater risk of stranding. Beluga whales commonly strand in upper Cook Inlet, which is characterized by shallow waters, extensive mud flats and a tidal range of up to 39 feet (12 m; Morsell et al. 1983). These stranding events are not normally fatal for all stranded whales, although differential mortality for different age and sex classes is likely (Moore et al. 2000). Strandings of 804 beluga whales have been recorded in upper Cook Inlet since 1988 (NMFS 2005a) with most mass strandings occurring in Turnagain Arm rather than Knik Arm (NMFS 2005a). However, Turnagain Arm is more visible to the public than Knik

Arm and stranded whales may be more readily observed there. Most mass strandings coincide with spring tides or killer whale (*Orcinus orca*) presence, during which whales may be exposed at low tides for 10 hours or more (NMFS 2000b, Shelden et al. 2003). Stranded whales, particularly large adults, are at risk of mortality due to stress, hyperthermia and suffocation. During two mass stranding events in 1996 and 1999 involving about 120 whales, 9 adult whales died (Moore et al. 2000). In 2003, 115 beluga whales stranded during five events. Five mortalities occurred during one of these events when 46 animals stranded in Turnagain Arm (Vos and Shelden 2005).

Beluga whale response to pile driving has not been reported in the literature although some studies have reported on the responses of other marine mammals to impact pile driving. Würsig et al. (2000) studied the response of Indo-Pacific humpback dolphins (*Sousa chinensis*) to pile driving. As with beluga whales, these dolphins are regularly found in shallow nearshore waters. The dolphins were exposed to SPLs reaching approximately 170 dB re 1 µPa rms and many dolphins appeared to temporarily abandon the area. In addition, dolphin traveling speed in areas near the pile driving more than doubled during pile-driving activities (Würsig et al. 2000).

Tougaard et al. (2003) reported that acoustic activity of harbor porpoises (*Phocoena phocoena*) declined dramatically during pile-driving activity associated with construction of a wind farm at Horns Reef in the North Sea off the coast of Denmark. Harbor porpoise acoustic activity resumed to normal levels several hours after the completion of pile-driving activities. The effects of pile-driving activity on harbor porpoises was observed at distances as far as 10-15 km from the activity and included a decrease in feeding behaviors and a decrease in the number of porpoises in the Horns Reef area during the construction period as compared to periods before and after construction. Henriksen et al. (2004) also reported similar decreases in harbor porpoise activities during monitoring of construction activities associated with offshore wind farms at Nysted in the Danish Baltic Sea. It may be relevant that harbor porpoises are known to be relatively responsive (skittish) to sounds from other human activities such as vessels (reviewed in Richardson et al. 1995). Belugas in areas with considerable human activity, such as Cook Inlet, are typically less skittish than harbor porpoises.

The effects of pile-driving activity on the distribution and behavior of pinnipeds may be reduced compared to these effects on cetaceans. Blackwell and Greene (2004) reported that ringed seals (*Phoca hispida*) showed little response to pile driving associated with construction activities in the Beaufort Sea of Alaska. Similarly, harbor seals (*Phoca vitulina*) did not seem to be affected by pile-driving noise during construction activities in San Francisco Bay (CalTrans 2004).

Masking is not expected to occur in beluga whales or other marine mammals during construction of a Knik Arm crossing. Vibratory pile driving would be the most likely source of masking because the sound emitted is continuous. However, Blackwell (2005) reported that most of the energy during vibratory activity was measured in the range of 400-2500 Hz and that beyond approximately 1300 m background sounds contributed more to received levels than did vibratory pile driving. The beluga whale's extensive vocal repertoire includes trills, whistles, clicks, bangs, chirps and other sounds (Schevill and Lawrence 1949; Sjare and Smith 1986a; Ouellet 1979). Beluga whistles have dominant frequencies in the 2 to 6 kHz range (Sjare and Smith 1986a). Other beluga call types reported by Sjare and Smith (1986a,b) included sounds at mean frequencies ranging upward from 1.0 kHz. Frequencies associated with vibratory pile driving overlap with some beluga whale call frequencies and could mask those calls. However, the 160 dB dB re 1 µPa rms SPL extends to approximately 200 ft from the source and is not likely to impact belugas. Beluga whales also have a very well developed high frequency echolocation system, as reviewed by Au (1993). Echolocation signals have peak frequencies from 40 to 120 kHz and broadband source levels of up to 219 dB re 1 µPa-m (zero-peak). These calls are far above the frequency range of the sounds produced by vibratory pile driving and other sounds produced by the proposed construction activities. Masking effects are minimal when the frequencies of the sounds of interest (here calls) do not overlap the frequencies of the masking sound.

Zone of Hearing Loss, Discomfort and Injury

The zone of potential auditory effects is the area within which beluga whales may experience discomfort, temporary (TTS) or permanent (PTS) hearing loss, or other injury. Studies in recent years have reported on the occurrence of TTS in some cetacean and pinniped species. However, no studies have reported on the occurrence of PTS, although odontocetes, baleen whales, and pinnipeds are known to have been killed by underwater explosions (Richardson et al. 1995). Ketten et al. (1993) reported mechanical trauma in the ears of humpback whales which died after exposure to an underwater explosion. Whales and other marine mammals at further distances from explosions or other underwater noise could suffer non-lethal injury to auditory systems, such as TTS or PTS, or other tissue damage.

TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). TTS occurs after exposure to a sound of sufficient intensity to cause the hearing threshold to rise, and a subsequent sound must be stronger in order to be heard. An energy-based criterion based on sound exposure level (SELs measured in dB re 1 microPa^2·s) that is under currently consideration for determining onset of TTS is based on sound intensity level as well as the duration of exposure. Under this criterion, onset of TTS would not be expected to occur until a marine mammal was exposed to a particular amount of energy in SELs based on a particular sound level for a given amount of time. PTS would not occur until received energy was above that required for TTS. TTS can last from minutes or hours to (in cases of strong TTS) days. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ends. Only a few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals, and none of the published data concern TTS elicited by exposure to multiple pulses of sound.

Although beluga whales may be susceptible to TTS after exposure to sound, some evidence suggests that beluga whales may recover from small levels of TTS quickly. Finneran et al. (2002) exposed a beluga whale to single underwater impulsive sounds from a seismic watergun and reported a TTS of 7 and 6 dB at 0.4 and 30 kHz, respectively, approximately 2 min after exposure to single impulses with peak pressures of 160 kPa, peak-to-peak pressures of 226 dB re 1 microPa, and total energy fluxes of 186 dB. Thresholds returned to within 2 dB of the pre-exposure value approximately 4 min after exposure. Schlundt et al. (2000) reported that stimuli levels between 192 and 201 dB were necessary to induce TTS in bottlenose dolphins and beluga whales although altered behavior in belugas occurred at stimuli between 180 and 196 dB. Ridgway et al. (2001) reported that depth, at least to 300 m, did not appear to affect beluga whale hearing ability.

Estimating "Takes"

KABATA seeks authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of NOAA Fisheries in the proposed region of activity. Species for which authorization is sought are harbor seals, Steller sea lions, harbor porpoises, killer whales and beluga whales. Any "takes" are most likely to result from construction noise, and/or vessel activity. This section summarizes the number of marine mammals that might be "taken" during construction of a bridge across Knik Arm.

The bridge construction project is expected to "take" only small numbers of Cook Inlet beluga whales and potentially a few harbor seals. These "takes" will have no more than a minor effect on individual animals or the populations of these two species. In addition, the construction is not expected to adversely impact subsistence hunting of marine mammal species that are of importance to the Alaskan Native communities of Upper Cook Inlet. It is anticipated that many of the marine mammals in the vicinity of the proposed activities will likely habituate to the construction sounds after repeated exposure, and that behavior or distribution patterns will likely not change sufficiently to constitute a "take".

Harbor Seal

Harbor seals are resident in Upper Cook Inlet but are rare in Knik Arm. Harbor seal "takes" by harassment would be unlikely, but a rare harassment "take" could occur during the mid-summer and fall when anadromous prey fishes return to Knik Arm. During most of the year, all age and sex classes except newborn pups could occur in the proposed activity area. In May to mid-July, female harbor seals haul out at terrestrial sites and give birth; at this time, pups may be encountered near pupping sites. Because no known pupping sites occur near the proposed crossing, pups are not expected to occur in the area of the proposed activity. Harbor seals are not known to reside in the proposed crossing area so any "takes" would likely involve seals that are moving through the area on foraging trips. Potential "takes" of harbor seals are most likely to result from construction noise (primarily pile driving) or vessel activity. Harbor seals that are "taken" may change their behavior, be temporarily displaced from the area of construction, or suffer TTS or PTS. With the absence of any major haulouts within the project area, potential "takes" by disturbance will have a negligible impact on individual harbor seals or subsistence hunting of them, and no effect on their population.

Steller Sea Lion

No Steller sea lion rookeries or haulouts are located in the vicinity of the proposed Knik Arm crossing project site and no sightings in Knik Arm were reported during baseline studies of marine mammals in the area (Funk et al. 2005a). It is unlikely that any Steller sea lions will be encountered in the project area during bridge construction. Steller sea lion "takes", if they occur at all, are most likely to result from construction noise (primarily pile driving) or vessel activity. If Steller sea lions are "taken", they are likely to change their behavior or be temporarily displaced from the area of construction. Even in the unlikely event that a Steller seal lion did occur near pile driving, auditory effects are unlikely if this species (like the California sea lion) is substantially less susceptible to TTS than is the harbor seal (Kastak et al. 2005). Steller sea lions are unlikely to be present within the project area and any "takes" would likely have only a minor effect on individual Steller sea lions and no effect on the Steller sea lion population in Cook Inlet.

