The environmental review, consultation, and other actions required by applicable federal environmental laws for this project are being, or have been, carried out by DOT&PF pursuant to 23 U.S.C. 327 and a Memorandum of Understanding dated November 3, 2017, and executed by FHWA and DOT&PF.

Final Environmental Assessment
Kivalina Evacuation and School Site Access Road

Project Number: 0002384/NFHWY00162

January 2018

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Prepared for:

Alaska Department of Transportation & Public Facilities,
Statewide Environmental Office

In Cooperation with:

Northwest Arctic Borough
Native Village of Kivalina
City of Kivalina
NANA Regional Corporation

Prepared by:

State of Alaska
Department of Transportation & Public Facilities, Northern Region
Stantec Consulting Services Inc.
Remote Solutions, LLC

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LIST OF ACRONYMS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AHRS	Alaska Heritage Resources Survey
ANCSA	Alaska Native Claims Settlement Act
APDES	Alaska Pollutant Discharge Elimination System
APE	Area of Potential Effect
ATVs	all-terrain vehicles
AVEC	Alaska Village Electric Cooperative
AWC	Anadromous Waters Catalog
BMP	best management practice
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CGP	Construction General Permit
CKNHL	Cape Krusenstern National Historic Landmark
CWA	*Clean Water Act*
CY	cubic yards
DCCED	Department of Commerce, Community, and Economic Development
DMTS	DeLong Mountain Transportation System
DNR	Alaska Department of Natural Resources
DOT&PF	Alaska Department of Transportation and Public Facilities
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ESA	*Endangered Species Act*
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
ft	feet
ILMA	Interagency Land Management Assignment
IRA	*Indian Reorganization Act*
K-Hill	Kisimigiuqtuq Hill
MBTA	*Migratory Bird Treaty Act*
MLLW	mean lower low water
MMPA	*Marine Mammal Protection Act*
NAB	Northwest Arctic Borough
NANA	NANA Regional Corporation

NEPA	*National Environmental Policy Act*
NLURA	Northern Land Use Research Alaska, LLC
NMFS	National Marine Fisheries Service
NPS	National Park Service
NWI	National Wetland Inventory
PSO	Protected Species Observer
PVC	polyvinyl chloride
ROW	right-of-way
SAIC	Science Applications International Corporation
SEL	sound exposure level
SHPO	State Historic Preservation Office
Stantec	Stantec Consulting Services Inc.
SWPPP	Storm Water Pollution Prevention Plan
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
WAH	Western Arctic Herd

1 PROPOSED ACTION

Project Location

The proposed project origin is at the City of Kivalina, located on the southeast tip of the barrier island located between the Chukchi Sea (Arctic Ocean) and Kivalina Lagoon (Figure 1). The project terminus is located on the mainland across the Kivalina Lagoon approximately six miles northeast at a community selected evacuation site on Kisimigiuqtuq Hill (K-Hill). The Study Area encompasses the Kivalina barrier island, the southern portion of Kivalina Lagoon, and the lower Wulik and Kivalina River drainages.

Proposed Action

The Proposed Action would construct a safe, reliable, all-season evacuation road between the community of Kivalina and K-Hill. A range of route alternatives are being considered (discussed further in Section 3), but common to all are the following actions:

- **Establishment of a safe, reliable, all-season Kivalina Lagoon crossing.** All alternatives include construction of a causeway across the lagoon that variously incorporate different configurations of hydrological openings including bridge(s), culvert(s), or both;
- **Construction of an all-season access road connecting the Kivalina Lagoon crossing to the K-Hill evacuation site.** The road would be designed to accommodate a wide variety of motorized vehicles over a two-way road with shoulders, multiple turnouts, and side slopes that may include guardrail and other safety features (e.g. signage) where determined to be necessary and prudent; and
- **Development of up to four material sources including the K-Hill Site, Wulik River Source 1, Relic Channel Source 1, and Relic Channel Source 2.** These material sources are anticipated to be suitable local sources of select material to supply the project. Selection and development of viable material sources and haul routes are considered as part of the Proposed Action.

2 PURPOSE AND NEED

Background

The community of Kivalina has been working for decades with a variety of local, state, and federal agencies to address threats of coastal erosion and flooding. Numerous study, concept, and planning documents exist on potential solutions, which range from erosion protection around a portion of the barrier island to relocation of the entire community at a new mainland site. Issues surrounding community relocation have been challenging to overcome, as they are neither culturally preferable nor fiscally practicable in the foreseeable future. Consequently, Kivalina proposes to develop a safe, reliable, and direct means of temporary community evacuation to an acceptable mainland location on K-Hill.

Purpose

The Kivalina Evacuation and School Site Access Road project would provide Kivalina residents a safe and reliable evacuation route in the event of a catastrophic storm or ocean surge, allowing evacuees to temporarily mobilize to safe refuge at an assembly site on K-Hill. This site is also identified by the Northwest Arctic Borough School District, and approved by the community, as a preferred new location for the community school. While school construction is remote and speculative[1], if constructed within the vicinity of the project terminus, the school could augment the undeveloped evacuation site by serving as a full-service community emergency shelter with all-season support capabilities.

Need

Recent climate data has indicated that arctic sea ice is forming later in the season, increasing fall and winter storm duration and intensity along the Northwest Arctic coast (Simmonds and Keay 2009; Screen et al. 2013). Consequently, residents of Kivalina face significant and increasing risks to life, health, and safety by storm systems predicted to further intensify over time (Brubaker et al. 2010). The need for a concerted effort to mitigate these risks became more evident during an evacuation event in October 2007, when debris-laden storm waves overtopped the barrier island. The event resulted in the need for helicopters to carry evacuees off the island, and illustrated that Kivalina currently has no safe method of evacuation in the event of a catastrophic storm surge. In the face of this increased threat, Kivalina needs a safe and reliable means of evacuation.

[1] An action or impact occurring at some distance or time in the future that depends on assumptions or events that are contingent, conjectural, or problematic [Eccleston, 2000]

3 ALTERNATIVES

For over a decade, Kivalina and the Northwest Arctic Borough (NAB) have evaluated the feasibility of numerous road routes, lagoon crossing options, and material source locations that could provide for evacuation road construction as well as other infrastructure or general material needs. DOT&PF has been working with the community, local and regional government stakeholders, and state and federal agencies to refine evacuation road alternatives to be evaluated under the *National Environmental Policy Act* (NEPA) (see Figures 2 and 3).

Road Route Alternatives: Three preliminary route options (Northern, Southern, and Combined Route A) were independently proposed by Kivalina and the NAB within the Study Area (Community Proposed Alternatives, Figure 2). These community initiated route concepts were refined and a fourth route was developed (Combined Route B) based on feedback received during public and agency scoping efforts in the fall of 2016. Route alternatives were evaluated for feasibility based on purpose and need; engineering considerations; wetland, fish, and wildlife impacts; number and type of water crossing structures; proximity to material sources; and cost. After evaluation (see Table 1), Combined Route B and the Southern Route have been determined feasible for further consideration. The Southern Route is the Preferred Alternative.

Lagoon Crossing Alternatives: Four lagoon crossing alternatives (Solid Causeway, Solid Causeway with Culverts, Solid Causeway with Culverts and Bridge, and Full Span Bridge) were considered and developed in collaboration with the community of Kivalina, agency stakeholders, and other local and regional stakeholders. Community input was gathered to determine the alternatives' ability to accommodate lagoon boat traffic and local subsistence activities. Agency input was used to evaluate potential resource impacts of the lagoon crossing alternatives. These alternatives were also evaluated for feasibility based on purpose and need, engineering considerations, hydrology, sediment transport, erosion, fish and wildlife passage, habitat impacts, and cost. After evaluation, only the Lagoon Crossing D was determined feasible and is carried forward for further evaluation (Table 1).

Material Source Location Alternatives: Four general areas known to contain potentially viable sources of various project materials were evaluated in past studies. Several material source locations within these areas were evaluated for feasibility based on proximity to potential routes, quantity and quality of material, access constraints, and potential impacts to protected resources (Golder Associates 2013). After evaluation, four potential sources within these areas have been determined feasible and are carried

forward for further evaluation (K-Hill, Wulik River Channel Source 1, Wulik Relic Chanel Source 1 and 2).

- **K-Hill**: K-Hill geology is characterized by exposed limestone and rock rubble at the ground surface. It is anticipated that sub-surface, larger frost-fractured rocks and boulders may also exist that may be suitable for armoring the lagoon crossing (Golder Associates 2013). Although the full extent of K-Hill has not been characterized for material availability and quality, one potential material source on the southeast side of K-Hill has been identified;
- **Wulik River Deposition:** This area is characterized by gravel deposits that contain suitable materials for construction of the proposed road (Golder Associates 2013). Three known locations with the potential for material extraction have been identified in the Wulik River Deposition area;
- **Wulik River Relic Channel**: This area is characterized by gravel and sand at the ground surface and contains suitable materials for construction of the proposed road (Golder Associates 2013). The Wulik River Relic Channel contains three known locations with the potential for material extraction; and
- **Kivalina River Deposition**: This area is characterized by gravel bars that contain suitable materials, with the potential for extraction, for construction of the proposed road (Golder Associates 2013). This area contains several gravel bars with the potential for material extraction.

3.1 Alternatives Evaluation

The following road route, lagoon crossing, and material source location alternatives (Figures 2 and 3) were evaluated based on the criteria detailed above and determinations were made to dismiss them without further study or carry them forward for full environmental assessment.

Table 1 Alternatives Evaluated

Alternative	Description	Alternative Evaluation
Lagoon Crossing Alternatives		
Crossing A	**Solid Causeway.** Lagoon Crossing A would require an approximately 3,200 ft solid earthen causeway armored with roughly 4 ft thick armor stone and under layer stone. A series of smaller overflow pipes would be placed in even increments over the length of the solid portions of the causeway to provide conveyance during high water events.	**This alternative is dismissed from further evaluation** as it does not meet environmental requirements regarding continued passage of fish and marine mammals, and may cause adverse impacts to natural hydrological regimes. It also does not allow for boat passage, which is preferred by the community.
Crossing B	**Solid Causeway with Culverts.** Lagoon Crossing B would require an approximately 3,200 ft solid earthen causeway armored with roughly 4 ft thick armor stone and under layer stone. Multiple large culverts, designed to accommodate all life-stage passage of fish, would be constructed at both the southwest and northeast end of the causeway. In addition, a series of overflow pipes would be placed incrementally over the length of the causeway to provide additional conveyance during high water events.	**This alternative is dismissed from further evaluation** as it does not meet environmental requirements regarding continued passage of marine mammals. It also does not allow for safe or efficient boat or snow machine passage beneath the causeway, which is preferred by the community.
Crossing C	**Full Span Bridge.** Lagoon Crossing C would require an approximately 3,200 ft bridge to cross the lagoon to the mainland.	**This alternative is dismissed from further evaluation** due to several factors: 1. Prohibitive cost ($90-$110M). 2. Substantially greater construction noise and vibration impacts, spread out over multiple seasons (a 30 span bridge would be required), as well as additional temporary work trestles with additional pile impacts. 3. Increased construction time (anticipated four full construction seasons would be required) would delay safe and reliable evacuation route in the event of a catastrophic storm surge.
Crossing D (Preferred Alternative)	**Solid Causeway with Culverts and Bridge.** Lagoon Crossing D would require an approximately 3,020 ft solid, armored, earthen causeway. A single span bridge would cross the existing 110 ft lagoon channel located approximately 160 ft northeast from the barrier island. Large culvert(s) designed to accommodate all life-stage passage of fish, would be constructed at the northeast end of	**This alternative is considered feasible and is incorporated in the Preferred Alternative**. Crossing D provides the most feasible lagoon crossing option that balances community preference, cost, and environmental considerations. The single span bridge across the lagoon channel, large culvert pipes on the northeast end of the causeway, and a series of overflow pipes over the length of the causeway would

Alternative	Description	Alternative Evaluation
	the causeway. A series of overflow pipes would be placed incrementally over the length of the solid portions of the causeway to provide additional conveyance during high water events.	minimally impact natural hydrological regimes. The bridge over the existing lagoon channel would also provide passage of fish and marine mammals as well as boat passage for the local community.
Evacuation Route Alternatives		
Northern Route	**The Northern Route** was originally proposed by the community of Kivalina and the NAB, and later refined by DOT&PF subsequent to the public and agency scoping process. The Northern Route is approximately 9.5 miles in length. The route would originate near the south end of the Kivalina Airport, parallel the runway on its northeast side northward for approximately 1.5 miles, cross the lagoon eastward via a causeway and/or bridge, and follow higher ground between the Wulik and Kivalina Rivers to its terminus at K-Hill.	**This route is dismissed from further evaluation** as it does not meet the purpose and need of the project by failing to provide a safe and reliable evacuation route in the event of a catastrophic storm surge. The Northern Route would require Kivalina residents to travel 1.5 miles along the barrier island during an evacuation when prolonged exposure to debris laden waves would increase danger during transit. In addition, the Northern Route would require a large amount of fill to be placed in Kivalina Lagoon marine intertidal wetlands for the portion of the route that parallels the airport in order to remain compatible with adjacent aviation related land uses. This would cause additional environmental impacts and significant cost increase.
Combined Route A	**The Combined Route A** was originally proposed by the community of Kivalina and the NAB, and is approximately 8.6 miles in length. Combined Route A would follow the Northern Route northward along the barrier island, across the lagoon, and then eastward for approximately 4.1 miles before merging with the Southern Route via a one mile long connecting segment.	**This route is dismissed from further evaluation** as it does not meet the purpose and need of the project by failing to provide a safe and reliable evacuation route in the event of a catastrophic storm surge. It follows the same route along the barrier island as the Northern Route and would put residents in potential danger during an evacuation by prolonging exposure to intense storm surge waves and debris. In addition, the Combined Route A would require a large amount of fill to be placed in Kivalina Lagoon marine intertidal wetlands for the portion of the route that parallels the airport in order to remain compatible with adjacent aviation related land uses. This would cause additional environmental impact and significant cost increase. The mainland portion of the route deviates southward from the Northern Route to provide a shorter, more direct route to K-Hill. However, the more direct route would require additional water crossings and traverse additional lowlands.

Alternative	Description	Alternative Evaluation
Southern Route (Preferred Alternative)	**The Southern Route** was originally proposed by the community of Kivalina and the NAB, and later refined by DOT&PF subsequent to the public and agency scoping process in fall 2016. The Southern Route is approximately 7.7 miles in length and would begin near the south end of the Kivalina Airport, immediately cross the lagoon eastward, and follow lowlands between relic channels of the Wulik River to K-Hill. The embankment northeast of the lagoon would be armored with rock.	**This route is considered feasible and is the Preferred Alternative**. The Southern Route was identified as a feasible option as it follows the most direct path from the community across the Kivalina Lagoon to the mainland and therefore provides the safest, most reliable evacuation route across the lagoon in the event of a catastrophic storm surge. The mainland portion of the route lies between the active Wulik River and a series of relic channels and is proximal to several viable material source options on either side of the route. The route also minimizes impacts by following the shortest, most direct mainland route to the terminus.
Combined Route B	**The Combined Route B** is approximately 8.9 miles long and was developed subsequent to public and agency scoping. The route would begin near the south end of the Kivalina Airport, immediately cross the lagoon eastward, and follow lowlands and relic channels of the Wulik River for approximately 5 miles before shifting northward, following higher ground approximately 3.9 miles to the terminus. The embankment northeast of the lagoon would be armored with rock.	**This route is considered feasible** and carried forward for further evaluation. Combined Route B was identified as a feasible option as it follows the most direct path from the community across the Kivalina Lagoon to the mainland and therefore provides the safest, most reliable evacuation route across the lagoon in the event of a catastrophic storm surge. The Combined Route B shifts northerly off the southern route through a series of relic channels of the Wulik River where multiple viable material sources have been identified. The route's immediate proximity to material sources would minimize impacts associated with temporary access to material sources.
Material Source Alternatives		
K-Hill Site	This site consists of predominately limestone material located on the southeast side of K-Hill. A 100 acre material source within this area would support materials extraction, staging, and a construction camp. This site is expected to produce up to ~1,000,000 cubic yards (CY) of select material suitable for use in the roadway embankment, crushable material for use as roadway surfacing, and rock for potential use as armor stone.	**This alternative is considered feasible** and carried forward for further evaluation. The K-Hill Site is situated adjacent the terminus of all route alternatives. Material quality is anticipated to be suitable for use in the roadway embankment, for use as crushed surfacing material, and for potential use as armor stone. Once reclaimed, the developed area could be utilized as a potential evacuation site for the community.

Alternative	Description	Alternative Evaluation
Wulik River Source 1	This source is located on a point bar along the west banks of the Wulik River. The source consists of unvegetated and vegetated gravel bars in the floodplain and wetlands outside of the floodplain. A 40 acre material source within this area is expected to produce up to ~240,000 CY of well graded alluvial gravels, suitable for use in the roadway embankment, and roadway surfacing.	**This alternative is considered feasible** and carried forward for further evaluation. Wulik River Source 1 is located proximal to route alternatives and is anticipated to produce a high volume of high quality alluvial material suitable for use as embankment fill and crushed surfacing. The source is also centrally located along the route alternatives to minimize haul distance to construct the causeway embankment.
Wulik River Source 2	This source is located on a point bar along the west banks of the Wulik River. The source consists of unvegetated gravel bars in the floodplain and wetlands outside of the floodplain. A material source within this area is expected to produce poorly graded alluvial gravels with sand, suitable for use in the roadway embankment, and potentially as crushable material for roadway surfacing.	**This alternative is dismissed from further evaluation.** Wulik River Source 2 is located a long distance from the route alternatives and would require construction of a spur road in excess of one mile over wetlands. Access to the source would also require crossing a minor channel of the Wulik River.
Wulik River Source 3	This source is located along the west banks of the Wulik River. The source consists of unvegetated gravel bars in the floodplain. A material source within this area is expected to produce up to ~50,000 CY of alluvial gravel and sand, suitable for use in the roadway embankment and potentially as crushable material for roadway surfacing.	**This alternative is dismissed from further evaluation**. Wulik River Source 3 is located a long distance from the route alternatives and would require construction of a spur road in excess of one mile. The material quality is suitable for use as embankment material and potentially as crushable surfacing material, however the anticipated material quantity is small.
Relic Channel Source 1	This source is located within wetlands associated with relic channels of the Wulik River. A 50 acre material source within this area is expected to produce up to ~250,000 CY of gravel and sand, suitable for use in the roadway embankment and possibly as crushable material for roadway surfacing in limited quantities.	**This alternative is considered feasible** and carried forward for further evaluation. This source is immediately proximal to route alternatives and is centrally located to provide minimal haul distance to construct the causeway and roadway embankment.
Relic Channel Source 2	This source is located in wetlands located within relic channels of the Wulik River. A 40 -acre material source within this area is expected to produce up to ~200,000 CY of gravel and sand, suitable for use in the roadway embankment and possibly as crushable material for roadway surfacing in limited quantities.	**This alternative is considered feasible** and carried forward for further evaluation. This source is immediately proximal to route alternatives and is centrally located to provide minimal haul distance to construct the causeway embankment.

Alternative	Description	Alternative Evaluation
Relic Channel Source 3	This source is located within relic channels of the Wulik River and tidal area of the Kivalina lagoon. A material source within this area is expected to produce gravel and sand, suitable for use in the roadway embankment, but likely unsuitable as crushable material for roadway surfacing.	**This alternative is dismissed from further evaluation** because of its long distance from route alternatives, proximity to tidelands, and the added cost and wetland impacts associated with constructing access to the source. The anticipated quantity of material is limited, and quality expected from the source is likely only suitable as roadway subbase in the embankment and likely unsuitable as crushed material for roadway surfacing.
Kivalina River Source	This source is located on a point bar along the east banks of the Kivalina River. The source consists of unvegetated gravel bars in the floodplain and wetlands outside of the floodplain. A material source within this area is expected to produce alluvial gravel and sand, suitable for use in the roadway embankment, and potentially as crushable material suitable for roadway surfacing.	**This alternative is dismissed from further evaluation** because of its long distance from route alternatives and the added cost and wetland impacts associated with constructing access to the source.

3.2 No-Action Alternative

Under the No-Action Alternative, an evacuation road would not be constructed from Kivalina to K-Hill. Residents would continue to be exposed to environmental threats with no safe way to evacuate during storm events with the potential to detrimentally impact the community over time. As a consequence, there would remain severe risk to life, health, and safety of residents during a storm surge event.

3.3 Evacuation Road and Lagoon Crossing Alternatives Carried Forward

3.3.1 Preferred Alternative: Southern Route with Lagoon Crossing D

The Southern Route is approximately 7.7 miles in length and would begin adjacent to the Kivalina Airport, immediately cross the lagoon, and follow lowlands and relic channels of the Wulik River to a permanent 5 acre gravel staging pad configured to not preclude later development of a community evacuation site (Figure 4 and 5).

The 3,200 ft lagoon crossing would require construction of an earthen causeway protected with a layer of armor stone, a bridge, and culvert(s). The top of the causeway would be at an elevation to accommodate the anticipated maximum potential storm surge and design wave for no less than a 100 year recurrence event (Appendix B). The bridge would be constructed over the existing 110 ft wide lagoon channel, located approximately 160 ft northeast from the barrier island. The bridge would be a pile supported structure with sloped, rock protected earthen abutments or vertical sheet pile walls, and be designed to span the entire lagoon channel width to minimize potential impact to natural channel dimensions and function. Large diameter culvert(s), located near the northeast end of the causeway, would accommodate passage of all life-stage fish and maintain flow within a discontinuous channel. Overflow pipes would be spaced regularly in series over the length of the causeway at an elevation providing hydraulic conveyance during high water events to protect the evacuation road and community from potential flooding.

The road would be constructed within a 300 ft right-of-way (ROW) and consist of a 24 ft wide, two-lane/two-way gravel surface with edge markers or the appropriate roadside hardware for improved safety and visibility during winter use. The embankment would be constructed with a minimum of 3 (horizontal) to 1 (vertical) side slopes for safety, thermal stability, and to minimize snow drifting. The road would be surfaced with crushed aggregate. Side slopes and all other disturbed areas would be seeded with regionally appropriate seed mix that minimizes introduction of noxious weeds. Roadway embankment height would average between 5 and 8 ft above existing ground. Greater embankment thickness would occur at natural grade depressions and over water crossings. An average embankment thickness of 6 ft

would minimize impacts from drifting snow and the thawing of permafrost in the Study Area. The roadway would end at a permanent 5 acre gravel staging pad configured to not preclude later development of a community evacuation site (Figure 4).

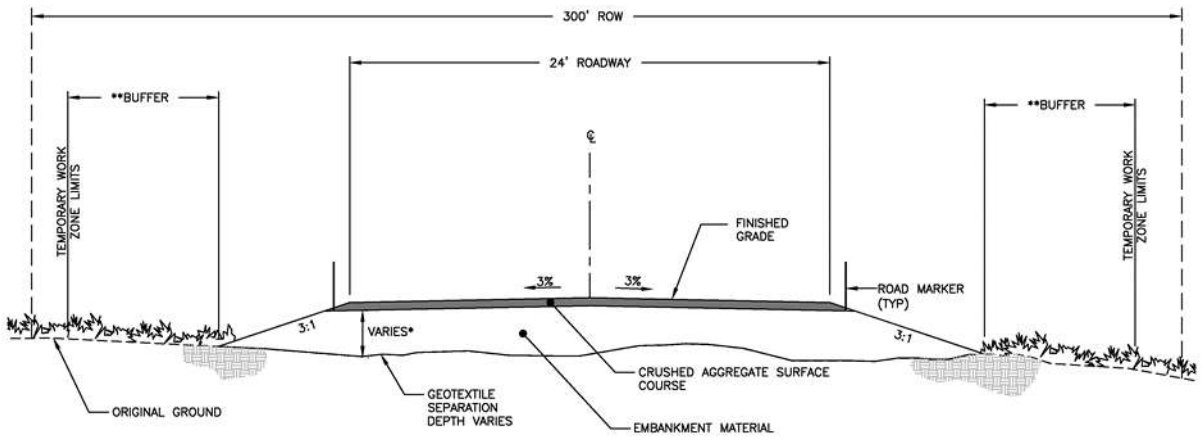

Exhibit 1 Typical Evacuation Road Cross Section

Culverts would be placed at appropriate locations along the roadway to accommodate cross drainage, with larger culverts placed along identified permanent and intermittent water crossings. Culverts at water crossings would be designed to accommodate icing conditions. Culverts may require outlet aprons with rip rap of various thicknesses in locations with significant flow. Insulation board may be used under culvert crossings and the roadway embankment in areas of degrading permafrost.

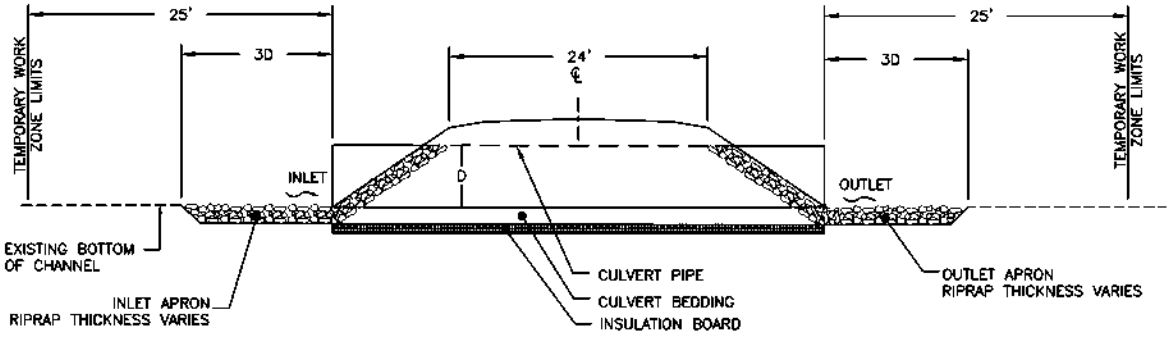

Exhibit 2 Typical Culvert Detail

Turnouts would be constructed along the road and would consist of a 25 ft wide by 200 ft long area adjacent to either side of the road to accommodate vehicle parking and equipment turnarounds. One turnout per mile is expected to be constructed, along with gradual side slopes to help facilitate exit from and entrance onto the roadway. Ongoing maintenance and operations would take place to ensure year-round use, maintain drainage structures, implement dust control, and provide snow plowing.

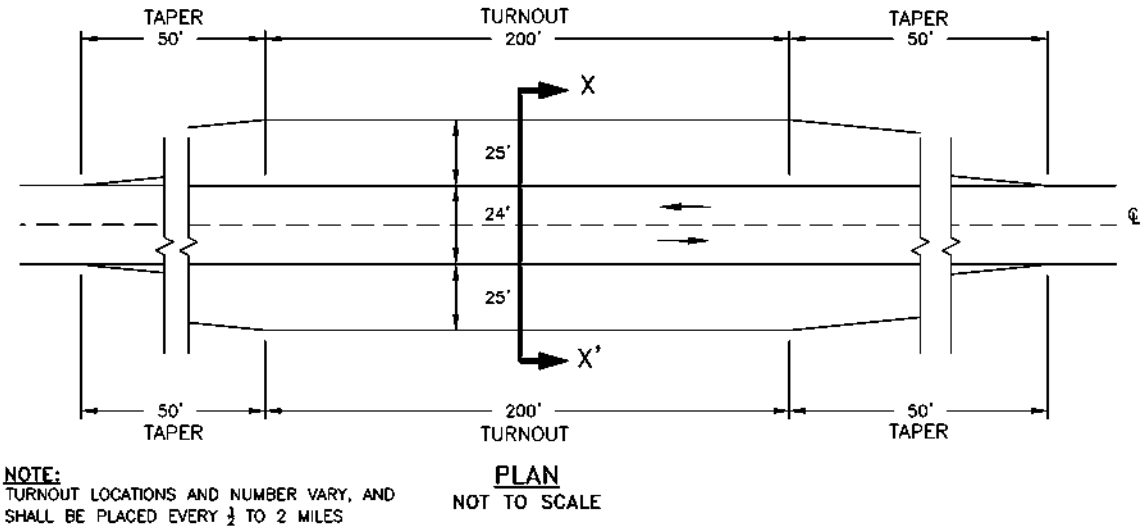

Exhibit 3 Typical Vehicle Turnout Plan

3.3.2 Combined Route B with Lagoon Crossing D

The Lagoon Crossing D for this alternative is the same as proposed for the Southern Route, consisting of an approximately 3,200 ft long earthen causeway with a bridge and culvert openings (Figure 3).

The Combined Route B is approximately 8.9 miles in length and would begin adjacent to the Kivalina Airport, immediately cross the lagoon, and follow lowlands and relic channels of the Wulik River for approximately 5 miles before shifting northward, following higher ground approximately 3.9 miles to the permanent 5 acre gravel staging pad configured to not preclude later development of a community evacuation site (Figure 4).

Combined Route B would be constructed similarly to the Southern Route with the exception that three additional water crossings are required.

3.4 Material Source Alternatives Carried Forward

Based on reconnaissance field work and limited subsurface investigations, the following material sources are expected to supply materials required to construct the proposed project, and are carried forward for consideration: K-Hill Site, Wulik River Source 1, Relic Channel Source 1, and Relic Channel Source 2 (Table 1 and Figure 4). These sources would be made available to the contractor for development of the Preferred Alternative, with the K-Hill site and Relic Channel sources given highest priority, and the Wulik River Source used last, if needed, once the other sites have been exhausted of the needed material. Details regarding typical methods for development of these sources are described in Section 4.3.

4 ENVIRONMENTAL CONSEQUENCES

4.1 Overview

This section describes the existing environment that would be affected by Proposed Action alternatives, and establishes a baseline for their comparison and selection. Direct, indirect, secondary (induced), and cumulative environmental impacts of alternatives are analyzed as are temporary impacts associated with construction including haul routes, material source development, and permanent pads used for contractor staging areas.

Direct effects are caused by an action and occur at the same time, whereas indirect effects are caused by an action and occur later in time or farther removed in distance. Cumulative and secondary (induced) impacts result from incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions regardless of what entities (agencies or persons) undertake such other actions.

This section is organized to concurrently discuss impacts of all alternatives, and highlight differences in alternatives' impacts in tabular format within each resource category as many potential impacts are the same across the range of Proposed Action alternatives. This allows for a streamlined description of potential impacts and their comparison across alternatives for each resource category.

4.2 Past, Present, and Potential Future Actions

Cumulative impacts to the natural and human environment occur as a result of a synergy between Proposed Action effects and those of other past, present, and potential future actions taking place within the same geographic area.

For the proposed project, no past actions are considered as no recent actions have taken place within the Study Area. One action presently occurring within the Study Area includes implementation of runway and coastal erosion control measures at the existing Kivalina Airport. An action potentially occurring within the Study Area in the future includes development of a school project near the proposed road terminus. The potential school project and its location is in the early planning stages and at this time is remote and speculative. Details about what the school project would entail is not known. Therefore, potential impacts associated with that action are acknowledged, but a full assessment is not completed.

No other viable potential future actions are identified at this time. While community relocation has been discussed for some time, it is not considered reasonably foreseeable. At present, the community supports construction of an evacuation road due to the immediate threat of storm events.

Secondary (Induced) impacts may occur as a result of the proposed project. Several Alaska Native allotments lie adjacent to the Study Area (Figure 4) and development of these and other adjacent public and private lands may occur consequent to road development. In addition, temporary material sources developed in support of this project may be further developed or expanded for community use.

4.3 Potential Construction Methods

Potential construction methodology may vary across such elements as timing of construction, contractor methods, locations of permanent pads used for contractor staging areas, camps, haul routes, and sequencing of activities. This section describes typical construction methods that may be employed for the Proposed Action alternatives.

4.3.1 Contractor Staging and Haul Route Development

Large equipment and bulk supplies necessary for construction may be flown or barged to the project area. Due to the availability of local material for this project, use of project specific barges that would transport material and equipment solely to and from the project area is not anticipated. It is anticipated that the contractor will utilize barges that regularly service communities in the region to deliver equipment or other materials needed to construct the project.

Initial mobilization activities may require temporary storage of equipment and fuel in the community of Kivalina or at the DeLong Mountain Transportation System (DMTS) port site. Some equipment and material may be barged directly to the Kivalina barge landing, or the contractor may choose to utilize the DMTS port site, and then haul the material and equipment to Kivalina in the winter along a winter ice road. Once sea ice is formed and ground is frozen, equipment could be moved to Kivalina on a 16 mile ice road (if at the port site) and then inland for development of material sources and construction of roadway embankments (Figure 4). Mobilization and demobilization activities would result in a moderate increase in the use of Kivalina infrastructure.

Construction may require two or more work seasons. In addition to available space near the Kivalina Airport, two permanent pads used for contractor staging areas may be constructed, including one on the northeast side of the lagoon for the storage of fuel, equipment and embankment material, and another at the K-Hill Site for a temporary construction camp, material and equipment staging area, and a rock quarry. No disposal sites are anticipated for this project. Any temporary stockpiling of material is anticipated to take place within contractor staging areas. All construction-related waste would be hauled off site by the contractor at the end of the project.

4.3.2 Lagoon Crossing

Construction of the lagoon crossing may include in-water placement of fill, bridge support pile driving, and placement of culvert(s). Placement of fill is generally done during ice-free conditions, but several construction components associated with the lagoon crossing could be completed in the winter. Grounded ice in shallow depths of the lagoon could be removed allowing placement of the base causeway embankment layer and rock protection with no, or minimal water present, thereby minimizing disturbance of fine sediments. Pile driving would take place on both sides of the bridge opening, and consist of driving piles at each abutment. The final design of the bridge foundation would establish the specific number, size, and depth of the pilings.

For evaluating potential impacts, the following assumptions are made:

- Four piles per abutment for a total of eight piles would be required to construct the single span bridge;
- Piles would typically be 3 ft diameter steel pipes, driven roughly 100 to 150 ft deep. Each abutment would require roughly 3–5 days to construct; and
- Pile driving will be conducted on land, through constructed embankments;
- Pile driving would occur over approximately 30-60 days, not continuous, in which the shift duration would be guided by agency recommendations. The contractor's methods could potentially alter the frequency and duration.

Both winter and summer construction activities are anticipated. Pile driving windows and durations would be established to minimize hydraulic and noise impacts to fish, birds, and marine mammals. The bridge work would likely utilize cranes and other equipment working from the new causeway fill.

Best management practices (BMPs) to minimize water quality and habitat impacts would be developed and implemented.

4.3.3 Evacuation Road

For evaluating potential impacts, the following assumptions are made.

- Arctic road construction in areas dominated by tundra underlain with continuous permafrost would begin in the winter after the ground freezes;
- Road and drainage structure construction would continue during summer months and may require temporary bridges and culverts to provide for seasonal drainage;

- A leveling course of gravel may be required under geotextile depending on local ground conditions;
- Vegetative clearing would be limited to brush removal within the roadway footprint, however the existing organic mat would not be removed;
- Temporary construction impacts may occur within a 25 ft area outside the roadway embankment footprint, and would be permitted for use for contractor equipment access, culvert installation, and placement of sediment control (BMPs);
- Water crossings would include placement of appropriately sized drainage structures, with additional cross culverts installed along the roadway as needed to equalize drainage;
- Excavation would be avoided to minimize thermal degradation of subgrade permafrost;
- Installation of larger culverts needing bedding materials for fish passage or for maintaining stream flow would require diverting flow into a temporary channel while constructing the structure;
- Use of temporary bridges, temporary culverts, and pumping may also be employed;
- Disturbed areas outside the roadway footprint would be stabilized; and
- Ongoing maintenance and operations would take place to ensure year-round use, maintain drainage structures, implement dust control, and provide snow plowing.

Both winter and summer construction activities are anticipated. Construction windows and durations would be established to minimize impacts when fish, birds and wildlife are more abundant.

4.3.4 Material Source Development

Methods and means used to develop project material sources would be determined by the selected construction contractor.

