Request for Letter of Authorization under Section 101(a)(5) of the Marine Mammal Protection Act Incidental to Construction of the Knik Arm Crossing Project in Upper Cook Inlet, Alaska

Submitted to:

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Acronyms, Abbreviations, and Symbols

°	degrees
ADF&G	Alaska Department of Fish and Game
AFB	Air Force Base
AMR	Adaptive Management Review
AS	Alaska Statutes
CF	correction factor
C.F.R.	Code of Federal Regulations
cm	centimeter(s)
dB	decibel(s)
dBA	A-weighted decibel
dB re 1 µPa	dB referenced to 1 micropascal
DoA	Department of the Army
DoD	Department of Defense
DOT&PF	Alaska Department of Transportation and Public Facilities
DPS	distinct population segment
EAR	ecological acoustic recorder
EPA	Environmental Protection Agency
EFH	essential fish habitat
ESA	Endangered Species Act of 1973
FEIS	Final Environmental Impact Statement
FR	*Federal Register*
FHWG	Fisheries Hydroacoustic Working Group
FHWA	Federal Highway Administration
Hz	hertz
ICRC	Integrated Concepts and Research Corporation
KABATA	Knik Arm Bridge and Toll Authority
KAC	Knik Arm Crossing
kg	kilogram(s)
kHz	kilohertz
km	kilometer(s)
L_{eq} (or L_{Aeq1h})	hourly equivalent sound level: logarithmic energy average over a 1-hour period
LOA	Letter of Authorization
m	meter(s)

Mat–Su	Matanuska–Susitna Borough
MHHW	mean higher high water
MLLW	mean lower low water
mm	millimeter(s)
MMPA	Marine Mammal Protection Act
mph	miles per hour
MTR	Marine Terminal Redevelopment
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PAM	passive acoustic monitoring
PCB	polychlorinated biphenyls
POA	Port of Anchorage
PTS	permanent threshold shift
rms	root mean square
s	second
SE	standard error
SEL	sound exposure level
SFS	Scientific Fishery Systems
SL	source level
SPL	sound pressure level
SU	sampling unit
TAH	total aromatic hydrocarbons
TAqH	total aqueous hydrocarbons
TEK	traditional ecological knowledge
TNM	Traffic Noise Model
TTS	temporary threshold shift
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USCG	U.S. Coast Guard
WSDOT	Washington Department of Transportation

1 Description of Activities

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

1.1 Introduction

The Knik Arm Bridge and Toll Authority (KABATA) and the Federal Highway Administration (FHWA), pursuant to Section 101(a)5 of the Marine Mammal Protection Act (MMPA), Title 16 United States Code (U.S.C.) § 1371.101 (a)(5); 50 Code of Federal Regulations (C.F.R.) § 216, Subpart I, request the National Marine Fisheries Service (NMFS) to issue a Letter of Authorization (LOA) to cover the taking of marine mammals, primarily the endangered Cook Inlet beluga whale (*Delphinapterus leucas*), incidental to construction of the Knik Arm Crossing (KAC) project in upper Cook Inlet during the period 2013 through 2016, with project or weather contingencies possibly forcing construction into 2017.

Regulations governing the issuance of an LOA permitting incidental “takes” under certain circumstances are codified in 50 C.F.R. Part 216, Subpart I (216.101–216.106). Section 216.104 sets out 14 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.

1.2 Project Purpose

The KAC project will construct a new bridge spanning Knik Arm (the Crossing) and develop approaches from the Matanuska-Susitna Borough (the Mat-Su) side of Knik Arm (the Mat-Su Approach) and the Municipality of Anchorage (Anchorage) side of the arm (the Anchorage Approach) to connect the Crossing to existing transportation infrastructure (Figure 1).

The project will further the development of transportation systems in the upper Cook Inlet region by providing improved vehicular access and surface transportation connectivity between Anchorage and the Mat-Su through the Port MacKenzie District, with a financially feasible and efficient crossing to meet the needs for (FHWA 2007):

- Improved regional transportation infrastructure to meet existing and projected population growth and locally adopted economic development, land use, and transportation plans, and as directed by the Alaska State Legislature in Alaska Statutes (AS) § 19.75
- Regional transportation connectivity for the movement of people and the movement of freight and goods to, from, and between Anchorage, the Mat-Su, and Interior Alaska
- Safety and transportation system redundancy for alternative travel routing and access between regional airports; ports; hospitals; and fire, police, and disaster relief services for emergency response and evacuation

1.3 Project Description

The Crossing will connect the Mat-Su Approach to the Anchorage Approach by way of an 8,200-foot (2.5-kilometer [km])-long, pier-supported bridge with armored gravel fill approaches that will extend waterward from the eastern and western sides of Knik Arm. The Crossing will begin at the shoreline on the Mat-Su side of Knik Arm, approximately 1,500 feet (457 m) south of Anderson Dock, and extend eastward across Knik Arm toward Anchorage, reaching the shoreline approximately 1 mile (1.6 km) north of Cairn Point (see Figure 2). Armor rock, approximately 3 to 5 feet (0.9 meter [m] to 1.5 m) in diameter, will be placed on the slopes of the roadway sections to prevent undercutting and erosion that would result from tidal currents, storm surges, wave run-up, and ice floes. The Crossing will account for all in-water KAC project construction. The bridge will be supported on 29 piers with 30 spans, each measuring 275 feet (83.8 m) wide. A navigable opening will be provided near midspan that meets dimensions required by the U.S. Coast Guard (USCG) (250 feet [76 m] wide by 50 feet [15 m] high above mean higher high water [MHHW]). Bridge height will be approximately 80 feet (24.4 m) above mean lower low water (MLLW) at the navigable opening.

The armored-fill bridge approaches will be between approximately 300 and 500 feet (91.4 m and 152.4 m) in width at seabed, 2,000 feet (610 m) long on the western shore, and 3,300 feet (610 m) long on the eastern shore. An approximate 80-foot (24.4-m)-wide paved roadway will be constructed on the approaches. The approach from the western bluff will be approximately 70 feet (21.3 m) high and extend from the bluff to connect to the western side of the pier-supported bridge. On the Anchorage side, the fill approach will curve and run southward along the shoreline around Cairn Point to the northern edge of the future Port of Anchorage (POA) expansion.

When fully built out, the Crossing will accommodate four lanes of traffic and a multiuse pathway. The functional classification of the Crossing will be a Rural Principal Arterial highway, with a design speed of 70 miles per hour (mph).

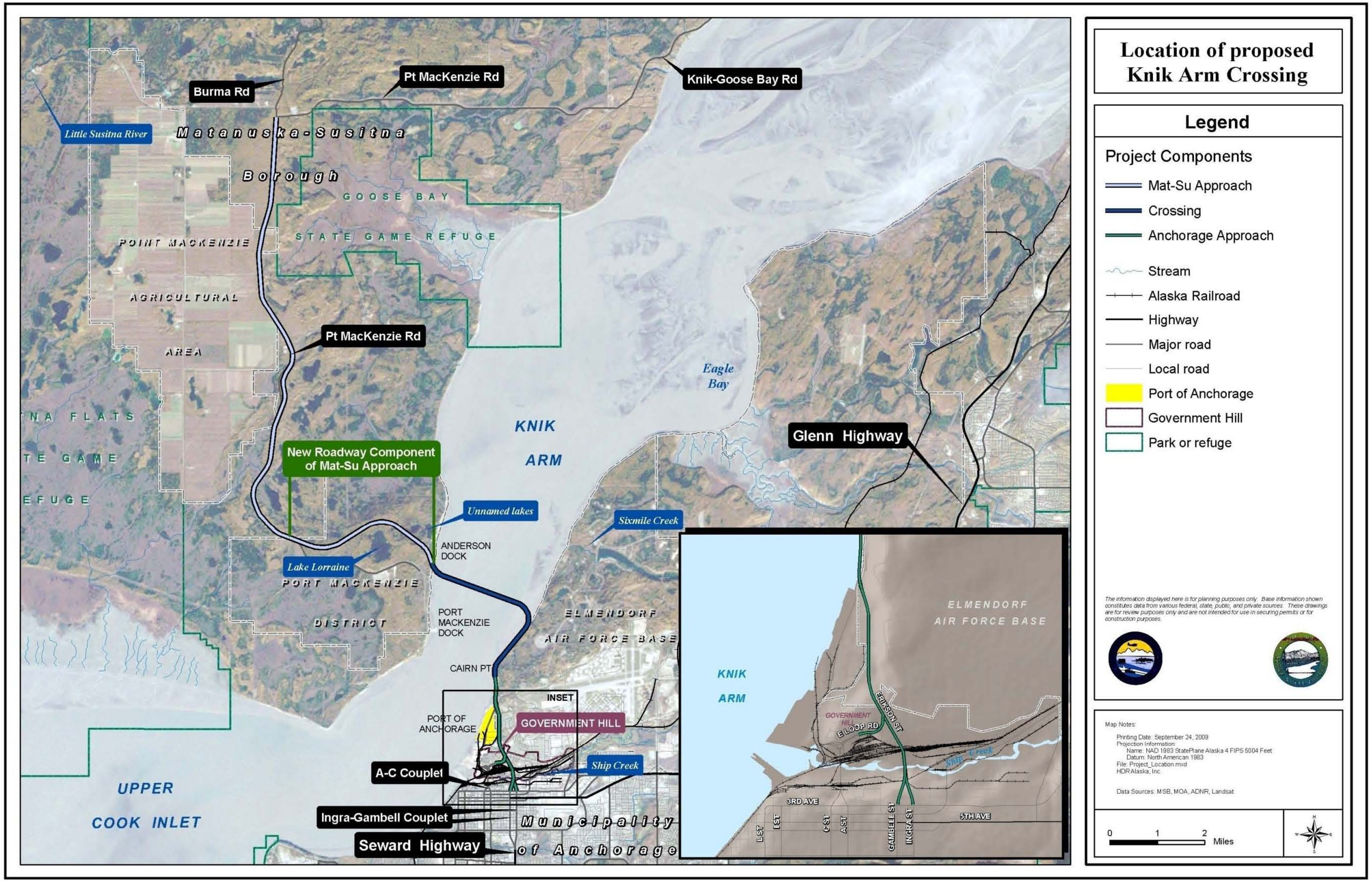

Figure 1 Location of Knik Arm Crossing in upper Cook Inlet

Figure 2 Location of the KAC bridge and portions of the adjacent Mat-Su and Anchorage roadway approaches on either side. The Port MacKenzie deep-draft dock is shown on the left side, and the POA and Ship Creek in the lower center.

1.4 Operations to be Conducted

The KAC project is designed to allow for conventional construction means and methods currently employed for projects of similar scope throughout the world. The selected contractor and subcontractors will be required to have extensive upland, civil works, and engineering-related project experience as well as cold weather and marine-related experience in environments of significant water currents and tidal ranges, and in environmentally sensitive areas.

The following subsections provide a brief overview of the key activities as they might relate to potential harassment of marine mammals. Additional detailed descriptions of the activities that could occur during construction of the KAC project are provided in the KAC Final Environmental Impact Statement (FEIS).

1.4.1 In-water and Over-water Work

All Knik Arm in-water work associated with the KAC project will occur during construction of the bridge crossing and the associated roadway approaches over a 5-year period, beginning in 2012 and extending through 2016. In 2012, the roadway approaches will be constructed, and then bridge construction will begin in 2013, ending in 2016 with completion of the superstructure and demobilization of the project work area. A sixth-year extension to 2017 may be necessary because of construction delays associated with weather conditions, construction logistics, beluga whale shut-down periods, etc. Generally, the typical construction season is estimated to occur from March through November because hazardous ice flows, extreme weather, and short daylight conditions in Knik Arm during the winter months (December through February) prevent construction activities. Some construction operations may, however be possible during winter months if opportunities such as unseasonably warm weather or low-ice conditions present themselves, or if there is a need to conduct mobilization and demobilization activities for materials, operations, and vessels.

The following discussion provides details on the specific in-water and over-water activities associated with construction of the Crossing.

Bridge Approaches

The roadway approaches to the bridge crossing will be constructed as the first component of the Crossing in 2012. They will be constructed simultaneously from the eastern and western sides of the arm and are anticipated to be completed to the top of subgrade in the initial construction season. Because no in-water pile-driving activities will occur during 2012, there are no anticipated takes of beluga whales until bridge construction begins in 2013. As noted in Sections 2.1.1 and 11.4, FHWA and KABATA are committed to the implementation of construction methods and daily work sequencing that will prevent simultaneous pile driving. (*Exception*: Whenever beluga whales are not present in the project area and weather conditions are favorable, KABATA will, however, coordinate with NMFS to determine whether pile driving at multiple locations would be acceptable to minimize the project's in-water duration of disturbance. See the Adaptive Management Process, discussed in Sections 7.2.1 and 13.1.)

The width of the approaches will range between 300 and 500 feet (91.4 m and 152.4 m) at the seabed. Fill material will be composed of clean gravels and protected along the exposed side slopes with filter rock material and armor rock riprap (stones exceeding 3–5 feet in diameter and weighing more than 2,500 pounds [1,134 kg]). The maximum height of the fill, at the end of the approaches near both bridge abutments, will be approximately 70 feet (21.3 m) above the channel bottom (about 30 feet above high tide).

As part of the KAC FEIS, several mitigation measures were committed to in order to reduce impacts to fish during construction of the roadway approaches, including:

- To reduce the risk of directly covering fish during the months of March through August and to minimize the amount of fill lost to tidal erosion in the intertidal zone (between –6 [–1.8 m] and +34 feet [+10.4 m]), initial fill for intertidal roadway and bridge approach construction activities will be placed when the construction area is above waterline or in a dry condition.
- Any in-water filling in subtidal areas during the months of April through August will be accomplished during the 3 hours on either side of low tide—when volumes and currents will be lowest—to reduce the risk of directly covering fish and to minimize the amount of loss of fill due to erosion. To the extent practicable, filling in the subtidal areas will be accomplished during the months of September through March, when juvenile and adult salmon will be less likely to be present. Also, subtidal construction techniques that help to minimize fish entrapment and loss of fill to tidal erosion will be employed. As an example, one possible technique could involve initial construction of two peninsulas defining the outer edges of the final embankment build-out. Fill material for the peninsulas will be placed during low tides. During subsequent low tides, dikes will be built between the piers to exclude water during high tides. During high tides the diked areas could then be filled and the upper lifts of the peninsulas built up.

Intertidal Zone: Placement of fill within the intertidal zone for the western (Mat-Su) approach will be only a few hundred feet from the shoreline; however construction of the eastern (Anchorage) approach along the bluff of Knik Arm (Figure 4) will be performed primarily within the intertidal zone. Fill material will be placed using conventional construction, with end-dump trucks or scrapers. Compaction will be accomplished with roadway vibratory drum compactors. The embankment will be protected with filter and armor rock as construction proceeds along the shoreline.

In addition, any subtidal infilling occurring between April and August will take place only within 3 hours on either side of low tide.

Subtidal Zone. In the channel below the intertidal zone, the contractor will likely construct two peninsulas, or perimeter dikes—the outer edges of the ultimate embankment—with coarser material to minimize loss in the current, again by either truck haul or barge dumping. The middle section will then be filled, proceeding outward in a way that will not impound water or trap fish. Initially, large coarse pit-run gravel (as found in natural deposits) or shot-rock material will be brought in, either by truck or barge.

As the earth-fill approaches are constructed in the water, conventional compaction methods cannot be applied until the fill is above the water, at an elevation of approximately 20 feet (6 m) above MLLW. To consolidate fill material placed below elevation +20, deep compaction techniques such as suspended vibrating compactors, heavy weights, or other similar methods are typically employed.

A method referred to as vibro-compaction has been successfully used to compact thick layers (10–40 feet) of deep fill for similar projects in Cook Inlet. The process of vibro-compaction is physically similar to the effort to vibrate freshly placed concrete. Vibratory energy is imparted into the surrounding material by plunging a vibrating probe such as a steel beam into the substrate. Agitation of the substrate material enables densification by allowing particles to reorient themselves in a tighter, more compact arrangement. Supplemental granular fill, is typically placed at the compaction location to compensate for the reduced volume resulting from the densification. This action is repeated at predetermined intervals (typically 10 feet on center) across the site to achieve optimum results.

For all fill material placed above the water elevation, conventional construction techniques (trucks, push cats, and vibratory rollers) can be used to achieve desired compaction densities.

The outside exposed slopes of the embankments will then be lined with protective rock materials in conjunction with the embankment-filling operation. The heavier filter material and armor rock will be brought to the site by either side-dump trucks or barge and placed in the intertidal zone at low water along the perimeter of the toe of the slope at the base of the embankment. In deeper waters, the rocks will likely be placed generally with track-mounted excavators that have thumb attachments or clamshell bucket cranes, either from the peninsula embankment or a floating barge. The terminus nose of each approach, at the location of each bridge abutment will also be protected with filter material and armor rock. Best practice for rock placement is to key the large stones into a matrix by individual placement.

Some material loss will occur during construction as the currents flow over the exposed upper surface of the fills; the filler material and armor rock will, however, protect the granular fills as the section is brought up to the final elevation, as shown in the approach roadway typical cross section in Figure 3.

The embankment building operation can occur at any time during the year as long as the embankment materials above the water are not frozen so that the specified compaction can be achieved. However, in order to accommodate fish migration, any subtidal infilling occurring between the months of April through August will take place only within 3 hours on either side of low tide.

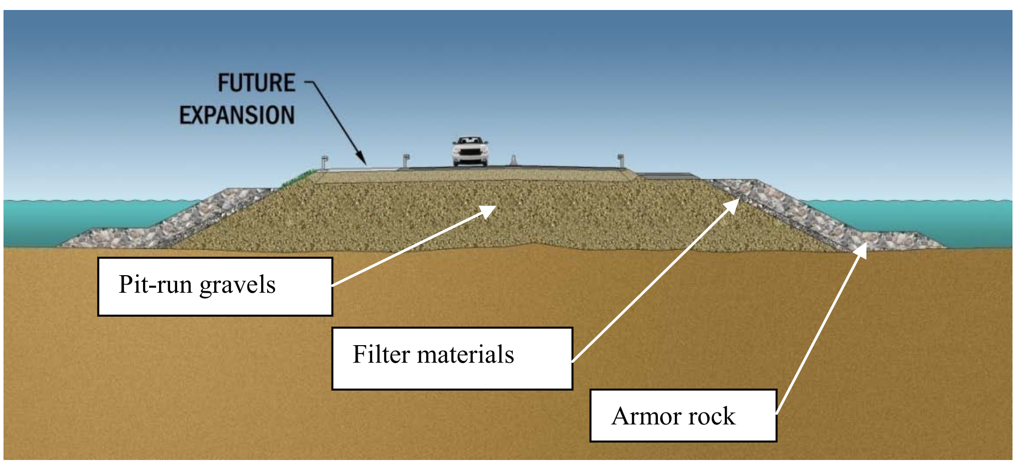

Figure 3 Typical cross section of a roadway approach for the KAC. (Future expansion refers to the addition of pavement.)

Approximately 2.4 million cubic yards of fill and riprap material will be needed for the western fill approach and approximately 6 million cubic yards of material will be needed for the eastern fill approach. A total of approximately 90 acres of intertidal/subtidal habitat will be impacted by this fill material.

When construction of the approach embankment is completed to the designed elevation, selected material, base course, and asphalt pavement will be placed as shown in Figures 3 and 4. The placement of the selected materials and asphalt may occur toward the end of the construction timeline to preserve the integrity of the pavement structure and not subject it to construction-related traffic and loadings.

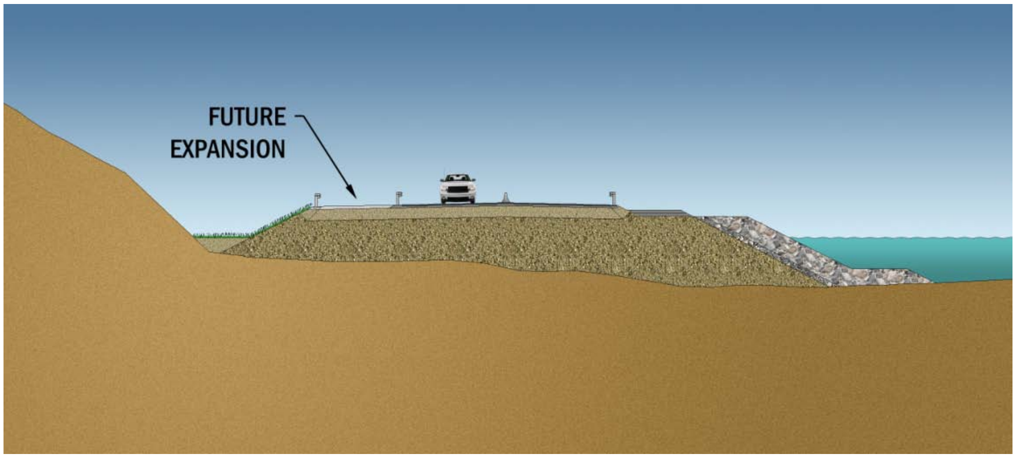

Figure 4 Typical roadway section for the eastern fill approach embankment. (Future expansion refers to the addition of pavement.)

The bridge approach embankments are curved, hence the actual distance into the arm is somewhat less than the centerline distance. The Mat-Su approach extends approximatley 1,700 feet perpendicularly from the shoreline (MHHW elevation 29 feet) to the abutment, and the Anchorage approach stretches about 2,500 feet into the arm. Knik Arm is approximately 12,400 feet wide at this location.

Bridge Abutments

Upon completion of each approach embankment, the associated bridge abutment will be built. This will allow the contractor to perform all work associated with construction of the abutments in an upland environment, away from the water. Abutments are anticipated to consist of several large-diameter piles with a concrete foundation supporting the end of the bridge structure. Trucks could be used to haul steel and concrete to the ends of the approaches and track-mounted cranes could be used to install abutment piles. The piles will be driven or drilled, and they are expected to be completed in the first year (2012).

Temporary Construction Docks

The project will need temporary construction docks, as shown in Figure 5. A temporary dock will be constructed at the end of each bridge approach to provide for transshipment of workers and materials to support bridge construction. A third temporary dock may also be constructed at the existing Port MacKenzie Dock. Between trips to barge-mounted derricks used for installing foundation piles and structural elements, workboats, crew boats, and materials barges will tie up on a daily basis at one (or more) of these three docks. A total of 66 temporary steel piles, measuring 24 inches in diameter, will be needed for these three temporary docks, which will be installed—pile-driven with an impact hammer—between April and July of Construction Year 2 (2013) and removed at the end of the project (2016). It is anticipated that the driving time for each 24-inch-diameter pile will be just over 1 hour.

Figure 5 Typical approach showing temporary construction dock at bridge abutments

Temporary Moorage Piles for Marine Vessels

Barge moorage will be vital to the execution of the project because a substantial tonnage of equipment and materials will be transported and delivered on barges. Items such as foundation piles, precast concrete footing shells, false work and shoring components, concrete pumps, and placing booms will all require floating hulls for effectively provisioning the work tasks. When not in use, the barges will need safe and secure moorage locations. During construction operations, some barges will tie up to permanent[*] seabed anchors to maintain their position.

The moorage piles would be in designated areas close to the sheltered ends of the approach embankments. Twenty-four 24-inch-diameter temporary piles will be needed for moorage of all marine vessels. These piles will be driven with an impact hammer, and it is expected to take about 1¼ hour to drive each pile. Temporary moorage piles for marine vessels will be installed from April to May of the second construction year (2013) and removed at the end of the project (2016). Moorage piles may take the form of either 3-pile dolphins or vertical-pile groups to which barge lines can be attached. It is anticipated that vessels will be allowed to "hull swing" as the tidal current flow direction changes from ebb to flood and vice versa.

Permanent Seabed Anchors

Before in-water work can begin, the contractor will place seabed anchors on the bottom of Knik Arm along the bridge pier lines. The anchoring arrangement consists of the anchor, chain lead, and connecting cable; the marine anchor will be a Danforth-type galvanized steel shank and flukes with chain lead that keeps the anchor secured to the bottom. The anchors will be located on the surface with crown buoys that will be connected to the steel connecting cables. The cables will be pulled aboard the barge deck and secured. When the barge moves to the next location, the anchoring cables will be buoyed, ready for the next barge. Two types of barges will be tied to the seabed anchors: one with four anchors and one with

[*] The anchors are "permanent" only in the sense of remaining in one position while being used during the construction period.

six anchors. Thus, at least ten seabed anchors will be used at each pier, and there will be 29 piers. Some barges may be rafted to each other, sharing a common anchor. Upon completion of the project, all the permanent anchors will be retrieved.

Bridge Piers

The bridge design (8,200-foot [2.5-km] bridge with 30 275-foot [84-m] span lengths) calls for installation of 29 permanent piers for the foundation (substructure), each consisting of four, large-diameter, drilled shafts. The drilled shafts will be connected to the pier cap and column through use of a concrete footing. Figure 6 shows the typical bridge design details and calls out a typical drilled shaft footing, column, and pier cap.

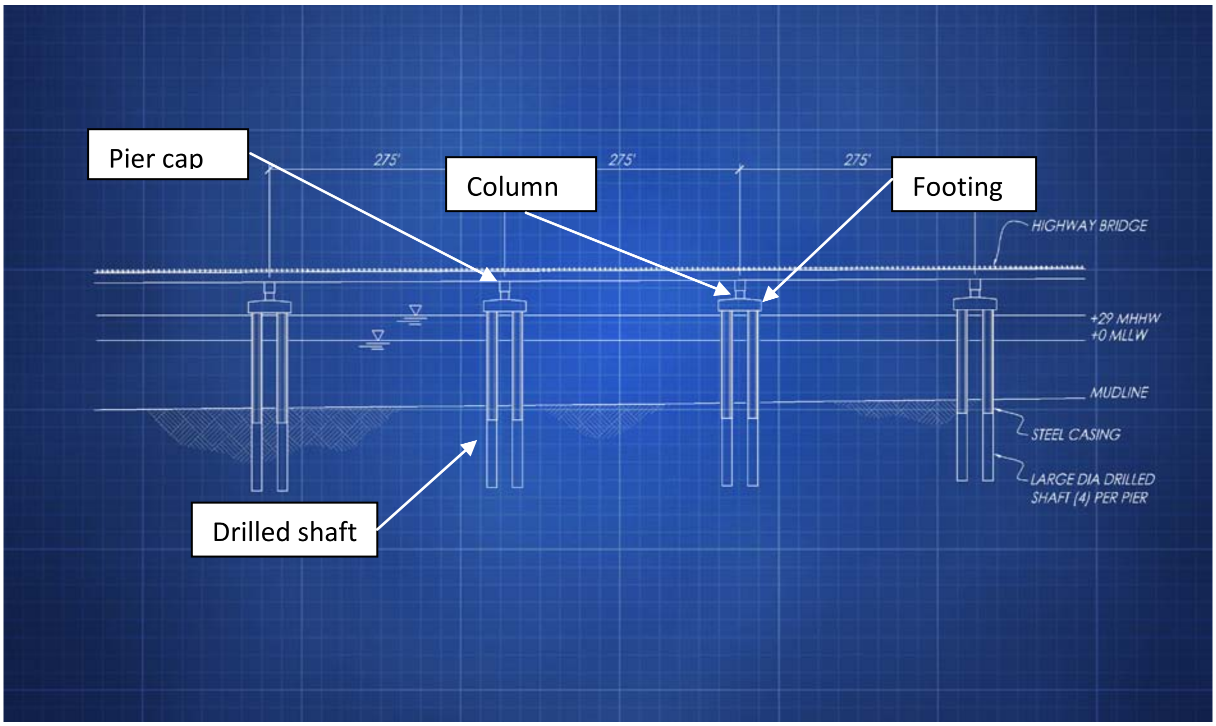

Figure 6 Bridge design detail with drilled shafts and 275-foot (84-m) spans

Foundations for the bridge will be constructed using a combination of floating cranes, materials barges, crew boats, and work skiffs (Figure 7). Material barges will facilitate transport of construction materials, such as large-diameter steel shaft casing, reinforcing steel, concrete precast elements, and ready-mix concrete, from the shore to the work site.

Figure 7 Example of typical barge-mounted construction cranes

Substructure construction will be ongoing from each side of the arm simultaneously and at multiple pier locations to maintain schedule and minimize overall in-water work times. Construction of each pier will start with erection of a temporary structural frame known as a “template,” as shown in Figure 8. The template ensures that permanent foundation shafts are installed within specified tolerances for vertical and horizontal alignment.

A secondary purpose of the template is to support construction of the footing. This footing may be either a precast concrete shell that will be filled with reinforced concrete or a cast-in-place concrete footing to cap the permanent shaft foundation and provide the stable base for the superstructure. After curing, the concrete column and pier cap will be cast on top of the footing.

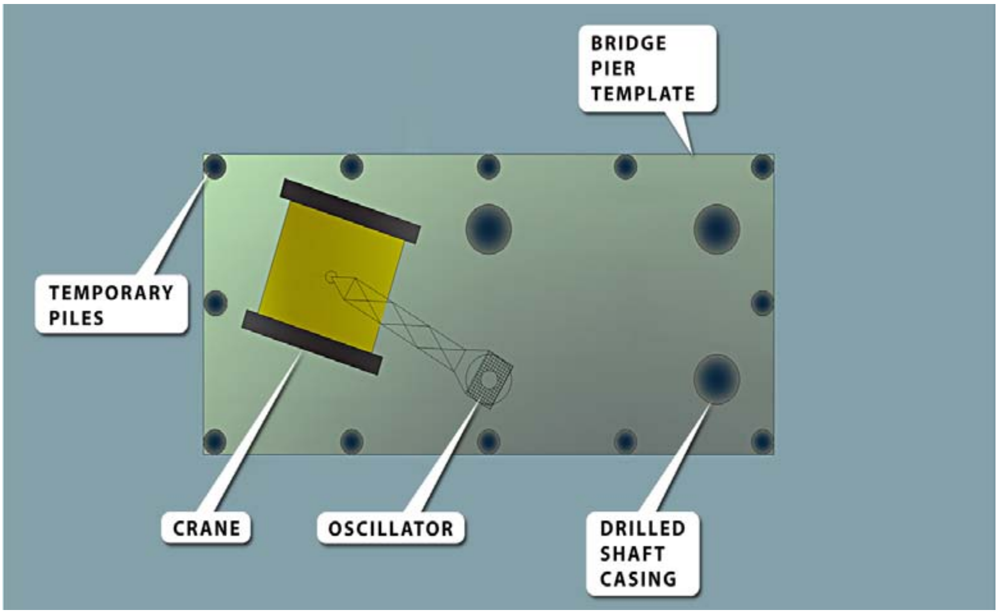

Figure 8 Drilled-shaft construction template

The template is made up of 12, temporary, 48-inch-diameter steel piles at each pier and of steel beams connected just above the high-tide line. The combination of temporary piles and beams provides a structure that is robust and laterally rigid under the influence of construction equipment loads, 30-foot (9-m) tidal changes, 7 mph currents, ice loads, and modest mooring loads. The temporary piles will be driven to a minimal depth to support the drilled-shaft construction template and pier placement. The steel pile will first be installed using a vibratory hammer until refusal, and then the final set will be with an impact hammer to verify the needed capacity. There will be a total of 348 pile installations, but the majority of these will be reuse of previously installed piles. It is anticipated that the total driving time for each 48-inch-diameter pile will be 2 hours.

Using the template for guidance and support, the shaft casings for each individual drilled shaft are oscillated into the substrate. This method of installation grips the steel casing with hydraulic rams and twists the steel casing side to side while using the mass of the machine to apply downward pressure to advance the casing into the ground rather than using impact or vibratory hammers commonly used for pile installation (Figure 9). A power unit will accompany the oscillator attachment to drive the system hydraulics.

Figure 9 Oscillator attachment

Figure 10 shows the sequencing of a typical drilled shaft installation.

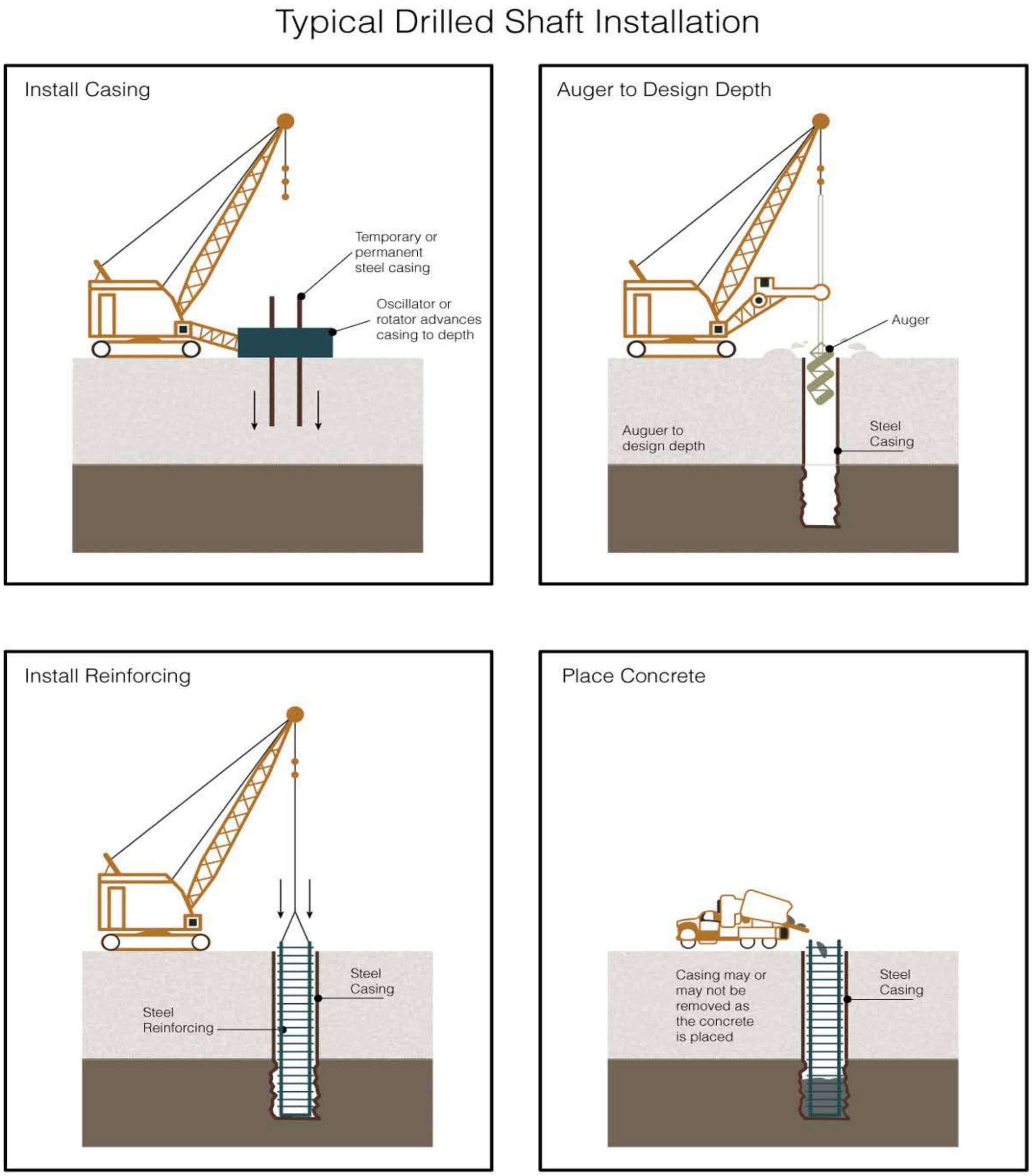

Figure 10 Typical drilled-shaft installation sequence

Figure 11 shows a typical setup for a drilled-shaft installation including a template supported with four temporary perimeter piles and a single drilled-shaft casing in the middle of the template structure. An oscillator can also be seen attached to the shaft.

Figure 11 Typical drilled-shaft installation setup

Figure 12 shows additional detail on oscillator operations set-ups with the spoils and materials barge.

Figure 12 Rendering of an oscillatory equipment setup with concrete, materials, and spoils barges and tug

Once the casings are seated to the predetermined depth, shaft drilling and dredge equipment will be deployed. The flights of the auger drilling tip will excavate hard native soils to a specified depth beyond the embedded tip of the shaft casing. The drill spoils will be raised to the top of the casing and deposited on the deck of the spoils barge. Spoils will be disposed of in a manner consistent with regulatory requirements. Alternatively, a hammer-grab dredge (clamshell-type excavator for large-diameter casings) may be used to extract materials from the shaft casing. The materials and dirty water will be contained in a lined box on the spoils barge. It is estimated that each shaft will take about 7 days to complete. Figure 13 shows typical shaft drilling equipment used to excavate material out of the drilled shaft prior to placement of reinforcing steel and concrete.

Figure 13 Drilling equipment used to remove soils from a drilled shaft

After the shaft is augured out, inspected, and accepted, a reinforcing steel cage will be placed in the hole and the shaft will be filled with concrete.

The concrete will be batched either on a barge-mounted concrete batch plant, with materials coming from the on-site staging area, or from an on-shore batch plant with the mix shuttled out to the shaft on a materials barge. There is no anticipated wastewater in this operation. Once all four drilled shafts are complete for each pier, the footing will be constructed over the tops to join them as a working group.

To maintain beluga whale passage in areas during construction, FHWA and KABATA are committed to the implementation of construction methods and daily work sequencing that will prevent installation and/or removal for moorage, dock, and template piles at simultaneous locations in Knik Arm to provide a corridor for beluga whale passage away from pile-driving activities. Whenever beluga whales are not present in the project area and weather conditions are favorable, KABATA will however, coordinate with NMFS to determine whether pile driving at multiple pier locations would be acceptable to minimize the project's in-water duration of disturbance. See the Adaptive Management Process, discussed in Sections 7.2.1 and 13.1.

Concrete Footing, Column, and Pier Cap

A footing will be constructed at the top of the four drilled shafts at each pier location to combine the individual shafts into one structural element. Either a precast shell or conventional forming will be used to construct the footing and encapsulate the tops of the shafts. Reinforcing steel and concrete will be poured for the footing, providing a robust structure able to transmit vertical and horizontal loads to the shaft foundations.

Next, the column between the drilled shaft and the pier cap will be formed. A reinforcing steel cage will be inserted, and concrete again placed. Finally, the pier cap at the top of the substructure that will take the superstructure loading will be formed, reinforcing steel placed, and concrete poured.

