



# Atqasuk to Utqiagvik All Season Access Road Arctic Strategic Transportation and Resources Project North Slope, Alaska

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Prepared for

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## ACRONYMS

ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADOT&PF	Alaska Department of Transportation and Public Facilities
AES Alaska	ASRC Energy Services Alaska, Inc.
ASRC	Arctic Slope Regional Corporation
ASTAR	Arctic Strategic Transportation and Resources
BLM	United States Bureau of Land Management
BMP	Best Management Practice(s)
CFR	Code of Federal Regulations
CWAT	Community Winter Access Trail(s)
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
GIS	geographic information system
IAP	Integrated Activity Plan
LIDAR	Light Detection and Ranging
MP	Milepost
NEPA	National Environmental Policy Act
NHD	National Hydrography Dataset
NGO	Non-governmental organization
NPR-A	National Petroleum Reserve – Alaska
NSB	North Slope Borough
ROW	right-of-way
Section 106	Section 106 of the National Historic Preservation Act
Section 401/404	Sections 401 and 404 of the Clean Water Act
SME	subject matter expert
UIC	Ukpeagvik Inupiat Corporation
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service

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## 1.0 Introduction

This report presents the results of a desktop analysis of a proposed all-season gravel access road extending from Atqasuk to Utqiagvik, Alaska. This study was completed by ASRC Energy Services Alaska, Inc. (AES Alaska) for the Arctic Strategic Transportation and Resources (ASTAR) project.

The Atqasuk Comprehensive Plan (North Slope Borough [NSB] 2017) identifies a gravel road to Utqiagvik as a priority infrastructure project desired by the local residents. A year-round road would broaden and diversify the region's transportation network and create economic opportunities for the community of Atqasuk.

This project was evaluated using a cumulative benefits analysis process developed specifically for ASTAR. This evaluation found the proposed project provides numerous regional benefits, enhances community connectivity, and receives broad local support.

The process for selecting and evaluating this project follows that set forth in the *Assessment of Potential Tools for Cumulative Benefits Analysis* (July 2018) report prepared for ASTAR. Specifically, the methods presented here fall under Stage 3 where advanced projects are given a more rigorous desktop analysis by subject matter experts (SMEs) to characterize the project scope; describe or quantify expected benefits; and identify feasible alternatives, important constraints, data gaps, and other key factors affecting project success. This process involves adopting an analysis strategy; further definition of factors and constraints; selecting scoring criteria and weighting methods; and performing alternatives analysis.

### 1.1 Project Setting

The project area is on Alaska's North Slope within the Arctic Coastal Plain physiographic province. The terrain is characterized by relatively flat arctic tundra, although terraces and steep riverbanks are found adjacent to the Meade River. The ground surface elevation within the project area varies from about 5 to 100 feet above sea level. The project area is shown on Figure 1.1-1, along with existing winter trails and potential route alternatives for the proposed gravel road.

Atqasuk is located on the southern extent of the Arctic Coastal Plain, approximately 60 miles south of Utqiagvik, and 58 miles east of the village of Wainwright. The community is entirely within the boundaries of the National Petroleum Reserve – Alaska (NPR-A). The village lies between Imagruiq Lake and the Meade River as shown on Figure 1.1.2. The community has grown steadily over recent years to approximately 261 residents (NSB 2019).

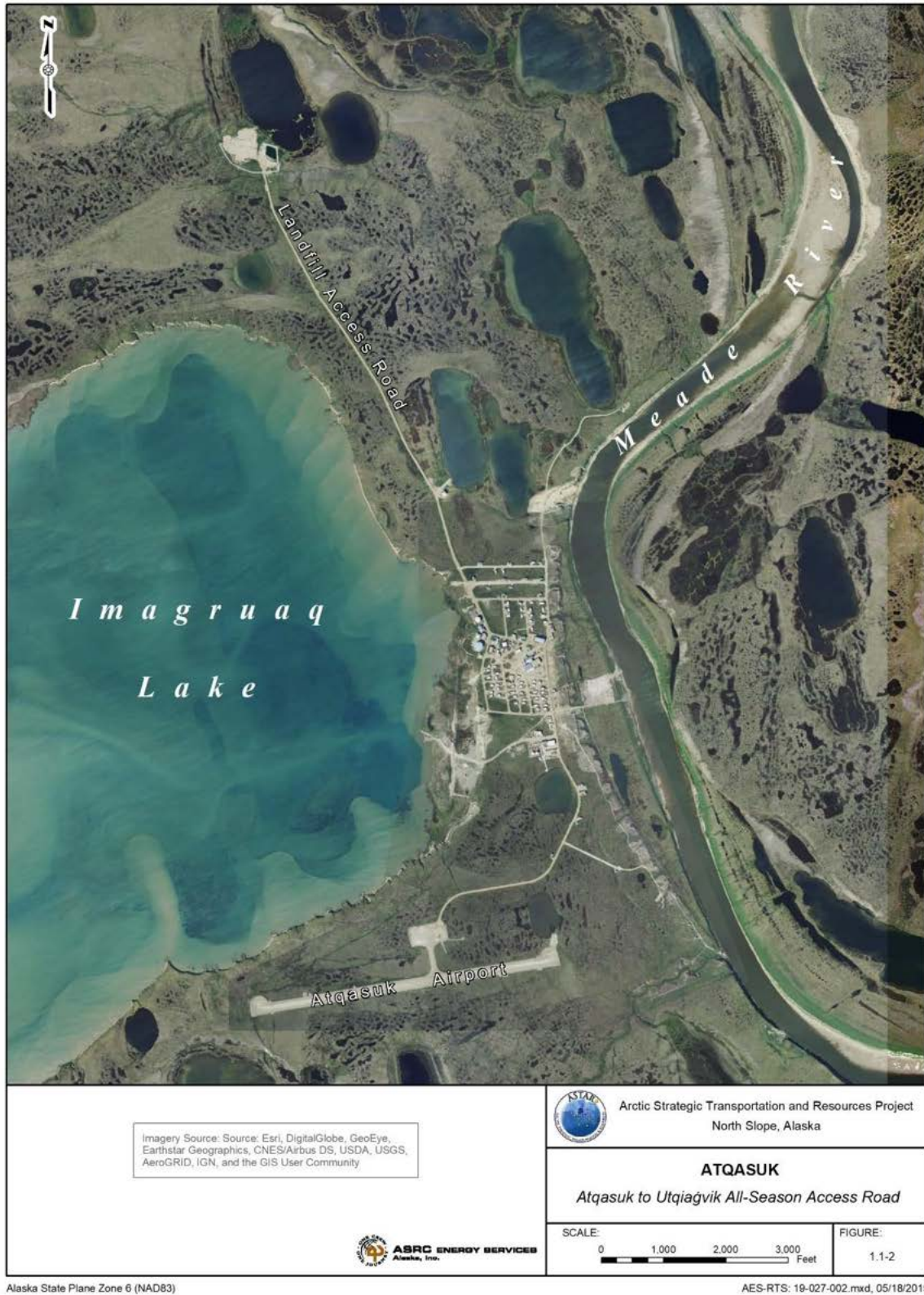
Utqiagvik is the northernmost community in the United States, at the base of the Point Barrow peninsula, and bordered by the Chukchi and Beaufort Seas of the Arctic Ocean (Figure 1.1.3). The surrounding landscape is characterized by tundra with numerous lakes and permafrost soils underlying almost the entire region. The 2018 population estimate for Utqiagvik is 5,256 people (NSB 2019). Utqiagvik is the NSB seat of government where diverse issues converge, among them Native Iñupiat subsistence rights, oil and gas development activity, and the study of climate change in the Arctic (NSB 2015).