For evaluating potential impacts, the following overall assumptions are made:

- Access to and development of selected material sources may occur year-round;
- Extracted materials, not hauled and placed, may be stockpiled within a material source or staging area for later use; and
- Construction windows and durations would be established to minimize impacts when fish, birds, and wildlife are more abundant.
- The K-Hill site and Relic Channel sources given highest priority, and the Wulik River Source used last, if needed, once the other sites have been exhausted of the needed material

4.3.4.1 K-Hill Site

The following assumptions outline the material source development methodology for the K-Hill Site:

- A quarry site on K-Hill would be likely accessed when the ground is frozen and equipment can travel overland;
- The site would be developed by removing overburden and temporarily stockpiling for reclamation activities;
- Materials from the site are expected to be used for constructing staging areas and roadway embankments;
- Ripping, drilling, and blasting would likely be used to remove overburden as well as to produce select material and armor rock from subsurface deposits; and
- Quarry excavation would be benched to maintain slope stability, drainage, and access for development and reclamation activities.

4.3.4.2 Wulik River Source 1

The following assumptions outline the material source development methodology for the Wulik River Source 1:

- A material source would be initially developed along the west bank of the Wulik River when ground is frozen and water levels are relatively low;
- Excavation may occur below the water table; however, a minimum of 100 ft buffer would be maintained between the active river channel and the excavation area;
- Source development would require excavation of overburden that may be used for reclamation. Material would be extracted, hauled, and placed using conventional equipment, though blasting may be necessary if permafrost is encountered;
- Material source reclamation would include converting the source into a pond. A fish escapement channel may be connected to the Wulik River to prevent trapping fish;
- The Southern Route, the Preferred Alternative, would require a 1,500 ft spur road to access this source (Exhibit 4 and Figure 4); and
- Combined Route B would require a 4,500 ft spur road to access this source.

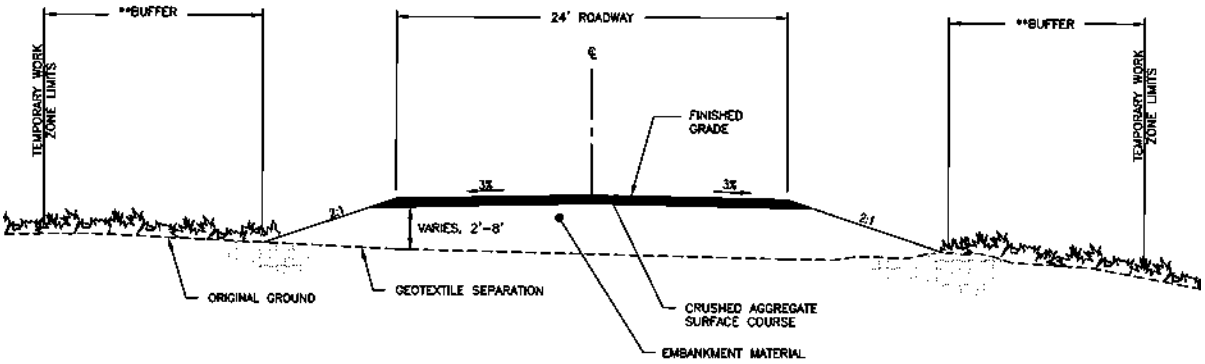

Exhibit 4 Typical Permanent Material Source Spur Road Cross Section

4.3.4.3 Wulik Relic Channel Sources 1 and 2

The following assumptions outline the material source development methodology for the Wulik Relic Channel Source 1 and 2:

- Material sources adjacent to the relic channels of the Wulik River would be developed as a series of deep cells extending below the water table;
- Blasting may be required depending on the presence of permafrost, moisture content, and types of materials encountered;
- The Southern Route, the Preferred Alternative, would require a 3,000 ft spur road to access the Wulik Relic Channel Source 1 (if all the material sites are developed);
- The Combined Route B alternative would require a 4,550 ft spur road to connect to the Wulik Relic Channel Source 1 (if all the material sites are developed).
- Wulik Relic Channel Source 2 would require development of a 2,000 ft spur road to the preferred Southern Route alternative (if all the material sites are developed); and
- Sources would be reclaimed by excavating ponds and may be connected to existing relic channels, that could provide potential overwintering habitat for juvenile fish.

4.4 Non-Issue Resource Categories

This EA is issue-based, meaning that only resource categories that were identified as potential issues through public and agency involvement are evaluated in detail. Table 2 summarizes resource categories identified as non-issues, and consequently not discussed further in this document.

Table 2 Non-Issue Resource Categories

Resource Category	Evaluation
Noise	• Land uses along the road corridor are not noise sensitive uses, including aviation, industrial, undeveloped lands zoned for subsistence uses, and undeveloped Native Allotments (Categories F and G in 23 CFR 772). • Noise sensitive receivers occur within the community of Kivalina, but are more than 400 feet outside the proposed ROW corridor. Noise sensitive receivers include residences, the McQueen School, and other public buildings. Impacts to noise sensitive receivers are not anticipated. • Kivalina has ~412 residents that primarily use all-terrain vehicles (ATVs) and snowmobiles to currently access the Study Area; the evacuation road is not anticipated to increase noise levels along the route. • The Northwest Arctic Borough (NAB), which is responsible for land use planning in the Study Area, and NANA, the primary land owner of undeveloped lands, have been involved in the development of the Proposed Action, and have not expressed concerns about noise-related impacts. • Construction-related noise impacts are discussed throughout this EA in each applicable resource category.
Air Quality	• The Study Area has no Non-Attainment areas for national air quality criteria pollutants. Accordingly, the State Implementation Plan does not have any special control strategies that apply for air quality concerns in the Study Area. • Federal Highway Administration (FHWA) does not require the project to undergo a transportation conformity analysis for carbon monoxide or particulate matter with an aerodynamic diameter of 10 microns or less because the Study Area is not located in Non-Attainment or Maintenance areas (40 Code of Federal Regulations [CFR] Parts 51 and 93). • Temporary impacts from construction would be minimized through compliance with the Alaska Pollutant Discharge Elimination System (APDES) which would include development of dust control Best Management Practices associated with the project's Stormwater Pollutant Prevention Plan (SWPPP). • Cumulative impacts to air quality from fugitive dust may occur from future use of the road. However, given the relatively low levels of traffic the impacts from fugitive dust would be minimal. A long term operation and maintenance contract will be developed with the community that will include measures for dust control.
Farmlands	• There are no prime or unique farmlands in the Study Area, as defined by the *Farmland Protection Policy Act* of 1981, Public Law 97-98.

Resource Category	Evaluation
Natural Resources and Energy Supply	• The proposed project would not change the energy requirements for the community of Kivalina. • Fill material, construction materials, and other natural resources are required for construction. Adequate supplies are expected to be available through local sources with some material being imported. • Energy resources needed for construction camps and temporary facilities associated with construction are expected to be relatively small, and would be predominantly self-contained. • The proposed project would not cause demands exceeding available or future natural resource or energy supplies. The project would likely increase accessibility to additional natural resources.
Coastal Resources	• The Alaska Coastal Management Program expired on June 11, 2011 and is no longer in effect. Although a state coastal consistency determination is no longer required, the NAB Comprehensive Plan (1993) and the Northwest Area Plan (DNR, 2008) were evaluated to confirm no adverse coastal impacts occur within the Study Area and the project is consistent with coastal resource management referenced in these plans.

4.5 Land Use and Transportation

4.5.1 Affected Environment

The community of Kivalina lies on a barrier island with no access road (see also Section 1, Project Location), relying on supplies solely delivered by air and barge. There is year-round air service to Kivalina, although severe weather often prevents air travel. Community residents use all-terrain vehicles (ATVs), snow machines, and boats as personal modes of transportation within the community and to access subsistence use areas. There are no reliable transportation options for evacuation during storm surge events. Land ownership within the Study Area includes NANA, Native allotments, DOT&PF, and the Alaska Department of Natural Resources (DNR). The following describes land uses, formal land use plans, and long range transportation goals within the Study Area:

- The undeveloped Study Area is within a NAB Subsistence Conservation zoning district (NAB 2011). Subsistence Conservation zoning districts are designated for natural ecosystem conservation, subsistence resource access, subsistence harvest lands, and are of high importance for subsistence resources and activities (NAB 1993);
- The Northwest Arctic Borough Comprehensive Plan (NAB 1993) contains language specifying that the NAB needs to develop a system of managing lands in the best interest of Borough residents and assist communities and regional organizations with identifying and solving problems with infrastructure development. Additionally, the Comprehensive Plan states that the NAB would work with villages to identify transportation priorities for the region;

- The Northwest Alaska Transportation Plan (DOT&PF 2004) recommended the community of Kivalina either move inland to avoid storm surges or fortify its surrounding shoreline. Issues surrounding community relocation have been challenging to overcome, as they are neither culturally preferable nor fiscally practical in the foreseeable future;
- The Kivalina [2016-2026] Comprehensive Community Development Plan identified the permitting and construction of the evacuation road as the #1 top Native village and city priority for Kivalina (NAB and Remote Solutions, LLC);
- The Kivalina Strategic Management Plan (Department of Commerce, Community, and Economic Development [DCCED] 2016) identifies the immediate need to develop an evacuation road so residents have a safe place of refuge for use in an emergency;
- The Native Village of Kivalina Long Range Transportation Plan (WHPacific 2012c) identifies the Kivalina Evacuation Road as a high priority transportation project;
- The DNR Northwest Area Plan (DNR 2008) states that permanent roads should be routed, to the extent feasible and prudent, to avoid long-term adverse effects on water quantity and/or quality, and surface access routes should be sited and designated to accommodate future development and avoid unnecessary duplication;
- The Study Area is located entirely within the Cape Krusenstern National Historic Landmark (CKNHL), managed by the National Park Service (NPS) (NPS 2016a), and established to preserve extensive archaeological resources in the area. Section 4(f) of the *U.S. Department of Transportation Act* would apply to any use of land identified within the CKNHL;
- Kivalina Lagoon includes a small portion of the Alaska Maritime National Wildlife Refuge (Chukchi Sea Unit; USFWS 2017a) consisting of two islands, totaling 75 acres, owned by NANA, and located directly southeast of Kivalina at the mouth of the Wulik River (Figure8). Another 116 acres of the Refuge, also owned by NANA, are located 4 miles south of the community and effectively constitute the land spit separating Imikruk Lagoon from the Chukchi Sea. None of the proposed alternatives would include development within the Alaska Maritime National Wildlife Refuge; and
- 17(b) easements are reservations of use to allow access across lands conveyed to Alaska Native Village and Regional Corporation in the Alaska Native Claims Settlement Act. Three 17(b) easements are present in the project vicinity. Two of these easements make up the trail that allows for winter travel between Kivalina and both Point Hope and Noatak. One easement runs along the shoreline north and south of Kivalina. This is the route proposed to the DMTS port for the proposed Haul Route (Figure 4).

4.5.2 Environmental Consequences

4.5.2.1 No Action Alternative

An evacuation road would not be constructed and no changes to current land use or transportation infrastructure would occur. As a consequence, there would remain severe risk to life, health, and safety of residents during a storm surge event with the potential to detrimentally impact the community over time. There would be no reliable transportation options for evacuation during storm surge events. Implementing this alternative would be inconsistent with the Native Village of Kivalina Long Range Transportation Plan (WHPacific 2012c).

4.5.2.2 Route and Lagoon Crossing Alternatives

Direct and Indirect Impacts:

Changes to Traffic: Availability of a road for travel would increase traffic in the area for subsistence, recreation, and other land uses. Traffic is expected to consist of primarily ATVs or snow machines, currently the primary modes of transportation in Kivalina. Few highway vehicles are present due to the lack of suitable support infrastructure.

Consistency with Land Use Plans: The proposed route and lagoon crossing alternatives are consistent with local land use and transportation plans, including the Native Village of Kivalina Long Range Transportation Plan (WHPacific 2012) and the State of Alaska Northwest Area Plan (DNR 2008) which anticipate transportation facility authorizations across State-owned waterbodies. Additionally, letters of support were written to acquire funding for an evacuation route by NANA, the Native Village of Kivalina, and the City of Kivalina (Appendix D).

Section 4(f) Evaluation: Section 4(f) of the *U.S. Department of Transportation Act* would apply as proposed project alternatives would be located on lands within the CKNHL (see Section 4.14 for impacts to historic resources, Section 5 for information on Section 4(f) considerations, and Appendix K for the Section 4(f) De Minimis Impact Finding).

Impacts to Zoning and Easements: As the entirety of the Study Area outside of the community of Kivalina is designated as a Subsistence Conservation District (NAB 2011), all route and lagoon crossing alternatives would need to be permitted as a Conditional Use under Title 9 of the NAB Code. Title 9 provides NAB the authority to control and regulate future land development within the Borough in accordance with its land use policies. The NAB Planning Commission considers Conditional Use permit

applications, and either rejects or approves the proposed use after public notice and a formal hearing. As the Study Area is not within a NAB Resource Development Zone or Transportation Corridor, all route and lagoon crossing alternatives would require rezoning by the NAB Planning Commission (Title 9, Article VIII, Section 9.28.220) prior to construction. Where 17(b) easements exist (Section 4.5.1), legal access will be maintained.

ROW Requirements: Land interest sufficient for a dedicated 300-foot public ROW along either proposed route alternative would ultimately be conveyed by NANA (the current private landowner) to a government entity currently identified as the City of Kivalina. Additionally, an easement would be acquired from the State of Alaska DNR for tidelands associated with the lagoon crossing.

Secondary (Induced) and Cumulative Impacts:

Changes to Future Transportation Needs: According to the community, during storm events access to an evacuation area may be challenging because not all residents have access to, or are physically able to safely operate or ride on an ATV, making efficient evacuation impractical. Therefore, additional transportation options, such as highway vehicles, may be needed; and the proposed evacuation road has been designed to accommodate this need. As a result of this accommodation, transportation may increase the already limited number of highway vehicles in Kivalina. The top of the causeway would be at an elevation to accommodate the anticipated maximum potential storm surge and design wave for no less than a 100 year recurrence event (Appendix B).

Increased Access to Adjacent Lands: Construction of either road and crossing alternative would allow increased summer overland access to the lower Wulik River and K-Hill for subsistence use. Public access to the Wulik River is currently limited by adjacent privately-owned lands.

Increased access to adjacent public and private lands may occur, potentially resulting in changes to land use and increased transportation activities along the road corridor. Any change in land use would require rezoning by the NAB Planning Commission and approval by ordinance by the Assembly prior to construction (Title 9, Chapter 9.20.060). Future school construction at a site identified by the NAB is remote and speculative at this time; however, the Northwest Arctic Borough School District has commented that if constructed within the vicinity of the project terminus, school operations could potentially include transportation of students between the school and community using private or public vehicles. In addition, school management and operations could include the provision of teacher housing in proximity to the eventual school location and the associated supply and support infrastructure necessary to maintain it.

4.5.2.3 Material Source Alternatives

Direct and Indirect Impacts:

Changes to Traffic: Traffic levels would temporarily increase near material source alternatives during construction. The impact due to elevated traffic levels would be minimized by using material sources proximate to the project, improving haul efficiency. Traffic levels near material sources are expected to decrease to very low levels after construction.

Consistency with Land Use Plans: Proposed material sources are consistent with local land use and transportation plans. Additionally, letters of support were written to acquire funding for an evacuation route by NANA, the Native Village of Kivalina, and the City of Kivalina (Appendix D).

Impacts to Zoning and Easements: Proposed material sources are currently located within a Subsistence Conservation District (NAB 2011). Development of all sources would require review and permitting for Conditional Use and rezoning by the NAB Planning Commission.

The DNR would also need to designate the material sites, and develop a material sales agreement with DOT&PF. This may include permitting for Land Use and Tideland uses for each material site.

ROW Requirements: Land ownership for material sources would remain with current landowners: NANA (most lands above ordinary high water), State of Alaska for submerged land, and Native allotments. In all cases, proposed material source development has been designed to avoid and minimize impacts to Native allotments. The use of a portion of the Wulik River Source 1 material source would require agreement with a Native allotment owner.

Secondary (Induced) and Cumulative Impacts:

Changes to Future Needs: Material sources may be reopened and/or expanded by the community to accommodate future needs for community projects. The location and material source characteristics of the K-Hill Site may encourage future use of this specific site over other local material sources.

Increased Access to Adjacent Lands: With permission of the private land owner, material sources and the lands adjacent may be used for subsistence activities. Private lands adjacent to material sources may experience increased use due to ease of access.

4.5.2.4 Alternatives Comparison

Table 3 compares impacts that vary between proposed route and crossing alternatives, as well as potential material source alternatives. All other impacts are similar across all proposed alternatives.

Table 3 Land Use and Transportation Impacts

Land Use and Transportation: Differences Between Route Alternatives		
	Southern Route (Preferred Alternative) with Lagoon Crossing D	**Combined Route B with Lagoon Crossing D**
Direct and Indirect and Construction	ROW Requirements: • 280 acres of ROW required from NANA	ROW Requirements: • 324 acres of ROW required from NANA
Secondary and Cumulative	Increased Access to Adjacent Lands: • Shorter summer overland access to the lower Wulik River than Combined Route B	Increased Access to Adjacent Lands: • Less practical summer overland access to the lower Wulik River than Southern route

Differences Between Material Source Alternatives				
	K-Hill Site	**Wulik River Source 1**	**Relic Channel Source 1**	**Relic Channel Source 2**
Direct and Indirect and Construction	Changes to Land Use: • 100 acres of lands zoned Subsistence Conservation District would require rezoning	Changes to Land Use: • 40 acres of lands zoned Subsistence Conservation District would require rezoning • Would require permission from Native allottee • Spur road would be required	Changes to Land Use: • 50 acres of lands zoned Subsistence Conservation District would require rezoning • Spur road would be required	Changes to Land Use: • 40 acres of lands zoned Subsistence Conservation District would require rezoning • Spur road would be required
Secondary and Cumulative	Changes to Future Transportation Needs: • Most likely to be used for future material source needs for community projects	Changes to Future Transportation Needs: • Less likely to be used for future material source needs for community projects	Changes to Future Transportation Needs: • Less likely to be used for future material source needs for community projects	Changes to Future Transportation Needs: • Less likely to be used for future material source needs for community projects

4.5.3 Avoidance, Minimization, and Mitigation

- Wulik River Source 1 is adjacent to and includes a portion of a Native allotment (less than a quarter of the proposed material site); however, use of this material source has been given lower priority as described in Section 4.3.4., and the material source may be developed outside of the Native allotment if a material sales agreement with the owner cannot be reached. All other material sources and route alternatives avoid development in Native allotments; and
- Material sources near Native allotments would be designed to not block access to these areas.
- During permitting of the Wulik Relic Channel Source 2, DOT&PF will work with DNR to avoid the use of state-owned submerged lands.

4.6 Social and Economic Environment

4.6.1 Affected Environment

4.6.1.1 Socioeconomics and Environmental Justice

Executive Order 12898: Environmental Justice addresses impacts from Federal Actions to minority populations and low-income populations. According to the most recent State of Alaska data, Kivalina is a

community of approximately 412 residents (DCCED 2016). Most of Kivalina's residents are Inupiat; 96.3% of the population identifies their race as American Indian or Alaska Native; and over half of Kivalina's residents are under the age of 20 (U.S. Census Bureau 2010).

Kivalina is designated as a second-class city with a mayor and a seven-member city council (DCCED 2016). The current town site became a permanent settlement in 1905 when the Bureau of Indian Affairs built a school on the barrier island on the southwest side of Kivalina Lagoon and mandated compulsory attendance of the local school-age children (Haley et al. 2009). NANA is the *Alaska Native Claims Settlement Act* chartered regional corporation representing Kivalina. The Native Village of Kivalina *Indian Reorganization Act* (IRA) Council serves as the federally recognized tribal government. Maniilaq Association, a non-profit corporation, provides tribal government services for the twelve tribes of northwest Alaska including the Native Village of Kivalina. NANA serves Kivalina as both the regional and village corporation for the community.

Community and public facilities include the washeteria, the City/Tribal Office, the U.S. Post Office, the Alaska Village Electric Cooperative (AVEC) power plant, a heavy equipment building, the airport snow removal equipment building, an armory, two churches, a bingo hall, community hall, and the Boys and Girls Club (NANA 2016). AVEC provides electricity to the community via diesel generators. Drinking water is obtained every summer by the community who lays out a combination of hose and sections of PVC pipe to convey water from a pump intake on the Wulik River (Figure 4) extending three-miles to a pair of holding tanks near the center of the community where the water is treated and stored for use during the winter months. No households in the community have full plumbing. Typically, water is hauled from the storage tanks to residences. Residential sewage is hauled from residences in "honey buckets" to disposal bunkers located throughout the community. The washeteria, operated by the city, is a community facility which houses restroom, laundry, and bathing facilities to allow community members to have access to running water and sewage disposal. In addition, the regional Maniilaq Association operates the Kivalina Clinic, which provides basic medical services.

The McQueen School provides instruction from pre-school through 12th grade. The ~15,000 sq. ft. school has both running water and sewage disposal and purchases electricity through AVEC. According to DCCED, the school had approximately 145 students and 12 teachers in 2016. Online post-secondary courses are available for those with internet access through the Chukchi Campus, a rural division of the University of Alaska located in Kotzebue (Himes-Cornell et al. 2013).

Economic opportunities in Kivalina are limited, with many of the wage labor job/positions being part-time or seasonal. The Alaska Department of Labor and Workforce Development (DLWD 2015) reports almost two thirds of the available workforce was employed in local government, education, health and social services, resource extraction industries, and other service sectors. Local employers include the City, Village Council, school district, local store, Maniilaq Association, NANA Regional Corporation, and the Red Dog Mine (located 50 miles away by air). Commercial fishing offers limited seasonal employment outside of Kivalina; and the sale of Alaska Native ivory carvings brings additional revenue to individuals in the community (Himes-Cornell et al. 2013; WHPacific 2014). According to the U.S. Census Bureau's 2009-2013 American Community Survey 5 Year Estimates, per capita annual income was estimated at $14,185, and the median household income was $59,167 (DCCED 2017). It is estimated that 28% of people in the community of Kivalina live below poverty level (DCCED 2017).

There are no roads connecting Kivalina with other communities in the region. Existing ANCSA 17b easement trails allow for winter travel between Kivalina and both Point Hope and Noatak (Figure 4). Air freight and passenger services are provided by commercial carriers operating between Kotzebue and Kivalina. Heavy freight including fuel, automobiles, and general supplies are transported by barge to the community between July and August (Himes-Cornell et al. 2013). Nearly all of Kivalina is dependent, to varying degrees, on subsistence fish and game resources.

4.6.1.2 Subsistence

Subsistence activities are an integral part in the lives of Kivalina's residents (Braem and Kostick 2014). A comprehensive subsistence survey, conducted by the ADF&G in 2008, stated that over 88% of respondents reported using fish, land mammals, marine mammals, birds and eggs, berries, and greens. Of surveyed households, 95% reported harvesting at least one kind of wild food (Magdanz et al. 2010). Kivalina residents made use of at least 12 fish species, five species of large land mammals, six species of small land mammals, eight species of marine mammals, nine species of migratory birds, three resident bird species, as well as bird eggs and shellfish. When quantified by edible weight, bearded seals, Dolly Varden (locally referred to as "trout"), and caribou contributed 78% of the total community harvest. Four types of berries and at least six types of greens were also harvested.

A recent project, completed by the NAB, (Satterthwaite-Phillips et al. 2016) focused on mapping the subsistence harvest areas of the residents of the Kotzebue Sound region, and recorded Kivalina residents' harvest locations and targeted resources.

- Kivalina residents reported harvesting marine mammals along the coast from Cape Krusenstern to Chariot in spring and summer, and offshore from the Kivalina barrier islands in the fall;
- Birds were taken in the winter around Kivalina Lagoon, the mouth of the Kivalina River, and the lower reaches of the Wulik River. Spring and summer bird harvest locations were reported throughout the Study Area;
- Egg collection locations were reported throughout the Study Area in the spring. During the fall, egg collection locations were reported along the middle and lower Wulik River drainage and in the lowlands south and east of Kivalina Lagoon;
- Fishing areas were reported in Kivalina Lagoon and along the Kivalina and Wulik Rivers during all seasons;
- Large game harvest locations were reported in the middle and upper Kivalina River drainage, in the uplands between the Kivalina and Wulik Rivers in the spring and summer, along the middle Kivalina River and in the middle and lower Wulik River channels in the fall, and throughout the Study Area in the winter;
- Small game is hunted or trapped along the middle Wulik River channel in the fall, and along the Kivalina and Wulik River channels and the interior uplands in the Study Area during the winter; and
- Spring plant harvest locations were reported around the mouth of the Kivalina River, and throughout the Study Area in the summer and fall.

Based on this mapping data and earlier descriptions of local subsistence hunting, fishing, and gathering (Burch 1985), the Kivalina and Wulik Rivers are currently the two main routes from Kivalina into the interior and that the Study Area is at the center of Kivalina's subsistence harvest area.

4.6.2 Environmental Consequences

4.6.2.1 No-Action Alternative

An evacuation road would not be constructed and no changes to current subsistence use would occur. Residents would continue to be exposed to environmental threats with no reliable options for evacuation during storm event with the potential to detrimentally impact the community and its socioeconomic stability over time. There would remain severe risk to life, health, and safety of residents.

4.6.2.2 Route and Lagoon Crossing Alternatives

Direct and Indirect Impacts:

Environmental Justice: Since the entire Kivalina population would be affected similarly, neither of the route and crossing alternatives would result in disproportionately high and adverse impacts to minority or low-income populations. Both route and crossing alternatives would increase safety of all Kivalina residents by providing a reliable route to a safe mainland evacuation location during emergencies. Therefore, neither route and crossing alternative would result in environmental health or safety risks to Kivalina residents.

Impacts to Subsistence: The Proposed Action would provide reliable access to subsistence hunting, fishing, and gathering locations during seasons when low river flows prohibit boat travel and during warm winters when thin river and lagoon ice prevents safe snow machine operation. It would also expand subsistence harvest opportunities to Kivalina residents who do not currently have access to boats or other off-road transportation necessary to reach subsistence use areas within the Study Area. A road to K-Hill would increase the window of available time to easily access caribou hunting areas in the foothills and within the Kivalina and Wulik River drainages. Installation of signs along the road would remind the public of Alaska Fish and Game regulations that prohibit shooting from, on, or across a highway (5AAC 92.080; ADF&G 2006).

Public dialogue has indicated that there are berry picking resources along the Combined Route B alternative (Appendix D). The project may result in a reduction of some berry picking resources within the road footprint along the Combined Route B. Fugitive dust has been measured to impact vegetation out to 300 feet from the Dalton Highway (Auerback et al, 1997; Walker and Everett, 1987). However, the evacuation road would not see levels and type of traffic nearing those of an industrial road like the Dalton Highway, and fugitive dust impacts to berry picking resources are not anticipated to extend that far from the roadway. In addition, both alternatives are likely to expand access to additional berry resources beyond the footprint of the road resulting in more harvest intensity over a broader area. Berry harvest may also intensify along the roadside, rather than expanding harvest areas, due to easier access along the road corridor.

Construction Impacts:

Impacts to Socioeconomics: Construction of either route and crossing alternative is anticipated to have a positive socioeconomic impact on the community. Economic advantages could arise from local hire opportunities during construction, improved access to private lands along the Wulik River, and increased

opportunities for subsistence activities in portions of the Study Area. Permanent jobs could be created for maintenance of the road in the future. The community water source infrastructure would not be impacted by the Proposed Action.

Secondary (Induced) and Cumulative Impacts:

Increased access to subsistence resources may cause an increase in harvest. Both route alternatives would allow greater scouting of the area, allowing increased hunting efficiency. Individuals without boats would also be able to participate in the harvest.

Increased road access may increase the participation of non-subsistence hunting and/or fishing. Land outside of the project's ROW is privately owned. This secondary impact is expected to be managed through existing NANA permit requirements. Installation of signs along the road would remind the public of State of Alaska Fish and Game regulations that prohibit shooting from, on, or across a highway (5 Alaska Administrative Code [AAC] 92.080; ADF&G 2006).

4.6.2.3 Material Source Alternatives

Direct and Indirect Impacts:

Impacts to Socioeconomics: Development of new local material resources is expected to increase the socioeconomic wellbeing of the community. Mineral resources sold by NANA would provide a direct revenue stream to the Native corporation. Locally available materials could also reduce the cost of building and maintaining infrastructure in the region.

Impacts to Subsistence: Material source spur roads would provide additional access to subsistence locations, beyond the roadway. Depending on the route and material sources selected, between ~0 and 6,400 ft of spur roads may be constructed (depending on contractor methodology used (spur road, ice road, or combination). Alternatives with spur roads would increase the amount of additional access for subsistence. Reclaimed material sources may also provide additional deep-water habitat for subsistence fish species.

Construction Impacts:

Impacts to Socioeconomics: Construction of any of the material sites is anticipated to have a positive socioeconomic impact on the community. Economic advantages could arise from local hire opportunities during construction, improved access to private lands along the Wulik River, and increased opportunities for subsistence activities in portions of the Study Area. Development and operation of the Wulik River

Source 1 has the potential to introduce sediment laden Stormwater into the Wulik River, the community water source. However, the use of this material has been given lower priority as described in Section 4.3.4 and, if developed, use of BMPs and compliance with the APDES would reduce the potential for impacts.

Secondary (Induced) and Cumulative Impacts:

Impacts to Socioeconomics: Material sources may be reopened and/or expanded by the community to accommodate future needs for community projects. Locally available materials could also reduce the cost of building and maintaining infrastructure in the region. The location and material source characteristics of the K-Hill Site may encourage future use of this specific site over other local material sources.

4.6.2.4 Alternatives Comparison

Table 4 compares impacts that vary between proposed route and crossing alternatives, as well as potential material source alternatives. All other impacts are similar across all proposed alternatives.

Table 4 Social Environment Impacts

Social Environment: Differences Between Route Alternatives				
	Southern Route (Preferred Alternative) with Lagoon Crossing D		**Combined Route B with Lagoon Crossing D**	
Direct and Indirect and Construction	No Difference Between Alternatives		No Difference Between Alternatives	
Secondary and Cumulative	No Difference Between Alternatives		No Difference Between Alternatives	
Differences Between Material Source Alternatives				
	K-Hill Site	**Wulik River Source 1**	**Relic Channel Source 1**	**Relic Channel Source 2**
Direct and Indirect and Construction	Socioeconomics: • Highest potential revenue generation to regional economy from material sales as compared to other sites Subsistence: • No opportunities for creation of	Socioeconomics: • Lowest revenue generation potential to regional economy from material sales Subsistence: • Some overwintering, habitat may be created, increasing resources	Socioeconomics: • Moderate potential for revenue generation to regional economy from material sales Subsistence: • Some overwintering habitat may be created, increasing resources	Socioeconomics: • Moderate potential for revenue generation to regional economy from material sales Subsistence: • Some overwintering habitat may be created, increasing resources

	overwintering habitat • No Spur Roads	• Spur Roads: 1,500 ft (Southern), or 4,550 ft Combined B)	• Spur Roads: 3,000 ft (Southern), or 0 ft (Combined B)	• Spur Roads: 2,000 ft (Southern), or 0 ft (Combined B)
Secondary and Cumulative	Socioeconomics: • Greatest potential to support future infrastructure	Socioeconomics: • Less potential to support future infrastructure	Socioeconomics: • Less potential to support future infrastructure	Socioeconomics: • Less potential to support future infrastructure

4.6.3 Avoidance, Minimization, and Mitigation

- Individual material source reclamation plans would be developed, in consultation with appropriate agencies, local government, and landowners. Potential reclamation options may include flooding for creation of wetland and waterfowl/fish habitat, which may support increased subsistence use at these locations.

4.7 Hazardous Materials, Pollution Prevention, and Solid Waste

4.7.1 Affected Environment

The Alaska Department of Environmental Conservation (ADEC) *Contaminated Sites Program Database* (ADEC 2016a) identifies only one contaminated site in the Study Area: Alaska Air National Guard (AKARNG) Kivalina FSA, which is listed for petroleum contamination. The site is in the middle of the community of Kivalina near the Kivalina Lagoon, and is not near proposed evacuation route alignments or material sources (Figure 2). The ADEC issued a Cleanup Complete determination for AKARNG Kivalina FSA on January 5, 2009.

The City of Kivalina Hazard Mitigation Plan (City of Kivalina, 2015) describes the 6.5 acre Class 3 unpermitted municipal landfill that is located within the Study Area on the barrier island, approximately 0.3 miles northwest of the Kivalina Airport (Figure 2). Possible hazardous materials at the landfill include construction and demolition waste, asbestos, and sewage.

The ADEC Spill database tracks reported spills from 1995 to the present. A search for the City of Kivalina on October 9, 2017 revealed three reports. These reports were all for spills at the McQueen School Tank Farm in 1998 (40 gal diesel), 2000 (150 gal diesel), and 2005 (400 gal diesel).

Residential sewage is hauled from residences in honey buckets to disposal bunkers located throughout the community. Honey bucket waste is comingled with solid waste at the landfill (ADEC 2016b). Other

potential sources of waste may include the power plant and clinic. Figure 5 shows locations for all recorded sources of contamination within the Kivalina area.

4.7.2 Environmental Consequences

4.7.2.1 No-Action Alternative

An evacuation road would not be constructed and no changes to hazardous materials, pollution prevention, and solid waste use would occur. Residents would continue to be exposed to environmental threats with no reliable options for evacuation during storm events with the potential to detrimentally impact the community over time. There would remain severe risk to life, health, and safety of residents.

4.7.2.2 Route and Lagoon Crossing and Material Site Alternatives

Direct and Indirect Impacts:

No known hazardous waste sites, generators, or contaminated sites are identified within footprint of the proposed alternatives. Therefore, contamination or hazardous waste would not likely be encountered during construction, and no impacts would be expected. Storm surge related destruction of the AKARNG or other contaminated sites in the Study Area are not expected to prevent access to the evacuation route.

A plan for disposal and hauling of solid waste generated during construction would need to be developed prior to construction. It is anticipated the Kivalina municipal landfill would not have sufficient area to accommodate project construction waste.

Land interest sufficient for a dedicated public ROW along either proposed route alternative would ultimately be made available by private land owners or a government entity. This process would require completion of a Phase I Environmental Site Assessment for the proposed evacuation route prior to DOT&PF ROW acquisition.

Construction Impacts:

Construction activities pose a small risk of incidental spills taking place, primarily from heavy equipment and fuel storage at material sites, staging areas, and temporary construction camps. Either alternative is expected to have a similar risk of incidental spills. Releases would trigger spill response operations, and the site would be treated in accordance with consultation with ADEC.

Secondary (Induced) and Cumulative Impacts:

While increased access to adjacent public and private lands may occur along the route in the future, no secondary (induced) or cumulative impacts to hazardous materials and solid waste are anticipated, as a result of this project, with proper implementation of BMPs.

4.7.2.3 Alternatives Comparison

There are no notable differences between alternatives relevant to impacts to hazardous materials, pollution prevention, and solid waste. Impacts described above are relevant for both route and lagoon crossing alternatives, as well as materials source alternatives.

4.7.3 Avoidance, Minimization, and Mitigation

- Prior to construction, the contractor would develop a BMP-based Solid Waste and Hazardous Materials Control Plan to address contaminant spill response, storage, management, and handling of hazardous materials, including fuel and lubricants. If leaks or spills occur, contaminated material and soils would be contained and disposed of properly; and
- The construction contractor would be required to stop work and notify the DOT&PF Project Engineer if suspected contaminated soil or water is encountered. DOT&PF would notify ADEC in compliance with 18 AAC 75.300. Any contamination encountered would be handled and disposed of in an ADEC-approved manner.

4.8 Water Resources and Water Quality

4.8.1 Affected Environment

The major surface water sources in the Kivalina area include the Kivalina Lagoon, Wulik and Kivalina Rivers, the Chukchi Sea, and various streams and lakes (WHPacific 2012a). Marine waters in the Study Area have historically been ice-free from early July through late October. However, later freeze-up and earlier melting has resulted in longer ice-free periods during recent years. As a result, Kivalina has been facing significant increased risks of flooding and erosion from storms (DCCED 2015). Sea level information in the area is available since August 2003 from the Red Dog Mine Dock tide station. Tides range from 0.79 ft mean high water to 0.12 ft mean low water (USACE 2016). Trends in the tidal signal over this period are not identifiable and there are no regional specific sea level change estimates available. The most recent global estimate of sea level rise by 2100 ranges from 1.7 to 2.4 ft, depending on the carbon emission scenario used (AMAP 2017).