Template and Temporary Pile Removal

After completion of the concrete substructure work, the template will be removed and the temporary template piles will be extracted. Typically, temporary piles will be removed for reuse on subsequent template construction. The temporary construction support dock and the moorage piles will be removed by vibrating hammer at the end of the bridge work. The hammer used for this operation will be on a barge, and the extracted piles will be placed on the materials barge.

This is the most efficient removal method and minimizes overall in-water construction work. As an option, if requested takes were to approach threshold limits within a given construction year, pile removal by cutting the piles at the surface of the seafloor could be employed for a percentage of the temporary piles as an adaptive management measure to reduce the potential for acoustic harassment to beluga whales. However, additional measures would have to be considered, such as construction feasibility due to high tidal currents, additional construction times, magnitude of additional construction costs, additional material costs, required equipment, and potential resource agency concerns about leaving cut-off piles in the substrate. This option is included in the proposed Adaptive Management Plan, discussed in Sections 7.2.1 and 13.1.

As noted in Sections 2.1.1 and 11.4, FHWA and KABATA are committed to the implementation of construction methods and daily work sequencing that will prevent simultaneous pile driving. (*Exception*:

Whenever beluga whales are not present in the project area and weather conditions are favorable, KABATA will, however, coordinate with NMFS to determine whether pile driving at multiple locations would be acceptable to minimize the project's in-water duration of disturbance. See the Adaptive Management Process, discussed in Sections 7.2.1 and 13.1.)

Bridge Superstructure

As soon as practicable, sections of the bridge superstructure will be lifted atop the completed substructure. This process will begin with the mobilization of two large floating barges equipped with heavy-lift (200–300 tons) cranes capable of lifting and setting the bridge components. Large portions of the bridge superstructure weighing up to 600 tons will likely be prefabricated off site and transported to the construction location by charter barge service.

During a typical superstructure installation, two crane barges will be anchored into position and the supply barge with tug boat will position itself between the two cranes. Beginning at the abutments and working toward midspan, the sections will be lifted from the barge and set in place on the pier caps. The crane barges will then move and set the next segment. After the crane barges move to the next section, a smaller barge will be used for completion work of the superstructure. Figure 14 shows an example of a typical superstructure installation using crane barges. The process of setting prefabricated superstructure segments is efficient and is projected to be completed sequentially as piers are installed.

Figure 14 Bridge superstructure lifting and setting by large floating cranes (representative only)

Marine Vessels

A variety of marine vessels will be required to support construction of the bridge. Vessels would travel from the temporary construction docks to the work site and also occasionally from other supply locations like the POA. In addition to the heavy-lift crane and materials barges, there will be smaller crane barges and support barges for welding equipment, generators, rigging, dry storage, safety supplies and small tools. Local tugboats will be moving these barges around, as well as smaller work boats and skiffs that will move the personnel.

Table 1 summarizes the marine vessels proposed to support bridge construction for coincidental construction work from both sides of the Knik Arm to minimize duration of in-water work. As noted in Sections 2.1.1 and 11.4, FHWA and KABATA are committed to the implementation of construction methods and daily work sequencing that will prevent simultaneous pile driving. (see the Adaptive Management Process, discussed in Sections 7.2.1 and 13.1). KABATA estimates that a peak of approximately 52 marine vessels may be needed, made up of 14 powered vessels, 36 nonpowered barges, and two Flexifloat platforms.

It is anticipated that the largest vessel that will be used for construction will be the support barges, which will measure approximately 400 feet by 100 feet. The majority of the vessels used during construction will be much smaller, measuring approximately 120 feet by 30 feet. Conservatively, it is assumed that eight barges will be in use at any given time and that the remaining vessels to be used will be smaller, support vessels.

The primary surface area that will be occupied by construction work and equipment will be along the alignment of the bridge itself. Other smaller areas, including vessel moorage and temporary dock structures, will also occupy surface area within Knik Arm. It is anticipated that construction will require an approximate width of 0.6 mile, roughly centered on the bridge alignment, to allow vessels room to maneuver during periods of work. It is also anticipated that work will span approximately eight piers at any given time.

A minimum of 4,000 feet, or approximately half of the bridge length, will remain unobstructed (free of moored and anchored barges and vessels) within Knik Arm at any given time to ensure unrestricted passage for belugas; this distance may not always be linearly continuous because of the need for staging of vessels for substructure and superstructure construction, but this minimum total length will always be maintained and further increased whenever reasonably possible.

Table 1 Proposed marine equipment to support construction of the KAC

Vessel type	Engine	Quantity
Tug boat	In-board/Diesel	4
Survey skiff	Outboard/Gas	2
Workboat, 18-foot (aluminum)	Outboard/Gas	6
Crew boat, 45-foot	In-board/Diesel	2
Flat material barge, 150 × 45 feet	N/A	18
Crane barge	N/A	10
Flexifloat, 10 × 20 feet	N/A	2
Derrick crane barge, 150-ton	N/A	4
Spoils barge, 140 × 35 feet	N/A	4
	Project total	**52**[a]

[a] Only 14 of the 52 vessels have engines/self propulsion.

Completed Bridge

Once constructed, the total bridge length will be approximately 8,200 feet (2.5 km), with 275-foot (84-m) individual span lengths between piers with approximately 237 feet of free channel between the drilled-shaft foundations. To meet USCG requirements for navigable waters for the few vessels that might navigate north of the bridge, an opening with a minimum clear height of 50 feet (15 m) will be provided near the center of the bridge, between the high-water elevation and the bottom of the bridge girder. This separation distance will be approximately 80 feet (27 m) above MLLW. The USCG free channel width here will be approximately 260 feet (76 m). Figure 15 displays a rendering of how the completed bridge structure would appear at both high and low tides.

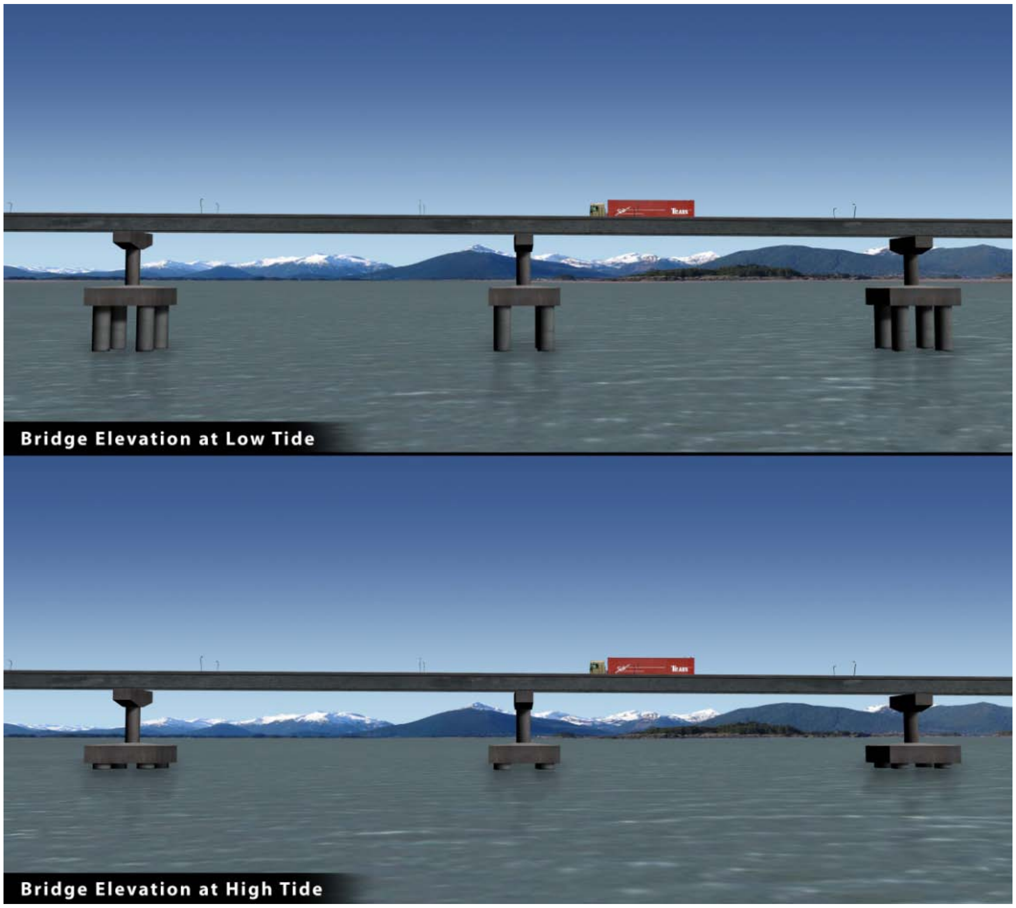

Figure 15 Rendering of completed bridge

At some future date when the traffic would warrant, the deck will be expanded to four lanes. The substructure or foundation for the bridge will be constructed initially to handle this future additional deck expansion. The hanging of the new superstructure girder and deck will be accomplished by an operation similar to the initial superstructure erection operation—two crane barges, a supply barge, and needed tugboats. No additional pier construction would be required.

Once operational, the bridge will need no more in-water work except for biennial bridge inspections that will be partially performed from a small motor boat. These usually take a couple of days for a structure this size and, weather permitting, can be scheduled for a particular nonintrusive time during the summer months. Major maintenance and repairs (repainting, structural part replacement, etc) would need to be programmed several years in advance and would probably require permitting actions.

Normal and routing maintenance includes ditch cleaning, pothole patching, vegetative clearing, and snow and ice control. The roadway approach embankments will be a rural typical section, meaning that surface drainage will sheet flow off the road, over the edge, and run down the side slopes through the riprap, and eventually into the arm. Drainage from the bridge will also sheet flow across the road and cascade from the edge of the deck.

Roadway pollutants and heavy metals are not expected to be a concern,* but what little that may accumulate will be swept in the spring after breakup and again in the fall. When traffic volumes exceed 20,000 trips per day, sweeping will be increased to monthly or possibly twice a month to collect the accumulation.

Snow will be removed by high-speed trucks with bellyboards and large front-mounted snow plows that will send ("wing") the snow over the guardrail. With large volumes of high-speed traffic, deicing from snow buildup is not typically necessary. For an unusual event (frozen rain, fog, etc), sanding is the treatment of choice. Clean sand with a 5–8 percent mixture of salt (chlorides derived from sea salt) to keep the sand from freezing in the stockpile will be used.

* NCHRP *Assessing the Impacts of Bridge Deck Runoff Contaminants in Receiving Waters*, 2002, evaluated several large bridges, including the San Francisco Oakland Bay Bridge. With 274,000 vehicles per day, it was found that while there was some toxicity in the runoff, it was expected to be negligible after falling from the bridge and mixing in the receiving waters. Metals were found, but sweeping was determined to be an effective mitigation to reduce pollutant loading.

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2 Dates, Duration, and Location of Activities

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

2.1 Location and Timing of the Proposed Action

This request is for issuance of an LOA associated with bridge construction of the KAC project. FHWA and KABATA plan to construct the bridge component of the Crossing during a 4-year construction program; potential delays associated with a project of this size and scope may, however, require a longer construction period. Therefore, it is requested that the LOA cover the period 2013 through 2017, should an additional year or more be required to complete construction of the Crossing.

The objective of the proposed action is to construct the KAC project as efficiently and quickly as possible, while minimizing incidental take of Cook Inlet beluga whales. Given the variables of the upper Cook Inlet environment, weather, construction logistics, and the unpredictability of beluga whale movements and required shut-down periods, however, schedules and construction techniques may need to be adapted to situations. As the project progresses, FHWA and KABATA may consult with NMFS during construction to request changes or develop reasonable methods for take reduction not included in the issued LOA, if appropriate or necessary. Furthermore, if the take limit has not been reached or has reasonable tolerance in a given year, construction scheduling and techniques may be adapted to reduce the overall amount of time spent working in the waters of Knik Arm and, therefore, reduce the duration of potential exposure of beluga whales to construction activities (e.g., request to install or remove temporary piles during the August–November period). Should any unanticipated modification(s) to the action be determined appropriate or necessary during construction, FHWA and KABATA will consult with, and obtain approval from, NMFS prior to changing any component of the planned construction that might impact beluga whales.

2.1.1 Timing

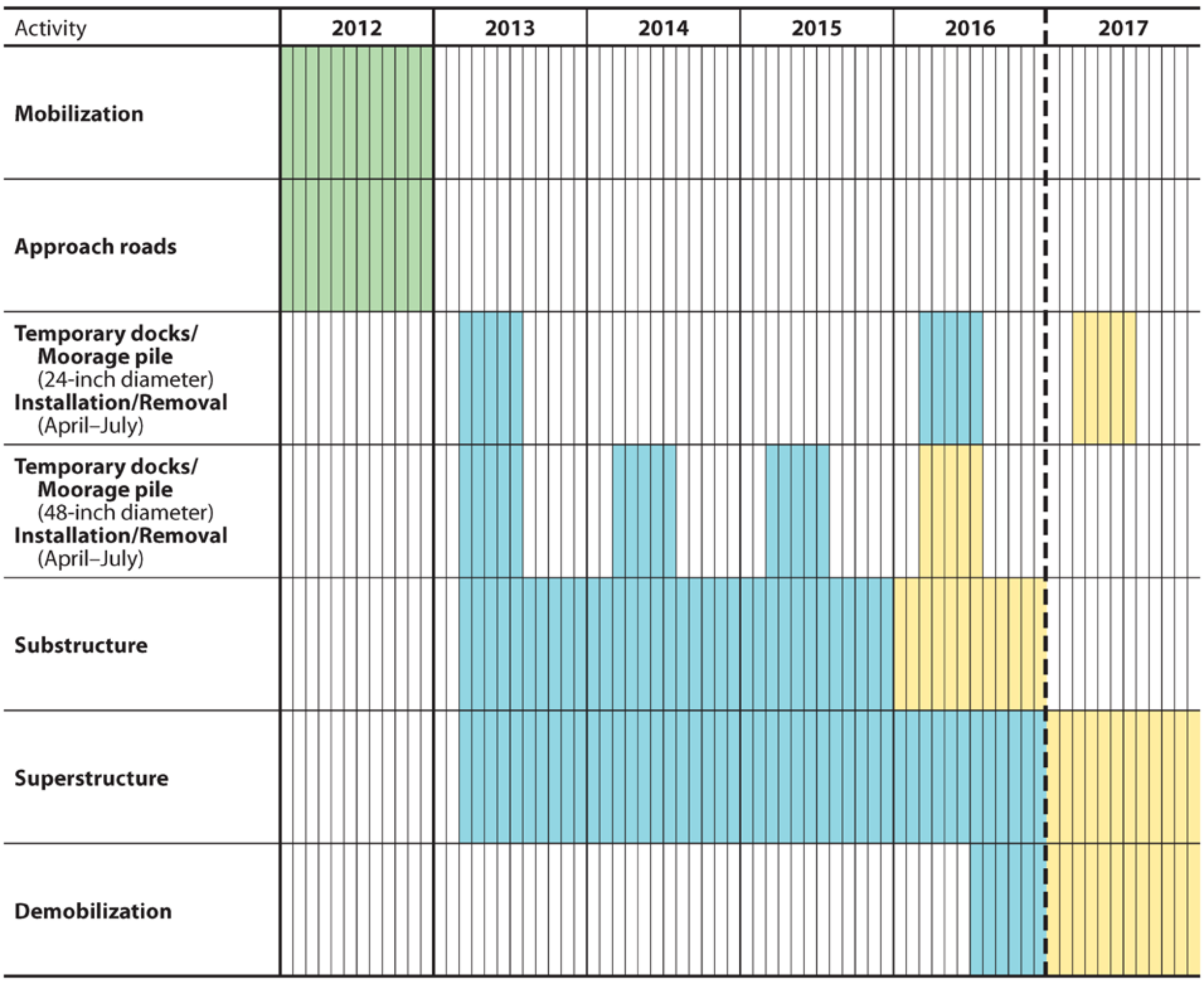
Overall Project Timeline and Sequencing

Long-term project construction will occur in two phases. All Knik Arm in-water construction work will occur during Phase 1. When traffic volumes increase to the point that additional capacity is needed, Phase 2 will be constructed (FHWA 2007). This will involve widening of the bridge deck or superstructure, but no additional foundation or substructure work will be required.

The roadway approaches and bridge abutments will be constructed in 2012, followed by bridge construction from 2013 through 2016. Total in-water bridge construction duration is scheduled for 4 years, with a potential fifth year (2017) of bridge construction because of unanticipated delays associated with weather conditions, construction logistics, beluga shut-down periods, etc. (Figure 16).

Phase 1 construction will include initial improvements to existing roadways and the development of the Mat-Su Approach, construction of the bridge substructure and superstructure, construction of the Anchorage Approach, and construction of a cut-and-cover tunnel under Government Hill. A toll plaza and lanes on the Mat-Su Approach are also planned as part of Phase 1 construction. All in-water work within Knik Arm will occur during Phase 1, and will include installation of 29 piers (four drilled-shafts per pier) for the substructure of the bridge that will accommodate eventual expansion of the bridge deck to four lanes. ***This request for an LOA is a request for takes associated with Phase 1 construction only.***

Table 2 shows a tentative construction schedule for all temporary construction dock piles, moorage piles, and template piles (installation and removal), along with permanent drilled-shaft/pier construction activities. Generally, the typical construction season is estimated to occur from March through November because hazardous ice flows, extreme weather, and short daylight conditions in Knik Arm during the winter months (December through February) prevent construction activities. Some construction operations may, however be possible during winter months if opportunities such as unseasonably warm weather or low-ice conditions present themselves, or if there is a need to conduct mobilization and demobilization activities for materials, operations, and vessels.



Note: Construction in 2012 (▢) involves no bridge work. Requested Letter of Authorization is for 2013–2016 (▢), plus 2017 (▢) serving as a contingency year for unforeseen construction delays associated with weather conditions, construction logistics, beluga whale shut-down periods, etc.

Figure 16 Construction schedule showing the 5 years for which a Letter of Authorization is requested (4 construction years and a contingency year). Each cell represents one month.

Following is a bulleted year-by-year timeline for construction of the Knik Arm Crossing:

2012 (involves no in-water bridge work)

- Mobilize construction equipment
- Construct approach roadways

2013

- Mobilize sea-based vessels and equipment
- Install barge moorage piles
- Install construction docks
- Begin installing temporary template piles
- Begin installing permanent casings
- Begin constructing footings
- Begin removing temporary template piles as footings are completed
- Begin installation of superstructure

2014

- Continue installing temporary template piles
- Continue installing permanent casings
- Continue constructing footings
- Continue removing temporary template piles as footings are completed
- Continue installation of superstructure

2015

- Finish installing temporary template piles
- Finish installing permanent casings
- Finish constructing footings
- Continue removing temporary template piles as footings are completed
- Continue installation of superstructure
- Begin demobilizing non-necessary vessels and equipment

2016

- Finish removing temporary template piles
- Finish installation of superstructure
- Remove temporary docks
- Remove barge moorage piles
- Finish demobilizing all equipment
- Contingency[*] for finishing permanent casings

2017 (contingency year)

- Contingency for finishing superstructure, removing temporary docks and moorage piles, and demobilization

[*] Contingency is for unforeseen construction delays associated with weather conditions, construction logistics, beluga whale shut-down periods, etc.

The selected contractor will largely determine the work schedule and hours worked each day. It is anticipated that a contractor would be allowed to work 24-hours a day, 7 days per week on any necessary activity except temporary pile driving and removal between August 1 and November 30. Specific daily construction activities cannot be accurately detailed at this stage of project development, but will generally follow the construction schedule and sequencing shown in Figure 16. The number of potential support vessels is described in Section 1.4.1. These will consist of crane barges, material supply barges, tugboats, and personnel transport vessels. These vessels will primarily be working within ½-mile, centered on the bridge alignment. There will be times when each vessel will be maneuvered to a designated mooring site. Material supply and personnel transport vessels will also need to maneuver between construction docks and the work area along the alignment of the bridge. Transits between construction docks and the work area will be direct.

Phase 2 will be constructed when increased traffic volumes warrant the additional capacity. When expansion is required, just the bridge deck or superstructure will require widening; the substructure will already have been constructed to structurally accommodate additional loading from the expanded superstructure. Although Phase 2 will not require in-water substructure construction, floating barge equipment and vessels may be required to facilitate deck expansion of the superstructure. Because Phase 2 will be constructed at a future date, compliance with regulations MMPA may have in place at that time will need to be reassessed. Phase 2 construction will also include extension of the Anchorage Approach to the Ingra-Gambell Couplet by way of a bridge (the Ingra-Gambell Viaduct) across the Ship Creek rail yard. Traffic studies have shown that the A-C Couplet has capacity available for additional traffic until approximately 2023.

As discussed in Section 11, several avoidance, minimization, and mitigation measures are proposed for beluga whales as part of bridge construction activities, including:

- using drilled-shaft technology for the large-diameter, permanent bridge piers—as opposed to driven piles—significantly reducing in-water noise exposure
- increasing bridge span lengths from the 250-foot (76-m) span lengths in the FEIS to 275-foot (84-m) span lengths, reducing the number of bridge piers from 33 to 29
- scheduling temporary pile installation and removal only during beluga whale low-density months (i.e., March through July)
- employing soft-start applications for initial pile driving
- employing monitoring and shut-down procedures
- using boat safety zones for construction vessels
- maintaining a minimum of 4,000 feet, or approximately half of the bridge length, unobstructed (free of moored and anchored barges and vessels) within Knik Arm at any given time to ensure unrestricted passage for belugas; this distance may not always be linearly continuous because of the need for staging of vessels for substructure and superstructure construction, but this minimum total length will always be maintained and further increased whenever reasonably possible.
- avoiding simultaneous pile installation and/or removal for moorage, dock, and template piles in multiple locations (*Exception*: Whenever beluga whales are not present in the project area and weather conditions are favorable, KABATA will however, coordinate with NMFS to determine whether pile driving at multiple locations would be acceptable to minimize the project's in-water

duration of disturbance. See the Adaptive Management Process, discussed in Sections 7.2.1 and 13.1.)

Table 2 Projected temporary pile and drilled-shaft/pier construction schedule

Bridge construction year	Temporary pile placement			Permanent drilled-shafts for piers	Temporary pile removal	
	Barge moorage (24-inch diameter)	Construction docks (24-inch diameter)	Templates (48-inch diameter)		Barge moorage and construction docks (24-inch diameter)	Templates (48-inch diameter)
2013	24	66	84	16	0	0
2014	0	0	180	60	0	108
2015	0	0	84	40	0	192
2016	0	0	0	0	90	48
2017 [a]	TBD [b]	TBD	TBD	TBD	TBD	TBD
Total	**24**	**66**	**348**	**116**	**90**	**348**

[a] The construction schedule includes a contingency for a sixth year extension to 2017 (initial year 2012 construction is for bridge approach roadways and does not involve bridge construction), which may be necessary because of construction delays associated with weather conditions, construction logistics, beluga whale shut-down periods, etc.

[b] to be determined

Construction Schedule Timing and In-water Work

Project scheduling and cost estimating are based on the assumption that no construction will take place during winter months because of the significant risk to personnel and equipment and the potential for cost impacts and delays, given the harsh winter environmental conditions. This applies particularly to in-water work associated with the project. However, project scheduling may be adjusted in a given year through adaptive management measures (discussed in Sections 7.2.1 and 13.1) to further minimize impacts to beluga whales, should such opportunities present themselves (e.g., taking advantage of a mild winter by extending work at the end of the construction season and/or initiating work earlier in the next construction season).

Construction Schedule and Beluga Whales

As suggested by Funk and Rodrigues (2005), the most effective way to prevent harassment of beluga whales in the construction area is to avoid driving piles during periods when beluga whales use the area most frequently and intensely—from August through November (Markowitz, Funk, et al., "Seasonal Patterns," 2005; Markowitz, Funk, et al., "Use of Knik Arm," 2005). Accordingly, no in-water temporary pile driving or removal is proposed to take place from August through November. FHWA and KABATA assume that with the used of drilled-shaft technology for permanent piers, there will be no takes of beluga whales (see Section 7.1.5). FHWA and KABATA are committed to obtaining sound level and transmission-loss data for large-diameter, drilled-shaft construction methods involving oscillator and drilling activities prior to construction of the project to verify noise source data. Requested takes associated with construction of the KAC will be associated with in-water temporary pile-driving and removal activities for dock, moorage, and pier template piles.

2.1.2 Geographic Setting

Cook Inlet, Alaska, is a subarctic estuary extending about 250 km (155 miles) from the Gulf of Alaska in the south to the city of Anchorage in the northeast, where it branches into two shallower extensions, the Knik Arm north of Anchorage and the Turnagain Arm southeast of Anchorage (Figure 1).

Knik Arm is a 31-mile (50-km)-long by 5-mile (8-km)-wide, glacially formed estuary fed by numerous rivers and creeks. Lining Knik Arm are bluffs that are 50 to 150 feet (15 m to 46 m) in height. Knik Arm is characterized by narrow channels with large tidal flats to the periphery. Large semidiurnal tides in Cook Inlet produce strong currents and tidal bores. Tidal fluctuations in excess of 38 feet (11.6 m) result in currents that exceed 11 feet per second (3.4 meters per second). Twice daily, the large tides expose extensive mud flats throughout the upper inlet during the ebb period, leaving approximately 60 percent of Knik Arm exposed at MLLW. The strong currents suspend large volumes of sediment from the Matanuska and Knik rivers, resulting in a highly turbid marine environment. Sea ice is typically present in Knik Arm from December through March. Primary fish species of upper Cook Inlet are the spring-to-fall migration of eulachon (*Thaleichthys pacificus*), outmigrating salmon (*Onchorynchus* spp.), smolt, and returning adult salmon (Houghton et al. 2005; Rodrigues et al. 2006, 2007).

The project area includes the Municipality of Anchorage and the Mat-Su Borough. Development along Knik Arm in addition to the Municipality of Anchorage includes two military bases and two major ports. The eastern end of the Crossing is to be located north of Cairn Point adjacent to Elmendorf AFB; the Crossing will extend across Knik Arm and terminate north of the Port MacKenzie Dock (Figure 1).

2.2 Site Selection Criteria

Beluga whale habitat was a key constraint that influenced selection of the project location and the location of alternatives developed for the KAC. The white paper *Constraints Affecting the Location of the Knik Arm Crossing Project* (KABATA 2009) addresses concerns about how FHWA selected the location for a bridge crossing in Knik Arm. Studies of beluga whale habitat use in Knik Arm, funded by KABATA and the POA, were reviewed to determine potential locations for the KAC that would have the least impact on belugas. Habitat use by beluga whales within and near the Crossing alignment has been characterized (Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005) as "intermittent transit" and "occasional limited feeding" in localized areas, such as the Cairn Point gyre, the mouth of Sixmile Creek, and the mouth of Ship Creek (see Section 4 for more information). To reduce impacts to beluga whale habitat, the Crossing alignment location was selected because:

- its location in lower Knik Arm avoids areas in mid- and upper Knik Arm (e.g., the Eklutna area) that appear to be used by relatively high numbers of cows and calves
- when present, belugas use this area less frequently than other parts farther north in Knik Arm
- its location is as far as practicably possible from consistent feeding habitats at the mouth of Sixmile Creek (approximately 1.5 mile (2.4 km) north of the Crossing) and at the mouth of Ship Creek (approximately 4 miles [6.4 km] south of the Crossing).

The selected bridge design also minimizes impacts to belugas by reducing the fill footprints. Multiple roadway and embankment options were investigated, including habitat restoration designs successfully used elsewhere (refer to *Knik Arm Crossing Options Technical Report*, KABATA 2006a). Because of their extensive footprints, however, these options were not brought forward.

The project was designed to avoid water bodies to the extent practicable. All roads were designed to maintain existing surface water courses. Alterations to surface drainage and hydrology that could impact nearby water bodies will be avoided or minimized through incorporation of appropriately designed, sized, and placed culverts. These culverts will maintain natural timing, direction, and volumes of surface water flow beneath the roadway.

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3 Marine Mammal Species and Numbers

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

Of the 15 species of marine mammals with documented occurrences in Cook Inlet, only 5 species are documented in the upper inlet: beluga whale (*Delphinapterus leucas*), harbor seal (*Phoca vitulina*), harbor porpoise (*Phocoena phocoena*), killer whale (*Orcinus orca*), and Steller sea lion (*Eumetopias jubatus*) (e.g., Rodrigues et al. 2006, 2007). A summary of these 5 species and the abundance of each stock as determined by NMFS are presented in Table 3. A description of the status, distribution, and seasonal distribution of the 5 species is provided in Section 4. The Cook Inlet distinct population segment (DPS) of the beluga whale is the most abundant marine mammal in upper Cook Inlet and, specifically, in the area of the Crossing. Harbor seals occasionally occur in Knik Arm. Harbor porpoises and killer whales have been sighted in Knik Arm, although their occurrence in the arm is considered rare. The Steller sea lion is unlikely to occur in upper Cook Inlet, because sightings there are also rare.

Table 3 Marine mammal species and stocks documented to occur in upper Cook Inlet, with their abundance as determined by NMFS

Species	**Abundance** (number of individuals)	**Source**
Harbor seal (*Phoca vitulina*)	45,975 (Gulf of Alaska stock)	Allen and Angliss (2010)
Steller sea lion (*Eumetopias jubatus*)	44,780 (Gulf of Alaska stock)	Allen and Angliss (2010)
Harbor porpoise (*Phocoena phocoena*)	31,046 for the Gulf of Alaska stock[a]	Allen and Angliss (2010)
Killer whale (*Orcinus orca*)	314 for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock 1,123 for the Eastern North Pacific Alaska Resident stock	Allen and Angliss (2010)
Beluga whale (*Delphinapterus leucas*)	321 for the Cook Inlet stock	NOAA (2009); Hobbs et al. (2009)

[a] The number of harbor porpoises using Knik Arm is unknown. Based on vessel-based surveys conducted during 1991, however, Dahlheim et al. (2000) estimated density as 7.2 animals per km^2 in the entire Cook Inlet.

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4 Affected Species Status and Distribution

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

4.1 Harbor Seal (*Phoca vitulina*)

NMFS currently recognizes three harbor seal stocks in Alaskan waters: Bering Sea, Gulf of Alaska, and Southeast Alaska (Allen and Angliss 2010). Harbor seals found in Cook Inlet are part of the Gulf of Alaska stock (Allen and Angliss 2010).

- **Status** – Harbor seals are not listed as "depleted" under the MMPA or as "threatened" or "endangered" under the Endangered Species Act (ESA) of 1973, as amended.
- **Distribution** – In Cook Inlet, harbor seals are year-round residents; they move into the upper inlet in summer, coinciding with movements of their anadromous fish prey such as eulachon and salmon. Harbor seals occasionally forage near river mouths during summer and fall salmon runs when fish aggregate there typically in large numbers. During salmon runs, seals have been observed in upper Cook Inlet in the Susitna River and are believed to enter other Cook Inlet rivers (e.g., Shelden, Goetz, Vate Brattstrom, et al. 2008; Shelden, Rugh, et al. 2009; Shelden, Goetz, et al. 2009). Salmon runs in Fish and Ship creeks likely attract harbor seals. During winter, seals are absent from the upper inlet and have likely moved into the lower inlet.

Harbor seals are occasionally present in Knik Arm, but these occurrences are considered rare. In the NMFS annual beluga whale surveys conducted from 1994 to 2005, three sightings of harbor seals in Knik Arm were recorded (Rugh et al. 2005). During baseline marine mammal surveys in the area of the KAC project, 22 sightings of harbor seals were reported over a 13-month period during approximately 14,000 observer hours (Rodrigues et al. 2006, 2007). These sightings were recorded from September through October 2004 and from June through September 2005 from a small vessel (Rodrigues et al. 2006, 2007). No harbor seals were recorded during POA marine mammal monitoring in 2007 (Cornick and Saxon Kendall 2008). One harbor seal was observed during POA marine mammal monitoring from July to November 2008 (ICRC 2009). Scientific marine mammal monitoring at the POA conducted May–November 2009 documented only one harbor seal; the sighting was made during mid-June (Cornick et al. 2010); six harbor seal takes were reported for the POA's 2009 construction season (March 28–December 14) (ICRC 2010). Of interest was a seal pup sighted on the shore on the evening of June 15, 2009, determined to be abandoned and later transferred to Alaska SeaLife Center (ICRC 2009). DoA (2010) lists sightings of harbor seals made during 2007–2009 in the Eagle River Flats area. Using both manual and remote camera observations, seals were sighted from mid-June through the end of September/early October, feeding and hauled-out on sandbars.

The closest established harbor seal haul-out site to the KAC project is in the West Forelands (approximately 116 km [72 miles] southwest of Point MacKenzie). Harbor seals may intermittently haul out near Susitna Flats (approximately 39 km [24 miles] southwest of Point MacKenzie) and in Turnagain Arm at Chickaloon Bay (e.g., Rugh et al. 2005; Shelden, Goetz, Sims, et al 2008). Harbor seals are occasionally killed by subsistence hunters in the Susitna Flats area (Stanek et al. 2007).

In lower Cook Inlet, high-density haul-out areas are found on Yukon Island and the Bradley-Fox River Flats within Kachemak Bay (State of Alaska 2004). Seals are present year-round along the western shore of Cook Inlet and Kamishak Bay, where major haul-out areas include Gull Island, the area between the mouths of Oil and Iniskin bays, Augustine Island, No Name Reef, Nordyke Island, Juma Reef, Douglas River Reefs, and Shaw Island (State of Alaska 2004).

4.2 Steller Sea Lion (*Eumetopias jubatus*)

Two separate stocks of Steller sea lions are recognized within U.S. waters: an eastern U.S. stock, which includes animals east of Cape Suckling, Alaska (144°W), and a western U.S. stock, which includes animals at and west of Cape Suckling (NMFS 2008a). Individuals observed in Cook Inlet are part of the western U.S. stock.

- **Status** – The western U.S. stock of Steller sea lion is listed as "endangered" under the ESA[*] and is, therefore, designated as "depleted" under the MMPA. As a result, the stock is classified as a strategic stock.
- **Distribution** – Steller sea lions occur in lower, rather than upper Cook Inlet. Steller sea lions are rarely sighted north of Nikiski. Haul-outs and rookeries are located near Cook Inlet at Gore Point, Elizabeth Island, Perl Island, and Chugach Island (NMFS 2008a). Steller sea lion critical habitat has been established at locations in the southern portion of lower Cook Inlet (NMFS 2008a). No Steller sea lion rookeries or haul-outs are located in the vicinity of the KAC project. No sightings were reported in Knik Arm during baseline studies of marine mammals in the area (Markowitz, Funk, et al., "Seasonal Patterns," 2005; Funk, Markowitz, et al. 2005; Ireland, McKendrick, et al. 2005). A single adult male was sighted in 1999 southwest of the KAC project area, in the Susitna Flats area.[†] Monitors observed a single, adult Steller sea lion in June 2009 near the POA construction area (ICRC 2009, 2010).

It is unlikely that any Steller sea lions will be encountered in the KAC project area given their rarity in the area; therefore, no further analysis for this species is presented in this request for an LOA.

4.3 Harbor Porpoise (*Phocoena phocoena*)

NMFS currently recognizes three stocks of harbor porpoise in Alaskan waters: Southeast Alaska, Gulf of Alaska, and East Bering Sea (Allen and Angliss 2010). NMFS notes that the stock boundaries are set arbitrarily: 1) the Southeast Alaska—occurring from the northern border of British Columbia to Cape Suckling, Alaska; 2) the Gulf of Alaska—occurring from Cape Suckling to Unimak Pass; and 3) the East Bering Sea—occurring throughout the Aleutian Islands and all waters north of Unimak Pass (Allen and Angliss 2010). Harbor porpoise found in Cook Inlet are part of the Gulf of Alaska stock.

- **Status** – The Gulf of Alaska stock of harbor porpoise is not listed as depleted under the MMPA; this stock is also not listed as threatened or endangered under the ESA (Allen and Angliss 2010).
- **Distribution** – Harbor porpoise occur in Cook Inlet throughout the year, but are only occasionally seen in Knik Arm near the site of the KAC project. Four sightings of harbor porpoise were reported during baseline studies in Knik Arm over a consecutive 13-month period (Rodrigues et al. 2006,

[*] 62 *Federal Register* (FR) 30772

[†] Matthew Eagleton, NMFS-AFSC, personal communication with Dagmar Fertl, HDR | e²M, September 11, 2009

2007). A stranded[*] harbor porpoise was found in lower Knik Arm in September 2005 (Rodrigues et al. 2006, 2007). A single harbor porpoise was seen in October 2007 in the vicinity of the POA during test pile-driving studies (URS 2007). No harbor porpoise were sighted during 2008 POA monitoring (ICRC 2009). Scientific marine mammal monitoring at the POA conducted May–November 2009 documented no harbor porpoise (Cornick et al. 2010); four harbor porpoise takes were reported for the POA's 2009 construction season (March 14–December 28) (ICRC 2010). Acoustic monitoring for beluga whales has also detected harbor porpoise occurrence in Knik Arm (e.g., Small 2010).

4.4 Killer Whale (*Orcinus orca*)

NMFS recognizes five killer whale stocks in Alaskan waters: 1) Eastern North Pacific Alaska Resident; 2) Eastern North Pacific Northern Resident; 3) Gulf of Alaska, Aleutian Islands, and Bering Sea Transient; 4) AT1 Transient; and 5) West Coast Transient (Allen and Angliss 2010). For upper Cook Inlet, the only killer whale stock documented above Kalgin Island is the Gulf of Alaska Transient stock (part of the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock).[†] Individuals of the Southern Alaska Resident stock (part of the Eastern North Pacific Alaska Resident stock) are frequently found in the lower inlet, but it is unclear how far up the inlet they swim—very unlikely above Kalgin Island.

- **Status –** Whales sighted in Cook Inlet belong to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient or Eastern North Pacific Alaska resident stocks. None of these stocks is classified as a strategic or depleted stock; none is listed under the ESA (Allen and Angliss 2010).
- **Distribution –** Killer whales have been sighted throughout Cook Inlet (Shelden et al. 2003; NMFS 2008b). Occurrence of this species in Cook Inlet is sporadic. Sightings are more common in lower Cook Inlet and the Gulf of Alaska, and the number of killer whales using the upper Inlet appears to be small (Shelden et al. 2003; NMFS 2008b). No killer whales were sighted during recent marine mammal studies in Knik Arm (Markowitz, Funk, et al., "Seasonal Patterns," 2005; Funk, Markowitz, et al. 2005; Ireland, McKendrick, et al. 2005; Ireland, Funk, et al. 2005) or during POA marine mammal monitoring efforts (ICRC 2009, 2010). Killer whales have been reported in Turnagain and Knik arms, between Fire Island and Tyonek, and near the mouth of the Susitna River (Shelden et al. 2003; NMFS 2008b). Killer whales were most recently reported in Turnagain Arm on September 11, 2009.[‡]

It is unlikely that any killer whales will be encountered in the KAC project area; therefore, no further analysis for this species is presented in this request for an LOA.