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Figure 1.1-2 Atqasuk Area Map



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**Figure 1.1-3 Utqiagvik Area Map**



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## 1.2 Project Description

Land transportation beyond the community of Atqasuk is limited because there are no road connections to other communities. There is a historic winter trail route between Atqasuk and Utqiagvik used to transfer fuel to the village using Rolligons. The trail has also been used to haul gravel from Utqiagvik for maintenance and construction needs; gravel hauling was accomplished with dump trucks outfitted with specialized tires for off-road travel. In the winter of 2017/2018, the NSB established a Community Winter Access Trail (CWAT) to allow seasonal movement of goods, services, and passengers between the two communities. The CWAT overlaps with segments of the historic winter trail. The community has long sought a gravel road connection to Utqiagvik and/or Wainwright (NSB 2017). Year-round road access offers the possibility of increased economic opportunities, more frequent social and cultural connections, lower costs for goods and services, enhanced subsistence traditions, improved health and safety, access to education opportunities, and enhanced training and workforce development. Each of these benefits is described in greater detail in Section 1.4.

For the purpose of this study, the proposed road is envisioned as a two-lane gravel road connecting the existing road networks between Atqasuk and Utqiagvik. The all-season gravel road would traverse roughly 64 to 74 miles, with termini near the north end of Landfill Access Road in Atqasuk; and at Emaiksoun Road or the Barrow Gas Field road system in Utqiagvik.

The proposed 2-lane road is expected to be roughly 24.5 feet wide with 2 horizontal to 1 vertical (2H:1V) side slopes and an assumed embankment thickness of 5 feet to protect the underlying permafrost from thermal degradation. The proposed road will cross several significant rivers and streams depending on the route selected (e.g. Nigisaktuvik River, Inaru River, and Niklavik Creek). These larger crossings will likely require bridges, whereas culverts will be needed for minor drainages along the route. Additional culverts will be required in low-lying areas to facilitate cross drainage during runoff events.

## 1.3 Objective

The objective of this desktop analysis is to provide the ASTAR stakeholders with a better understanding of potential benefits that could influence future development of the proposed road, as well as important engineering, environmental, regulatory, and stakeholder inputs that affect routing. Additionally, this desktop study will assist the stakeholders and the NSB in identifying and filling potential data gaps necessary to support future phases of the project.

## 1.4 Benefits of the Proposed Road

Table 1.4-1 identifies specific benefits the proposed road provides for residents of Atqasuk and Utqiagvik. The list of benefits is not comprehensive, but provides representative examples to highlight key benefits of an all-season road connection. Both communities benefit from the road, however, because Utqiagvik is larger and already has a wider array of existing services and opportunities, a larger proportion of the benefits are derived by residents of Atqasuk.

**Table 1.4-1. Benefits of Proposed Atqasuk to Utqiagvik Road**

Benefit Category	Representative Examples of Specific Benefits of an All-Season Road
<b>Supports cultural connectivity</b>	Allows more frequent travel between Atqasuk and Utqiagvik, enabling additional cross-community connections, increasing the quality of links or bonds among community members, and creating or enhancing the capability to join together in various cultural activities, events, and celebrations. Examples include Inupiaq language workshops, whaling seasons, Kivgiq Festival, Nalukataq, and art workshops (dance, music, and art)

Benefit Category	Representative Examples of Specific Benefits of an All-Season Road
<p><b>Lowers costs of goods and services</b></p>	<ul style="list-style-type: none"> <li>• Allows Atqasuk residents to ship bulk goods by barge or larger aircraft to Utqiagvik, then retrieve those goods via the all-season road</li> <li>• Facilitates trucking of gravel to Atqasuk for expansion or improvements to the airport and community roads</li> <li>• Allows routine transport of bulk fuel from Utqiagvik</li> <li>• Facilitates potential installation of gas line from Barrow Gasfields to Atqasuk, lowering the cost of power generation and home heating</li> <li>• Alternatively, road facilitates installation of power line from Utqiagvik to Atqasuk</li> <li>• Facilitates potential installation of fiber optic line, allowing high-speed internet connection to Atqasuk school, facilities, and residences</li> <li>• Lowers the capital cost of infrastructure development like construction of homes, schools, public buildings, commercial buildings, utilities, etc.</li> <li>• Improves accessibility to a greater range of recreational, leisure, entertainment and consumer opportunities like restaurants, bowling alley, roller rink, hotels, grocery stores, etc.</li> <li>• Allows Atqasuk residents access to NSB government offices</li> <li>• Improves access and lowers cost for basic services provided by maintenance technicians, repairmen, skilled labor, etc.</li> <li>• Allows NSB to lower costs of providing and maintaining public services in Atqasuk</li> </ul>
<p><b>Preserves or enhances subsistence traditions</b></p>	<ul style="list-style-type: none"> <li>• Allows access to a wider range of subsistence areas for fishing, hunting, and berry picking</li> <li>• Allows residents of Atqasuk to more readily participate in whaling or other marine mammal harvest</li> <li>• Allows more access and options for small engine repair, boat repair, snowmachine sales and service, gunsmithing, etc.</li> <li>• Allows more access and options to enhance subsistence economy (e.g. bartering)</li> </ul>
<p><b>Improves health and safety conditions</b></p>	<ul style="list-style-type: none"> <li>• Provides an evacuation route from each community in case of natural disaster or emergency</li> <li>• Allows Atqasuk residents to access Samuel Simmonds Memorial Hospital, other healthcare and social service providers, and veterinary services</li> <li>• Provides access to second airport option for air ambulance medevac when inclement weather closes one airport</li> <li>• Allows consolidation of waste streams for recycling or disposal</li> <li>• Helps facilitate cleanup of NPR-A legacy wells</li> </ul>
<p><b>Improves access to education opportunities</b></p>	<ul style="list-style-type: none"> <li>• Allows Utqiagvik residents to attend educational events or presentations at Meade River School</li> <li>• Allows Atqasuk residents to attend educational events or presentations at Ipalook Elementary School, Hopson Middle School, and Barrow High School</li> <li>• Allows Atqasuk residents access to Iliisaqvik College</li> <li>• Allows greater access to cultural centers/activities, Simon Paneak Museum, the Inupiat Heritage Learning Center, and the Residential Learning Center</li> <li>• Allows residents of both communities to exchange indigenous knowledge (elders/youth; subsistence areas)</li> </ul>
<p><b>Enhances workforce development</b></p>	<ul style="list-style-type: none"> <li>• Improves access to more job opportunities for both communities</li> <li>• Improves access to more skills training and apprenticeship opportunities for both communities</li> <li>• Provides direct jobs for road construction and maintenance</li> <li>• Could provide the catalyst for new business opportunities</li> <li>• Allows opportunities for workers to fill needed local service gaps</li> </ul>

## 2.0 Data Analysis and Corridor Identification

There are numerous criteria and constraints that affect routing of the proposed road. The preferred route is often based on a balance of cost, engineering, environmental, and sociocultural factors. In order to assess the most advantageous route alignment, the first step typically involves analysis of available data to recognize and describe key issues, inform stakeholders, and identify data gaps. The following sections outline the methodology used to identify and characterize the key issues for the Atqasuk to Utqiagvik Road, develop route alternatives, and analyze those alternatives.