Killer Whales

Killer whales are occasionally found in Upper Cook Inlet. Encounters in Knik Arm are rare and "takes" are unlikely in the region of the proposed construction activity. Killer whales are known to prey on belugas, and there is evidence that they have preyed upon belugas in the Upper Cook Inlet region (Shelden et al. 2003). Killer whale "takes", if they occur at all, will likely occur at times when prey (beluga whales, in the case of "transient" killer whales, and anadromous fish, in the case of "resident" killer whales) are most readily available, which is in summer and fall. Potential "takes" of killer whales are most likely to result from construction noise (primarily pile driving) or vessel activity. Killer whales that are "taken" are likely to change their behavior, be temporarily displaced from the area of construction, or could suffer TTS or PTS. Killer whales are unlikely to be within the project area and any "takes" would likely have only a minor impact on individual killer whales and no effect on the killer whale population in Cook Inlet.

Harbor Porpoise

Harbor porpoises reside in Upper Cook Inlet but are rare in Knik Arm. In the recent 13-month monitoring study, only four sightings of harbor porpoises were recorded and none of these occurred in the bridge corridor (LGL, unpublished data). One much decomposed and beach-cast harbor porpoise was found in lower Knik Arm during a boat survey on 11 August 2005 (LGL, unpublished data). Harbor porpoise "takes", if they occur at all, are most likely to result from construction noise (primarily pile driving) or vessel activity. Harbor porpoise that are "taken" are likely to alter their behavior or be temporarily displaced from the area of construction. Harbor porpoises are less sensitive to low frequency sounds, such as those produced by pile driving, than beluga whales, but could potentially suffer TTS or PTS after exposure to pile-driving noise. Harbor porpoises are unlikely to be present within the project area and any "takes" by disturbance would likely have only a minor effect on individual harbor porpoises and no effect on the harbor porpoise population in Cook Inlet.

Beluga Whale

The beluga whale is the most abundant and most frequently encountered species of marine mammal in Knik Arm. Belugas are known to move in and out of Knik Arm at most times of the year, but rarely use Knik Arm during November through February and infrequently use the area from March through May (Rugh et al. 2000; Markowitz et al. 2005a). During the times when beluga whales are present in Knik Arm, some of the same individuals could potentially be "taken" by harassment on more than one date. Beluga whale "takes" will likely occur at times when prey is most abundant in Knik Arm in late summer and fall. During late summer and fall beluga whales use the area north of the proposed bridge corridor but do not appear to feed or remain for long periods in the project area. Rather the project corridor is used primarily for transit into the upper reaches of Knik Arm and movement out of Knik Arm into other parts of Upper Cook Inlet (Markowitz et al. 2005b).

Potential "takes" of beluga whales are most likely to result from changes in behavior or distribution caused by construction noise (primarily pile driving) or vessel activity. Beluga whales that are "taken" may be displaced from the project area during in-water construction activities which will propagate sound into adjacent waters. Some of the belugas that are repeatedly exposed to construction noise may habituate to the sounds and, upon subsequent exposures, not change their behavior and distribution when exposed to those sounds. These animals would not be considered "taken" during the latter exposures, and the proposed activities would not have any significant effect on these individuals once they became habituated to the sounds. Beluga whales that become habituated to the construction sounds could potentially be attracted to the project area if fish are stunned or killed by pile driving. SPL's of sufficient strength have been known to cause injury and fish mortality (Cal Trans 2001; Longmuir and Lively 2001). There is also the possibility that disturbance from pile-driving noise could preclude beluga whales entering Knik Arm as they typically do in the fall months thus disrupting their seasonal use of the area. Given that pile driving will occur during a relatively short portion of each day (2-4 hrs) it is unlikely that the whales would abandon use of Knik Arm.

When possible and practicable, noise producing in-water activities will be conducted when beluga whales are not in the area to reduce the exposure of animals to pile-driving sounds. Monitoring within the zone of responsiveness and the zone of hearing loss, discomfort and injury during pile-driving activity to determine the presence of beluga whales will provide a mechanism to allow operators to terminate noise producing activities until belugas have departed the construction area.

Any "take" of beluga whales is expected to be limited to Level B harassment which includes temporary changes in the behavior or distribution of individual belugas, and the potential for TTS. Using energy-based criterion, Finneran et al. (2005) observed TTS in bottlenose dolphins after dolphins were exposed to SELs of 195 dB re 1 microPa^2·s. TTS was no longer measurable 10 min after exposure to SEL of 195-199 dB re 1 microPa^2·s . Recovery time increased with increasing SEL and recovery was not complete 10 min after exposure. These experiments suggest a SEL threshold of 195 dB re 1 microPa^2·s for the onset of TTS in bottlenose dolphins and beluga whales exposed to mid-frequency sounds.

"Takes" could include animals of all age and sex classes. Calving probably occurs mid-May through mid-July in the Cook Inlet region. The whales using Knik Arm appear to calve primarily in the Susitna Flats portion of Upper Cook Inlet. There is no evidence that calving occurs in Knik Arm as relatively few whales use the area during the calving period. However, calves 1-4 months of age could be encountered, as well as all other sex and age classes. Monitoring and mitigation measures will be used to minimize the number of "takes" by disturbance and to prevent close approach of the animals to activities that could result in injury or mortality.

Potential Numbers of "Takes"

Marine mammal "takes" have traditionally been calculated based on exposure to various levels of SPLs which are based on the sound pressure levels averaged over the duration of the pulse. Using this criterion, the estimated annual numbers of marine mammals that will potentially be exposed to SPL's of 180, 170, and 160 dB re 1 μPa (rms) during the construction of a Knik Arm crossing are presented below in Table 2. A detailed description of the methods used to calculate potential beluga whale exposure to each of these sound levels is presented in Appendix A.

Table 2. The number of marine mammals estimated to occur within radii where SPLs of 180, 170, and 160 dB re 1 μPa (rms) are expected to occur based on acoustical measurements for pile driving activity at the Port MacKenzie dock (Blackwell 2005). The number in parentheses includes a 1.15 CF.

SPL	Radius (ft)	Harbor Seal	Steller Sea Lion	Harbor Porpoise	Killer Whale	Beluga Whale
180	824	0(0)	0(0)	0(0)	0(0)	1(1)
170	3071	1(1)	0(0)	1(1)	0(0)	7(8)
160	11,450	3(3)	0(0)	3(3)	0(0)	120(138)

*See Appendix A for a detailed description of the method used to determine these estimates.

The numbers of observations of marine mammal species other than beluga whales during baseline studies in Knik Arm (Funk et al. 2005a) were low compared to the number of beluga whale observations. Only four and 22 observations of harbor porpoise and harbor seal, respectively, were recorded during the 13 month study (LGL, unpublished data). No Steller seal lions or killer whales were reported. Estimates of the numbers of marine mammal species other than beluga whale that were likely to be exposed to SPLs of 180, 170, and 160 dB re 1 μPa (rms) could not be made due to the low numbers of sightings of these species observed within the project area. The numbers reported above assume that a few harbor porpoise and a few harbor seals could be present.

More recently it has been suggested that the use of an energy-based criterion may be a more appropriate approach for determining marine mammal “takes” related to sound exposure from industrial activities. Although SPLs have been used extensively in the past for estimating marine mammal impact zones, peak pressure and sound energy level (SEL) metrics are increasingly being favored by the acoustics community for reporting impulsive noise (Madsen 2005). The energy-based criterion uses the accumulated energy to which a marine mammal is exposed to determine possible onset of TTS or PTS and is expressed in SELs (dB re 1 $\mu Pa^2 \cdot s$). In the case of pile driving activity, accumulated energy is calculated by adding the energy to which a marine mammal is exposed from each hammer strike. In most cases a marine mammal will be exposed to a higher energy level with decreasing distance from the source, and accumulated energy will be related to the number of hammer strikes and the distance of the marine mammal from the sound source. Assuming a constant strike rate for an impact hammer, the accumulated energy for a marine mammal can be considered a function of the amount of time spent within the various sound level radii during pile-driving activity.

Based on studies of captive animals, Finneran et al. (2002) suggested a SEL of 186 dB re 1 $\mu Pa^2 \cdot s$ for the onset of TTS in bottlenose dolphins (*Tursiops truncatus*) and beluga whales. It may be appropriate to adjust this figure downward since only a fraction of the energy produced by watergun pulses in the Finneran et al. (2002) study was in frequencies effective at causing auditory effects in odontocetes. We will consider onset of TTS to occur at a SEL of 183 dB re 1 $\mu Pa^2 \cdot s$. Based on TTS onset after exposure to accumulated energy of 183 dB re 1 $\mu Pa^2 \cdot s$, plus an assumed increase of 15 dB re 1 $\mu Pa^2 \cdot s$ for onset of PTS, we would expect PTS to occur after exposure to 198 dB re 1 $\mu Pa^2 \cdot s$ for pulsed sounds such as that from pile driving.

Scenarios involving the movements of beluga whales were developed to estimate the accumulated energy to which a beluga whale will be exposed over a given time period within specific zones associated with SPLs of 180, 170, and 160 dB re 1 $\mu Pa^2 \cdot s$ during pile driving activity for the Knik Arm crossing construction (Table 3). The scenarios were based on a total energy accumulation likely necessary for onset of PTS in beluga whales (i.e., 198 dB re 1 $\mu Pa^2 \cdot s$) and estimate the amount of time (or hammer strikes) to which a whale may be exposed prior to onset of PTS (a Level A “take”). The total accumulated energy exposure is indicated for each scenario in the right-hand column. The methods used to calculate accumulated energy are described in Appendix A.

Based on Blackwell’s (2005) measurements, whales would receive SLPs of 180, 170, and 160 dB re 1 μPa (rms) at approximately 820, 3,070, and 11,450 ft, respectively, from the pile driving source (Figure 6). Results from calculations to determine the amount of exposure time required at various SPLs to potentially induce onset of PTS (198 dB re 1 $\mu Pa^2 \cdot s$) for beluga whales exposed to impact pile driving ranged from 2 to 200 min between 180 dB and 160 dB dB re 1 μPa (rms) (Scenarios 1-5; Table 3). Scenario 6 (Table 3) describes the exposure time required for the potential onset of PTS for a whale traveling from the 180 dB dB re 1 μPa (rms) SPL radius to the 170 dB dB re 1 μPa (rms) SPL radius based on the average cumulative energy exposure while transiting each zone. Under this scenario a whale could experience onset of PTS after 11 min of exposure in this zone.