4.5 Cook Inlet Beluga Whale (*Delphinapterus leucas*)

NMFS recognizes five beluga whale stocks in Alaskan waters: (1) Cook Inlet, (2) Bristol Bay, (3) East Bering Sea, (4) East Chukchi Sea, and (5) Beaufort Sea (Allen and Angliss 2010). Only the Cook Inlet stock occurs in the KAC project area. Cook Inlet beluga whales are the most abundant marine mammal in upper Cook Inlet and specifically in the KAC project area.

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[*] *Stranding* refers to any dead marine mammal on a beach or floating nearshore; it also refers to any live cetacean on a beach or in water so shallow that it is unable to free itself and resume normal activity.

[†] Craig Matkin, North Gulf Oceanic Society, personal communication, September 11, 2009

[‡] Craig Matkin, North Gulf Oceanic Society, personal communication, September 11, 2009

- **Status** – The DPS of the beluga whale found in Cook Inlet was listed as "endangered" under the ESA in October 2008.* The Cook Inlet beluga whale is designated as "depleted" under the MMPA and is classified as a strategic stock. On January 28, 2010, NMFS published a notice of intent to prepare a recovery plan for this stock.† The recovery plan is targeted for completion in March 2013 (NMFS 2010).

  NMFS recently proposed designating two areas of marine habitat comprising 7,809 square km (3,016 square miles) as critical habitat for the population (Figure 17).‡ Knik Arm and the KAC project area are within this proposed critical habitat.

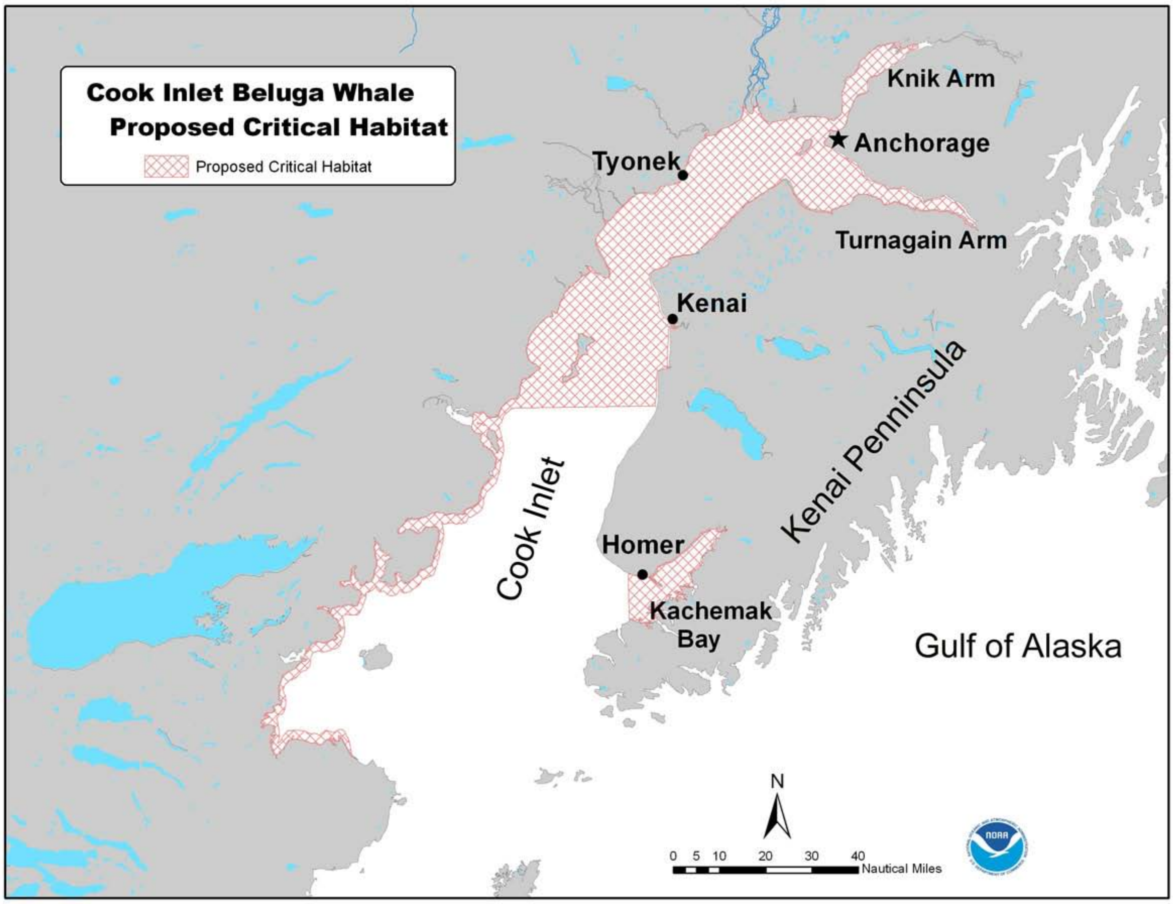

Figure 17 Proposed critical habitat for the Cook Inlet beluga whale (source: NMFS)

- **Distribution** – Cook Inlet belugas reside in Cook Inlet year-round although their distribution and density change seasonally. Factors likely influencing beluga whale distribution within the 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; NMFS 2008b). Seasonal

* 73 FR 62919

† 75 FR 4528

* 74 FR 63080

movement and density patterns as well as site fidelity appear to be closely linked to prey availability, coinciding with seasonal salmon and eulachon concentrations (Moore at al. 2000). Cook Inlet beluga whales forage intensely during the summer, when prey availability is high and locally concentrated near river mouths (Huntington 2000; Moore et al. 2000); this seasonal feeding is presumably important in providing energy storage and reserves for the winter. Beluga whales use several areas of the upper Cook Inlet for repeated summer and fall feeding. The primary hotspots for beluga feeding areas include the Big and Little Susitna rivers, Eagle Bay to Eklutna River, Ivan Slough, Theodore River, Lewis River, and Chickaloon River and Bay (NMFS 2008b). Availability of prey species appears to be the most influential environmental variable affecting Cook Inlet whale distribution and relative abundance (Moore et al. 2000). The patterns and timing of eulachon and salmon runs have a strong influence on beluga whale feeding behavior and their movement during the spring and summer (Nemeth et al. 2007; NMFS 2008b). The presence of prey species may account for the seasonal change in beluga group size and composition (Moore et al. 2000).

Belugas are often seen near coastal mud flats and river mouths in Cook Inlet from spring through fall (e.g., Goetz et al. 2007; NMFS 2008b). Belugas move into Knik Arm during the late summer and early fall and remain through ice-free periods, through November (e.g., Cornick and Saxon Kendall 2009; Cornick et al. 2010).

Markowitz et al. (2005) found that group composition in the Crossing area does not vary significantly throughout the year, although researchers had only limited data for January and February, with no sightings. At all other times, adults generally made up between 40 and 60 percent of the groups, while subadults made up 15 to 30 percent of the groups. Calves made up 10 percent of total group composition (Markowitz et al. 2005).

Belugas have been observed moving into the upper shallow arms of upper Cook Inlet, including Knik Arm, during high tides and departing during ebb tides (Hobbs et al. 2005; Ezer et al. 2008). In Knik Arm, beluga whales appear to follow fast-moving tidal fronts, whereby animals move with large velocity gradients slightly ahead of salinity fronts. Belugas spread farther out during high tide and travel into the upper reaches of Knik Arm on flooding tides to gain access to mud flats at river mouths that are not accessible during low tides (Ezer et al. 2008). Therefore, whales concentrate more as they follow flooding tides up channels and are observed, accordingly, mostly along coastal areas such as south of Goose and Eagle bays (Rugh et al. 2004; Rugh et al. 2005). POA monitoring reports also indicate that animals concentrate in coastal areas during flooding and ebbing tides, with a greater concentration of animals observed on the eastern shoreline of the POA study area during low ebb and high slack tides and on the western shoreline during low slack and high flood tides (ICRC 2009; ICRC 2010).

Observer data for the POA project in southern Knik Arm indicate, however, that beluga whales were evenly distributed across the study area in the southern Knik Arm during low, low ebb, and slack tides (ICRC 2009; ICRC 2010). These findings contrast those of Hobbs et al. (2005) and Ezer et al. (2008) in that animals concentrated more in channels during ebbing tides and distributed less densely during high tides.

Funk, Markowitz, et al. (2005) also documented that belugas in Knik Arm move with the tides, northward during flooding and southward during ebbing tides. Some animals remained in the vicinity of Eklunta during the peak of high tide. Most of the remaining whales in this area participated in traveling or suspected feeding behaviors (Funk, Markowitz, et al. 2005). The Eklutna area is also the source of many recorded observations of groups resting, either to rest there or to wait for prey to move through the area (Funk, Markowitz, et al. 2005).

Although reports on monitoring for the POA contrast these previous studies and suggest that animals have high concentrations in the areas of Knik Arm near the project site during high ebb tides as compared with low ebb tides, nearly 65 percent of the observations during high ebb tides occurred in one period, during November 2008 (ICRC 2009). The authors conclude that "the peak in number of whales during this tidal cycle [high ebb tide] is not typical" (ICRC 2009). Significant peaks also occurred in 2009 for low and high flood tides and high ebb tides (ICRC 2010). These findings indicate that animals do follow tidal cycles in movements throughout the Knik Arm.

As ebb tides begin, belugas move south and out of the northern portions of Knik Arm to return by way of Birchwood to Sixmile Creek and Eagle Bay (Funk, Markowitz, et al. 2005). During low tides, frequent sightings have been documented in Sixmile Creek and Eagle Bay. Funk et al. (2005) also found that beluga whales move in channels close to the shoreline. Based on these studies, it can be concluded that belugas primarily travel through the KAC project area on the incoming and outgoing tides to and from likely foraging areas farther up Knik Arm (e.g., Fish Creek, Eagle River, Eklutna). The movement of belugas with the tides allows access to important feeding and nursery areas.

POA monitoring has determined consistent spatial distribution in Knik Arm, with the majority of beluga whale sightings concentrated along the shorelines (e.g., Cornick and Saxon Kendall 2008; Cornick and Saxon Kendall 2009; Cornick et al. 2010). POA monitoring during 2008 revealed an increased use of midchannel areas, although Cornick et al. (2010) suggested that this may be a reflection of the greater number of whales sighted during that year. Studies prior to POA monitoring also indicated that beluga whale presence is higher in shoreline habitats. Markowitz, Funk et. al. (2005) concluded that, based on data corrected for reduced detection for farther observation distances, three areas were utilized most extensively, including shoreline along Birchwood. Data indicated lower use in the Knik Arm Narrows, however (Markowitz, Funk, et. al. 2005). During monitoring of seismic activity in April and May, Brueggeman et al. (2007) documented that belugas occurred nearshore, while Cornick and Saxon Kendall concluded that there was substantial use of western shoreline habitat in Knik Arm.

Ireland, McKendrick et al. (2005) found that beluga whales exhibited distinct distribution patterns across seasons and tides. Whales were sighted throughout Knik Arm during the study even though observations appeared clustered along eastern shorelines. Because researchers collected observational data from land as well as by boat, they adjusted for potential bias associated with land-based observers seeing and recording more animals nearshore. Adjusting for this potential bias, Ireland, McKendrick et al. (2005) found that belugas gaining access to upper Knik Arm use nearshore areas. These conclusions coincide with the movement patterns of belugas through upper Knik Arm during tides, as described previously in this section.

NMFS tagging studies also generally show that belugas occur close to shore (Rugh et al. 2004; Rugh et al. 2005). Rugh et al. (2004) and Rugh et al. (2005) found that whales in Knik Arm occur in shallow coastal areas, particularly bays. One NMFS tagging study indicated that beluga whales concentrate in rivers and bays in summer, while animals may be more widely dispersed and occur farther offshore in winter (Hobbs et al. 2005). Researchers documented this change in distribution in

December of the study year and observed it continuing through February. Sighting rates based on ice cover coupled with the limited number of tagged animals (14) may have influenced the data.

POA monitoring also includes use of passive acoustics, which can detect vocalizing animals underwater. Sirovic and Saxon Kendall (2009) found that belugas were detected by passive acoustic monitoring (PAM) offshore in deep channels more often than in the shallow shoreline areas. The authors concluded that deeper water habitat may be more important that previously documented because observers may miss sightings as whales become more distant from shore. PAM, however, provides data coverage over a smaller area (Sirovic and Saxon Kendall 2009). Additional recent PAM work in Cook Inlet is still in the preliminary stages of analysis. No data on habitat use, whether along shorelines, nearshore, or offshore from PAM, have been released at this time, although Small indicates that PAM use indicates this type of analysis for beluga whales in the study area could be forthcoming (Small 2008; Small 2009a,b; Small 2010).

Because belugas spend much of their time in shallow waters, stranding is a constant risk (Hobbs and Shelden 2008). Mass strandings primarily occur in Turnagain Arm, coinciding with extreme tidal fluctuations (“spring” tides) or killer whale sightings reports (Shelden et al. 2003). On August 22, 2009, a mass stranding of belugas was documented on the mud flats in Knik Arm off the Birchwood area north of Anchorage (Pemberton 2009).

Calving probably occurs mid-May through mid-July in the Cook Inlet region (Calkins 1983). Belugas using Knik Arm appear to calve primarily in the Susitna Flats portion of upper Cook Inlet (Huntington 2000). There is no evidence that calving occurs in Knik Arm, because relatively few whales use the area during the calving period (Markowitz, Funk, et al., “Seasonal Patterns,” 2005). Markowitz, Funk, et al. (“Seasonal Patterns” 2005) reported that calves represented roughly less than 10 percent or less of beluga whales observed in Knik Arm.

Calves normally occur in groups larger than 9 individuals, whereby group sizes for all beluga observations, including groups without calves, have ranged from 1 to 57 individuals (Cornick and Saxon Kendall 2009). Observations from POA monitoring documented a reduction recently in observed group sizes with calves, a mean of 5 individuals in 2009 as compared with 8 in 2007 and possibly 13 in 2008 (ICRC 2010). The lower numbers in 2009 were not statistically significant, however. Furthermore, the trend coincides with lower numbers of observations and a documented reduction in the population (ICRC 2010).

Markowitz and McGuire (2007) also documented that calves typically occur in larger groups and that groups with calves occurred all in August (late summer) and September (early fall). POA monitoring (IRCR 2009; ICRC 2010) also supports conclusions by previous researchers that the larger groups with calves generally show up in Knik Arm in late summer and early fall (e.g. Cornick and Saxon Kendall 2008; Markowitz and McGuire 2007). An analysis of the 2009 POA monitoring data shows the number of calves as compared with adults sighted by month (Table 4).

Table 4 POA beluga whale sightings and percentage of calf observations, by month, 2009

Month	Whales sighted	Calves (%)
March/April	8	0.0
May	118	5.1
June	1	0.0
July	8	25.0
August	572	11.0
September	231	7.4
October	137	5.8
November	129	7.0
December	17	0.0

Source: Derived from ICRC, 2010: Table 1

These seasonal movements indicate that animals gain access to upper Knik Arm during late summer and early fall to provide increased protection for calves in addition to following the migratory patterns of their prey (ICRC 2009; ICRC 2010). McGuire et al. (2008) studied potential calving areas in upper Cook Inlet; however, the researchers concluded that distinct calving areas could not be determined from their photo-identification work because calves were seen in all portions of their study area, including the Susitna River delta, Knik Arm, Chickaloon Bay/Southeast Fire Island, and Turnagain Arm (McGuire et al. 2008).

Traditional ecological knowledge (TEK) of Alaska Natives and the NMFS aerial survey data document a historical contraction of the summer range of Cook Inlet belugas (NMFS 2008b). While belugas were once abundant and frequently sighted in the lower inlet during summer, they now primarily concentrate in the upper half of the inlet (NMFS 2008b). This range contraction is likely a function of a reduced population seeking the highest-quality habitat offering the most abundant prey, most favorable feeding bathymetry, best calving areas, and best protection from predation. An expanding population would likely force extension of the species' range back into the lower inlet (NMFS 2008b). Studies that provide occurrence data on beluga whale distribution in upper Cook Inlet are summarized in Sections 4.5.1 through 4.5.5.

4.5.1 NMFS Aerial Surveys

NMFS conducts annual aerial surveys to study beluga distribution and abundance in Cook Inlet (e.g., NMFS 2008b; Shelden et al. 2008). These surveys typically occur in June and have been repeated each year since 1993. NMFS aerial survey data reveal that Cook Inlet beluga whales exhibit interannual variability in their use of Knik Arm, with heavy use at times (Markowitz, Funk et al. "Use of Knik Arm" 2005). The proportion of the Cook Inlet population using Knik Arm during annual NMFS aerial surveys conducted during June through July, 1993 through 2005, was 0 to 61 percent, with a mean of 23 percent (Markowitz, Funk, et al. "Use of Knik Arm" 2005). From 2006 through 2009, 0 to 34 percent of the beluga whale population in Cook Inlet used Knik Arm (Rugh, Goetz, and Sims 2006; Rugh, Goetz, Sims, et al., "Aerial Surveys – June 2006," 2006; Rugh et al. 2007; Shelden et al. 2007; Shelden, Rugh, et al. 2008; Sheldon, Goetz, et al. 2008; Shelden, Goetz, Sims, and Mahoney 2008; Shelden et al. 2009).

Studies have demonstrated that the lower reach of Knik Arm is regularly used by Cook Inlet belugas (NMFS 2008a). The most common activities observed are traveling and feeding, with belugas exhibiting distinctive seasonal and tidal behavioral patterns (NMFS 2008a). As noted earlier, Type 1 habitat for the beluga as defined by NMFS includes the KAC project area (NMFS 2008a). The pattern of beluga whale use of Knik Arm is high during the fall (August through October), reduced and more sporadic in shoulder seasons (April through July and November through early December), and only occasional visited at other times of year (mid-December through March) Markowitz, Funk, et al., "Use of Knik Arm," 2005.

Aerial surveys to document calf rearing areas have been conducted since August 2005. Surveys have also been conducted during fall, winter, and spring months to document year-round beluga distribution in the inlet. Based on those surveys, beluga whale concentrations in the northernmost portion of Cook Inlet appear to be fairly consistent from June through October. Intensive aerial surveys for abundance conducted in June and July since 1993 have consistently documented high use of Knik Arm, Turnagain Arm, Chickaloon Bay, and the Susitna River delta areas of the upper inlet (NMFS 2008b). The combination of satellite telemetry data and long-term aerial survey data demonstrates that beluga whales use Knik Arm year-round, often entering and leaving the arm on a daily basis (Hobbs et al. 2005; NMFS 2008b). However, the number of individuals in these areas during winter is considerably less than during spring, summer, and fall. Aerial surveys also found that sightings in Knik Arm were annually variable, ranging from 0 belugas in 1994 and 2004, to 224 belugas in 1997 (NMFS 2008b)**.**

Goetz et al. (2007) used previous NMFS aerial survey data in predictive modeling to assess beluga habitat use in Knik Arm. This study identified all of Knik Arm, including the area around the KAC project, as a high-use area and determined that both presence of mud flats and amount of freshwater flow may be important environmental factors influencing beluga distribution in the summer.

4.5.2 NMFS Satellite Tagging

Hobbs et al. (2005) tracked 14 beluga whales from late September 2000 through March 2003 in upper Cook Inlet using satellite telemetry. These satellite-tagging data confirmed the aerial survey data, indicating seasonal movements between different parts of upper and central Cook Inlet. Data from satellite-tagged whales also documented that belugas concentrated in the upper inlet at rivers and bays in the summer and fall and then tended to disperse offshore and move to mid-inlet waters in the winter (Hobbs et al. 2005; NMFS 2008b). As late as October, tagged belugas continued to use Knik and Turnagain arms and Chickaloon Bay, with some individuals ranging into lower Cook Inlet south to Chinitna, Tuxedni, and Trading bays (McArthur River) in the fall (Hobbs et al. 2005). During November, belugas moved between Knik and Turnagain arms and Chickaloon Bay, similar to movement patterns obtained for September (Hobbs et al. 2005). By December, tagged individuals were distributed throughout the upper to mid-inlet. From January through March, tagged belugas were found as far south as Kalgin Island and in central offshore waters. Tagged belugas occasionally swam into Knik and Turnagain arms in February and March, even though there was over 90 percent ice cover in the area (Hobbs et al. 2005).

Using a three-dimensional numerical model of Cook Inlet, Ezer et al. (2008) combined NMFS tagging data (presented in Hobbs et at al. 2005) to confirm significant correlations between beluga movements in upper Cook Inlet and modeled sea level and currents; the belugas moved some 30 km to 50 km (19 to 31 miles) each day to follow the tidal cycle and water coverage.

4.5.3 KABATA 2004–2005 Baseline Study in Knik Arm

KABATA initiated a study to collect baseline data on beluga whales by conducting land- and small boat-based surveys in Knik Arm and adjoining areas of upper Cook Inlet (refer to Funk, Markowitz, and Rodrigues 2005). The baseline study focused on:

- beluga whale distribution and use of Knik Arm and the KAC corridor
- examination of spatial and temporal patterns of beluga whale habitat use
- group composition
- group activity

Sighting data within the KAC project area were collected from land-based survey sites adjacent to Knik Arm* and included nine observation points in the KAC corridor. Observations were conducted daily from July 15, 2004, through July 31, 2005. Across all observation points, 1,863 observation sessions averaging 6 hours in length were conducted for a total of 11,124 hours of land-based monitoring. In addition, 405 hours of boat-based surveys across 76 days were conducted primarily at higher stages of the tide from August to October 2004 and from May to July 2005 in Knik Arm.

Results of the Markowitz, Funk, et al. ("Seasonal Patterns," 2005) study indicated strong seasonal patterns of beluga whale use in Knik Arm. In general, sighting rates of beluga whales there were low from December through July (Figure 18). Sighting rates were highest during late summer and fall (mid-August through mid-November), peaking during September (Markowitz, Funk, et al., "Seasonal Patterns," 2005). Sighting rates during spring and early to midsummer were higher than those in winter but they were low compared with those in 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 percent of those during fall 2004. A shift in distribution from Knik Arm in the fall (2004) to the Susitna River area during the summer (2005) was evident. Encounter rates during boat surveys were higher in Knik Arm than in the Susitna River area during the fall (2004) and higher in the Susitna River area than in Knik Arm in the summer (2005). The closest areas to the Crossing corridor used for feeding by whale aggregations appeared to be Sixmile Creek and Eagle Bay (Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005).

Baseline surveys revealed that the mean estimated age class composition of observed whale groups changed little throughout the 13-month study period (Markowitz, Funk, et al., "Seasonal Patterns," 2005; Markowitz, Funk, et al., "Survey Effort," 2005). The mean proportion of adults ranged from 40 to 60 percent, while subadults made up approximately 15 to 30 percent of whales in groups. On average, calves represented roughly 10 percent or less of the whales observed in Knik Arm. Whales of unknown age class made up a substantial portion of those sighted; these generally ranged from 10 to 30 percent in most months. During the baseline study, adults made up a higher proportion of whales observed in and around the Crossing corridor than groups observed farther north in upper Knik Arm (Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005). Subadults and mother/calf pairs feeding on salmon

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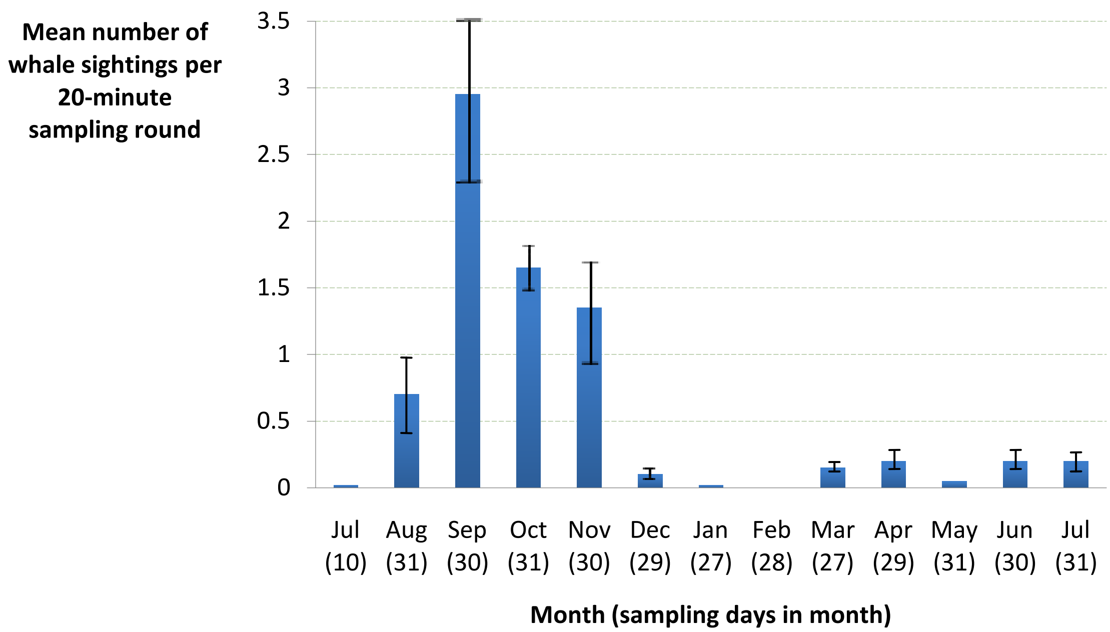
* Shore stations adjacent to Knik Arm were at the following locations: Cairn Point, Point Woronzof, Birchwood, Eklutna, Goose Bay, West Crossing, Sixmile Tower, Point MacKenzie, and Fort Richardson (Markowitz, Funk, et al., "Survey Effort," 2005).

made up a higher proportion of whales observed in upper Knik Arm than in the Crossing corridor (Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005). Mother/calf pairs were less likely to leave the area and return than were other whales. Once in feeding areas, they likely stayed until salmon runs ended.



Note: Error bands are represented with brackets.

Figure 18 Beluga whale sighting rate, by month (2004–2005), during baseline studies in Knik Arm, shown for all shore-based stations combined (source: adapted from Markowitz, Funk, et al., "Seasonal Patterns," 2005)

During fall, beluga whales in Knik Arm generally remained north of the KAC construction area. However, on a few occasions, whales were seen transiting the Knik Arm Narrows between Cairn Point and Port MacKenzie. The number of group sightings decreased during November 2004. The whales returned to Knik Arm sporadically during spring and summer 2005.

Year-round, extreme tidal fluctuations in Knik Arm influence accessibility of habitat and thus movement of belugas there (Figure 19; Funk, Markowitz, et al. 2005). As the tide floods, beluga whales typically move from areas near Sixmile Creek and Eagle Bay past Birchwood toward the northern reaches of Knik Arm. As the tide ebbs, whales return to areas near Eagle Bay and Sixmile Creek, where they remain during the lower portions of the tidal cycle (e.g., Ireland, Funk, et al. 2005).

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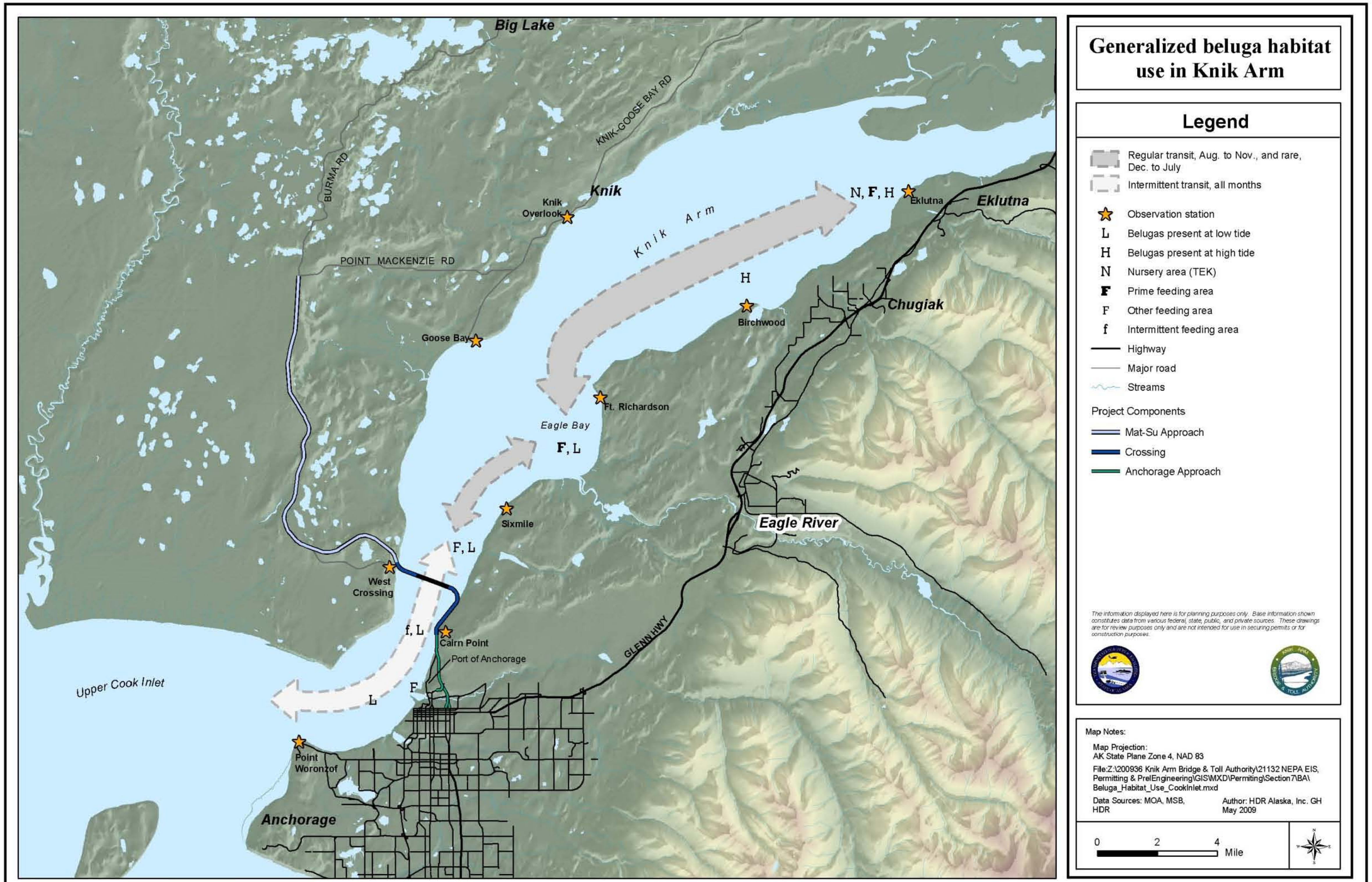

Figure 19 Generalized beluga habitat use in Knik Arm by tidal stage, beluga whale activity, and transit routes. *Sources*: NMFS (2008b); Markowitz, Funk, et al. ("Seasonal Patterns"2005); Funk, Markowitz, et al. (2005); Ireland, McKendrick, et al. (2005); Prevel-Ramos et al. (2006); McGuire et al. (2007);Savarese (2007); Cornick and Saxon Kendall (2008, 2009); FR 73, 41318; and USACE (2007)

During the low-tide period, beluga whales remain in Eagle Bay most of the time. During boat-based surveys in September and October 2005, however, 62 percent of sighted whales moved out of Eagle Bay toward the Sixmile Creek area at some time during the low-tide period (Ireland, Funk, et al. 2005). On average, whales spent less than 3 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 (2.4 km [1.5 mile] north of the KAC) was used most frequently during September, when the greatest numbers of beluga whales were present in Knik Arm (Ireland, Funk, et al. 2005).

Sighting rates in the KAC project area were generally lower than elsewhere in Knik Arm. On average, including the high whale-use months of fall, one group of approximately five beluga whales was sighted within 500 m (0.3 mile) of the KAC site for every 33 to 70 hours of observation effort. As in other parts of Knik Arm, sighting rates were highest in the fall (August through October), lower in spring, and lowest in the winter. Sighting rates in summer (May through July) and winter (December through January) were very low, with roughly one group sighted within 4 km (2.5 miles) of the KAC Crossing during every 30 hours of observation. During all seasons, sighting rates in the 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.

The observed behavior of beluga whales in the Crossing area was similar to that documented outside the area (Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005). Whales in the Crossing area, however, were observed diving a higher proportion of the time than whales outside the Crossing area. Based on behavioral observations (Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005), the Crossing does not appear to be a resting or nursing area, but rather an area for deep-water foraging by adults and a transit area for entering or leaving Knik Arm. Belugas were also seen resting slightly less often in the Crossing area than at other locations (Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005). Resting was most prevalent at the location farthest from the Crossing area: Eklutna (Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005).

During the course of this study, 90 percent of the recorded sightings in Knik Arm occurred from August through November. The relatively low number of sightings in Knik Arm in the rest of the year suggests that the whales were using other portions of Cook Inlet during that time.

4.5.4 KABATA September-October 2005 Eagle Bay and the Sixmile Area of Knik Arm

As a follow-up to the baseline study by Ireland, McKendrick, et al. (2005), Ireland, Funk, et al. (2005) conducted a 2-month study to understand the usage patterns and relative importance of the Eagle Bay and Sixmile Creek areas to beluga whales during low tide. The high use of the Eagle Bay and Sixmile Creek areas by beluga whales at low tide, and the proximity of these areas to the project area create the potential for KAC construction to impact beluga whales (Funk and Rodrigues 2005). The goal of the project was to examine the use of the Sixmile Creek area relative to Eagle Bay to better mitigate takes of belugas incidental to construction of the Crossing.

From September 7 to October 21, 2005, 23 boat surveys were conducted in Eagle Bay and the Sixmile Creek areas around low tide (Ireland, Funk, et al. 2005). Belugas were sighted on 22 of 23 surveys during over 128 hours of total time on the water (Ireland, Funk, et al. 2005). Ireland, Funk, et al. (2005) collected boat- and shore-based data similar to that recorded by Markowitz, Funk, et al. ("Survey Effort" 2005), although efforts in the Ireland, Funk, et al. 2005 study were concentrated in the area of the Crossing.

Similar patterns of use relative to the tidal cycle were documented in both studies. The area north of the Crossing was used by beluga whales primarily during the lower portions of the tidal cycle. Sighting rates were much higher in September than in October. Whales were frequently documented in the Sixmile Creek area at the northern edge of the Crossing site. However, more whales were observed spending a greater amount of time in Eagle Bay (located further north) than at Sixmile Creek (Ireland, Funk, et al. 2005). Whale activity patterns were not noticeably different between the Eagle Bay and Sixmile Creek areas. Traveling was the most commonly noted activity (65 to 85 percent), followed by diving (55 to 70 percent), and suspected feeding (25 to 30 percent) (Ireland, Funk, et al. 2005).

Eagle Bay was shown to be of primary importance as a low-tide holding location for most beluga whales frequenting Knik Arm at this time of year (Ireland, Funk, et al. 2005). On average, whales spent less than 3 hours in Eagle Bay around low tide (Ireland, Funk, et al. 2005). On about 80 percent of days, over 60 percent of whales occurring in Eagle Bay moved at least a short distance farther south of Eagle Bay, into the northern portions of the Sixmile Creek area (Ireland, Funk, et al. 2005). On average, whales occupied areas south of Eagle Bay for less than 2 hours, with animals occasionally entering or departing Knik Arm through the narrows (Ireland, Funk, et al. 2005). Beluga whale use of waters near the mouth of Sixmile Creek occurred with some regularity, but was limited to about one-quarter of boat surveys (Ireland, Funk, et al. 2005). This southern portion of the Sixmile Creek area was used most frequently during mid-September, when whale numbers were near their peak (Ireland, Funk, et al. 2005).

Beluga whales can be seen throughout most of Knik Arm (Ireland, McKendrick, et al. 2005), but their distribution within the arm is not uniform (Markowitz, Funk, et al., “Use of Knik Arm,” 2005). Examination of the spatial distribution of whale group sightings in Knik Arm during the course of the baseline study indicated areas of high use near Sixmile Creek, Eagle Bay, Birchwood, and Eklutna (Markowitz, Funk, et al., “Use of Knik Arm,” 2005). Because increased distance reduces the probability of detecting belugas, the group sightings were analytically adjusted, with the results suggesting a broader distribution. In the course of the entire year, beluga whales most often use three areas in Knik Arm: the Sixmile Creek/Eagle Bay areas, the deep channel along the Birchwood shore, and the Eklutna/Palmer Slough areas (Markowitz, Funk, et al., “Use of Knik Arm,” 2005). Across all seasons and tidal states, the highest whale counts occurred in the Sixmile Creek/Eagle Bay, Birchwood, and Eklutna/Palmer Slough areas, and the lowest counts were in the Knik Arm Narrows (Markowitz, Funk, et al., “Use of Knik Arm,” 2005).

In the course of the 1-year study, whale groups were sighted in most of the analyses’ grid cells within the Crossing area (Markowitz, Funk, et al., “Use of Knik Arm Crossing Corridor,” 2005). The number of groups and number of whales per group sighted in the Crossing area were, however, relatively low. In total, 355 beluga whale group sightings were documented in the Crossing corridor from nearby shore stations from July 2004 through July 2005 (Markowitz, Funk, et al., “Use of Knik Arm Crossing Corridor,” 2005). The sighting rate in the Crossing corridor was 0.016 whale group per 20-minute sampling round. Overall, a mean of 0.078 individual beluga whale per 20-minute sampling round (standard error [*SE*] = 0.040) was documented (best counts) in the Crossing corridor. Thus, for every 20.9 hours of observation effort at the surrounding shore stations, on average one group of 6 beluga whales was observed in the Crossing area (0.28 whale/hour). By comparison, a mean of 0.43 beluga whale per 20-minute sampling round (*SE* = 0.080) was documented in grid cells north of the Crossing area (11 whales every 8.3 hours; 1.32 whale/hour) (Markowitz, Funk, et al., “Use of Knik Arm Crossing Corridor,” 2005).