### 2.1 Project Area Boundaries

The project area is bounded by Atqasuk to the south, Utqiagvik to the north, the Chukchi Sea coast to the west, and the Meade River to the east (Figure 1.1-1). Lands east of the Meade River were excluded from the analysis to avoid the expense of constructing two very long bridges over the Meade.

### 2.2 Methodology

To assist in identifying feasible routes for an all-season road, a group of SMEs was convened to research, gather, and analyze available information characterizing the project area and describing features and benefits of the project. Both spatial and non-spatial data and background information were gathered. Spatial data were captured in a Geographic Information System (GIS). The data and information were summarized by SMEs in technical memoranda presented in Appendix A. The memoranda address the following key topics that affect the project:

- Land Status
- Hydrology
- Geoscience
- Existing Infrastructure
- Engineering
- Cultural Resources
- Paleontological Resources
- Subsistence Patterns
- Wetlands
- Threatened and Endangered Species
- Fish and Fish Habitat
- Avian Resources and Habitat
- Construction Cost

Spatial data were incorporated into a GIS cost-weighted raster analysis as described in Appendix B. The analysis was used to identify potential route alternatives that align with likely river crossings and account for features and constraints identified in the technical memoranda.

### 2.3 Corridor Alternatives

The following corridors were identified as preliminary route alternatives for the road (Figure 1.1-1):

- Corridor A – Coastal Route
- Corridor B – Central Route
- Corridor C – Eastern Route

**Corridor A** is shown on Figures 2.3-1 and 2.3-2. The corridor begins at the Landfill Access Road in Atqasuk and traverses approximately 67.5 miles to a junction point with Emaiksoun Road in Utqiagvik. After exiting Atqasuk and crossing the Nigisaktuvik River, Corridor A is generally oriented northward for the first 28 miles, passing over the Inaru River at route milepost 17.3. The corridor then turns northeasterly and essentially parallels the Chukchi Sea coastline before turning inland to bypass Walakpa Bay and connect to Emaiksoun Road. North of

Walakpa Bay, the corridor parallels the west side of the Walakpa Gathering Line for the Barrow Gasfields. The estimated number of river and stream crossings for Corridor A is 15, with the Nigisaktuvik and Inaru Rivers, as well as Singaruak Creek, being the most significant crossings.

**Corridor B** is shown on Figures 2.3-3 and 2.3-4. The corridor begins at the Landfill Access Road in Atqasuk and traverses approximately 64.4 miles to a junction point with Emaiksoun Road in Utqiagvik. After exiting Atqasuk and crossing the Nigisaktuvik River, Corridor B is generally oriented northward for 6 miles before turning northeasterly to parallel the Inaru River for 11 miles where it then swings northerly again to cross the Inaru at route milepost 23.9. From this point the route is generally oriented northeasterly for 22 miles, crossing Niklavik Creek at milepost 32.6. It takes a northerly turn at milepost 45.5 and runs for approximately 8 miles before turning northeasterly again to the terminus in Utqiagvik. The estimated number of river and stream crossings for Corridor B is 16, with the Nigisaktuvik and Inaru Rivers, as well as Niklavik Creek being the most significant crossings.

**Corridor C** is shown on Figures 2.3-5 and 2.3-6. The corridor begins at the Landfill Access Road in Atqasuk and traverses approximately 73.6 miles to a junction point with the end of East Field road in Utqiagvik. After exiting Atqasuk and crossing the Nigisaktuvik River, Corridor C runs northward for approximately 14 miles before turning northeasterly to parallel the Inaru River, which it crosses at route milepost 45.4. After this crossing, the route is oriented generally northward to its terminus in Utqiagvik. The estimated number of river and stream crossings for Corridor C is 15, with the Nigisaktuvik and Inaru Rivers, as well as Avak Creek, being the most significant crossings.

Alignment of all three corridors were informed by the results of the GIS cost-weighted analysis, as well as SME consultation, aerial imagery, and other GIS datasets, such as the National Hydrography Dataset (NHD) for crossing locations and alignment. The cost-weighted analysis generally favored a path along the Chukchi coast (Corridor A), so additional analysis forcing path alignment towards specific river crossing locations was required to produce distinct alignments.

The GIS-generated alignment for Corridor A was subsequently adjusted through heads-up digitizing to avoid several small stream crossings and move the corridor eastward away from the coastal bluff.

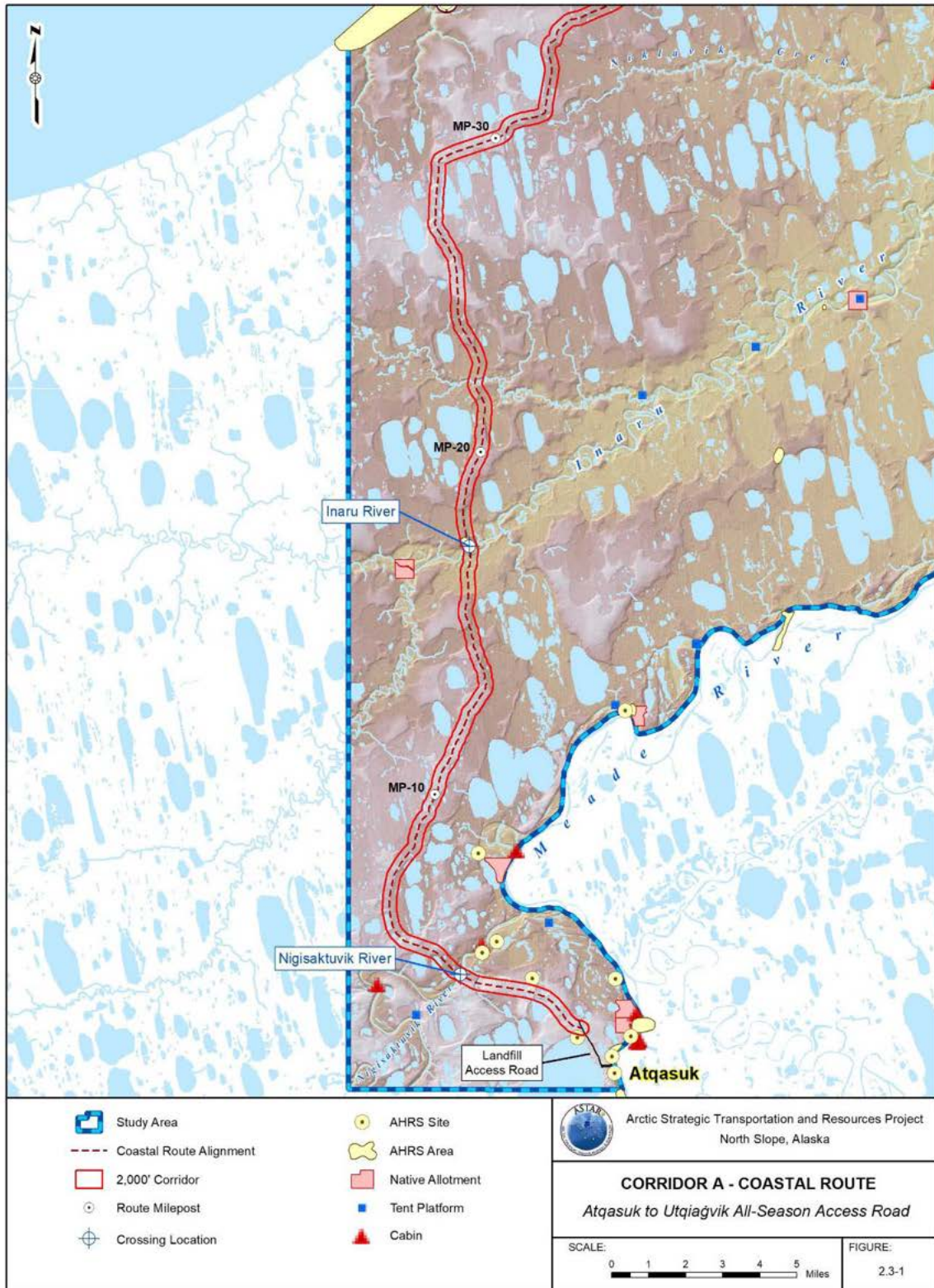
Corridor B was produced by hybridizing the cost-weighted path, CWAT alignments, and heads-up digitizing. This route deviates from the CWAT alignment in some areas because it represents the corridor for an all-season gravel road (as opposed to a snow trail). Given that, the alignment was adjusted to avoid lakes, take advantage of elevated terrain features that better support a gravel road, and to align with potential river crossings at locations with relatively stable bank conditions.