4.8.1.1 Lagoon

Kivalina Lagoon is a shallow body of marine, tidally influenced water approximately 10 miles long that ranges in width from 3,000 ft near the mouth of the Wulik River to 8,000 ft north of the Kivalina River (Figure 2). The lagoon is fed by the Kivalina River in the northern half, the Wulik River at the southern end, and by tidal flows from the Chukchi Sea through two inlets that define the Kivalina barrier island: Singuak Inlet on the southeastern side of the community of Kivalina, and Kivalik Inlet, approximately 5.5 miles to the northwest. The lagoon's northeast shoreline is dominated by the deltas of the Kivalina and Wulik Rivers. The majority of the lagoon is between 1 and 3 ft deep. Deeper areas have been recorded in the channels extending from the mouths of the rivers towards the Chukchi Sea as well as along the barrier island on which the community is located (USACE 2016).

The Kivalik and Singuak Inlets correspond with the rivers' outlets and allow for the conveyance of the lagoon's tidal and river hydraulic loading; though sediment transport along the Chukchi Sea shoreline of the Kivalina barrier island can occasionally block them (USACE 2016). These blockages result in elevation of the lagoon water level until it breaches the blocked inlet and reestablishes a new channel as the flow head cuts through the sand deposits. These inlets are the most dynamic part of the littoral system and are constantly shifting in response to river flow, longshore wave-driven transport of sediments along the outer beach, and the equilibrium cross section that responds to the flood and ebb of tidal surges. Normally the inlets are in balance with the river flow and would have a similar hydraulic radius (Appendix B).

Historical aerial imagery is an indicator of Singuak Inlet and lagoon channel stability (Appendix C). Other than river currents, assumed to pass directly from the river deltas to the Chukchi Sea through river channels in lagoon sediment, there is typically little to no flow inside the lagoon except during large surge events (USACE 2016; Appendix B). Waves from the Chukchi Sea are primarily blocked by the barrier island, or its energy is dissipated by sand bars of material deposited by the rivers and through interaction with the current of the rivers (USACE 2016). It is therefore assumed that waves in Kivalina Lagoon are mostly generated by local winds. Local knowledge provided by Kivalina residents support that assumption, with many lagoon travelers indicating that north winds can raise substantial waves and elevate the lagoon water level by several feet in a short period of time (Appendix D). Analyses of wind speed data from the Kivalina Airport resulted in an estimated maximum wind-driven wave height, during a storm surge, inside the lagoon of 3–4.5 ft (USACE 2016).

4.8.1.2 Rivers and Streams

Neither the Wulik nor Kivalina Rivers are listed as Wild and Scenic Rivers by the NPS, but are important anadromous Essential Fish Habitat for fish and provide important habitat for other biological resources in the area (see Sections 4.10 through 4.13). Neither river is listed as navigable by the USACE, but both are considered navigable by the State of Alaska.

Wulik River

The Wulik River roughly defines the southeast boundary of the Study Area (Figure 2). Ponds, sloughs, and one major relic channel of the Wulik River regularly flood and flow in a southwesterly direction to the Kivalina Lagoon and the Chukchi Sea. The Wulik River is not listed as impaired (ADEC 2010).

The Wulik River is approximately 80 miles long and originates in the DeLong Mountains, generally flowing southwest into Kivalina Lagoon. There is a U.S. Geological Survey (USGS) streamflow gauge located 22 miles upstream of the river mouth that has been continuously operating since 1984. Based on flow data from this gauge, the 100 year flow event was calculated to be 55,000 cubic-feet-per-second (cfs) (USACE 2016).

The Wulik River has annual average discharge of approximately 1,600 cfs with large seasonal variation in surface water flow ranging from a monthly average discharge of 136 cfs in November to 3,175 cfs in June (U.S. Environmental Protection Agency [USEPA] 2009). The Wulik River Watershed drainage basin is approximately 578,000 acres (USDA 2017).

Water rights govern the legal use to use surface or groundwater in Alaska. The Wulik River has two water rights for public drinking water issued to the City of Kivalina (ADL 46323 and ADL 72129). A reservation of water for the Wulik River has been issued to ADF&G (LAS 10067).

A visual investigation of the stability of the mouth of the Wulik River from the 1950s to the present revealed a fairly stable system morphology through time, with most changes only evident in the southern portion of the delta and not along the north bank where the proposed crossing is planned (Appendix C).

The Wulik River has had extensive biological and physical monitoring due to the activities of the Red Dog Mine. The Ikalukrok Creek, Buddy Creek, and Red Dog Creeks are the draining watersheds of Red Dog Mine, and tributaries to the Wulik River 37 miles upstream of the lagoon. The mine's wastewater and effluent discharge permits require annual monitoring for metals, pH, total dissolved solids, periphyton (chlorophyll-a), and invertebrates. Detailed analyses of water quality results are documented

in the aquatic biomonitoring technical reports (e.g., ADF&G 2017a). In brief, results from 2016 showed median metals concentrations to be lower than pre-mining levels; total dissolved solids and pH to be higher than pre-mining levels; periphyton measurements to vary with zinc and cadmium concentrations; and variable invertebrate results depending on the tributaries considered. Fishery monitoring has also been conducted and is discussed in Section 4.10 and Appendix I (ADF&G 2017a).

Kivalina River

The Kivalina River roughly defines the northwest boundary of the Study Area (Figure 2). The Kivalina River is not listed as impaired (ADEC 2010). The Kivalina River is approximately 60 miles long and originates in the DeLong Mountains, generally flowing southwest into Kivalina Lagoon. It is neither gauged nor has any hydrologic analysis been performed to estimate peak flows. However, previous studies have assumed that the Kivalina River exhibits the same general flow pattern as the Wulik River (USACE 2016). Based on basin areas and similarities to the Wulik River in its watershed and river slope, the U.S. Army Corps of Engineers (USACE) estimated that the Kivalina River could convey approximately 75% of the discharge of the Wulik River, resulting in an estimated 100 year flow of 41,250 cfs.

4.8.1.3 Floodplains

Executive Order 11988 Floodplain Management requires federal agencies to avoid adverse impacts associated with the occupancy and modification of floodplains. The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP) which aims to reduce the impacts of flooding on private and public structures. The program encourages communities to adopt and enforce floodplain management regulations and is intended to reduce the socioeconomic impact of disasters by promoting the purchase of flood insurance. Kivalina does not participate in the NFIP and there are no FEMA floodplain maps available for the Study Area.

In lieu of available flood maps for the Study Area, DOT&PF used existing hydrology studies (Appendix B) of the Kivalina Lagoon to inform design and assess potential floodplain impacts of the Proposed Action. Information presented in various location hydrology studies within the Study Area are summarized as follows:

The elevation of the island at the location of the community varies between +10 and +11 ft mean lower low water (MLLW). Analysis using the Wulik River gauging station to estimate the 100 year flood water surface elevation on the lower Wulik River using the HEC-2 numerical river flow model, found water

surface elevation in the lagoon had a much greater effect on flood elevations than river discharge (USACE 1998). The size of the lagoon and the low ground elevation on the mainland provide a large area for storage when the river flows overtops their banks. With river flow into the lagoon passing through to the ocean with little change in water surface elevation, high flows in the rivers cause only minor changes to the lagoon water level during flood events (USACE 2016).

Flood hazards in Kivalina result almost exclusively from Chukchi Sea storm surges caused by south to southeasterly winds (City of Kivalina 2015). Erosion is a particular concern for the Singuak Inlet, as storm events in 2004, 2005 and 2006 resulted in significant erosion on the seaward side of the inlet from wind driven tidal surges (USACE 2006). Chapman et al. (2009) estimated the 100 year storm surge flood event at 7.77 +/- 1.08 SD ft (MLLW) based on the four years of tide gauge data from Red Dog Mine available at the time. The USACE (2016) later adapted this estimate, and used 7.3 ft MLLW for their design recommendations. In 2011, a storm surge event of 7.4 ft MLLW occurred. Using 12 years of tide gauge data, a recent analysis updated the 100 year surge event estimate to 8.5 ft MLLW and provided a 500 year estimate of 9.6 ft MLLW (Appendix B). The author noted that elevations at or above the new estimated 100 year event could cause significant damage along the seaward shoreline of the village and likely trigger evacuation.

4.8.2 Environmental Consequences

4.8.2.1 No-Action Alternative

An evacuation road would not be constructed from Kivalina to K-Hill and no impacts to water resources and water quality would occur. Residents would continue to be exposed to environmental threats with no reliable options for evacuation during storm events with the potential to detrimentally impact the community over time. There would remain severe risk to life, health, and safety of residents.

4.8.2.2 Route and Lagoon Crossing Alternatives

This section focuses on Kivalina Lagoon and the lower Wulik River drainage system. No interactions between the proposed alternatives and the lower Kivalina River have been identified. As such, no discussion of lower Kivalina River is included.

Direct and Indirect Impacts:

Impacts to Navigability: No impact to navigability is expected from the proposed lagoon crossing. Due to the shallow bathymetry of the lagoon (1–3 ft deep), navigability is limited to personal boats sized to

support subsistence activities. The bridge has been designed to span the deepest channel, and would be designed so that the community can continue to access both sides of the Kivalina Lagoon.

Impacts to Water Quality: Once the road is constructed, rainfall or melting events may result in mobilization of runoff from the roadway, which could discharge into nearby freshwater resources. Wind generated and fugitive dust deposition in adjacent waterways could occur along the route. Other potential impacts to water quality would be associated with accidental spills or leaks from vehicles or heavy equipment operating adjacent to wetlands and water bodies during either construction or subsequent use of the evacuation route (see also Section 4.7).

Impacts to Wulik River Hydrology: There are four types of water crossings in the Proposed Action alternatives: fish passage, non-fish passage, enhanced design and Wulik River Relic Channel crossings. Fish passage crossings are for fish-bearing waterways which incorporate stream simulation designs per the DOT&PF and ADF&G 2001 Memorandum of Agreement for the Design, Permitting and Construction of Culverts for Fish Passage. Non-fish passage crossings are not located in fish-bearing waterways and are designed to DOT&PF design standards. Enhanced design crossings are for fish-bearing waterways that require more coordination with ADF&G to determine design requirements. The Wulik River Relic Channel is fish-bearing, and would be individually designed and permitted.

The Southern Route (Preferred Alternative) would require two fish passage crossings, four non-fish passage crossings, three enhanced design crossings, and no crossings of the Wulik River relic channel. Combined Route B would require three fish passage crossings (one of which is a crossing of the Wulik River relic channel), six non-fish passage crossings, and three enhanced design crossings. The water crossing of the Wulik River relic channel would be designed as a fish passage culvert, which would also maintain stream geomorphology and its hydrological regime. Channel crossing locations and types are shown in Figure 9.

Impacts to Lagoon Currents and Sediment Transport: Other than the river currents assumed to pass directly from the river deltas through river channels in lagoon sediment and the inlets into the Chukchi Sea (USACE 2016), there is typically little to no current and sediment transport inside the lagoon except during large surge events (Appendix B). Recent surveys and photography have observed that the Kivalina and Wulik River sediments simply pass through the lagoon and are deposited on the outer shoreline. With river water outflow into the lagoon and Chukchi Sea not anticipated to be impacted by the proposed project, sediment transport would also not be impacted, allowing for this accretion of the barrier island on the outer beach to continue and maintain this natural erosion buffering dynamic (Appendix B).

A bridge would span the approximately 110 ft wide channel that parallels the inside of the barrier island (Figure 3) and is mostly the result of scour during the ebb portion of the surge, thus maintaining that dynamic. Culvert(s) would be placed across the northeast end of the causeway, with overflow pipes placed regularly in series along the length of the causeway, further ensuring maintenance of any low-level energy flow and sediment transport regime in the lagoon.

Impacts to Floodplains: Portions of the Proposed Action alternatives would be constructed within base floodplain areas susceptible to storm surge flooding, but would not be located within a regulatory floodway or FEMA mapped 100 year floodplain. Neither the proposed crossing alternative nor the evacuation routes are likely to increase the 100 year floodplain backwater elevation of the Wulik River. With what are basically two separate and independent inlet and river systems with an intermediate 'stagnation zone' in the middle of the lagoon (as described above), the proposed hydraulically permeable crossing alternative with a bridge and culverts should not impact the dynamics currently observed during storm surge events nor substantively alter the estimated storm surge flood levels (Appendix B; USACE 2016).

A *Location Hydraulic Study for the Wulik River* (Stantec, 2017, and in Appendix D) was conducted to address floodplain impacts, including the practicability of alternatives to any longitudinal encroachments. The study found there are no practicable alternatives to development outside the floodplain; however, the proposed project design (bridge and numerous cross culverts with overflow pipes) is expected to maintain existing flow and drainage patterns and convey seasonal runoff.

Construction Impacts:

Impacts to Water Quality: Minor, short term impacts to water quality would likely result from construction of either route and crossing alternative within the Wulik River drainage and Kivalina Lagoon. These impacts would primarily be associated with construction-related sediment releases during causeway fill and armor stone placement, drainage structure construction, and stormwater runoff on disturbed road embankments before final stabilization is completed. Proper installation techniques of the proposed road water crossings (e.g., bypass or plug and pump) would limit the introduction of sediment into freshwater resources (ADF&G 2001), and winter construction would minimize the potential for runoff generation and transport. Localized effects of sediment-laden runoff during construction are anticipated to be temporary and of short duration with the implementation of required SWPPPs and BMPs.

Impacts to Wulik River Hydrology: During project construction, water withdrawals would be required to create temporary ice/snow roads, dust control, to support road compaction, and to support temporary construction camps. Water to support these activities would likely be sourced from surface waterbodies along the final selected route alignment, and permitted through a Temporary Water Use authorization and Title 16 permit. Winter water withdrawal could lead to reduced flows in small streams, and summer season withdrawal could lead to similar effects if volume removal is too great relative to water levels at that time.

Secondary (Induced) and Cumulative Impacts:

The ongoing activity of implementing runway or coastal erosion control measures at the existing Kivalina airport would have minimal cumulative impact on water resources as it is outside the influence of the Kivalina Lagoon, and the Wulik and Kivalina Rivers.

The potential development of adjacent public and private lands may create a demand for greater water use; however, water use is regulated by the state through permitting. No cumulative impacts to water quality or quantity are anticipated. Proper implementation of BMPs would be required to operate under the APDES Construction General Permit (CGP). Such developments could alter the path and amount of surface water, but would not be anticipated to substantively impact the floodplain. Dust impacts to water quality from an increase in traffic along the road are anticipated to be minor. A road maintenance and operations contract with the community will be developed that would include long term measures for dust abatement, as needed.

4.8.2.3 Material Source Alternatives

Direct and Indirect Impacts:

Except for K-Hill, material source development involves extraction in or adjacent to waterbodies. This type of material source development can lead to destabilization of river channels, river channel capture, floodplain widening, increased erosion and sedimentation, increased water velocities, and reduced water quality (Joyce et al. 1980). Through appropriate planning and adherence to site specific mitigation measures and management plans, however, material source excavation within relic channels and the river bar of the Wulik River would likely be temporary and have minimal effects.

Secondary (Induced) and Cumulative Impacts:

Once the proposed lagoon crossing and evacuation route is constructed, increased access to adjacent public and private lands may enable development in those areas, which may encourage expansion or

development of material sources. This could cause additional potential impacts on water quality and flow regimes if unmitigated.

4.8.2.4 Alternatives Comparison

Table 5 compares impacts that vary between proposed route and crossing alternatives, as well as potential material source alternatives. All other impacts are similar across all proposed alternatives.

Table 5 Water Resources and Water Quality Impacts

Water Resources: Differences Between Route Alternatives				
	Southern Route (Preferred Alternative) with Lagoon Crossing D		**Combined Route B with Lagoon Crossing D**	
Direct and Indirect and Construction	• Total of 9 water crossings: • 0 crossings of Wulik River Relic Channel; • 2 fish passage crossings; • 4 non-fish passage crossings; and • 3 enhanced design crossings.		• Total of 12 water crossings: • 1 fish passage crossing (Wulik River Relic Channel); • 2 fish passage crossings; • 6 non-fish passage crossings; and • 3 enhanced design crossings.	
Secondary and Cumulative	No Difference Between Alternatives.		No Difference Between Alternatives.	
Differences Between Material Source Alternatives				
	K-Hill Site	**Wulik River Source 1**	**Relic Channel Source 1**	**Relic Channel Source 2**
Direct and Indirect and Construction	• Least potential for water quality impacts to area water bodies as compared to other resources due to further distance form Wulik River.	• Most potential for water quality impacts, river capture, floodplain widening, and increased erosion to the Wulik River as compared to other resources due to close proximity to the Wulik River.	• Medium potential for water quality impacts, river capture, floodplain widening, and increased erosion to area water bodies as compared to other resources due to proximity to the Wulik River Relic Channel.	• Medium potential for water quality impacts, river capture, floodplain widening, and increased erosion to area water bodies as compared to other resources due to proximity to the Wulik River Relic Channel.
Secondary and Cumulative	• More potential secondary and cumulative impacts could occur due to proximity to	• More secondary impact potential compared to relic channel sources due to increased access for greater	• Less secondary impact potential compared to other material sources due to greater distance from Wulik River and	• Less secondary impact potential compared to other material sources due greater distance from Wulik River and

	proposed school site.	number of private land owners near the Wulik River.	fewer number of private land owners.	fewer number of private land owners.

4.8.3 Avoidance, Minimization, and Mitigation

Water Quality:

- Measures to minimize releases of sediment to water bodies would be implemented during construction as part of compliance with the APDES CGP. Compliance with the CGP includes preparation of a SWPPP and implementation and monitoring of erosion and sediment control BMPs;
- Utilization of low erodible material and armor rock placed in the Kivalina Lagoon would minimize sedimentation to these waterbodies. Sediment entrainment measures would further reduce impacts to water quality; and
- Water withdrawal requires permitting through DNR and ADF&G would specify appropriate BMPS, including water withdrawal volume limitations, which would reduce the potential effects on stream flows and existing water rights during construction.

Floodplain:

- Material sites would be constructed to avoid river capture, floodplain widening, and increased erosion;
- The road would be designed above the 100-year flood elevation.
- Causeway bridge and culvert would be designed for adequate flows through the causeway at flood stage.

Hydrology:

- Roadway and causeway embankments would be protected from erosion to prevent sediment transport to adjacent habitats; and
- Construction of a bridge or causeway in tidal waters falls under the jurisdiction of the U.S. Coast Guard (USCG) Office of Bridge Programs (33C.F.R. Chapter I, Subchapter J, Part 115) and all necessary USCG authorizations would be obtained prior to construction.

4.9 Wetlands and Vegetation

4.9.1 Affected Environment

The Study Area falls within the Wulik-Kivalina Rivers Watershed (USEPA/USGS hydrologic catalog unit 19050404 [https://cfpub.epa.gov/surf/huc.cfm?huc_code=19050404]), which is comprised primarily of dwarf shrub and emergent tundra, and located immediately adjacent to Kivalina Lagoon and the Chukchi Sea.

National Wetlands Inventory (NWI) was used to initially classify wetlands within the entire Study Area, with a more detailed desktop mapping effort completed by the NAB for the area surrounding the community proposed alternatives. A wetland verification report was completed for the Study Area, using both the NWI and the more detailed mapping provided by the NAB (USFWS 2017c; ASRC 2015). The objective of that study was to verify and refine existing wetland mapping with ground data collected in the vicinity of the proposed alternatives. This effort also used LiDAR data (DOT&PF 2011) and information from four field investigations conducted in 2015, 2016, and 2017 (in four reports: Golder Associates 2015; Stantec 2016b, 2017c; USACE 2017). The following affected environment descriptions are based on the findings described in the verification report.

4.9.1.1 Wetlands and Vegetation

The wetland verification report (Stantec 2017c) provides detailed ground truthed wetland delineation using the Cowardin classification system (Cowardin et al. 1979). The report verified limited uplands within the Study Area. The field data confirmed the presence of wetlands throughout the Study Area, with the Wulik River and Kivalina River being important features. The report identified isolated small additional areas of uplands, generally on pingos or relic stream banks. Wetland classifications were updated with field data throughout the Study Area. Table 6 provides a summary of acres and percentage of Study Areas of the verified water, wetland types, and uplands.

Table 6 Summary of Wetlands, Waters of the U.S., and Uplands

Wetlands, Waters of the U.S., and Uplands		
Habitat Type	**Acres**	**% Study Area**
Estuarine	3,822.0	10.4%
Lacustrine	1,164.3	3.2%
Marine	182.8	0.5%
Palustrine Flooded	3,540.10	9.6%
Palustrine Saturated & Seasonally Flooded	23,894.0	64.6%

Wetlands, Waters of the U.S., and Uplands		
Habitat Type	**Acres**	**% Study Area**
Pond	949.5	2.6%
Riverine	2,292.2	6.2%
Upland	1,071.5	2.9%
Total Study Area	**36,916.4**	**100.0%**

The wetland verification work determined that the mainland portion of the Study Area is dominated by Palustrine wetlands. The mainland area also contains some Uplands, which occur within a few higher elevation areas between the Kivalina and Wulik Rivers (Figure 6).

Vegetation types within the Study Area were mapped using the Viereck classification system (Viereck et al. 1992). Results indicate the majority of the Study Area is comprised of Mesic Graminoid Herbaceous (III.A.2) vegetation, followed by Willow Dwarf Scrub (II.D.2), Wet Graminoid Herbaceous (III.A.3), and Closed Low Scrub (II.C.1) vegetation (Stantec 2017c) (Table 7, Figure 8). Developed areas are locations where gravel fill has been placed, such as around the houses in the current town or the airport runway.

Closed Low Scrub has shrubs which are 20 cm (centimeter) to 1.5 m (meter) tall, and are often found bordering waterways. These habitats were identified by the U.S. Fish and Wildlife Service (USFWS) (2016b) as important bird nesting habitat, providing nesting habitat, elevation above predators, and locations for surveillance. They are the highest canopy vegetation available in the Study Area and provide some of the only perching locations.

Table 7 Summary of Habitat (Viereck) Types

Habitat (Viereck) Type	Acres	% Study Area
Developed	64.8	0.2%
Closed Low Scrub (II.C.1)	3,228.7	8.7%
Willow Dwarf Shrub (II.D.2)	9,057.3	24.5%
Mesic Graminoid Herbaceous (III.A.2)	14,348.7	38.9%
Wet Graminoid Herbaceous (III.A.3)	1,877.6	5.1%
Water (W)	8,339.3	22.6%
Total Study Area	**36,916.4**	**100.0%**

4.9.1.2 Wetland Hydrology and Connectivity

Wetland hydrology within the Study Area appears to be driven by a restrictive permafrost layer perching water on the surface. Soil data collected during the fall 2016 cultural resource survey, showed that in low

lying areas, permafrost was shallow (e.g., 4–10 in.). In contrast, depth to permafrost was greater (e.g., greater than 10 in.) in relic channels or on the outer bends of oxbow lakes (Stantec 2017b, 2017c). Vegetation differences are apparent on aerial photography where these slight elevation differences occur. While most of the higher elevation areas within relic channels had greater depth to permafrost, the ground surface remained saturated at or near the surface, or standing water was observed, with hydrophytic plants dominating the landscape. Uplands were observed in some elevated areas including remnant pingos and point bars preserved along relic channels. In these areas, well drained gravels were visible near the surface and dominated by larger willow species (Stantec 2017b, 2016b).

All wetlands and waters within the Study Area appear to have a surface water connection to either the Kivalina River or Wulik River, and an apparent hydrologic connection to the Chukchi Sea via Kivalina Lagoon. While many of the lakes, ponds, and sloughs appear to be isolated from these waterbodies, as observed during the 2016 reconnaissance survey (Stantec 2016b), it is assumed they are connected via surface saturation on top of permafrost and seasonal flooding during annual breakup.

4.9.1.3 Wetland Functional Value

Wetlands were generally found to be high ranking (Category I and II, Table 8, Figure 7). This is expected for a largely undisturbed ecosystem (Stantec 2017c).

Due to most Study Area wetlands falling into Category I classification, a further category of higher functioning wetlands (Category I+), was introduced. Waters of the U.S. (ponds, riverine, estuarine, and lacustrine) were promoted to Category I+ to indicate their intrinsic importance. Upon consultation with the USFWS (2016b), all Closed Low Scrub habitat was promoted one functional level (e.g., II to I or I to I+) because this type of vegetation is considered important bird habitat in this area. This Category I+ designation allows project planners, regulators, and the public to evaluate impacts to wetlands in a largely undisturbed ecosystem where most wetlands are very high quality.

The wetlands and waters within the Study Area are generally of high value, but are not rare or unique. Rather, they are ubiquitous in both the Study Area and regionally. They also provide several important functional characteristics, including nutrient and toxicant removal, native plant richness, and production and export of organic material (ASRC 2015). The majority of Study Area wetlands are either seasonally inundated or permanently flooded, and have high surface water connectivity to the Wulik or Kivalina Rivers (Stantec 2017c).

Table 8 Functional Value of Study Area Wetlands and Waters of the U.S.

Functional Value of Study Area Wetlands and Waters of the U.S.					
Habitat Type	**Initial Functional Value**	**USFWS Bird Habitat?**	**Final Functional Value/Category**	**Acres**	**% Study Area**
Estuarine	I+	No	I+	3,822.0	10.4%
Lacustrine	I+	No	I+	1,164.3	3.2%
Marine	I+	No	I+	182.8	0.5%
Palustrine Flooded	I	Yes	I+	759.4	2.1%
		No	I	2,780.7	7.5%
Palustrine Saturated & Seasonally Flooded	I	Yes	I+	2,247.6	6.1%
		No	I	15,326.4	41.5%
	II	Yes	I	150.3	0.4%
		No	II	6,169.7	16.6%
Pond	I+	No	I+	949.5	2.6%
Riverine	I+	No	I+	2,292.2	6.2%
Upland	Upland	Upland	Upland	1,071.5	2.9%
			Total Study Area	**36,916.4**	**100.0%**

4.9.2 Environmental Consequences

4.9.2.1 No-Action Alternative

An evacuation road would not be constructed from Kivalina to K-Hill and no impacts to wetlands would occur. Residents would continue to be exposed to environmental threats with no reliable options for evacuation during storm events with the potential to detrimentally impact the community over time. There would remain severe risk to life, health, and safety of residents.

4.9.2.2 Route and Lagoon Crossing Alternatives

Direct and Indirect Impacts:

Impacts to Wetland Habitat and Functional Value: Impacts to wetlands from either proposed route and crossing alternative would result in a reduction of wetlands within the Study Area. Permanent impacts are the areas of fill.

Given the ubiquity of wetlands and Waters of the U.S. in the Study Area, the relative loss of wetland habitat due to the proposed route and lagoon crossing temporary and permanent impacts would be minor. Neither route or lagoon crossing alternative is expected to change area drainage patterns or the

surrounding area's ability to retain floodwaters. Culverts and other water crossings would be constructed to maintain drainage.

The impacted wetlands and Waters of the U.S. would no longer provide wetland functions, including habitats for various fish and wildlife. This impact is expected to be minor due to the abundance of similar surrounding habitat types given the undisturbed landscape surrounding the Study Area. The amount of Category I+ wetlands affected by temporary and permanent impacts is relatively small.

In addition, while the lagoon crossing would result in the loss of relatively minimal benthic habitat, it would also create more rock shoreline habitat than currently exists, which can contribute to biotic diversity

Closed Low Scrub habitat has been identified by the USFWS as having characteristics of important bird nesting habitat (USFWS 2016b). Both the Southern Route (Preferred Alternative) and Combined Route B alternatives avoid Closed Low Scrub habitat to the extent practicable.

Elevated surfaces tend to be drier and support more shrub species so new Closed Low Scrub habitat may become naturally established along the road embankments. However, operations and maintenance of the road may require clearing of vegetation established on the embankment. BMPs could limit impacts of these activities.

Impacts to Wetland Connectivity: No impacts to wetland connectivity are expected from route and lagoon crossing alternatives. Cross drainage culverts would be installed as appropriate to maintain connectivity. The lagoon crossing alternative being evaluated incorporates bridge and cross drainage culverts to retain connectivity of the Kivalina Lagoon. While wetlands in the Study Area may be impacted, wetlands in the surrounding landscape would retain connectivity with Waters of the U.S.

Construction Impacts:

Temporary impacts would occur within the 25 ft width from the embankment toes of slope (along the road, material source spur roads, staging areas) which may be used during construction for temporary equipment access and natural vegetative buffer.

Secondary (Induced) and Cumulative Impacts:

Impacts to Vegetation and Wetland Habitat: Potential development of a school site, as well as new road access within the Study Area may encourage private land owners adjacent to the alignment to develop portions of their land, requiring additional fill in wetlands to support such new development. As the

Southern Route (Preferred Alternative) provides more direct access to existing allotments than the Combined Route B, cumulative impacts to wetlands may be greater along the Southern Route. Cumulative impacts to wetlands from fugitive dust are not anticipated for this project. Potential fugitive dust resulting from potential increases and changes to traffic along the road would be covered under a road operations and maintenance agreement with the community, as described in 3.3.1.

Impacts to Wetland Hydrology and Connectivity: Secondary and cumulative impacts are not expected to affect wetland connectivity. The proposed school site and nearby private lands could potentially be developed, but these are not expected to be a barrier to connectivity. The Study Area landscape is predominately flat and the wetlands have a variety of connections to Waters of the U.S.

4.9.2.3 Material Source Alternatives

Direct and Indirect Impacts:

Impacts to Wetland Habitat and Functional Value: Development of material source alternatives and spur roads with a 25 ft buffer would result in both temporary and permanent alteration to wetlands and Waters of the U.S. Material sources avoid Category I+ wetlands as much as practicable. Material source development would only impact a relatively small percentage of Category I and Category II wetlands and would not impact overall wetland functionality within the Study Area. In addition, as some of the impacted material source acres can be reclaimed, impacts to wetlands would be further minimized.

Proposed material source locations avoid high quality bird habitat (Closed Low Scrub) where possible, although Wulik River Source 1 and Wulik River Relic Channel Source 1 & 2 do contain this habitat. This type of habitat is difficult to avoid during material source planning, as high quality material sources often exhibit soil characteristics required to support low scrub habitat.

Impacts to Wetland Hydrology and Connectivity: No impacts are expected to affect wetland connectivity from developing material source alternatives. While wetlands in the Study Area may be affected, connectivity would be retained with Waters of the U.S. Connectivity may be increased during material source reclamation by the creation of surface water habitat connecting to palustrine wetlands.

Secondary (Induced) and Cumulative Impacts:

Impacts to Wetland Habitat: Secondary and cumulative impacts to wetlands may be ongoing if material sources are kept open after construction is complete. Considering the amount of regionally available similar habitats, cumulative impacts would be minor and not impact overall availability and functionality.

Secondary and cumulative impacts to habitat would occur near material sources with access to private lands adjacent to the Wulik River. While the majority of Study Area lands are privately owned, the Southern Route (Preferred Alternative) provides increased access for a larger number of private land owners. Most of this use can be expected to be local, and in support of subsistence activities, as off route use would require an access permit by NANA.

Impacts to Wetland Connectivity: No secondary and cumulative impacts are expected to affect wetland connectivity from development of material source alternatives. While a small percentage of local wetlands may be permanently affected, wetlands surrounding the material sources are expected to retain connectivity to Waters of the U.S.

4.9.2.4 Alternatives Comparison

Tables 9–14 compare impacts that vary between proposed route and crossing alternatives, as well as potential material source alternatives. All other impacts are similar across proposed alternatives. Permanent impacts are expected within the footprint of disturbance (embankment toe of slope to embankment toe of slope). Temporary impacts would occur within an additional 25 ft width from the embankment toes of slope (along the road, material source spur roads, staging areas) which may be used during construction for temporary equipment access and natural vegetative buffer.

Table 9 Wetlands Impacts: Route and Crossing Alternatives

Alternative	Southern Route (Preferred Alternative) with Lagoon Crossing D and Staging Areas				Combined Route B with Lagoon Crossing D and Staging Areas		
	Wetlands and Waters Type	Permanent (Acres)	Temporary (Acres)	Total	Permanent (Acres)	Temporary (Acres)	Total
Direct and Indirect and Construction	Estuarine	8.7	2.6	**11.3**	8.7	2.6	**11.3**
	Lacustrine	-	-	**-**	-	-	**-**
	Marine	-	-	**-**	-	-	**-**
	Palustrine Flooded	19.2	5.6	**24.8**	11.7	3.4	**15.1**
	Palustrine Saturated & Seasonally Flooded	86.0	24.8	**110.8**	111.8	32.6	**144.4**
	Pond	0.1	0.3	**0.4**	0.2	0.3	**0.5**
	Riverine	-	-	**-**	-	-	**-**
	Upland	1.0	0.3	**1.3**	1.0	0.3	**1.3**
	Total	**115.0**	**33.6**	**148.6**	**133.4**	**39.2**	**172.6**

Alternative	Southern Route (Preferred Alternative) with Lagoon Crossing D and Staging Areas				Combined Route B with Lagoon Crossing D and Staging Areas		
	Wetlands and Waters Type	Permanent (Acres)	Temporary (Acres)	Total	Permanent (Acres)	Temporary (Acres)	Total
Secondary and Cumulative	• Greater potential secondary impacts compared to the Combined Route B due increased access to greater number of private land owners near the Wulik River.				• Fewer potential secondary impacts compared to the Southern Route due to greater distance from Wulik River and fewer private land owners.		

Table 10 Wetland Functions Impacts: Route and Crossing Alternatives

Alternative	Southern Route (Preferred Alternative) with Lagoon Crossing D and Staging Areas				Combined Route B with Lagoon Crossing D and Staging Areas		
	Function	Permanent (Acres)	Temporary (Acres)	Total	Permanent (Acres)	Temporary (Acres)	Total
Direct and Indirect and Construction	Category I+	8.8	2.9	**11.7**	8.9	2.9	**11.8**
	Category I	101.7	29.3	**131.0**	109.1	32.0	**141.1**
	Category II	3.5	1.1	**4.6**	14.4	4.0	**18.4**
	Upland	1.0	0.3	**1.3**	1.0	0.3	**1.3**
	Total	**115.0**	**33.6**	**148.6**	**133.4**	**39.2**	**172.6**
Secondary and Cumulative	• Greater potential secondary impacts compared to the Combined Route B due increased access to greater number of private land owners near the Wulik River.				• Fewer potential secondary impacts compared to the Southern Route due to greater distance from the Wulik River and fewer numbers of private land owners.		

Table 11 Habitat (Viereck) Impacts: Route and Crossing Alternatives

Alternative	Southern Route (Preferred Alternative) with Lagoon Crossing D and Staging Areas				Combined Route B with Lagoon Crossing D and Staging Areas		
	Viereck	Permanent (Acres)	Temporary (Acres)	Total	Permanent (Acres)	Temporary (Acres)	Total
Direct and Indirect and Construction	Developed	1.0	0.3	**1.3**	1.0	0.3	**1.3**
	Closed Low Scrub (II.C.1)	1.8	0.5	**2.3**	4.8	1.5	**6.3**
	Willow Dwarf Shrub (II.D.2)	17.9	5.4	**23.3**	34.8	10.4	**45.2**
	Mesic Graminoid Herbaceous (III.A.2)	80.7	23.2	**103.9**	74.7	21.5	**96.2**
	Wet Graminoid	4.8	1.3	**6.1**	9.2	2.6	**11.8**

	Herbaceous (III.A.3)						
	Water (W)	8.8	2.9	**11.7**	8.9	2.9	**11.8**
	Total	**115.0**	**33.6**	**148.6**	**133.4**	**39.2**	**172.6**
Secondary and Cumulative	• Greater potential secondary impacts compared to the Combined Route B due increased access to greater number of private land owners near the Wulik River.				• Fewer potential secondary impacts compared to the Southern Route due to greater distance from the Wulik River and fewer numbers of private land owners.		