4.5.5 Port of Anchorage Marine Mammal Monitoring Program

Scientific monitoring at the POA started in 2005 and includes the following published reports: August through November 2005 (Prevel-Ramos et al. 2006), April through November 2006 (Markowitz and Link 2007; McGuire et al. 2007; Savarese et al. 2007; Markowitz and McGuire 2007a; Markowitz and McGuire 2007b), October through November 2007 (Cornick and Saxon Kendall 2008), June through November 2008 (Cornick and Saxon Kendall 2009; ICRC 2009), and June through December 2009 (ICRC 2009, 2010; Cornick et al. 2010; Širović and Saxon Kendall 2009, 2010). Construction activities are planned at the POA into 2014 (USDOT and POA 2008).Construction associated with the Marine Terminal Redevelopment Project (MTRP) at the POA from 2006 through 2009 included pile driving and fill placement (Markowitz and McGuire 2007; Cornick and Saxon Kendall 2008, 2009; ICRC 2009, 2010). Throughout the four construction seasons for the MTRP, beluga whales were observed during pile driving only in 2008 and 2009 (Markowitz and McGuire 2007; Cornick and Saxon Kendall 2008, 2009; ICRC 2009). To comply with the POA's marine mammal take permit issued by NMFS, construction was shut down 14 times in 2008 and 59 times in 2009. No unusual behavioral changes were observed during pile driving (ICRC 2009, 2010). Additionally, onshore observations identified no unusual responses or subsurface responses such as changed vocalizations (Cornick and Saxon Kendall 2009; Kendall et al. 2009; Cornick et al. 2010). Sightings of belugas within and adjacent to areas where pile-driving and other construction activities took place at the POA indicate belugas that entered Knik Arm did not avoid the area, suggesting no diminished use of habitat as a result of the construction of the MTRP.

Beluga whales primarily travel through the POA footprint on incoming and outgoing tides, swimming to and from likely foraging areas farther up Knik Arm (e.g., Fish Creek, Eagle River, Eklutna) (e.g., Cornick et al. 2010). Beluga whales have been observed during all tidal stages; significant sighting peaks during low and high flood tides and during high ebb tides have been documented during scientific monitoring (e.g., Cornick et al. 2010).

Fort Richardson Beluga Monitoring

Pursuant to the Eagle River Flats Settlement Agreement in October 2004, the U.S. Army (Fort Richardson) agreed to have Army personnel monitor the health and behavior of beluga whales in and around Eagle River Flats, within the boundaries of Fort Richardson (DoA 2010; DoD 2009; USAG-AK 2007).

Belugas are often found in Eagle Bay between May and November (e.g., Huntington 2000; Hobbs et al. 2005; DoA 2010), with some individuals seen as far inland in Eagle River as 1.25 mile upstream (DoA 2010). The majority of sightings occur at the mouth of Eagle River (USAG-AK 2007). The number of whales sighted during 2007–2008 beluga monitoring ranged from to 68 individuals (DoA 2010). Group color composition during 2007–2008 monitoring ranged from 37 to 92 percent white belugas, 6 to 100 percent gray belugas, and 0 to 26 percent calves (DoA 2010). Milling (resting) and traveling were the most often documented behaviors, with diving and suspected feeding also observed (DoA 2010). Belugas have even been observed chasing fish (thought to be salmon) onto the river banks (DoD 2009).

4.5.6 Other Survey/Monitoring Efforts in Upper Cook Inlet

- Markowitz et al. (2007) documented May-through-November beluga whale habitat use and behavior in Turnagain Arm, near the Seward Highway.
- Boat-based surveys were conducted from May through October 2006 from North Forelands (near Tyonek), north past Ladd Landing and the Beluga River, then north and east across the Susitna River

delta (Nemeth et al. 2007). Shore-based surveys were conducted from April through October 2006 in lower Knik Arm at shoreline developments of the POA and Port MacKenzie (Nemeth et al. 2007).

- Prevel-Ramos et al. (2008) conducted surveys near Ladd Landing on the north side of upper Cook Inlet between Tyonek and the Beluga River from April through October 2006 and from July through October 2007.
- Brueggeman et al. (2007a, 2007b, 2008) conducted vessel and aerial surveys in 2007 near the Beluga River between April 1 and May 15, at Granite Point between September 29 and October 21, and at North Ninilchik between October 25 and November 7.
- Land-based surveys from northwest Fire Island in and around Ocean Renewable Power Company's (ORPC) proposed Cook Inlet Tidal Energy Project Deployment Area in upper Cook Inlet were conducted from June to November 2009 (McGuire et al. 2010). All 2009 sightings in the vicinity of the ORPC's deployment area occurred in or near the mouth of the Little Susitna River (McGuire et al. 2010). Surveys in 2010 have been ongoing since May (Bourdon and McGuire 2010; McGuire and Bourdon 2010). Plans are underway for deployment of four passive acoustic monitoring hydrophones known as DASARs (directional autonomous seafloor acoustic recorders) to monitor for the presence and distribution of beluga whales in the proposed project area.
- A beluga whale photo-identification study has been ongoing since 2005 in upper Cook Inlet (McGuire et al. 2008; McGuire and Kaplan 2009; McGuire et al. 2009; LGL Research Associates 2009). Work in 2010 includes development of a catalog of left-side digital images of identified individuals. Twelve beluga whales were sighted during aerial surveys conducted by the U.S. Fish and Wildlife Service to monitor water bird use of Eagle River Flats during spring, summer, and fall 2009, as part of the ongoing water bird mortality and monitoring studies sponsored by the U.S. Army at Fort Richardson (Marks and Eldridge 2009).
- Sightings of beluga whales have also been compiled into the Cook Inlet Beluga Opportunistic Sightings Database, which contains sightings from 1975 to the present throughout Cook Inlet (Vate Brattstrom et al. 2010). The database includes historical sightings from the Alaska Department of Fish and Game (ADF&G) and other governmental agencies conducting aerial surveys for other species. More recently, sightings include casual observations at locations with easy access, particularly in the upper region of the Cook Inlet (Vate Brattstrom et al. 2010).
- During summer 2008, passive ecological acoustic recorders (EARs) were deployed in upper Cook Inlet to test their ability to detect beluga calls and ambient noise in the harsh environment (Small 2008; Atkinson et al. 2009; Small et al. 2009). Because of their apparent success, the researchers deployed moorings consisting of 10 EARs (which record lower-frequency whistles and calls) and acoustic loggers (C-PODs, which record the presence or absence of high-frequency echolocation clicks) in this same area, beginning in summer 2009 (Small 2009a,b; Small et al. 2010). These passive recordings of beluga whales continued in upper Cook Inlet through spring 2010 (Small 2010). Although data have been collected, the research has released only preliminary regional results. These preliminary results indicate that beluga whales exhibit various acoustic behaviors and that passive acoustics can be used to understand distribution patterns (Small et al. 2010); however, these results are forthcoming and have not been publicly released. Future plans for research by Small et al. (2010) include implementation of alternative designs for moorings of EARs and loggers in summer 2010.

5 Type of Incidental Take 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

FHWA and KABATA request an LOA from NMFS for the incidental take by harassment (Level B, as defined in 50 C.F.R. Part 216.3) of a small number of marine mammals during its planned construction of the KAC project for the period of 2013–2017, effective on March 1, 2013. The operations outlined in Sections 1 and 2 have the potential to result in takes of marine mammals by noise disturbance during construction activities, including temporary pile driving and removal. The effects will depend on the species as well as the distance and received level of the sound (see Section 7). Temporary disturbance or localized displacement reactions are the most likely to occur. No takes by serious injury or death are anticipated, given the planned mitigation and monitoring procedures (Sections 11 and 13).

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6 Number of Incidental Takes

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in paragraph (a)(5) of this section, and the number of times such takings by each type of taking are likely to occur

Note: The content of Sections 6 and 7 has been combined. For estimates of the numbers of incidental takes, refer to Section 7.

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7 Description of Impacts on Marine Mammals

The anticipated impact of the activity upon the species or stock

Both acoustic and nonacoustic activities associated with construction of the KAC could impact marine mammals. Bridge construction and associated activities in marine waters would introduce sound into the local underwater noise environment, primarily because of construction noise emitted during pile installation and removal activities. A literature review suggests that increased noise may impact marine mammals in various ways. The following text provides applicable noise criteria, a description of noise sources in the project area, a description of the methods used to calculate take, and the calculation of take.

7.1 Background Information

7.1.1 Applicable Acoustic Exposure Criteria

A series of efforts to measure, assess, and mitigate the effects of anthropogenic noise on marine mammals has evolved. Legal efforts to reduce the negative impacts of anthropogenic noise on marine mammals and on the marine environment have, in large part, driven this progressive development. The MMPA prohibits the take[*] of marine mammals, with certain exceptions, in waters under U.S. jurisdiction and by U.S. citizens on the high seas. Take of marine mammals includes harassment. Two levels of harassment[†] were defined in the 1994 amendments: Level A and Level B.

NMFS uses generic sound exposure thresholds to determine when an anthropogenic activity produces sound that might result in a take of a marine mammal. Additional guidelines have been drafted for risk assessment, including more realistic measures of (underwater) sound and its effects, such as sound exposure level (SEL) (Finneran et al. 2002; Southall et al. 2007) and other exposure metrics.[‡] In these proposed metrics, noise impacts are determined through frequency weighting scales, based on the hearing threshold of a particular species, to determine the actual received SEL (Nedwell et al. 2005). The laudable goal of these efforts has been to adopt more accurate and humane measures to reduce noise impacts on marine mammals. However, as noted by NMFS regarding the Cook Inlet beluga whales, "until such acoustic guidelines are approved, NMFS will continue to apply the current behavioral disturbance threshold levels when evaluating in-water construction and other activities with the potential to introduce noise into Cook Inlet" (NMFS 2008b).

The currently applicable NMFS "do-not-exceed" criteria for exposure of marine mammals to various underwater sound sources are identified below.[§]

- **Level A Harassment: injury by impulse** (e.g., impact pile driving) **and continuous** (i.e., vibratory pile driving) **sounds**: NMFS has a "do-not-exceed" exposure criterion set at a sound pressure level

[*] Under Section 3 of the MMPA, *take* is defined as "to harass, capture, hunt, kill, or attempt to harass, capture, hunt, or kill any marine mammal."

[†] *Harassment* is defined in the MMPA as any act of pursuit, torment, or annoyance that has the potential to injure marine mammal stock in the wild (Level A); or has the potential to disturb marine mammal stock in the wild by disrupting behavioral patterns, including migration, breathing, nursing, breeding, feeding, or sheltering (Level B).

[‡] exposure metrics that follow the logic of the dBA scale used in measuring noise exposure in humans

[§] 70 FR 1871–75

(SPL) value of 180 dB referenced to 1 micropascal (dB re 1 μPa) root mean square (rms)[*] for cetaceans and 190 dB re 1 μPa rms for pinnipeds

- **Level B Harassment: harassment by impulse sounds**: (e.g., impact pile driving) is set at an SPL value of 160 dB re 1 μPa rms
- **Level B Harassment: harassment by continuous noise**: (e.g., vibratory pile driving) is set at an SPL value of 120 dB re 1 μPa rms. Background noise levels in Knik Arm are consistently at or above 125 dB re 1 μPa. As noted in the POA LOA, attempts to measure and identify the distance to the 120 dB isopleth from various sources were unsuccessful given the higher background ambient levels (USDOT and POA 2008). Therefore, calculations for continuous noise exposure use 125 dB re 1 μPa rms instead of the 120 dB re 1 μPa rms; further discussion is found in Section 7.1.3.

7.1.2 Description of Noise Sources

For the purposes of this LOA application, the sound field in Knik Arm will be the existing ambient noise plus additional construction and operational noise from the KAC project area. Ambient underwater noise levels in the project area are both variable and relatively high, primarily because of extreme tidal activity, high winds, the seasonal presence of ice, and anthropogenic activities. Paradoxically, ice may increase ambient noise from thermal and mechanical stress and decrease it by eliminating wind and wave noise (Greene 1995). Vessel activity, air traffic, construction noise (including dredging), and other anthropogenic sources are significant contributors to the ambient levels in Knik Arm. Approximately 4,500 vessels travel Knik Arm annually; approximately 4,000 are recreational boats, while 500 ships and barges use the POA and Port MacKenzie (KABATA 2006b). Ambient noise from naturally occurring sources is generally highest during the rising tide and during periods of strong winds, particularly breaking waves caused by high winds.[†] Higher ambient noise levels will be close to areas of high human activity, while ambient noise levels will be lower in areas away from such activity. Dickerson et al. (2001) report that, in the vicinity of Point Woronzof, average bucket dredge sounds were audible at 5,500 m from the source; the most intense sounds were audible up to 7,000 m from the sources. The variable bottom composition (e.g., sandy, muddy, rock covered) and shallow depth of Knik Arm combine to produce a complex acoustic transmission environment further resulting in a highly variable ambient noise field. For example, in the middle of Knik Arm, where water is deeper, the ambient noise levels may be 40 dB to 50 dB louder than very shallow, muddy tidal flats where sounds attenuate more quickly (NMFS 2008b).

7.1.3 Summary of Relevant Pile-driving and Ambient Noise Studies in Knik Arm

Pile driving in or near water is known to produce strong underwater noise levels (e.g., Greene and Moore 1995; Würsig et al. 2000; David 2006; Bailey et al. 2010). The level of received sound at any specific distance from pile driving depends on the depth of the water in which the piles are driven, the density or resistance of the substrate, bottom topography and composition (e.g., mud, sand, rock), the physical properties and dimensions of the pipe being driven, and the type of pile driver that is used. Pile-driving and ambient noise in Knik Arm were investigated in the following studies:

[*] 180 decibels (dB) referenced to (re) 1 micropascal (μPa). Root mean square (rms): "rms" refers to average pressure over the duration of a single pulse, often 1 second.

[†] 74 FR 18492

- During August 2004, Blackwell (2005) reported background levels (not devoid of industrial sounds) without strong currents of 115 to 118 dB re 1 μPa. Background levels with strong currents were between 125 and 132 dB re 1 μPa. Blackwell (2005) measured in-water sound produced from impact and vibratory pile driving during construction activities at the Port MacKenzie Dock in August 2004. Two 91-cm (36-inch)-diameter steel pipes that were 46 m (150 feet) in length, were driven 12 to 15 m (40 to 50 feet) into the seabed. These construction sounds were characterized in terms of their broadband and one-third octave band levels. Information on transmission loss was gathered by repeated measurements at different distances from the source. The source level (i.e., sound level at 1 m from the source; SL) of impact pile driving was 234 dB re 1 μPa rms, centered at about 400 Hz, with a –10 dB bandwidth of approximately 350 Hz to 1.5 kHz. The spectrum of the vibratory pile driving was higher than the impact pile driving, centered at 1 kHz, with a –10 dB bandwidth from 400 Hz to 3.5 kHz; SL of vibratory pile driving was not reported. Blackwell (2005) reported that most of the energy during vibratory activity was measured in the range of 400 Hz to 2.5 kHz and that beyond approximately 1,300 m (0.8 mile), background sounds contributed more to received levels than did the vibratory pile driving.
- During October 2007, URS (2007) reported ambient noise levels of 105 to 120 dB re 1 μPa when no industrial sounds were identified; background levels of 120 to 140 dB re 1 μPa were recorded when other vessels were operating. In preparation for a proposed expansion of the POA, a series of 36-cm (14-inch) H piles were driven using both impact and vibratory techniques (URS 2007). The SL for impact pile driving was 223 dB re 1 μPa rms. Most of the energy was reported as between 100 Hz and 1.5 kHz. The SL for the vibratory pile driving was estimated to be 194 dB re 1 μPa rms with the spectrum of 400 Hz to 2.5 kHz.
- During September through October 2008, Scientific Fishery Systems (SFS) further measured the noise of construction pile driving for the POA Expansion Project (SFS 2009). Driving was conducted with sheet pile only; therefore, results are not comparable with those for round pile. However, the noise from vibratory driving of a round pile was measured. The spectrum was considerably higher, centered at 6 kHz, with a –10 dB bandwidth from 200 Hz to 10 kHz. The SL was calculated as 175 dB re 1 μPa rms using a 20 dB attenuation rate. SFS (2009) indicated that background levels ranged from 125 to 150 dB re 1 μPa, depending heavily on wind speed and tide level. SFS recorded very high ambient noise levels at the POA, ranging from 120 dB re 1 μPa to 150 dB re 1 μPa, with a mean of 133 dB re 1 μPa. During the 6 hours that SFS conducted acoustic sampling, about 1.4 percent of the time ambient noise was at or below 120 dB, the upper range reported by Blackwell and Greene (2002).
- During August through September 2009, a passive acoustic monitoring study of Cook Inlet beluga whales was conducted during the 2009 POA Marine Terminal Redevelopment (MTR) project (Širović and Saxon Kendall 2009). The average SPL in the vicinity of the MTR project during the survey was 129.4 ±5.4 dB re 1 μPa with construction activities, and 117.9 ±10.5 dB re 1 μPa without construction. The average SL of impact hammer pile driving during the survey was 196.9 ±6.1 dB re 1 μPa rms at 1 m. Individual impact pile drives lasted an average of 0.0776 ±0.0110 s. The sound energy of impact hammer pile driving extended up to 20 kHz, although most of it was below 10 kHz. The average SL of vibratory hammer pile driving was 183.2 ±4.8 dB re 1 μPa rms at 1 m and the energy from vibratory pile driving was mostly contained at frequencies lower than 10 kHz.
- During April 2007, underwater recordings of ambient noise levels were made in the upper reaches of Knik Arm near the Knik River Bridge, which includes both a northbound and southbound structure

with two lanes each (Warner and Hannay 2009). These measurements provide the only empirical data available for evaluating project-specific operational noise. Underwater sound levels from all noise sources were measured in the frequency band of 200 Hz to 3 kHz. During the moored recordings, noise levels ranged from 97.5 to 111.9 dB re 1 µPa (Warner and Hannay 2009). The maximum recorded measurement of 114.8 dB re 1 µPa was collected during a drift (Warner and Hannay 2009). The recorded measurements near Knik River Bridge were approximately 27.5 miles (44 km) farther upstream in the arm than the KAC, with very different environmental and structural variables. For example, the Knik River Bridge is in shallower water with lower salinity than will be the KAC. Also, the Knik River Bridge is two structures, as noted earlier (instead of one, like the KAC), and is lower in height than will be the KAC. These differences imply that noise produced by traffic at the Knik River Bridge will likely be different than the noise produced during operation of the KAC project. However, the data from the Knik River Bridge provide benchmarks for comparison with the KAC.

- During August 2001, Blackwell and Greene (2002) made recordings of background levels in Cook Inlet in areas with and without industrial noise. Broadband (10 Hz to 20 kHz) values for ambient underwater sound at eight 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 to 118 dB re 1 µPa rms) were comparable to the values obtained in Cook Inlet in 2001.
- The U.S. Army (Fort Richardson) has proposed to resume year-round, live-fire training at Eagle River Flats, just inland from the mouth of the Eagle River (DoA 2010). Tremblay et al (2007) modeled the noise that will be received by beluga whales in the Eagle River estuary with detonations of 6.8 kg (15 lb) plastique charges as a proxy for the effects of 155-millimeter (mm) (6-inch) artillery detonations on land at Eagle River Flats. Charges were detonated 500 m (0.3 mile) from the water's edge. The underwater peak received levels were approximately 180 dB re 1 µPa at a depth of 8 m (26.3 feet) when measured approximately 30 m (98.4 feet) from shore.

In summary, the aforementioned studies indicate that ambient levels (in the absence of industrial sounds) in Knik Arm range from approximately 95 dB re 1 µPa in protected areas (Birchwood) to 120 dB re 1 µPa and higher when the tide is outgoing/incoming or under conditions of increasing wind speeds. Background levels (in the absence of pile driving, but with other industrial sounds) ranged from 115 to 150 dB re 1 µPa. All studies indicate that measured background levels rarely are below 125 dB re 1 µPa, except in conditions of no wind and slack tide. Thus, although NMFS harassment zone requirements for continuous noise sources is 120 dB re 1 µPa, it is unlikely that beluga whales would be able to hear any pile-driving noise until it exceeds the background level of 125 dB. Therefore, the analysis of numbers of beluga whales potentially exposed to pile-driving noise employed calculations of the area of noise exposure within the 125 dB isopleth, rather than the 120 dB isopleth.

7.1.4 Impact and Vibratory Pile-driving Noise Levels and Resulting Noise Impact Radii

Bridge construction noise will be emitted from temporary pile installation and removal activities. Temporary piles used for bridge construction will be installed in the substrate using vibratory and impact driving. However, KABATA anticipates all drilled-shaft piles will be placed using oscillatory techniques (see Section 7.1.5). An oscillator will be used to place the permanent, large-diameter drilled shafts. Temporary piles will generally be placed and removed between April and July, thus avoiding months of the highest beluga whale densities. For construction docks, barge moorages, and pier templates, vibratory and impact driving will be used to place temporary, standard steel piles. SPLs of 190 to 220 dB re 1 µPa rms have been reported for piles of different sizes in a number of studies; the majority of the sound energy associated with pile driving is in the low-frequency range, <1 kHz (Section 7.1.3; Caltrans 2007).

Impact pile driving is likely to be the loudest noise component associated with bridge construction. Impact pile drivers place the pile by hammering it into place, which creates impulse noise that may be repeated many times before the pile reaches the desired depth. The expected SLs for the KAC project for the piles driven with impact hammers are presented in Table 5, along with the estimated distances from the source to the acoustic harassment threshold level of 160 dB re 1 µPa rms for impulse sounds. See Section 7.2.4 for a description of how these SLs were calculated. Distances from the pile-driving source to the acoustic harassment threshold level of 180 dB are herein referred to as *safety zones* (representing a Level A take, or serious injury). Distance from the pile-driving source to the acoustic harassment threshold level of 160 dB represent a Level B take. Herein, harassment zones refer to distance to the 160 dB and 125 dB isopleths for impact and vibratory pile driving (including vibratory removal), respectively, and reflect the area of ensonification to be monitored (which includes isopleths for Level A and B takes).

A vibratory pile driver works by applying downward pressure to the top of the pile by vibrating a weight, which creates a continuous signal. Table 5 presents the estimated SL and distance to the acoustic harassment threshold of 125 dB for 24-inch- and 48-inch-diameter piles placed using the vibratory method. The SL from vibratory pile driving is less than that for impact-driven piles for piles of the same diameter, by approximately 20 dB to 35 dB. Sections 7.1.1 and 7.1.3 provide an explanation for why calculations for continuous noise exposure for this request for an LOA use 125 dB instead of the typical 120 dB acoustic criterion.

The duration of pile driving may be considerable and is a function of the desired depth and resistance to penetration, which are determined by substrate characteristics and the diameter of the pile (Caltrans 2007). Placement of a 24-inch-diameter temporary pile is estimated to require 15 minutes of vibratory hammer and 1 hour of impact hammer. Placement of a 48-inch-diameter temporary pile is estimated to require 30 minutes of vibratory hammer and 90 minutes of impact hammer. Vibratory removal of 24-inch- and 48-inch-diameter piles is estimated to require 1 and 2 hours, respectively.

Table 5 Source levels and distances to NMFS's Level A and Level B acoustic harassment thresholds for the various pile placement methods, based on pipe diameter[a]

Pile diameter (inches)	**Impact pile-driving source level** (dB re 1µPa at 1 m)	**Distance to the 180 dB isopleth**	**Distance to the 160 dB isopleth**	**Vibratory pile-driving source level** (dB re 1 µPa at 1 m)[b]	**Distance to the 180 dB isopleth[b]**	**Distance to the 125 dB isopleth[b]**
24	202–205	9–12 m (30–39 feet)	64–86 m (210–282 feet)	195	4.4 m (14 feet)	1,028 m (3,373 feet)
48	231	156 m (512 feet)	1,135 m (3,724 feet)	197	5.5 m (18 feet)	1,253 m (4,111 feet)

[a] For this project, because of the high ambient noise levels, the 125 dB isopleth is used rather than the 120 dB isopleth.
[b] Includes installation and removal.

7.1.5 Drilled-shaft Noise Levels and Resulting Impact Radii

There is no published literature or source data regarding the in-water noise levels produced by drilled-shaft installation using oscillators. Oscillators work by reciprocally oscillating a device that both grips and applies downward force. The noise generated by an oscillator is a continuous signal. We assume that because physical impact is avoided, the noise level is likely to be lower in amplitude than that produced by vibratory and impact pile driving. Additionally, the drilled-shaft installation potentially has higher-frequency components because of metal rubbing against metal. Higher frequencies attenuate more quickly than do lower frequencies (Urick 1983). Based on available information and lack of specific sound source data for drilled-shaft construction, it is assumed there will be zero takes of beluga whales associated with this construction technique. To verify noise source data prior to construction of the project, FHWA and KABATA are committed to obtaining sound level and transmission-loss data for large-diameter, drilled-shaft construction methods involving oscillator and drilling activities (see Section 13).

7.1.6 Zones of Noise Influence

Richardson and Malme (1995) described a series of zones of noise influence in an attempt to assess potential effects of noise on marine mammals. Factors that can determine the ranges at which the signal diminishes to below ambient noise and becomes inaudible, include the sound level and spectral characteristics of the signal, the rate of attenuation over distance (i.e., transmission loss), the animal's hearing, and ambient noise levels. Marine mammal specialists have posited three concentric circles originating from a sound source as a means of describing the following zones of noise influence (moving away from the source, respectively): (1) *zone of hearing loss, discomfort*, *and injury*; (2) *zone of responsiveness*; and (3) *zone of audibility* (Richardson and Malme 1995).

The *zone of hearing loss, discomfort and injury* coincides with the NMFS acoustic exposure criterion for Level A harassment (see Section 7.1.1). It is the area near a noise source where exposed animals experience the most acute impact, including discomfort and injury. Exposure to loud underwater sound can decrease hearing sensitivity based on the amplitude, frequency, and duration of the signal. Very loud sound levels can cause injury and tissue damage. Lower-level exposures of sufficient duration can cause permanent or temporary hearing loss called a sound-induced threshold shift, or simply a threshold shift. A threshold shift can be either permanent, in which case it is termed a permanent threshold shift (PTS), or it can be temporary, in which case it is termed a temporary threshold shift (TTS) (reviewed in Richardson and Malme 1995 and Southall et al. 2007). There are very few data on PTS and TTS in marine mammals, all of which were obtained from captive individuals and, therefore, may not be representative of free-ranging animals. The magnitude of the threshold shift may vary from total loss of hearing to permanent reduction in thresholds, although the animal may still be able to hear. For example, many animals have permanent thresholds shifts as they age. TTS occurs when an animal's hearing recovers from the exposure and its hearing returns to preexposure sensitivity. A few animals are known to have been killed by underwater explosions (Richardson and Malme 1995).

The *zone of responsiveness* coincides with the NMFS acoustic exposure criterion for Level B harassment (see Section 7.1.1). It is the area around a sound source within which animals show observable behavioral responses to that sound (Richardson and Malme 1995). The distance at which a response becomes evident may vary among individual or groups and depends on previous experiences. Opposite and difficult to interpret responses may occur for the same signal and even for the same animal at different times. Habituation is the behavioral response where, to the same stimulus, the amplitude or magnitude of the overt response diminishes with time. Conversely, sensitization is increasing responsiveness to a stimulus, human activity for example. The animal may become frightened by a signal and respond at lower thresholds. While the responses noted within this zone are real, "its radius is a statistical phenomenon," according to Richardson and Malme (1995), with only small percentages of the population responding at any given time. Thus, sampling design and sample size become important and appropriate analyses essential.

The *zone of audibility* is the maximum possible radius of influence of anthropogenic noise on a marine mammal. It is the distance from the noise source at which the noise can be barely heard. This distance is determined by the background noise level and the hearing ability of the animal. Generally, a marine mammal can barely detect a sound if the received level is equal to the background level. Additionally, a marine mammal can hear a noise only if it is within its absolute hearing threshold (the range of frequencies and SPLs that a marine mammal is capable of hearing). Based on various field studies, Richardson and Malme (1995) noted that an anthropogenic sound may have few or no deleterious effects at the maximum distance where it can be heard by a marine mammal. No criteria apply for the zone of audibility because of difficulties in the human ability to determine audibility of a particular noise for a particular species. This audibility zone does not fall in the sound range of a take as defined by NMFS.

7.1.7 Noise Characteristics and Effects

Acoustic effects on marine mammals could result from sound produced during bridge construction activities, particularly impact and vibratory pile driving, but also vessel and machinery noise. FHWA and KABATA expect pile-driving noise will produce the greatest level of construction-related noise and thus be more likely to impact marine mammals than will other project-related anthropogenic sound sources.

Given that hearing is one of the most important sensory receptors for marine mammals, construction noise could affect marine mammals in several ways, because noise effects on marine mammals are highly variable (e.g., Richardson and Malme 1995). For example:

- 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).
- The noise may be audible but not strong enough to elicit any overt behavioral response. This has been demonstrated through exposure of various species, including beluga whales, to low levels of seismic, drilling, dredge, or icebreaker sounds.
- The noise may elicit reactions of variable conspicuousness and variable relevance to the well-being of the animal. These reactions can range from subtle effects on respiration or other behaviors (detectable only by statistical analysis) to the animal actively avoiding the source.
- 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.

  Masking can interfere with the ability of marine mammals to hear important sounds associated with echolocation, communication calls, and environmental sounds (Richardson 1995a; Richardson and Würsig 1995). Masking occurs when a signal of interest is embedded in noise. It is the interference of one sound with another. Masking is a complex relationship between the frequency and amplitude of both the masked and masking signals. Signals of similar frequency and amplitude will mask each other when the frequency and amplitude levels are the same. If the signal of interest contains a narrower band of sound, a beluga whistle for example, it may be perceived at lower amplitudes than the masking signal, such as high ambient noise caused by ice break-up. That is, animals may hear through the noise. However, with impulse noise, such as that from impact hammers, other sounds are likely to be audible between the noise pulses, reducing potential masking effects. High ambient noise levels can mask marine mammal signal detection, even in the absence of anthropogenic noise (Richardson 1995a; Richardson and Würsig 1995). Another effect is that in response to loud noise, belugas may shift the frequency of their echolocation clicks to prevent masking by anthropogenic noise (Au 1993; Tyack 2000).

- Very strong sounds can cause temporary or permanent reduction in hearing sensitivity. PTS is considered to be an injury and to constitute a Level A take, whereas TTS is not considered injurious and constitutes a Level B take. Effects of nonexplosive sounds on hearing thresholds of marine mammals have received little study. However, some data are now available for three species of toothed whales (beluga whale, bottlenose dolphin [*Tursiops truncatus*], and harbor porpoise) exposed to a single strong noise impulse or tonal sound (Ridgway et al. 1997, Finneran et al. 2000, 2002, 2005; Schlundt et al. 2000; Lucke et al. 2009)—and for three species of pinnipeds (harbor seal, northern elephant seal [*Mirounga angustirostris*], and California sea lion [*Zalophus californianus*]) exposed to moderately strong sound for extended periods (Kastak et al. 1999). As previously noted in Section 7.1.6, TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound. A TTS occurs after exposure to a sound of sufficient intensity to cause the hearing threshold to rise, and a subsequent sound must be stronger to be heard. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ceases. Only a few data on the sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals. None of the published data concern TTS elicited by exposure to multiple pulses of sound such as those associated with the KAC project. 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 (reviewed below).

7.1.8 Sensitivity of Marine Mammal Hearing

Sound is a primary means for marine mammals to collect information about their environment. However, hearing capabilities have been tested for only a few small toothed whales, primarily the bottlenose dolphin, beluga whale, and harbor porpoise. For species that have not been tested, information on hearing is based on the frequencies of sounds produced and recorded, behavioral observations, anatomical evidence, and extrapolations from what is known about other marine mammal hearing. Auditory thresholds of a species vary with frequency and are presented in audiograms.[*] Audiograms are typically U-shaped,[†] with thresholds generally higher (poor sensitivity) at the upper and lower frequencies and with improved sensitivity (thresholds diminish) in a frequency band of best sensitivity in between (Richardson 1995a). While this shape is relatively constant among marine mammals, the frequency ranges are highly variable.

[*] An audiogram is a chart of an animal's hearing where frequency (measured in Hz) is graphed relative to the amplitude (measured in dB) of a particular frequency.

[†] The U-shape starts at the lowest perceptible frequency after which sensitivity slowly increases to some band of maximum sensitivity.

When considering the influence of various kinds of noise on the marine environment, it is necessary to understand that different marine animals are sensitive to different frequencies of sound. Southall et al. (2007) delineated five groups of marine mammals (cetaceans and pinnipeds only) based on similarities in their hearing or ear type:

(1) **low-frequency cetaceans**: All baleen whales are considered low-frequency cetaceans,[*] but no baleen whales are anticipated to occur in upper Cook Inlet.

(2) **mid-frequency cetaceans and (**3) **high-frequency cetaceans**: toothed whales are termed mid- or high-frequency cetaceans. This is in part based on similarities of vocal behavior—both whistles and presumed echolocation pulses—and on auditory morphologies similar to those species whose hearing capabilities are known. As reported by Southall et al. (2007), toothed whales "functionally" hear from approximately 100 Hz to 180 kHz. Toothed whale species anticipated in Knik Arm are the beluga whale and harbor porpoise. As noted in Section 4, the killer whale is a toothed whale species with rare occurrence in the KAC project area.

(4) **pinnipeds in air** and 5) **pinnipeds in water**: pinnipeds hear best in water, from approximately 75 Hz to 75 kHz, while in air they hear up to about 30 kHz. The only pinniped species anticipated in the KAC project area is the harbor seal. The Steller sea lion is a pinniped species not expected to occur in the project area, as noted in Section 4.

Marine mammal species in the area of the KAC project are presented with respect to their hearing capabilities in Table 6.

Table 6 Functional marine mammal hearing groups and hearing ability (estimated lower- to upper-frequency hearing cut-off) for species with greatest likelihood of occurrence in the KAC project area[a]

Functional hearing group	Generalized auditory bandwidth	Species with greatest likelihood of occurrence in the KAC project area
Mid-frequency cetaceans	150 Hz to 160 kHz	beluga whale
High-frequency cetaceans	200 Hz to 180 kHz	harbor porpoise
Pinnipeds	75 Hz to 75 kHz (in water) 75 Hz to 30 kHz (in air)	harbor seal

[a] modified from Southall et al., 2007

Toothed whales hear a broad range of frequencies. Beluga whales have a well-developed and well-documented sense of hearing. White et al. (1978) measured the hearing of two belugas whales and described hearing sensitivity between 1 kHz and 130 kHz, with best hearing between 30 kHz to 50 kHz. Awbrey et al. (1988) examined their hearing in octave steps between 125 Hz and 8 kHz, with average hearing thresholds of 121 dB re 1 μPa at 125 Hz and 65 dB re 1 μPa at 8 kHz. Johnson et al (1989) further examined beluga hearing at low frequencies, establishing that the beluga whale hearing threshold at 40 Hz was 140 dB re 1 μPa. Ridgway et al (2001) measured hearing thresholds at various depths down to 300 m (984 feet) at frequencies between 500 Hz and 100 kHz. Beluga whales showed unchanged hearing sensitivity at this depth. Lastly, Finneran et al. (2005) measured the hearing of two belugas,

[*] Baleen whales have estimated auditory bandwidths from 7 Hz to 22 kHz, with best hearing frequencies below 1 kHz, based on vocalization frequencies and studies of auditory morphology (e.g., Ketten 1992).

describing their auditory thresholds between 2 kHz and 130 kHz. In summary, these studies indicate that beluga whales hear from approximately 40 Hz to 130 kHz, with maximum sensitivity from approximately 30 kHz to 50 kHz. It is important to note that these audiograms represent the best hearing of belugas, measured in very quiet conditions. These quiet conditions are rarely present in the wild, where high levels of ambient noise may exist.

Pinnipeds respond to sound in both air and water, although their thresholds are different in the two media based on controlled studies of captive individuals (Kastak et al. 2004). Harbor seals hear well in water at frequencies of 1 kHz to 60 kHz and can detect sound levels as weak as 60 to 85 dB re 1 μPa. Harbor seals also hear well in air and had lower thresholds than California sea lions and northern elephant seals (Kastak and Schusterman 1998). Kastak and Schusterman (1998) reported low-frequency (100 Hz) sound detection thresholds at 65.4 dB for a harbor seal. Harbor seal hearing sensitivity diminishes as frequencies decrease below 1 kHz, but individuals 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 single or multiple pulses of underwater sound have not been measured. Initial evidence from prolonged exposures suggests that some pinnipeds may incur TTS at somewhat lower received levels than do small toothed whales exposed for similar durations (Kastak et al. 1999, 2005; Ketten et al. 2000; Ketten et al. 2001). More recent indications are, however, that onset of TTS in the most sensitive pinniped species studied (i.e., harbor seal) may occur at a similar SEL as in toothed whales (Kastak et al. 2004).

7.1.9 Vessel Traffic

Existing small vessel traffic in Knik Arm (approximately 4,000 vessels annually) will temporarily increase during the Phase 1 construction period. However, only about 14 of the 52 expected KAC construction vessels will be motorized (see Table 1). Furthermore, routes to and from work sites will be monitored by observers to minimize and avoid potential impacts of vessels on belugas and other marine mammals. Construction activities have the potential to interfere with movements of the whales and affect their passage. In particular, vessels may present obstacles to whale passage, causing the whales to swim further and change direction more often, which potentially increases energy expenditure for whales and affects foraging behavior. To prevent construction activities from blocking travel through an area (thereby creating a potential impact over a much larger area than the construction activity itself), FHWA and KABATA will require the construction contractor to maximize vessel-free beluga passage zones during construction by minimizing multiple aggregations of unnecessary, nonactive construction vessels. A minimum of 4,000 feet, or approximately half of the bridge length, will remain unobstructed (free of moored and anchored barges and vessels) within Knik Arm at any given time to ensure unrestricted passage for belugas; this distance may not always be linearly continuous because of the need for staging of vessels for substructure and superstructure construction, but this minimum total length will always be maintained and further increased whenever reasonably possible.

Of note, 500 of the approximately 4,500 vessels that use Knik Arm each year are ship and barge calls to the POA and Port MacKenzie. In summary, given the above considerations, Level B harassment of beluga whales due to construction vessel traffic and noise is expected to be minimal when compared with the overall vessel traffic noise already present in Knik Arm and to be limited to the period of construction.