Corridor C is strictly the product of the GIS cost-weighted analysis with no post-process modifications.

More detailed description of the routes are included in the memoranda in Appendix A. Table 2.3-1 presents a summary of features and benefits unique to each of the corridors for comparison and contrast.

River and stream crossing locations were initially derived by intersecting route alignments with flowline features from the NHD. They were then adjusted based on aerial imagery and characterized by width and presumed crossing type (bridge vs. culvert).

**Figure 2.3-1 Corridor A – Coastal Route**



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**Figure 2.3-2 Corridor A – Coastal Route**



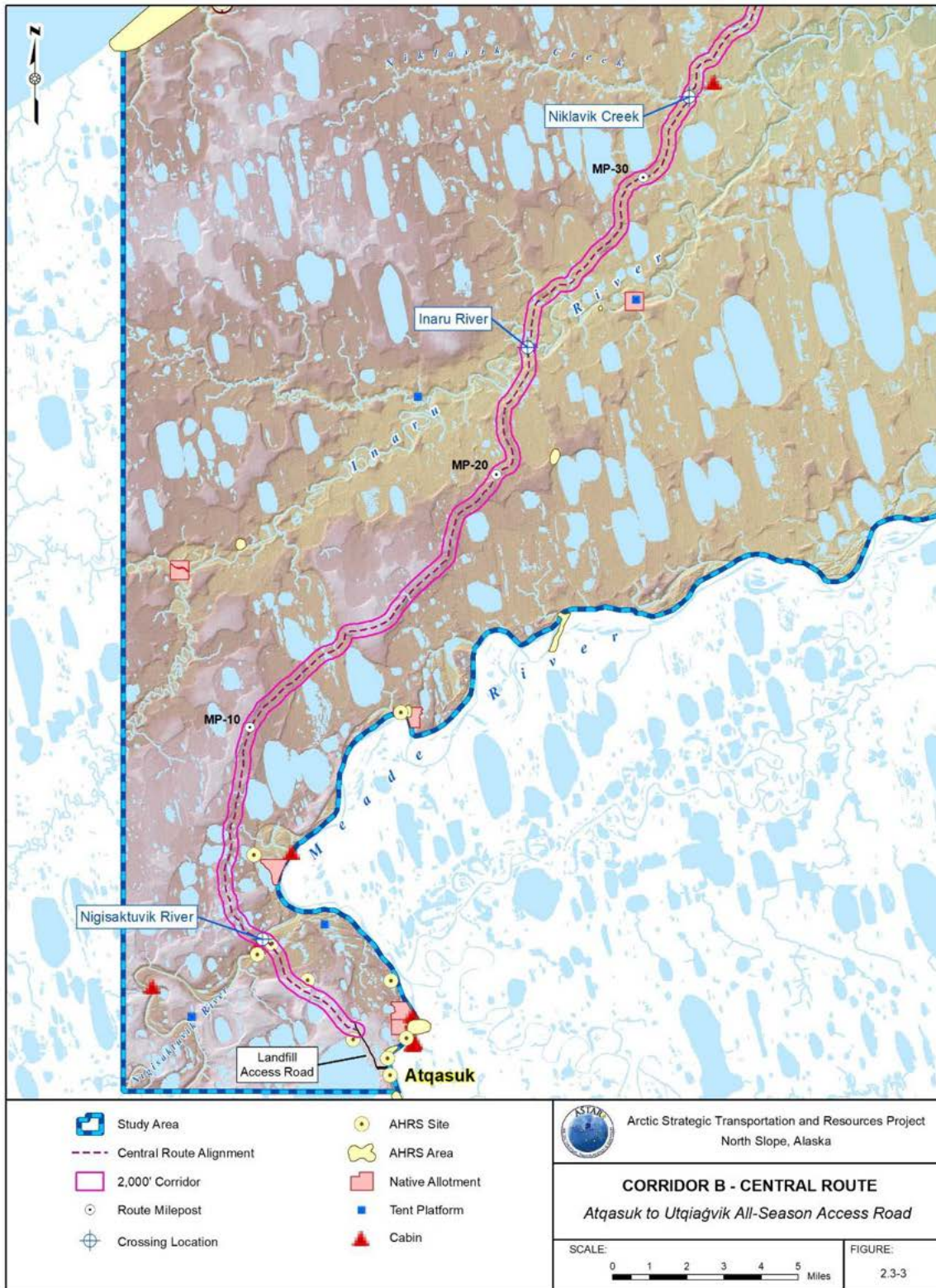
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**Figure 2.3-3 Corridor B – Central Route**



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**Figure 2.3-4 Corridor B – Central Route**