Table 12 Wetlands Impacts: Material Source Alternatives*

Alternative	K-Hill Site		Wulik River Source 1	Relic Channel Source 1 and Access**		Relic Channel Source 2 and Access***	
	Wetland Type	Permanent (Acres)	Permanent (Acres)	Permanent (Acres)	Temporary (Acres)	Permanent (Acres)	Temporary (Acres)
Direct and Indirect and Construction	Estuarine	-	-	-	-	-	-
	Lacustrine	-	-	2.0	-	-	-
	Marine	-	-	-	-	-	-
	Palustrine Flooded	-	33.7	2.1	0.1	0.4	0.1
	Palustrine Saturated & Seasonally Flooded	86.6	0.3	48.0	5.1	42.4	2.3
	Pond	-	-	2.5	-	2.3	-
	Riverine	-	5.7	-	-	-	-
	Upland	13.3	-	6.8	-	-	-
	Total	**99.9**	**39.7**	**61.4**	**5.2**	**45.1**	**2.4**
Secondary and Cumulative	• More potential secondary and cumulative impacts could occur due to proximity to proposed school site.		• More secondary impact potential compared to relic channel sources due to increased access for greater number of private land owners near the Wulik River.	• Less secondary impact potential compared to other material sources due to greater distance from Wulik River and fewer number of private land owners.		• Less secondary impact potential compared to other material sources due greater distance from Wulik River and fewer number of private land owners.	

NOTES:
* Acreages reflect a sub-portion of the areas depicted on figures.
** Includes Relic Channel Source 1 to Wulik River Source 1 Spur road.
*** If Combined Route B is selected, impacts would be slightly less due to shorter spur road.

Table 13 Wetland Functions Impacts: Material Source Alternatives*

Alternative	K-Hill Site		Wulik River Source 1	Relic Channel 1 and Access**		Relic Channel 2 and Access***	
	Function	Permanent (Acres)	Permanent (Acres)	Permanent (Acres)	Temporary (Acres)	Permanent (Acres)	Temporary (Acres)
Direct and Indirect and Construction	Category I+	-	20.6	4.6	0.1	2.3	-
	Category I	86.6	19.1	50.0	5.1	32.6	2.4
	Category II	-	-	-	-	10.2	-
	Upland	13.3	-	6.8	-	-	-
	Total	**99.9**	**39.7**	**61.4**	**5.2**	**45.1**	**2.4**
Secondary and Cumulative	• More potential secondary and cumulative impacts could occur due to proximity to proposed school site.		• More secondary impact compared to other material sources due to increased access for greater number of private land owners near the Wulik River.	• Less secondary impact compared to other material sources due to greater distance from Wulik River and fewer number of private land owners.		• Less secondary impact compared to other material sources due to greater distance from Wulik River and fewer number of private land owners.	

NOTES:

* Acreages reflect a sub-portion of the areas depicted on figures.

** Includes Relic Channel 1 to Wulik River Source 1 Spur road.

*** If Combined Route B is selected, impacts would be slightly less due to shorter spur road.

Table 14 Habitat (Viereck) Impacts: Material Source Alternatives*

Alternative	K-Hill Site		Wulik River Source 1	Relic Channel Source 1 and Access**		Relic Channel Source 2 and Access***	
	Viereck	Permanent (Acres)	Permanent (Acres)	Permanent (Acres)	Temporary (Acres)	Permanent (Acres)	Temporary (Acres)
Direct and Indirect and Construction	Closed Low Scrub (II.C.1)	-	14.9	0.1	0.1	17.3	0.2
	Willow Dwarf Shrub (II.D.2)	13.3	18.8	12.0		10.6	0.1
	Mesic Graminoid Herbaceous (III.A.2)	86.6	0.3	42.8	5.1	14.9	2.1
	Wet Graminoid Herbaceous (III.A.3)	-	-	2.0	-	-	-
	Water (W)	-	5.7	4.5	-	2.3	-
	Total	**99.9**	**39.7**	**61.4**	**5.2**	**45.1**	**2.4**
Secondary and Cumulative	• More potential secondary and cumulative impacts could occur due to proximity to proposed school site.		• More secondary impact potential compared to relic channel sources due to increased access for greater number of private land owners near the Wulik River.	• Less secondary impact potential compared to other material sources due to greater distance from Wulik River and fewer number of private land owners.		• Less secondary impact potential compared to other material sources due greater distance from Wulik River and fewer number of private land owners.	

NOTES:

* Acreages reflect a sub-portion of the areas depicted on figures.

** Includes Relic Channel Source 1 to Wulik River Source 1 Spur road.

*** If Combined Route B is selected, impacts would be slightly less due to shorter spur road.

4.9.3 Avoidance, Minimization, and Mitigation

Executive Order 11990, "Protection of Wetlands," issued May 24, 1977, requires there be no practicable alternative to a Proposed Action if such action affects wetlands, and that any proposed federally funded action include all practicable measures to avoid and minimize harm to wetlands. As the majority of the Study Area is dominated by high functioning wetlands and waters, construction of an evacuation route from Kivalina to K-Hill would cause impacts to high value wetlands, and a USACE Section 404/10 Individual Permit would be required.

Avoidance, minimization and, if required, either compensatory or sponsor-proposed mitigation are the primary measures available to offset wetland losses for the proposed project. In fulfillment of Executive Order 11990, the following avoidance and minimization measures would be implemented to reduce the unavoidable impacts to wetlands:

- The proposed route alternatives are routed to avoid and minimize impacts to Waters of the U.S. and the higher Category I+ wetlands. Upland areas are utilized as possible, while avoiding upland important bird habitat (Closed Low Scrub) at the same priority as Category I+ wetlands;
- Project elements (e.g., road embankment geometry, vehicle turn outs, water crossings) are designed to safely incorporate the minimal dimensions necessary to serve the project purpose and need in order to minimize required wetland fill;
- Staking or otherwise delineating the road embankment footprint and associated temporary impact areas would be completed prior to construction;
- Construction materials would be stockpiled within existing fills and/or developed staging areas to minimize construction disturbance and avoid impacting additional wetland acreage;
- Setbacks from surface waters would be maintained for refueling and vehicle maintenance activities to reduce the likelihood of hazardous substances entering waterbodies from accidental spills or releases; and
- A project Erosion and Sediment Control Plan, SWPPP, and Hazardous Material Control Plan would be implemented to protect streams and wetlands, and minimize the introduction of sediment and runoff to adjacent waterbodies.

4.10 Fish and Fish Habitat

4.10.1 Affected Environment

The Study Area encompasses the Kivalina barrier island, the southern portion of Kivalina Lagoon, and the lower Wulik and Kivalina River drainages. The Kivalina River (Anadromous Waters Catalog [AWC] Stream No. 331-00-10044) and the Wulik River (AWC Stream No. 331-00-10060) are both listed as important for the spawning, rearing, and migration of anadromous fish including all five species of Pacific salmon (ADF&G 2016a). The Kivalina Lagoon is documented to provide habitat for anadromous fish, Pacific salmon, and several demersal species, and is listed in the AWC as Stream No. 331-00-10060-0010 (ADF&G 2016a). As the Kivalina Lagoon, Wulik River, and Kivalina River are listed watercourses in the AWC, they are considered Essential Fish Habitat (EFH) under the Federal Management Plan for Pacific Salmon in the Economic Exclusion Zone off the Coast of Alaska (NMFS 2005; ADF&G 2016a). A detailed report focused on EFH is provided in Appendix I.

4.10.1.1 Kivalina Lagoon

Algal communities in nearshore marine habitats of the region are typically made up of pelagic phytoplankton, benthic algae, and sea-ice-associated algal mats (USACE 2005). The relative proportion of these algae depends on the season and extent of sea ice. During the summer season of sustained daylight and warmer temperatures, there are phytoplankton blooms in the water column, and benthic algae cover bottom substrates (USACE 2005).

Muddy and sandy substrates in the region provide habitat for fish and invertebrates such as polychaete worms, clams, tunicates, sponges, and burrowing anemones (USACE 2007). Sea stars (*Evasterias echinosoma*, *Asterias amurensis*, *Leptasterias polaris acervata*, and *L. nanimensis*), basket star (*Gorgonocephalus eucnemis*), and shrimp from the family Crangonidae, were all captured during surveys to the south of the lagoon for the DeLong Mountain Transportation System project (USACE 2005). Brackish water tolerant amphipods and clams have been noted inside Kivalina Lagoon (USACE 2007).

Kivalina Lagoon is considered EFH for five species of Pacific salmon, saffron cod (*Eleginus gracillis*), and Arctic cod (*Arctogadus glacialus*) (USACE 2007; NMFS 2011). EFH for crab (e.g., snow crab, *Chionoecetes opilio*) is located on the marine side of the Kivalina barrier island, with habitat inside Kivalina Lagoon expected to be marginal (NMFS 2017b). See Appendix I for more details about EFH.

In addition to the salmon and Dolly Varden that pass through the lagoon, various species of demersal fish can be found in the lagoon during summer months, including yellowfin sole, Bering flounder (*Hippoglossoides robustus*), starry flounder (*Platichthys stellatus*), and sculpins (USACE 2007). Schooling Pacific herring (*Clupea pallasii*), capelin (*Mallotus villosus*), and rainbow smelt (*Osmerus dentex*) are all caught seasonally inside the lagoon, while Arctic cod (*Boreogadus saida*) and saffron cod (*Eleginus gracilis*) are present year-round (USACE 2007).

4.10.1.2 Wulik River

The Wulik River supports chum salmon (*Oncorhynchus keta*), Chinook salmon (*O. tshawytscha*), sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), Dolly Varden (*Salvelinus malma*), Arctic grayling (*Thymallus arcticus*), slimy sculpin (*Cottus cognatus*), and several species of whitefish (ADF&G 2016a). Studies of the Ikalukrok Creek, a tributary the enters the Wulik River 37 miles upstream from Kivalina Lagoon, found small numbers of spawning Chinook salmon (Tetra Tech, Inc. 2009); however, aerial surveys conducted by the ADF&G along the Wulik River and Ikalukrok Creek have most consistently identified runs of chum and pink salmon and Dolly Varden with other salmon species identified in lower numbers and less consistently (ADF&G 2017a). Chum salmon have been observed spawning in the lower portion of Ikalukrok Creek annually since the late 1980s in late July and August (Scannell and Ott 2002). Since 2006, annual return estimates for chum salmon in lower Ikalukrk Creek have ranged from around 1,000–7,000 salmon. Chum salmon spawning has been documented in the Wulik River, with preferred spawning habitat conditions located approximately five miles upstream from the lagoon (ADF&G 2017a).

Dolly Varden are a main source of subsistence fish for people in Kivalina, contributing 86% edible weight of all harvested fish species (ADF&G 2010). Juveniles emerge in the spring after spawning in the Wulik River (Ott and Morris 2007), and spend between one and five years in the Wulik River drainage before migrating to the Chukchi Sea. Most adult Dolly Varden migrate out of the Wulik River shortly after peak break-up flows recede and as water clarity begins to improve. Adults typically re-enter the lagoon in later summer (USACE 2007); however, spawning fish typically return earlier in the summer. Annual surveys conducted between 1979 and 2015 as part of ongoing monitoring for the nearby Red Dog Mine, estimated between 22,000 and 144,000 mixed stock Dolly Varden in the Wulik River in each year (Ott et al. 2016). In most years, greater than 90% of Dolly Varden overwintered downstream from Ikalukrok Creek (ADF&G 2017a). The Dolly Varden found upstream of Ikalukrok are those believed to be natal to the Wulik River and move into the upper river for spawning. Most Dolly Varden spawning

outside of the Wulik River occur in Tutak Creek and Dudd Creek, tributaries of Ikalukrok Creek, both of which are likely used by summer spawners (Ott and Morris 2012).

From late August to September, age-0 and adult Arctic grayling move downstream from spawning habitat in Red Dog Creek to overwinter in the Wulik River (Ott and Morris 2007; Tetra Tech Inc. 2009). Several species of whitefish (Bering cisco, *Coregonus laurettae*; least cisco, *C. sardinella;* broad whitefish, *C. nasus*; humpback whitefish, *C. pidschian*; and round whitefish, *Prosopium cylindraceum*) all make use of the lower Wulik River (USACE 2005; Tetra Tech Inc. 2009; USACE 2007).

The Wulik River estuary (confluence of the Wulik River with the Kivalina Lagoon) is located immediately east of Kivalina. The estuary is characterized by a series of small, low gradient tributary channels across the Wulik River floodplain. Several relic channels to the Wulik River and isolated lake/pond features are also located in the estuary (northwest of the river confluence). The relic channels appear to have lost connectivity to the mainstem of the Wulik River; however, many are directly connected to the Kivalina Lagoon (Figure 7). Estuary habitat can be important habitat for outmigrating juvenile salmon, Dolly Varden, and numerous marine fish and invertebrate species discussed further in Section 4.10.1.1 (McClelland 2012). The relic channels are characterized by low velocity conditions and could provide high value rearing habitat for juvenile Arctic grayling if salinity conditions in the lagoon do not create a migration barrier blocking seasonal access. Fish-bearing status of the various isolated lake/pond features is unknown, but most of the ponds are shallow and they are anticipated to provide rearing habitat for juvenile Arctic grayling. The ponds likely cannot support overwintering fish due to shallow depths and probability of freezing to the channel bed.

4.10.1.3 Kivalina River

No interactions between the Proposed Action and fish or fish habitat in the lower Kivalina River were identified. As such, no further discussion of lower Kivalina River is included.

4.10.2 Environmental Consequences

4.10.2.1 No-Action Alternative

An evacuation road would not be constructed from Kivalina to K-Hill and no impacts to fish or fish habitats would occur. Residents would continue to be exposed to environmental threats with no reliable options for evacuation during storm events with the potential to detrimentally impact the community over time. There would remain severe risk to life, health, and safety of residents.

4.10.2.2 Route and Lagoon Crossing Alternatives

Direct and Indirect Impacts:

Evacuation Road Water Crossing Impacts to Freshwater and Anadromous Fish: With the exception of the lagoon crossing, no other portions of the proposed route alternatives would cross anadromous and/or EFH waterbodies. The Southern Route (Preferred Alternative) would require two fish passage crossings, four non-fish passage crossings, three enhanced design crossings, and no crossings of the Wulik River relic channel.

Combined Route B would require three fish passage crossings (one of which is a crossing of the Wulik River relic channel), six non-fish passage crossings, and three enhanced design crossings. The crossing types are described in Section 4.8.2.2 and are shown in Figure 9.

Causeway Fill Impacts to Marine and Anadromous Fish and Fish Habitat: Placement of aggregate materials and/or crossing structures in the Kivalina Lagoon would result in localized alteration of soft sediment and sand habitats to a coarse aggregate habitat. Given the localized placement of these structures and the abundance of both soft sand and sediment habitat types in the lagoon, the overall effect to fish is anticipated to be minimal. The alteration of the otherwise ubiquitous soft or sandy benthic habitats to coarser aggregate along the crossing would likely increase species richness and overall biological utility of the lagoon in this area. Sessile invertebrates could use coarse aggregate habitat for attachment and feeding, while fish species could use it for feeding, cover, and potentially breeding (Reynolds et al. 2010). It is anticipated that benthic communities could take 1–4 years to recover and colonize the disturbance (Jewitt et al. 1999), and fish species could use the habitat immediately. Therefore, placement of rock armoring along the causeway into the Kivalina Lagoon would likely have a positive effect with respect to marine and anadromous fish and invertebrate richness, by creating habitat diversity, and ecological function.

Placement of the aggregate fill could cause mortality of invertebrates or marine and anadromous fish even with implementation of appropriate BMPs. Mortality is anticipated to be limited and predominantly restricted to sessile, infaunal, and slow moving invertebrates and some demersal fish (e.g., starry flounder). If material is placed along the seafloor of the lagoon, these species may become buried or crushed; although mortality of invertebrate and demersal fish is not expected to have a measurable effect on the sustainability and success of local fishery species. Placement of the base causeway and rock protection would be done with no or minimal water present (see Section 4.3.2), avoiding potential impacts

to fish and other aquatic organisms. DOT&PF would coordinate with ADF&G to determine the timing of low-risk work windows to minimize potential for fish mortality.

Causeway Impacts to Marine and Anadromous Fish Passage: Fish passage would not be impeded by placement of the causeway as an open bridge would span the channel nearest Kivalina. This channel is likely the pathway for most fish moving north-south in the lagoon. In addition, culverts would be placed across the northeast end of the causeway, further providing passage opportunities for fish. These culverts will be designed to be easily maintained as an open water passage at mean tide, preventing an area of stagnant water. Based on the proposed causeway design, no velocity barriers to fish passage are anticipated at any of the structures.

Construction Impacts:

Evacuation Road In-water Work Impacts to Freshwater and Anadromous Fish: Placement of culverts would likely require the temporary dewatering or diversion of stream sections. This may result in the displacement of fish and the temporary interruption of fish migration or movement, depending on construction timing. Critical timing windows (e.g., salmon outmigration, spawning, migration) would be avoided or fish could be captured and relocated outside of the construction area prior to culvert placement, if required. As culvert installation can typically be completed within a week, temporal impacts to fish migration and movement of resident or anadromous species would be minimal. Through proper design and planning, culvert type and size would maintain fish passage during low and high flow conditions (ADF&G 2001).

In-water work has the potential to impact fish and their habitat through degradation of water quality. Culvert installation may cause an increase in sediment loading and turbidity in fish habitat, which may inhibit oxygen exchange in all life stages (Bash et al. 2001). Proper installation techniques (e.g., bypass or plug and pump) would limit the introduction of suspended sediments into fish habitat (ADF&G 2001). Winter construction would minimize the potential for runoff generation and transport into adjacent freshwater resources during critical life history stages (e.g., spawning or egg development) (NMFS 2017a). Once the proposed road is constructed, rainfall or melting events may also result in mobilization of runoff from previously frozen, ice-rich sediments, which could discharge into nearby freshwater resources. Localized effects of sediment-laden runoff, following construction, are anticipated to be temporary and of short duration with limited potential to adversely affect freshwater anadromous fish and fish habitat.

Water Withdrawal Impacts to Freshwater and Anadromous Fish and Fish Habitat: During project construction, water withdrawals would be required to create temporary ice/snow roads, dust control, and to support road compaction. Water to support these activities would likely be sourced from surface waterbodies along the final selected route alignment. Water withdrawal activities can affect fish directly through entrainment or trapping within the pumping system itself or impingement on the intake structure at the point of withdrawal. Excessive withdrawal from any given source could also impact fish habitat through the reduction of water levels or habitat quality, including inadequate volume to resist freezing in winter or to retain high enough dissolved oxygen concentration for fish survival. Winter withdrawal could also lead to reduced flows in small streams, affect spawning beds and fish eggs within the gravel, or impede fish passage to and between important overwintering habitats. Summer season withdrawal could also lead to similar effects if volume removal is too great relative to water levels at that time. In general, reductions in water levels and flows can increase water temperatures. Species tolerance of thermal changes would vary and may exceed lethal thresholds of some species or increase the productivity for others. Any withdrawal resulting in discontinuous surface flows within a creek or lake outlet would trap fish.

Screened intake and volume withdrawal criteria would be identified to mitigate potential effects to fish and fish habitat. Volume limitations and use of ADF&G-compliant screened intakes would reduce the potential for effects associated with fish impingement and entrapment. Through appropriate BMPs, minimal effects to freshwater and anadromous fish and fish habitat are anticipated due to water withdrawal activities during construction.

Causeway Construction Impacts to Marine and Anadromous Fish and Fish Habitat: Noise and hydraulic forces from causeway construction or pile driving could impact fish and invertebrate use of nearby habitats in the lagoon. In particular, in-water pile driving causes large sound pressure waves, which could injure or kill fish, and adversely impact invertebrates (NMFS 2017a). The primary methods to avoid impacts from pile driving are to conduct installation on land, or in water when larval and juvenile fish are not present (NMFS 2017a). Consequently, DOT&PF has committed to no in-water pile driving. In addition, placement of the base causeway and rock protection would be done with no or minimal water present (see Section 4.3.2). This would reduce potential impacts to fish and other aquatic organisms.

Secondary (Induced) and Cumulative Impacts:

Increased Access to Subsistence Fisheries: The Wulik River is currently fished year-round by residents of Kivalina for subsistence use, and sites are typically accessed via boat in the summer and snow machine during winter months for fishing through the ice. Construction of either road and crossing alternative

would allow increased summer overland access to the lower Wulik River for subsistence fisheries. Public access to the Wulik River is limited by adjacent privately-owned lands. Some redistribution of current fishing efforts is expected.

4.10.2.3 Material Source Alternatives

Direct, Indirect, and Construction Impacts:

Material Source Impacts to Freshwater and Anadromous Fish and Fish Habitats: Development of material sources and their spur roads have the potential to impact freshwater anadromous fish and fish habitats. Material extraction sites studied in arctic and subarctic floodplains in Alaska have demonstrated both adverse and beneficial effects on fish and fish habitats depending on the type and size of the river, type of material extraction employed, and the amount of material extracted (Joyce et al. 1980; Ott et al. 2014). Material source development can lead to destabilization of river channels, river channel capture, floodplain widening, increased erosion and sedimentation, increased water velocities, reduced water quality, can lead to aquatic habitat shifts, and in some instances, has been documented to cause subsurface flows, creating a barrier to fish passage (Joyce et al. 1980). Alternatively, local fish populations have benefited from gravel mine sites in some locations through the creation of overwintering and productive feeding habitats (Ott et al. 2014). Ott et al. (2014) also found that several gravel mine sites, most constructed as pits, were eventually connected to nearby drainages on Alaska's North Slope, and successfully used for overwintering. Gravel extraction sites in that study provided a habitat that is limited in the arctic and thus functioned as viable habitat creation.

Material source development for this project is not anticipated to alter current predator-prey relationships. While some species present in the Wulik River (e.g. Dolly Varden, whitefish, Arctic Grayling) can eat salmon eggs or juveniles, they are not expected to be present in the reclaimed material site ponds concurrent with salmon smolts. The primary salmon species spawning in the Wulik River drainage are pink and chum salmon which smolt as age-0 fish, migrating out of the drainage during peak flows at break-up. Residence of juvenile pink and chum salmon within the reclaimed material sources is unlikely. Salmon spawning within the reclaimed material sources is also unlikely as suitable habitat occurs further upstream (Figure 9).

Blasting at material sources may be required to develop adequate source rock (Kolden and Aimone-Martin 2013). Blasting has the potential to impact fish from substrate vibration and water overpressure (Kolden and Aimone-Martin 2013). These can disrupt incubating egg and embryo development, and lead to trauma to adult fish (Kolden and Aimone-Martin 2013). Kolden and Aimone-Martin (2013) also found

that current ADF&G (1991) blasting standards appear to sufficiently protect salmonid embryos, juveniles, and adults. Blasting at individual material sources would require site specific mitigation measures to comply with ADF&G guidelines and prevent impacts to fishery resources.

Access to and development of material sources near the Wulik River and its relic channels would likely occur, at least in part, during the winter months when the ground is frozen. Upon completion of the project, material sources would be reclaimed as per permit requirements (see Section 4.10.3).

Through appropriate planning and adherence to site specific construction timing windows, and other mitigation measures and management plans, material excavation impacts within relic channels or river bars of the Wulik River are expected to be only temporary and have minimal effects on freshwater and anadromous fish and fish habitat.

Secondary (Induced) and Cumulative Impacts:

Once the evacuation route is constructed, increased access to adjacent public and private lands may enable development in those areas, which may encourage reclaimed material sources to be reopened. This may cause additional impacts to fish and fish habitats through expansion of existing material sources.

4.10.2.4 Alternative Comparison

Table 15 compares impacts that vary between proposed route and crossing alternatives, as well as potential material source alternatives. All other impacts are similar across all proposed alternatives.

Table 15 Fish and Fish Habitat Impacts

Fish Habitat: Differences Between Route Alternatives		
	Southern Route (Preferred Alternative) with Lagoon Crossing C	**Combined Route B with Lagoon Crossing C**

Direct and Indirect and Construction	Water Crossings:
	• No EFH disturbance outside of lagoon
	• Total of 9 water crossings:
	  • 0 crossings of Wulik River Relic Channel;
	  • 2 fish passage crossings;
	  • 4 non-fish passage crossings; and
	  • 3 enhanced design crossings.
	Water Crossing Disturbance*:
	• 1.24 acres.
		Water Crossings:
		• No EFH disturbance outside of lagoon
		• Total of 12 water crossings:
		  • 1 fish passage crossing (Wulik River Relic Channel);
		  • 2 fish passage crossings;
		  • 6 non-fish passage crossings; and.
		  • 3 enhanced design crossings.
		Water Crossing Disturbance*:
		• 1.65 acres.

Secondary and Cumulative	Access to Adjacent Lands: • Greater access to the Wulik River as compared to Combined Route B.		Access to Adjacent Lands: • Lesser access to the Wulik River than Southern route.	
Differences Between Material Source Alternatives				
	K-Hill Site	**Wulik River Source 1**	**Relic Channel Source 1**	**Relic Channel Source 2**
Direct and Indirect and Construction	Fish and Fish Habitat • No impacts anticipated.	Fish and Fish Habitat • Potential impacts to chinook, sockeye, pink and chum salmon spawning habitat, incubating salmon eggs and embryos. • Potential impacts to EFH. • Permanent impact: 5.7 acres of within ordinary high water of the Wulik River.	Fish and Fish Habitat • No impacts to salmon spawning habitat, incubating eggs, or embryos. • No impact to EFH. • Permanent impact: 2.0 acres to lacustrine 2.5 acres to ponds.	Fish and Fish Habitat • No impacts to salmon spawning habitat, incubating eggs, or embryos. • No impact to EFH. • Permanent impact: 2.3 acres to ponds.
Secondary and Cumulative	No secondary impacts anticipated.	• Increased access to the Wulik River may cause some redistribution of current fishing locations. • Increased access may encourage reclaimed material sources to be re-opened and cause additional impacts to fish or fish habitat.	• Increased access may encourage reclaimed material sources to be re-opened and cause additional impacts to fish or fish habitat.	• Increased access may encourage reclaimed material sources to be re-opened and cause additional impacts to fish or fish habitat.

NOTE:
* Water crossing area disturbance assumes an average impact length of 120 ft and width of 50 ft (0.138 acres) for each crossing.

4.10.3 Avoidance, Minimization, and Mitigation

The following measures are identified to avoid, minimize, or mitigate potential effects to fish and fish habitats in the Study Area freshwater and marine environments.

<u>All Features:</u>

- Compliance with the APDES CGP, and implementation of the required SWPPP and BMPs during construction, to reduce the potential for sediment laden storm water runoff during construction. Stabilization of side slopes with vegetation or non-erodible material would also be implemented as part of CGP compliance to further reduce the potential for sedimentation of nearby streams;

- Construction of all crossing structures would adhere to appropriate BMPs for in-water works to minimize potential effects to fish or fish habitats from sediment mobilization and transport, and accidental contaminant spills;
- During in-water construction activities, monitoring may be required onsite to implement site specific BMPs and other potential permit requirements; and
- Obtain Fish Habitat Permit from ADF&G.

Lagoon Crossing:

- In-water work associated with the lagoon crossing would be scheduled to reduce impacts to fish;
- Implementation of BMPs that avoid or minimize adverse impacts to water quality and marine habitats;
- The causeway's northeastern culvert(s) will be designed to accommodate fish passage, be easily maintained as an open water passage at mean tide and accommodate anticipated debris and icing mitigation to prevent flow blockage; and
- Pile driving would be conducted through constructed embankment, to limit impacts to salmon juveniles and adults (NMFS, 2017a).

Road Construction:

- During construction occurring concurrent with critical timing windows, appropriate measures would be implemented (e.g., construction of a diversion channel) to maintain fish migration and passage
- DOT&PF will coordinate with ADF&G to mitigate impacts to fish during water withdrawal activity and ice harvest that may be needed for construction of ice roads; and
- DOT&PF and the construction contractor would coordinate with ADF&G to identify and implement appropriate migration measures.

Material Sources:

- Material source selection, site specific mining plan design, permitting, and reclamation would reduce the potential for adverse impacts and could enhance fish habitats in some drainages, such as the Wulik Relic Channel;
- Reclamation plans may include developing shallow littoral zones and shrubby riparian areas for migratory bird habitat;
- Site specific material site plans will incorporate work timing windows to work around sensitivities for salmon and Dolly Varden;

- Material sites will be prioritized for use: 1) K-Hill and Relic Channel sources and 2) Wulik River 1 (only after other sites are exhausted);
  - If the Wulik River Material Site 1 is constructed, maintain a connection to the Wulik River; and
- Coordination with ADF&G and NMFS would be conducted during design to develop an adequately sized material source at the selected location, maintain adequate setbacks from the river, and avoid adverse impacts to EFH.

4.11 Terrestrial and Aquatic Birds

4.11.1 Affected Environment

More than 100 species of birds, primarily waterfowl and shorebirds, migrate from southern latitudes of North, Central, and South America to breed in the Study Area (Tetra Tech 2009; Audubon Alaska 2016). Terrestrial and aquatic birds, and their nests and eggs, are protected under the *Migratory Bird Treaty Act* (MBTA). All species discussed in this section would be protected by MBTA except for the Willow and Rock Ptarmigan (see below). The following sections describe the occurrence, abundance, richness, and habitat associations of terrestrial and aquatic bird species in the Study Area.

Upland habitats and water bodies in the Study Area support vegetation, invertebrates, and freshwater, marine and anadromous fish, that serve as food for shorebirds, waterbirds, and waterfowl. Coastal habitats in the Study Area are comprised of grass-dominated gravel beaches that divide the Chukchi Sea from the Kivalina Lagoon (Figure 6 and Figure 8). The inland areas surrounding the community of Kivalina include scrub-shrub, emergent, riparian, and intertidal areas, some of which provide breeding habitat for birds (Figure 6 and Figure 8). The Kivalina and Wulik Rivers flow into the Kivalina Lagoon, creating brackish water conditions. The near-shore marine environment experiences seasonal ice build-up between mid-November and late May. Polynyas (i.e., open water areas surrounded by sea ice) can occur under the right sea conditions and provide important migration, foraging, and reproduction areas for arctic birds (ADF&G 2016b).

4.11.1.1 Terrestrial Birds

Most terrestrial birds in the Study Area are transitory or seasonal breeders, and their abundance and diversity are relatively low during winter months (USACE 2016). Inland scrub, inland shrub, tussock tundra, riparian vegetation, and wetland habitats provide foraging, breeding, staging, molting, and habitat

for raptors, ptarmigan, shorebirds, waterfowl, and migratory and resident songbird species (WHPacific 2012b).

Within the Study Area, riparian corridors of willow and alder shrubs likely support the highest diversity of terrestrial bird species. The USFWS has indicated that high quality shrub areas are important migratory bird habitat (USFWS 2017d). This habitat was mapped and identified in this report as Closed Low Scrub habitat (Section 4.9). This "low scrub" habitat represents the highest regional vegetation (i.e., 20 cm–1.5 m), taller than "dwarf shrubs", which are less than 20 cm tall. This additional level of shrub canopy provides nesting, perching, and refuge from predators for terrestrial bird species.

Coastal tundra provides breeding habitat for the Northern Pintail (*Anas acuta*), Long-tailed Duck (*Clangula hyemalis*), American Golden-Plover (*Pluvialis dominica*), Red-necked Phalarope (*Phalaropus lobatus*), Lapland Longspur (*Calcarius lapponicus*), Baird's Sandpiper (*Calidris bairdii*), Stilt Sandpiper (*Calidris himantopus*), and Buff-breasted Sandpiper (*Calidris subruficollis*) (ADF&G 2016b; USACE 2016; USGS 2016). Rock Ptarmigan (*Lagopus muta*) breed on hilly or mountainous tundra throughout Alaska (ADF&G 2016b). In winter, most male Rock Ptarmigan migrate to lower elevations within their breeding range whereas the hens move to the hills where they spend the winter in shrubby, open habitat. In western Alaska, Willow Ptarmigan (*Lagopus lagopus*) prefer riparian areas that support abundant willow and other tall bushes for breeding (ADF&G 2016d). In winter, Willow Ptarmigan remain close to shrubby slopes and valleys, but seek out areas at lower elevations compared to the breeding season. Willow and Rock Ptarmigan are a regionally important subsistence resource (ADF&G 2005a).

Higher elevation cliffs, rock outcrops, and hill outcroppings in the region provide potential suitable breeding habitat for cliff-nesting raptors such as Rough-legged Hawk (*Buteo lagopus*), Gyrfalcon (*Falco rusticolus*), and Peregrine Falcon (*Falco peregrinus*) (ADF&G 2008; 2011a). In the Study Area, potential raptor nesting habitat for these species is likely limited to K-Hill near the proposed project terminus, as well as to other rock outcroppings northeast of K-Hill near the Study Area boundary (Figure 6 and Figure 8). Hawk and Gyrfalcon nests were previously recorded within or near the Red Dog Mine footprint and transportation corridor (Tetra Tech 2009; ADF&G 2016c). Unidentified raptor presence (skull) was recorded during a fall reconnaissance survey (Stantec 2016c).

4.11.1.2 Aquatic Birds

Near-shore coastal waters and the Kivalina Lagoon are situated along the Pacific Flyway (USFWS 2017d) and provide important staging habitat for migrating seabirds, shorebirds, waterfowl, and waterbirds

(USACE 2006, 2017). During the spring migration, thousands of ducks, geese, loons, and other aquatic bird species migrate north, flying low along the barrier islands or over the near-shore ice (USACE 2005). Notable numbers of Canada Goose (*Branta canadensis*), Greater White-fronted Goose (*Anser albifrons*), Brant (*Branta bernicla*), Tundra Swan (*Cygnus columbianus*), Northern Pintail (*Anas acuta*), and all five species of loon (Red-throated Loon [*Gavia stellate*], Arctic Loon [*Gavia arctica*], Pacific Loon [*Gavia pacifica*], Common Loon [*Gavia immer*], Yellow-billed Loon [*Gavia adamsii*]) migrate through coastal habitats in the Study Area (USACE 2005; Tetra Tech 2009; WHPacific 2012b; Audubon Alaska 2016).

The Study Area contains two small islands that are part of the Alaska Maritime National Wildlife Refuge and are located approximately 45 miles south of a much larger portion of the refuge located around Cape Thompson, which provides globally significant breeding habitat for various auklets (*Aethia sp.*, *Cerorhinca sp.*, *Ptychoramphus sp.*), Red-legged Kittiwakes (*Rissa brevirostris*), Aleutian Terns (*Onychoprion aleuticus*), and Red-faced Cormorants (*Phalacrocorax urile*) (USFWS 2016a; Figure 8).

Coastal lagoons in Cape Krusenstern National Monument, 8.5 miles south of the Study Area, provide breeding habitat for Yellow-billed Loon (*Gavia adamsii)* as well as for Threatened species, including Spectacled Eider and Steller's Eider (USFWS 2012; NPS 2016b). The Krusenstern Lagoon, within the Cape Krusenstern National Monument, supports significant summer populations of Black Scoter (*Melanitta americana*). Coastal habitats north of the community of Kivalina also support regionally large colonies of murres, gulls, and terns (Audubon Alaska 2016).

The Wulik and Kivalina River deltas and the Kivalina Lagoon host brackish-water tolerant fish and invertebrates. Accordingly, these areas provide important spring and fall staging habitats for migrating seabirds, waterfowl, waterbirds, and shorebirds (Tetra Tech 2009; Audubon Alaska 2016). Due to the combination of open water and emergent vegetation, low-lying sedge marshes and riparian habitat along the Kivalina River also serve as breeding habitat for Canada Goose, Northern Pintail, and American Wigeon (*Anas americana*) (WHPacific 2012b). The lagoon and lakes in the Study Area may support breeding habitat for Yellow-billed Loon (Earnst 2004; Earnst et al. 2006; USFWS 2012).

4.11.1.3 Threatened and Endangered Species

The Spectacled Eider and Steller's Eider (Alaska breeding population) are listed as Threatened under the *Endangered Species Act* (ESA). Spectacled Eider (*Somateria fischeri*) and Steller's Eider (*Polysticta stelleri*) are recorded infrequently in the Study Area during their migration to breeding habitats in northern latitudes (WHPacific 2012b).