Table 3. Estimated number of hammer strikes and SELs (in dB re 1 µPa2 •s) produced during specific time period scenarios for proposed impact pile driving during construction of the Knik Arm crossing. Scenarios are based on 30 hammer strikes per minute at distances from the source where specific SPLs (in dB re 1 µPa rms) are estimated to occur. Estimated total accumulated energy (Total SELs) for each scenario is indicated in right hand column.

	180 SPL (824 ft)			173.5 SPL (1,948 ft)			170 SPL (3,071 ft)			163.5 SPL (7,260)			160 SPL (11,450 ft)			
Scenario	Time (min)	Hammer Strikes	SEL	Time (min)	Hammer Strikes	SEL	Time (min)	Hammer Strikes	SEL	Time (min)	Hammer Strikes	SEL	Time (min)	Hammer Strikes	SEL	Total SEL
1	2	60	197.8													197.8
2				9	270	197.8										197.8
3							20	600	197.8							197.8
4										90	2700	197.8				197.8
5													200	6000	197.8	197.8
6				11	330	198.6										198.6
7				5	150	195.3				40	1200	194.3				197.8

A beluga whale can spend ≤ 2 min at distances less than ≤ 824 ft (180 dB dB re 1 μPa (rms) SPL) from the sound source prior to potential onset of PTS. This safety radius is relatively small and would be monitored by MMOs for 30 min prior to ramp up and during ramp up and pile driving activities. It is not likely that a beluga whale could enter this safety radius unobserved prior to or during ramp up or pile driving activity. MMOs would have the ability to delay the onset of ramp up if beluga whales were in or near the safety radius, or to shut down pile driving activity if a whale approached the safety radius after pile driving had begun. It would be unlikely that a Level A "take" could occur within the safety radius with appropriate mitigation.

The exposure time required at 170 dB dB re 1 μPa (rms) SPL (3,071 ft from the source) prior to onset of PTS is 20 min and decreases as the 180 dB dB re 1 μPa (rms) SPL radius is approached. A much greater exposure time (200 min) is required for potential onset of PTS from exposure to 160 dB dB re 1 μPa (rms) SPL (11,450 ft; Table 3).

Richard et al. (2001) reported mean swimming speeds of beluga whales in the eastern Beaufort Sea of 5.1 km/hour. Beluga whales can likely swim at greater speeds particularly if aided by tidal movement. Beluga whales in Knik Arm have been recorded at swimming speeds ranging from 2.4 to 7.8 mph (LGL unpublished data).

At a swimming speed of 2.4 mph, a beluga whale would require approximately 11 min to transit from the 180 dB dB re 1 μPa (rms) SPL zone to the 170 dB dB re 1 μPa (rms) zone, plus another 66 min to transit from the 170 dB dB re 1 μPa (rms) zone to the 160 dB dB re 1 μPa (rms) zone. In this example, an exposure time of 66 minutes in the 170-160 dB dB re 1 μPa (rms) SPL zone would not subject the whale to SELs sufficient to induce onset of PTS (Scenario 4; Table 3). However, during 11 minutes of exposure in the 180 to 170 dB dB re 1 μPa (rms) SPL zone the whale would likely accumulate enough sound energy to reach or surpass the PTS threshold of 198 dB re 1 $\mu Pa^2 \cdot s$ (Scenario 6; Table 3) which would be considered a Level A "take".

A swim speed of 2.4 mph was the slowest speed observed for beluga whales in Knik Arm (LGL unpublished data). A whale swimming at 5 mph could transit the 180 to 170 dB dB re 1 μPa (rms) SPL zone in approximately 5 min and the 170 to 160 dB dB re 1 μPa (rms) SPL zone in 32 min. In this example the whale would not be exposed to sound energy sufficient to induce PTS (Scenario 7; Table 3). Any whales traveling through the area at speeds greater than 5 mph would have the ability to pass through the area quickly enough to preclude onset of PTS as long as they do not enter the safety radius (≤ 824 ft from the sound source).

Cumulative Impacts

The noise impacts of bridge construction alone are expected to be short-lived on beluga whales and other marine mammals. The project will strive to accomplish all in-water activities within one or possibly two years with a goal of reducing any potential cumulative effects of operating vessels and pile driving in Knik Arm. Combined with mitigation measures to reduce the "take" of beluga whales, the cumulative effects of noise are likely to be small. In addition, this population of belugas has habituated to

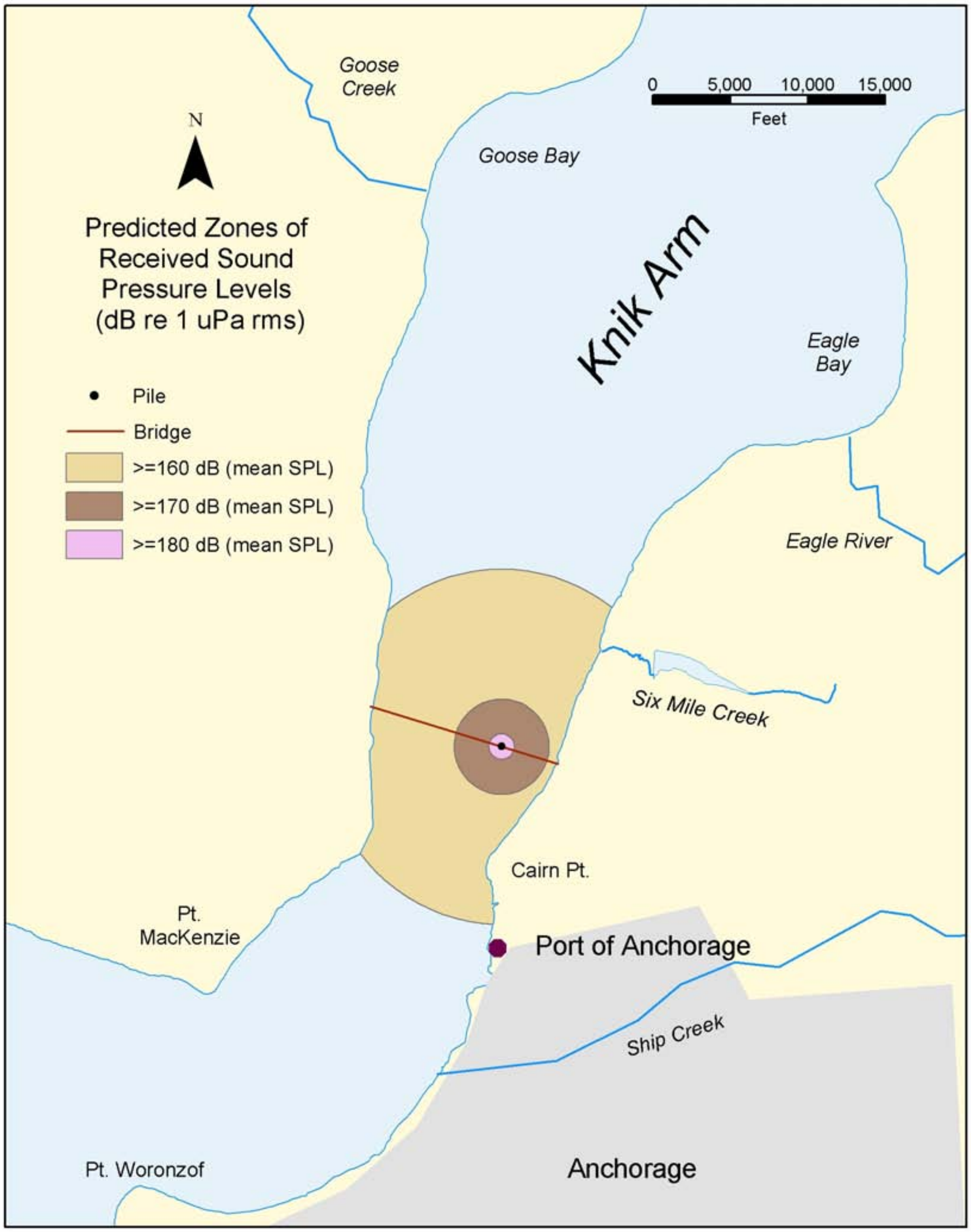

Figure 6. Locations of zones within which SPLs of ≥ 180, 170, and 160 dB re 1 µPa (rms) are estimated to occur during impact pile driving for construction of the Knik Arm crossing based on data from Blackwell (2005).

other man-made sounds and activities such as vessel traffic and they will probably habituate to the repetitive sounds produced by construction activities.

Noise from construction activities such as pile driving could cause TTS, or potentially PTS with sufficient exposure levels, to occur in beluga whales or other marine mammals. Repeated exposure to noise levels sufficient to induce TTS may have the potential to increase recovery time of animals exposed to construction noise. Finneran et al. (2005) using an energy based criterion suggested that a SEL of 195 dB re 1 $\mu Pa^2 \cdot s$ was a reasonable threshold for the onset of TTS. Repeated exposure to this or greater levels of SELs could add incrementally to the effects of noise from construction activities on beluga whale hearing.

Vessel traffic associated with bridge construction will be in addition to existing shipping and small vessel traffic to the Port of Anchorage and Port Mackenzie. Land and boat-based observations indicated that beluga whales occasionally move in and out of Knik Arm past the two existing port facilities (Funk et al. 2005a). At least a good portion of Cook Inlet beluga whales appear habituated or at least accustomed to small and large vessel traffic.

Many of the vessels used for construction of the bridge will be moved into and anchored in the crossing area in early spring of each construction season, which is a time when whale use of the crossing area appears to be low (Markowitz et al. 2005a). Once the pile driving and materials barges are in place at the crossing area, regular vessel traffic will be primarily light duty personnel vessels and occasional larger supply barges. This additional traffic associated with bridge construction will be of smaller magnitude (vessel size) and far less frequent than the vessel traffic associated with the two nearby ports.