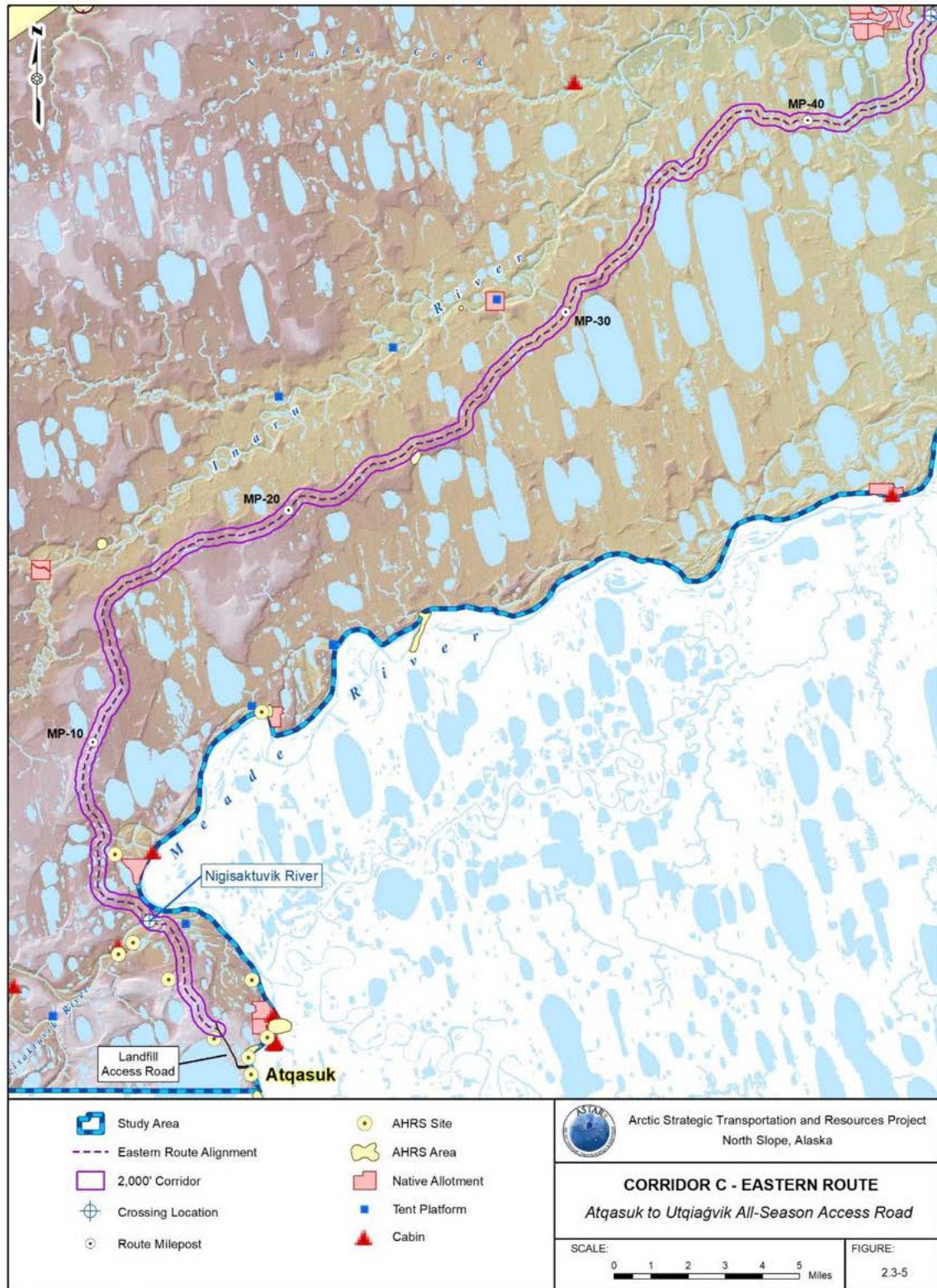
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**Figure 2.3-5 Corridor C – Eastern Route**



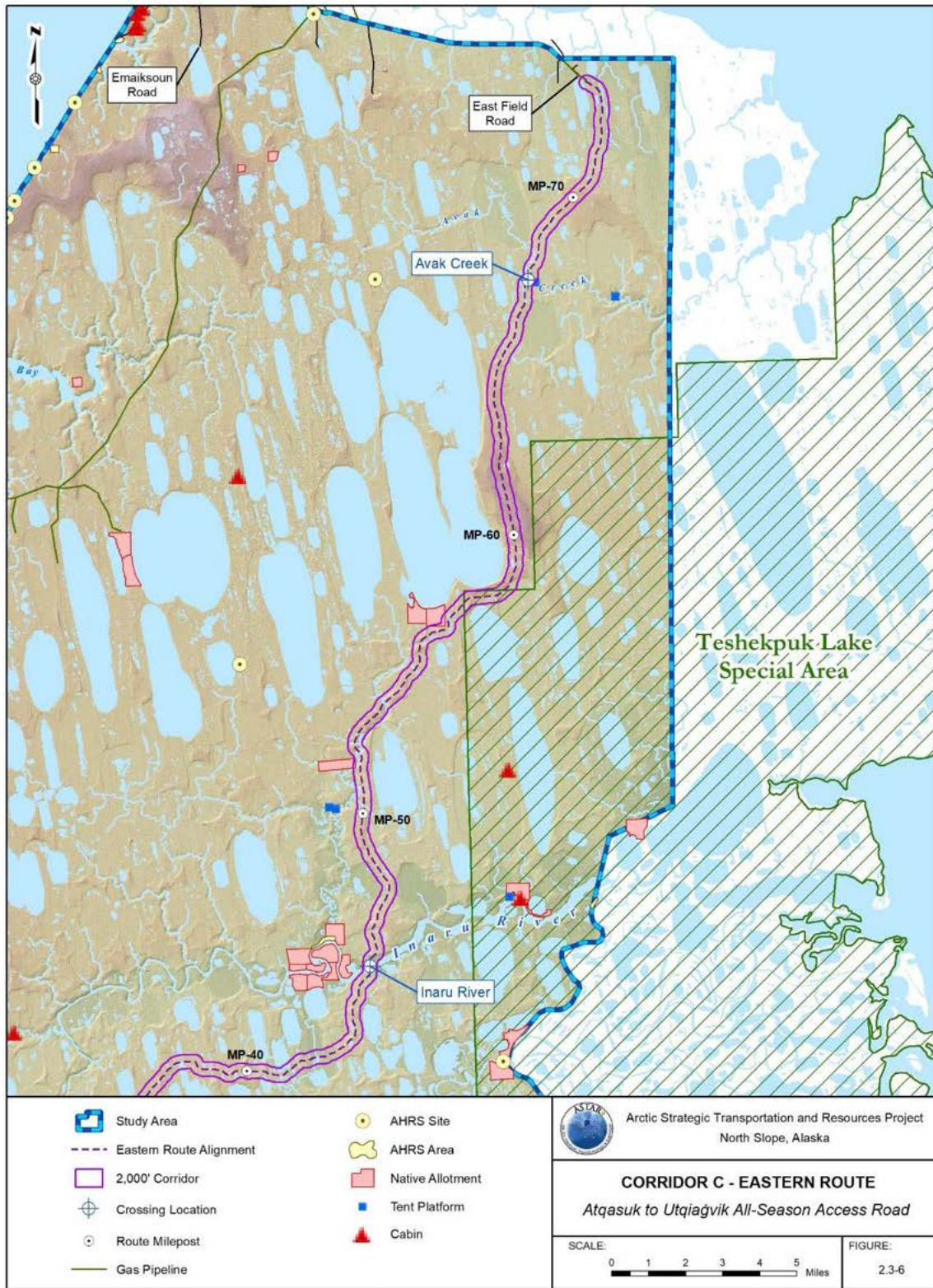
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**Figure 2.3-6 Corridor C – Eastern Route**



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**Table 2.3-1. Summary of Features and Benefits of Each Corridor**