Vessel Noise

Construction vessels used during KAC project construction will be similar to the vessels currently used at the POA and Port MacKenzie. The approximate SLs for construction vessels and the distance from these sources to where sound is predicted to fall below the threshold of acoustic harassment for continuous noise sources (125 dB re 1 μPa) is provided in Table 7. Based on these estimates, the loudest construction noise will be produced by vessels ranging in length from 55 m to 85 m (180 to 279 feet), with SLs ranging from 170 to 180 dB re 1 μPa. Sound from a vessel of this size will attenuate below 125 dB re 1 μPa at distances of 86 m and 233 m (282 and 764 feet) from the source based on transmission loss values used to calculate the 180, 160, and 125 dB isopleths, where the overall attenuation was estimated to be 23.24 dB/decadal distance (that is, for every 10-fold increase in distance there is a 23.24 dB decrease in SPL, for example at, 1 m, 10 m, 100 m, and 1,000 m). Tugboats have broadband SLs measured at 145 to 170 dB re 1 μPa (Table 7). Hydraulic or electric bow thrusters are often used on supply ships to maneuver. In one case, bow thrusters increased the received level (at 50 m [164 feet]) of one supply vessel by 11 dB, from 130 to 141 dB re 1 μPa (Greene and Moore 1995). Similar vessels will likely be used during construction of the KAC project. Impacts of construction vessels on ambient noise levels will depend on the number and types of vessels employed for construction. Vessel traffic associated with bridge construction activities will be an irregularly occurring, temporary, continuous noise source. That is, the noise produced by a vessel will be continuous (versus an impulse noise); however, it will occur intermittently during the construction period.

Table 7 Estimated broadband sound source levels associated with construction vessel activity and the distance at which the sound pressure level falls at or below ambient noise (125 dB)

Vessel type and size	**Broadband source level** (dB re 1 μPa[a])	**Distance from source at which SPL falls at or below 125 dB re 1 μPa**
Tugboat pulling a loaded barge	161 to 170	35 m to 86 m (115 to 282 feet)
Tugboat pulling an empty barge	145 to 166	7 m to 58 m (23 to 190 feet)
Supply ships (55 m to 85 m [180 to 279 feet])	170 to 180	86 m to 233 m (282 to 764 feet)

Source: Adapted from Greene and Moore,1995
[a] dB referenced to 1 micropascal

The loudest vessels, the largest supply vessels at 170 to 180 dB re 1 μPa, will determine the added noise floor such that additional vessels and their noise will be additive to, or masked by, that noise. The amount of noise from the small number of engine-equipped construction vessels will be minimal given that the SLs will be approximately 156 dB re 1 μPa. The noise from an outboard crew vessel, in the absence of the larger and louder vessels, will attenuate to the 125 dB ambient level within 22 m (72 feet) and therefore, barely be detectable above existing ambient noise levels at those distances. Vessel noise, which is transmitted through both air and water, will be created by propulsion machinery, thrusters, generators, and hull vibrations. Vessel noise will vary with ship and engine size. Machinery noise from underwater construction will be transmitted through water and will vary in duration and intensity.

Beluga reactions to vessels depend on whale activities and experience, habitat, boat type, and boat behavior (Richardson 1995b; NRC 2003). Beluga whales also show the full range of types of behavioral response, including altered headings; fast swimming; changes in dive, surfacing, and respiration patterns; and changes in vocalizations (NRC 2003). For example, belugas in the MacKenzie River estuary appeared to react less to a stationary dredge as opposed to a moving one, even though there was no difference in the vessel noise (Fraker 1977a). Cook Inlet beluga whales are familiar with, and likely habituated to, the presence of large and small vessels. Belugas are frequently sighted in and around the POA, the Port MacKenzie Dock, and the small boat launch adjacent to the outlet of Ship Creek (Blackwell and Greene 2002; NMFS 2008b; Markowitz, Funk, et al., "Seasonal Patterns," 2005; Funk, Markowitz, et al. 2005; Ireland, McKendrick, et al. 2005). For example, Cook Inlet beluga whales did not appear to be bothered by the sounds from a passing cargo freight ship (Blackwell and Greene 2002). Despite increased shipping traffic and upkeep operations (e.g., dredging) beluga whales continue to utilize waters within and surrounding the port area, interacting with tugboats and cargo freight ships (Markowitz and McGuire 2007; NMFS 2008b). During the POA monitoring studies, animals were consistently found in higher densities in the nearshore area (6 km^2) around the port area throughout the April-to-October period each year where vessel presence was highest (POA et al. 2009). Noise from increased marine vessel activity during project construction could affect beluga whales through behavioral disturbance and displacement near the Crossing. Background sound levels in Knik Arm are already high because of strong currents, eddies, recreational vessel traffic, and commercial and military shipping traffic entering and leaving the port (e.g., Blackwell and Greene 2002; Blackwell 2005; URS 2007).

Vessel Strikes

Potential direct impacts to beluga whales from vessel traffic include increased noise (as noted earlier), harassment of animals in the form of disturbance, and an increased potential for vessel collisions that could result in serious injuries or death. Impacts on belugas will be minimized by consistent and safe navigation and incorporating the NMFS vessel operation guidelines (see Section 11) (NMFS-ARO 2008). Construction vessels will also operate in a slow (approximately 2–3 knots), purposeful manner while transiting to and from work sites in as direct a route as possible. Additionally, visual and acoustic monitors will alert vessel captains as animals are detected to ensure safe and effective measures are applied. See Section 11 for further details on proposed mitigation measures.

Vessel traffic associated with the POA, Port MacKenzie, and other activities commonly occurs in the Knik Arm. Beluga whales are known to use areas near Port MacKenzie and the POA, and during photo-identification surveys are commonly seen in and around large ships (LGL Research Associates 2009). Despite the regularity of vessel movement in and out of Knik Arm, ship strikes have not been definitively confirmed in a Cook Inlet beluga whale death (NMFS 2008b). However, marks attributed to propeller strikes have been reported on Cook Inlet belugas (LGL Research Associates 2009). Because of their slower speed and linear movements, large vessels (such as those proposed for use in constructing the KAC), are not expected to pose a substantial threat to Cook Inlet beluga whales (NMFS 2008b). Beluga whales have displayed avoidance reactions when approached by watercraft, particularly small, fast-moving craft that can maneuver quickly and unpredictably. Larger vessels that do not alter course or motor speed around whales seem to cause little, if any, reaction (NMFS 2008b). Disturbance from vessel traffic, whether because of the physical presence of the vessels or the noise created by them, could cause short-term behavioral disturbance to beluga whales if they are present, or localized short-term displacement of belugas from their preferred habitats (Richardson 1995b).

7.1.10 Toothed Whale Responses to Pile Driving (Summary of Observations)

Beluga Whale

Beluga whales have one of the most diverse vocal repertoires of any marine mammal, earning them the name "sea canaries." Like most toothed whales, belugas produce two quite different sets of signals: (1) a diverse series of relatively low-frequency communication signals, and (2) echolocation pulses that contain a very wide band of frequencies, from approximately 5 kHz to over 120 kHz. The beluga whale's extensive vocal repertoire includes trills, whistles, clicks, bangs, chirps, and other sounds (Schevill and Lawrence 1949; Sjare and Smith 1986a). Beluga whistles have dominant frequencies in the 2 kHz 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 kHz. Beluga whales produce individually distinctive calls and often communicate over long distances (Bel'kovitch and Sh'ekotov 1993). During foraging, belugas may be able to maintain communication with other belugas over areas of up to approximately 1,640 m (1 mile) (Bel'kovich and Sh'ekotov 1992). For beluga whales, foraging usually begins with a deliberate movement synchronized with acoustic localization of prey. Short periods of rapid swimming then follow, accented by sudden changes of direction. Beluga whales echolocate throughout this whole sequence of activities to orient themselves and catch prey (Bel'kovich and Sh'ekotov 1993).

Beluga whales have a very well-developed, high-frequency echolocation system (reviewed by Au 1993). Echolocation signals known to be used by foraging belugas have peak frequencies from 40 kHz to 120 kHz and broadband SLs of up to 219 dB re 1 µPa. The beluga's echolocation system is well-adapted to the Arctic's icy waters. The beluga whale's ability to emit and receive signals underwater and to detect targets in high levels of ambient noise and backscatter enable the animals to navigate through heavy pack ice and locate areas of ice-free water and possibly even find air pockets under the ice (Turl 1990). Because beluga whales are often found in highly turbid waters—including those in Cook Inlet—and in northern latitudes where darkness extends over many months, they use sound rather than sight for many important functions (NMFS 2008b). When foraging, beluga whales echolocate to orient themselves and catch prey (Bel'kovich and Sh'ekotov 1993).

Frequencies associated with vibratory pile driving overlap with some beluga whale call frequencies and may mask those calls. However, properties of beluga calls likely minimize masking by low-frequency ambient noise, which until recently would have been noise from natural sources such as ice and tidal noise, and only now includes significant levels from anthropogenic sources. Beluga whistles are narrow-band, which limits masking by relatively more wide-band noise. Other apparently social signals are pulsed, which also limits masking by continuous sound. Finally, their echolocation signals, or at least that segment of the signal attended to by the animals, are far above the frequency range of the sounds produced by vibratory pile driving and other sounds produced by the proposed construction activities and, therefore, are unlikely to be masked by construction noise.

Beluga whale response to pile driving is not well-understood. The most common beluga response to pile-driving noise is likely to be avoidance, although Kendall et al. (2009) documented no statistically significant behavioral responses by beluga whales to noise associated with in-water pile driving at the POA during the 2008 and 2009 summer construction seasons. Beluga whales in the MacKenzie River estuary in the Beaufort Sea moved farther away during construction on an artificial island, but did not leave the area (Fraker 1977). In Cook Inlet, beluga whales have continued to utilize the habitat in Knik Arm despite its being heavily disturbed by maritime operations, maintenance dredging, and aircraft (e.g., Moore et al. 2000; NMFS 2008b). This behavior, however, may be taken as evidence of a possible high motivation to use important habitat rather than as an indication that the noise is not bothersome to them.

Other Toothed Whale Species

There are published reports of behavioral responses of other toothed whale species to pile-driving activities. As mid-frequency-hearing cetaceans (see Section 7.1.8), the Indo-Pacific humpback dolphin (*Sousa chinensis*) has hearing capabilities similar to those of the beluga whale. The harbor porpoise (see Section 7.1.8) is a high-frequency-hearing cetacean and, thus, might be more sensitive to frequencies of pile-driving noise. The results of available studies on impacts of pile driving on these species are summarized below.

- In an effort to assess the possible impact pile-driving activity might have on bottlenose dolphin (*Tursiops* spp.) populations in the United Kingdom, David (2006) reviewed situations such as Indo-Pacific humpback dolphin responses to pile driving in Hong Kong (see below) and bottlenose dolphin responses to seismic surveys in the United Kingdom. The author noted that behavioral modifications have been observed in response to underwater sounds, including those produced by pile drivers, but that in the case of pile driving noise, behavioral responses might have been due to a redistribution in prey species.
- Würsig et al. (2000) reported that Indo-Pacific humpback dolphins in Hong Kong increased speeds of travel during pile driving and were found in lower abundance immediately after pile driving; no overt changes in behavior were, however, observed. The authors concluded that it was not possible to determine whether this temporary displacement from the area was due to a direct effect of the pile driving or indirect factors such as changes in prey distribution.
- Tougaard et al. (2003, 2009) reported that the acoustic behavior of harbor porpoises declined dramatically during pile-driving activity associated with construction of a wind farm at Horns Reef in the Danish North Sea. 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 km to 15 km (6 to 9.3 miles, respectively) 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 with periods before and after construction. Henriksen et al. (2004) reported similar decreases in harbor porpoise activities during monitoring of construction activities associated with offshore wind farms at Nysted in the Danish Baltic Sea.
- Brandt et al. (2009) reported observing impacts of pile driving in the Danish North Sea on harbor porpoise acoustic activity. Porpoises temporarily avoided the area following pile-driving operations. No porpoise clicks were recorded next to the construction site for a median of 16.6 hours and for a maximum of 74.2 hours after pile driving. Modeling results of relative porpoise activity revealed that full recovery was possibly not reached between pile-driving events closest to the construction site (ca. 2.6 km [1.6 mile]), where noise levels were about 168 dB_{SEL}. At a mean distance of about 3.2 km (2 miles) and received noise levels of about 166 dB_{SEL}, recovery time ranged between 9 and 15 hours. Consequently, porpoise activity, and possibly density, was reduced near the construction site over the 5-month period that pile driving occurred. Negative effects were no longer apparent at about 20 km (12.4 miles) distance, where noise levels ranged around 146 dB_{SEL}; porpoise activity temporarily increased, possibly as a result of porpoises leaving the vicinity of the construction site.

7.2 Take Calculation Methodology

The level of incidental take by acoustic harassment for the KAC project was determined by estimating the density of a target species within an area of ensonification above NMFS acoustic criteria (see Section 7.1.1 for presentation of acoustic criteria followed by NMFS). Density estimates for beluga whales were determined based on a mean monthly density within the project area using sighting data from Markowitz, Funk, et al. ("Seasonal Patterns" 2005) (see Section 7.2.1). The potential area of ensonification was determined by estimating SL intensities (see Section 7.2.2) for likely pile types and sizes and applying attenuation coefficients representative of shallow waters (see Section 7.2.3). The following sections provide a detailed discussion of the methods used to estimate takes from pile-driving activities. However, the mitigation proposed within this permit application is expected to result in fewer Level B takes of marine mammals than estimated in this LOA application, as indicated below.

7.2.1 Adaptive Management

The ultimate goal is construction of the KAC project while minimizing take of Cook Inlet beluga whales. Given the variables of the upper Cook Inlet environment, weather, construction logistics, and the unpredictability of beluga whale movements and required shut-down periods, however, schedules and construction techniques may need to be adapted to situations as the project progresses. FHWA and KABATA may consult with NMFS during construction to request changes or develop reasonable methods of take reduction not included in the issued LOA, as appropriate. Furthermore, if the take limit has not been reached or has reasonable tolerance in a given year, construction scheduling and techniques may be adapted to reduce the overall amount of time spent working in the waters of Knik Arm and, therefore, to reduce the duration of potential exposure of beluga whales to construction activities (e.g., request to install or remove temporary piles during August through November). Should any modification to the KAC project be required during construction, FHWA and KABATA will consult with and obtain approval from NMFS prior to changing any component of the proposal that might impact beluga whales.

7.2.2 Density of Beluga Whales

Data Truncation – Sighting data within the KAC project area were originally collected from nine land-based survey sites (Section 4.5.3; Funk, Rodrigues, et al. 2005; Markowitz, Funk, et al., "Seasonal Patterns," 2005). We restricted our data use to three of those locations: Cairn Point, Point Mackenzie, and Sixmile Creek. These areas represented those locations directly adjacent to the KAC project area and the only location (Cairn Point) with year-round survey effort. The survey effort from these three sampling locations represents over 200 unique sightings across a compilation of over 5,000 hours of observations.

For each unique sighting, group size was an instantaneous count by the observer. During the visual surveys, sightings were recorded every 20 minutes; this constituted a sampling unit (SU).[*] The largest estimate of group size for a unique sighting was used to calculate the number of animals seen because this was considered a conservative method of estimating group size. Group size data, in combination with effort (number of hours of observation), were used to calculate monthly beluga sighting rates. Beluga whale densities within the KAC project footprint were calculated as described below.

[*] Data collected during each sighting included time, location, group size estimation, group composition (age class: adult, juvenile, calf, unknown), and behavior, as well as direction of travel.

Group Size Correction Factor

Correction factors (CFs) for Cook Inlet beluga whales from aerial surveys were reviewed by Hobbs et al. (2000); published CFs range from 1.15 to 2.9, with an average of 2.03. Hobbs et al. (2000) reported that availability bias is more influential on group size estimation than is perception bias. Perception bias, however, can be highly variable, especially with belugas. Therefore, for the purpose of estimating beluga whale numbers and densities for this permit application, the average CF of 2.03 was applied as the most conservative CF for group size for data collected by Markowitz, Funk, et al. ("Seasonal Patterns" 2005).

Density Estimation

Monthly beluga whale density (*D*, number of animals per km^2) in the KAC project area was calculated as:

$$D = \left[\frac{SR}{A}\right] CF$$

where:

SR = sighting rate defined as the number of animals/hour; A = area of the construction corridor (500 m^2-grid; 35.5 km^2; Figure 20); and *CF* = correction factor.[*] Table 8 provides the densities for beluga whales in the KAC project area, based on the Markowitz, Funk, et al. ("Seasonal Patterns" 2005) baseline surveys in Knik Arm. Beluga density is highest during August through November (Figure 21). FHWA and KABATA will require that in-water pile-driving activities (impact and vibratory) will be conducted outside the months of high beluga whale density.

[*] When counting the number of individuals in a group of cetaceans, it is common that some individuals are missed during visual surveys, resulting in an underestimation of true numbers (i.e., animals are either underwater during the observation period [availability bias] or simply missed by the observer [perception bias]). Correction factors (CFs) are commonly applied to group size estimates to account for either bias.

Table 8 Beluga whale density calculations within the Knik Arm Crossing footprint

Month[a]	**Observation hours**[b]	**Individuals/ month**[c]	**Number of groups/ month**[d]	**Number of belugas/hour**[e] (belugas × CF/hour)	**Beluga density**[f] (belugas × CF/hour/km^2)
April	478.33	155	45	0.6578	0.01850
May	607.66	54	13	0.1804	0.0051
June	980.33	276	36	0.5715	0.0161
July	929.33	130	7	0.2840	0.0080
August	576.00	190	28	0.6696	0.0189
September	261.00	386	47	3.0022	0.0846
October	298.00	312	34	2.1254	0.0599
November	156.00	64	8	0.8328	0.0235

[a] Beluga whale monitoring data are from 2004–2005 monitoring for KABATA (Markowitz, Funk, et al., "Seasonal Patterns," 2005).
[b] number of hours spent observing
[c] number of individual whales per month observed in the monitoring studies
[d] number of whale groups per month observed in the monitoring studies
[e] The number of belugas per hour was calculated by dividing individuals per month by observation hours per month.
[f] Whale density was calculated as individuals per month divided by observation hours per month divided by observation area (35.5 km^2). The mean density of whales observed each month was used for the calculation of the take. Area used was based on a 500 m^2-grid (35.5 km^2) within Knik Arm (see Markowitz, Funk, et al., "Survey Effort," 2005; Figure 18).

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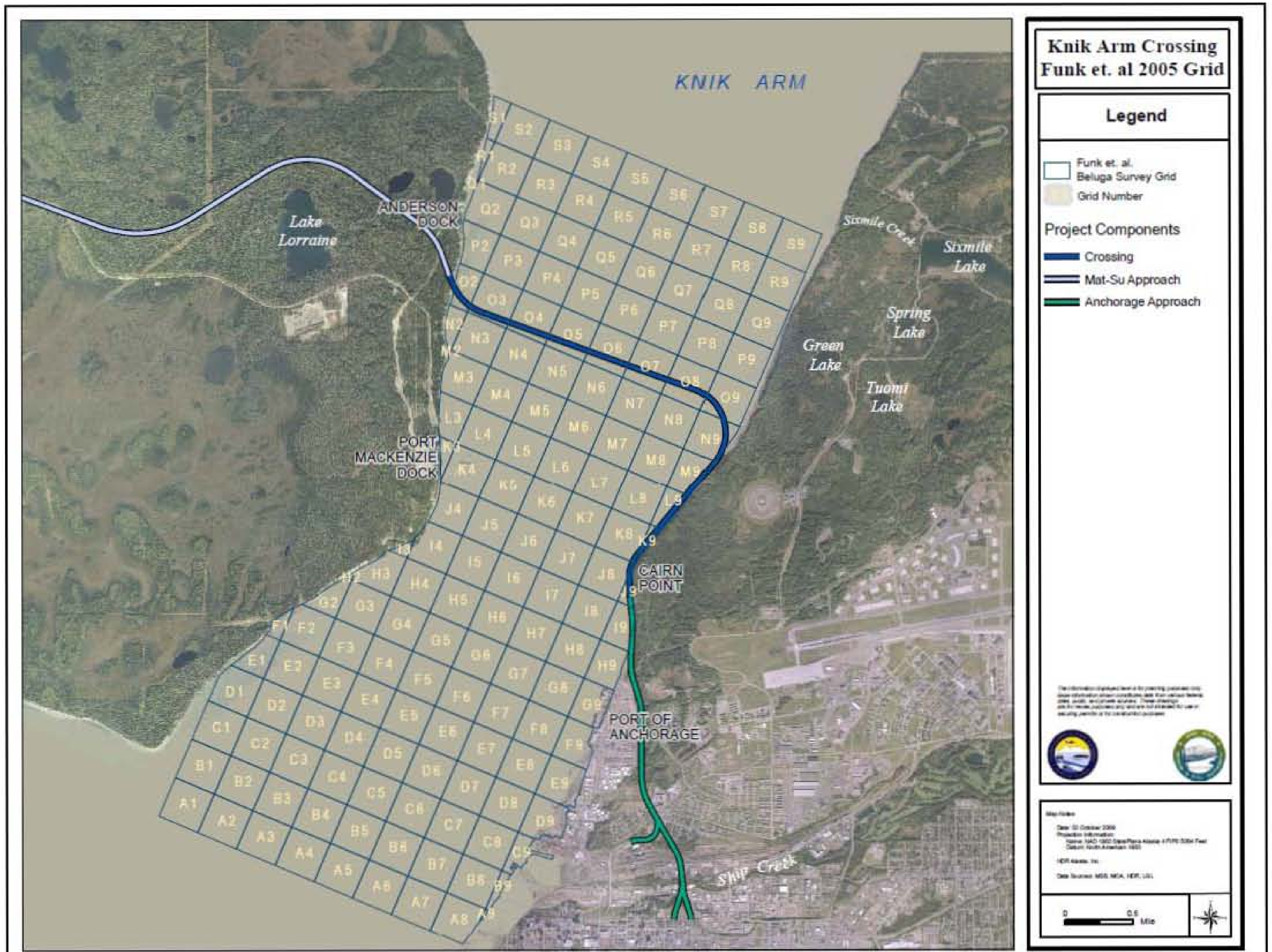


Figure 20 Composite map of all grids used to estimate beluga whale locations in Knik Arm. Data collected from Cairn Point, Sixmile Creek, and Point MacKenzie were used to estimate beluga density in take calculations for the KAC project. Grid cells in the Knik Arm Narrows (smaller squares) were drawn at a resolution of 500 m^2. (*Source*: Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005 – Beluga Survey Grid)

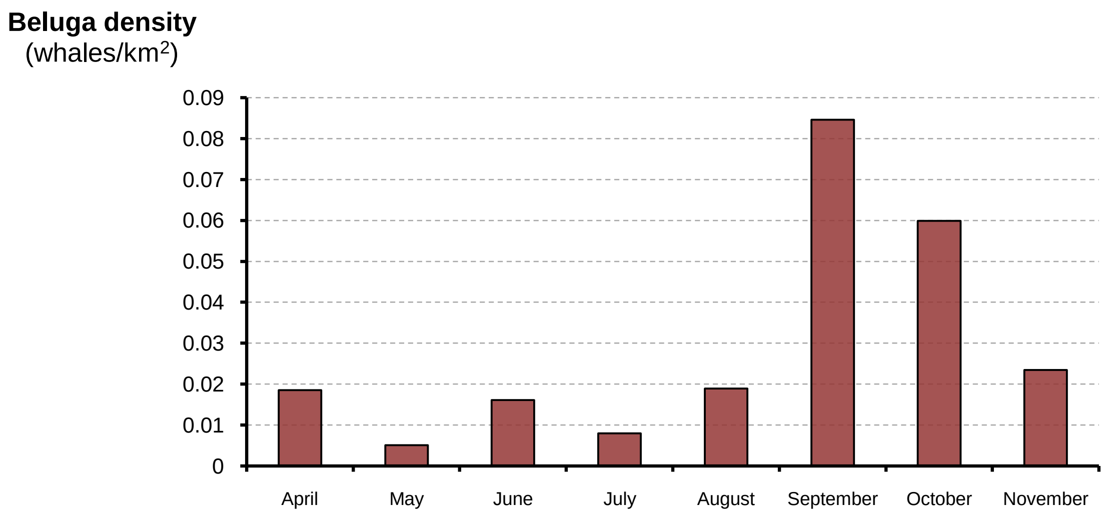


Figure 21 Monthly Cook Inlet beluga whale density estimates adapted from Markowitz, Funk, et al. ("Seasonal Patterns" 2005) using Cairn Point, Sixmile Creek, and Point MacKenzie land-based observational data

7.2.3 Data Decisions Used for the Beluga Take Calculator

Table 9 presents the decisions made regarding data treatment for the estimation of beluga whale takes. Actions taken at various steps of data use were a conservative approach (i.e., overestimating takes); Table 9 details what alternative approaches were considered, but not used here.

7.2.4 Estimating Source Levels

SLs were estimated in two ways, both using linear regression techniques. The first estimation procedure uses the measured SPL at measured distances, typically from relatively short distances from the source, for example, at 10 m, 50 m, and 100 m (33, 164, and 328 feet, respectively). In this standard acoustical procedure, the SL is estimated by graphing the measured amplitudes relative to the log of the distance from the source. The resulting linear regression equation provides the SL as the y-intercept of the graphed equation and the attenuation rate as the slope of the relationship (see for example, Blackwell (2005)). In the second procedure, SLs are estimated for piles of particular diameters for which there are no direct measures, such as 48-inch. In these cases, SLs are estimated using linear regression procedures where the relationship between SL and pile diameter is determined using known SLs and pile diameter data from nine pile driving placements with piles of 14-, 30-, 36-, and 96-inch diameters. The resulting equation is then used to calculate the SL for a pile of a given diameter, in this case, one of 48 inches.

Table 9 Data decisions used for the beluga take calculator

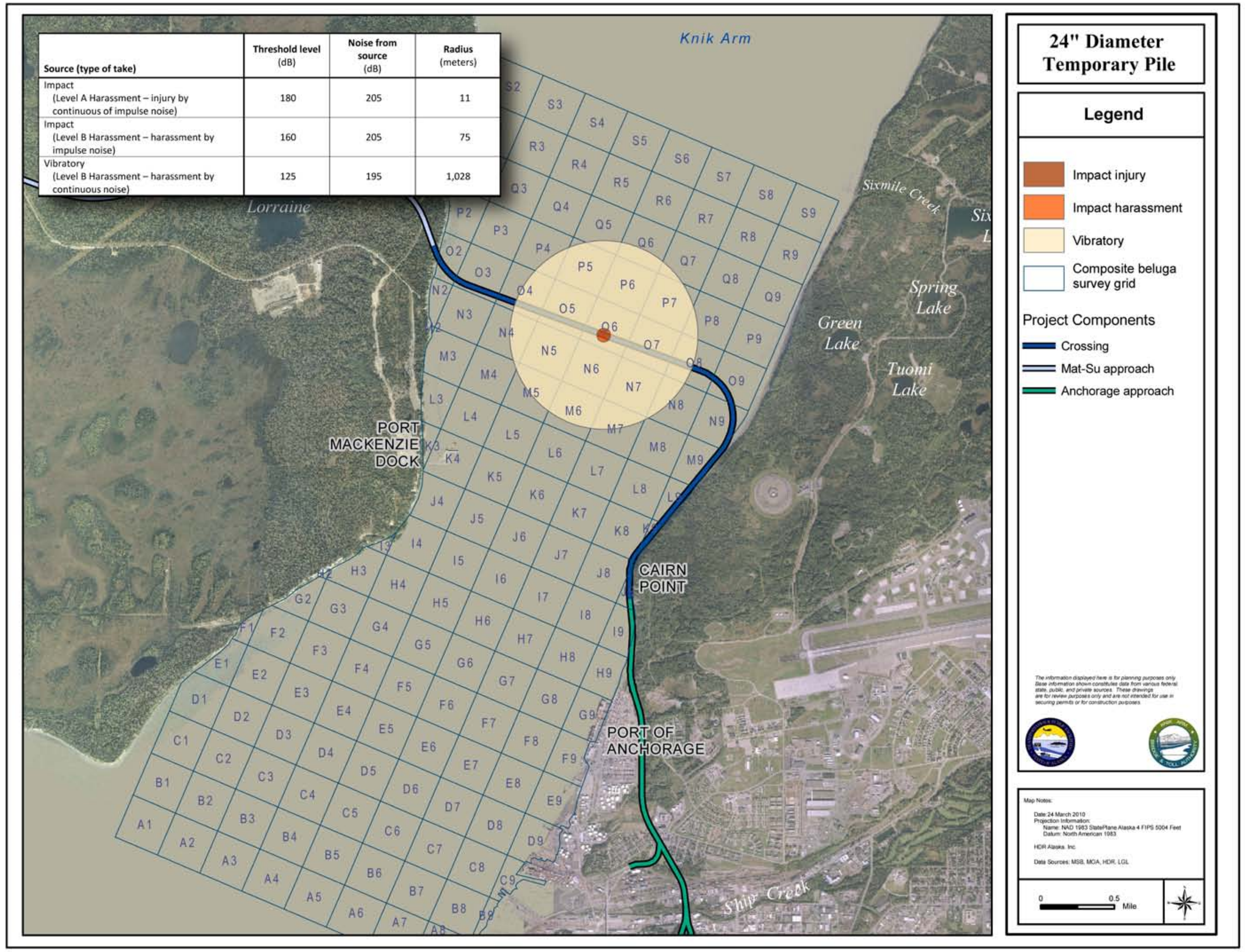
Caveat	Action[a]	Alternative[b]
Group size estimation	Largest count used in estimating group size of belugas regardless of timeline of observation	Group size is estimated when animals are first sighted with no changes
Unique sightings	Sightings outside of the 500 m^2-observation grid (1000 m^2-grid) were included in the density calculations	Remove beluga sightings outside of the 500 m^2-grid
Duplicate sightings	Sightings from West Crossing and Sixmile Creek observation locations were not queried for duplicate sightings with Cairn Point sightings	Remove duplicate sightings
Beluga correction factor (CF)	CF of 2.03 (Hobbs et al. 2000) was used to account for animals not seen in estimating group sizes (availability bias) and is applied to the monthly beluga numbers	Hobbs et al. (2000) also has a lower CF of 1.15 used in the previous KABATA LOA application, which could be used in lieu of 2.03. Additionally, the CF could be applied to the calculated takes after data analysis instead of before.
Rounding of fractional animals	Currently, the fraction of animals is rounded up regardless of value (e.g., if it is not = 0, it is = 1) each month	Values <0.50 = 0 and >0.501 = 1; rounding could be applied to the number of takes for each month

[a] Action taken during take calculations: this represents a conservative approach and overestimates takes.

[b] Alternative approach that could have been taken: these would result in an underestimate of takes.

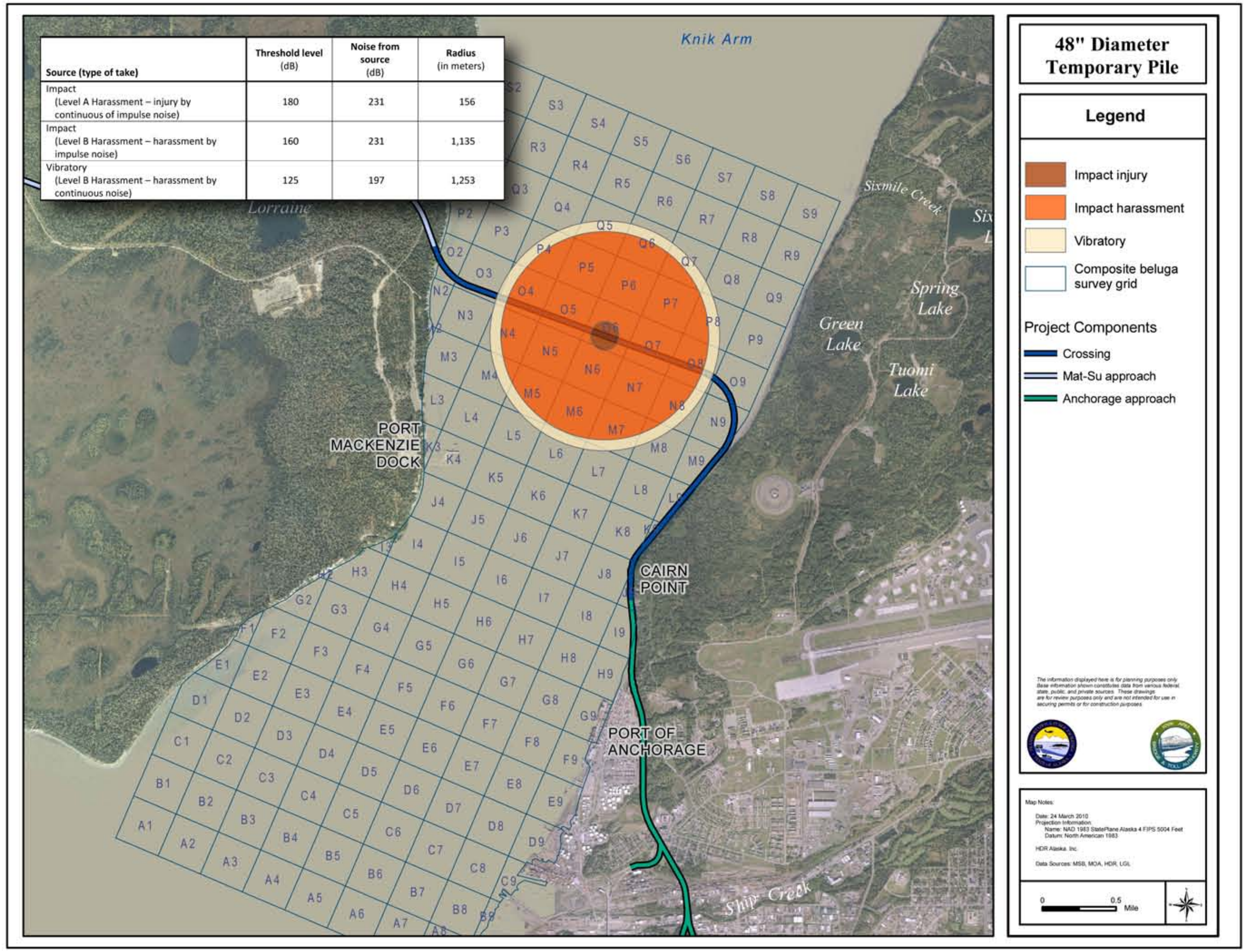
7.2.5 Area of Ensonification

The attenuation coefficient was determined by taking measured SPLs at known distances and establishing the relationship of how those SPLs change over those distances. For example, by graphing measured SPLs at 100 m, 500 m, and 1,500 m (0.06, 0.3, and 0.9 mile, respectively), the resulting relationship predicts how those measured SPLs attenuate as they radiate over those measured distances. Data from seven pile-driving exercises in Knik Arm and similar locations (Caltrans 2007) were used to calculate a mean attenuation rate of 23.24 dB per decadal distance. In actual conditions, attenuation is not constant and modeling sound transmission is very complicated (Urick 1983; Kuperman and Lynch 2004). This is particularly the case in areas such as Knik Arm, where the signals eventually move into shallow mud flats where the acoustic conditions are markedly different than those where the signal was produced. Figures 22 and 23 graphically demonstrate the areas of ensonification for installation and removal of 24-inch- and 48-inch-diameter temporary piles, respectively.



Source (type of take)	Threshold level (dB)	Noise from source (dB)	Radius (meters)
Impact (Level A Harassment – injury by continuous of impulse noise)	180	205	11
Impact (Level B Harassment – harassment by impulse noise)	160	205	75
Vibratory (Level B Harassment – harassment by continuous noise)	125	195	1,028

Figure 22 Areas of ensonification in the KAC project area for 180 dB impact (too small to be seen), 160 dB impact (orange), and 125 dB (yellow) vibratory driving for 24-inch-diameter temporary piles; includes both installation and removal of temporary piles (*Source*: Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005 – Beluga Survey Grid)



Source (type of take)	Threshold level (dB)	Noise from source (dB)	Radius (in meters)
Impact (Level A Harassment – injury by continuous of impulse noise)	180	231	156
Impact (Level B Harassment – harassment by impulse noise)	160	231	1,135
Vibratory (Level B Harassment – harassment by continuous noise)	125	197	1,253

Figure 23 Areas of ensonification in the KAC project area for 180 dB impact, 160 dB impact, and 125 dB vibratory driving for 48-inch-diameter temporary piles; includes both installation and removal of temporary piles (*Source*: Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005 – Beluga Survey Grid)

7.2.6 Calculation of Threshold Isopleths

Once SLs and attenuation coefficients were estimated, the ranges to prescribed sound threshold levels, or sound propagation radii, were calculated using the following equation:

$$Range\ (m) = 10^{\left(\frac{SL - dB_{threshold}}{attenuation\ coefficient}\right)}$$

Where range (m) is the distance in meters from source to a prescribed sound level; SL = source level in dB; dB threshold = the threshold dB level, for example, 180 dB, 160 dB, or 125 dB; and attenuation coefficient = 23.24 dB/decadal distance. A decadal distance would mean that the signal attenuates by 23.24 dB every 10-fold increase in distance (e.g., if the signal were 231 dB at 1 m, at 10 m it would be 231 dB – 23.24 dB = 207.76 dB; at 100 m, 207.76 dB – 23.24 dB = 184.52 dB; and at 1,000 m, 184.52 dB – 23.24 dB =161.28 dB.

Calculation of Takes (Number of Beluga Whales Potentially Exposed to Project-related Construction Noise)

To minimize impacts of construction noise on beluga whales, all in-water impact and vibratory driving activities for temporary pile installation and removal associated with docks, moorage, and pier templates, will be conducted outside of the period of high beluga whale density in Knik Arm (August 1 through November 30) (Markowitz, Funk, et al., "Seasonal Patterns," 2005; Figure 19). This will reduce the chance of exposing beluga whales to KAC project in-water pile-driving noise.

As described in Section 1, the piles for the construction docks, barge moorages, and pier templates will be temporary. Thus, the KAC project will both install and remove piles during Phase 1 construction. Temporary piles will be removed by employing vibratory methods to extract the entire pile from the substrate. As an option, pile removal by cutting the piles at the surface of the seafloor could be employed for a percentage of the temporary piles as an adaptive management measure to reduce the potential for acoustic harassment to beluga whales if Level B takes approach threshold limits within a given construction year. However, additional measures would have to be considered, such as construction feasibility due to high tidal currents, additional construction times, magnitude of additional construction costs, required equipment, and potential resource agency concerns of leaving cut-off piles in the substrate. This option is included in the proposed Adaptive Management Plan discussed in Sections 7.2.1 and 13.1.