The Port of Anchorage is planning an expansion of its dock facilities over the next 6 years. The onset of higher vessel traffic at the port associated with its expanded size will occur after completion of the proposed Knik Arm bridge and therefore the port's greater traffic activity will not be cumulative with vessel support traffic during bridge construction. However, any pile-driving activity at the port that was concurrent with the bridge construction could create impacts greater than those described for the bridge alone. Of potential concern is that activities at the Port of Anchorage coupled with bridge construction could result in beluga whales abandoning use of Knik Arm for one or more seasons. While this is probably unlikely, MMOs will note if beluga whales do not enter Knik Arm in the late summer to early fall as expected and will notify NOAA Fisheries.

Future development related to the coal industry could occur in upper Cook Inlet west of the Susitna River. Construction of a proposed coal terminal near Tyonek would likely involve impact pile driving. This potential development is currently in the planning stage but pile-driving activity or other construction-related disturbance that impacted beluga whales and was concurrent with activities in Knik Arm could also add to the cumulative impacts on the Cook Inlet beluga population. KABATA will work with the Port of Anchorage and other marine construction operators to communicate and coordinate all pile-driving and marine mammal monitoring to help mitigate cumulative effects of the two potentially concurrent operations.

8. ANTICIPATED IMPACT ON SUBSISTENCE

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

Under a co-management agreement covering Cook Inlet, Native hunters are allowed to hunt beluga whales in Cook Inlet and one or two strikes per year are authorized. The number of strikes alternates each year. This establishes a potential maximum removal via subsistence hunting of one to two whales/year until the population recovers to 780 whales. Recovery under this scenario is estimated to take approximately 25 years, or three years longer than expected in the absence of a harvest (NMFS 2000c). These harvests currently take place in the Susitna Flats region to the southwest of the project. Construction activities for the Knik Arm crossing are expected to have no impact on these small harvests or on the recovery of the whale population.

The only other subsistence hunting of marine mammals in the area is for harbor seals. Currently there are an estimated three subsistence hunters living in the Anchorage area who harvest harbor seals. These hunters do not hunt in Knik Arm, in part because harbor seals rarely occur in this area. Also Knik Arm is difficult to access and hunt since it is too “swift, muddy and deep” to hunt successfully. These hunts typically occur far outside the proposed crossing area in the Susitna River Flats and Tyonek regions (Daniel Fabriese, Alaska Native Harbor Seal Commission, Pers. Comm. 2005). No impacts of the construction on native harvests of pinnipeds are expected.

9. ANTICIPATED IMPACT ON HABITAT

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

Noise Effects on Foods of Seals and Whales

Beluga whales feed on a variety of fish, shrimp, squid and octopus (Burns and Seaman 1988). Common prey species in Knik Arm include salmon, eulachon and cod. Harbor seals and Steller sea lions feed on fish such as pollock, cod, capelin, eulachon, herring and salmon as well as a variety of benthic species, including crabs, and shrimp and cephalopods. Harbor porpoises feed primarily on herring, cod, whiting (hake), pollock, squid and octopus (Leatherwood et al. 1982).

Construction activities will produce both impulsive sounds (e.g., impact pile driving) and longer-duration sounds (vibratory pile driving; vessel sounds). Fish often react to sounds, especially strong and/or intermittent low-frequency sounds. Short duration, sharp sounds can cause overt or subtle changes in fish behavior and local distribution. Chapman and Hawkins (1969) field tested the reactions of whiting (hake) to a seismic airgun. When received sound levels from the airgun were higher than 178 dB re 1 μPa, the fish dove from 25 to 55 m (80-180 feet; Pearson et al. 1992). Many other studies of fish reactions to impulsive sounds have produced similar results. Sound pulses at received levels of 160 dB re 1 μPa may cause subtle changes in fish behavior. SPLs of 180 dB may cause noticeable changes in behavior (Chapman and Hawkins 1969; Pearson et al. 1992; Skalski et al. 1992). It also appears that fish often habituate quickly to repeated intense sounds, on time scales of minutes to an hour. However, the habituation does not endure, and resumption of the disturbing activity may again elicit disturbance responses from the same fish.

SPLs of sufficient strength have been known to cause injury to fish and fish mortality (CalTrans 2001; Longmuir and Lively 2001). Impacts to fish from pile driving noise during the pile installation demonstration project included damage to the swim bladder and other internal organs (CalTrans 2001). The largest fish known to be affected by the pile driving was a surfperch with a length of 11.5 in (29.2 cm), however data appeared to have been collected opportunistically and it is possible that larger fish may have been affected but were undetected.

Bottom Disturbance

Suspended sediment concentrations and the physical dimensions of the turbidity plume generated by construction activities depend on a number of factors including

- Timing of the construction activities
- Water depth at the construction site
- Current speed
- Circulation patterns in the vicinity of the site

Sea-floor surface disruption will occur with bridge construction and will result in disturbance to benthic communities within the bridge and causeway footprint. Benthic communities have a naturally patchy distribution. In nearshore areas, these communities are subject to natural seasonal disruption by ice scour and ice gouging of the sea floor. This suggests that recovery of disturbed areas will occur in a manner similar to that occurring after natural disturbance. Anchoring of tugs and barges in the area is not expected to result in any significant disruption to benthic communities and these disruptions will be temporary. Some bridge construction activities (such as piling installation) will cover the sea floor with a turbid plume that will settle on the area immediately adjacent to the bridge and to the north or south, depending on the tide direction. However, the waters of Knik Arm are naturally turbid and any construction-induced turbidity would add only incrementally to that existing naturally. These effects will be localized, short-term, negligible and indistinguishable from naturally occurring disturbances to the benthos.

The bridge-site marine footprint will cover approximately 360 acres. This estimate includes the causeways and the pier structures. The primary disruption and potential loss of habitat will occur from the formation of fillets to the north and south of the causeways. An intertidal fill and sediment accumulation will occur in an arcuate-shaped deposit extending 500 feet (152 m) on both the north and south sides of the causeways covering approximately 340 acres (138 ha).

Conclusions Regarding Impacts on Habitat

Fish near the construction activities may be temporarily displaced from the area surrounding the bridge construction site, or may exhibit some other kind of behavioral response. Fish directly adjacent to pilings may be temporarily stunned or potentially be killed by the sound pressures of impact pile driving (Longmuir and Lively 2001; CalTrans 2004). These direct losses of forage prey are expected to be negligible relative to forage prey available in Knik Arm and adjacent areas of Cook Inlet.

The direct loss of habitat available to marine mammals (primarily beluga whales) during construction is expected to be minimal. Beluga whales in this area are primarily transiting the area. The construction and related noises will occupy a small fraction the area available to beluga whales (or harbor seals) for foraging and any disruptions of this activity are expected to be minimal and temporary, having no unmitigable effects.

10. ANTICIPATED IMPACT OF LOSS OR MODIFICATION OF HABITAT

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed bridge construction activities are not expected to result in significant permanent impacts to habitats used by marine mammals, or to their food sources. The greatest impact on marine mammals associated with the proposed activity will be a temporary loss of habitat due to elevated noise levels. Displacement of beluga whales by noise would not be permanent and the long-term effects of this displacement would be minor.

A secondary impact on marine mammals could result from changes in prey availability due to bottom disturbances from filling for causeway construction and bottom disturbance at pier installations. Baseline research indicates that the bridge corridor area is not a primary feeding area for beluga whales (Funk et al. 2005a), and therefore, changes in prey availability by bottom disturbance is unlikely to affect the beluga whale population.

The presence of a bridge is not expected to significantly impact marine mammal use of Knik Arm. Cetaceans commonly navigate around and under bridges and other marine structures. Southern right whales have been observed swimming under the Harbour Bridge in Sydney Australia (ABC News Online). Gray whales (*Eschrichtius robustus*), while not historically known to inhabit San Francisco Bay (Oliver et al. 2001), are now sighted regularly below Dumbarton Bridge and other bridges in the area. Cook Inlet beluga whales are often sighted in and around the nearby Port of Anchorage and the Port MacKenzie dock (Brad Kroon, Cook Inlet Tug and Barge, Pers. Comm. 2005).

11. MITIGATION MEASURES

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

Throughout the design and planning stages of the Knik Arm crossing project KABATA has worked to develop mitigation measures to minimize impacts to marine mammals that could be caused by bridge construction. These measures include changes to design specifications and location of the bridge, scheduling construction activities to coincide with periods when beluga whales are not in Knik Arm or the project area in large numbers, a soft start to pile driving operations, acoustic monitoring to determine appropriate safety zones around pile driving activities, and the use of monitoring and shut down procedures to prevent injury to marine mammals.

Changes to design specifications and location

Initial design criteria identified 12 ft (3.7 m) diameter piles as the size to be used for construction of the Knik Arm Bridge. Current design of the bridge calls for use of a similar number of 4 ft (1.2 m) diameter piles. The size of the pile greatly affects the energy required to set the pile, which in turn affects the amount of noise generated during pile driving.

The current location proposed for the bridge is farther south in Knik Arm than was originally proposed. Results from studies of beluga whale habitat use in Knik Arm (Funk et al. 2005b, Ireland et al. 2005) suggested that the use by beluga whales of Sixmile Creek, to the north of the project area, was important enough to warrant shifting the proposed location of the bridge to the south. This will avoid potential impacts to whales using the Sixmile Creek area.

Scheduling of construction activities to avoid periods of high whale use of Knik Arm

As described in Section 4, there are strong seasonal and tidal patterns that influence the use of Knik Arm by beluga whales (Funk et al. 2005b, Markowitz et al. 2005a, Ireland et al. 2005). Construction activities are planned to occur when beluga whale use of Knik Arm is low. Specifically, construction will occur to the greatest extent practicable during the December through mid-August time period when beluga whale numbers in Knik Arm are generally low. During the fall period when beluga whales are present in the arm in greater numbers (15 August to 15 November), impact pile driving activities will not occur during the three hour period around low tide when whales are most likely to be in or near the construction area. These measures will greatly reduce the number of beluga whales potentially affected by construction and will help assure that impacts on beluga whales are negligible (See Appendix A).