Spectacled Eider

Spectacled Eider occurs throughout marine habitats in Alaska, and are typically found within coastal waters 1 to 28 miles from shore. Molting eiders are found in eastern Norton Sound and Ledyard Bay mid-July through December and wintering birds congregate in small groups near St. Lawrence Island. In western Alaska, core breeding habitat extends from Nelson Island to the Askinuk Mountains (Petersen et al. 2000). They are recorded infrequently in the Study Area during their migration to breeding habitats in northern latitudes (WHPacific 2012b). Coastal lagoons in Cape Krusenstern National Monument, 8 miles south of the Study Area, provide breeding habitat for spectacled eider (NPS 2016b).

Population declines are primarily attributed to alteration or destruction of habitat, contaminant exposure, and predation (USFWS 2010). Critical habitat for Spectacled Eider has been designated for molting sites in Norton Sound and Ledyard Bay, for breeding on the Yukon-Kuskokwim Delta, and for wintering south of St. Lawrence Island (USFWS 2010). The closest tract of designated critical habitat represents critical habitat to the Study Area in Ledyard Bay, approximately 143 miles from the Study Area (USFWS 2010). The Study Area does not overlap with any designated critical habitat for this species.

Steller's Eider

Steller's Eider breed primarily along the Arctic Coastal Plain, but also have a small population that nests on the Yukon-Kuskokwim Delta. Eiders molt throughout southwest Alaska mid-July through December, primarily along the north side of the Alaska Peninsula, Izembek Lagoon, Nelson Lagoon, Port Heiden, and Seal Islands (Frederickson 2001; USFWS 2002). Wintering birds congregate in shallow, sheltered waters along the south side of the Alaska Peninsula.

Reasons for population declines are poorly understood but potential threats include oil or contaminant exposure, predation, and hunting pressures (USFWS 2002). Critical habitat for Steller's Eider has been designated for breeding habitat on the Yukon-Kuskokwim Delta, and molting sites in Kuskokwim Bay, Izembek Lagoon, Nelson Lagoon, and Seal Islands (USFWS 2002).

There are no records of Steller's Eider occurring within the Study Area. The NPS indicates that coastal lagoons in Cape Krusenstern National Monument, 8 miles south of the Study Area, provide breeding habitat for Steller's Eider (NPS 2016b). The closest tract of designated critical habitat represents critical molting habitat in Hooper Bay, approximately 429 miles from the Study Area (USFWS 2002). The Study Area does not overlap with any designated critical habitat for this species.

4.11.2 Environmental Consequences

4.11.2.1 No-Action Alternative

An evacuation road would not be constructed from Kivalina to K-Hill and no impacts to terrestrial and aquatic birds would occur. Residents would continue to be exposed to environmental threats with no reliable options for evacuation during storm events with the potential to detrimentally impact the community over time. There would remain severe risk to life, health, and safety of residents.

4.11.2.2 Route and Lagoon Crossing Alternatives

Direct and Indirect Impacts:

Potential Changes to Terrestrial Bird Habitat: A permanent loss or alteration of terrestrial bird habitat would result from construction of route and lagoon crossing alternatives. The placement and construction of a road would result in the loss of existing habitat to both resident and seasonal species. The footprint of the Proposed Action would result in the removal or alteration of Closed Low Scrub habitat from construction of the Southern or Combined Route B with Lagoon Crossing D. Resident and migrant species would likely relocate to other nearby, similarly suitable habitats available in the Study Area resulting in no permanent impacts to the use of habitats by terrestrial bird species (Figure 7).

Potential Changes to Aquatic Bird Habitat: Placement and construction of a permanent lagoon crossing structure across Kivalina Lagoon would result in a direct loss of approximately 11.3 acres of estuarine habitat due to placement of fill, piers, and culverts (Figure 3 and Table 9). Armor rock placed along the causeway portion of the structure would provide new habitat potentially suitable for many algal and invertebrate species that could serve as potential prey for aquatic birds (ADF&G 2005b).

Potential Changes to Terrestrial and Aquatic Bird Movement: Construction and operation of the evacuation road has potential to cause changes in movement for terrestrial and aquatic birds by creating a perceived or physical barrier to movement, or by causing sensory disturbances; although the sensitivity and degree of response is expected to vary by species (Barber et al. 2009; Ortega 2012). The construction and use of the route alternatives and lagoon crossing can alter bird activity along existing movement corridors (e.g., daily or seasonal migratory routes, dispersal routes) or change access to preferred habitats (e.g., staging, foraging, and breeding sites) (MacKinnon et al. 2013; Bishop et al. 2017). Although the response varies by species or species group and the nature of a disturbance activity, birds tend to avoid habitats subjected to high sensory disturbance (Korschgen and Dahlgren 1992; Madsen 1995; Mayo et al.

2015). Project infrastructure and activities are not expected to limit access to key staging, foraging, or breeding habitats for terrestrial or aquatic birds based on availability of habitats within the Study Area (Figure 5 and Figure 7).

Threatened and Endangered Species:

Spectacled Eider

Spectacled Eider breed along peninsulas, pond shorelines, or wet meadows dominated by sedges (Petersen et al. 2000). Construction of the Proposed Action would result in some loss or alteration of shoreline or wetland habitats potentially suitable for spectacled eider breeding. Although some areas of aquatic and shoreline habitats would be removed or altered by construction of a lagoon crossing structure, aquatic habitats in the Study Area are ubiquitous. Remaining suitable aquatic and shoreline habitats are expected to be sufficiently abundant for aquatic bird species to not be disrupted in staging, foraging, or breeding activities.

Construction-related noise impacts to the Spectacled Eider are similar to those described for aquatic birds in the *Construction Impacts* discussion. The project would implement several avoidance, minimization, or mitigation measures (described in Sections 4.10.2 and 4.12.2) to limit potential adverse effects of the project.

Steller's Eider

Steller's Eider breed in open tundra or within shrubby willow or birch stands in close proximity to coastal areas (Frederickson 2001; USFWS 2002). Construction of the project would result in some loss or alteration of tundra or shrub habitats adjacent to the Kivalina Lagoon or wetlands along the evacuation road, as described above for Spectacled Eider. Construction-related noise impacts described for aquatic birds in the *Construction Impacts* discussion could also potentially impact Steller's Eider.

Construction Impacts:

Potential Changes to Terrestrial Bird Habitat: Construction activities that result in the clearing of vegetation or other terrain alteration (e.g., excavation or placement of material) have potential to remove suitable breeding, staging, or foraging habitats used by resident or migratory waterfowl, raptors, shorebirds, and songbirds. Construction related sensory disturbances (e.g., noise) in winter would be limited to resident species, such as ptarmigan. Activities scheduled during spring or summer would potentially affect seasonal species that use the Study Area for staging during migration or for breeding (USFWS 2017d).

Potential Changes to Aquatic Bird Habitat: Construction activities within and adjacent to the lagoon may result in changes to the physical, chemical, or acoustic parameters of that section of the lagoon that could result in the temporary displacement of species that stage, feed, or breed there (e.g., geese, swans, waterfowl, and shorebirds). However, the footprint of the crossing represents less than 1% of potentially suitable estuarine intertidal and subtidal habitat for aquatic birds in the Study Area (Table 9). Although aquatic and shoreline habitats would be removed or altered by construction of a lagoon crossing structure, aquatic habitats in the Study Area are ubiquitous (Figure 5). Remaining suitable aquatic and shoreline habitat is expected to be sufficient for aquatic bird species to not be disrupted in staging, foraging, or breeding activities.

Change in habitat availability and use by aquatic birds can similarly result from sensory disturbance associated with pile driving in Kivalina Lagoon. Water filling, culvert installation, and construction boats would also create noise, but is anticipated to be at levels below that of pile driving. The frequency, intensity, and duration of in-air or underwater acoustic emissions can result in displacement from suitable staging, foraging, or breeding habitats (Ronconi and St. Clair 2002; Bellefleur et al. 2009). Gladwin et al. (1988), found that waterfowl, waterbirds, and shorebirds can be disturbed by in-air noise levels up to 105 decibel (dB) from 500 m–1,200 m away. The effect of underwater noise on aquatic birds is poorly understood compared to other marine wildlife (e.g., marine mammals). Nevertheless, existing studies suggest that underwater noise results in low-level responses among aquatic bird species (Lacroix et al. 2003 and Melvin et al. 1999).

The propagation and attenuation of in-air or underwater noise is influenced by the size, speed, and design of construction boats, equipment, and materials in combination with localized oceanic conditions (e.g., depth, topography, surface conditions; Ronconi and St. Clair 2002). DOT&PF has committed to pile driving through constructed embankments to avoid and minimize underwater noise. In addition, placement of the base causeway and rock protection would be done with no or minimal water present (see Section 4.3.2). The duration of noise associated with pile driving for the lagoon crossing structure is assumed to be 30-60 days (not continuous). As a result, in-air or underwater noise levels in the vicinity of the lagoon would increase for only a relatively short period of time, resulting in only temporary, localized displacement of aquatic birds.

Potential Changes to Terrestrial and Aquatic Bird Mortality: Terrestrial and aquatic birds, and their nests and eggs, are protected under the MBTA. Construction of either route alternative and the lagoon crossing has the potential to result in direct injury or mortality of birds, nests, and eggs depending on the timing of construction activities. Impacts are expected to be limited by scheduling construction and vegetation

clearing activities to take place outside of important nesting periods (USFWS 2017d). Infrastructure development may alter habitat indirectly via changes in noise, traffic, and vegetation cover (Benítez-López et al. 2010; Liebezeit et al. 2009; NRC 2003; Ortega 2012).

There is limited potential for construction of either route and lagoon crossing alternative to result in mortality of nesting aquatic birds. Because shoreline habitats along the mainland side of the lagoon crossing are not expected to be lost or altered during construction, except at the tie-in points for the crossing structure, mortality of nesting birds, including their nests and eggs is expected to be limited.

The potential for change in mortality risk is primarily associated with permanent injury resulting from short-duration impulsive or vibratory underwater activities (i.e. impact pile driving) produced during construction of the lagoon crossing structure. At high enough received sound levels, diving birds can experience direct physiological effects. Sudden, high-amplitude noise sources that produce pressure pulses in the vicinity of the source can result in lethal or sub-lethal injury (e.g., barotrauma) from shock waves (SAIC 2011).

However, as discussed, DOT&PF has committed to no in-water pile driving to avoid and minimize underwater noise. In addition, placement of the base causeway and rock protection would be done with no or minimal water present (see Section 4.3.2). Therefore, underwater noise levels are not anticipated to reach the surrogate thresholds recommended by SAIC (2011), and auditory and non-auditory injury to aquatic birds is not expected. In addition, diving species are generally expected to be present in nearshore coastal habitats as opposed to inside Kivalina Lagoon, and aquatic birds using the lagoon for staging or foraging are anticipated to avoid active construction areas and move to alternative suitable habitat available in the area, and are thus not expected to interact with construction equipment.

Secondary (Induced) and Cumulative Impacts:

With construction of the route alternatives and lagoon crossing, there is potential for increased vehicle traffic to access the evacuation site and adjacent lands for subsistence and recreation. There is some risk for vehicle/bird strikes due to the presence of the new road corridor, however, the anticipated risk is minimal. There is also likely less off-road vehicle use, resulting in fewer impacts to nests and bird habitat from travel inland. Any off-road vehicle use is likely to be concentrated along the road corridor.

Potential development of adjacent public and private lands may also increase because of new road access created by the project. This increase in human presence and activity may cause additional indirect impacts to terrestrial and aquatic birds through further development or disturbance in the Study Area (Kertell et al.

1997; NRC 2003; Liebezeit et al. 2009; Meixell and Flint 2017). Although potential development of adjacent lands may result in the direct loss of bird habitat, most habitat types are common and distributed ubiquitously throughout the region (Figure 6 and Figure 8). Increased access supporting subsistence activities may result in a redistribution of effort, however, the majority of subsistence take of birds is concentrated around the mouth of the Wulik River. Increased impacts to bird habitat from expansion of access to subsistence use areas is anticipated to be minimal for birds as these species are not a major subsistence resource within lands along the road corridor inland from the lagoon crossing.

4.11.2.3 Material Source Alternatives

Direct and Indirect Impacts:

Potential Changes to Terrestrial Bird Habitat: A permanent loss or alteration of terrestrial bird habitat could result from development of the material source alternatives (including spur roads), and the stockpiling of materials at various locations.

Construction Impacts:

Potential Changes to Terrestrial Bird Habitat: Clearing of vegetation or other habitat alteration (e.g., excavation or placement of material) has potential to remove suitable staging, foraging, or breeding habitats used by resident or migratory waterfowl, raptors, shorebirds, and songbirds. An estimated 12% of the material source alternatives is comprised of Closed Low Scrub habitat that would be removed or altered, depending on the source(s) selected. Conversely, these altered habitats may create new habitat for certain bird species. For example, gravel sources may support ptarmigan or grouse grit digestion (ADF&G 2005a), or may support nesting habitat for some upland shorebirds and songbird species following site abandonment (ConocoPhillips 2005).

During winter, construction-related impacts would be limited to resident species, such as ptarmigan. Spring or summer activities are more likely to affect seasonal species that use the Study Area for staging during migration or for breeding (USFWS 2017d). Summer construction also has the potential to impact raptors that may be nesting near K-Hill. While permanent material sources could result in altered habitats to both resident and seasonal species, both groups are expected to continue to access or relocate to other nearby suitable habitats available in the Study Area (Figure 6 and Figure 8) (ConocoPhillips 2005).

Blasting activities to support excavation at material source alternatives and construction noise have potential to result in displacement of terrestrial birds. Sudden, impulsive or impact noises can shock birds; repetitive in-air or ground vibration disturbance can be sufficient that terrestrial birds would avoid

habitats up to several kilometers from material source alternatives (Dooling and Popper 2007; ECCC 2017). The level of disturbance is influenced by the size and location of blasting activities, blast depth and material, direction, sediment type and topography, wind conditions. Based on studies completed on raptors in the central and southern U.S., terrestrial birds are expected to alter patterns in habitat used in habitats adjacent to material source alternatives based on the timing and duration of blasting activities (Bednarz 1984). However, buffer areas around blasting activities have been shown to limit changes in breeding behavior (Holthuijzen et al. 1990).

Potential Changes to Terrestrial Bird Mortality: As described for the alternatives, terrestrial birds, and their nests and eggs, are protected under the MBTA. Development of all material source alternatives has potential to result in direct injury or mortality of birds, nests, and eggs. Consistent with regional recommendations, winter construction would further limit the temporary impacts related to construction activity and restrict it to resident species only (USFWS 2017d). If vegetation clearing, site preparation, and construction is scheduled within sensitive nesting periods, pre-construction nest surveys would be conducted by qualified personnel.

Secondary (Induced) and Cumulative Impacts:

With increased access to adjacent public and private lands additional material sources may be developed over time. This increase in activity may cause additional impacts to aquatic and terrestrial birds. Direct conversion of habitat could take place from specific activities, although the majority of habitat types are common in the Study Area. Material sources located near USFWS identified high quality bird habitat may have an increased impact from secondary development. This high-quality Closed Low Scrub habitat is relatively rare in the Study Area, but is common in the Relic Channel Source 2 and Wulik River Source 1 (Table 14).

4.11.2.4 Alternatives Comparison

Table 16 compares impacts that vary between proposed route and crossing alternatives, as well as potential material source alternatives. All other impacts are similar across all proposed alternatives.

Table 16 Terrestrial and Aquatic Birds Impacts

Terrestrial and Aquatic Birds: Differences Between Route Alternatives		
	Southern Route (Preferred Alternative) with Lagoon Crossing D and Staging Areas	**Combined Route B with Lagoon Crossing D and Staging Areas**

Direct and Indirect and Construction	Habitat (including Threatened and Endangered): • Loss of 115.0 acres (permanent) and 33.6 acres (temporary) of habitat. • Habitat impact includes 1.8 acres (permanent) and 0.5 acres (temporary) of high quality bird habitat (Closed Low Scrub).	Habitat (including Threatened and Endangered): • Loss of 133.4 acres (permanent) and 39.2 acres (temporary) of habitat. • Habitat impact includes 4.8 acres (permanent) and 1.5 acres (temporary) of high quality bird habitat (Closed Low Scrub).
Secondary and Cumulative	Habitat (including Threatened and Endangered): • Higher potential for secondary development as compared to Combined Route B due to the number of private land owners and proximity to Wulik River.	Habitat (including Threatened and Endangered): • Lower potential for secondary development overall due to fewer number of private land owners and distance to Wulik River.

Differences Between Material Source Alternatives

	K-Hill Site	Wulik River Source 1	Relic Channel Source 1	Relic Channel Source 2
Direct and Indirect and Construction	Habitat (including Threatened and Endangered): • Loss of 86.6 acres (permanent) of wetland habitat and 13.3 acres (permanent) of uplands. • Impacts to potential raptor nesting areas on K-Hill. • No impacts to high quality bird habitat (Closed Low Scrub)	Habitat (including Threatened and Endangered): • Loss of 34.0 acres (permanent) of wetland habitat and 5.7 acres (permanent) of riverine. • Habitat impact includes 14.9 acres (permanent) of high quality bird habitat (Closed Low Scrub).	Habitat (including Threatened and Endangered): • Loss of 50.1 acres (permanent) of wetland habitat, 2.0 acres (permanent) of lacustrine, 2.5 acres (permanent) of pond, and 6.8 acres (permanent) of upland. • Loss of 5.2 acres (temporary) of wetland habitat. • Habitat impact includes 0.1 acres (permanent) and 0.1 acres (temporary) of high quality bird habitat (Closed Low Scrub).	Habitat (including Threatened and Endangered): • Loss of 42.8 acres (permanent) of wetland habitat, and 2.3 acres (permanent) of pond. • Loss of 2.4 acres (temporary) of wetland habitat. • Habitat impact includes 17.3 acres (permanent) and 0.2 acres (temporary) of high quality bird habitat (Closed Low Scrub).
Secondary and Cumulative	Habitat (including Threatened and Endangered): • Higher probability for secondary development	Habitat (including Threatened and Endangered): • Increased potential for secondary habitat loss of high quality bird habitat (Closed Low Scrub).	Habitat (including Threatened and Endangered): • Relatively low chance of loss of important bird habitat due to	Habitat (including Threatened and Endangered): • Increased potential for secondary habitat loss of high quality bird habitat (Closed Low Scrub).

	due to proximity to evacuation site.	• High potential for secondary development overall due to greater number of private land owners and proximity to Wulik River.	secondary development.	

4.11.3 Avoidance, Minimization, and Mitigation

Mitigation measures to avoid, minimize, or mitigate potential changes in habitat, mortality risk, or movement of terrestrial and aquatic birds were selected based on state and federal regulations and policies, management practices and guidelines, and relevant peer-reviewed literature, and include:

- The Proposed Action alternatives have been routed to minimize interactions with waterbodies (i.e., aquatic bird habitat) wherever feasible. Where possible, the road alignment would approach the waterbody perpendicularly to minimize impacts to the riparian habitats;
- Temporary disturbance, reclaimed land, and other areas of ground disturbance would be revegetated with regionally appropriate seed mix that minimizes introduction of noxious weeds where practicable;
- Where possible, vegetation clearing, site preparation, and construction activities would adhere to the recommended periods to avoid vegetation clearing from June 1–July 31 for Northern Alaska (USFWS 2017d). If vegetation clearing, site preparation, and construction occurs within these periods, pre-construction nest surveys would be conducted by qualified personnel and appropriate mitigation developed in consultation with the USFWS; and
- High-disturbance project-related activities (e.g., blasting, pile driving) would be avoided where practicable during the nesting and peak migration window.

4.12 Marine Mammals

4.12.1 Affected Environment

Marine mammals are an essential part of the culture and food security in Kivalina. Marine mammal species that can occur in the coastal waters near Kivalina include: beluga whale (*Delphinapterus leucas*), gray whale (*Eschrichtius robustus*), bowhead whale (*Balaena mysticetus*), bearded seal (*Erignathus barbatus*), ringed seal (*Phoca hispida*), spotted seal (*Phoca largha*), and polar bear (*Ursus maritimus*). Of these species, those identified as important subsistence species are bowhead whale, beluga whale, bearded seal, and ringed seal (Huntington et al. 2016; SRB&A 2009). Walrus are also an important subsistence species, but are typically found farther offshore (Huntington et al. 2016; Tetra Tech 2009).

All marine mammals in the U.S. are protected under the *Marine Mammal Protection Act* (MMPA), which was enacted in response to concerns about population declines caused by human activities. The National Marine Fisheries Service (NMFS) is charged with protecting whales, dolphins, porpoises, seals and sea lions, whereas the USFWS is responsible for walrus, manatees, otters and polar bears (*Marine Mammal Protection Act* of 1972). One of the policies of the MMPA is to protect stocks of these species from falling below the level of "depleted" (i.e., population numbers for the species that are below optimum for a sustainable population). In Alaska, given their cultural and dietary importance, marine mammals are co-managed by the federal government and a variety of Alaska Native organizations such as the Ice Seal Committee, the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, and the Eskimo Walrus Commission.

On a federal level, several marine mammal species have further protection under the ESA. The ESA lists four of the marine mammal species in the project vicinity: bowhead whale, bearded seal, ringed seal, and polar bear. Although project specific barging is not anticipated, if it occurs, additional ESA listed species could be encountered, including western Distinct Population Segment (DPS) Steller sea lions (*Eumetopias jubatus*), western North Pacific DPS humpback whales (*Megaptera novaeangliae*), Mexico DPS humpback whales, fin whales (*Balaenoptera physalus*), sperm whales (*Physeter macrocephalus*), North Pacific right whale (*Eubalaena japonica*), and bowhead whales. Critical habitat has been designated for polar bear and overlaps with Kivalina (75 FR 76086 76137). Proposed critical habitat for ringed seals also overlaps with Kivalina Lagoon (79 FR 73010). In addition, if project specific barges are required, vessel traffic may occur within Steller sea lion (58 FR 45269) and North Pacific right whale (73 FR 19000) designated critical habitat.

The seasonal occurrence of marine mammal species found in the Study Area and along potential project specific barge route, if required, their typical subsistence hunting seasons (where applicable), population estimates, and status under the ESA and MMPA are summarized in Table 17.

Table 17 Marine Mammal Seasonal Occurrence in Coastal Waters associated with the Project, Population Estimates and Conservation Listings

Species	Stock	Typical subsistence hunting period for Kivalina[d]	Minimum population estimate	ESA listing	Critical Habitat	MMPA listing
Beluga whale	Beaufort Sea	April–May	32,453[a]	not listed	None Designated	not listed
	Eastern Chukchi Sea	July	3,710*[a]	not listed	None Designated	not listed
Bowhead whale	Western Arctic	April–May	16,091[b]	endangered	None Designated	depleted
Gray whale	Eastern North Pacific	-	20,125[c]	not listed	None Designated	not listed
North Pacific Right Whale	Eastern North Pacific	-	26 [b]	endangered	Designated	depleted
Humpback Whale	Western North Pacific DPS	-	865 [b]	endangered	None Designated	depleted
Humpback Whale	Mexico DPS	-	6,000-7,000[e]	threatened	None Designated	depleted
Fin Whale	Northeast Pacific Stock	-	1,036 *[c]	endangered	None Designated	depleted
Sperm Whale	North Pacific Stock	-	N/A [b]	endangered	None Designated	depleted
Bearded seal	Alaska (Beringia Distinct Population Segment)	May–July	273,676[b]	threatened	In Process	depleted
Ringed seal	Alaska	November-April	300,000*[b]	not listed**	In Process	not listed
Spotted seal	Alaska	-	391,000[a]	not listed	In Process	not listed
Polar bear	Chukchi/Bering Sea	-	2,000[b]***	threatened	Designated	depleted

NOTES:

Marine mammal presence can vary and sightings of other species not listed may occur.

* Considered an underestimate.

** ESA listing is currently being appealed in the U.S. District Court; National Oceanic and Atmospheric Administration (NOAA) Fisheries published a final rule listing the Arctic subspecies as threatened.

*** Not considered reliable as based on extrapolation from aerial den surveys.

SOURCES: [a] Allen and Angliss (2014), [b] Muto et al. (2016), [c] Carretta et al. (2015), [d] USEPA (2009), [e] Calambokidis et al (2008)

4.12.1.1 Marine Mammals within the Study Area

Marine mammals typically seen in Kivalina Lagoon include spotted seals, bearded seals, ringed seals, and polar bears (Stantec 2016a; Huntington et al. 2016). Although numerous observations of marine mammals within Kivalina Lagoon have been documented through sampling of local traditional knowledge, to date no systematic marine mammal surveys have been conducted in the lagoon.

Spotted Seals

Spotted seals are seasonally present in the lagoon, arriving after the ice melts (Huntington et al. 2016), and using both the north and south entrances (Stantec 2016a; P. Hawley, pers. comm., June 30, 2017). No systematic information on seal sighting locations in Kivalina Lagoon have been collected.

Threatened and Endangered Species

Bearded Seals

Bearded seals are seen coming into Kivalina Lagoon in the summer following fish (Huntington et al. 2016, Stantec 2016a) and have been sighted at the north (Kivalik) (Stantec 2016a) and south (Singuak) entrance to the lagoon (P. Hawley, pers. comm., June 30, 2017). Juvenile bearded seals have been observed foraging up river channels in the fall (Huntington et al. 2016; Stantec 2016a). Aerial surveys in the eastern Chukchi Sea, conducted in May and June, estimated highest densities of bearded seals (0.401–0.7 seals/km^2; unadjusted for survey timing and haulout behavior) south of Kivalina and west of Kivalina in the offshore area, and moderate densities in coastal waters by Kivalina (0.051–0.2 seals/km^2; unadjusted for survey timing and haulout behavior) (Bengtson et al. 2005). Movement data shows they have a wide range in the Chukchi Sea including the coastal waters near Kivalina in fall and summer (Boveng and Cameron 2013; Wiese et al. 2017).

Ringed Seals

Ringed seal activity in the Chukchi Sea is strongly influenced by sea ice (Kelly et al. 2010). Movement data suggests that ringed seals use the Chukchi Sea, and coastal waters near Kivalina, year-round (ADF&G 2015c; Crawford et al. 2012; Von Duyke et al. 2017). Density estimates, based on aerial surveys conducted in May and June, are higher along the coast south of Kivalina (10.001-20 seals/km^2; unadjusted for survey timing and haulout behavior) compared to the coastal region around Kivalina (2.001-5 seals/km^2; unadjusted for survey timing and haulout behavior) (Bengtson et al. 2005). Ringed seals occur year-round in the Kivalina area (Huntington et al. 2016).

Recent field observations (Stantec 2016b) confirmed seal presence within Kivalina Lagoon near the Kivalik and Siguak Inlets. Personal interviews conducted with local subsistence hunters concurrent to the Stantec survey effort also yielded generalizations that seals occasionally access shallower portions of the lagoon. However, follow up interviews with those and other local subsistence hunters in 2017 clarified that the majority of seal foraging in lagoon occurs directly south and east of Singuak Inlet proximate to deeper water near and within the Wulik River outlet, and in like fashion within deeper waters between the mouth of the Kivalina River and its outlet to the Chukchi Sea at Kivalik Inlet. Comparatively, seal use of the shallow Lagoon Channel lying parallel to Kivalina Island is substantially less common, and generally limited to infrequent occasions of combined high water and thin ice in the lagoon (pers. comm. O. Hawley, September 15, 2017; R. Sage, September 15, 2017 and October 5, 2016; D. Foster October 5, 2016; P. Hawley September 15, 2017).

Polar Bears

Two polar bear populations occur in Alaska: the Beaufort Sea population and the Chukchi Sea population (Schliebe et al. 2006). The Chukchi Sea population typically moves into the southern Chukchi Sea with the pack ice in fall and winter and migrates north with the pack ice in spring and summer (Garner et al. 1990). Traditional knowledge indicates that polar bear tracks are found along the coast and on barrier islands in late fall and winter in the south-eastern Chukchi Sea, when they first arrive in the region (Voorhees et al. 2014). Tagging and movement data show polar bear presence on the sea ice west of Kivalina in spring (Garner et al. 1990; Rode et al. 2014). Although polar bears in the Chukchi Sea are typically closely associated with sea ice, recent increases in land use (primarily Wrangel Island, rather than the Alaskan coast) have been detected (Rode et al. 2015). Habitat selection modeling predicts lower probability of habitat selection by polar bears along the coast near Kivalina, compared to offshore regions in the Chukchi Sea in winter and spring (Wilson et al. 2016). Polar bears have been observed near Kivalina in winter; during interviews on seals, walrus, and whales a community member mentioned possible polar bear dens in the hills behind Kivalina, although the specific locations were not provided (Huntington et al. 2016). Region-wide subsistence interviews and data collection highlight the existence of polar bear dens north of Kivalina near Cape Thompson (Satterthwaite-Phillips et al. 2016).

4.12.1.2 Other Listed Species

If project specific barges are required, other listed species may be encountered along the vessel routes. These species include Western DPS Steller sea lions, North Pacific right whales, Western North Pacific and Mexico DPS humpback whales, fin whales, sperm whales and bowhead whales. Life history

summaries for these species can be found in the Section 7 consultation letter located in Appendix G. Summaries of Western DPS Steller sea lion and North Pacific right whale critical habitat are below.

Steller Sea Lion Critical Habitat

NMFS designated critical habitat for Steller sea lions on August 27, 1993 (58 FR 45269). In Alaska, designated critical habitat includes the following areas as described at 50 CFR §226.202.

- Terrestrial zones that extend 3,000 feet (0.9 km) landward from each major haulout and major rookery.
- Air zones that extend 3,000 feet (0.9 km) above the terrestrial zone of each major haulout and major rookery in Alaska.
- Aquatic zones that extend 3,000 feet (0.9 km) seaward of each major haulout and major rookery in Alaska that is east of 144° W longitude.
- Aquatic zones that extend 20 nm (37 km) seaward of each major haulout and major rookery in Alaska that is west of 144° W longitude.
- Three special aquatic foraging areas: the Shelikof Strait area, the Bogoslof area, and the Seguam Pass area, as specified at 50 CFR §226.202(c).

North Pacific Right Whale Critical Habitat

Critical habitat for the North Pacific right whale was designated in the eastern Bering Sea and in the Gulf of Alaska on April 8, 2008 (73 FR 19000). The Gulf of Alaska portion includes a small area just east of Kodiak Island, where whales seasonally migrate to the Bering Sea. The eastern Bering Sea portion includes a polygon, which is roughly 50 miles north of the Aleutian Islands, and at least 100 miles off the Bristol Bay coastline, leaving the majority of the Bering Sea outside of Critical Habitat (73 FR 19000).
Environmental Consequences

4.12.1.3 No-Action Alternative

An evacuation road would not be constructed from Kivalina to K-Hill and no changes to current impacts to marine mammals would occur. Residents would continue to be exposed to environmental threats with no reliable options for evacuation during storm events with the potential to detrimentally impact the community over time. There would remain severe risk to life, health, and safety of residents.

4.12.1.4 Route and Lagoon Crossing Alternatives

Based on the project activities in the lagoon (see Section 4.3.2) and the proposed avoidance, minimization, and mitigation measures, adverse effects to marine mammals are not anticipated. DOT&PF will coordinate with NMFS and USFWS to ensure impacts will be minimized. The following sections detail potential impacts to marine mammals. Whales in the vicinity are not anticipated to be impacted since they do not enter the shallow lagoon where impacts to marine mammals could occur.

Direct and Indirect Impacts:

Habitat Quality and Movement: All three species of seal observed in Kivalina Lagoon are known to enter it through the north (Kivalik Inlet) and south (Singuak Inlet) entrance to the lagoon (P. Hawley, pers. comm., June 30, 2017). Juvenile bearded seals have been observed foraging up river channels in the fall (Huntington et al. 2016). The presence of the lagoon-crossing structure may result in an ecological and physical alteration of marine mammal habitat in the lagoon as it may change distribution of prey species, and area movement of seals. It is not known if seals would swim through culverts, but the presence of a bridge with water flowing freely beneath it would likely not impede passage of marine mammals (e.g., Shelden et al. 2013). Marine mammal use of habitat on either side of in-water structures, and their swimming beneath such structures, has been observed for other projects (e.g., Twentymile River Bridge, Cook Inlet, Alaska; HDR Alaska Inc. 2010). The proposed design of the lagoon crossing is not anticipated to negatively affect bearded, spotted, or ringed seal habitat use and foraging as it would accommodate the passage of seals and their prey. Prey densities are not anticipated to be adversely affected.

Threatened and Endangered Species Critical Habitat: Polar bear critical habitat has been designated in the Kivalina region (75 FR 76086 76137). For Kivalina, this habitat consists of the barrier island the town is currently located on, and the adjacent similar islands fronting the Chukchi Sea. The Kivalina River Delta is also considered critical habitat and is inside the study area, but North of the proposed alternatives.

Given the presence of the community and activities in the area such as low flying aircraft, vessel use, and subsistence hunting activity, it is anticipated that project in-water and terrestrial construction activities would not appreciably impact critical polar bear habitat. Bearded seal critical habitat has not yet been defined (77 FR 76740) and no critical habitat has been designated for bowhead whale (67 FR 55767).

Construction Impacts:

Potential for Injury and/or Disturbance from Underwater Noise during Construction: Construction boat operation, and placement of fill in water would create increased levels of underwater noise in Kivalina Lagoon. No additional increase in underwater noise from pile driving is expected due to DOT&PF's commitment of pile driving within constructed embankments. The relative isolation from open water, soft substrates, and shallowness of the lagoon would further reduce propagation of underwater noise. Injury and changes in marine mammal behavior could result from underwater noise, although potential effects depend on the species, individual, animal activity, and the novelty, type, and level of underwater noise (Ellison et al. 2012; Richardson et al. 1995; Southall et al. 2007). The effects of noise on ice-associated seals such as ringed, bearded, and spotted seals, and their auditory capabilities are poorly understood (Sills et al. 2016). Ringed and spotted seals have similar ranges of underwater hearing (Sills et al. 2014; Sills et al. 2015). Both species can hear a broad range of frequencies underwater, and have hearing capabilities similar to harbor seals (Sills et al. 2014). The range of underwater hearing of bearded seals has not been studied, although the frequency range of their vocalizations is very large (up to 11 kHz; Risch et al. 2007), and so similarities to spotted and ringed seals may be assumed.

Changes in marine mammal behavior due to underwater noise can include avoidance of the area, change in vocalizations, change in foraging activity, or no detectable response. For example, construction of an offshore island during a pipeline construction project had no significant effect on the densities of basking ringed seal when spring densities before intensive winter construction of the island was compared to densities in spring following construction (Moulton et al., 2005). Abandonment of breathing holes and subnivian lairs by ringed seal, when exposed to anthropogenic noise (i.e., seismic surveys), was highest closer to seismic activity (Kelly et al., 1988). However, ringed seals have also shown no significant change in abandonment of subnivian lairs when exposed to noise from an oil-production facility (e.g., drilling activity, pipeline construction) (Williams et al., 2006).

Construction-related boat traffic in the lagoon would create underwater noise, which may result in the disturbance or communication masking of seals. The effects of boat noise on ringed, spotted, and bearded seal behavior are not well known. Studies on other seal species have shown displacement due to the presence of high levels of vessel traffic in the case of grey seals (Anderwald et al. 2013). Harbor seals are more likely to be disturbed and enter water from a haulout if vessels are within 150 m than when vessels are farther away (Mathews et al. 2016). Currently, all boat traffic in the lagoon is related to community activities. The duration of noise associated with the installation of piles is assumed to be 30-60 days (not continuous) and, as a result, would increase levels of underwater noise in the lagoon for only a relatively

short period of time. Reductions in boat speeds have been shown to reduce the extent of underwater noise (e.g., Houghton et al. 2015).

Placement of fill in water would also create underwater noise, but is anticipated to be at levels below that of boat noise. The anticipated specific levels of these noises are not known for this project, but it is unlikely that their levels would result in injury to seals within the lagoon. Levels of underwater noise may result in disturbance of marine mammals, although ringed seals were not displaced by slope preparations and deposition of gravel during construction of an artificial island in the Beaufort Sea (Blackwell et al. 2004). Placement of the base causeway and rock protection could be done with no or minimal water present (see Section 4.3.2). Ice associated species are naturally exposed to underwater noise from ice movement and cracking, with varying intensities, depending on conditions and scenario (Richardson et al. 1995). For example, an active pressure ridge produced source levels of 124–137 dB re 1 µPa m in the 4 and 8 Hz tones (Buck and Greene 1979). Mitigation measures to further reduce any potential for injury or disturbance from underwater noise to seals that may be present in the lagoon during construction are outlined in Section 4.12.3.