Although pile installation and removal are anticipated to be completed by the end of 2016, potential construction schedule delays associated with weather, construction logistics, beluga whale shut-downs, and uncontrollable environmental variables may cause the need for pile installation and removal to occur in 2017. The proposed 4-year pile-removal schedule is anticipated to be maintained; however, if there is a need to modify this schedule during construction, and the beluga whale take limit has not been reached or has reasonable tolerance in a given year, FHWA and KABATA will consult with and obtain approval from NMFS prior to making any modifications (noted in Section 11).

As noted in Section 7.1.5, based on available information, FHWA and KABATA assume that, with use of drilled-shaft technology for the permanent piers, there will be no takes of beluga whales. FHWA and KABATA are committed to obtaining sound level and transmission-loss data for large-diameter, drilled-shaft construction methods involving oscillator and drilling activities prior to or during the initial stages of construction of the project to verify noise source data. Requested takes associated with construction of the KAC will be associated with in-water temporary pile-driving and removal activities for dock, moorage, and pier template piles (see Table 10).

The calculated estimates of the number of beluga whales that might enter the various noise impact radii (i.e., safety zones and harassment zones) 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. Additionally, these data reflect the upper range of beluga whales that may be exposed to pile-driving noise during KAC construction; whether whales will exhibit behavioral responses when encountering these noise levels is unknown. Cook Inlet beluga whales appear to tolerate a variety of human disturbances in this area (e.g., Moore et al. 2000; Appendix A). For these reasons, we expect the actual number of takes to be a small fraction of the number of whales exposed to construction noise.

Table 10 Estimated number of beluga whale takes (Level B) from temporary pile installation and removal

Bridge construction year	Pile action	Takes for 24-inch piles (*n* = 90)	Takes for 48-inch piles (*n* = 348)	Takes subtotal	Takes total
2013	Impact installation	2	5	11	11
	Vibratory installation	2	2		
	Removal	0	0	0	
2014	Impact installation	0	12	17	29
	Vibratory installation	0	5		
	Removal	0	12	12	
2015	Impact installation	0	7	10	30
	Vibratory installation	0	3		
	Removal	0	20	20	
2016	Removal	3	5	8	8
2017	TBD[a]	TBD	TBD	TBD	TBD

[a] to be determined

7.3 Beluga Whale

As noted in Section 4.5, the beluga whale is the most abundant and most frequently encountered species of marine mammal in Knik Arm. Beluga whale density is highest during August through November (Section 7.2.1); no in-water pile-driving activities will take place during that time of year (Section 2).

We expect any take of beluga whales to be limited to Level B harassment involving temporary changes in the behavior or distribution of individual belugas and to the potential for TTS. Level B takes are most likely to result from temporary changes in behavior or short-term, localized distribution changes caused by acoustic effects of construction noise (primarily pile driving, but potentially other construction activities). Acoustic effects could range from masking of important acoustic signals of biological importance (e.g., echolocation, communication) to behavioral changes and TTS. Because marine mammals depend on acoustic cues for vital biological functions, such as orientation, communication, finding prey, and avoiding predators, marine mammals that suffer from PTS or TTS will have reduced fitness in survival and reproduction, either permanently or temporarily. In addition, chronic exposure to excessive, although not high-intensity, noise could cause masking at particular frequencies for marine mammals that utilize sound for vital biological functions. Masking can interfere with detection of acoustic signals such as communication calls, echolocation sounds, and environmental sounds important to marine mammals. Therefore, as with TTS, marine mammals whose acoustical sensors or environment are being masked are also impaired from maximizing their fitness in survival and reproduction. Unlike threshold shifts, masking impacts the species at population, community, or even ecosystem levels (instead of individual levels caused by threshold shifts). Masking affects both senders and receivers of the signals and has long-term chronic effects on marine mammal species and populations. All anthropogenic noise sources, such as those from vessel traffic and pile driving, contribute to the elevated ambient noise levels, thus intensify masking.

Behavioral responses could range from subtle changes in surfacing and breathing patterns, to cessation of vocalizations, to active avoidance or escape from the region of the highest sound levels. The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Southall et al. 2007). Similar takes could occur in response to project-related vessel activity. However, we consider the latter effects to be less likely, given the relatively high existing levels of vessel activity in Knik Arm, the relatively high existing ambient noise levels, and the probability that belugas have habituated to this long-term activity and noise as they have continued to use the area for transiting and feeding. Adherence to proposed monitoring and mitigation efforts and active use of an Adaptive Management Plan (see Sections 7.2.1 and 13.1) are expected to further reduce takes and lessen impacts on individuals and the population as a whole.

Level B takes by harassment could include individual belugas of all age and sex classes. As also noted in the marine mammal take permit application for POA construction activities (USDOT and POA 2008), data on construction disturbance sensitivity of different beluga whale age classes, including cow/calf pairs, are lacking. However, it is known that some age and sex classes are more sensitive to noise disturbance, and such disturbance may be more detrimental to young animals (e.g., NRC 2003). Marine mammal calves are believed to be more susceptible to anthropogenic stressors (e.g., noise) than adults. For example, McIwem (2006) suggested that pile-driving operations should be avoided when bottlenose dolphins are calving because lactating females and young calves are likely to be particularly vulnerable to such sound. Additionally, Indo-Pacific humpback dolphin mother/calf pairs appear to be more disturbed than animals of other social/age classes, and mother/calf pairs exhibit an increased need to establish vocal contact after such disturbance (e.g., Van Parijs and Corkeron 2001). Monitoring and mitigation measures implemented for the project will be used to minimize the number of takes by disturbance caused by in-water pile driving by shutting down when beluga whales approach the project area.

Displacement effects, if they were to occur, would most likely involve local displacement from the immediate areas surrounding the pile-driving operations. While either temporary or permanent abandonment of the project area is a possible scenario, it is expected that beluga whales would likely return after completion of pile driving, as demonstrated by a variety of studies about temporary displacement of marine mammals by industrial activity (reviewed in Richardson 1995b). Some of the belugas repeatedly exposed to construction noise may become tolerant of the sounds and, with subsequent exposures, not change their behavior and distribution when exposed to those sounds. While beluga whales that become tolerant of the construction sounds could be attracted to the project area if fish were to be stunned or killed by pile driving. SPLs of sufficient strength have been known to cause injury and fish mortality (e.g., Caltrans 2001). It should be noted, however, that Houghton et al. (2010) examined the effects of impact and vibratory driving of 30-inch-diameter steel sheet piles at the POA on 13 caged juvenile coho salmon in Knik Arm. Acute or delayed mortalities, or behavioral abnormalities, were not observed in any of the coho salmon. Furthermore, results indicated that the pile driving had no adverse effect on feeding ability or the ability of the fish to respond normally to threatening stimuli (Houghton et al. 2010).

It is possible that disturbance from construction activities could preclude beluga whales from entering Knik Arm, where they typically go in fall months, thus disrupting their seasonal use of the area. There is no evidence to suggest, however, that construction activities at the port are affecting beluga whale use of Knik Arm as demonstrated by the consistency of timing, location, and numbers of belugas (including calves) in the area each year (Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon Kendall 2008, 2009; ICRC 2010). Monitoring and mitigation measures will be used to minimize the number of takes by disturbance by implementing shut-downs of equipment if any belugas are seen within the harassment zone (and safety zone within). This mitigation will help prevent potential close approach of animals to activities that could result in injury or mortality. Given that pile driving will occur during the lower-density months (April through July) and harassment zone (and safety zone within) will be monitored daily (see Section 11), it is unlikely that the whales would abandon Knik Arm. For example, during pile driving associated with POA activities, belugas continued to travel past this noise source and move up and down Knik Arm to feed.

When possible and practicable—and to reduce the exposure of animals to pile-driving sound—noise-producing in-water activities will be conducted when beluga whales are not observed within the harassment zone. Furthermore, monitoring during pile-driving activity to determine the presence of beluga whales within the harassment zone (and safety zone within) will provide a mechanism to allow operators to terminate (shut-down) noise-producing activities until belugas have departed the construction area.

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); however, the long-term and/or population effects of these changes are unknown. Based on extrapolations from investigations in terrestrial mammals, Wright et al. (2007a) speculated that underwater noise, including chronic exposure, can act as a stressor in marine mammals, with consequences to individual health and population viability.

Areas in upper Knik Arm frequented by whales at high tide are about 24 km (15 miles) north of the KAC project area. It is unlikely that whales in those areas would be displaced by pile-driving sounds, resulting in exclusion from those areas.

7.4 Marine Mammal Species Other than Beluga Whale

7.4.1 Harbor Seal

As noted in Section 4.1, harbor seals are not often found in Knik Arm. Estimates of how many individuals would likely be exposed to SPLs of 180, 160, and 125 dB re 1 μPa rms could not be made because of the low numbers of sightings within the project area. Therefore, a conservative approach was taken; takes of four individuals are requested for each year of construction (see Section 7.6). Because only a few individuals would be taken by harassment, there are no expected population level impacts on harbor seals.

Takes by harassment would be unlikely, but could occur during the mid-summer and fall, when anadromous prey fishes return to Knik Arm. Harbor seals that are taken may change their behavior, be temporarily displaced from the area of construction, or suffer TTS. With the absence of any major harbor seal haul-outs within the project area, potential takes will have a negligible impact on the population or on subsistence hunting. Potential takes of harbor seals are most likely to result from construction noise (primarily pile driving) or vessel activity.

7.4.2 Harbor Porpoise

As noted in Section 4.3, harbor porpoise reside in upper Cook Inlet, but are rarely sighted in Knik Arm. Estimates of how many individuals would likely be exposed to SPLs of 180, 160, and 125 dB re 1 μPa rms could not be made because of the low numbers of sightings within the project area. Therefore, a conservative approach was taken: takes of five individuals are requested for each year of construction (see Section 7.6). Because only a few individuals would be taken by harassment, there are no expected population level impacts to harbor porpoise.

Any takes are most likely to result from construction noise (primarily pile driving) or vessel activity. Harbor porpoise that are taken may change their behavior, be temporarily displaced from the area of construction, or suffer TTS.

7.4.3 Steller Sea Lion and Killer Whale

As noted in Sections 4.2 and 4.4, the killer whale and Steller sea lion are considered to be rare in upper Cook Inlet (e.g., ICRC 2009, 2010). Therefore, no further analysis is presented and zero takes are requested (see Section 7.6).

7.5 Takes Requested

Table 11 lists the number of takes requested from NMFS for acoustic harassment associated with in-water pile-driving activities**.** If the take limit has not been reached, or has reasonable tolerance in a given year, in-water impact and vibratory pile-driving activities may be proposed during the high-density period to shorten overall in-water work schedules for the project (see the Adaptive Management Process, discussed in Sections 7.2.1 and 13.1). Should this condition occur during construction, FHWA and KABATA will consult with and obtain approval from NMFS prior to conducting temporary pile installation and removal activities during the period of high beluga whale density (August–November) in Knik Arm to further minimize impacts to the beluga whale.

Table 11 Number of takes requested from NMFS for acoustic harassment during construction of the KAC in upper Cook Inlet

Construction year	Beluga whale	Harbor porpoise	Killer whale	Harbor seal	Steller sea lion
2013	30	5	0	4	0
2014	30	5	0	4	0
2015	30	5	0	4	0
2016	30	5	0	4	0
2017	30	5	0	4	0
Total	**150**	**25**	**0**	**20**	**0**

7.6 Impacts on Prey During/After Action

As noted in Section 9.2, definitive studies on how the KAC project's construction activities will likely affect prey availability for marine mammals are lacking; this uncertainty will be diminished, however, by implementing the proposed mitigation measures. Therefore, impacts on marine mammal prey during KAC project construction activities are expected to be insignificant.

7.7 Other Projects that May Affect Marine Mammals

NMFS lists development projects in Cook Inlet beluga habitat—in both upper and lower Cook Inlet.* These projects (ongoing and proposed) in the area near or adjacent to the KAC project could result in harassment to marine mammals and habitat degradation/loss. As noted by NMFS in the conservation plan for the Cook Inlet beluga (NMFS 2008b), the primary concern for belugas in Knik Arm is that development may affect beluga whale passage. The following provides a brief overview of ongoing and proposed projects in upper and lower Cook Inlet.

Potential development projects of interest include ongoing Cook Inlet oil and gas exploration in lower Cook Inlet, the proposed Knik Arm Ferry and ferry dock construction, Ship Creek watershed improvements, expansion of the POA, and any modifications that may be proposed at Port MacKenzie. Work is ongoing for the Alaska Communications Systems Group Fiber-Optic Cable Project, a submarine cable communication system (called SPANDEX) (Entrix 2009). Additional planned projects in the Knik Arm area include development of a Beluga-to-Fairbanks (B2F) natural gas pipeline and the construction and operation of mining facilities. Other projects to extract resources include a planned surface coal mining project known as the Chuitna Coal Project; a mineral exploration and development project known as the Pebble Mine Power Source and Ore Transfer Facilities; and the development of a large, armor rock granite quarry (Entrix 2009). There are also planned bridge and road improvements along Seward Highway and Point MacKenzie Road, while the Alaska Department of Transportation and Public Facilities (DOT&PF), in conjunction with the Federal Aviation Administration and the Ted Stevens Anchorage International Airport, is proposing runway expansions at the airport (Entrix 2009). The Alaska Railroad Corporation recently published a Draft EIS to build a proposed rail line (Port MacKenzie Rail Extension) that would provide a rail connection for freight services between Port MacKenzie and Interior Alaska (ARRC 2010). The Cook Inlet region is also being explored for alternative energy projects; likely

* www.fakr.noaa.gov/protectedresources/whales/beluga/development.htm

viable projects include the Fire Island Wind Farm, Central Cook Inlet Tidal Energy Project, Cook Inlet Tidal Energy Project, and the Mt. Spurr Geothermal Power Plant (Entrix 2009).

As noted in NMFS' conservation plan for the Cook Inlet beluga whale (NMFS 2008b), the potential for impact on these whales is heightened by the following aspects of actual or potential Knik Arm development projects:

- encroachment into lower Knik Arm from the east due to expansion of the POA
- encroachment into lower Knik Arm from the west due to expansion of Port MacKenzie
- increased dredging requirements with port expansions
- increased ship traffic because of expansion of both ports in lower Knik Arm, new boat launches, and possible operation of a commercial ferry
- increased in-water noise levels because of port construction, port operations, and associated increased vessel traffic
- increased need for vessel anchorage off both ports
- possible causeway construction to Fire Island
- physical loss of habitat because of fill
- in-water noise, physical loss of habitat and possible changes in water velocities associated with installing and operating 70–100 tidal energy generators in and around the entrance to Knik Arm

There is no evidence to suggest that construction activities at the Port are affecting beluga whale use of Knik Arm as evidenced by the consistency of timing, location, and numbers of belugas (including calves) in the area each year (Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon Kendall 2008, 2009; ICRC 2010).

Airborne noise sources that contribute to the underwater ambient noise field include air traffic noise and proposed live-fire artillery training at Eagle River Flats. Aircraft arrivals and departures from Ted Stevens Anchorage International Airport and Elmendorf create most of the overflight noise near the Crossing area (FHWA 2007). Furthermore, the U.S. Army has proposed resumption of year-round live-fire training at Fort Richardson, which will increase underwater noise level at Eagle River Flats (DoA 2010).

Navigation routes in Knik Arm connect Cook Inlet to the POA and Port Mackenzie. Of the estimated 4,500 vessels traveling Knik Arm annually (predominantly recreational boats), 500 are ship and barge calls to the POA and Port MacKenzie (KABATA 2006b). Vessel activity near the mouth of Ship Creek is primarily associated with cargo traffic to the POA. While both the amount of tonnage and the number of calls have decreased over time, the POA anticipates continued growth based on a steady or increasing customer base, which may include construction of large infrastructure projects in Southcentral and Interior Alaska (POA 2010). In addition to potential increases in port vessel activity, the proposed Cook Inlet Ferry could begin operations in 2014, pending construction of a dock in Anchorage. The ferry would transport people and goods between Anchorage and Port MacKenzie and possibly Tyonek. Large-ship traffic can increase noise disturbance and the risk of ship strikes on beluga whales (see Section 7.1.9). However, ship strikes from large vessels are not expected to pose a significant threat to Cook Inlet beluga whales (NMFS 2008b).

Increased human activity in Knik Arm and along the shoreline and increased recreational boating, associated with increased tourism and development, may negatively affect beluga whale use of adjacent habitats. Recreational boating may have varying effects on belugas. The slower speeds and straight-line movements of larger ships such as cruise ships make them less likely to strike whales than smaller boats would. Smaller boats such as those used for personal recreation travel at higher speeds and change direction often, creating a higher potential for ship strikes (NMFS 2008b). Vessels may also affect ambient noise, which in turn could affect beluga whales (see Section 7.1.9).

The KAC project will add to the environmental baseline some of the following effects (specific details are found earlier in Section 7 as well as Section 9):

- temporary high in-water noise because of construction of the bridge (e.g., temporary pile driving and removal); this in-water noise may affect both belugas and their fish prey
- temporary increase in vessel traffic
- slightly increased water velocities in Knik Arm
- physical loss of habitat because of roadway approaches or constructed embankments

To assist in offsetting the incremental contribution of the KAC project, FHWA and KABATA will work with the POA and other marine construction operators to communicate and coordinate all pile driving and marine mammal monitoring to help mitigate cumulative effects of concurrent operations. Advantages to multiple operations in the area include an overlap in monitoring efforts to detect the presence of belugas. For example, currently with monitoring at the POA and at Fort Richardson, a better understanding of beluga whale occurrence and use of Knik Arm continues to evolve. Communication across ongoing projects and associated monitoring projects can benefit the beluga whale directly by detection of their presence and avoidance of impacts to individuals and the population.

KABATA has been in recent contact with the POA and is in the planning phases of a collaboration plan that would coordinate mitigation and marine mammal monitoring efforts in a cooperative manner. Cooperative endeavors discussed thus far include preliminary discussions regarding sharing monitoring resources and the development of communication plans to share information on beluga sightings and minimize impacts to the animals. KABATA has attempted communications with Fort Richardson to discuss collaborative monitoring efforts.

KABATA will also conduct habitat restoration that will offset the incremental contribution to impacts on habitat, prey, and temporary impacts associated with noise. FHWA and KABATA will work with NMFS, USACE, and other appropriate resource agencies to develop a compensatory mitigation plan to offset cumulative impacts. By enhancing salmon habitat and the Pacific salmon populations within the Knik Arm ecosystem, mitigation would provide a direct benefit to beluga whales, by maintaining and enhancing a primary food source.

8 Description of Impact on Subsistence Use

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

The Cook Inlet beluga whale has traditionally been hunted by Alaska Natives for subsistence purposes. The subsistence hunt has been managed under the MMPA Section 119 (Cooperative Agreements with NMFS) since 2000.[*] The 2008 Cook Inlet Beluga Whale Subsistence Harvest Supplemental EIS authorizes the number of beluga whales that can be taken during a 5-year interval based on the 5-year population estimates and the 10-year measure of the population growth rate (NMFS 2008c). At the current population level, NMFS determined that Cook Inlet beluga whales can no longer sustain unregulated subsistence harvests, but that a limited harvest will be sustainable, once the population 5-year average is at least 350 belugas. Because the 5-year average abundance was below 350 whales for the 2003–2007 time period, the allowable harvest during the 5–year period (2008–2012) is zero.[†] The Cook Inlet beluga whale population and possible subsistence harvest will be reexamined by NMFS for the 2013–2017 5-year interval, using the previous 5-year abundance estimates.

Residents of the Native Village of Tyonek are the primary subsistence users in the Knik Arm area. This hunt has typically occurred around mid-July in the Susitna Flats area about 40 km (25 miles) southwest of the KAC Crossing project. The KAC project is not located in an area federally or State-recognized for subsistence use; local tribes, the Knik Tribal Council, and the Native Village of Eklutna do not qualify as subsistence users because the greater Anchorage-Matanuska Valley region developed around their traditional lands (Section 3.2.1.3.2 in the KAC FEIS). Knik Arm was closed to subsistence salmon fishing in 1951; the Native Village of Eklutna, however, continues to harvest salmon under an educational fish resource permit issued by the State of Alaska. The Native Village of Tyonek is located within a State-designated subsistence use zone and is a federally recognized tribe.

If a harvest were to be permitted during the time period of an issued LOA, construction activities for the KAC project are expected to have no impact on these small harvests or on the recovery of the whale population because anticipated takes from implementation of the project will be takes by harassment, involving temporary changes in behavior. Section 12 provides additional information on subsistence hunting.

Data on the harvest of other marine mammals in Cook Inlet are lacking. Available data on subsistence harvest are found in the most recent NOAA marine mammal stock assessment report (Allen and Angliss 2010) for the Gulf of Alaska including Cook Inlet, but are not indicative of the harvest in Cook Inlet. Subsistence hunts for harbor seals within Cook Inlet typically occur far outside the Crossing area, in the Susitna River Flats and Tyonek regions. As noted in Sections 3 and 4, a small number of harbor seals occur in upper Cook Inlet and, therefore, the number harvested is expected to be quite small. Thus, no impacts on subsistence harvests of pinnipeds are expected from construction of the KAC project; any potential takes would be temporary disturbances to very few animals and the project would not negatively affect availability of the animals for subsistence uses.

[*] 65 FR 59164

[†] 73 FR 60976

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9 Description of Impact on Marine Mammal Habitat

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

Environmental conditions in Knik Arm provide suitable habitat for beluga whales. NMFS has divided Cook Inlet into three beluga whale habitat regions (NMFS 2008b). Type 1 habitat is the most valuable, used intensively by belugas from spring through fall for foraging and nursery habitat. Type 2 is used heavily in the fall and winter, with a few isolated spring feeding areas, while Type 3 encompasses the remaining portions of the beluga whale range in Cook Inlet. The upper reaches of Cook Inlet, including all of Knik Arm, are classified as Type 1 habitat (NMFS 2008b). Of additional concern is that upper Cook Inlet is where the greatest potential for anthropogenic impacts exists (NMFS 2008b). NMFS (2008b) expressed concern that restricting or deterring access to Type 1 habitat could reduce calving success and feeding ability or could increase susceptibility to predation. Although within Type 1 habitat, the action area does not appear to be used for breeding or calving (e.g., Funk et al. 2005).

As noted in Section 4.5, NMFS has proposed designating critical habitat in portions of Cook Inlet, including Knik Arm and the KAC project area (Figure 17). The ESA requires a comprehensive analysis of potential effects to critical habitat; therefore, *Knik Arm Crossing Biological Assessment* provides additional information on and potential effects on proposed critical habitat for the Cook Inlet beluga whale.

Proposed activities are not expected to result in significant permanent impacts to habitats used by marine mammals. Construction activities associated with the KAC project will result in long-term loss of a relatively small amount of marine habitat because of fill, as well as temporary changes in the acoustic environment (see following subsection). Marine mammals may experience a temporary loss of habitat because of elevated noise levels. Long-term effects of any displacements are not expected to affect the overall fitness of the Cook Inlet beluga whale population or its recovery; effects would be minor and would terminate after cessation of construction.

KABATA has funded research on various aspects of beluga habitat, including their prey. Baseline studies of belugas (Funk et al. 2005: Section 4.5.3; Ireland, Funk, et al. 2005: Section 4.5.4) include evaluations of habitat use by belugas in the KAC project area and vicinity. As noted in Section 13, upon issuance of the requested LOA, KABATA has committed to additional preconstruction baseline survey effort. KABATA is also committed to a Scientific Marine Mammal Monitoring Program (see Section 13) that will help to determine any impacts associated with beluga whale habitat use. KABATA has funded baseline studies of marine fish and benthos (Houghton et al. 2005; Sections 7.1 and 14). Houghton et al. (2005) identified, by month, fish species available to belugas in Knik Arm. FHWA and KABATA propose to mitigate the KAC project's unavoidable impacts on the prey species of the Cook Inlet beluga whale as part of overall compensatory mitigation for wetlands and water bodies. Fisheries enhancement mitigation approaches include habitat and conservation, improvement of fish passage and stock enhancement; these are described in more detail in Sections 9.7.2 and 10. NMFS has indicated that ambient noise is an important habitat characteristic for Cook Inlet belugas. KABATA has funded research on underwater measurements of ambient noise and pile-driving sounds during Port MacKenzie Dock modifications (Blackwell 2005; Burgess et al. 2005; KABATA 2006c) to better understand noise levels for construction of the KAC project. (see Section 14). KABATA has also committed to an Acoustic Monitoring Program (see Section 13), which will include measurements of impact and vibratory pile driving sounds to verify calculated harassment isopleths, measure SLs from drilled shafts, and PAM that will monitor ambient noise levels and pile-driving SLs that will assist with determinations of impacts to ambient noise levels as habitat for belugas. KABATA also funded a white paper that reviewed available literature, observations, and NMFS satellite tagging data to examine whether belugas would swim under the KAC bridge (Section 9.2; Appendix A).

Nonacoustic effects could result from the physical presence of structures and equipment. Structures such as causeways and pilings could alter benthic habitats locally, although these structures would not likely obstruct movements of beluga whales or other marine mammals. Because of mitigation measures that will be implemented during all bridge construction activities, it is possible—although very unlikely—that a beluga whale, harbor seal, or harbor porpoise may be injured or killed by a vessel strike or that construction activities might result in the stranding of one or more beluga whales. However there have been no documented incidents of either vessel strikes to or strandings of beluga due to construction activities.

9.1 Intertidal Fill

Implementation of the KAC project will permanently modify a small percentage of available beluga whale habitat by replacing current marine habitat with fill approaches and bridge piers. The intertidal habitat and location of the KAC project's approaches are illustrated in Figures 24 and 25. Approximately 90 acres of existing intertidal and subtidal habitat will be filled to support the bridge approaches. This makes up approximately 0.03 percent of the total intertidal and subtidal habitat available in Knik Arm. Over time, an additional 260 acres of intertidal/subtidal habitat will be replaced as stable depositional areas. This makes up approximately 0.10 percent of the available intertidal/subtidal habitat available in Knik Arm.

Increased suspended sediments in Knik Arm during construction will result primarily from fill placement for the approaches and in-water pile driving. Gravel fill with a low content of fines will be used for construction of the bridge approaches to maximize compaction; therefore, only a small amount of fine sediment prone to suspension will be introduced to the marine environment. Deposition of the gravel fill will, however, suspend native fine-particle sediment from the bed of Knik Arm, temporarily increasing turbidity levels. Similarly both vibratory and impact pile-driving activities employed to support the bridge structure will temporarily suspend fine native sediments from the bed of Knik Arm. 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, and circulation patterns in the vicinity of the site. The naturally high turbidity levels will substantially reduce the severity of any effects that may result. Furthermore, extremely strong tidal currents will assist in dissipating water with increased turbidity caused by construction, resulting in only minimal impacts to water clarity. Regular use of this area by belugas indicates ability to navigate and feed in natural, low-visibility conditions. Increased turbidity resulting from these activities will not likely impact beluga whales.

Juvenile and adult salmon and eulachon and smaller numbers of groundfish species occupy intertidal and subtidal waters in the KAC project footprint. Placement of fill in nearshore habitats during construction of the bridge approaches could isolate, injure, or kill fish. Any potential effects from this activity will be minimized by working during low-tide periods, dewatering intertidal habitats before filling, and filling in subtidal habitats for only 3 hours on either side of low tide from April through August. These measures will help to minimize the effects of noise as well as the increase in turbidity on beluga prey such as eulachon and salmon. The small number of groundfish species observed in Knik Arm (Houghton et al. 2005) suggests that groundfish will not experience a substantial impact from placement of fill. Juvenile and adult eulachon and salmon in the project footprint could be impacted by fill activities in shallow waters. It is likely that larger juveniles and adults will move away from the area in response to construction noises, thereby minimizing mortality as a direct effect of in-water construction. It is possible that this response would force eulachon and adult salmon into deeper, more turbid and higher-velocity water, causing them to expend additional energy during migration. This type of flee response is natural for these species and typically occurs in response to predators and other disturbances throughout their life cycle. While Fagerlund et al. (1995) report that stress can result in reduced reproductive success and vulnerability to predation, this would, at most, affect only individual fish, and would not be detectable at the population level. Thus, it is unlikely that fill placement will substantially impact the long-term availability of prey for beluga whales.

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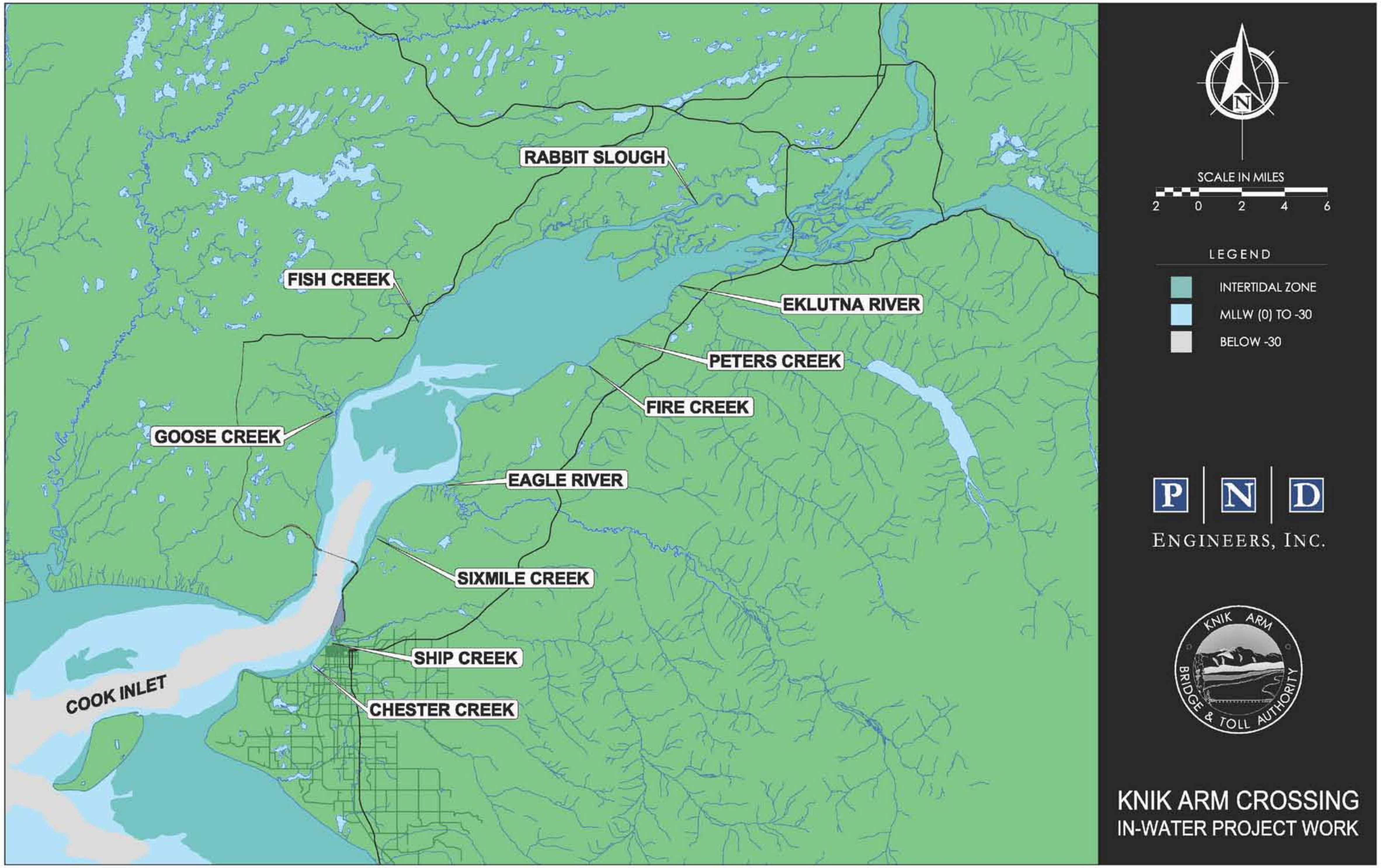

Figure 24 Extent of the intertidal zone in relation to the KAC project area

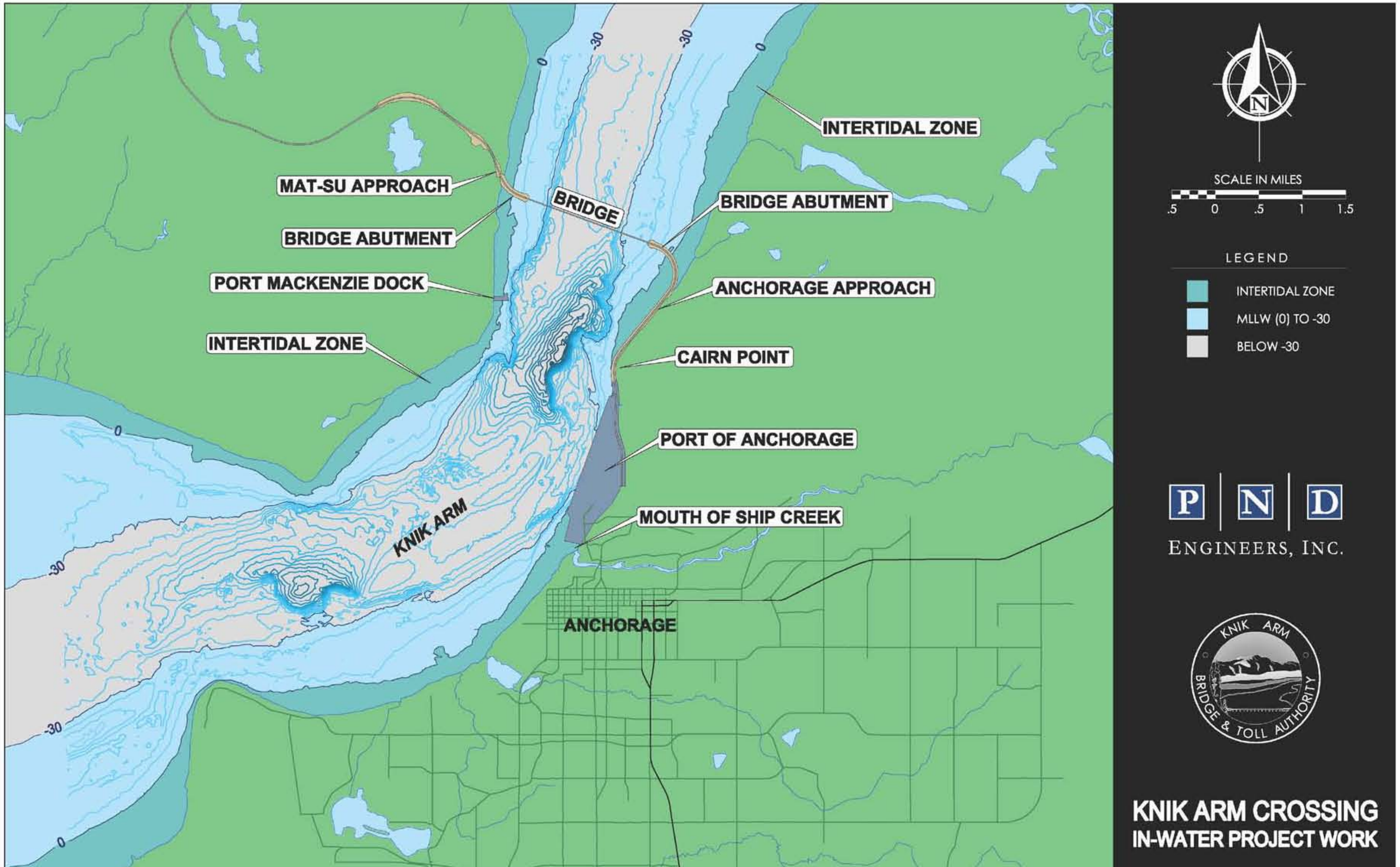

Figure 25 Location of KAC approaches within the intertidal zone

9.2 Beluga Responses to Bridges

NMFS has expressed concern that Cook Inlet belugas would avoid or be reluctant to swim under the KAC project. FHWA and KABATA conducted a literature review to evaluate the available qualitative and quantitative information related to possible responses of beluga whales to the Crossing (Appendix A). Evidence supporting NMFS's concern is mixed and not beluga-specific; therefore, causal explanations for observed behaviors remain speculative. Worldwide, toothed whales have been seen swimming freely around bridge supports and under bridge spans, but have also been observed doing so haltingly or seemingly reluctantly. There is uncertainty regarding how individual beluga whales might react to the bridge structure. Context is extremely important in how an animal might respond to a given situation (e.g., Wright et al. 2007b). Potential factors that affect behavioral responses include:

- prior experience with a particular situation
- age, maturity, sex class, and other life history factors
- environmental factors
- individual sensitivities, resilience, and personality
- condition (e.g., well-fed or hungry)
- other stressors currently acting on an individual (e.g., infection, chemical exposure)
- behavioral context (e.g., what the animal is doing when subjected to the stimuli)
- current psychological state (e.g., anxious, optimistic)
- social structure (i.e., group composition: adults, calves, subadults)

While there might be some alteration of movement, or inhibition of behavior, we expect no impact to long-term survival of the population. Circumstances such as motivation to move farther upstream into Knik Arm to feed or desire by an individual(s) to continue to travel and feed with other beluga whales might override any hesitancy by an individual(s).

An understanding of unconfirmed instances of reluctance to swim under bridges is challenging because of the general absence of behavioral studies designed specifically to address responses of free-ranging toothed whales to in-water structures (particularly bridges) in their environment. Causal interpretation of possible hesitancy remains necessarily conjectural. Pursuit of prey, fleeing predators, being startled by overhead shadows, and avoidance of noises from boats as well as from overhead vehicular traffic could all play a role—individually or in combination. Disease, injury, and/or stress could also account for reluctance—typically temporary—to pass under a bridge.

9.2.1 Beluga whale responses to in-water structures

The literature review revealed records of beluga whale presence upriver of 4 bridges outside Cook Inlet in Alaska, and upriver of 15–19 bridges worldwide outside of Alaska. These findings indicate that beluga whales from at least five stocks pass beneath 33–37 bridges (Appendix A). No evidence of belugas hesitating or refusing to pass under bridges was found.