Soft start to pile driving activities

A "soft start" technique will be used at the beginning of each piling installation to allow any marine mammal that may be in the area to leave before impact piling reaches full energy. The soft start requires an initial set of 3 strikes from the impact hammer at 40 percent energy with a one minute waiting period between subsequent 3-strike sets (NMFS 2003). If marine mammals are sighted within the safety zone prior to pile-driving, or during the soft start, the Resident Engineer (or other authorized individual) will delay pile-driving until the animal has moved outside the safety zone. The safety zone will be defined by the190 dB re 1 μPa (rms) radius in the case of pinnipeds and 180 dB_{rms} in the case of odontocetes. Piling will resume only after the marine mammal is determined to have moved outside the safety zone by a qualified observer or after 15 minutes have elapsed since the last sighting of the marine mammal within the safety zone.

Acoustic monitoring to determine appropriate safety zones

Sound generated by the pile driver will be measured and used to refine the radii of the safety zones for marine mammals. Initially the safety zones will be defined based on measurements made by Blackwell (2005) at the nearby Port MacKenzie dock reconstruction with allowances for differences in pile size and pile driver energy. Initial radii will be 1.5 times the size of those estimated by Blackwell (2005) until actual radii can be determined. Safety zones appropriate to the conditions and equipment used for the Knik Arm Bridge will be empirically determined and implemented as soon as practicable.

Monitoring and shut down procedures

The safety zone around the pile driving activity will be monitored for the presence of marine mammals before, during, and after any pile driving activity. If the safety radius is obscured by fog or poor lighting conditions, pile driving will not be initiated until the entire safety radius is visible. The safety zone will be monitored for 30 minutes prior to initiating the soft start for pile driving. If marine mammals are present within the safety zone, the start of pile driving will be delayed until the animals leave the area. The safety zone will also be monitored throughout the time required to drive a pile. If a marine mammal is observed entering the safety zone, piling operations will be discontinued until the animal is clear of the safety zone. Monitoring of the safety zone will continue for 30 minutes following pile driving.

12. PLAN OF COOPERATION

> *Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:*
>
> *(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;*
>
> *(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;*
>
> *(iii) A description of what measures the applicant has taken an/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and*
>
> *(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.*

A Communications Plan and Conflict Avoidance Agreement will be negotiated with subsistence users to ensure that activities associated with construction of the Knik Arm crossing do not interfere with the subsistence beluga whale hunt. This hunt typically takes place around mid-July in the Susitna Flats area about 25 mi (40 km) to the southwest of the bridge site. Thus, there is little potential for the hunt to be affected by construction activities. However, if the hunt is planned to take place in Knik Arm, KABATA will coordinate its actions with hunters to avoid conflicting with these subsistence activities. This is the only expected potential conflict with subsistence users in the area.

13. MONITORING AND REPORTING PLAN

> *The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on 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…*

The proposed Bridge Construction Monitoring Plan is in the process of being developed and is summarized below. KABATA understands that a more detailed monitoring plan may be required.

Bridge construction activities may cause localized disturbance and displacement of a small number of marine mammals, primarily beluga whales and possibly harbor seals. With the mitigation measures described above, most effects on marine mammals will be limited to temporary changes in behavior or displacement from a small area near the construction activities, and will involve small numbers of animals. Effects on marine mammals are expected to be limited to "Level B harassment".

The following monitoring plan describes efforts KABATA will undertake to assess and measure the effects of bridge construction on seals and whales, and (where necessary) to trigger mitigation measures in real time. The monitoring plan will include both monitoring of marine mammal use of the project area, and measurements of mean sound pressure levels, peak sound pressure levels, and sound energy resulting from construction activity. The monitoring program will take an adaptive management approach to provide data needed to assess the types and numbers of marine mammal "takes". Some of the monitoring efforts will also provide the basis for implementing mitigation measures (e.g., suspension of impact pile driving when mammals are approaching the safety zone). The monitoring efforts will provide the data needed to assess whether, as expected, effects on marine mammals are no more than negligible, and to assess whether there are effects on subsistence hunting.

Acoustic Measurements

Measurements of in-water sound will be used to document the actual levels of noise generated from bridge construction activities. Initially the safety zones around impact pile drivers will be defined based on measurements made by Blackwell (2005) at the nearby Port MacKenzie dock reconstruction. Safety zones appropriate to the conditions and equipment used for the Knik Arm Bridge will be empirically determined and implemented as soon as practicable. Boat-based recordings will be made at the start of pile-driving operations as a basis for measuring the levels and characteristics of the pile-driving sounds as a function of distance from the pile-driving operation. In particular, these measurements will be used to refine and validate the "safety radii" within which seals and whales might be subjected to 190 and 180 dB re 1 μPa (rms), respectively. (It is proposed that the appearance of seals or whales within these zones, as detected by visual monitoring, would result in temporary cessation of pile-driving activity.)

The acoustic measurements will also provide the information needed to refine and validate the radius within which received levels are ≥170 and 160 dB re 1 μPa_{rms}. These are the radii within which marine mammals might be expected to be disturbed by noise exposure.

Sound measurements will be replicated during pile driving in different water depths. Where relevant, levels will be measured in different directions from the pile driver, and at different depths in the water column (near surface, mid-water, near-bottom). The acoustical measurement program will provide data on the levels, spectral characteristics, and durations of the signals from both impact pile driving and vibratory pile driving.

Land-based Visual Monitoring

Two experienced marine mammal observers will be positioned at sites appropriate for monitoring whales and seals within and approaching the safety zone and the larger area where marine mammals might be disturbed by pile-driving operations. Established observation sites near Cairn Point and Sixmile Creek will be used initially (Figure 1). Based on measurements by Blackwell (2005), observers at those sites will be able to see the area within the safety radius (180 dB SPL) and the area within which behavioral disturbance may potentially occur (170 and 160 dB SPL). These observers will monitor the safety radius and the surrounding areas commencing 30 minutes prior to the beginning of pile-driving operations, during pile driving, and for 30 minutes after pile driving is completed. Each observer will have binoculars with an internal compass, a data book and hand-held computer to record observations, and a two-way radio to communicate with the other observers and the authorized construction personnel. Each observer will also have a cellular phone for back-up communication and for safety purposes. The primary task of all observers will be to note whales approaching, or within the safety radius, in order to alert the pile driving operators. If whales or other marine mammals are sighted within the safety zone, pile driving operations will be halted until the animals are outside of the area (See below "Boat-based Monitoring). If the safety radius is obscured by fog or poor lighting conditions, pile driving will not be initiated until the safety radius is visible.

The Cairn Point observation station (Figure 1) provides a view of the entire safety zone and waters to the south in order to detect whales entering Knik Arm. At the Cairn Point site, a digital theodolite with attached portable computer will be used to accurately track the movements of whales to determine the locations of whales relative to the observation platform and any potential source of disturbance. This system will allow distances from the pile driver to be determined accurately in near-real-time, and the movements of animals will be documented to allow detailed analysis.

The Sixmile Creek site (Figure 1) has been identified as a place where whales may occur during lower tidal phases (Funk et al. 2005b). The Sixmile Creek observer's primary task will be to monitor the safety radius and whales that may approach the safety radius from the Eagle Bay/Sixmile Creek area.

The areas at the south end of Eagle Bay and to the south of Ship Creek were identified by Blackwell's (2005) measurements to be within the zone where whales are likely to be able to detect noise generated by impact pile driving. Observers will also record the number of whales that come into view and any behavioral responses to pile driving or other construction related disturbance that may occur. These observations will be used to assess whether any animals beyond the safety radius are disturbed, and if so, to estimate the numbers disturbed.

During all observation periods, observers will use binoculars and the naked eye to search continuously for marine mammals. To assist in estimating distances, rangefinders will be used at the Sixmile Creek site and, as noted above, a digital theodolite will be used at the Cairn Point site. The observers will record the following:

- construction activities occurring during each observation period,
- species and number of marine mammals seen,

- bearing and distance of the mammal(s) from the observation point,
- behavior of mammal(s), and
- any indications of disturbance or reactions to construction or other activities.

The data on bearings, distances, behavior and movements will be recorded in most detail from the Cairn Point site, where the digital theodolite will provide more precise measurements.

Boat-based Monitoring

LGL Alaska Research Associates, Inc., conducted boat-based research on beluga whales in Knik Arm in 2004 and 2005 and was successful at regularly locating whales. Two trained boat-based observers will survey Knik Arm and adjacent areas in an open Zodiak skiff once per week during pile driving operations. The primary purpose of these observers will be to inform construction and shore-based observation personnel of whale group locations and the potential of these groups to approach and/or enter the safety zone. The boat based observers will also obtain information on the distribution and movements of belugas. Those data will be complementary to those obtained by shore-based observers and will contribute to a better characterization of the reactions of the animals to construction operations.

Reporting Requirements

During the period of bridge construction, brief progress reports concerning recent construction activities, marine mammal and acoustic monitoring work, and any other information that NOAA Fisheries may require will be provided to NOAA Fisheries on a weekly, monthly or such other schedule as may be specified in the LoA. Any significant observations concerning impacts on marine mammals will be transmitted to NOAA Fisheries within 48 hours.

Preliminary results of the acoustical measurements, as necessary to refine and validate the safety radii, will be reported to NOAA Fisheries as soon as the relevant data can be obtained and analyzed. These data will be available no later than 1 month after the onset of pile driving.

During construction, it is proposed that a preliminary report on activities and results (acoustical and mammal) will be submitted to NOAA Fisheries within 90 days after the termination of the fall construction season—the season when most belugas are likely to be present in the area. The report will provide summaries of the dates and locations of construction operations, details of marine mammal sightings (dates, times, locations, activities, associated construction activities), estimates of the amount and nature of marine mammal "take", and any apparent effects on accessibility of marine mammals to subsistence hunters. It will also provide a fuller account of the levels, durations, and spectral characteristics of the impact and vibratory pile driving sounds. For the impact pile driving, the peak, rms, and energy levels of the sound pulses, and their durations, will be reported as a function of distance, water depth, and depth in the water column.