If project specific barges are required, underwater noise from barges may temporarily disturb or mask communication of bearded seal, and ringed seal, western distinct population segment (DPS) Steller sea lion, North Pacific right whale, Mexico DPS humpback whale, western North Pacific DPS humpback whale, fin whale, sperm whale, and bowhead whale.

It is expected that vessel noise from barges, if project specific barges are required, are the only project specific activity that may result in potential impacts to listed whales and Steller sea lions, due to the rest of the work being located inside of Kivalina Lagoon. If animals are exposed to vessel noise they may exhibit avoidance behavior, short-term vigilance behavior, or short-term masking behavior, but these behaviors are not likely to result in adverse consequences for the animals due to the temporary nature of barge noise along the vessel route. Individual whales' past experiences with vessels appear to be important for individual whale response (Shell 2012). Vessels moving at slow speeds and avoiding rapid changes in direction may be tolerated by some species. Other individuals may deflect around vessels and continue on their migratory path. Humpback whale reactions to approaching boats are variable, ranging from approach to avoidance (Payne 1978, Salden 1993). Whales have been known to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Wartzok et al. 1989, Richardson et al. 1995a, Heide-Jorgensen et al. 2003). Mitigation measures would limit potential residual

adverse effects of the project on marine mammal species exposed to underwater noise as a result of construction activities (Section 4.12.3).

Decrease in Habitat Quality due to Increases in Turbidity from Placement of Fill and Culverts in Water: Ringed and spotted seals are visual hunters and increases in turbidity from fill or culvert placement may temporarily modify visibility within preferred feeding habitats. However, pinnipeds (including ringed seals and bearded seals) have highly developed sensory organs (i.e., vibrissae) which likely assist with foraging in dark or turbid conditions (e.g., Hyvärinen 1989; Marshall et al. 2006). As such, any changes in behavior caused by increased turbidity in the lagoon are unlikely to translate into harmful effects on seals. Further, if this activity occurs in winter, effects would be limited to ringed seals as the only species likely to be present.

The location and presence of the proposed lagoon crossing is not anticipated to negatively affect bearded seal or ringed seal habitat accessibility and foraging as its design would facilitate movement of seals and their prey through the crossing. Seal prey densities are not anticipated to be adversely affected. While the lagoon crossing lies within proposed ringed seal habitat, this proposed designation has not been finalized. The project would implement several avoidance, minimization, or mitigation measures to limit potential residual adverse effects of the project.

Boat Strikes during Construction: Recreational boats currently use the lagoon and are active when seals are present. The possibility of vessel strikes of seals in the Kivalina Lagoon is minimal per the data analyzed in Alaska waters which documented no ship strikes of spotted, bearded or ringed seals over a five year period (Helker et al. 2016, 2017).

Project specific barges, if needed, have the potential to collide with, or strike, marine mammals (Laist et al. 2001, Jensen and Silber 2003). From 1978-2012, there were at least 108 recorded whale-vessel collisions in Alaska, with the majority occurring in Southeast Alaska (Neilson et al. 2012). Among larger whales, humpback whales are the most frequent victims of ship strikes in Alaska, accounting for 86% of all reported collisions. Fin whales accounted for 2.8% of reported collisions, gray whales 0.9%, and sperm whale 0.9%. Six of the whales (5.6%) were unidentifiable and the remaining are of non-listed species. The probability of strike events depends on the frequency, speed, and route of the marine vessels, as well as distribution of marine mammals in the area. Vanderlaan and Taggart (2007) used observations to develop a model of the probability of lethal injury based upon vessel speed. They projected that the chance of lethal injury to a whale struck by a vessel is approximately 80 percent at vessel speeds over 15 kn (27.78 km/hr) and approximately 20 percent at 8.6 kt (15.92 km/hr).

Although risk of ship strike has not been identified as a significant concern for Steller sea lions (Loughlin and York 2000), the recovery plan for this species states that Steller sea lions may be more susceptible to ship strike mortality or injury in harbors or in areas where animals are concentrated [e.g., near rookeries or haulouts; (NMFS 2008)]. To minimize this risk, project vessels will not travel within 3 nm (5.5 km) of major Steller sea lion haulouts or rookeries.

Secondary (Induced) and Cumulative Impacts:

Potential Disturbance from Vehicle Noise: Spotted seals and ringed seals have acute in-air hearing (Sills et al. 2014; Sills et al. 2015). In-air hearing of bearded seals has not been studied, but due to the wide frequency range of their vocalizations (Risch et al. 2007), similar in-air hearing capabilities to spotted and ringed seals may be assumed. Vehicular noise would be audible to species present in the lagoon and may result in changes in behavior, although behavioral responses can vary widely depending on context and novelty of the noise source (Ellison et al. 2012; Richardson et al. 1995; Southall et al. 2007). Densities of basking ringed seals present in spring during active use of a proximate ice road did not vary between years (Moulton et al. 2005). Harwood et al. (2007) also report no avoidance of an ice road by ringed seals in the south-eastern Beaufort Sea, suggesting they were not displaced by in-air noise from the vehicular traffic. A contrasting study concluded that in-air noise from snow machines, when within 2.8 km, resulted in most ringed seals leaving their lairs (Kelly et al. 1988). Given the current presence of boat traffic within the lagoon in the open water season and the presence of snow machines during the winter, seals in the lagoon would have been previously exposed to noise. Seals would be expected to habituate to this new noise regime (Moulton et al. 2005), and no long-term changes of seal presence and behavior due to vehicle noise is expected.

Hunting Pressure: A permanent structure across the lagoon would increase lagoon accessibility. The location of the crossing would span an area of the lagoon that is currently accessible via boat during the open water period. State of Alaska Fish and Game regulations state that shooting from, on, or across a highway is illegal (5AAC 92.080; ADF&G 2006). Installation of signs along the road would remind the public of the regulations. As a result, it is anticipated that hunting pressure would remain unchanged.

4.12.1.5 Material Source Alternatives

Direct and Indirect Impacts:

No direct or indirect negative impacts to marine mammals are expected as a result of the development of the proposed material sites and use of in-project-area materials as fill. Local sourcing of construction

materials would reduce the need for increased boat activity otherwise required to import materials from outside the region, and thus limit any anticipated disturbance of marine mammals in the Chukchi Sea.

Secondary (Induced) and Cumulative Impacts:

No secondary or cumulative impacts to marine mammals are expected as a result of the development of the proposed material sites and use of in-project-area materials.

4.12.1.6 Alternatives Comparison

As there is only one Kivalina Lagoon crossing alternative proposed, no alternatives comparison is provided.

4.12.2 Avoidance, Minimization, and Mitigation

The following are proposed to reduce impacts to marine mammals (also in Appendix G):

- Pile driving would will occur through constructed embankment;
- Project specific barges and small boats:
  - If project specific barges are required, operators would be required to follow the best practices and safety regulations required of barge operators which regularly service the communities.
  - Barges that may provide some incremental project support but are not strictly under project control will be encouraged to avoid designated (73 FR 19000) North Pacific right whale critical habitat or maintain vigilant watch while under way in order to avoid vessel strikes to individuals of the Critically Endangered population frequenting the Bering Sea.
  - If project specific barges are required, during vessel transit, the project will follow 50 CFR 224.103 regulations and NMFS marine mammal viewing guidelines.
  - Small project-specific boats will move at less than 10 knots (kn; 18.52 km/h) when in the Kivalina Lagoon to reduce noise impacts and for safe vessel maneuverability to avoid obstacles and marine mammals in the water.
  - If project specific barges are required and practicable vessel operation requires purposely approaching within 1.6 km (1 mile) of observed whales, except in emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the whales
  - Reducing vessel speed to less than 5 kn (9.26 km/h) within 300 yards (274 m) of pinnipeds
  - If project specific barges are required, they will avoid transiting through identified (73 FR 19000) North Pacific right whale critical habitat. Protected Species Observers (PSOs) are not required if barges do not enter designated North Pacific right whale critical habitat.

- If project specific barges are required to transit through North Pacific right whale critical habitat, the following will be implemented:
  - Vessels will not make way in excess of 10 kn (18.52 km/h) while travelling within the boundaries of designated North Pacific right whale critical habitat.
  - Dedicated PSOs will be on board all motorized vessels travelling through designated North Pacific right whale critical habitat. PSO's are not required if barges transit around North Pacific right whale critical habitat. PSOs will maintain a constant watch for all marine mammals from the bridge or other a similar vantage point. PSO's will maintain direct contact with the vessel pilot, advising the pilot/operator of the position of all observed marine mammals as soon as they are observed.
  - The vessel pilot/operator will maneuver vessels to the extent practicable to:
    - Remain further than 874 yds (800 m) from North Pacific right whales,
    - Remain further than 100 yds from other marine mammal species, and
    - Avoid approaching any species of whale head-on.
  - Vessels will adjust speed and heading as needed to avoid disturbance of all marine mammals, provided vessel speed and heading adjustments are consistent with maintaining vessel safety.

- Fill placement:
  - If material is being placed in summer during ice-free conditions, a qualified PSO will monitor for marine mammal presence and implement a 50 m (164 ft) exclusion zone around the material placement site to avoid physical harm, direct, and indirect takes by construction equipment.
  - If material is being placed in the winter, a PSO is only needed if there are areas of naturally occurring open water within 50 m (164 ft) of construction activities. If there is no naturally occurring open water within 50 m (164 ft) of construction activities, no PSO is required and no exclusion zone is necessary.
  - If an observed marine mammal is likely to approach within 50 m (164 ft) of the fill placement site, fill placement will stop until the marine mammal is farther than 50 m (164 ft) from the fill placement site, or is not seen for 15 minutes. The PSO will continuously scan the activity-specific monitoring zone for the presence of species for 30 min before any fill placement activities take place.
    - If any species are present within the exclusion zone, fill placement activities will not begin until such animal(s) has left the exclusion zone or no species have been observed in the exclusion zone for 15 min (for pinnipeds) or 30 min (for cetaceans).

- If any species enter, or appear likely to enter, the exclusion zone during fill placement, all inwater activities will cease immediately. Fill placement activities may resume when the animal(s) has been observed leaving the area on its own accord. If the animal(s) is not observed leaving the area, fill placement activities may begin 15 min (for pinnipeds) or 30 min (for cetaceans) after the animal is last observed in the area.

- Subsistence Activities
  - Signs will be installed reminding the public that State of Alaska Fish and Game regulations prohibit shooting from, on, or across a highway (5AAC 92.080; ADF&G 2006).
- A polar bear interaction plan would be developed as required by USFWS.

4.13 Wildlife—Terrestrial Mammals

4.13.1 Affected Environment

Five species of large terrestrial mammals are known to occur in the Study Area: caribou (*Rangifer tarandus*), moose (*Alces alces*), muskoxen (*Ovibos moschatus*), Dall's sheep (*Ovis dalli)*, and brown bear (*Ursus arctos*). Caribou, moose, and Dall's sheep have historically been and continue to be important subsistence resources for Kivalina (SRB&A 2009). Common furbearers in the Study Area include wolf (*Canis lupus*), wolverine (*Gulo gulo*), red fox (*Vulpes vulpes*), Arctic fox (*Alopex lagopus*), lynx (L*ynx canadensis*), marten (*Martes americana*), and mink (*Mustela vison*). Many of these species are important to hunters and trappers in the region for their pelts, which are used to make traditional Alaska Native crafts and clothing (USEPA 2009).

There are no federally listed Threatened or Endangered species or federally designated critical habitat for terrestrial mammal species that occur in the Study Area. The discussion below focuses on *other species of concern* known to occur in the Study Area including caribou, moose, muskoxen, Dall's sheep, and brown bear (ADF&G 2015a).

4.13.1.1 Caribou

The Study Area occurs along the border of caribou summer range and the migratory area of the Western Arctic Herd (WAH) (Western Arctic Caribou Herd Working Group 2011). The WAH is currently the largest herd in the State of Alaska with a 2016 estimate of 201,000 individuals (ADF&G 2016e). Satellite collar data (1988–2006) reveal the general WAH caribou distribution providing migration date approximations, which vary year to year. Caribou occupy the vicinity of the Study Area in low densities between September 1–May 31, leave between June 1–June 30 for calving, spend July 1–July 31

approximately 10–30 miles north of the Study Area for bug relief, and leave August 1–August 31 for the Brooks Range to feed (CARMA 2017). Since 1996, most individuals have wintered south of the Study Area, on the Seward Peninsula (CARMA 2017). Satellite collar data also revealed that a few individuals of the Teshekpuk Lake Herd are present in the region from November 1–May 1 (CARMA 2017). These data suggest that caribou can be present in the Study Area at any time, but are most likely to be present in low densities during September 1–May 31 with a few individuals remaining throughout July.

Although there are several traditional migration pathways connecting the WAH winter range with summer/calving grounds, a portion of the WAH migrates through the Study Area during September as individuals move south to winter range located south of the Kobuk River near the Nulato Hills (Joly et al. 2012; WHPacific 2012b; ADF&G 2015d). The herd generally crosses the Kivalina and Wulik Rivers on the southwestern side of K-Hill during migration, and occasionally spends time in the hills to the east of K-Hill (WHPacific 2012b). Although caribou often move to the east of the Study Area during spring migration, some do migrate through the Study Area as they head north to calving grounds on the North Slope of the Brooks Range near the Utokuk Hills (USEPA 2009; Western Arctic Caribou Herd Working Group 2011; ADF&G 2015d). Caribou sign (pellets, antlers, skeletal remains) were observed at multiple locations throughout the Study Area, including trails on the north and east sides of K-Hill (Appendix J).

Caribou are the principal terrestrial subsistence animal in the region and are hunted in the mainland tundra hills east of Kivalina Lagoon. A subsistence survey conducted in Kivalina by ADF&G in 2007 indicated a harvest of 268 caribou which equates to 14.2% of the community total edible weight and 94% of the land mammal harvest (ADF&G 2010). Most caribou are harvested in the fall when the main migration reaches the Kivalina area, but they are also hunted throughout the winter, as available, and harvested opportunistically year-round.

4.13.1.2 Moose

Compared to other areas in Alaska, moose presence within the Study Area is of low density (MMS 2007; USEPA 2009). Fall and spring surveys conducted between 1992 and 2001 (Dau 2002), as well as more recent survey estimates conducted in Game Management Unit 23 (ADF&G 2012), indicate densities averaging less than one moose per square mile in the Lower Noatak and Wulik River drainages. During winter, moose are found along the drainages of the Wulik and Kivalina Rivers (Tape et al. 2016; Mould 1979; LeResche et al. 1973). As snow cover subsides, moose disperse to higher elevation shrub habitats outside the Study Area during the summer and fall (Tape et al. 2016; Mould 1979; LeResche et al. 1973).

4.13.1.3 Muskoxen

Reintroduced in 1970, the Cape Thompson population (ranging from the Noatak River north to Cape Lisburne) remains fairly small (around 300 animals), and is generally found within 20–35 miles of the coast (ADF&G 2015b). The Cape Thompson population has been expanding their range north and out from the coast (ADF&G 2015a). The Wulik River muskoxen population was 89 in 2004 but declined to 11–14 between 2009 and 2012 (the most recent data available, ADF&G 2015b). Muskoxen were observed during field visits of the Study Area in 2016 and a 2017 cultural resource survey (Appendix J; Stantec 2017d).

Small numbers of muskoxen can be expected in the Study Area, primarily during spring and summer. During spring calving season (April–June) muskoxen use riparian areas, such as the Wulik and Kivalina River, where there are abundant sources of grasses and willows exposed from melting snow and ice (Danks and Klein 2002; Klein et al. 1991). During winter, muskoxen are less likely to be in the Study Area, as they prefer exposed ridgetops which maintain easier access to forage (primarily lichen, sedges, and mosses) with shallow soft snow cover (Ihl and Klein 2001; Klein et al. 1991).

4.13.1.4 Dall's Sheep

Dall's sheep range is limited to the rolling hills and mountainous terrain of the DeLong and Baird Mountains of the western Brooks Range (DeLong Mountains population) located northwest and outside of the Study Area (ADF&G 2011b). Dall's sheep typically inhabit mountainous terrain (Schmidt et al. 2012), and K-Hill (~460 ft) has a rubble topography without escape habitat; not fitting typical sheep preferences.

Dall's sheep are prized for their meat, fat, sinew, skins, and horns, and are hunted in the fall in the upper Wulik and Kivalina River drainages (MMS 2007). Overall, population densities of the DeLong Mountains population are relatively low compared to other areas of the Brooks Range that contains more suitable seasonal habitat. Recent population estimates indicate the Dall's sheep populations are declining in the Western Brooks Range (ADF&G 2014).

4.13.1.5 Brown Bear

Brown bears occur throughout northwestern Alaska, including the Study Area, but at relatively lower densities as compared to parts of southern Alaska (Sterling et al. 1997; USEPA 2009). Availability of seasonal food resources influences brown bear habitat use. Brown bears in northern parts of Alaska use

tussock tundra, tall shrubland, and riparian communities during spring and summer (Phillips 1987). Tussock tundra provides seasonally important forage plants (e.g., sedges) as well as potential prey or carrion (e.g., caribou calves). Riparian areas provide hedysarum roots as well as availability of prey such as moose (Philips 1987). Kivalina residents have also reported that brown bears are occasionally harvested during the fall in riparian areas inside the Study Area when bears are feeding on fish and berries (Loon and Georgette 1989). In addition, Ballard et al. (1991) studied brown bear habitat use between the Wulik and Noatak Rivers and reported radio-collared brown bears move to lower elevations during late summer and fall, which coincides with the arrival of spawning salmon in major river systems and tributaries as well as sloughs.

Brown bears in the central arctic excavate their own dens each year with no apparent fidelity to the same den site (McLoughlin et al. 2002). In these areas, bears excavate dens in heath tundra and heath boulder habitats as well as riparian tall shrub and birch seeps. Dens are commonly constructed under cover of dwarf birch with other tundra shrubs nearby (e.g., crowberry). Overall, bear dens are typically found on steep (greater than 25 degrees) slopes, with sandy substrates and warm aspects (McLoughlin et al. 2002). Previous reconnaissance efforts identified potential bear excavations, one of which may have been used as a denning site. When observed, excavations and the potential den site did not appear to have been used recently; and all exhibited some weather-related erosion and/or appeared collapsed (Appendix J).

4.13.2 Environmental Consequences

4.13.2.1 No-Action Alternative

An evacuation road would not be constructed from Kivalina to K-Hill and no changes to current impacts to terrestrial mammals would occur. Residents would continue to be exposed to environmental threats with no reliable options for evacuation during storm events with the potential to detrimentally impact the community over time. There would remain severe risk to life, health, and safety of residents.

4.13.2.2 Route and Lagoon Crossing Alternatives

Direct and Indirect Impacts:

Habitat Alteration: Construction of the project, as well as material source development and associated access, would result in habitat alteration for terrestrial mammals (Tables 9 through 14). Both routes would disturb less than 1% of the Study Area: 148.6 acres Southern Route (Preferred Alternative) and 172.6 acres Combined Route B (see Section 4.9). Overall, the Combined Route B Route would result in

the permanent loss of a slightly more Palustrine Saturated and Seasonally Flooded vegetation (see Table 9). The removal of these vegetation communities would result in a small reduction in the amount of potential foraging habitat for brown bears, moose, muskoxen, and caribou.

K-Hill site has steep slopes and potential denning habitat for brown bears (McLoughlin et al. 2002). Multiple bear excavations were observed on the south and eastern flank of K-Hill in 2016 and 2017 (Figure 8; Stantec 2016b; Appendix J). When observed, the excavations did not appear to be recent and had experienced erosion and cave ins. The Southern Route largely avoids this habitat, but comes within 0.25 miles of K-Hill. The Combined Route B parallels K-Hill for 0.5 miles, coming within 400 ft of K-Hill. State of Alaska guidelines generally prohibit construction within half a mile of occupied bear dens (DNR 2016).

Mortality Risk: Mortality risk during operations of the evacuation road is expected to be relatively higher than during construction due to potential vehicle-animal collisions. Overall, the degree of mortality risk during operations of roads are dependent on seasonality and species. Winter coincides with environmental factors (e.g., poor driving conditions and reduced visibility) that can increase direct mortality risk. Mortality risk is a factor of roads paralleling habitat, and cutting across drainages (Gunson et al. 2011). Increased road side vegetation can also lead to higher mortality (Gunson et al. 2011). Both routes are similar for such characteristics and so are expected to have equally low mortality risks. Avoidance and minimization measures, such as brush clearing along embankments, can reduce the risk for vehicle/animal encounters (FHWA 2008).

Mortality risk for individual species include:

- Caribou are most likely to be present September 1–May 31 (CARMA 2017) but a few individuals may be present year-round. Neither route has a significant difference in mortality risk for caribou;
- Moose are most likely to be present in riverine areas during the winter and equally distributed during the summer (Tape et al. 2016; Mould 1979). The Southern Route (Preferred Alternative) is in closer proximity to riverine areas, increasing relative mortality risk for moose along this route in the winter;
- Bears are most likely to be encountered during the summer, as they hibernate during the winter. They congregate in riparian areas in the fall (Philips 1987; Ballard et al. 1993), when they focus on salmon food resources. Although mortality risk is low, the Southern Route (Preferred Alternative) has greater potential impacts due to closer proximity to the Wulik River riparian area; and

- Muskoxen are more likely to be present in riverine systems during the summer (Danks and Klein 2010; Klein et al. 1991), and windswept ridges during the winter (Ihl and Klein 2001; Klein et al. 1991). Although mortality risk is low, the Southern Route (Preferred Alternative) has increased relative mortality risk during the summer as it is located along the Wulik River. The Combined B Route has slightly increased relative mortality risk during the winter, as it is closer to ridge habitat.

Migration Patterns and Movement: Traffic during operation might result in changes to species migration patterns. Overall, potential effects depend on species, season, timing and duration of construction activities as well as traffic volume and road maintenance activities during operation (Benítez-López et al. 2010; Northrup et al. 2012; Beyer et al. 2013; Lesmerises et al. 2013; Kite et al. 2016). Roads and associated activities may alter local caribou migration patterns and habitat use (Murphy and Curatalo 1987), as well as movement behavior of the WAH (Wilson et al. 2016). Wilson et al. (2016) studied the WAH response to the Red Dog Mine Road located to the south of the Study Area, and observed individuals altering their movement behavior by taking longer to cross the road (i.e., delayed crossing time) and increasing their movement rates despite the relatively low traffic volume. Particularly sensitive periods would be during migration, which according to the satellite collar data would be approximately May 17–June 14, and August 24–September 15 (CARMA 2017). No difference in impact between routes is expected in terms of migration patterns and avoidance and minimization measures for both routes may include reducing construction activity or vehicle traffic during these time periods.

Moose occur in relatively low densities in the Study Area, but both route alternatives have the potential to alter moose seasonal movement patterns. Moose use riparian areas for forage, shelter, and movement corridors during the winter (Tape et al. 2016; Mould 1979). The Southern Route (Preferred Alternative) is the closest to the Wulik River riparian areas, which could result in more sensory disturbance to wintering moose.

Muskoxen use riparian and lowland areas during the summer, and prefer windswept ridges during the winter (Ihl and Klein 2001, Danks and Klein 2002; Klein et al. 1991). The muskoxen calve in the spring, and raise their young along riparian and lowland areas during the summer (Danks and Klein 2002; Klein et al. 1991). The Southern Route (Preferred Alternative) is closer to the riparian areas, with a greater potential impact to movement during summer. The Combined B Route is closer to windswept ridges, and would have greater potential impact to movement during winter.

Bear are evenly distributed throughout the summer, but congregate along riparian areas in the fall (Philips 1987; Ballard et al. 1993). The Southern Route (Preferred Alternative) is closer to the Wulik River and traverses relatively more wetland and herbaceous vegetation communities that occur in riparian areas. As such, this route has potential to result in greater sensory disturbance to bears using riparian areas along the Wulik River system during spring and fall.

Construction Impacts:

Mortality Risk: Although there is potential for increased mortality risk to terrestrial wildlife during construction and operation of the evacuation road, proposed mitigation (such as stop work authorizations) is expected to reduce potential effects (see Section 4.13.3). As a result, direct mortality risk would not be considered substantial, as affected species would likely use other suitable habitats available in and nearby the Study Area. The largest route is proposed to disturb less than 1% of the Study Area (Section 4.9), which is undisturbed with comparable habitat.

Indirect mortality during construction may pose a risk to wildlife due to human-wildlife conflicts. Bears and other wildlife can be attracted to solid waste as an alternative feeding strategy (ADF&G 2017c). Minimization measures to manage bear interaction include proper solid waste management strategies, including bear-proof dumpsters (ADF&G 2017c).

Migration Patterns and Movement: Road construction might result in changes to species migration patterns, similar to those discussed for traffic during operation above.

Secondary (Induced) and Cumulative Impacts:

Subsistence and Non-Subsistence Hunting Pressure: Subsistence pressure may increase due to easier access to the area proximate to the selected route. This would decrease the time and cost of those participating in subsistence activities, potentially allowing a greater number of participants from the community. The Southern Route (Preferred Alternative) would make access to portions of the Wulik River easier, and open land year-round. Such areas include important habitat to a number of species (e.g., summer muskoxen, winter moose, fall bear habitat). The Combined Route B would open land year-round and provide increased road access closer to the Kivalina River.

Non-subsistence hunting pressure may increase due to road access from either route. However, this pressure is expected to be limited due to the requirement for NANA land use permits for non-shareholders to access NANA lands outside of the proposed new ROW. Hunting could also be closed or restricted if necessary. This type of action has precedent in the region. In response to concerns about Western Arctic

Caribou population growth, the local community worked with the Federal Subsistence Board to close sport hunting in Game Management Unit 23 in 2016 and 2017 (FSMP 2016a, 2016b, 2017).

Private Land Allotment Development: Permanent road access to the evacuation site has potential to increase the likelihood of Native allotment development. Material source development on private lands could result in additional habitat loss or alteration as well as increased mortality risk and changes to wildlife movement in the Study Area. Overall, development of the Southern Route (Preferred Alternative) might result in relatively greater secondary effects due to the number of private land owners and the increased access to the Wulik River as compared to Combined Route B. In addition, should construction and operation of the proposed school on K-Hill occur, it could result in cumulative effects due to potential additional loss and alteration of terrestrial mammal habitat and increased risk of collisions from increased traffic.

4.13.2.3 Material Source Alternatives

Direct and Indirect Impacts:

Habitat Alteration: Material source development would result in the direct alteration of wildlife habitat. The Lower Wulik and Kivalina River drainages surrounding are undisturbed. The removal of these vegetation communities inside the Study Area would result in a small reduction in the amount of potential foraging habitat for brown bear, moose, muskox, and caribou, and is not considered to pose any threats to these populations.

Material source development would reduce the potential number of berry-producing shrubs and willow browse available to brown bears and ungulates by up to 87.3 acres (Table 14), or approximately 0.7% of all scrub/shrub habitat in the Study Area (Table 7). These reductions are not expected to cause any population level impact to terrestrial wildlife species given the 12,286 acres of scrub and shrub habitat available in the Study Area (Table 7) and other undisturbed, comparable habitat surrounding it.

Wildlife, particularly ungulates, can be attracted to gravel sites for insect relief or as mineral licks. Caribou have been shown to prefer developed sites as a relief from tundra and associated insect harassment (Pollard et al. 1996, Noel et al. 1998). Wildlife on the North Slope have also been shown to be mineral deficient (O'Hara et al. 2001), and gravel sources can expose minerals to the surface for easy consumption. While these attraction mechanisms may potentially increase the local population, it may also change traditional migration and movement patterns.

Mortality Risk: Indirect mortality may take place at inactive or rehabilitated material sources. Deep pits can pose a fall hazard to wildlife, which can be mediated by sloping material sources side slopes (ADF&G 1993). Flooded material sources can also present entrainment hazards to wildlife, which encounter side slopes too steep to escape (ADF&G 1993). Reclamation plans should include the creation of shallow benches around material source boundaries to allow a gradual slope to the water (ADF&G 1993).

Construction Impacts:

Habitat Alteration: The K-Hill material site is located within half a mile of potential bear denning habitat. State of Alaska guidelines generally prohibit industrial activity (e.g., road construction) within half a mile of occupied bear dens (DNR 2016). Pre-construction activities would need to include fall and winter bear denning surveys to determine if there are active bear dens.

Mortality Risk: Construction activities associated with material source development are not anticipated to significantly increase mortality. Avoidance and minimization measures would include pre-construction surveys to identify active dens and implementation of appropriate mitigation as well as development of a bear-human conflict management plan, which would reduce the potential for additional mortality to bears and other wildlife.

Migration Patterns and Movement: Material sources have the potential to impact wildlife migration and movement in the Study Area. Potential changes to caribou movement would be the result of sensory disturbance during the construction phase (i.e., drilling, blasting, human activity). These would be expected to be similar to the disturbance studied at Red Dog by Wilson et al. (2016). It is expected that individuals temporarily displaced due to sensory disturbance would use other suitable habitats available in the Study Area and surrounding habitats.

Material source development at the K-Hill site has potential to alter caribou movement during the spring and fall migration period, when individuals of the WAH caribou herd are known to travel through the Study Area near the southwest side of K-Hill (WHPacific 2012b). Overall, potential effects on caribou movement are difficult to predict based on the variability of project activities and resulting caribou reactions (Wilson et al. 2016). Avoidance and minimization measures may include reducing activity at the site during migration periods.

The Wulik River Source 1 may impact the use of the Wulik River as a wildlife movement corridor. Muskox prefer riverine habitat during the summer (Danks and Klein 2002; Klein et al. 1991), and moose

prefer riverine corridors during the winter (Tape et al. 2016). Development of the material source may cause avoidance activity at the site. It is not clear if wildlife would avoid only the material source, or also avoid movement throughout the lower reaches of the Wulik River.

Activity at the Wulik River Relic Source 1 and Source 2 may also impact wildlife migration and movement, but the impacts are expected to be lower. The Wulik River Relic sites may be used by wildlife, but are a smaller system without an active river channel and the variation in vegetation of the Wulik River. Although material source development has potential to temporally alter local movement patterns of terrestrial mammals (e.g., moose, brown bear, furbearers), construction activities are not expected to result in barriers to wildlife movement within the Study Area (Wilson et al. 2016).

Secondary (Induced) and Cumulative Impacts:

Subsistence and Hunting Pressure: Both subsistence and non-subsistence hunting pressure would likely increase near material sources and material source spur roads. Once reclaimed, these areas may serve as staging areas for activities into the surrounding area. For either road route, the Wulik River Source 1 Source and associated spur road pose the largest potential impact to wildlife from subsistence and hunting pressure. This site would directly open the Wulik River to road access; facilitating subsistence, hunting, and fishing activities. The other material sources are located relatively close to the route alternatives, and would have relatively smaller impacts to wildlife from subsistence and non-subsistence hunting pressure.

Private Land Development: Private lands are distributed throughout with Study Area, and road access could open those areas to development, which may include subsistence use, hunting, or fishing camps. The Southern Route (Preferred Alternative) includes easier access for a greater number of private land owners than the Combined Route B. Additionally, the Southern Route is closer to a larger number of privately owned land parcels abutting the Wulik River. These parcels could be developed to provide access to fishing resources and summer muskox and winter moose and caribou range.

4.13.2.4 Alternatives Comparison

Table 18 compares impacts that vary between proposed route and crossing alternatives, as well as potential material source alternatives. All other impacts are similar across all proposed alternatives.

Table 18 Terrestrial Mammals Impacts

Terrestrial Mammals: Differences Between Routes		
	Southern Route (Preferred Alternative) with Lagoon Crossing D	**Combined Route B with Lagoon Crossing D**
Direct and Indirect and Construction	Habitat Alteration: • Total disturbance of 148.6 acres of habitat, including a permanent loss of 25.6 acres of potential scrub/shrub habitat for ungulates and bears. • Proximity to Wulik River has potential to result in relatively greater sensory disturbance and mortality risk to bears and ungulates.	Habitat Alteration: • Total disturbance of 172.6 acres of habitat, including a permanent loss of 51.5 acres of potential scrub/shrub foraging habitat for ungulates and bears. • Traverses relatively more upland habitat and is farther away from the Wulik River, which would reduce sensory disturbance and mortality risk to bears and ungulates using the Wulik River during spring and fall. However, this route could result in more sensory disturbance to wintering muskoxen and bears foraging on berries in upland areas during summer.
Secondary and Cumulative	Subsistence and Hunting Pressure • This route would make access to the Wulik River easier and open land year-round that is already relatively accessible during certain seasons, which would result in increased mortality risk to bears and ungulates due to increased subsistence and non-subsistence hunting pressure.	Subsistence and Hunting Pressure • This route would open land year-round which is currently difficult to access, which would result in relatively greater mortality risk to wildlife using upland habitats (e.g., caribou, muskoxen) due to increased subsistence and hunting pressure. Although this route would result in less potential mortality risk to wildlife using the Wulik River, mortality risk could increase along the Kivalina River where a portion of the route alignment lies within a half mile.

Differences Between Material Source Alternatives				
	K-Hill Site	**Wulik River Source 1**	**Relic Channel Source 1**	**Relic Channel Source 2**
Direct and Indirect and Construction	Habitat Alteration: • Total disturbance of 99.9 acres of habitat, including a permanent loss of 13.3 acres of potential scrub/shrub foraging habitat for ungulates and bears. • Potential to result in sensory	Habitat Alteration: • Total disturbance of 39.7 acres of habitat, including a permanent loss of 33.7 acres of potential scrub/shrub foraging habitat for ungulates and bears. • Potential to result in relatively greater sensory disturbance to wildlife using riparian areas along the Wulik River	Habitat Alteration: • Total disturbance of 66.6 acres of habitat, including a permanent loss of 12.1 acres of potential scrub/shrub foraging habitat for ungulates and bears. • This site is farther away from the Wulik River, which would result in less potential sensory disturbance to wildlife using riparian	Habitat Alteration: • Total disturbance of 47.5 acres of habitat, including a permanent loss of 27.9 acres of potential scrub/shrub foraging habitat for ungulates and bears. • These sites are farther away from the Wulik River, which would result

	disturbance to caribou during spring and fall migration. Potential to result in loss and alteration of brown bear denning habitat.	(e.g., muskoxen, moose, bears).	areas along the Wulik River.	in less potential sensory disturbance to wildlife using riparian areas along the Wulik River.
Secondary and Cumulative	• No secondary impacts anticipated due to overlap with end-route alignments.	• Development of this site would result in increased road access directly to the Wulik River, which could result in additional mortality risk to wildlife from increased subsistence and hunting pressure.	• This site is located close to Combined Route B, which would result in relatively less incremental change in mortality risk to wildlife.	• These sites are located closer to Combined Route B and would result in relatively less incremental change in mortality risk to wildlife.

4.13.3 Avoidance, Minimization, and Mitigation

- To reduce potential disturbance to caribou during migration, mitigation measures such as those applied at the Red Dog Mine are recommended during construction. Vehicles traveling the project road would be required to stop when they are within sight of migrating caribou either approaching or actively crossing the road. Vehicles would not be permitted to proceed until all caribou have crossed the road. Road closures may last anywhere from 30 minutes to multiple days depending on the number of caribou and speed of travel (USEPA 2009; Teck 2013);
- Reduce speed limit along the project road as well as any temporary spur roads; and
- A bear-human conflict management plan would be developed to reduce potential mortality risk. Such a plan would include, among other considerations, measures to manage waste disposal and reduce bear attractants at camps or temporary works sites.

4.14 Historic, Architectural, Archaeological, and Cultural Resources

4.14.1 Affected Environment

One Alaska Heritage Resources Survey (AHRS) site, the Cape Krusenstern Archaeological District National Monument National Historic Landmark (CKNHL), is located within the Area of Potential Effects to Historic Resources (APE) defined by the DOT&PF (2017). The boundary of the CKNHL (AHRS site number NOA-00042) extends more than 10 miles northwest of the Cape Krusenstern National Monument boundary (NPS 2016a), encompassing the entirety of the APE.