9.2.2 Cook Inlet beluga whales responses to in-water structures

Tagging data from NMFS combined with data from other scientific studies, TEK, and opportunistic sightings provide evidence that belugas are generally tolerant of in-water structures (Appendix A). The compiled information also strongly indicates that beluga whales cross under bridges. To summarize:

- Belugas were found swimming near rock-armored shorelines, oil and gas production platforms, and bridges.
- Beluga whales were opportunistically sighted (including photo-documented) and documented through NMFS's tagging efforts—upriver of or passing beneath 14 highway and railroad bridges spanning seven rivers within the Cook Inlet watershed, including Turnagain and Knik arms.

9.2.3 Potential beluga whale responses to the KAC project

The above-mentioned information is relevant to understanding how beluga whales might respond to the KAC project, because the above examples indicate that beluga whales tolerate operational noise and other characteristics of these highway and railroad bridges and provide general evidence that Cook Inlet beluga whales tolerate in-water structures. This information helps to address NMFS's concerns regarding how beluga whales might react to the bridge's presence in Knik Arm. The review provides reliable empirical evidence that Cook Inlet beluga whales do swim beneath and upriver of bridges, addressing NMFS's concerns regarding whether whales would pass under the KAC. All of the bridges that Cook Inlet beluga whales have been shown to swim under have narrower spans, lower deck heights (i.e., closer to the water, see Table 12), and span shallower and more constricted water bodies than the KAC (see Figure 26).

An additional measure of assessment was conducted by calculating the theoretical degree of obstructed sky from underneath the bridge. The last column in Table 12 contains data on the extent of sky obstructed. These were calculated from an assumed observer position immediately underneath each bridge and looking directly upward. The bridge deck would obstruct the noted arc of the sky, as measured in degrees. Considering obstructed sky alone, it can be seen that beluga passage under the KAC bridge would be fully consistent with the known ability of belugas to swim under other Cook Inlet bridges with comparable amounts of obstructed sky. Beluga whale behavior is not sufficiently understood to establish a causal relationship between extent of sky obstructed and hesitancy of belugas to swim under static, overhead structures, but the correlated data in this column suggest no impediment may exist with a 2°–6° range of obstructed sky.

9.3 Hydrology

The KAC approach embankments will slightly alter the flow past the bridge because of the narrowing of the tidal channel. Hydrodynamic modeling indicated that this will result in a slight decrease in the tidal amplitude and delay within Knik Arm during flood tide, north of the Crossing. The reduction in tidal amplitude will diminish northward to about 0.002 foot (0.06 cm) approximately 2 miles (3.2 km) north of the Crossing. This decrease in water surface elevation will result from the increased flow velocity through the bridge opening and will be most evident during spring flood tides (KABATA 2007).

It is also expected that the tide will be delayed by 1 to 2 minutes north of the bridge, reflecting the slight decrease in flow capacity through the bridge, which in turn, will delay the draining of the same area. At the bridge, the ebb tide will be delayed by 1 to 3 minutes, reflecting the increased time needed to drain the area behind the embankments (KABATA 2007).

Estuarine waters will not reach the highest tide levels in intertidal marsh habitats north of the Crossing, such as Eagle Bay and Goose Bay. Without wetting at the highest levels, these intertidal habitats could minimally decrease in area over time. However, extreme high tides (spring tides) occur only approximately once a month for about a 2-hour period. The 0.25-inch (0.64 cm) decrease in the extreme high-tide level will be very small relative to the influence that wind, waves, or other sea conditions could have on locally observed extreme high-tide levels. Tidal effects of the KAC project will not impact beluga whale habitat access. Variations in the extent of extreme high tides will be negligible and will not isolate or prevent belugas from using existing habitat.

The approach embankments associated with the KAC project will narrow the tidal channel and increase the current through the bridge opening. This will be most evident during spring flood tides (KABATA 2007). Analysis of actual velocity measurements across Knik Arm showed that 96 percent of the total flow within Knik Arm passes through the 2.5-km (8,200-foot) gap that the KAC project will bridge. Because all of the flow must pass through this gap, the average flow would be increased by approximately 4 percent (KABATA 2007). Belugas are known to move into the upper reaches of Cook Inlet during flood tide and depart these areas during ebb tide (Moore et al. 2000; Funk et al. 2005; Hobbs et al. 2005). They move with the tides once or twice daily in Cook Inlet, allowing access to feeding and nursery areas not accessible at lower tides (Hobbs et al. 2005). Beluga presence and direction of travel in Knik Arm are directly related to tidal stage (Funk et al. 2005; Ezer et al. 2008). As such, an increase in current through the bridge opening is not expected to impact beluga movement.

9.4 Effects from Potential Land Use Changes

The KAC project will improve access from Anchorage to developable land in the Mat-Su. The change in accessibility will affect land markets in both Anchorage and the Mat-Su, which will cause a change in the distribution of land uses in the area. Increased numbers of homes along the western shoreline of Knik Arm could result in more people walking or using motorized vehicles in the intertidal areas. Shoreline activity is not anticipated to deter beluga use of nearshore waters; beluga whales often inhabit or move through developed areas, such as the POA and Turnagain Arm alongside Seward Highway.

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Table 12 Structural attributes of bridges within upper Cook Inlet with confirmed Cook Inlet beluga whale passage compared with those of the Knik Arm Crossing

Bridge	Bridge superstructure type	Bridge substructure type	Bridge deck type	Total length	Span lengths	Number of lanes	Width	Vertical clearance	Water depth	Bridge location	Extent of sky obstructed[a]
Knik Arm Crossing	Not finalized	Pier-supported	Not finalized	2,499 m (8,200 feet)	84 m (275 feet)	4 (at full build out)	Approximately 21 m (70 feet)	15 m (50 feet) at highest clearance point	6 -20 m (20-65 feet)	Knik Arm, north of Cairn Point	2.44°
Beluga River Bridge	Steel stringer	—[b]	—	152 m (500 feet)	19.8 m (65 feet)	1	4.9 m 16 feet)	—	—	—	—
Bird Creek Bridge	Steel stringer	Reinforced concrete pier walls (assumed atop piles)	Reinforced concrete	62 m (204 feet)	24 m (79 feet)	2	12 m (40 feet)	8.2–9.1 m (27–30 feet)	—	Mouth	2.33°
Glacier Creek Bridge	Steel stringer	Reinforced concrete pier walls (assumed atop piles)	Reinforced concrete	50 m (163 feet)	25 m (81 feet)	2	9 m (30 feet)	4 m (13 feet)	—	Mouth	4.03°
Kenai River Bridge	Steel box girder	Reinforced concrete pier walls atop steel H-piles	Reinforced concrete with asphalt	299 m (981 feet)	65.5 m (215 feet)	2	13 m (44 feet)	10.7–12.2 m (35–40 feet)	6 m (20 feet)	± RKm[c] 6 (RM[d] 4)	1.92°
Knik River ARRC Bridge	Continuous steel stringer	Battered reinforced concrete piers	N/A	259 m (850 feet)	24.4 m (80 feet)	N/A	6 m (20 feet)	3 m (10 feet)	3 m (10 feet)	Mouth	3.49°
Knik River Highway Bridges	Continuous steel stringer	Reinforced concrete pier walls atop pipe piling/driven steel pipe piles (48-inch)	Reinforced concrete	467 m (1,532 feet) (each)	62 m (203 feet)	2	9 m (30 feet) (each)	5.5 m (18 feet)	3 m (10 feet)	Mouth	5.82°[e]
Mears Memorial (ARRC over Tanana)	Simple steel truss	Clear span (no mid-river substructure)	—	214 m (700 feet)	214 m (700 feet)	—	—	15.2 m (50 feet)	—	RKm 1,520 (RM 950)	—
Placer River Main Cross	Steel stringer	Reinforced concrete pier walls (assumed atop piles)	Reinforced concrete	148 m (487 feet)	25 m (81 feet)	2	9 m (30 feet)	4 m (13 feet)	—	Mouth	4.03°
Safety Sound Estuary Bridge	Prestressed concrete bulb tee	Driven steel pipe piles (30-inch)	—	246 m (808 feet)	35 m (115 feet)	2	7 m (24 feet)	5.5–6.1 m (18–20 feet)	7 m (24 feet)	Estuary mouth	2.09°
Tanana River Bridge (on Parks Hwy)	Steel through truss	Reinforced concrete pier walls (assumed atop piles)	Reinforced concrete	398 m (1,307 feet)	152 m (500 feet)	2	9 m (30 feet)	7 m (24 feet)	3.7–9.1 m (12–30 feet)	RKm 1,520 (RM 950)	2.18°
Twentymile River Bridge	Steel stringer	Reinforced concrete pier walls atop concrete piles	Reinforced concrete	173 m (568 feet)	25 m (81 feet)	2	9 m (30 feet)	5 m (15 feet)	3 m (10 feet)	Mouth	3.49°
Yukon River Bridge	Orthotropic steel box girder	Reinforced concrete pier walls (assumed atop piles)	Timber plank deck with running planks	700 m (2,295 feet)	125 m (410 feet)	2	9 m (30 feet)	14.9–61 m (49–200 feet)	6.1–22.9 m (20–75 feet)	RKm 1,200 (RM 750)	—

Note: Railroad bridges with confirmed beluga whale passage at Bird Creek, Glacier Creek, the Placer River, and the Twentymile River are not included in this table because specific railroad bridge data were not available.

[a] The extent of sky obstructed was calculated from an assumed observer position immediately underneath each bridge and looking directly upward. The bridge deck would obstruct the noted arc of the sky, as measured in degrees. Considering obstructed sky alone, it can be seen that beluga passage under the Knik Arm bridge would be fully consistent with the known ability of belugas to swim under other Cook Inlet bridges with comparable amounts of obstructed sky. Beluga whale behavior is not sufficiently understood to establish a causal relationship between extent of sky obstructed and hesitancy of belugas to swim under static, overhead structures, but the correlated data in this column suggest no impediment may exist with a 2°–6° range of obstructed sky.

[b] data not available

[c] river kilometer

[d] river mile

[e] calculated by combining the two separate highway bridge widths into one, continuous width

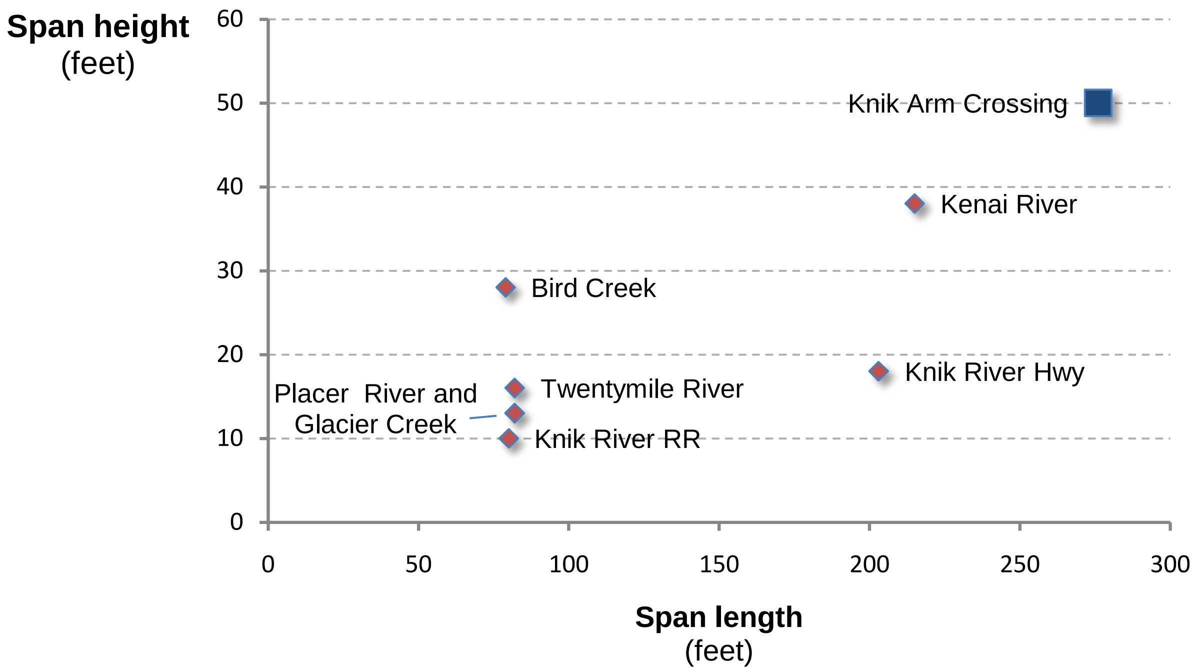

Figure 26 Scatter diagram depicting span lengths and heights for the bridges in upper Cook Inlet where beluga whale passage has been documented (red diamonds) compared with the corresponding dimensions of the KAC Bridge (blue square). All bridges with documented beluga passage have narrower spans and are closer to the water than the KAC Bridge. Refer to Table 12 for full details of each bridge.

Increased development in the Mat-Su could result in increased use of watercraft in Knik Arm, which could increase harassment of beluga whales. Increased boat traffic is likely to consist mostly of commercial fishing boats and sport fishers seeking access to the Little Susitna River. Because of the strong tidal currents and cold water, few people use Knik Arm for personal recreational boating or watercraft pursuits, and a substantial increase in recreational use would be unlikely. Incidental harassment of beluga whales in Knik Arm is likely sporadic and infrequently reported. With an increase in human presence in the area, however, intentional or unintentional incidents of harassment could increase.

Increased commercial and industrial growth in the Port MacKenzie District could generate more marine vessel traffic at the Port MacKenzie Dock. Beluga whales could be impacted by additional vessel noise and traffic. Belugas, however, use the eastern side of Knik Arm more frequently than they do the western side, or the area near Port MacKenzie (Markowitz, Funk, et al., “Use of Knik Arm,” 2005). Under existing conditions, belugas regularly experience vessel traffic throughout Cook Inlet (approximately 4,500 vessel trips in Knik Arm annually), and few conflicts are reported.

Pollution is a concern with regard to the health of beluga whales (NMFS 2008b; URS 2010). The two major sources of pollution that will result from future land use development are wastewater and stormwater runoff. Development in the Mat-Su will consist mostly of low-density housing that will likely rely on private septic systems. While densely populated communities are expected to be developed in some places, it is anticipated that such communities will install community septic tank and leach field systems or small-package, wastewater treatment plants. While wastewater from these areas eventually drains to Cook Inlet, proper maintenance and operation of these facilities will limit potential impacts to Cook Inlet water quality. Pollutants in stormwater runoff and wastewater that reach Knik Arm will dissipate and dilute rapidly because of the tidally influenced high circulation rates. The fast currents and high assimilative capacity of upper Cook Inlet, and specifically Knik Arm, substantially minimize the severity of water quality impacts that might result from land use development indirectly resulting from implementation of the KAC project. Tidally influenced high-circulation rates in Knik Arm will help dilute and dissipate any temporary localized increases in runoff contaminants. Therefore, the effect of this increased pollutant loading will likely be within the range of natural variation and is not expected to impact beluga whales or their habitat. Table 13 presents the anticipated increase in pollution and pollution sources that could affect the water and habitat quality of Knik Arm.

Table 13 Environmental indicators forecast for construction of the Knik Arm Crossing project

Indicator	**Base Year** (a)	**2030 No-KAC** (b)	**No-KAC Change** (b) minus (c)	**2030 with KAC** (c)	**With KAC Change** (c) minus (a)	**2030 difference** (with KAC minus No-KAC)
Wastewater generation (gallons/day)	577,252	1,867,361	1,290,110	3,542,665	2,965,413	1,675,304
Imperviousness (percentage of total land area)	0.9	2.6	1.7	4.8	3.9	2.2
Impervious surface (acres)	2,247	6,425	4,177	11,701	9,454	5,276
Stormwater runoff (cubic feet/acre/year)	12,132	12,660	528	13,347	1,215	687
Nonpoint pollution (pounds/acre/year)[a]	3.1	4.9	1.8	7.1	4.0	2.2

Source: KABATA 2006d

[a] Pollutants modeled were suspended solids, nitrogen compounds, and phosphorus compounds.

9.5 Bridge Operation – Operational Noise

Noise generated by traffic on the bridge may enter the water through an airborne-noise pathway and a structure-borne noise pathway.

9.5.1 Noise Sources

KABATA's *Traffic Noise Technical Report* (2006d) included an analysis of future noise levels using the FHWA Traffic Noise Model (TNM). TNM is a three-dimensional computer model that calculates traffic noise levels using vehicle mix and volume, vehicle speeds, roadway geometry, and receptor locations. To determine the level of noise generated by the bridge as the noise would enter the water through an air-water interface, the noise level was modeled as if a receptor were located in air directly beneath the bridge. From there, the sound would be transmitted into the water by the same transmission method as any other sound. The in-air result was an hourly L_{eq}* of 61.8 dBA re 20 µPa. Assuming certain air-water acoustic transmission values, this would translate to an underwater sound level of approximately 94 dB re 1 µPa just below the water's surface (Kinsler et al. 2000).

A model of the structure-borne bridge vibration is feasible (modeled at the pavement using FHWA guidelines). However, given the expected SPL level and very low frequency of that added noise, FHWA and KABATA do not anticipate that any modeled results would contribute significantly to the existing ambient noise. The following discussion of adding different sources of noise supports this assumption.

Determining the impact of traffic noise on the existing ambient noise involves the addition of noise originating from multiple sources. The addition of underwater noise generated by project operation to the approximate ambient noise involves translating the dB values back into pressure measurements, adding those pressure values together, and then recalculating the dB values. If two sound sources of the same amplitude are added, the resulting SPL is increased by 3 dB. Any value less than doubling of the noise would result in less than a 3 dB increase in the noise level (Kinsler et al. 2000). For example, if the ambient noise is 125 dB re 1 µPa and another 125 dB re 1 µPa source is added, the resulting new level would be 128 dB re 1 µPa. If the difference between the two sound levels is 6 dB, for example, 125 dB re 1 µPa and 119 dB re 1 µPa, the resulting SPL would be 126 dB re 1 µPa. When sound sources differing by more than 10 dB are combined, there is no additive increase in noise levels. Therefore, the addition of the modeled underwater sound level of 94 dB re 1 µPa associated with operational traffic noise of the KAC bridge to an ambient sound level of 125 dB re 1 µPa would mean a remaining sound level of 125 dB re 1 µPa, i.e., no increase in the ambient sound level condition.

In summary, FHWA and KABATA expect traffic noise from bridge operation to be substantially below ambient noise levels and, therefore, have no impact on the existing ambient noise levels and no impact on beluga whales.

9.6 Bridge Construction and Operation – Runoff and Other Pollution

Upper Cook Inlet is classified as a Category 3 water body (a water for which there is insufficient or no data to determine whether any designated use is impaired). Therefore, there are no identified water quality concerns or total maximum daily loads for Cook Inlet. Several point sources discharge to Knik Arm, including three wastewater treatment facilities and two military bases. Pollution might also originate from military training at Eagle River Flats and discharge of ballast water from ships in Knik Arm (NMFS 2008b). Nonpoint sources of pollution to Knik Arm include stormwater runoff from Anchorage and airport deicing (NMFS 2008b). Deicing and anti-icing operations require the use of different chemicals that eventually migrate into Cook Inlet. These operations occur from October through May at Ted Stevens Anchorage International Airport, Merrill Field Airport, Elmendorf AFB, and Lake Hood Seaplane Base (NMFS 2008b). Previous testing has indicated that levels of total aromatic hydrocarbons (TAH) and total aqueous hydrocarbons (TAqH) within the project area are low (KLI 2000, 2001, 2002, 2003, 2004, 2005). Substantial contamination is not anticipated in proposed action area substrates. Samples tested for volatile and semivolatile organic compounds, total recoverable petroleum hydrocarbons, polychlorinated biphenyls (PCBs), pesticides, cadmium,

* L_{eq} (or L_{Aeq1h}) is the hourly equivalent sound level, or the logarithmic energy average over a 1-hour period

mercury, selenium, silver, arsenic, barium, chromium, and lead at the POA have yielded concentrations below screening levels (Alaska Administrative Code 173-204) (POA et al. 2009).

Seafloor-disturbing activities such as drilled-shaft installation and pile driving will suspend sediments during construction. Toxins have not been found at detectable levels in sediment near the action area, and tidal mixing will dilute and disperse any contaminated sediment that may be disturbed during in-water work. Any contaminated sediments released by these activities are unlikely to have a measureable effect on the health of beluga whales.

Marine vessel and heavy equipment operation used during construction in or near Knik Arm increases the possibility of a spill or release of hazardous materials into beluga whale habitat. Standard measures will be in place to reduce the potential for these accidents to occur. Refueling and other operations involving handling of harmful materials will be under strict U.S. Army Corps of Engineers (USACE) and Environmental Protection Agency (EPA) regulations prohibiting water pollution. Vessels will likely be fueled at the POA vessel fueling area, where spill containment measurements will be in place, or will be refueled from barges specially designed and equipped for this purpose.

Some contaminants will likely reach Knik Arm during project operations. Examples include when rainwater and snowmelt wash materials off the approaches and bridge surfaces, when snow is cleared from roads and the bridge, and during bridge maintenance activities. As rainwater and snowmelt wash off the approaches and bridge surfaces into Knik Arm, the water could pick up dirt, dust, small pieces of rubber and metal, fuel from spills (during traffic accidents), engine oil, grease, heavy metals, deicing agents, antifreeze drippings, and miscellaneous debris. Snow clearing from roads and the bridge could result in these pollutants entering Knik Arm. Pollution might also enter Knik Arm during bridge maintenance activities, such as cleaning, painting, repairing, and rehabilitation activities.

No comprehensive studies or analyses have been performed to determine whether stormwater discharge has harmful effects on beluga whales (NMFS 2008b). Little is known about the role of multiple stressors in the health of Cook Inlet beluga whales, however, and future research is needed (Becker et al. 2000). NMFS (2008b) reported that in general, it appears that Cook Inlet belugas have lower levels of contaminants in their bodies compared with other beluga populations. NMFS also noted that the impact of contaminants on Cook Inlet belugas is unknown (NMFS 2008b). FHWA and KABATA do not expect road and bridge runoff to impact beluga whales.

The Anchorage Approach follows the shoreline and western perimeter of Elmendorf AFB at the bottom of the bluff to south of Cairn Point. Construction of this roadway section will include placement of as many as 2 miles (3.2 km) of armor-protected intertidal gravel fill. Because of various environmental contamination issues related to former and ongoing military activity, several hazardous materials sites along this roadway segment belong to Elmendorf AFB and have been identified as being on the National Priorities List of known hazardous substances sites. Under existing conditions, these sites pose a potential threat to water quality in Knik Arm because of their locations along the bluff, uphill from the shoreline. The KAC project will provide a benefit to water quality by armoring and protecting this currently exposed bluff and, therefore, further containing the contaminated sites. The armor-protected roadway will provide a barrier and protection from current scour, wave damage, and ice impacts to the bluff, thereby reducing direct release of toxins into Knik Arm from erosion near these contamination sources. In addition, the KAC project will include a flat-bottom ditch paralleling

LF04,[*] between the roadway and the landfill, to allow military access to the landfill for debris collection from other erosive effects on the bluff, such as rainfall and wind, and to maintain routine clean-up activities.

Impacts on water quality as a result of inputs from the KAC will be negligible. This is based on the effects of fast tidal currents and the assimilative capacity of upper Cook Inlet, particularly Knik Arm. Tidally influenced high-circulation rates in Knik Arm will help to dilute and dissipate any temporary localized increases in runoff contaminants. Additionally, KABATA and FHWA will obtain and meet all the conditions of a Section 401 Certificate of Reasonable Assurance from the Alaska Department of Environmental Conservation. Therefore, road and bridge runoff and other pollutants are not expected to impact beluga whales or their habitat.

9.7 Effects of Project Activities on Marine Mammal Prey

9.7.1 Beluga Whale Prey Species

Fish are the primary prey species for marine mammals in upper Cook Inlet, including Knik Arm. The diet of Cook Inlet beluga whales in Knik Arm can be generalized based on a comparison of fishes found in stomach analyses of beluga whales and fish species observed in Knik Arm (Houghton et al. 2005). Houghton et al. (2005) identified, by month, fish species available to belugas in Knik Arm. Common prey species in Knik Arm include salmon, eulachon, and Pacific cod (*Gadus macrocephalus*) (Houghton et al. 2005; Rodrigues et al. 2006, 2007). Fish species found in Knik Arm with designated essential fish habitat (EFH) include Pacific cod, Pacific staghorn sculpin (*Leptocottus armatus*), walleye pollock (*Theragra chalcogramma*), eulachon, and all five Pacific salmon species. All have been found in stomach content analyses and fatty acid analyses of blubber of Cook Inlet beluga whales (Calkins 1989; Huntington 2000; Moore et al. 2000; Hobbs et al. 2008). Anecdotal reports of beluga whales feeding in Cook Inlet indicate that their diet includes Pacific herring (*Clupea pallasii*), Pacific tomcod (*Microgadus proximus*), lingcod (*Ophiodon elongatus*), steelhead/rainbow trout (*Oncorhynchus mykiss)*, flatfishes, and whitefish (*Coregonus oidschian)* (Huntington 2000; NMFS 2008b). Adult male belugas tend to feed on larger fish (e.g., adult salmon species), while adult females feed on smaller fish and younger whales feed on very small prey such as shrimp (Lowry et al. 1985). Very little is known about beluga winter foraging habits (NMFS 2008b).

9.7.2 Altered Predator-Prey Relationships

Habitat alterations associated with project construction will affect fishes at some level (KABATA 2006e). While impacts on individuals might occur, populations are not expected to be impacted to the degree that prey availability to marine mammals would be significantly altered. Few definitive studies have addressed how construction activities associated with projects like the KAC will impact prey availability for marine mammals. Results of a POA study on the impacts of vibratory pile driving on juvenile coho salmon indicated that the pile driving had no adverse effect on feeding ability or the ability of the fish to respond normally to threatening stimuli (Hart Crowser et al. 2009; Houghton et al. 2010). Uncertainty will, however, be alleviated by adherence to mitigation measures.

[*] Existing contaminated site – this former landfill was used as a surface dump from 1945 to 1957 and is located on the western side of Elmendorf AFB. LF04 contains clean debris, contaminated soil, and small arms unexploded ordinance. LF04 stretches from Cairn Point to the southern boundary of Elmendorf AFB. The base of the bluff is actively eroding, exposing landfill debris, some of which falls to the beach.

Therefore, it is expected that impacts on marine mammal prey during construction activities will be negligible.

To date, KABATA has funded research on underwater measurements of pile-driving sounds during Port MacKenzie Dock modifications (Blackwell 2005; Burgess et al. 2005; KABATA 2006c) and marine fish and benthos (Houghton et al. 2005) (see Section 14). Scientific monitoring during construction, as described in Section 13, will help to determine impacts associated with beluga prey. Additionally, FHWA and KABATA propose to mitigate the KAC project's unavoidable impacts on prey species of the Cook Inlet beluga whale as part of overall compensatory mitigation for wetlands and water bodies through use of the Anchorage Debit/Credit Methodology. Fisheries enhancement mitigation approaches being considered by FHWA and KABATA for anadromous waterways or waters in the Anchorage Bowl and Mat-Su area include habitat and conservation, improvement of fish passage and stock enhancement. These are described in detail in Section 10.

Construction

Pile-driving operation (see below) and the placement of fill (see Section 9.1 for discussion) for the bridge approaches could displace or harm fish typically preyed upon by belugas; these include salmon species, eulachon, and groundfish. The effects on individual fish might benefit beluga whales by temporarily increasing prey availability in a localized portion of the action area. Impact estimates suggest that construction will have no appreciable effect on salmon or groundfish populations within Knik Arm (KABATA 2006e). Because data on adult and juvenile eulachon densities and habitat use in Knik Arm are not available, impacts are difficult to determine. Construction is unlikely to substantially impact the long-term availability or accessibility of prey species for beluga whales.

Construction impacts from pile-driving activities could produce underwater noise and vibrations that might locally displace or harm fishes that serve as forage for beluga whales. High underwater SPLs have been documented to alter behavior, cause hearing loss; and injure or kill individual fish by causing serious internal injury (Hastings and Popper 2005). In addition to direct trauma, ensonification of aquatic environments may mask important signals as well as elevate stress levels, thereby affecting fitness and increasing the likelihood of predation (Hastings and Popper 2005).

Juvenile salmonids would be the most susceptible to injury or mortality resulting from pile driving, because of their small body mass (Yelverton et al. 1975), entrainment within swift currents, and distribution throughout Knik Arm from May to August (Houghton et al. 2005). Some studies have indicated that fish may be more physically and behaviorally tolerant of sounds produced by pile driving. The effects of impact and vibratory driving of 30-inch-diameter steel sheet piles at the POA on 133 caged juvenile coho salmon in Knik Arm were studied (Hart Crowser et al. 2008; Houghton et al. 2010). Maximum peak SPLs observed ranged from 177 dB re 1 μPa to 195 dB re 1 μPa and accumulated SELs ranged from 174.8 dB re 1 μPa to 190.6 dB re 1 μPa. Acute or delayed mortalities, or behavioral abnormalities, were not observed in any of the coho salmon. Furthermore, results indicated that the pile driving had no adverse effect on feeding ability or the ability of the fish to respond normally to threatening stimuli (Hart Crowser et al. 2009; Houghton et al. 2010). Ruggerone et al. (2008) investigated the effects of exposing coho salmon in Puget Sound to more than 1,600 impact hammer strikes of 14 20-inch-diameter hollow steel piles over the course of 4.3 hours. SLs reached 208 dB re 1 μPa_{peak} and 194 dB re 1 μPa rms, and the accumulated SEL was approximately 207 dB re 1 μPa. No mortalities or visible sublethal effects were observed; the exposed fish continued to feed normally and showed only a minor startle response upon continuation of pile driving (Ruggerone et al. 2008).

Noise thresholds for most fish species have not been codified in either state or federal regulations, although NMFS uses a SPL of 180 dB re 1 μPa_{peak} as a threshold for impacts to fishes. Pile-driving experiments using juvenile steelhead found no barotraumas with exposure to peak SPLs as high as 211 dB (Caltrans 2005) and no statistically significant mortality at SELs as high as 182 dB re 1 $\mu Pa^2 \cdot s$ (Caltrans 2004). The Fisheries Hydroacoustic Working Group (FHWG)* has interim criteria for injury to fish set at an SPL of 206 dB re 1 μPa_{peak} and an accumulated SEL of 187 dB re 1 µPa for all listed fish that are 2 grams (0.07 ounce) or more (FHWG 2008). For fish less than 2 grams (0.07 ounce), an accumulated SEL of 183 dB re 1 µPa applies (FHWG 2008).

Fish in Knik Arm could be exposed to SPLs greater than 206 dB re 1 μPa_{peak} (KABATA 2006c). Even if these peak SPLs resulted in direct or indirect mortality, the percentage of fishes exposed is expected to be well within the annual variability in all species of adult salmon returns for Knik Arm drainages. No appreciable effect on any salmon population within Knik Arm is anticipated as a result of project-related pile-driving activities (KABATA 2006e).

Pile-driving impacts to eulachon are difficult to determine because data on adult and juvenile eulachon densities and habitat use in Knik Arm are not available. Adult eulachon have been observed migrating in the nearshore waters of Knik Arm (Houghton et al. 2005), likely staying close to shore to navigate to freshwater spawning grounds and also using the shallow water environment to reduce predation. Because most of the proposed pile driving will occur well out into Knik Arm, away from the area of impact for larger fish, it is not likely that adult eulachon, an important prey species for beluga whales, will be substantially impacted by pile driving.

Operation

As noted earlier, the KAC project area is used by belugas primarily for transit and occasional feeding (Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005). Placement of bridge approach structures along the shoreline of Knik Arm will cause changes to the shoreline and possibly alter the migration of beluga prey, thereby changing the whales' foraging patterns in a small, limited area. Adult salmon are documented to exclusively use nearshore waters during immigration (Houghton et al. 2005). The bridge approaches might force migrating adult and juvenile anadromous fish into deeper, faster waters where they may be more susceptible to beluga predation (KABATA 2006e).

As stated in Section 9.2.2, empirical evidence indicates that Cook Inlet beluga whales do swim beneath and upriver of bridges, and the Crossing will not block beluga passage to valuable feeding grounds. Other comparable feeding grounds, however, do exist in the Upper Cook Inlet and more specifically in Critical Habitat Area 1. These include 21 streams classified by Goetz et al. (2007) as medium- and high-flow streams (i.e., these stream are in the top 25 percent of the highest-flowing streams entering Cook Inlet) and rivers downriver of the KAC project† (NMFS 2009). The timing for salmon runs for all anadromous streams in upper Cook Inlet, downriver of the KAC project, is

* FHWG is a multiagency group that includes Caltrans, Oregon Department of Transportation, Washington Department of Transportation, FHWA, NOAA Fisheries, USFWS, California Department of Fish and Game, the USACE CDFG, and USACE.

† 74 FR 63080–63095

expected to be similar to those upriver of the KAC project, with salmon runs generally starting in May and ending in September (ADFG 2007).

Presence of the approaches will increase sedimentation in areas where currents will be reduced. Sediment will be expected to accumulate on both sides of the bridge approaches, resulting in the formation of stable areas of settled sediment. These depositional areas will cover approximately 260 acres, causing the existing subtidal and intertidal habitat to change. The 260 acres of eventually affected habitat will account for approximately 0.1 percent of the available intertidal and subtidal habitat in Knik Arm. Long-term habitat shifts and bathymetric alterations may result from substantial areas of silt deposition along the bridge approaches. Stable areas of settled sediment are likely to benefit beluga prey species. As these areas increase over time, they might smooth the nearshore bathymetry of the migration corridor used by anadromous fishes near the bridge approaches, thus countering or reducing the effects of forcing these fishes into deeper water. These depositional areas might also benefit the local food web by increasing primary productivity through enhanced production of organic matter and invertebrates.

A beneficial impact from the project would be the creation of habitat for small fishes. Friction will cause water moving across armor rock lining approaches to create wedges of slower-moving water (0.2 meter per second [0.5 foot per second or less]) to form adjacent to the approaches. The slower-moving water, along with crevices (interstitial spaces) in the armor rock itself, will provide velocity refugia and cover for small fishes (KABATA 2007). Thus, a typical fry of approximately 35 mm (1.3 inch) in length would be able to avoid entrainment (Smith and Carpenter 1987) as well as have opportunities for rest and shelter within the numerous crevices of the armor rock. Because fish passage is not expected to be impacted, these effects will not substantially alter long-term prey availability or accessibility for beluga whales.

It was suggested that beluga whales might use the steep slopes of the bridge abutments as preferred areas for preying on adult salmon. However, Markowitz, Funk, et al. ("Use of Knik Arm Crossing Corridor," 2005) reported that there was no conclusive evidence that belugas preferentially use steep or vertical obtrusions in Knik Arm to hunt salmon. Lack of conclusive data suggests that the bridge approaches might not necessarily increase the predatory success of beluga whales on salmon species. On the other hand, beluga whales have been seen feeding along rock armors in Turnagain and Knik arms (see Appendix A). Although out-migrating juvenile salmon species in the nearshore areas could be funneled toward the abutments, the level of possible effects is unknown. Effects may be similar to those experienced at Port MacKenzie Dock, where juvenile salmon species were likely transported passively around the structure by currents that can exceed 3.4 m per second (11 feet per second) (Houghton et al. 2005). Although the abutments might create feeding habitat for beluga whales, individuals are not expected to preferentially remain in these areas for extended periods to feed. Based on known site fidelity, beluga whales are more likely to travel farther upstream of the Crossing to their known, perennial feeding areas. Therefore, the change in hydrodynamics is not likely to change prey accessibility for belugas in Knik Arm.

10 Description of Impact from Loss or Modification of Habitat

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

Descriptions of KAC project impacts on habitat were discussed in Section 9. As noted earlier, the ESA requires a comprehensive analysis of potential effects to critical habitat; therefore, *Knik Arm Crossing Biological Assessment* provides additional information and potential effects on proposed critical habitat for the Cook Inlet beluga whale.

The greatest impact on marine mammals associated with construction of the KAC project will be a temporary loss of habitat because of elevated noise levels. Displacement of beluga whales by noise will not be permanent and there will be no long-term effects.

A secondary impact on marine mammals could result from changes in prey availability attributable to bottom disturbances from filling for roadway approaches and bottom disturbance at pier installations. Baseline research indicates that the bridge corridor area is not a primary feeding area for beluga whales (Markowitz, Funk, et al., "Use of Knik Arm Crossing Corridor," 2005). Therefore, any changes in prey availability as a result of bottom disturbance are unlikely to impact the beluga whale population.

Road and bridge runoff is not expected to impact beluga whales. Given the fast currents, tidal volumes, and assimilative capacity of upper Cook Inlet and Knik Arm, impacts on water quality as a result of inputs from the bridge will be negligible. Tidally influenced high-circulation rates in Knik Arm will help to dilute and dissipate any temporary, localized increases in runoff contaminants.

As noted in Section 9.2, NMFS has expressed concern that Cook Inlet belugas might avoid or be reluctant to swim under the KAC. Placement of bridge piers may affect whale movement by creating in-water obstacles. It is expected, however, that belugas will use echolocation to effectively navigate around the bridge embankments, piers, and any depositional material. Documented responses of Cook Inlet beluga whales indicate tolerance of in-water structures (see Appendix A). There was uncertainty regarding how individual beluga whales might react to the bridge structure. Section 9.2 provides details on how context is extremely important in how an animal might respond to a given situation. While there might be some alteration of movement, or inhibition of behavior, FHWA and KABATA expect no impact on the long-term survival of the population. Circumstances such as motivation to move farther upstream into Knik Arm to feed or desire by an individual(s) to continue to travel and feed with other beluga whales might override any hesitancy by an individual(s).

Impacts to prey fishes consumed by beluga whales may result from placement of fill and pile-driving activities. However, the KAC project is not expected to impact feeding habitat or prey that could result in permanent or long-term consequences for individual marine mammals or their populations in Cook Inlet. Adherence to best management practices as well as application of other mitigation efforts will reduce negative impacts on habitat during construction.