Criteria	Reference	Corridor A Coastal Route	Corridor B Central Route	Corridor C Eastern Route
Benefits Overview	Table 1.4-1	<p>In addition to the overall benefits of a road listed in Section 1.4, Corridor A provides the following specific benefits:</p> <ul style="list-style-type: none"> <li>When compared with the other route alternatives, Corridor A best sets the stage for a road extension to Wainwright, allowing year-round connection between the three communities, and strengthening the case for a regional marine port or dock facility. MP 28 to 67.5 is routed in the direction of Wainwright; and could serve as a common access route from Utqiagvik to an intersection that branches toward Wainwright.</li> <li>If the road is constructed along Corridor A, it facilitates access to the vicinity of the Skull Cliff Core Test #1 legacy well, significantly reducing the cost of surface cleanup of the well site and proper plugging and abandonment of the well.</li> <li>The Corridor A Coastal Route runs parallel to the west side of the Walakpa Gathering Line, improving access to the Walakpa gas field, lowering the cost of maintenance for gasfield infrastructure, and allowing for further development of the gas reservoir (see Appendix A, Tech Memo 4).</li> <li>In comparison to the other route alternatives, Corridor A is the most advantageous route for preserving high-value wetlands associated with fish-bearing waters and deep water systems, Eider nesting habitat, and Yellow-billed loon habitat; and for complying with BLM NPR-A Best Management Practices (BMPs) for lake and river setbacks.</li> <li>Corridor A passes through the block of six sections conveyed to UIC for gravel rights, and facilitates development of a potential gravel mine site (See Appendix A, Tech Memo 3).</li> </ul>	<p>In addition to the overall benefits of a road listed in Section 1.4, Corridor B provides the following specific benefits:</p> <ul style="list-style-type: none"> <li>The Corridor B Central Route runs parallel to the east side of the Walakpa Gathering Line, improving access to the Walakpa gas field, lowering the cost of maintenance for gasfield infrastructure, and allowing for further development of the gas reservoir (see Appendix A, Tech Memo 4).</li> <li>Corridor A passes through the block of six sections conveyed to UIC for gravel rights, and facilitates development of a potential gravel mine site (See Appendix A, Tech Memo 3).</li> </ul>	<p>In addition to the overall benefits of a road listed in Section 1.4, Corridor C provides the following specific benefits:</p> <ul style="list-style-type: none"> <li>Corridor C passes through the block of 14 sections conveyed to UIC for gravel rights, and facilitates development of a potential gravel mine site (See Appendix A, Tech Memo 3).</li> </ul>
Land Status	Appendix A, Tech Memo 1	Route traverses through surface lands owned by Atqasuk Corporation, the U.S. government (NPR-A), ASRC, and UIC. In addition, the route passes near several Native allotments and camps or cabins, the closest being within 0.6 miles.	Route traverses through surface lands owned by Atqasuk Corporation, the U.S. government (NPR-A), ASRC, and UIC. In addition, the route passes near several Native allotments and camps or cabins, the closest being within 0.4 miles.	Route traverses through surface lands owned by Atqasuk Corporation, the U.S. government (NPR-A), ASRC, and UIC. In addition, the route passes near several Native allotments and camps or cabins, the closest being within 0.1 miles.  Route passes through a small corner of the Teshekpuk Lake Special Area from MP 57 to 58.4
Hydrology	Appendix A, Tech Memo 2	Coastal Route corridor has approximately 15 river and stream crossings, with the Nigisaktuvik and Inaru Rivers, as well as Singaruak Creek being the most significant crossings.	Central Route corridor has approximately 16 river and stream crossings, with the Nigisaktuvik and Inaru Rivers, as well as Niklavik Creek being the most significant crossings.	Eastern Route corridor has approximately 15 river and stream crossings, with the Nigisaktuvik and Inaru Rivers, as well as Avak Creek being the most significant crossings.
Geology / Geotechnical	Appendix A, Tech Memo 3	Existing gravel mine sites include the City of Barrow SKW Gravel Pit and the DOT & PF Gravel Pit located south of the airport (see Appendix A, Tech Memo 3). Other undeveloped potential mine sites in the same vicinity include the West Material Source, the East Material Source, and a block of six sections where UIC has been conveyed gravel rights. Along the route, geologic interpretation suggests there may be gravel sources near MPs 3, 10.5, 19.5, 30, 42, 51, and 62; however, field investigation is needed to validate this interpretation.	Existing gravel mine sites include the City of Barrow SKW Gravel Pit and the DOT&PF Gravel Pit located south of the airport (see Appendix A, Tech Memo 3). Other undeveloped potential mine sites in the same vicinity include the West Material Source, the East Material Source, and a block of six sections where UIC has been conveyed gravel rights. Along the route, geologic interpretation suggests there may be gravel sources near MPs 5, 14.5, 24, 35, 45.5, 55, and 62.5; however, field investigation is needed to validate this interpretation.	Existing gravel mine sites include the UIC Gravel Pit on Eastfield 4 Road (see Appendix A, Tech Memo 3). A potential source includes the block of 14 sections where UIC has been conveyed gravel rights. Along the route, geologic interpretation suggests there may be gravel sources near MPs 5.5, 11, 22, 31, 40, 52, 61, and 70; however, field investigation is needed to validate this interpretation.  The City of Barrow SKW Gravel Pit and the DOT&PF Gravel Pit could also be considered potential sources, however, gravel from these locations would have to be trucked a significant distance through the population center of Utqiagvik, then down Cakeeater Road to the Barrow Gasfield road system.