Archaeological investigations intended to identify archaeological resources within the APE have included predictive modeling and archaeological field investigations conducted in 2016 and 2017. The following identification efforts were conducted:

- Northern Land Use Research Alaska, LLC (NLURA) used geospatial modeling techniques to prepare an archaeological predictive model that integrated environmental, archaeological, and ethnohistoric data from the region to rank locations in terms of their probability for containing archaeological resources (NLURA 2016). The model predictions suggested that there was a high probability of identifying cultural resources along interior portions of the APE, and at other specific locations including areas along the relic channels of the Wulik River. Elevated areas within the proposed material source locations were assigned a moderate probability value. The NLURA report recommended that an archaeological survey involving pedestrian survey and shovel testing be conducted to ground-truth the model predictions (NLURA 2016);
- Stantec conducted a cultural resources assessment, including pedestrian survey and subsurface testing of high, moderate, and low probability areas within the Study Area that was defined in the fall of 2016 (Stantec 2017b). The 2016 field investigations focused on three preliminary route options identified by the NAB, and potential material sources identified at K-Hill and in the Wulik and Kivalina River Deposition zones. No buried pre-contact or historic archaeological resources were identified within the three preliminary route corridors or within any of the identified material sources during the 2016 field investigations (Stantec 2017b); and
- Stantec conducted a supplemental archaeological resources assessment in August 2017 to address data gaps identified by DOT&PF in coordination with State Historic Preservation Office (SHPO) and NPS. The goals of Stantec's field investigations were to examine revisions to proposed alignments and material sources and to determine whether buried resources were present at the western terminus of the evacuation road on the barrier island of Kivalina (Stantec 2017b). Four artifacts were found at the causeway terminus on the barrier island: three were recovered in imported or highly disturbed contexts and the fourth was recovered from intact stratigraphic context well below the level of proposed ground disturbance (Stantec 2017b).

4.14.2 Environmental Consequences

4.14.2.1 No-Action Alternative

An evacuation road would not be constructed from Kivalina to K-Hill and impacts to historic, architectural, archaeological, and cultural resources would not occur. Residents would continue to be exposed to environmental threats with no reliable options for evacuation during storm events with the

potential to detrimentally impact the community over time. There would remain severe risk to life, health, and safety of residents.

4.14.2.2 Route and Lagoon Crossing Alternatives

Direct and Indirect Impacts:

Pursuant to 36 CFR 800.5(b), implementing regulations of Section 106 of the *National Historic Preservation Act*, DOT&PF, in consultation with SHPO and the National Park Service (NPS), has made a Finding of No Historic Properties Adversely Affected to historic properties by the Proposed Action. DOT&PF initiated consultation with the SHPO on August 7, 2017.

The DOT&PF transmitted a Finding of Effect letter on Sept. 19, 2017, documenting the Finding of No Historic Properties Adversely Affected. Responses were received from the NPS on October 6, 2017 and from SHPO on October 9, 2017 stating concurrence with the Finding of No Historic Properties Adversely Affected, conditional to including an archaeological monitoring and an Inadvertent Discovery Plan (Appendix F). On December 29, 2017, the DOT&PF transmitted an informational letter to SHPO, NPS, Native Village of Kivalina, City of Kivalina, Native Village of Noatak, NANA Regional Corporation, NAB, NPS-Western Arctic National Parklands, and BIA to respond to comments received from NPS in their October 2017 concurrence letter. The updated letters address two AHRS sites on the periphery of the APE, where visual effects were of greatest concern. No ground disturbing activities are planned for the portions of the APE containing these two sites. The updated letters also include a finalized Inadvertent Discovery Plan (Appendix F).

The archaeological investigations conducted over the 2016 and 2017 field seasons did not result in the identification of any elements which contribute to our continuing understanding of the prehistory or history of the Arctic within the APE which is located within the boundaries of the CKNHL. As such, construction of the Proposed Action would not have an adverse effect to the integrity of the CKNHL or its continuing eligibility for the National Register of Historic Places as no contributing elements have been identified. Due to the project being located within the CKNHL boundary, DOT&PF submitted the Archaeological Monitoring Procedures and Inadvertent Discovery Plan to be implemented during the continued planning and execution of the project (Appendix F). In the event that cultural resources are encountered, this plan will be implemented and all identified parties will be contacted.

Section 4(f) Evaluation: The project is located entirely within the boundaries of the CKNHL. The Proposed Action would permanently incorporate a portion of the CHNHL, a Section 4(f) property, into a

transportation facility; therefore, Section 4(f) of the *U.S. Department of Transportation Act* would apply under criteria 23 CFR 774.17(1).

Pursuant to 36 CFR 800.5(d)(2), implementing regulations of Section 106 of the *National Historic Preservation Act*, DOT&PF has found that the Proposed Action would not adversely affect the CKNHL. Based on this, DOT&PF proposes a *de minimis* (23 CFR 774.17) impact to the CKNHL (Section 5).

Secondary (Induced) and Cumulative Impacts:

Future development of private lands may result in additional impacts to historic, archaeological, and cultural resources outside of the APE assessed in 2016 and 2017. Several Native allotments are located immediately south of the proposed Southern Route alignment. The allotment boundaries included elevated areas with direct access to the Wulik River, which increases the probability of identifying archaeological resources at these locations.

4.14.2.3 Material Source Alternatives

Direct and Indirect Impacts:

No archaeological or historical resources were identified during pedestrian survey and subsurface testing within any of the potential material source. The presence of buried surfaces, identified beneath flood deposited sediments at Wulik River Source 1 and Relic Channel Source 1, could indicate there is an increased possibility that buried archaeological resources may be identified at these locations.

Secondary (Induced) and Cumulative Impacts:

Future development of material sources may result in additional impacts to historic, archaeological, and cultural resources. Elevated areas with direct access to current or relic channels of the Wulik River have an increased probability of containing archaeological resources associated with repeated occupation and use of these locations in the past. Future expansion of material sources developed as part of the current project may encounter and impact archaeological resources located on high probability landforms outside of the APE assessed in 2016 and 2017.

4.14.2.4 Alternatives Comparison

Table 19 compares impacts that vary between proposed route and crossing alternatives, as well as potential material source alternatives. All other impacts are similar across all proposed alternatives.

Table 19 Historic, Architectural, Archaeological, and Cultural Resources Impacts

Historic and Cultural Resources: Differences Between Routes				
	Southern Route (Preferred Alternative) with Lagoon Crossing D		**Combined Route B with Lagoon Crossing D**	
Direct and Indirect and Construction	• No relative difference in impacts.		• No relative difference in impacts.	
Secondary and Cumulative	• Increased likelihood of impacts compared to Combined Route B from secondary development due to proximity of the Wulik River.		• Decreased likelihood of impacts compared to Southern Route from secondary development due to distance from the Wulik River.	
Differences Between Material Source Alternatives				
	K-Hill Site	**Wulik River Source 1**	**Relic Channel Source 1**	**Relic Channel Source 2**
Direct and Indirect and Construction	• No known impacts.	• Increased probability of impacts due to the presence of buried surfaces below current permafrost.	• Increased probability of impacts due to the presence of buried surfaces below current permafrost.	• No known impacts.
Secondary and Cumulative	• No known impacts.	• Greater likelihood of impacts from secondary development due to proximity the Wulik River, and the presence of buried surfaces under flood-deposited sediments along the Wulik River.	• Greater likelihood of impacts from secondary development due to proximity of high probability landforms and the presence of buried surfaces along relic channel of the Wulik River.	• Relatively low likelihood of secondary impacts due to distance from the Wulik River, and lack of high-probability landforms with evidence of buried surfaces.

4.14.3 Avoidance, Minimization, and Mitigation

- An Archaeological Monitoring Procedures and Inadvertent Discovery Plan has been developed in consultation between DOT&PF, SHPO, NPS, and local consulting parties to be implemented during the continued planning and execution of the project, including ground-disturbing work associated with construction and material source development; and
- A professional archaeologist would monitor vegetation removal and stripping of fine-grained sediments possibly capping buried gravel deposits within Relic Channel Source 1, and north of the exposed gravel bar within the Wulik River Source 1 area.

4.15 Permits and Authorizations

The permits and authorizations listed in the following table will be the same for both Proposed Action alternatives and material site alternatives and, unless otherwise noted, would be obtained prior to construction to comply with applicable federal, state, and local regulations:

Table 20 Permits and Authorizations

#	Permit or Authorization; Agency	Why Permit/Clearance is Required
Federal Permits and Authorizations		
1	Section 404/10 *Clean Water Act* (CWA) Wetlands Dredge or Fill Permit; USACE	A Section 404/10 permit is required for the placement of fill within jurisdictional wetlands and waters of the U.S.
2	USCG Bridge Permit	Construction of a bridge or causeway in tidal waters falls under the jurisdiction of the USCG Office of Bridge Programs (33C.F.R. Chapter I, Subchapter J, Part 115).
3	ESA Section 7 Consultation; USFWS	Section 7 consultation is required as part of NEPA when the project may affect a listed Threatened or Endangered species. Section 7 consultation with USFWS would cover potential impacts to Spectacled and Steller's Eiders and Polar Bear Critical Habitat. Consultation with USFWS is complete and they concurred that the project is not likely to adversely affect listed eiders or polar bears (Appendix G).
4	MBTA compliance; USFWS	Compliance with MBTA USFWS recommended "no clearing" timing windows would reduce the potential for incidental take of protected migratory bird species and their nests. USFWS recommended timing window is May 20-July 20.
5	Magnuson-Stevens Fishery Conservation and Management Act EFH consultation and assessment (NMFS)	EFH assessment is prepared by the lead agency (DOT&PF) to describe potential impacts to EFH and propose conservation measures to reduce those impacts. This is used to consult with NMFS, who would either concur on the lead agency's findings or recommend additional conservation measures and/or mitigation. Consultation with NMFS is complete as of approval of the Final EA and additional conservation measures have been incorporated into the project (Appendix I).
6	ESA Section 7 and MMPA Consultation (NMFS)	Section 7 and MMPA consultation is required as part of NEPA when the project may affect a listed Threatened or Endangered species that is also a marine mammal protected under the MMPA. Section 7 and MMPA consultation with NMFS would cover potential impacts to bearded and ringed seals, as well as other listed species that may be encountered along project specific barge routes (if required). Consultation with NMFS is complete and they concurred with a finding of may effect but it not likely to adversely affect, any listed species or critical habitat under NMFS jursidiciton (Appendix G).
State Permits and Authorizations		
7	Cultural, Historical, and Archaeological Resources Consultation (Section 106 Review); DNR, Office of History & Archaeology and SHPO	Section 106 compliance is required as part of NEPA, and provides for the identification and protection of cultural and historic resources that are listed or eligible for listing in the National Register of Historic Places. Consultation is completed with SHPO, Tribes, and other consulting parties, and a determination of effect is issued, with mitigation measures and agreements amongst stakeholders completed as needed, depending on anticipated impacts. Consultation has been completed at the time of this publication.
8	Section 401 Certification – Certificate of Reasonable	A 401 water quality certification would be issued concurrently with the USACE 404/10 permit and notify compliance with state water quality

#	Permit or Authorization; Agency	Why Permit/Clearance is Required
	Assurance; ADEC Division of Water Quality	administrative code. The USACE 404/10 permit would not be issued until this certification is complete.
9	ROW (State-owned non-marine waters and submerged lands); DNR, DMLW	An Interagency Land Management Assignment (ILMA) would be required from DNR DMLW to cross the state owned tidelands with the lagoon crossing.
10	DNR Material Site Designation	To develop any new material sites within state-owned lands, DNR DMLW would need to designate those sites as material sites/sources which would require a "best interest" decision.
11	APDES CGP for Stormwater Associated with Large and Small Construction Activities; ADEC, Division of Water	For projects with disturbance of over 1 acre, compliance with the APDES CGP is required. A SWPPP and notice of intent to seek coverage under the CGP would be required prior to construction.
12	Title 16 Fish Habitat Permit; ADF&G	For any work below the ordinary high water of a stream containing fish, a Title 16 permit would be required. Measures to maintain fish passage within these waters would be required, as well as measures to avoid and minimize impacts to fish and their habitats.
13	Temporary Water Use Permit (TWUP)	Water use (including water withdrawals, dewatering, diversions) can be authorized through a TWUP. These will last for up to 5 years, and allow the use of water during construction.
Local Permits and Authorizations		
14	Title 9 Community Infrastructure and Conditional Use Permit; NAB Planning Department	Development of lands within the Study Area designated as a Subsistence Conservation District, a conditional use permit would be required from the NAB planning department. Also as the Study Area is not within a zoned NAB resource development or transportation corridor, an evacuation route would need to be zoned as such by the NAB Planning Commission prior to construction.

5 SECTION 4(F) EVALUATION

Cape Krusenstern National Historic Landmark: Proposed project alternatives would permanently incorporate a minor portion of the CKNHL (approximately 400 acres of the CKNHL expanse of 500,000 acres), a Section 4(f) property, into a transportation facility; therefore, Section 4(f) of the Department of Transportation Act would apply under criteria 23 CFR 774.17(1).

Pursuant to 36 CFR 800.5(d)(2), implementing regulations of Section 106 of the National Historic Preservation Act, DOT&PF has found, and the NPS and SHPO concurred (on October 6 and 9, 2017, respectively) that the Proposed Action would not adversely affect the CKNHL. Based on the undertaking not adversely affecting the function or historic qualities of the CKNHL and that agreement from the SHPO and NPS has been obtained in writing, the proposed project alternatives appear to meet a *de minimis* (23 CFR 774.17) use.

DOT&PF determined that there are no feasible and prudent alternatives that meet the project's purpose and need and avoid using the Section 4(f) property, and has prepared a De Minimis Impact Finding for the proposed activities in the CKNHL (Appendix K). The following measures were implemented to avoid adverse impacts to the CKNHL, and are included in the De Minimis Impact Finding (Appendix K):

- Project elements (e.g. road embankment geometry, vehicle turn outs, water crossings) would be designed to incorporate the minimal dimensions necessary to serve the project purpose and need to minimize required fill placement;
- Project elements would be contained within a 300-ft ROW, the road would be no greater than 24 ft wide with 3:1 side slopes, and embankment height no greater than 8 ft above existing ground;
- Develop an Archaeological Monitoring Procedures and Inadvertent Discovery Plan between DOT&PF, SHPO, NPS, and local consulting parties to be implemented during the continued planning and execution of the project, including ground disturbing work associated with material site development; and
- Monitor vegetation removal and stripping fine-grained sediments, possibly capping buried gravel deposits within Relic Channel Source 1, and north of the exposed gravel bar within the Wulik River Source 1 area. A professional archaeologist would complete monitoring.

Alaska Maritime National Wildlife Refuge: None of the proposed alternatives would include development within the Alaska Maritime National Wildlife Refuge (Refuge), a Section 4(f) property. The closest proposed project alternative would be 0.4 mile from the Refuge which would include construction of a

new 24 ft wide road, separated by land and sea. Proposed project alternatives are not anticipated to result in noise or vibration impacts to the Refuge as construction work would be temporary and the community of Kivalina is about the same distance from the Refuge with existing noise generated from vehicular and aircraft traffic. There would be a change in the aesthetic nature of land where the proposed project alternative would be constructed, but the nearest distance to the refuge would be 0.4 mile away. No ecological intrusions would result from proposed project alternatives as the alternatives are not within the Refuge itself. Migratory bird impacts would be reduced by scheduling construction and vegetation clearing activities to occur outside of important nesting periods (USFWS 2017d). The proposed project alternatives would not have a permanent incorporation, adverse temporary occupancy, or constructive use of the Refuge; therefore, the Proposed Action would not result in a use of the Refuge.

6 PUBLIC INVOLVEMENT AND AGENCY COORDINATION SUMMARY

6.1 Activities

Public involvement and agency coordination activities occurred throughout the development of the EA. Newspapers, flyers, community working group meetings, and public meetings were held consistently for this project to keep the community involved and informed about project elements, impact assessments, and schedule. The community was an important part of the project team and informed much of the design parameters and assisted with alternatives evaluation. Local staff provided technical field work support, informed impact assessments for wildlife and marine mammals, and provided input on the socioeconomic benefits of the project. Table 21 outlines the public involvement activities and Table 22 outlines agency coordination completed to date. Records of correspondence, meeting materials and summaries are included in Appendix D and E.

Table 21 Public Involvement Activity Summary

Public Involvement		
Date/Time	**Activity**	**Description**
11/12/16	Publish Newspaper Ad	Public Notice to Conduct NEPA and public meeting invitation
11/11/16	Public Scoping letter	Scoping letter sent to interested public stakeholders
11/15/16	Public Meeting	Kivalina Public meeting
11/16/16	Public Meeting	Noatak Public meeting
11/16/16	Public Meeting	Kotzebue Public meeting
6/1/17	Newsletter	Spring 2017 Newsletter
7/6/17	Working Group Meeting	Community Working Group Meeting
8/3/17	Working Group Meeting	Community Working Group Meeting
8/15/17	Public Meeting	Community Update Meeting, Kivalina
11/14/17	Online Public Notice	Notice of EA availability and public meetings on DOT&PF website
11/14/17	Email Notice	Notice of EA availability and public meetings to ANCSA Corporations, Native Village of Kivalina, and NAB.
11/15/17	Email Notice	Notice of EA availability and public meetings to ANCSA Corporations, Native Village of Kivalina, NAB, and interested agencies.
11/27/17	Facebook Events Posted	Public meeting open houses for Kotzebue, Kivalina, and Noatak to solicit draft EA comments on DOT&PF Facebook page
12/5/17	Public Meeting	Kivalina Public Meeting
12/5/17	Public Meeting	Kotzebue Public Meeting
12/5/17	Public Meeting	Noatak Public Meeting

Public Involvement		
Date/Time	**Activity**	**Description**
12/5/17	Radio Interview	DOT&PF interview on air with 720 AM, KOTZ Radio

Table 22 Agency Coordination Activity Summary

Agency Scoping and Coordination		
Date	**Activity**	**Description**
11/10/16	Agency Scoping letter	Scoping letter sent to agencies
11/25/16	Agency Comment	SHPO Scoping comment
11/29/16	Agency Comment	NPS Scoping comment
12/12/16	Agency Comment	DNR Scoping comment
12/12/16	Agency Comment	USFWS Scoping comment
12/19/16	Agency Meeting	USFWS Scoping meeting
12/19/16	Agency Meeting	ADF&G Scoping meeting
12/20/16	Agency Meeting	NPS and SHPO Scoping meeting
12/21/16	Agency Meeting	NMFS Scoping meeting
12/21/16	Agency Meeting	USACE Scoping meeting
6/6/17	Agency Meeting	NMFS Lagoon Hydrology Meeting
7/10/17	Agency Meeting	SHPO and NPS Section 106 Coordination Meeting
7/25/17	Agency Meeting	USACE Wetland Delineation Presentation and Meeting
8/8/17	Agency Meeting	DNR Project Update Meeting
8/9/17	Agency Meeting	NMFS Marine Mammals Meeting
8/15/17	Agency Site Visit	USACE Site Visit and Project Update Meeting
8/15/17	Agency Site Visit	ADF&G Site Visit and Project Update Meeting
8/16/17	Agency Site Visit	SHPO and NPS Site Visit and Project Update Meeting
8/17/17	Agency Site Visit	NMFS Site Visit and Project Update Meeting
12/12/17	Agency Meeting	NMFS Comments on Draft EA
12/12/17	Agency Meeting	USACE Comments on Draft EA
12/12/17	Agency Letter	NWAB Comments on Draft EA
12/13/17	Agency Letter	EPA Comments on Draft EA
12/14/17	Agency Letter	NMFS Comments on EFH for Draft EA
12/14/17	Agency Meeting	ADF&G Comments on Draft EA
12/14/17	Agency Letter	ADF&G Comments on Draft EA
12/14/17	Agency Meeting	USFWS Comments on Draft EA
12/14/17	Agency Letter	USACE Comments on Draft EA
12/15/17	Agency Letter	ADNR Comments on Draft EA

Agency Scoping and Coordination		
Date	**Activity**	**Description**
12/18/17	Agency Meeting	EPA Comments on Draft EA

6.2 Comments Summary

Public and agency comments were collected throughout development of this EA. Comments gathered have served to shape the evaluation of alternatives, and identify appropriate measures to avoid, minimize, and mitigate adverse effects of the final proposed project. Kivalina residents shared local traditional knowledge of the area and its natural and cultural resources that have contributed to descriptions of the potentially affected environment. Similarly, agency coordination and consultation informed overall project design. Most comments obtained to date were received through public and agency meeting discussions, and have been paraphrased and presented in meeting notes provided in Appendices D and E.

7 LIST OF PREPARERS

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- **Katherine Keith,** Project Director
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TECHNICAL LEADS

Name	Title	Role(s)
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Kacy Hillman	Environmental Scientist, Stantec	Land Use and Transportation; Hazardous Materials and Solid Waste; 4(f)
Seifu Guangul	Senior Water Resources Engineer, Stantec	Water Resources and Water Quality
Ryan Cooper	Environmental Scientist, Stantec	Wetlands and Vegetation
Jason Cote	Environmental Scientist, Stantec	Fish and Fish Habitat
Megan Willie	Environmental Scientist, Stantec	Aquatic and Terrestrial Birds
Rowenna Gryba	Environmental Scientist, Stantec	Marine Mammals
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Ross Smith	Archaeologist, Stantec	Social Environment; Historic, Architectural, Archaeological, and Cultural Resources
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Francis Wiese	National Technical Lead, Stantec	Environmental Technical Lead, and Quality Review
Andrew Niemiec	Transportation Manager, Stantec	Construction Methods; Independent Review

8 REFERENCE LIST

ADEC (Alaska Department of Environmental Conservation). 2010. Alaska's impaired waters. http://dec.alaska.gov/water/wqsar/Docs/impairedwaters.pdf. Accessed on August 19, 2017.

ADEC. 2016a. Alaska Department of Environmental Conservation Spill Prevention and Response, Contaminated Sites Program. http://dec.alaska.gov/spar/csp/db_search.htm. Accessed on November 11, 2016.

ADEC. 2016b. Alaska Department of Environmental Conservation, Solid Waste Information Management System. http://dec.alaska.gov/Applications/EH/SWIMS/ModFacility.aspx?SiteId=451. Accessed on December 18, 2016.

ADF&G (Alaska Department of Fish and Game). 1991. Blasting standards for the protection of fish. https://www.adfg.alaska.gov/static/license/uselicense/pdfs/adfg_blasting_standards.pdf. Accessed on August 1, 2017.

ADF&G. 1993. North slope gravel pit performance guidelines. Technical Report No. 93-9. Habitat and Restoration Division. https://www.wc.adfg.state.ak.us/static/license/uselicense/pdfs/93_09.pdf Accessed on August 3, 2017.

ADF&G. 2001. Memorandum of Agreement between Alaska Department of Fish and Game and Alaska Department of Transportation and Public Facilities for the Design, Permitting, and Construction of culverts for fish passage. http://www.adfg.alaska.gov/static/license/uselicense/pdfs/dot_adfg_fishpass080301.pdf. Accessed on August 1, 2017.

ADF&G. 2005a. The grouse and ptarmigan of Alaska. A guide to their identification, habits, and habitat. https://www.adfg.alaska.gov/static/home/library/pdfs/grouse_ptarmigan_booklet.pdf. Accessed on July 20, 2017.

ADF&G. 2005b. Wildlife action plan appendix 5.4: Marine and coastline habitats. http://www.adfg.alaska.gov/static/species/wildlife_action_plan/appendix5_marine_and_coastal_habitats.pdf. Accessed on August 1, 2017.

ADF&G. 2006. Alaska Administrative Code. Title 5. Fish and Game, Chapter 92. Statewide Provisions, Section 80. Unlawful methods of taking game; exceptions. Code current as of June 2006.

ADF&G. 2008. Falcons. https://www.adfg.alaska.gov/static/education/wns/falcons.pdf. Accessed on August 1, 2017.

ADF&G. 2010. Subsistence. http://www.subsistence.adfg.state.ak.us/techpap/tp354.pdf. Accessed on August 28, 2017.

ADF&G. 2011a. Buteos. https://www.adfg.alaska.gov/static/education/wns/buteos.pdf. Accessed on August 1, 2017.

ADF&G. 2011b. Dall sheep management report of survey-inventory activities 1 July 2007 – 30 June 2010. Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/11_sheep.pdf. Accessed on August 1, 2017.

ADF&G. 2012. Moose management report of survey-inventory activities, 1 July 2009–30 June 2011. Alaska Department of Fish and Game Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/moose_12.pdf. Accessed on August 19, 2017.

ADF&G. 2014. Sheep populations, hunters and harvest: a summary of current status and trends. http://www.adfg.alaska.gov/static/species/speciesinfo/Dall'sheep/pdfs/sheep_populations_hunters_harvest_summary_status_trends.pdf. Accessed on August 1, 2017.

ADF&G. 2015a. Alaska wildlife action plan. Juneau. http://www.adfg.alaska.gov/static/applications/web/nocache/species/wildlife_action_plan/draft_alaska_wildlife_action_plan_2015.pdf045BC5697BB8479ECD7A7B747C94939E/draft_alaska_wildlife_action_plan_2015.pdf. Accessed on August 1, 2017.

ADF&G. 2015b. Chapter 3a: Species management report. Muskox management report. Alaska Department of Fish and Game, Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/research/wildlife/speciesmanagementreports/pdfs/muskox_2015_chapter_3_units_23_26a.pdf. Accessed on August 1, 2017.

ADF&G. 2015c. Movements of ice seals: Animated locations of ice seals tagged with satellite transmitters and seasonal changes in sea ice in the Bering, Chukchi and Beaufort seas for 2014. https://vimeo.com/116608370. Accessed on August 19, 2107.

ADF&G. 2015d. Species management report. Chapter 14: Caribou management report. http://www.adfg.alaska.gov/static/research/wildlife/speciesmanagementreports/pdfs/caribou_2015_chapter_14_wah.pdf. Accessed on August 1, 2017.

ADF&G. 2016a. Fish resource monitor. http://extra.sf.adfg.state.ak.us/FishResourceMonitor/?mode=awc. Accessed on December 8, 2016.

ADF&G. 2016b. Rock Ptarmigan - Species Profile.: http://www.adfg.alaska.gov/index.cfm?adfg=rockptarmigan.main. Accessed on August 20, 2017.

ADF&G. 2016c. Wildlife action plan section IIIB: Alaska's 32 ecoregions. http://www.adfg.alaska.gov/index.cfm?adfg=ecosystems.ecoregions. Accessed on December 8, 2016.

ADF&G. 2016d. Willow Ptarmigan - Species Profile. http://www.adfg.alaska.gov/index.cfm?adfg=willowptarmigan.main. Accessed on August 20, 2017.

ADF&G. 2016e. Western arctic caribou update. http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=794. Accessed on August 1, 2017.

ADF&G. 2017a. Aquatic biomonitoring at Red Dog mine, 2016. Technical Report No. 17-07. http://www.adfg.alaska.gov/static/home/library/pdfs/habitat/17_07.pdf. Accessed on August 28, 2017.

ADF&G. 2017c. Living in harmony with bears: bears and "food". http://www.adfg.alaska.gov/index.cfm?adfg=livingwithbears.bearharmony. Accessed on August 3, 2017.

Allen, B.M., and R.P. Angliss. 2014. Alaska marine mammal stock assessments, 2014. U.S. Dep. Commer., *NOAA Tech. Memo*. NMFSAFSC-301, 304 p. doi:10.7289/V5NS0RTS.

AMAP (Arctic Monitoring and Assessment Program). 2017. *Snow, Water, Ice and Permafrost. Summary for policy-makers*. Arctic monitoring and assessment programme (AMAP), Oslo, Norway. 20 pp

Anderwald, P., A. Brandecker, M. Coleman, C. Collins, H. Denniston, M. Damien Haberlin, M. O'Donovan, R. Pinfield, F. Visser, and L. Walshe. 2013. Displacement response of a mysticete, an odontocete, and a phocid seal to construction related vessel traffic. *Endangered Species Research*, 21: 231-240.

ASRC (Arctic Slope Regional Corporation). 2015. *Wetland delineation and functions & values assessment, Kivalina evacuation route wetlands mapping study*. Prepared for the Northwest Arctic Borough.

Audubon. 2016. *Ecological atlas of Alaska's western Arctic*, Third Edition. Anchorage, Alaska, 71 pp.

Auerbach, N.A., M.D. Walker, and D.A. Walker. 1997. *Effects of roadside disturbance on substrate and vegetation properties in the Arctic Tundra*. Ecological Applications 7(1):218:235.

Ballard, W.B, L.A. Ayres, K.E. Roney, D.J. Reed, S.G. Fancy. 1991. Demography of Noatak grizzly bears in relation to human exploitation and mining development. Alaska Department of Fish and Game. Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/research_pdfs/91_grb_noatak_ballard_et al.pdf. Accessed on August 19, 2107.

Barber, J.R., K.R. Crooks, and K.M. Fristrup. 2009. The costs of chronic noise exposure for terrestrial organisms. *Trends in Ecology and Evolution*, 25: 180-189.

Bash, J., C.H. Berman, and S. Bolton. 2001. *Effects of turbidity and suspended solids on salmonids*. University of Washington Water Center.

Bednarz, J. 1984. The effect of mining and blasting on breeding prairie falcon (*Falco mexicanus*) occupancy in the Caballo Mountains, New Mexico. *Raptor Research*, 18(1): 16-19.

Bellefleur, D., P. Lee, and R.A. Ronconi. 2009. The impact of recreational boat traffic on Marbled Murrelets. *Journal of Environmental Management*, 90: 531-538.

Bengtson, J.L., L.M. Hiruki-Raring, M.A. Simpkins, and P.L. Boveng. 2005. Ringed and bearded seal densities in the eastern Chukchi Sea, 1999-2000. *Polar Biology* 28: 833-845.

Benítez-López. A., R. Alkemade, and P.A. Verweij. 2010. The impacts of roads and other infrastructure on mammal and bird populations: A meta-analysis. *Biological Conservation* 143: 1307–1316.

Beyer, H.L., R. Ung, D.L. Murray, and M.J. Fortin. 2013. Functional responses, seasonal variation and thresholds in behavioural responses of moose to road density. *Journal of Applied Ecology*, 50: 286-294.

Bishop, M.J., M. Mayer-Pinto, L. Airoldi, L.B. Firth, R.L. Morris, L.H.L. Loke, S.J. Hawkins, L.A. Naylor, R.A. Coleman, S.Y. Chee, and K.A. Dafforn. 2017. Effects of ocean sprawl on ecological connectivity: impacts and solutions. *Journal of Experimental Marine Biology and Ecology*, 492: 7-30.

Blackwell, S.B., J.W. Lawson, and M.T. Williams. 2004. Tolerance by ringed seals (*Phoca hispida*) to impact pipe-driving sounds at an oil production island. *Journal of the Acoustical Society of America*, 115(5): 2346-2357.

BLM. 2017. Section 17(b) Easements Online. https://sdms.ak.blm.gov/scanned_images/esmtindex.html?

Boveng, P.L. and M.F. Cameron. 2013. *Pinniped movements and foraging: seasonal movements, habitat selection, foraging and haul-out behavior of adult bearded seals in the Chukchi Sea*. Final Report, BOEM Report 2013-01150. Bureau of Ocean Energy Management, Alaska Outer Continental Shelf Region, Anchorage, Alaska, USA. 91 Pp + Appendix.

Braem, N.M. and M. Kostick, 2014. *Subsistence wildlife harvests in Elim, Golovin, Kivalina, Koyuk, Noatak, and Wales, Alaska 2010-2011*. Special Publication No. SP2012-04. Alaska Department of Fish and Game, Division of Subsistence, Fairbanks, Alaska.

Brubaker M., J. Berner, J. Bell, and J. Warren. 2010. Climate change in Kivalina, Alaska, Strategies for community health. ANTHC. http://www.anthc.org/chs/ces/climate/climateandhealthreports.cfm. Accessed on December 8, 2016.

Buck, B.M. and C.R. Greene. 1979. Source level measurements of an arctic sea ice pressure ridge. The *Journal of the Acoustical Society of America*, 66(S1): S25-S26.

Burch, E.S. 1985. *Subsistence production in Kivalina, Alaska: A Twenty-Year perspective*. Technical Paper, 128. Juneau: Alaska Department of Fish and Game, Division of Subsistence.

Burch, E.S. 1998. *The Iñupiaq Eskimo Nations of Northwest Alaska*. University of Alaska Press (Fairbanks).

Calambokidis, J., E. A. Falcone, T. J. Quinn, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. K. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán-Ramirez, R. D. Weller, B. H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Cascadia Research

CARMA (CircumArctic Rangifer Monitoring and Assessment Network). 2017. Western arctic caribou herd and Teshekpuk Lake caribou herd. https://carma.caff.is/. Accessed on August 2, 2017.

Carretta, J.V., E.M. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, M.M. Muto, B. Hanson, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell, and R.L. Brownell Jr. 2015. U.S. Pacific marine mammal stock assessments: 2014. U.S. Department of Commerce, *NOAA Technical Memo*. NOAA-TM-NMFS-SWFSC-549, 414 pp.

Chapman, R.S., S.C. Kim, and D.J. Mark. 2009. Storm damage and flooding evaluation: Storm induced water level prediction study for the Western Coast of Alaska. U.S. Army Corps of Engineers, Engineer Research and Development Center. http://www.ariesnonprofit.com/SmithCorpsAKstormSurgeReport.pdf. Accessed on July 26, 2017.

City of Kivalina, Hazard Mitigation Planning Team. 2015. *City of Kivalina Hazard Mitigation Plan*. Kivalina, AK, 275 pp.

ConocoPhillips. 2005. Shorebirds. Fish and wildlife of Alaska's north slope. http://alaska.conocophillips.com/Documents/SMID_056_Shorebirds_Fact_Sheet.pdf. Accessed on July 20, 2017.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. *U.S. Fish and Wildlife Service Report* No. FWS/OBS/-79/31.Washington, D.C.

Crawford, J.A., K.J. Frost, L.T. Quakenbush, and A. Whiting. 2012. Different habitat use strategies by subadult and adult ringed seals (*Phoca hispida*) in the Bering and Chukchi Sea. *Polar Biology* 35: 241-255.

Dau, J. 2002. Unit 23 moose management report. Pages 496-515 IN C. Healy, editor. *Moose management report of survey and inventory activities*. 1 July 1999-30 June 2001. Alaska Department of Fish and Game. Project 1.0 Juneau, Alaska.

Danks, F.S., and D.R. Klein. 2002. Using GIS to predict potential wildlife habitat: a case study of muskoxen in northern Alaska. *International Journal of Remote Sensing* 23.21: 4611-4632.

DCCED (Department of Commerce, Community, and Economic Development). 2015. *Kivalina Strategic Management Plan*. State of Alaska, Alaska Department of Commerce, Community, and Economic Development, 17 pp.

DCCED. 2016. *Division of Community and Regional Affairs on behalf of the Community of Kivalina*. Kivalina Strategic Management Plan. 79 pp.

DCCED. 2017. Community Index. State of Alaska. https://www.commerce.alaska.gov/dcra/DCRAExternal/community. Accessed on August 19, 2107.

Department of Natural Resources. 2008. Northwest Area Plan for State Lands. Adopted October 2008, Alaska Department of Natural Resources, Division of Mining, Land and Water, Resource Assessment, and Development Section. http://dog.dnr.alaska.gov/Documents/Leasing/SaleDocuments/NorthSlope/LatestSale/NS2016W-MitigationMeasures.pdf. Accessed August 2, 2017.

Department of Natural Resources. 2016. North Slope areawide 2016 competitive oil and gas lease sale. Mitigation Measures and Lessee Advisories.

DLWD (Department of Labor and Workforce Development), Research and Analysis. 2015. Kivalina City. State of Alaska. http://live.laborstats.alaska.gov/alari/index.cfm?r=4&b=20&p=160&goplace=go. Accessed on August 28, 2017

Department of Transportation and Public Facilities. 2004. *Northwest Alaska Transportation Plan*. Community Transportation Analysis. An Element of the Alaska Statewide Transportation Plan. State of Alaska, Department of Transportation and Public Facilities. February 11, 2004.