In addition to the 90-day reports noted above, KABATA proposes to submit a draft technical summary report to NOAA Fisheries 60-120 days before the LoA expires. All technical reports will provide full documentation of methods, results and interpretation of all monitoring tasks. The draft final report may be subject to a review process determined by NOAA Fisheries, and will then be finalized if comments are received. The final comprehensive report will be submitted within 90 days following expiration of the LoA.

14. COORDINATING RESEARCH TO REDUCE AND EVALUATE INCIDENTAL "TAKE"

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

To minimize the likelihood that impacts will occur to the species, stocks and subsistence use of marine mammals, all construction activities will be conducted in accordance with all federal, state and local regulations. KABATA will coordinate all activities with the relevant federal and state agencies. These will include, but not be limited to, NOAA Fisheries, U.S. Fish and Wildlife Service, U.S. Coast Guard, Elmendorf Air Force Base, Alaska Department of Natural Resources, U.S. Environmental Protection Agency, and Alaska Department of Fish and Game. KABATA will also coordinate all activities with local authorities (Municipality of Anchorage and Matanuska-Susitna Borough), communities (Anchorage and residents in the Port MacKenzie area), and subsistence users. A Plan of Cooperation (Section 12) is being developed between KABATA and the subsistence users in the region. This will ensure that construction and operational activities do not interfere with the hunting of beluga whales and harbor seals, and to ensure that all activities are conducted safely.

KABATA plans to cooperate and coordinate with other marine mammal research currently being conducted or intended in Upper Cook Inlet especially as it relates to beluga whales. Groups currently involved with or planning beluga research include NOAA Fisheries, the Alaska Department of Fish and Game, the Minerals Management Service (MMS), National Fish and Wildlife Foundation (NFWF), Unocal, LGL Alaska Research Associates, Inc., Port of Anchorage, International Whaling Commission (IWC), and other traditional subsistence users.

As mentioned in Section 7, the noise impacts of bridge construction alone are expected to be short-lived on beluga whales and other marine mammals. KABATA is committed to coordinating its activities with those of other groups whose activities might cause disturbance to beluga whales simultaneous with bridge construction activities. These could include

- Cook Inlet oil and gas exploration and production,
- Seward highway upgrades in Turnagain Arm,

- Port of Anchorage expansion and operation,
- Port MacKenzie dock operations
- Future Knik Arm ferry operations,
- Future coal development in the Tyonek area,
- Various scientific research activities

III. CONCLUSION

Five species of marine mammal under the jurisdiction of NOAA Fisheries occur in Knik Arm in Upper Cook Inlet. Only beluga whales are common within the project area. Beluga whales regularly use Knik Arm during the late summer and fall months (mid-August through November) and are present the rest of the year only in low numbers. Harbor seals and harbor porpoises occasionally use Knik Arm but are only present in very low numbers near the project area. Killer whales and Steller sea lion have also been reported in Upper Cook Inlet but are considered very rare in the area.

KABATA is requesting a LoA to authorize the potential "taking" of small numbers of marine mammals incidental to the construction of a Knik Arm crossing. KABATA is requesting authorization for potential non-lethal incidental take by harassment during its planned activities. In the unexpected event that a vessel collides with a whale or seal KABATA is requesting authorization for a potential lethal take of very small numbers of marine mammals. KABATA has proposed specific monitoring and mitigation measures to reduce the likelihood of impacts to marine mammals, as well as to accurately estimate the actual numbers of marine mammals potentially "taken" during planned activities.

The potential impacts of the planned construction activities are related to the sounds produced by heavy equipment operations, impact and vibratory hammering, increased vessel traffic, and placement of gravel fill. Responses by beluga whales and harbor seals to noise are highly variable. In general, responses are expected to be limited to short-term displacement from the area of construction, which is primarily used by these mammals as a travel corridor and does not appear to be important for feeding, resting, or other activities. TTS, and possibly PTS, could occur if beluga whales or other marine mammals are exposed to sound levels of sufficient intensity and duration. Impacts to marine mammal food resources or habitat are not expected from any of the planned construction activities in Knik Arm.

Mitigation and monitoring plans for the Knik Arm crossing are designed to minimize impacts to marine mammals and their habitat, to ensure the availability of marine mammals for subsistence purposes, and to estimate the actual numbers of marine mammals that may be "taken" incidental to the Knik Arm crossing construction. Monitoring plans are outlined in this document, and a more detailed monitoring plan will be prepared upon receipt of initial feedback from NMFS on the present outline.

For reasons set forth above it is apparent that the construction will have no greater than a minor impact on beluga whales, harbor seals, Steller sea lions, killer whales, or harbor porpoise. Additionally, there will be no unmitigable adverse impacts on the availability of these species for subsistence uses. Accordingly, KABATA requests that the NOAA Fisheries issue a multi-year LoA allowing small "takes" of marine mammals incidental to the construction of the Knik Arm crossing in Upper Cook Inlet, Alaska.

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APPENDIX A

Methods used to calculate estimates of potential "take" of marine mammals during construction of a Knik Arm crossing, Upper Cook Inlet, Alaska

Introduction

This appendix details the methods used to calculate the estimates of potential "take" of marine mammals during construction of a bridge across Knik Arm in Upper Cook Inlet, Alaska. The data used to calculate "take" were collected during a 13-month intensive study of the use of Knik Arm by beluga whales and other marine mammals conducted from July 2004 through July 2005 (Funk et al. 2005a). The study documented beluga whale movement patterns and activity in Knik Arm in general, and included detailed observations in and around the area proposed for construction of a Knik Arm bridge. Observations were conducted daily and included 1,899 observation sessions averaging 6 hours in length for a total of over 14,000 hours of land-based monitoring effort. In addition, 140 boat surveys were conducted representing 748 hours of additional observation.

Results of the Funk et al. (2005a) study indicated strong seasonal patterns of beluga whale use of Knik Arm. In general, sighting rates of beluga whales in Knik Arm were low from December through July. Sighting rates were highest during late summer and fall from mid-August through mid-November peaking during September (Markowitz et al. 2005a). Sighting rates increased during the spring and summer when compared to winter but were low compared to fall

Limited data from boat surveys concurred with those from shore-based stations regarding patterns of beluga whale use of Knik Arm during late-summer and fall versus spring and early-mid-summer. During boat surveys most whale sightings in Knik Arm occurred during late-summer and fall, with relatively few whales encountered during early to mid-summer surveys. Sighting rates per hour of survey effort and per mile surveyed during spring and early to mid-summer 2005 in Knik Arm were roughly 10% of those during fall 2004. Comparison of group sightings between Knik Arm and the adjacent Susitna River area indicated a shift in distribution from the Susitna area into Knik Arm during the late summer and fall, and out of Knik Arm in the late fall. Encounter rates during boat surveys were higher in Knik Arm than in the Susitna River area in the late-summer and fall and higher in Susitna than in Knik Arm in the spring and early to mid-summer.

During fall beluga whales using Knik Arm generally remained north of the area proposed for construction of a Knik Arm bridge. On a few occasions, whales were seen transiting the narrows between Cairn Point and Port Mackenzie through the area proposed for construction of the Knik Arm crossing. However, no large groups of whales were seen moving into or out of Knik Arm during either land-based or boat-based surveys in the August through October 2004 period. The numbers of whale groups sighted decreased dramatically during November 2004. The whales returned to Knik Arm sporadically during the spring and summer 2005.

Extreme tidal fluctuations influenced the available habitat and the movement of beluga whales in Knik Arm (Funk et al. 2005b). As the tide flooded, beluga whales typically moved from areas near Sixmile Creek and Eagle Bay toward the northern reaches of Knik Arm. As the tide ebbed the whales returned to areas near Eagle Bay and Sixmile Creek where they remained during the lower portions of the tidal cycle.

Seasonal and tidal patterns of movement identified by Funk et al. (2005a) were confirmed and further refined in fall 2005 (Ireland et al. 2005). During the low tide period most beluga whales remained in Eagle Bay most of the time. However, 62% of the whales sighted during boat based surveys during September and October 2005 moved out of Eagle Bay toward the Sixmile Creek area at some time during the low tide period (Ireland et al. 2005). On average, whales spent less than three hours in the Eagle Bay/Sixmile Creek areas before they headed north into upper Knik Arm on the leading edge of the flooding tide, often as one large group. The southern portion of the Sixmile Creek area (nearest the bridge site) was used most frequently during September when the greatest numbers of beluga whales were present in Knik Arm (Ireland et al. 2005).

Sighting rates in the bridge crossing corridor itself were generally lower than elsewhere in Knik Arm. On average, including the high whale use months of fall, one group of approximately 5 beluga whales was sighted within ~0.3 mi (500 m) of the bridge site every 33 to 70 hours. As in other parts of Knik Arm, sighting rates were highest in the fall, followed by spring and lowest in the winter. Sighting rates in summer (May through July) and winter (November through January) were very low, with roughly one group sighted every 30 hours of observation effort on average within 2.5 mi (4 km) of the bridge site. Corridor sighting rates were highest during all seasons at the low tide when whales were limited by water depths in the northern part of Knik Arm and were forced to remain in Eagle Bay and areas to the south. Most beluga whales observed in the crossing corridor were adults transiting or diving suggesting that the area is not important for resting, feeding or protecting young (Markowitz et al. 2005b).

Very few other marine mammals were observed in Knik Arm during these studies. Twenty-two sightings of harbor seals and four sightings of harbor porpoises were reported during baseline studies in Knik Arm over a 13 month period (LGL, unpublished data). Fourteen of the harbor seal sightings and two of the harbor porpoise sightings occurred within the general project area. Two harbor seal and one harbor porpoise sightings were in the general area of the Knik Arm crossing project. No killer whales or Steller sea lions were observed during these studies, but these species have been occasionally reported in Upper Cook Inlet (Sheldon et al. 2003, Angliss and Lodge 2004).