Criteria	Reference	Corridor A Coastal Route	Corridor B Central Route	Corridor C Eastern Route
Existing and Proposed Infrastructure	Appendix A, Tech Memo 4	The Coastal Route traverses the Walakpa Gasfield and runs parallel to the west side of the Walakpa Gathering Line.  The route passes within about 3 miles of the Skull Cliff Legacy Well site.  With regard to proposed infrastructure, the road could facilitate installation of a gas line to supply Atqasuk with a less costly source of energy for power generation and heating. Alternatively, the road could facilitate installation of a power line to deliver electrical power from Utqiagvik to Atqasuk. In addition, the road could facilitate installation of fiber optic cable for high-speed internet connections to the Meade River School, other public facilities, and local residents of Atqasuk.	The Central Route traverses the Walakpa Gasfield and runs parallel to the east side of the Walakpa Gathering Line.  With regard to proposed infrastructure, the road could facilitate installation of a gas line to supply Atqasuk with a less costly source of energy for power generation and heating. Alternatively, the road could facilitate installation of a power line to deliver electrical power from Utqiagvik to Atqasuk. In addition, the road could facilitate installation of fiber optic cable for high-speed internet connections to the Meade River School, other public facilities, and local residents of Atqasuk.	With regard to proposed infrastructure, the road could facilitate installation of a gas line to supply Atqasuk with a less costly source of energy for power generation and heating. Alternatively, the road could facilitate installation of a power line to deliver electrical power from Utqiagvik to Atqasuk. In addition, the road could facilitate installation of fiber optic cable for high-speed internet connections to the Meade River School, other public facilities, and local residents of Atqasuk.
Engineering Considerations	Appendix A, Tech Memo 5	Starting Point: Atqasuk Landfill Access Road Ending Point: Utqiagvik Emaiksoun Road Route Length: 67.5 miles Min/Max Elevation: 20 feet / 91 feet Total River and Stream Crossings: 15 Major River Crossings (>100 feet): 10 Intermediate River Crossings (50-100 feet): 2 Minor River Crossings (<50 feet): 3	Starting Point: Atqasuk Landfill Access Road Ending Point: Utqiagvik Emaiksoun Road Route Length: 64.4 miles Min/Max Elevation: 15 feet / 89 feet Total River and Stream Crossings: 16 Major River Crossings (>100 feet): 5 Intermediate River Crossings (50-100 feet): 7 Minor River Crossings (<50 feet): 4	Starting Point: Atqasuk Landfill Access Road Ending Point: Utqiagvik End of Eastfield Road Route Length: 73.6 miles Min/Max Elevation: 5 feet / 86 feet Total River and Stream Crossings: 15 Major River Crossings (>100 feet): 5 Intermediate River Crossings (50-100 feet): 6 Minor River Crossings (<50 feet): 4
Cultural Resources	Appendix A, Tech Memo 6	Corridor A does not have any known cultural resource sites within the corridor.	Within Corridor B, there is a known cultural resource site near the Nigisaktuvik River between MP 3 and MP 4. However, the route can be adjusted to avoid the site or other mitigation measures can be implemented.	Corridor C does not have any known cultural resource sites within the corridor.
Paleontological Resources	Appendix A, Tech Memo 7	At the Inaru River crossing (between MP 17 and 18), the centerline for Corridor A is in close proximity to a known paleontological resource site. However, the route can be adjusted to avoid the site or other mitigation measures can be implemented.	Corridor B does not have any known paleontological sites within the corridor.	There is a paleontological site within Corridor C near MP 24. The route can be adjusted to avoid the site or other mitigation measures can be implemented.
Subsistence Patterns	Appendix A, Tech Memo 8	All routes pass through subsistence use areas. Corridor A does not have any known Native allotments, camps, or cabins within the alignment.	All routes pass through subsistence use areas. At the Inaru River crossing (MP 24), the centerline for Corridor B is in close proximity to a known subsistence camp tent platform.	All routes pass through subsistence use areas. Corridor C does has two Native allotments within the corridor at approximately MP 56 and between MP 51 and 52. In addition, a subsistence camp tent platform is located near MP 67 at Avak Creek.
Wetlands	Appendix A, Tech Memo 9	Corridor A is the most favorable route for avoiding wetlands that may require compensatory mitigation.	Corridor B is slightly less favorable than Corridor A for avoiding wetlands that may require compensatory mitigation, but is more favorable than Corridor C.	The USACE Alaska District Compensatory Mitigation Thought Process (2018) calls out wetlands that are considered to be rare, irreplaceable, or associated with special habitat designations. Based on the current USACE process, Corridor C is less favorable than Corridors A or B because it traverses high value wetlands associated with Polar Bear Designated Critical Habitat and more high-density eider nesting areas.
Threatened Endangered Species	Appendix A, Tech Memo 10	Corridor A is the most favorable route for avoiding eider nesting habitat and Polar Bear critical habitat.	Corridor B is less favorable than Corridor A for avoiding eider nesting habitat Polar Bear critical habitat.	Corridor C is the least favorable alternative for avoiding eider nesting habitat Polar Bear critical habitat (Corridor C ends in an area of high-density eider nesting habitat, and within Polar Bear critical habitat).
Fish & Fish Habitat	Appendix A, Tech Memo 11	Corridor A crosses one designated anadromous stream (Inaru River). However, fish surveys will be required at other streams to assess the presence or absence of anadromous fish.	Corridor B crosses one designated anadromous stream (Inaru River). However, fish surveys will be required at other streams to assess the presence or absence of anadromous fish.	Corridor C crosses two designated anadromous streams (Inaru River and Avak Creek). However, fish surveys will be required at other streams to assess the presence or absence of anadromous fish.
Avian Resources and Habitat	Appendix A, Tech Memo 12	Most eider nesting habitat is concentrated near Utqiagvik and all three routes appear to encompass a similar amount of nesting habitat. Nesting surveys and potential route adjustments will be required in later stages of the project.	Most eider nesting habitat is concentrated near Utqiagvik and all three routes appear to encompass a similar amount of nesting habitat. Nesting surveys and potential route adjustments will be required in later stages of the project.	Most eider nesting habitat is concentrated near Utqiagvik and all three routes appear to encompass a similar amount of nesting habitat. Nesting surveys and potential route adjustments will be required in later stages of the project.
Cost Estimate	Appendix A, Tech Memo 13	The cost estimate for Corridor A is higher than B, but less than Corridor C	Corridor B is the least costly alternative	The estimated construction cost for Corridor C is higher than Corridors A and B

Notes:  
ASRC = Arctic Slope Regional Corporation      BMP = Best Management Practices      MP = milepost      UIC = Ukpeagvik Inupiat Corporation  
BLM = United States Bureau of Land Management      DOT&PF = Department of Transportation and Public Facilities      NPR-A = National Petroleum Reserve - Alaska      USACE = United States Army Corps of Engineers

### 3.0 Corridor Evaluation

Using the available information, each corridor alternative has been analyzed and ranked in a decision matrix as described in the following sections. The decision matrix is based on the benefits-related criteria and constraints identified in Sections 1.4 and 2.2, respectively, and supported by the information compiled in the technical memoranda (Appendix A).

#### 3.1 Corridor Evaluation Criteria

Table 3.1-1 lists each of the decision matrix criteria along with a brief description of the associated factors and constraints to be considered for evaluation.

**Table 3.1-1. Decision Matrix Evaluation Criteria for Atqasuk to Utqiagvik Road**

Primary Criterion	Factors and Constraints
<b>Benefits-Related Criteria</b>	<b>To What Degree Does the Route...</b>
<i><b>Supports Cultural Connectivity</b></i>	Improve physical access between the communities. Create or enhance the capability to join together in various activities
<i><b>Lowers Costs of Goods and Services</b></i>	Lower the cost of energy, basic goods, utilities, and other services
<i><b>Preserves or Enhances Subsistence Traditions</b></i>	Improve local community access to subsistence resources while protecting those resources from outside pressure
<i><b>Improves Health and Safety Conditions</b></i>	Provide direct access to medical facilities and services, search and rescue personnel and law enforcement. Increase sustainability of necessary utilities.
<i><b>Improves Access to Education Opportunities</b></i>	Create physical access to education facilities, or facilitate attendance at schools, training centers, campuses, and cultural centers/activities
<i><b>Enhances Workforce Development</b></i>	Provide temporary and long-term jobs, identify and fill much-needed local service gaps, provide access to skills training or workplace experience, etc.
<b>Constraints-Related Criteria</b>	<b>To What Degree Does the Route...</b>
<i><b>Land Status</b></i>	Consider land ownership, leases, rights-of-way, etc.
<i><b>Hydrology</b></i>	Minimize river and stream crossings, locate crossings with stable bank conditions, consider BLM Best Management Practices setbacks
<i><b>Geoscience</b></i>	Consider granular material sources, avoid geohazards, where possible route over favorable (less icy) in situ soils
<i><b>Existing Infrastructure</b></i>	Take advantage of existing infrastructure where possible, consider synergies between proposed road and other existing or proposed infrastructure
<i><b>Engineering</b></i>	Consider topography, bridges, culverts, design criteria, material needs and haul distances
<i><b>Cultural and Paleontological Resources</b></i>	Avoid impacts to cultural or paleontological resources
<i><b>Subsistence Patterns</b></i>	Avoid or minimize encroachment on Native allotments, camps, or cabins
<i><b>Wetlands</b></i>	Avoid wetlands that would require compensatory mitigation
<i><b>Threatened &amp; Endangered Species</b></i>	Consider regulatory constraints and Best Management Practices for Eiders, Polar Bears, and Yellow-billed Loons
<i><b>Fish and Fish Habitat</b></i>	Consider anadromous streams and crossing modes
<i><b>Avian Resources and Habitat</b></i>	Avoid Eider and Yellow-billed Loon nesting locations and waterfowl nesting concentration areas
<i><b>Construction Cost Estimate</b></i>	Minimize overall construction cost to the extent practicable

### 3.2 Matrix Scoring

Table 3.2-1 presents a summary of the criteria scoring for each corridor. Based on the information in the technical memoranda and on the information presented in Table 3.1-1, each route alternative has been subjectively rated by SMEs with regard to each criterion. Each route has been assigned a score from 1 to 5 for each criterion using the Likert scale below.