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11 Measures to Reduce Impacts to Marine Mammals

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 development stages of the KAC project, FHWA and KABATA have worked with NMFS to develop avoidance, minimization, and mitigation measures to reduce the overall effects of the project on the Cook Inlet beluga whale. These measures include:

- selecting the KAC project location to avoid resting and feeding areas farther to the north in Knik Arm, north of Sixmile Creek; the project area is principally used as only a transitory route by belugas
- using drilled-shaft technology for the large-diameter, permanent bridge piers as opposed to driven piles originally proposed in the KAC FEIS, significantly reducing in-water noise exposure
- increasing bridge span lengths from the 250-foot (76.2-m) spans discussed in the KAC FEIS to 275-foot spans, reducing the number of bridge piers from 33 to 29
- scheduling temporary pile construction activities to coincide with periods when beluga whales are not in Knik Arm or the KAC project area in large numbers (as advised by Funk and Rodrigues [2005])
- implementing a soft-start application for initial pile-driving operations
- avoidance of simultaneous pile driving in different locations
- monitoring construction-related acoustics to determine appropriate safety and harassment zones around pile-driving activities
- implementing a multiple observer monitoring program in coordination with POA and Fort Richardson monitoring programs, with mandatory shut-down procedures to avoid injury and minimize potential harassment to marine mammals
- implementing a construction contractor specification to maximize vessel-free beluga passage zones during construction. A minimum of 4,000, feet or approximately half of the bridge length, will remain unobstructed (free of moored and anchored barges and vessels) within Knik Arm at any given time to ensure unrestricted passage for belugas; this distance may not always be linearly continuous because of the need for staging of vessels for substructure and superstructure construction, but this minimum total length will always be maintained and further increased whenever reasonably possible.
- implementing NMFS vessel operation guidelines to minimize construction vessel operation impacts
- focusing mitigation for fill impacts required for roadway approach construction to maximize fishery enhancements in Knik Arm
- developing an Adaptive Management Plan in close coordination with NMFS

In addition to the above mitigation measures, other methods of avoiding or limiting impacts to marine mammals were evaluated and found to be unsuitable. Sound-attenuating technologies were extensively investigated during preparation of the KAC EIS. Details of these findings are discussed in *Options for Mitigating Construction-related Effects on Beluga Whales* (Funk and Rodrigues 2005) and *Pile-Driving Noise Attenuation Measures* technical report (KABATA 2005). Sound deterrent/minimization techniques such as bubble curtains were considered; these techniques have, however, not proven successful in conditions similar to Knik Arm because of extreme tidal currents.

Additional investigations were conducted for encased bubble curtains or bubble sleeves because they had the greatest potential for application in Knik Arm waters. Caltrans, the Washington Department of Transportation (WSDOT), and the Bureau of Ocean Energy Management, Regulation and Enforcement (formerly, the Minerals Management Service) are some agencies that have recently supported studies regarding noise mitigation for pile driving in marine habitat (e.g., Reyff 2004, 2009; Stokes et al. 2010). Pile-driving noise mitigation techniques have proven to be successful in reducing SPLs by from 10 dB to 30 dB through use of encased bubble curtains surrounding the piles as they are being installed. The encased systems were successfully tested in 30–40 feet (9 m–12 m) of water at two ferry dock locations and at a river bridge. A Transportation Research Board study (Reyff 2004) mentions noise reductions of around 22 dB through use of air attenuation systems and an accompanying reduction of impacts to small fish. These studies, and conversations with WSDOT,[*] point out that for encased bubble curtains to be successful, the bottom of the casing needs to be seated into the mud line; the casing cannot touch the pile or be too close, and the bubble ring or rings need to be centered in the casing.

While these recent studies show that encased bubble curtains can be effective in certain environments, they are not practical in Knik Arm, where currents can exceed 11 feet per second (3.4 m per second) and where tidal fluctuations approach 40 feet (12 m). For optimal noise reduction, the size of the attenuation casing would need to be 24 inches (61 cm) larger in diameter than that of the structural pile. For application in the KAC project, this translates to a pile at least 8 feet (2.4 m) in diameter. Knik Arm's extreme tidal fluctuations and associated currents would exert forces on the large casings, making it very difficult to hold them in place. To keep currents from moving the casing, the casing bottom would need to be seated approximately 20–30 feet (6 m–9 m) below the mud line, necessitating a substantial driving effort that would exceed the effort required to install a 48-inch-diameter pile. Additionally, the top of the casing would need to be supported to prevent currents from tipping it.

Installation of the outer casing would require the same approach as has been planned for the 48-inch-diameter support piles. The construction template would have to be sized to hold the top end of the outer casing in place. Sleeve guides would be used to center the support pile within the outer casing at the bottom of the pipe. Removal of the outer casing would require additional work, generating still more noise. Installation and removal of the bubble curtain casing would offset any sound attenuation achieved during installation of the smaller pile and would extend the construction process. Overall, any benefit would be negated by both the noise created to seat the bubble casing and vibratory removal of the casing.

Additionally, FHWA and KABATA propose to mitigate the KAC project's unavoidable impacts on prey species of the Cook Inlet beluga whale as part of overall compensatory mitigation for wetlands

[*] Jim Laughlin, Air/Acoustics/Energy Technical Manager, WSDOT, personal communication with Loran Frazier (KABATA), March 30, 2010.

and water bodies through use of the Anchorage Debit/Credit Methodology. Fisheries enhancement mitigation approaches being considered by FHWA and KABATA for anadromous waterways or waters in the Anchorage Bowl and Mat-Su area include habitat and conservation, improvement of fish passage and stock enhancement. These are described in detail in Section 10.

Following is a more detailed description of proposed conservation measures.

11.1 Drilled Shafts

Based on advancements in bridge design to minimize impacts to the beluga whale since issuance of the KAC FEIS, drilled-shaft technology for the large-diameter, permanent bridge piers will be used as opposed to driven piles as originally proposed in the KAC FEIS, significantly reducing in-water noise exposure. Drilled shafts will be constructed using oscillators to place 116 shafts comprising 29 piers (4 shafts per bridge pier). In addition, the number of piers was reduced from an original 33 in the FEIS to 29 piers by increasing the width of the spans between bridge piers to 275 feet (84 m) from 250 feet (76 m). Fewer piers means not only reduced in-water construction time and construction noise, but also broader and fewer spans will serve to maximize passage zones for beluga whales transiting the area. By using drilled-shaft construction techniques to install permanent large-diameter shafts instead of using a combination of impact and vibratory pile driving to install piles, KAC construction will substantially reduce acoustic effects on beluga whales. There is no known literature regarding the noise produced by drilled-shaft installation using oscillators. Thus, it is assumed that because physical impact is avoided, the noise level is likely to be of a lower amplitude than would be the case with vibratory and impact pile driving. Additionally, the drilled-shaft installation potentially has higher-frequency components because of metal rubbing against metal. Higher frequencies attenuate more quickly than lower frequencies. KABATA is committed to obtaining sound level and transmission-loss data for large-diameter, drilled-shaft construction methods involving oscillator and drilling activities prior to or during the initial stages of construction of the project to verify noise source data.

11.2 Scheduling of Construction Activities during Low-use Period by Beluga Whales in Knik Arm

Strong seasonal and tidal patterns influence beluga whale use of Knik Arm (Markowitz, Funk, et al., “Seasonal Patterns,” 2005; Funk, Markowitz, et al. 2005; Ireland, Funk, et al. 2005; Ezer et al. 2008). Beluga whale use of Knik Arm is greatest during August through November (Markowitz, Funk, et al., “Seasonal Patterns,” 2005; Markowitz, Funk, et al., “Use of Knik Arm,” 2005). It should be noted that the NMFS tagging data (Hobbs et al. 2005) and sighting information from Markowitz, Funk, et al., “Seasonal Patterns,” 2005) suggest that some beluga whales use Knik Arm from August through March. Beluga whale use of the KAC project area is greatest during the lower portions of the tidal cycle. As the tide floods, belugas typically move into upper reaches of Knik Arm (Funk, Markowitz, and Rodrigues 2005; Funk, Markowitz, et al. 2005; Ireland, McKendrick, et al. 2005).

To minimize impacts of construction noise on beluga whales, all in-water impact and vibratory pile-driving activities for temporary pile installation and removal associated with docks, moorage, and pier templates will be conducted outside of the period of high beluga whale density in Knik Arm, from August 1 through November 30. This will reduce the chance of exposing beluga whales to KAC project pile-driving noise and may provide the most effective form of mitigation for construction of the KAC project (Funk and Rodrigues 2005). However, if the take limit has not been reached or has reasonable tolerance in a given year, in-water impact and vibratory pile-driving activities may be proposed during the high-density period to shorten overall in-water work schedules for the project. Should this condition occur during construction, and to further minimize impacts, FHWA and KABATA will consult with, and obtain approval from NMFS prior to conducting temporary pile installation and removal activities during the period of high beluga whale density in Knik Arm (see the Adaptive Management Process, discussed in Sections 7.2.1 and 13.1).

11.3 Soft Start for Pile-driving Activities

A "soft-start" technique (i.e., sound levels gradually increased over time) will be used at the beginning of each in-water piling installation to allow any marine mammal that may be in the immediate area to leave before pile driving reaches full energy. The soft start requires pile-driving operators to initiate noise from vibratory hammers for 15 seconds at reduced energy followed by a 1-minute waiting period. The procedure is repeated twice. If an impact hammer is used, operators will be required to provide an initial set of three strikes from the impact hammer at 40 percent energy, followed by a 1-minute waiting period, then two subsequent three-strike sets. If marine mammals are sighted within the harassment zone (which includes the smaller 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 harassment zone. Pile driving will resume only after a qualified observer determines that the marine mammal has moved outside the harassment zone or after 15 minutes have elapsed since the last sighting of the marine mammal within the harassment zone.

11.4 Sequencing of Pile-driving Activities

With two pile-driving crews working, the potential exists for dual, simultaneous in-water sound sources. However, FHWA and KABATA are committed to the implementation of construction methods and daily work sequencing that will prevent simultaneous pile driving. Exceptions that might be accommodated under adaptive management are presented in the discussions of the Adaptive Management Process (see Sections 7.2.1 and 13.1).

11.5 Monitoring and Shut-down Procedures

Adequate visibility is essential to beluga whale monitoring. Pile driving will occur when weather conditions are clear and allow visible detection of all waters within and surrounding the harassment zone (which includes the smaller safety zone). Conditions that can require in-water pile driving delays include darkness, fog, and a high sea state (i.e., rough seas).

To maintain an "exclusion zone" around the sound source, the harassment zone (which contains the smaller safety zone) around the pile-driving activity will be monitored for the presence of marine mammals before, during, and after any pile-driving activity. Marine mammal observers and a passive acoustic device with localization capabilities (i.e., hydrophones) will be used to monitor the construction area. The harassment zone (which contains the smaller safety zone) will be monitored by marine mammal observers for at least 60 minutes prior to initiating the soft start for pile driving. If marine mammals are present within the harassment zone, the start of pile driving will be delayed until the animals leave the area. The harassment zone (which contains the safety zone) will also be monitored throughout the time required to drive a pile. If a marine mammal is observed approaching or entering the harassment zone, piling operations will be discontinued until the animal is clear of the safety zone. Monitoring of the harassment zone will continue for 60 minutes following pile driving.

Prior to the start of seasonal pile-driving activities, construction supervisors and crews, marine mammal monitors, acoustical monitors, and all project managers will be briefed to establish the responsibilities of each party, define chains of command and communication procedures, and receive an overview of monitoring purposes and operation procedures.

11.6 Construction Vessel Avoidance of Impacts to Beluga

Construction activities have the potential to interfere with movements of the whales and impact their passage. In particular, vessels may present obstacles to whale passage, causing them to swim farther and change direction more often, which could increase their energy expenditure and could impact foraging behavior. FHWA and KABATA will require the contractor to maximize vessel-free beluga passage zones during construction by minimizing multiple aggregations of unnecessary, nonactive construction vessels, which in turn may impede movement by beluga whales. This requirement will reduce the potential for vessel presence to impede or block beluga transit through the work area (see the Adaptive Management Process, discussed in Sections 7.2.1 and 13.1).

Construction vessels will typically operate in a slow (approximately 2–3 knots), purposeful manner transiting between onshore staging areas and in-water work sites using as direct a route as possible. Vessel operators and crews will maintain vigilant watch regarding marine mammals to avoid a strike, because marine mammals may surface in unpredictable locations or approach slowly moving vessels. Vessel operators will attempt to maintain a distance of 100 yards (91 m) or greater between the marine mammal and vessel. Impacts from construction vessel operations will be minimized by following consistent and safe navigation, having trained marine mammal observers monitoring for marine mammals' presence to assist in directing vessel movements to avoid marine mammals. If a marine mammal is within 100 yards (91 m of the boat), vessels will slow to a reduced speed and attempt to avoid the marine mammal, while still maintaining control of the vessel and safe working conditions to avoid physical injury. Beluga whales have displayed avoidance reactions when approached by watercraft, particularly small, fast-moving craft that can maneuver quickly and unpredictably. Larger vessels that do not alter course or speed around these whales seem to cause little, if any, reaction (NMFS 2008b).

In addition, to minimize potential impacts to beluga concentration areas north of Sixmile Creek, the construction contractor will be required to restrict travel and operations north of the bridge construction site. Commercial navigation is nominal north of Port MacKenzie (KABATA 2009) because of hazardous water and tidal conditions and lack of developed land uses. Any necessary travel for materials, access, or operations north of Sixmile Creek will require coordination with NMFS prior to implementation.

A minimum of 4,000 feet, or approximately half of the bridge length, will remain unobstructed (free of moored and anchored barges and vessels) within Knik Arm at any given time to ensure unrestricted passage for belugas; this distance may not always be linearly continuous because of the need for staging of vessels for substructure and superstructure construction, but this minimum total length will always be maintained and further increased whenever reasonably possible.

11.6.1 Construction Contractor Coordination with NMFS

The prime contractor for the KAC project will be required to meet with NMFS a minimum of 60 days prior to in-water (Knik Arm) construction work to review and verify construction procedures, communication protocols, notification requirements, monitoring and reporting requirements, shut-down procedures, implementation of agreed-upon conservation measures, and other directions from NMFS to ensure that all precautionary measures are clearly communicated and in place well in advance of beginning construction.

11.7 Notification of Commencement and Beluga Whale Sightings

KABATA will formally notify the NMFS Alaska Regional Office and the NMFS Office of Protected Resources prior to the seasonal beginning of pile driving and removal and will provide monthly monitoring reports once pile-driving operations begin. A summary monitoring report will be submitted to NMFS annually.

11.8 Pile-driving Weather Delays

Adequate visibility is essential to beluga whale monitoring and determining take numbers. Pile driving will not occur when weather conditions restrict clear, visible detection of all waters within and surrounding the harassment zone. Such conditions that can impair detection and require in-water pile-driving delays include, but are not limited to, fog and a high sea state (i.e., rough seas).

11.9 Compensatory Mitigation

FHWA and KABATA propose to mitigate the KAC project's unavoidable impacts on the prey species of the Cook Inlet beluga whale as part of overall compensatory mitigation for wetlands and water bodies through use of the Anchorage Debit/Credit Methodology. In-kind mitigation options that involve the direct replacement of intertidal and nearshore subtidal habitat losses are not readily available in the project area. FHWA and KABATA will work with NMFS, USACE, and other appropriate resource agencies during the permitting phase of the project in an attempt to develop a compensatory mitigation plan to offset impacts by acquiring credits through a variety of mitigation projects within the Knik Arm ecosystem. FHWA and KABATA anticipate that the proposed projects to improve salmon habitat and to maintain and enhance Pacific salmon populations near the project area will provide a direct benefit to beluga whales by maintaining and enhancing a primary food source. Fisheries enhancement mitigation approaches being considered by FHWA and KABATA for anadromous waterways or waters in the Anchorage Bowl and Mat-Su area include habitat and conservation, improvement of fish passage, and stock enhancement.

11.9.1 Habitat and Conservation

Mitigation projects that restore, enhance, or preserve nearby estuarine and nearshore salmonid habitats would likely be of high value, but are limited because of the lack of a quantitative understanding of the Knik Arm estuarine function. Human-altered stream courses often lack the habitat diversity/complexity seen in natural streams. Altered stream courses are often ditched, and as such do not provide the habitat characteristics needed for spawning and rearing salmon. Habitat diversity/complexity within altered stream courses could be improved by reshaping the stream courses or by adding native material such as boulders and large woody debris.

Habitat conservation easements are another form of mitigation. Monetary compensation might be given to a nongovernmental organization such as the Great Land Trust to purchase properties that would be set aside as permanent conservation easements. These properties should include riparian areas, coastal shorelines and estuaries, or wetlands connected to anadromous streams.

HDR Alaska, Inc., maintains a database of potential fish habitat restoration and conservation projects. The database has been partially populated with project concepts in the Knik Arm area. A number of projects listed in the database include potential purchase of properties for conservation easements. At least nine segments of the upper portion of Chester Creek are proposed for conservation easements coupled with extensive stream daylighting and/or channel reconstruction. Another proposed project suggests relocating industry from the Swan Bay/North Star area near the mouth of Ship Creek to the new POA facilities. A prioritized inventory of restoration and conservation projects in the Anchorage Bowl and Mat-Su area could be developed during the permitting phase as part of an overall KAC project mitigation/funding plan.

11.9.2 Fish Passage

Deteriorating, perched, or undersized culverts serve as passage barriers for migrating salmon and other fish species. These culverts can prevent adult salmon from reaching upstream spawning habitat and juveniles from moving between rearing habitats. Culvert improvements based on stream discharge and passage calculations would make habitats available that are currently inaccessible and could increase salmon run numbers. The fish passage inventory database maintained by ADF&G identifies hundreds of culverts in the Mat-Su and Anchorage Bowl area where passage barriers might exist. The Mat-Su Borough Salmon Fish Passage Program combines data from ADF&G's fish passage inventory, with inventories from USFWS and the Mat-Su Borough Public Works. A figure from the 2009 Mat-Su Salmon Science and Conservation Symposium suggests that hundreds of culvert crossings or passage barriers exist in the Mat-Su, ranging in severity from minor to substantial. Examples of the more substantial cases are three key passage barriers resulting from the raised Alaska Railroad embankment blocking upland drainage and fish passage between Houston and Wasilla. A prioritized inventory of fish passage barriers in the Anchorage Bowl and Mat-Su area could be developed during the permitting phase as part of an overall KAC project mitigation/funding plan.

11.9.3 Stock Enhancement

Projects that directly enhance or supplement salmon populations in the project area are another mitigation option. The development of an enhancement program and related facilities as mitigation for the KAC project would require rigorous feasibility assessment to determine potential benefits to harvesters in the area and to ensure consistency with regional salmon-planning efforts. All enhancement projects must conform to State aquaculture permitting and State genetics and pathology policies, as well as receive approval from the Regional Salmon Planning Team (RPT). The Cook Inlet Phase II salmon enhancement plan (Cook Inlet RPT 2007) establishes enhancement guidelines for the Knik Arm planning unit. Additional planning documents include the ADF&G Sport Fish division statewide stocking plan (ADFG 2010). To provide long-term benefits, enhancement projects must be environmentally and fiscally sustainable.

Four hatchery facilities have operated in the Knik Arm planning unit (Cook Inlet RPT 2007): the Eklutna, Big Lake, Fort Richardson, and Elmendorf hatcheries. The Eklutna Hatchery, located at the Eklutna Tailrace on the Knik River, is permitted to the Cook Inlet Aquaculture Association (CIAA). It operated from 1982 to 1998 and produced chum, pink, coho, and sockeye salmon during different periods of its operation. The Eklutna Hatchery reopened in 2005 and continues to operate on a limited basis, providing additional rearing capacity for CIAA's Trail Lakes Hatchery sockeye salmon program. All smolts are released into Resurrection Bay. The Big Lake Hatchery, located on Big Lake south of Houston, is owned by ADF&G. The facility operated from 1974 through 1992 and produced sockeye and coho salmon. The Fort Richardson and Elmendorf hatcheries, on Ship Creek, are operated by ADF&G and produce coho and Chinook salmon as well as trout for local sport fisheries. The Anchorage Sport Fish Hatchery is under construction on Ship Creek and, when completed, will be a modernized facility that will replace the Fort Richardson and Elmendorf hatcheries.

12 Measures to Reduce Impacts to Subsistence Users

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

As noted in Section 8, the Cook Inlet beluga whale population is considered too small (less than 350 whales) to support a subsistence hunt and it is unknown when the population will rise to levels that would support a hunt. The hunt has usually occurred around mid-July in the Susitna Flats area about 40 km (25 miles) southwest of the KAC project area, and would, therefore, not likely be impacted by construction activities. Regardless, if a hunt were to be planned for Knik Arm, KABATA would coordinate its actions with hunters to avoid conflicting with these subsistence activities. A Communications Plan and Conflict Avoidance Agreement will be negotiated with subsistence users to ensure that activities associated with construction of the KAC project do not interfere with any subsistence beluga whale hunts. KABATA expects this would be the only potential conflict with subsistence users in the area. This coordination should be sufficient to comply with the LOA requirement for a Plan of Cooperation.

The following features of project activities, in combination with a number of actions to be taken by KABATA during project implementation, should prevent any adverse effects on the availability of marine mammals for subsistence.

- The KAC project activities will occur outside of the traditional area for hunting marine mammals.
- In-water construction activities will implement mitigation and monitoring procedures to minimize effects on the behavior of marine mammals and, therefore, opportunities for harvest by Alaska Native communities.
- Regional subsistence representatives may support recording marine mammal observations along with marine mammal biologists during the monitoring program and be provided annual reports.
- The combination of the project location and size of the affected area, mitigation and monitoring measures, and the Communications Plan and Conflict Avoidance Agreement should result in project activities having no effect on the availability of marine mammals for subsistence uses.

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13 Monitoring and Reporting

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.

FHWA and KABATA are committed to avoiding or minimizing impacts to marine mammals from project activities. The following monitoring plan describes efforts that KABATA will undertake to assess and measure the effects of bridge construction on beluga whales and other marine mammals to trigger mitigation measures in real time. The plan will include both monitoring of marine mammal use of the KAC project area and measurements of mean SPLs, peak SPLs, and sound energy resulting from construction activity. The monitoring program will use an adaptive management approach (see Sections 7.2.1 and 13.1) 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 approach the harassment zone). The monitoring efforts will provide 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.

13.1 Adaptive Management Plan

As mentioned in several sections throughout this request for an LOA, it will be important to adapt proposed avoidance, minimization, and mitigation measures to further protect the Cook Inlet beluga whale with respect to passage of time, new technologies, and successful lessons learned from this and other projects.

13.1.1 Adaptive Management

Adaptive management identifies uncertainties and then establishes methodologies to test hypotheses concerning those uncertainties. It will use management as a tool to assess performance of the beluga protection systems enacted before and during KAC construction activities and to respond in near-real time to feedbacks that will improve those systems' performance. As a result, the Knik Arm ecosystem will be better understood with respect to marine mammal vitality. FHWA and KABATA's monitoring plan will be evaluated annually through the Adaptive Management Process to assess progress, provide a matrix of goals for the following year, and make recommendations for refinement and analysis of the monitoring and mitigation techniques for upcoming years of construction.

FHWA and KABATA will work closely with NMFS to ensure that their Adaptive Management Process includes:

- An annual Adaptive Management Review (AMR) during which FHWA, KABATA, and NMFS will jointly consider the prior year's goals, monitoring results, and related science advances to determine whether modifications are needed to more effectively address monitoring program goals. FHWA and KABATA will also consider other scientific and technological developments for potential modification of future mitigation or monitoring methods.

- Modifications to the monitoring plan that result from AMR decisions will be incorporated by an addendum or revision to the LOA.
- FHWA and KABATA, with guidance and support from NMFS, will host an annual Monitoring Workshop to reviewing cumulative monitoring results from previous and ongoing research. The workshop will incorporate outside experts and expanded participation, enhancing the monitoring plan's transparency and allowing for greater input from various stakeholders. Findings of the workshop could lead to modifications in subsequent monitoring and mitigation.

Use of adaptive management will give FHWA, KABATA, and NMFS a framework for considering new construction technologies and equipment and for assessing data from different sources. These will help determine whether mitigation or monitoring measures should be modified, added, or deleted for use in subsequent annual LOAs.

The following are some of the possible sources of applicable data:

- Results from FHWA and KABATA's monitoring from the previous year
- Any information that reveals that marine mammals may have been taken in a manner or number not authorized by these regulations or subsequent Letters of Authorization
- Results from general marine mammal and acoustic research from other researchers

Discussions related to the Adaptive Management Plan should include:

- flexibility with installation/removal of temporary piles during peak beluga density months—August through November—if allowable Level B incidental take thresholds are favorable within a given year to shorten overall in-water construction times
- clarification of options for the construction contractor to reduce noise source data from temporary pile removal by cutting the piles off at the seafloor rather than using vibratory removal if requested Level B incidental takes approach threshold limits within a given construction year; however, several additional measures would have to be considered such as construction feasibility because of high tidal currents, additional construction times, magnitude of additional construction costs, additional material costs, required equipment, and potential resource agency concerns of leaving cut-off piles in the substrate
- development of a mitigation plan in case operational noise from the bridge is greater than reported
- continued monitoring of beluga whale presence in relation to tidal stages (low/high) for potential adaptive management measures for temporary pile-driving and removal activities during peak density months, if applicable (opportunity to shorten overall in-water construction schedule)
- brainstorming and coordination with NMFS to identify potential additional conservation measures to actively manage and lessen impacts on beluga whales

13.2 Marine Mammal Monitoring Programs

KABATA is committed to ensuring the Crossing is completed with as little disturbance to belugas as possible. This commitment is demonstrated by the initial implementation of a preconstruction scientific marine mammal monitoring program in 2004 (see Section 4.5). Furthermore, at the time of NMFS issuing the LOA, FHWA, and KABATA will conduct additional preconstruction scientific marine mammal monitoring that will provide more current baseline beluga data that will focus on beluga behavior, movement, and habitat usage.

KABATA will implement additional Marine Mammal Monitoring Programs as the Crossing project continues to move forward: a Scientific Marine Mammal Monitoring Program (mentioned above), Construction Marine Mammal Monitoring Program, and an Acoustic Monitoring Program. Both scientific and construction marine mammal monitoring programs will include real-time acoustic monitoring of the Crossing area beginning with the issuance of the LOA and continuing until the bridge is fully operational. The marine mammal monitoring programs will include all waters within Knik Arm visible from the site of the in-water construction activities located near the Crossing area. These programs are described below.

- The **Scientific Marine Mammal Monitoring Program** will be developed by an independent team of trained marine mammal observers and consist of two monitoring components: land-based visual and acoustic. Objectives of this proposed monitoring program include
  - the frequency of beluga whale presence in the KAC project footprint
  - habitat use, behavior, and group composition near the Crossing area and correlation of these data with construction activities observed reactions of beluga whales in terms of behavior and movement during each sighting

  The scientific monitoring program is further detailed in Section 13.2.1.

- The **Construction Marine Mammal Monitoring Program** will use trained marine mammal observers to
  - monitor the harassment zone (which contains the smaller safety zone) and to work in conjunction with the acoustic monitors to ensure detection and, by enforcing shut-down criteria during in-water pile placement (vibratory and impact pile-driving activities), protection of marine mammals from harassment
  - vessel movement around the construction zones (and Crossing footprint)
  - superstructure placement during construction of the bridge

  The construction monitoring program is further detailed in Section 13.2.2.

- The real-time **Passive Acoustic Monitoring Program** will place bottom-mounted hydrophones north (n = 1) and south (n = 1) of the Crossing area. Each hydrophone will be capable of broadcasting in real-time directly to acoustic monitors on each side of the Crossing at the observer locations, as well as to a separate acoustic monitor in the construction area. This approach will enable acoustic monitors to detect vocalizing beluga whales that may otherwise be undetected and to immediately inform the observers of any acoustic detections. Furthermore, there will be a continuous recording of all in-water noise within the Crossing footprint. The acoustic monitoring program is further detailed in Section 13.2.3.

13.2.1 Scientific Marine Mammal Monitoring Program

The Scientific Marine Mammal Monitoring Program will consist of two components: (1) land-based visual monitoring and (2) acoustic monitoring.

Land-based Visual Monitoring

Data collected during land-based visual monitoring will provide updated baseline information of beluga behavior before, during, and after bridge construction. Monitoring for marine mammals will be conducted using two experienced marine mammal observers at each of the four land-based observation stations (for a total of eight observers) to monitor for whales, porpoises, and seals within the Crossing footprint. Scientific monitoring will be conducted up to 12 hours per day, at least 4–5 days per week (weather permitting), from established land-based beluga whale observation sites at West Crossing, Port Mackenzie, Cairn Point, and Sixmile Creek. The West Crossing and Cairn Point observation stations (Figure 18) will provide a view of the entire harassment zone and waters to the south and facilitate detecting beluga whales swimming toward the KAC construction area after entering Knik Arm. The Sixmile Creek station will assist detecting whales heading south with the ebb tide toward the KAC construction area. The Cairn Point site has also been identified as a place where whales might occur during lower tidal phases (Funk, Markowitz, et al. 2005). Observers at these four sites will also be able to monitor the area within the 180 dB safety zone and the larger harassment zone within which behavioral disturbance might occur (the 160 dB and 125 dB isopleths).

Each observer station will have a digital theodolite with attached portable computer to accurately track the movements of whales and determine their locations relative to the observation platform and any potential source of disturbance. This system will facilitate determination of accurate distances from each shoreline in near-real time. Any observable associated movements of animals will be documented to allow later detailed analysis.

During all observation periods, observers will use tripod-mounted, high-power binoculars and the naked eye to search continuously for marine mammals. Observers will be on 2-hour shifts to avoid fatigue, with rotations every 30 minutes between observer and recorder positions. The following will be recorded:

- species and number of marine mammals seen
- bearing and distance of the mammal(s) from the observation point
- behavior of mammal(s) relative to vessels, shoreline, etc.
- any indications of disturbance or reactions to construction or other activities

Observers will work near the acoustic monitors. This arrangement will allow direct communication between the two monitoring groups and ensure as many animals are detected and monitored as possible. Further discussion of the acoustic monitoring is presented in Section 13.2.3.

FHWA and KABATA will provide monthly reports that document any important changes in seasonal abundance of beluga whales and will adjust exposure estimates and mitigation/monitoring techniques accordingly, in consultation with NMFS.

Acoustic Monitoring

See *Passive Acoustic Monitoring*, Section 13.2.3.

13.2.2 Construction Marine Mammal Monitoring Program

The Construction Marine Mammal Monitoring Program will also consist of two components: (1) land-based visual monitoring (similar to that described in Section 13.2.1) and (2) acoustic monitoring (see Section 13.2.3).

In addition to the regular scientific observers there will be an identical land-based Construction Marine Mammal Monitoring Team, including one or two observers located on the pile-driving barges during pile-driving, pile removal, and oscillatory activities.

Initially, construction monitoring will be conducted during both in-water and land-based construction activities. These monitoring events will serve as a primary way to determine whether land-based activities are having deleterious effects on beluga movement and use of near-shore habitat. If it is determined that land-based construction activities are not negatively influencing beluga movement (through discussions with NMFS), this monitoring will be terminated. If land-based activity is shown to have impacts determined to be negative to beluga movement, then alternatives will be discussed through the Adaptive Management Process with FHWA, KABATA, and NMFS.

Land-based marine mammal observers will be in colocated with the acoustic monitors and have direct contact with the lead construction personnel. Construction observers will document all marine mammal sightings in the same manner as discussed in the *Land-based Visual Monitoring* portion of Section 13.2.1 and will use the same equipment. Construction monitoring will, however, focus on the location of the animals in relation to harassment and safety zones, not behavioral observations. When weather and daylight hours permit, all in-water construction activities will be monitored by properly trained marine mammal personnel.

Communications among observer locations and construction personnel will be maintained with a two-way radio; a cellular phone will be used for back-up communication and safety purposes. The primary task of all observers will be to note whales approaching or within the harassment zone and to then alert the pile-driving and removal operators.

If whales or other marine mammals are sighted within the harassment zone, pile-driving and removal operations will be halted until the animals are outside of the area. If a marine mammal is located within a designated harassment zone while pile driving is taking place, it will be documented as a take. If the harassment zone is obscured by fog or other poor lighting conditions, pile driving or removal will not be initiated or resumed until the harassment zone is visible.

13.2.3 Passive Acoustic Monitoring

The goal of the proposed Passive Acoustic Monitoring Program is to collect acoustic information on marine mammal that will permit detection, identification and localization before, during, and after bridge construction. PAM will be conducted using two sets of hydrophone arrays, one south of the bridge and the second north of the bridge. Each of two the hydrophone arrays will be fixed to piles at known distances and depths apart. The output of each array will be telemetered to a central site using radios, similar to a sonobuoy, and processed in real time such that the identity and location of vocalizing animals can be determined. Given that species diversity in the Knik Arm is low, with only beluga and killer whales likely to be present, the identity of vocalizing animals should not be difficult to determine. Experienced bioacousticians will monitor the output of each array and coordinate the

PAM information with the visual monitoring teams. PAM will be conducted in parallel, but independently, of the visual monitoring. It should be weather-independent. The choice of the location of the arrays will be determined to maximize potential acoustic contacts with migrating animals. The location of the monitoring bioacousticians will be determined to best serve communication with the visual crews. Communication between the visual and PAM teams will be paramount, with each team prompting the other with information about observed animals. The synergies of the two monitoring activities, visual and acoustic, will result in better and more full descriptions of animal presence, location, and behavior relative to noise sources. The two PAM arrays will monitor animal locations and movements in the vicinity of the 180 dB safety zone and the larger harassment zone within which behavioral disturbance might occur (the 160 dB and 125 dB isopleths).

The data available from each PAM will be similar to those available from the observers—a location and identity of all acoustically located animals. Because sound travels so effectively underwater, the distinct advantage of PAM will be that animals can be detected at distances permitting full monitoring of the width of the Knik Arm around each PAM array. Additionally, acoustic contacts do not depend on detection of animals that are only briefly at the surface. It has the disadvantage in that it requires that the animals be vocalizing. Acoustic monitoring conducted at the POA indicates that belugas are more readily heard than seen, with more acoustic detections than sightings (Širović and Saxon Kendall 2009).

Like the visual teams, each PAM station will have a data output system that will permit accurate tracking of animal movements relative to observer location and any potential disturbance source. Likewise, the PAM system will permit accurate (1) locations in near-real time, and (2) characterizations of the movements of animals documented to allow detailed analysis. Additionally, because acoustic data will be recorded, event reconstruction can be more effectively analyzed at a later time. The durations of acoustic contacts is typically greater than those for observations and should permit longer tracking of vocalizing individuals or groups.

Finally, the output levels of the construction equipment, particularly pile drivers, will also be monitored using the PAM arrays. Given that the location of both PAM receiver and sound producer will be accurately known, the source level (the SL in dB re 1 µPa rms calculated to 1 m) can be determined in real time. This information will permit calculation of various isopleths distances of the loudest sound source at any given time.

PAM monitoring will follow protocols similar to the visual teams. During all observation periods, the bioacoustician will monitor the area for sound using both headphones and the output of the acoustic processor as displayed on a computer screen.

13.2.4 Reporting Requrements

KABATA will comply with annual LOA 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 NMFS may require will be provided to NMFS on a weekly, monthly, or such other schedule as may be specified in the issued LOA. Observed stranded or injured marine mammals will be reported to NMFS immediately. Preliminary results of the acoustical measurements, as necessary to refine and validate the harassment zones, will be reported to NMFS as soon as the relevant data can be obtained and analyzed. The acoustic study report identifying sound propagation and harassment isopleths for impact and vibratory pile driving will be made available to NMFS 45 days after completion of the study.

KABATA will submit monthly marine mammal monitoring reports by the 10th of the following month; these reports will include all marine mammal sighting sheets from the previous month and will include:

- a summary of pile-driving hours by type
- marine mammal take numbers and reactions, if any
- summary of the dates and locations of construction operations
- details of each marine mammal sighting
    - date
    - time
    - location
    - whale behavioral activity(ies)
    - associated construction activities
- estimate of the amount and nature of marine mammal take
- any apparent effect(s) on accessibility of marine mammals to habitat or subsistence hunters

The reports will also provide a more complete account of the levels, durations, and spectral characteristics of the impact and vibratory pile-driving sounds. For vibratory and impact pile driving and removal, the peak, rms, and energy levels of the sound pulses and their durations will be reported as a function of distance and bottom depth, as well as depth in the water column.

A final report summarizing all sighting (cumulative construction and scientific marine mammal monitoring) data will be submitted to NMFS no later than 90 days before the LOA expires to allow time for review, approval, and clearance process for the next LOA issuance.

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14 Research Coordination

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

The U.S. Department of Transportation Maritime Administration (MARAD) (on behalf of the POA) and FHWA (on behalf of KABATA) have provided a significant amount of funding and support to marine research in Knik Arm. FHWA and KABATA provided nearly $3 million in funding to support research as applied to beluga whales in the area (Table 14). Research funded by FHWA and KABATA combined with the NMFS survey data and satellite-tagging efforts have made important contributions to the general understanding of beluga (and other marine mammal species) occurrence in upper Cook Inlet.

Table 14 KABATA-supported studies related to beluga whales in Knik Arm, upper Cook Inlet

Description of research	Approximate expenditures ($)
Mitigation of cumulative effects in the Mat-Su (indirect cumulative effects)	270,000
Beluga whale research up to and above efforts as required by NEPA regulations (Funk et al. 2005)	1,850,000
Beluga whale research up to and above efforts as required by NEPA regulations (Ireland, Funk, et al. 2005)	227,000
Beluga whale behavior in relation to in-water structures (see Appendix A)	300,000
Underwater measurements of pile-driving sounds during Port MacKenzie Dock modifications (Blackwell 2005; Burgess et al. 2005; KABATA 2006c)	15,000
Ambient noise monitoring study	160,000
Fish study (Houghton et al. 2005)	200,000
Nonmonetary data sharing: KABATA provided data to POA and to the Mat-Su for the Port MacKenzie Rail Extension project; photo-identification data shared with the partnership of the National Fish and Wildlife Foundation/BP/ConocoPhillips/ Chevron/Shell)	Not quantified
Total	**$3,022,000**

FHWA and KABATA will cooperate with the MARAD, the POA, and other marine mammal researchers in Southcentral Alaska in sharing field data and behavioral observations on beluga whales and other marine mammals recorded in Knik Arm. The information will be shared with other governmental and private groups conducting studies of beluga whales, including NMFS; ADF&G; LGL Alaska Research Associates, Inc.; Alaska Pacific University; Hubbs-Sea World Research Institute; oil and gas companies; and other developers operating in Cook Inlet. As noted in Section 7.7, KABATA has already initiated discussions with the POA and Fort Richardson regarding collaborative monitoring efforts.

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Appendix A

A Review of Beluga Whale Behavior and Response to In-Water Structures

August 18, 2010