Methods

Data Collection

Data from observations in Knik Arm (Funk et al. 2005a) were used to calculate beluga whale "take" estimates. Land-based observations of beluga whales were conducted from nine survey stations. When beluga whale groups were sighted, observers recorded the time, location, minimum number of individuals and age composition of the group based on coloration (adult, sub-adult, calf and unknown age), and behavioral data. Whale groups were assigned a location based on a map overlaid with an alphanumeric grid system. Field data were entered into a Microsoft® Access database and were used to estimate the frequency of whale use of specific locations in Knik Arm. Tide heights every 6 minutes were available online from the NOAA reference station for Anchorage (<http://co-ops.nos.noaa.gov/pred_retrieve.shtml reference station #9455920>) and the level of whale use was related to tide height. Survey methods are explained in more detail in Markowitz et al. (2005a).

Sound Propagation Radii

NOAA Fisheries has indicated that cetaceans should not be exposed to impulsive sounds with sound pressure levels exceeding 180 dB re 1 µPa (rms) and considers 160 db re 1 µPa the level at which a behavioral response ***may*** occur. Recent work with captive beluga whales suggests that these levels may be overly conservative (Finneran et al. 2002). In recent years observations of odontocetes and pinnipeds have indicated that exposure to a SPL of 170 dB re 1 µPa (rms) may be a more appropriate sound level at which behavioral responses are initiated in these groups (Harris et al. 2001; LGL 2005). We used this conservative criterion, in conjunction with the measurements of Blackwell (2005), to predict the radii at which received levels of 180 as well as 170 and 160 dB re 1 µPa (rms) could potentially occur during impact pile driving for the Knik Arm crossing. Blackwell (2005) reported that mean sound pressure levels resulting from impact pile driving at the Port MacKenzie dock decreased below 180 dB re 1 µPa, 170 dB re 1 µPa and 160 dB re 1 µPa at distances of 824 ft, 3071 ft and 11,480 ft, respectively. We used these results to calculate estimates for the number of beluga whales that may potentially be exposed to these sound levels. Calculation of the actual safety radii will be based on materials and equipment used during crossing construction and may differ from those calculated by Blackwell (2005).

Estimated Hours of Impact Pile Driving

Based on the current specifications for the bridge design, each pile will require approximately 3,000 blows from the impact hammer. The hammer will operate at a rate of about 30 blows per minute, resulting in approximately 1.67 hours of drive time per pile. Construction plans call for 4-piles per 250 feet of span distance, which would require approximately 132 piles for the 8,160 ft bridge. Engineering estimates for the amount of time required to install the piles range from 150 to 220 hours. We have used the 220 hour figure to calculate our "take" estimates.

Queries and data analysis

We estimated the number of whales potentially exposed to the three SPL's based on results of observations from the four land-based survey stations closest to the proposed bridge location – Cairn Point, Port MacKenzie, Point Woronzof, and Sixmile Creek. These data were compiled from over 4,000 hours of observation from July 2004 through July 2005. Separate Microsoft® Access queries based on season and low-tide exclusion were constructed to encompass grid cells around the proposed bridge location defined by sound propagation radii (180, 170, and 160 dB re 1 μPa *rms*). Queries for each potential sound exposure level were based on seasonal abundance records in relation to the planned construction as follows: 1 April through 15 August, 15 August through 15 November (all tides), 15 August through 15 November (3 hour exclusion around the low tide), and 15 November through 31 March . The frequencies of whale occurrence per hour during each seasonal period within the three relevant radii were multiplied by the expected number of hours of impact pile driving to estimate the number of whales that may be exposed to those SPL's during impact pile driving.

Note that this process estimates the potential number of exposures of beluga whales to ≥180, ≥170, or ≥160 dB re 1 μPa (rms). Many of these exposures would involve the same individual belugas. The total number of different belugas exposed to such levels on one or more occasions would be lower.

Assumptions

Correction factor (CF)

For beluga whales, published correction factors (CFs) to estimate the number of whales present but not counted, either because they were beneath the water surface during the observation period or simply missed by the observer during the survey, range from 1.15 to 2.9 (Hobbs et al. 2000). During our land-based surveys, observers followed groups and recorded several different counts, listing a "best count" at a time the observer was most confident about the accuracy of the whale group total. Counts were therefore replicated during the observation period (Markowitz et al. 2005b). This provided the opportunity to count most if not all the whales in a particular group. We report the uncorrected values for the numbers of whales that may potentially be exposed to the three SPLs. We also report potential beluga whale exposure using a more conservative CF of 1.15

Inter-annual variability

Data used in these calculations include observations from July 2004 through July 2005. Research suggests some level of variability in the timing of beluga whale occupancy of Knik Arm (Rugh et al. 2000) that may be related to the relative abundance of forage fishes in Knik Arm and adjacent areas. KABATA intends to document and report any important changes in seasonal abundance of beluga whales and adjust exposure estimates and mitigation/monitoring techniques accordingly in consultation with NOAA Fisheries.

Pile Driver

The sound recordings at Port Mackenzie documented in-water noise made by a Delmag D62-22 pile driver with a 13.5-ton (12,280 kg) hammer and maximum net impact energy of 223 kJ. The piles were ~150 ft (46 m) long, 36 in (0.9 m) in diameter, and composed of 1 in (2.54 cm) thick steel. They were driven at an angle ("battered") 39–49 ft (12-15 m) into the seabed, the last ~15 ft (4.6 m) with the impact pile driver. A vibratory pile driver was used to set the pile prior to the use of the impact pile driver. During the recordings, water depth around the piles was tide-dependent and ranged from 33 to 56 ft (10-17 m).

The Knik Arm bridge design calls for pre-stressed steel pilings 150 ft (46 m) in length, 4 ft (1.2 m) in diameter and 1.5 in (3.1 cm) thick also to be battered 39-49 ft or to refusal at locations spanning Knik Arm near its narrowest point about 1.2 miles north of the Port MacKenzie dock.

Several factors related to impact piling are important to consider when estimating the area within which behavioral changes may occur in marine mammals. These include the depth of the water (shallower water attenuates waterborne sound faster), the substrate density or amount of resistance as it affects the sound propagation, substrate properties that affect sound propagation, the physical properties and dimensions of the pile, and the type of pile driver. It is difficult to determine the underwater sound pressure levels associated with individual piles due to the differences in depths, tidal height fluctuations, nearby piling structures, bottom structure and associated shoreline distances.

To more accurately assess the underwater environment during pile driving operations, KABATA intends to measure pile-driving sound during the initial stages of this activity (See Sections 11, 13 and 14). If pile-driving sound propagation differs from levels predicted by Blackwell (2005), safety radii and mitigation measures will be adjusted in consultation with NOAA Fisheries.

There is little scientific evidence to indicate that the 160 dB re 1 μPa (rms) SPL for behavioral reactions in odontocetes is accurate. More recent evidence suggests that odontocetes are unlikely to have behavioral reactions to SPLs below 170 dB re 1 μPa (rms) (Harris et al. 2001; LGL 2005). Additionally, simple exposure to a particular SPL may have less effect than the amount of energy to which an animal is exposed over time. Below we calculate the numbers of beluga whales that may be exposed to SPLs of 160, 170, and 180 dB re 1 μPa (rms). We also discuss accumulated energy and methods used to calculate exposure time required before onset of PTS is likely to occur.

Construction activities that may affect marine mammals

Impact pile driving during construction will cause most (if not all) of the potential disturbance to marine mammals. It is possible that beluga whales may exhibit behavioral reactions to vessel activities, fill emplacement or other construction related activities. However, the Cook Inlet population of beluga whales appears relatively habituated to vessel traffic and sounds associated with human activities in the nearshore environment (NMFS 2005).

Mitigation measures

Throughout the design and planning stages of the Knik Arm crossing project KABATA has worked to develop mitigation measures to minimize impacts to marine mammals that could be caused by bridge construction. Our exposure estimates assume that the mitigation measures described in Section 11 of this request for a multi-year LoA will be in place. These measures should eliminate most if not all Level A "takes". Additionally, these measures are designed to minimize potential Level B "takes".

Results

Beluga Whales

The planned construction calls for about 220 hours of impact pile driving divided evenly over one or two ice-free construction seasons. Current construction plans do not include winter impact pile driving due to cost and safety constraints. Should additional impact pile driving be necessary during winter months, we estimated that "takes" of beluga whales during these months would be very small due to the low frequency of occurrence of belugas near the construction site in winter.

Based on SPLs calculated by Blackwell (2005) for the Port MacKenzie dock, we calculated the numbers of beluga whales that were likely to occur in three radii (180, 170, and 160 dB re 1 µPa (rms) SPL) during pile driving activity for crossing construction (Table A1). The calculations were based on the number of whales that were observed at various distances from the proposed construction site from 1 April through 30 November by Funk et al. (2005a), and took into account that pile driving activity would occur over a total of 220 hours apportioned evenly throughout that time period. We also included a three-hour pile driving exclusion centered on low tide from 15 August through 15 November. Our calculations indicated that the number of whales likely to enter the 160 dB re 1 µPa (rms) zone would be reduced by approximately 75% by eliminating pile-driving activities during a three-hour period centered around low tide from 15 August through 15 November when whales are most abundant in Knik Arm. The calculations were based on the probability that a whale group would enter a particular radius while pile driving was underway. A CF of 1.15 was applied to the numbers of beluga whales likely to occur within each radii and is presented along with calculations based on the actual number of whales observed (Table A1).

Based on observations of beluga whales within the project area (Funk et al. 2005a) and allowing for a three-hour, low-tide exclusion, we estimate that during the period from 1 April through 15 November one beluga whale is likely to enter the 180 dB re 1 µPa (rms) radius (Table A1) where a Level A "take" would have the potential to result during pile-driving activity. This number is based in part on the probability of a whale group (n=10 whales) entering the safety zone (12.5%). Although small groups of one or two whales are sometimes observed, beluga whales usually occur in larger groups. If whales do occur within the safety zone during pile driving, it would be likely that the group could be larger than one whale. However, larger groups of whales are also more easily detected by marine mammal monitors making it more likely that the group would be seen and mitigation measures to halt pile driving instituted before whales were exposed to potentially injurious sound levels.