Department of Transportation and Public Facilities. 2011. *LiDAR Data for Kivalina Project Area*. State of Alaska, Department of Transportation and Public Facilities.

Department of Transportation and Public Facilities. 2011. *Noise Policy*. Alaska Environmental Procedures Manual. April 2011. 29 pgs.

DOT&PF (Department of Transportation and Public Facilities). 2017. *Kivalina evacuation and school site access road*. NRHP Section 106 consultation initiation letter from Thomas Gamza (DOT&PF) to Judith Bittner (SHPO). August 7, 2017.

Dooling, R.J. and A.N. Popper. 2007. *The effects of highway noise on birds*. Prepared for the California Department of Transportation. Sacramento, CA. 74 pp.

Earnst, S.L. 2004. *Status assessment and conservation plan for the Yellow-billed Loon* (*Gavia adamsii*). U.S. Geological Survey, Scientific Investigations Report 2004-5258, 42 pp.

Earnst, S.L., R. Platte, and L. Bond. 2006. A landscape-scale model of yellow-billed loon (*Gavia adamsii*) habitat preferences in northern Alaska. *Hydrobiologia* 567: 227. doi:10.1007/s10750-006-0042-2

Eccleston, C.H. 2000. *Environmental Impact Statements: A Comprehensive Guide to Project and Strategic Planning*. John Wiley & Sons,

Ellison, W.T., B.L. Southall, C.W. Clark and A.S. Frankel. 2012. A new context-based approach to assess marine mammal behavioural responses to anthropogenic sounds. *Conservation Biology* 26: 21-28.

ECCC (Environment and Climate Change Canada). 2017. Technical Information – Risk Factors for Migratory Birds. https://www.ec.gc.ca/paom-itmb/default.asp?lang=En&n=8D910CAC-1. Accessed on August 15, 2017.

FHWA (Federal Highways Administration). 2008. Wildlife-vehicle collision reduction study: report to Congress. Publication Number FHWA-HRT-08-034. https://www.fhwa.dot.gov/publications/research/safety/08034/exec.cfm. Accessed on August 3, 2017.

FHWA. 2012. Office of Planning, Environment and Realty Project Development and Environmental Review. Section 4(f) Policy Paper. https://www.environment.fhwa.dot.gov/4f/4fpolicy.asp. Accessed on: August 28, 2017.

FHWA. 2017. De Minimis Impact. Section 4(f) Tutorial. https://www.environment.fhwa.dot.gov/section4f/use_deminimis.aspx. Accessed on August 19, 2017.

Frederickson, L.H. 2001. Steller's Eider (*Polysticta stelleri*), The Birds of North America (P. G. Rodewald, Ed.). Available: https://birdsna.org/Species-Account/bna/species/steeid. Accessed on August 2, 2017.

FSMP (Federal Subsistence Management Program). 2016a. Federal subsistence board closes Federal public lands to caribou hunting. Press Release, 4/18/2016. https://www.doi.gov/subsistence/news/hunting/federal-subsistence-board-closes-federal-public-lands-caribou-hunting. Accessed on August 2, 2017.

FSMP. 2016b. Federal subsistence management regulations for the harvest of wildlife on federal public lands in Alaska. Office of Subsistence Management. Effective 1 July 2016 – 30 June 2018. Page 16/ https://www.doi.gov/sites/doi.gov/files/uploads/wildlife_regs_16-18_correctedreduced.pdf. Accessed on August 2, 2017

FSMP. 2017. Federal subsistence board approves partial closure of Federal public lands to caribou hunting in Unit 23. Press Release, 6/22/2007. https://www.doi.gov/subsistence/news/general/federal-subsistence-board-approves-partial-closure-federal-public-lands. Accessed on August 2, 2017.

Garner, G.W., S.T. Knick, and D.C. Douglas. 1990. *Seasonal movements of adult female polar bears in the Bering and Chukchi Seas.* International Conference on Bear Research and Management 8: 219-226.

Gladwin, D.N., D.A. Asherin, and K.M. Manci. 1988. *Effects of aircraft noise and sonic booms on fish and wildlife*: Results of a survey of U.S. Fish and Wildlife Service endangered species and ecological services field offices, refuges, hatcheries, and research centers. NERC-88/30. USFWS, National Ecology Research Center. Fort Collins, CO.

Golder Associates. 2013. *Geotechnical findings and conceptual recommendations, Kivalina Evacuation Road, Kivalina, Alaska.* Submitted to WHPacific, Inc.

Golder Associates. 2015. *Kivalina evacuation road geotechnical report, Kivalina, Alaska.* Submitted to: Northwest Arctic Borough c/o Chase Nelson, DOWL, 164 Lagoon Street, Kotzebue, AK 99752.

Gunson, K.E., G. Mountrakis, and L.J. Quackenbush. 2011. Spatial wildlife-vehicle collision models: A review of current work and its application to transportation mitigation projects. *Journal of Environmental Management*, 92(4), 1074-1082.

Haley, S., G. Fay, H. Griego and B. Saylor. 2009. Kivalina and Noatak Community Descriptions. Report Prepared by Institute of Social and Economic Research, University of Alaska Anchorage. IN *Red Dog Mine Extension Aqqaluk Project Final Supplemental Environmental Impact Statement*, Volume 2, Appendix F. Submitted to U.S. Environmental Protection Agency. Tetra Tech, Anchorage, Alaska.

Harwood, L., T.G. Smith and H. Melling. 2007. Assessing the potential effects of near shore hydrocarbon exploration on Ringed Seals in the Beaufort Sea Region 2003-2006. *Environmental Studies Research Funds Report* No. 162. 103 pp.

HDR Alaska, Inc. 2010. 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 Office of Projected Resources, National Marine Fisheries Service (NMFS).

Helker, V.T., M.M. Muto, and L.A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commerce, *NOAA Tech. Memo*. NMFS-AFSC-315, 89 p. doi:10.7289/V5/TM-AFSC-315.

Helker, V.T., M.M. Muto, K. Savage, S. Teerlink, L.A. Jemison, K. Wilkinson, and J. Jannot. 2017. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2011-2015. U.S. Dep. Commerce, *NOAA Tech. Memo*. NMFS-AFSC-354,112 pp.

Himes-Cornell, A., K. Hoelting, C. Maguire, L. Munger-Little, J. Lee, J. Fisk, R. Felthoven, C. Geller and P. Little. 2013. Community Profiles for North Pacific Fisheries – Alaska. Volume 4. *NOAA Technical Memorandum* NMFS-AFSC-259. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Services, Alaska Fisheries Science Center, Seattle, Washington.

Holt, D.W., M.D. Larson, N. Smith, D.L. Evans, and D.F. Parmalee. 2015. Snowy Owl (*Bubo scandiacus*), The Birds of North America (P. G. Rodewald, Ed.). https://birdsna.org/Species-Account/bna/species/snoowl1. Accessed on September 20, 2017.

Holthuijzen, M.A., W.G. Eastland, A.R. Ansell, M.N. Kochert, R.D. Williams, and L.S. Young. 1990. Effects of blasting behaviour and productivity of nesting Prairie Falcons. *Wildlife Society Bulletin*, 18(3): 270-281.

Houghton, J., M.M. Holt, D.A. Giles, M.B. Hanson, C.K. Emmons, J.T. Horgan, T.A. Branch and G.R. Van Blaricom. 2015. The relationship between vessel traffic and noise levels received by killer whales (*Orcinus orca*). *PLoS ONE* 10(12): e0140119. doi:10.1371/journal.pone.0140119.

Huntington, H.P., M. Nelson and L.T. Quakenbush. 2016. *Traditional knowledge regarding ringed seals, bearded seals, walrus, and bowhead whales near Kivalina, Alaska.* Final report to the Eskimo Walrus Commission, the Ice Seal Committee, and the Bureau of Ocean Energy Management for contract #M13PC00015. 8 pp.

Hyvärinen, H. 1989. Diving in darkness: whiskers as sense organs of the ringed seal (*Phoca hispida saimensis*). *Journal of Zoology* 218.4: 663-678.

Ihl, C., and D.R. Klein. 2001. Habitat and diet selection by muskoxen and reindeer in Western Alaska. *Journal of Wildlife Management* 65: 964-972.

Illingworth, R. and R. Rodkin. 2007. *Compendium of pile driving sound data.* Prepared for the California Department of Transportation, Sacramento, California.

Jensen, A. S., and G. K. Silber. 2003. *Large whale ship strike database.* NOAA Technical Memorandum NMFS-OPR:39

Jewitt, S.C. 1999. Assessment of red king crab following offshore Placer gold mining in Norton Sound, Alaska Fishery Research Bulletin 6(1):1-18. https://www.adfg.alaska.gov/static/home/library/PDFs/afrb/jewtv6n1.pdf. Accessed on August 1, 2017.

Joly, K., P.A. Duffy and T.S. Rupp. 2012. Simulating the effects of climate change on fire regimes in Arctic biomes: implications for caribou and moose habitat. *Ecosphere* 3:1-18.

Joyce. M.R., L.A. Rundquist, and L.L. Moulton. 1980. *Gravel removal studies in Arctic and Subarctic floodplains in Alaska*. US Dept. of Interior. U.S. Fish and Wildlife Service. Water Resource Analysis Project, Office of Biological Services. 404 pp.

Kelly, B.P., J.J. Burns and L.T. Quakenbush. 1988. Responses of ringed seals (*Phoca hispida*) to noise disturbance. *Port and ocean engineering under arctic conditions*, 2: 27-38.

Kelly, B.P., J.L. Bengtson, P.L. Boveng, M.F. Cameron, S.P. Dahle, J.K. Jansen, E.A. Logerwell, J.E. Overland, C.L. Sabine, G.T. Waring, and J.M. Wilder. 2010. Status review of the ringed seal *(Phoca hispida)*. U.S. Dep. Commerce, *NOAA Tech. Memo*. NMFS-AFSC-212, 250 pp.

Kertell, K., J.C. Truett, and M.E. Miller. 1997. Effects of Arctic Alaska oil development on brant and snow geese. *Arctic*, 50(2): 138.

Kite, R., T. Nelson, G. Stenhouse, and C. Darimont. 2016. A movement-driven approach to quantifying grizzly bear (*Ursus arctos*) near-road movement patterns in west-central Alberta, Canada. *Biological Conservation* 195: 24-32.

Klein, D.R., G.D. Yakushkin, and E.B. Pospelova. 1991. Comparative habitat selection by muskoxen introduced to northeastern Alaska and the Taimyr Peninsula, Russia. Rangifer, 13(1):21-25. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.734.2466&rep=rep1&type=pdf. Accessed on August 1, 2017.

Kolden, K.D., and C. Aimone-Martin. 2013. Blasting effects on salmonids. Alaska Seismic & Environmental, LLC and Aimone-Martis Associates, LLC. Prepared for Alaska Department of Fish and Game, Division of Habitat. https://www.adfg.alaska.gov/static/home/library/pdfs/habitat/blasting_report.pdf. Accessed on August 1, 2017.

Korschgen, C.E. and R.B. Dahlgren. 1992. Human disturbances of waterfowl: Causes, effects, and management in waterfowl management handbook, *Fish and Wildlife Leaflet* 13. US Fish and Wildlife Service, Washington, DC. 8 pp.

Lacroix, D.L., R.B. Lanctot, J.A. Reed, and T.L. McDonald. 2003. Effect of underwater seismic surveys on moulting male long-tailed ducks in the Beaufort Sea, Alaska. *Canadian Journal of Zoology*, 81:1862-1875.

Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. *Collisions between ships and whales.* Marine Mammal Science 17:35-75.

LeResche, R.E., R.H. Bishop, J.W. Coady. 1973. Distribution and habitat of moose in Alaska. Alaska Department of Fish and Game. http://www.arlis.org/docs/vol1/Susitna/10/APA1054.pdf. Accessed on August 2, 2017.

Lesmerises, F., C. Dussault, and M.H. St-Lauren. 2013. Major roadwork impacts the space use behaviour of gray wolf. *Landscape and Urban Planning* 112: 18-25.

Liebezeit, J.R., S.J. Kendall, S. Brown, C.B. Johnson, P. Martin, T.L. McDonald, D.C. Payer, C.L. Rea, B. Streever, A.M. Wildman, and S. Zack. 2009. Influence of human development and predators on nest survival of tundra birds, Arctic Coastal Plain, Alaska. *Ecological Applications*, 19: 1628–1644. doi:10.1890/08-1661.1

Loon, H. and S. Georgette. 1989. Contemporary brown bear use in northwest Alaska. Technical Paper No. 163. Prepared for Alaska Department of Fish and Game, Subsistence Division, Kotzebue, Alaska. http://www.subsistence.adfg.state.ak.us/TechPap/tp163.pdf. Accessed on August 19, 2017.

Loughlin, T. R., and A. E. York. 2000. *An accounting of the sources of Steller sea lion*, Eumetopias jubatus, *mortality*. Marine Fisheries Review 62:40-45.

MacKinnon, C.M., A.C. Kennedy, and M.L. Horsman. 2013. The flight of a flock of common eiders, *Somateria mollisima*, in Northumberland Strait interrupted by the Confederation Bridge, New Brunswick – Prince Edward Island. *The Canadian Field Naturalist*, 127: 175-177.

Madsen, J. 1995. *Impacts of disturbance on migratory waterfowl*. Ibis, 137: 67-74.

Magdanz, J.S., N.S. Braem, B.C. Robbins, and D.S. Koster. 2010. *Subsistence harvests in northwest Alaska, Kivalina and Noatak, 2007*. Alaska Department of Fish and Game Division of Subsistence, Anchorage.

Marshall, C.D., H. Amin, K.M. Kovacs and C. Lydersen. 2006. Microstructure and innervation of the mystacial vibrissal follicle sinus complex in bearded seals, *Erignathus barbatus* (Pinnipedia: Phocidae). The Anatomical Record Part A: *Discoveries in Molecular, Cellular, and Evolutionary Biology*. 288(1): 13–25.

Mathews, E.A., L.A. Jemison, G.W. Pendleton, K.M. Blejwas, K.E. Hood and K.L. Raum-Suryan. 2016. Haul-out patterns and effects of vessel disturbance on harbor seals (*Phoca vitulina*) on glacial ice in Tracy Arm, Alaska. *Fishery Bulletin*, 114: 186-202.

Mayo, T.W., P.W.C. Paton, and P.V. August. 2015. Responses of birds to humans at a coastal barrier beach: Napatree Point, Rhode Island. *Northeastern Naturalist*, 22(3): 501-512.

McClelland, J.W., R.M. Holmes, K.H. Dunton, and R.W. Macdonald. 2012. The Arctic ocean estuary. Estuaries and Coasts, 35(2), 353-368. https://link.springer.com/article/10.1007/s12237-010-9357-3. Accessed on August 1, 2017.

McLoughlin, P.D., H.D. Cluff., and F. Messier. 2002. Denning ecology of barren-ground grizzly bears in the Central Arctic. *Journal of Mammalogy* 83:188–19.

Meixell, B.W. and P.L. Flint. 2017. Effects of industrial and investigator disturbance on Arctic-nesting geese. *The Journal of Wildlife Management*: 1-14.

Melvin, E.F., J.K. Parrish, and L. Conquest. 1999. Novel tools to reduce seabird bycatch in coastal gillnet fisheries. *Conservation Biology*, 13(6): 1,386-1,397.

MMS. 2007. *Chukchi Sea Planning Area*. Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea. Final Environmental Impact Statement.

Mould, E. 1979. Seasonal movement related to habitat of moose along the Colville River, Alaska. *Murrelet* 60:6-11.

Moulton, V.D., W.J. Richardson, R.E. Elliott, T.L. McDonald, C. Nations, M.T. Williams. 2005. Effects of an offshore oil development on local abundance and distribution of ringed seals (*Phoca hispida*) of the Alaskan Beaufort Sea. *Marine Mammal Science* 21: 217-242.

Murphy, S.M., and J.A. Curatalo. 1987: Activity budgets and movement rates of caribou encountering pipelines, roads, and traffic in northern Alaska. *Canadian Journal of Zoology* 65: 2483-2490.

Muto, M.M., V.T. Helker, R.P. Angliss, B.A. Allen, P.L. Boveng, J.M. Breiwick, M.F. Cameron, P.J. Clapham, S.P. Dahle, M.E. Dahlheim, B.S. Fadely, M.C. Ferguson, L.W. Fritz, R.C. Hobbs, Y.V. Ivashchenko, A.S. Kennedy, J.M. London, S.A. Mizroch, R.R. Ream, E.L. Richmond, K.E.W. Shelden, R.G. Towell, P.R. Wade, J.M. Waite, and A.N. Zerbini. 2016. Alaska marine mammal stock assessments, 2015. U.S. Dep. Commerce, *NOAA Tech*. Memo. NMFSAFSC-323, 300 p. doi:10.7289/V5/TM-AFSC-323.

NANA. 2016. http://nana.com/regional/about-us/overview-of-region/kivalina/. Accessed on December 21, 2016.

Neilson, J. L., C. M. Gabriele, A. S. Jensen, K. Jackson, and J. M. Straley. 2012. *Summary of reported whale vessel collisions in Alaskan waters*. Journal of Marine Biology:106282.

NMFS (National Marine Fisheries Service). 2005. *Final Environmental Impact Statement for Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska.* Volume 2, Appendix D. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Region.

NMFS. 2008. *Recovery Plan for Steller sea lion, Eastern and Western Distinct Population Segments (*Eimetopias jubatus*)*. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.

NMFS. 2011. Essential Fish Habitat Mapper. http://sharpfin.nmfs.noaa.gov/website/EFH_Mapper/map.aspx. Accessed on August 19, 2017.

NMFS. 2017a. *Impacts to Essential Fish Habitat from Non-fishing activities in Alaska.* National Marine Fisheries Service, Alaska Region Habitat Conservation Division

NMFS. 2017b. NMFS Meeting. *Kivalina evacuation and school site access road.* NMFS Office. Anchorage, Alaska. June 6, 2017.

NPS (National Park Service). 2016a. Cape Krusenstern Archaeological District National Historic Landmark Boundary Map. Provided electronically to Sarah E. Schacher (DOT&PF) by Rhea Hood (NPS National Register of Historic Places Program) on November 29, 2016, in response to DOT&PF request for scoping comments.

NPS. 2016b. Cape Krusenstern – Birds. https://www.nps.gov/cakr/learn/nature/birds.htm. Accessed on August 19, 2017.

Noel, L.E., R.H. Pollard, W.B. Ballard, and M.A. Cronin. 1998. Activity and use of active gravel pads and tundra by Caribou, *Rangifer tarandus granti*, within the Prudhoe Bay oil field, Alaska. *Canadian Field-Naturalist*, 112(3), 400-409.

NLURA (Northern Land Use Research Alaska LLC). 2016. *Cultural resources study of the Kivalina evacuation route*. Report Prepared for WHPacific, Inc.

Northrup, J.M., J. Pitt, T.B. Muhly, G.B. Stenhouse, M. Musani, and M.S. Boyce. 2012. Vehicle traffic shapes grizzly bear behaviour on a multiple-use landscape. *Journal of Applied Ecology* 49: 1159-1167.

Northwest Arctic Borough. 1993. *Northwest Arctic Borough, Comprehensive Plan*. March 1993.

Northwest Arctic Borough. 2011. Zoning Districts 2011. http://www.nwabor.org/wp-content/uploads/zoningmap2011.pdf. Accessed on December 1, 2016

NRC (National Research Council). 2003. *Cumulative environmental effects of oil and gas activities on Alaska's North Slope*. National Academies Press, 2003.

O'Hara, T.M., G. Carroll, P. Barboza, K. Mueller, J. Blake, V. Woshner, and C. Willetto. 2001. Mineral and heavy metal status as related to a mortality event and poor recruitment in a moose population in

Alaska. *Journal of Wildlife Diseases*, 37(3), 509-522. http://www.bioone.org/doi/pdf/10.7589/0090-3558-37.3.509. Accessed on August 2, 2017

Ortega, C.P. 2012. Effects of noise pollution on birds: a brief review of our knowledge. *Ornithological Monographs* 74: 6-22.

Ott, A.G., J.F. Winters, W.A. Morris, and P.T. Bradley. 2014. *North Slope flooded gravel mine sites, case histories*. Alaska Dept. of Fish and Game. Juneau, AK. 76 pp.

Ott, A.G. and W.A. Morris. 2007. *Aquatic biomonitoring at Red Dog Mine, 2006* – Permit No. AK-003865-2. Technical Report No. 07-03. Alaska Department of Fish and Game, Division of Habitat and Restoration.

Ott, A.G. and W. A. Morris. 2012. *Aquatic biomonitoring at Red Dog Mine, 2011* – National Pollution Discharge Elimination System Permit No. AK-003865-2. Alaska Department of Fish and Game Division of Habitat

Ott, A.G., H.L. Scannell, and P.T. Bradley. 2016. *Aquatic biomonitoring at Red Dog Mine, 2015* – Permit No. AK-003865 (Modification #1). Technical Report No. 16-01. Alaska Department of Fish and Game, Division of Habitat and Restoration.

Petersen, M.R., J.B. Grand, and C.P. Dau. 2000. Spectacled Eider (Somateria fischeri), The Birds of North America (P. G. Rodewald, Ed.). Available at: https://birdsna.org/Species-Account/bna/species/speeid. Accessed on August 1, 2017

Phillips, M.K. 1987. *Behavior and habitat use of grizzly bears in northeastern Alaska*. International Conference on Bear Research and Management 7:159-167.

Pollard, R.H., W.B. Ballard, L.E. Noel and M.A. Cronin. 1996. Parasitic insect abundance and microclimate of gravel pads and tundra within the Prudhoe Bay oil field, Alaska, in relation to use by caribou, *Rangifer tarandus granti*. *Can. Field-Nat.* 110(4):649-658.

Reynolds, B.F., S.P. Powers, M.A. Bishop. 2010. Application of acoustic telemetry to assess residency and movements of Rockfish and Lingcod at created and natural habitats in Prince William Sound. *PLoS One* 5(8): e12130. http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0012130. Accessed on August 1, 2017

Richardson, J., C.R. Greene Jr, C. Malme and D. Thomson. 1995. *Marine mammals and noise*. Academic Press. San Diego, California.

Risch, D., C.W. Clark. P.J. Corkeron, A. Elepfandt, K.M. Kovacs, C. Lydersen, I. Stirling, and S.M. Van Parijs. 2007. Vocalizations of male bearded seals, *Erignathus barbatus*: classification and geographical variation. *Animal Behaviour* 73: 747–762.

Rode, K.D., E.V. Regehr, D.C. Douglas, G. Durner, A.E. Derocher, G.W. Thiemann, and S.M. Budge. 2014. Variation in the response of an Arctic top predator experiencing habitat loss: feeding and reproductive ecology of two polar bear populations. *Global Change Biology* 20: 76-88.

Rode, K.D., R.R. Wilson, E.V. Regehr, M.St. Martin, D.C. Douglas, and J. Olson. 2015. Increased land use by Chukchi Sea polar bears in relation to changing sea ice conditions. *PLoS One* 10(11): e0142213. doi:10.1371/journal.pone.0142213.

Ronconi, R.A. and C.C. St. Clair. 2002. Management options to reduce boat disturbance on foraging black guillemots (*Cepphus grille*) in the Bay of Fundy. *Biological Conservation*, 108: 265-271.

Satterthwaite-Phillips, D., C. Krenz, G. Gray and L. Dodd. 2016. *Iñuuniaŀiqput iļiļugu nunaŋŋuanun (Documenting Our Way of Life through Maps*): Northwest Arctic Borough Subsistence Mapping Project, Volume 1. Northwest Arctic Borough, Kotzebue, Alaska.

Scannell, P.W. and A.G. Ott. 2002. *Aquatic Biomonitoring at Red Dog Mine, 2001* – Permit No. AK-003865-2. Technical Report No. 02-04. Alaska Department of Fish and Game, Division of Habitat and Restoration.

Schliebe S., T. Evans, K. Johnson, M. Roy, S. Miller, C. Hamilton, R. Meehan, and S. Jahrsdoerfer. 2006. *Range-wide status review of the polar bear* (*Ursus maritimus*). U.S. Fish and Wildlife Service, Anchorage, Alaska.

Schmidt, J.H., K.L. Rattenbury, J.P. Lawler, and M.C. Maccluskie. 2012. Using distance sampling and hierarchical models to improve estimates of Dall's sheep abundance. *The Journal of Wildlife Management*, 76(2), 317-327.

SAIC (Science Applications International Corporation). 2011. *Environmental science panel for Marbled Murrelet underwater noise injury threshold.* Prepared for: U.S. Navy, Bothell, WA. 34 pp.

Screen, J.A., I. Simmonds, C. Deser, and R. Tomas. 2013. The atmospheric response to three decades of observed Arctic sea ice loss. *Journal of Climate* 26: 1230-1248; doi: 10.1175/JCLI-D-12-00063.1.

Shelden, K.E.W., D.J. Rugh, K.T. Goetz, C.L. Sims, L. Vate Brattström, J.A. Mocklin, B.A. Mahoney, B.K. Smith, and R.C. Hobbs. 2013. Aerial surveys of beluga whales, *Delphinapterus leucas*, in Cook Inlet, Alaska, June 2005 to 2012. U.S. Dep. Commerce, *NOAA Tech*. Memo. NMFS-AFSC-263, 122 pp.

Sills, J.M., B.L. Southall and C. Reichmuth. 2014. Amphibious hearing in spotted seals (*Phoca largha*): underwater audiograms, aerial audiograms and critical ratio measurements. *Journal of Experimental Biology* 217: 726-734.

Sills, J.M., B.L. Southall and C. Reichmuth. 2015. Amphibious hearing in ringed seals (*Pusa hispida*): underwater audiograms, aerial audiograms and critical ratio measurements. *Journal of Experimental Biology* 218: 2250-2259.

Sills, J.M., B.L. Southall and C. Reichmuth. 2016. *Psychoacoustic studies of spotted (Phoca largha) and ringed (Pusa hispida) seals*. The Effects of Noise on Aquatic Life II. Springer New York, 2016. 1025-1030.

Simmonds, I., and Keay, K. 2009. Extraordinary September Arctic sea ice reductions and their relationships with storm behavior over 1979–2008. *Geophysical Research Letters*, 36, L19715, doi:10.1029/ 2009GL039810.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas and P.L. Tyack. 2007. Special Issue: Marine mammal noise exposure criteria. *Aquatic Mammals* 33.

SRB&A (Stephen R. Braund and Associates). 2009. *Subsistence Use Areas and Traditional Knowledge Study for Kivalina and Noatak, Alaska*. Red Dog Mine extension Aqqaluk Project Supplemental Baseline Report. 302 pp.

Stantec (Stantec Consulting Ltd.). 2016a. *Kivalina evacuation and school access road marine mammal observations* Oct. 4-6, 2016. Stantec Consulting Inc. contract report submitted to Remote Solutions, October 25, 2016.

Stantec. 2016b. *Kivalina evacuation and school access road*. September 2016 Stantec site reconnaissance. Unpublished Data.

Stantec. 2017a. *Archaeological assessment update for the Kivalina evacuation and school access road*. Prepared for Alaska Department of Transportation and Public Facilities.

Stantec. 2017b. *Kivalina evacuation and school access road*. Cultural resources assessment report. Prepared for Remote Solutions, LLC

Stantec. 2017c. *Wetland verification report*. Kivalina evacuation and school access road. Prepared for State of Alaska Department of Transportation & Public Facilities.

Stantec. 2017d. *Noise Analysis Memo*. Kivalina evacuation and school access road. Prepared for State of Alaska Department of Transportation and Public Facilities.

Sterling, D.M., G.C. White, R.A. Sellers, H.V. Reynolds, J.W. Schoen, K. Titus, V.G. Barnes, Jr., R.B. Smith, R.R. Nelson, W.B. Ballard and C.C. Schwartz. 1997. Brown and black bear density estimation in Alaska using radiotelemetry and replicated mark-resight techniques. *Wildlife Monographs* No. 133: 3-55.

Tape, K.D., D.D. Gustine, R.W. Ruess, L.G. Adams, and J.A. Clark. 2016. Range expansion of moose in Arctic Alaska linked to warming and increased shrub habitat. *PloS One*, 11(4), e0152636. http://journals.plos.org/plosone/article?id=info%3Adoi%2F10.1371%2Fjournal.pone.0152636. Accessed on August 2, 2017.

Teck Resources. 2013. *Red Dog Operations - Biodiversity Management Plan*. Red Dog Document Control Document ID 2516, Revision 2.

Tetra Tech. 2009. Red Dog mine extension Final Supplemental Environmental Impact Statement, Volume 1. Anchorage, AK. 530 pp. http://dnr.alaska.gov/mlw/mining/largemine/reddog/pdf/rdseis2009vol1.pdf. Accessed on August 1, 2017.

USACE (U.S. Army Corps of Engineers). 1998. Community improvement feasibility report, Kivalina AK (April 1998). Appendix D. US Army Corps of Engineers Alaska District. http://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/commuityimprovementfeasibilityreportkivalina.pdf. Accessed on July 26, 2017

USACE. 2005. *Draft Environmental Impact Statement*; Navigation Improvements DeLong Mountain Terminal, Alaska.

USACE. 2006. *Relocation planning project master plan*, Kivalina, Alaska. Elmendorf, AK. 136 pp.

USACE. 2007. *Environmental Assessment and Finding of No Significant Impact*, Section 117 expedited erosion control project, Kivalina, Alaska. 40pp.

USACE. 2016. Kivalina Lagoon crossing planning assistance to states, causeway and bridge design report, Kivalina, Alaska. Elmendorf, AK. 228 pp. https://static1.squarespace.com/static/570404b22eeb819dde61ab0d/t/57c0aabc6b8f5bb6be4a44b9/1472244475186/Kivalina+Causeway+Main+Report+June+2016rd.pdf. Accessed on August 19, 2017.

USACE. 2017. *Kivalina evacuation route wetland delineation.* Prepared by Jeremy Grauf.

U.S. Department of Agriculture. 2017. Natural Resources Conservation Service. Geospatial data gateway. HUC 10 Download for the Alaska Northwest Arctic Borough. https://datagateway.nrcs.usda.gov/. Accessed online August 18, 2017.

U.S. Census Bureau. 2010. Profile of selected social, economic and housing characteristics of all places with Alaska. https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed on December 15, 2016.

USEPA (U.S. Environmental Protection Agency). 2009. *Red Dog Mine extension.* Aqqaluk Projct. Final Supplemental Environmental Impact Statement (EIS). Volume 1.

USFWS (U.S. Fish and Wildlife Service). 1999. Threatened and Endangered Species Spectacled Eider (*Somateria fischeri*). Factsheet. https://www.fws.gov/alaska/fisheries/endangered/pdf/spei.pdf. Accessed on October 2017.

USFWS. 2002. Steller's Eider recovery plan. https://ecos.fws.gov/docs/recovery_plan/020930b.pdf. Accessed on December 2016.

USFWS. 2010. 5-Year review for Spectacled Eider (*Somateria fischeri*). https://ecos.fws.gov/docs/five_year_review/doc3281.pdf. Accessed on December 2016.

USFWS. 2011. Threatened and Endangered Species Steller's Eider (*Polysticta stelleri*). Factsheet. https://www.fws.gov/alaska/fisheries/fieldoffice/anchorage/endangered/pdf/factsheet_stei.pdf. Accessed on October 2017.

USFWS. 2012. Yellow-billed Loon (*Gavia adamsii*). Threatened and Endangered Species. https://www.fws.gov/alaska/fisheries/endangered/pdf/yellowbilled_loon_factsheet_v2.pdf. Accessed on July 18, 2017

USFWS. 2016a. Alaska Maritime National Wildlife Refuge area. https://www.fws.gov/refuge/Alaska_Maritime/wildlife_and_habitat/birds.html. Accessed on August 19, 2016.

USFWS. 2016b. *Kivalina evacuation and school site access road.* USFWS Agency Scoping Meeting, USFWS Office, Anchorage, Alaska. December 19, 2016.

USFWS. 2017a. Alaska Maritime National Wildlife Refuge. Land status within the National Wildlife Refuges of Alaska. Interactive land ownership map. https://www.fws.gov/refuge/Alaska_Maritime/map.html. Accessed on August 28, 2017.

USFWS. 2017b. Flyways. https://www.fws.gov/birds/management/flyways.php. Accessed on August 18, 2017.

USFWS. 2017c. National Wetland Inventory mapping. https://www.fws.gov/wetlands/Data/Mapper.html. Accessed on August 19, 2017.

USFWS. 2017d. Timing recommendations for land disturbance & vegetation clearing. https://www.fws.gov/alaska/fisheries/fieldoffice/anchorage/pdf/vegetation_clearing_2017.pdf. Accessed on August 19, 2017.

USGS (U.S. Geological Survey). 2016. Bird conservation areas. https://alaska.usgs.gov/science/biology/bpif/conservation/bcr.php. Accessed on December 2016.

Vanderlaan, A. S., and C. T. Taggart. 2007. Ve*ssel collisions with whales: The probability of lethal injury based on vessel speed*. Marine Mammal Science 23:144-156

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. Alaska vegetation classification. United States Department of Agriculture, Forest Service. *General Technical Report* PNW-GTR-286.

Von Duyke, A.L., D.C. Douglas, J. Herreman, and A.W. Morris. 2017. *Ringed seal (Pusa hispida) spatial use, dives, and haul-out behavior in the Beaufort, Chukchi, and Bering Seas* (2011-2016). Presented at the Alaska Marine Science Symposium, Anchorage, Alaska, January 2017.

Voorhees, H., R. Sparks, H.P. Huntington, and K.D. Rode. 2014. Traditional knowledge about Polar Bears (*Ursus maritimus*) In *Northwestern Alaska. Arctic* 67(4): 523-536.

Walker, D.A., K.R. Everett. 1987. *Road dust and its environmental impact on Alaska taiga and tundra*. Arctic and Alpine Research. 19(4):479-489.

Western Arctic Caribou Herd Working Group. 2011. *Western arctic caribou herd cooperative management plan* - revised December 2011. Nome, Alaska. 47. pp.

WHPacific. 2012a. *Kivalina evacuation road project preliminary environmental report*. Anchorage Alaska (118 pages).

WHPacific. 2012b. *Native Village of Kivalina - Evacuation route significant biotic resources baseline report and preliminary Essential Fish Habitat analysis*. Consultant's report prepared for the Maniilaq Association on behalf of the Native Village of Kivalina. 28 pp plus appendices.

WHPacific. 2012c. Native Village of Kivalina. Long range transportation plan update. Prepared for Maniilaq Association. Prepared on behalf of the Native Village of Kivalina. Prepared by WHPacific. https://static1.squarespace.com/static/570404b22eeb819dde61ab0d/t/570ed97eb654f9b8989e4e19/1460590977442/2012-H-Kivalina%2C_LRTP_update.PDF. Accessed on August 19, 2017.

WHPacific. 2014. *Evacuation and school access road project, Kivalina, Alaska*: Route reconnaissance study. Report prepared for the Native Village of Kivalina.

Wiese, F.K., R. Gryba, and B.P. Kelly. 2017. *Marine arctic ecosystem study - pilot program: Marine mammals tagging and tracking*. US Dept. of the Interior, Bureau of Ocean Energy Management, Alaska Region, Anchorage, AK. OCS Study BOEM 2017-017. 78 pp. https://www.boem.gov/BOEM-2017-017/

Wiggins, D. A., W., W.H. Denver, and S.M. Leasure. 2006. Short-eared Owl (*Asio flammeus*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology. https://birdsna.org/Species-Account/bna/species/sheowl. Accessed on September 20, 2017.

Williams, M.T., C.S. Nations, T.G. Smith, V.D. Moulton and C.J. Perham. 2006. Ringed seal (*Phoca hispida*) use of subnivian structures in the Alaskan Beaufort Sea during development of an oil production facility. *Aquatic Mammals*, 32(3): 311-324.

Wilson, R.R., L.S. Parrett, K. Joly, and J.R. Dau. 2016. Effects of roads on individual caribou movements during migration. *Biological Conservation* 195:2-8.

9 FIGURES