Table A1. The number of marine mammals estimated to occur within radii where SPLs of 180, 170, and 160 dB re 1 μPa (rms) are expected to occur based on acoustical measurements for pile driving activity at the Port MacKenzie dock (Blackwell 2005). The number in parentheses includes a 1.15 CF.

SPL	Radius (ft)	Harbor Seal	Steller Sea Lion	Harbor Porpoise	Killer Whale	Beluga Whale
180	824	0(0)	0(0)	0(0)	0(0)	1(1)
170	3071	1(1)	0(0)	1(1)	0(0)	7(8)
160	11,450	3(3)	0(0)	3(3)	0(0)	120(138)

Based on 220 hours of impact pile driving during the course of the project, and with a three-hour low-tide exclusion period for impact pile driving, we estimate that 7 and 120 whales are likely to be exposed to SPLs of 170 and 160 dB re 1 μPa (rms) respectively (Table A1). With a 1.15 correction factor these numbers increase to 8 and 138 for the 170 and 160 dB radii, respectively. At these sound levels it is possible that changes in whale behavior may occur, but whether any biologically significant changes in whale behavior would result from this exposure is unknown. It is also possible that 1 whale could likely enter the 180 dB re 1 μPa (rms) zone during pile driving activity. However, the 180 dB zone is relatively small and it is likely that MMOs would be able to observe any whales within or near the safety radius prior to onset of pile driving or approaching the safety radius during pile driving, and take appropriate mitigation action.

Exposure Time and Onset of PTS

The numbers of whales indicated in Table A1 represent the numbers that would be likely to occur within each radius during pile-driving activity annually over the course of the construction period. These calculations estimate the numbers of beluga whales that may occur within the 180, 170, and 160 dB re 1 μPa (rms) zones, but do not necessarily estimate the numbers of “takes” that would occur. Simple exposure to a SPL pulse of 180, 170, or 160 dB re 1 μPa (rms) likely would not constitute a Level A or Level B “take” which would require further exposure to a particular SPL. It may be more appropriate to calculate the level of exposure in terms of the amount of energy received by a whale which would include a measure of the duration of exposure.

Finneran et al. (2002) suggested that onset of TTS in beluga whales was likely to occur when accumulated energy from exposure to pulsed sound, such as that produced during impact pile driving, reached 186 dB re 1 $\mu Pa^2 \cdot s$. Because only a fraction of the energy in the watergun pulses measured by Finneran et al. (2002) was at frequencies effective at causing auditory effects in odontocetes, we have adjusted this threshold downward to 183 dB re 1 μPa^2·s. We assume that possible onset of PTS, which would result in a Level A "take", would occur at approximately 15 dB higher than onset of TTS, or 198 dB re 1 μPa^2·s. Based on the energy output of each pulse (hammer strike) and pulse rate, the time required for exposure at a given SPL to reach the threshold for PTS can be calculated by summing the accumulated energy for each pulse and determining the number of pulses required for onset of PTS (Table A2). The exposure time required for onset of PTS can be calculated by dividing the number of pulses by the pulse rate.

To calculate the accumulated energy (SEL) for a given number of hammer strikes we used the equation:

$$SEL = \log\left(10^{\left(\frac{SPL}{10}\right)} * S\right) * 10$$

where SPL is the sound pressure level at a particular radius from the sound source, and S is the number of hammer strikes for a given period of time. The SEL was calculated for SPLs of 180, 170 and 160 dB re 1 μPa (rms) as well as for SPLs of 173.5 and 163.5 dB re 1 μPa (rms) which are located half way between the 180 to 170dB and 170 to 160 dB zones, respectively. Thus, accumulated energy (SEL) was calculated for a specified number of hammer strikes at each SPL. Based on information from project engineers, we assumed a strike rate of 30/min and exposure time in min required for accumulated energy to reach the threshold for possible onset of PTS (198 dB re 1 μPa^2·s) was calculated by dividing the number of strikes by 30 (Table A2).

A beluga whale observed within the project area would likely be transiting the area and to calculate the accumulated energy for exposure to sound in more than one SPL zone (Scenarios 6 and 7; Table A2), we used the equation:

$$SEL = \log\left(10^{\left(\frac{SPL_A}{10}\right)} * S_A + 10^{\left(\frac{SPL_B}{10}\right)} * S_B\right) * 10$$

where *A* and *B* represent SPL and S in one of two SPL zones. These calculations were used to estimate the amount of time that a beluga whale could be exposed to specific SPLs prior to onset of PTS. This exposure time is discussed in Section 7 of this request for a multi-year LoA.

Other Marine Mammal Species

The numbers of observations of marine mammal species other than beluga whales during baseline studies in Knik Arm (Funk et al. 2005a) was low compared to the number of beluga whale observations. Only four and 22 observations of harbor porpoise and harbor seal, respectively, were recorded during the 13 month study (LGL, unpublished data). No Steller seal lions or killer whales were reported. Estimates of the numbers of marine mammal species other than beluga whale that were likely to be exposed to SPLs of 180, 170, and 160 dB re 1 μPa (rms) could not be made due to the low numbers of sightings of these species observed within the project area. The numbers reported above assume that a few harbor porpoise and a few harbor seals could be present.

Discussion

The calculated estimates of the number of beluga whales that may enter the various radii reflect the number of potential, single exposure events that could occur and do not distinguish between exposure of different individuals and multiple exposures of the same individuals. It is likely that one or more individuals from the local population may be "taken" by incidental harassment on more than one occasion, and that many Cook Inlet beluga whales will not be affected at all. Additionally, these data reflect the upper range of beluga whales that may be exposed to ≥160 and 170 dB re 1 μPa (rms) during bridge construction; whether whales will exhibit behavioral responses when encountering these noise levels has not yet been determined. Cook Inlet beluga whales are highly habituated to a variety of human disturbances in this area. For these reasons, we expect the actual number of "takes" to be a small fraction of the number of whales exposed to construction noise.

Beluga whales are known to travel north away from the proposed construction area as the tide floods (Funk et al. 2005a, Ireland et. al 2005), thus reducing the potential for construction-related "takes" to occur during periods of low tide. Our calculations indicated that a low-tide exclusion of pile-driving activities would be effective in mitigating the effects of construction noise on beluga whales. With the low-tide exclusion during the fall when whales are most abundant in Knik Arm, the number of whales likely to enter the 160 dB re 1 μPa (rms) zone would be reduced by approximately 75%.

Simple exposure of beluga whales to construction noise within the 180, 170, or 160 dB re 1 μPa (rms) zones will not necessarily result in a Level A or Level B "take." The numbers of whales that may enter the safety radius or the 170 or 160 dB re 1 μPa (rms) zones are overestimates of the number of whales that will likely be affected by construction noise in some biologically significant manner. Using an energy-based criterion, (Finneran et al. (2002) suggested that onset of TTS in beluga whales is likely to occur after exposure to SELs of 186 dB re 1 $\mu Pa^2 \cdot s$. Because only a fraction of the energy in the watergun pulses measured by Finneran et al. (2002) was at frequencies effective at causing auditory effects in odontocetes, we have adjusted this threshold downward to 183 dB re 1 $\mu Pa^2 \cdot s$. Possible onset of PTS which would result in a Level A "take" would occur at approximately 15 dB higher than onset of TTS, or198 dB re 1 $\mu Pa^2 \cdot s$.

Table A2. Estimated number of hammer strikes and SELs (in dB re 1 µPa2 •s) produced during specific time period scenarios for proposed impact pile driving during construction of the Knik Arm crossing. Scenarios are based on 30 hammer strikes per minute at distances from the source where specific SPLs (in dB re 1 µPa rms) are estimated to occur. Estimated total accumulated energy (Total SELs) for each scenario is indicated in right hand column.

	180 SPL (824 ft)			173.5 SPL (1,948 ft)			170 SPL (3,071 ft)			163.5 SPL (7,260)			160 SPL (11,450 ft)			
Scenario	Time (min)	Hammer Strikes	SEL	Time (min)	Hammer Strikes	SEL	Time (min)	Hammer Strikes	SEL	Time (min)	Hammer Strikes	SEL	Time (min)	Hammer Strikes	SEL	Total SEL
1	2	60	197.8													197.8
2				9	270	197.8										197.8
3							20	600	197.8							197.8
4										90	2700	197.8				197.8
5													200	6000	197.8	197.8
6				11	330	198.6										198.6
7				5	150	195.3				40	1200	194.3				197.8

The threshold sound levels resulting in behavioral responses and TTS, as determined during experiments exposing captive odontocetes to single sound pulses, were higher than those previously assumed to result in Level A and Level B "takes". Two captive bottlenose dolphins and a beluga whale exposed to single impulse sounds did not show behavioral reactions until received peak-to peak sound levels reached over 200 dB re 1 µPa (Finneran et al. 2000). In addition, TTS was not observed in the beluga whales until peak-to-peak single exposure levels were as high as 226 dB re 1µPa (Finneran et al. 2002). Consequently, the 160 dB (rms) radius used in calculating the potential number of disturbance "takes" for this request is much larger than would be likely to occur based on the results of Finneran et al. (2000). Similarly, the 180 dB re 1 µPa (rms) radius (824 ft) we used to define the safety radius is likely much larger than the radius within which there is a realistic possibility of injury from a single pulse. Using an energy-based criterion, beluga whales would be able to spend a relatively short period of time (2 min) at received SPLs of 180dB re 1 µPa (rms) prior to potential onset of PTS. Beluga whales would be able to spend greater periods of time at lower SPLs prior to onset of PTS.

Literature Cited

All literature cited in this Appendix is included in the Literature Cited section of the attached reqest for a multi-year Letter of Authorization.