**Degree of Favorability**

- 1 – Not at all favorable
- 2 – Low favorability
- 3 – Moderately favorable
- 4 – Very favorable
- 5 – Extremely favorable

**Table 3.2-1: Scoring for Each Corridor Based on Criteria**

Criteria	Corridor A Coastal Route	Corridor B Central Route	Corridor C Eastern Route	Notes
<i>Supports Cultural Connectivity</i>	5	4	4	All routes support cultural connectivity, however, the Corridor A better sets the stage for a road extension to Wainwright, expanding the potential for connectivity from two communities to three.
<i>Lowers Costs of Goods and Services</i>	5	5	5	All routes lower the costs of goods and services.
<i>Preserves or Enhances Subsistence Traditions</i>	5	4	3	All routes enhance access to potential subsistence resources. However, Corridor B and C are scored lower because of proximity to subsistence camps, cabins, and Native allotments (this lower scoring is based on the assumption that encroaching near camps, cabins, and allotments is less favorable).
<i>Improves Health and Safety Conditions</i>	5	4	4	All routes equally improve health and safety conditions; however, the Corridor A better sets the stage for a road extension to Wainwright, thereby providing more options for healthcare and emergency response. Corridor A also facilitates cleanup and proper plugging of the Skull Cliff legacy well.
<i>Improves Access to Education Opportunities</i>	5	4	4	All routes improve access to education opportunities, however, Corridor A better sets the stage for a road extension to Wainwright, thereby providing potential for access to the greatest number of education opportunities
<i>Enhances Workforce Development</i>	5	4	4	All routes support workforce development. However, Corridor A better sets the stage for a road extension to Wainwright, thereby providing greater potential for additional job opportunities
<i>Land Status</i>	5	5	3	All routes cross the same properties. Corridor C is in closer proximity to more Native allotments than the other two routes. This is assumed to be undesirable, but this assumption will need to be verified with the owner of the Allotment.

Criteria	Corridor A Coastal Route	Corridor B Central Route	Corridor C Eastern Route	Notes
<i>Hydrology</i>	3	4	3	The number of crossings for Corridors A, B, and C are similar (15, 16, and 15). However, the relative size and type of crossings varies significantly, and is reflected in this scoring (see Tech Memo 2, Appendix A).
<i>Geoscience</i>	3	3	3	Based on known and potential mine sites, it appears that all corridors have equal access to granular materials, and terrain units along the corridors are similar.
<i>Existing Infrastructure</i>	5	4	2	Corridors A and B improve access to Walakpa gas field for maintenance and further development, and Corridor A improves access to the Skull Cliff wellsite for remedial activities.
<i>Engineering</i>	4	4	3	From an engineering perspective, all routes are relatively similar with regard to crossings, material sources, and terrain features. However, Corridor C has one crossing significantly longer than all others (Inaru River, >1,000 feet).
<i>Cultural and Paleontological Resources</i>	3	3	3	Based on available information, all three routes encounter either cultural or paleontological resources within the corridors. Future route adjustments or other mitigation measures can be implemented to preserve cultural and paleontological resources that are currently known or are identified during later project stages.
<i>Subsistence Patterns</i>	4	3	2	There are no known Native allotments, camps, or cabins within Corridor A. There is a subsistence tent platform within Corridor B near the Inaru River. There are two Native allotments and one subsistence tent platform at Avak Creek within the Corridor C.
<i>Wetlands</i>	4	3	2	Corridor A is the most favorable route for avoiding wetlands that will require compensatory mitigation, followed by Corridor B and C.
<i>Threatened &amp; Endangered Species</i>	5	4	3	With regard to areas of high-density Eider nesting habitat, Corridor A is most favorable, followed by Corridor B, and then Corridor C.
<i>Fish and Fish Habitat</i>	4	4	3	All three routes cross one known anadromous stream (Inaru River), while Corridor C additionally crosses a second anadromous stream (Avak Creek). Note however, that all streams will need to be surveyed for the presence of anadromous fish.
<i>Avian Resources and Habitat</i>	3	3	3	Most nesting habitat is concentrated near Utqiagvik. All three routes appear to encompass a similar amount of nesting habitat. Nesting surveys and potential route adjustments will be required in later stages of the project.
<i>Construction Cost Estimate</i>	3	4	2	The cost estimate for Corridor B is lowest, followed by Corridor A, then Corridor C (highest)
<b>TOTAL</b>	<b>76</b>	<b>69</b>	<b>57</b>	

### 3.3 Criteria Weighting

Each criterion was analyzed from eight societal and landowner viewpoints: Federal Government, State Government, Local Government (NSB), community residents, village corporations (UIC [Ukpeagvik Inupiat Corporation] and Atqasuk Corporation), regional corporation (Arctic Slope Regional Corporation [ASRC]), environmental non-governmental organizations (NGOs), and pro-development NGOs. A description of each viewpoint is described below.

**Federal Interest:** This viewpoint considers which criteria are most and least important for the Federal government, specifically the United States Bureau of Land Management (BLM), the primary land manager and lessor within the NPR-A.

**State Interest:** This viewpoint considers which criteria are the most and least important for the State of Alaska in terms of supporting the people and finances of the State. The State of Alaska is not a landowner within the project area, but does have management authority over some resources (e.g. surface waters, wildlife). In addition, the State is the entity sponsoring the ASTAR project.

**NSB Interest:** This viewpoint considers which criteria are most and least important for the NSB. The NSB would potentially be responsible for construction and maintenance of the road, and holds mineral rights to gravel resources that could be used for construction.

**Community Interest:** This viewpoint considers local issues and needs when considering what criteria are most and least important to the communities and Native landowners in the project vicinity.

**Village Corporation Interest:** This viewpoint considers which criteria are most and least important to UIC and Atqasuk Corporation. Both corporations are landowners affected by the potential road.

**ASRC Interest:** This viewpoint considers which criteria are most and least important to ASRC, a landowner within the project area.

**Environmental NGO Interest:** This viewpoint considers issues important to environmental advocates and what criteria have the most and least effect on the environment.

**Pro-Development NGO Interest:** This viewpoint considers which criteria are the most and least important from development advocates.

This weighting method is based on a similar multi-disciplinary approach by Atkinson et al. (2005) that is intended to reduce bias in the decision-making process for infrastructure projects of this magnitude. This method was recently used by the Alaska Department of Transportation and Public Facilities (DOT&PF) in the Foothills West Transportation Access Project to rank corridor alternatives for a proposed road to Umiat (DOT&PF 2009).

Similar to a public input process, this process involves consideration of different societal viewpoints to evaluate the criteria for each corridor. Since this ranking is subjective, additional effort should be placed into developing “real world” viewpoints through future meetings with local community members, agency personnel, local and state government representatives, and other key stakeholders. As the project advances, these stakeholders should review project criteria and help verify the weightings based on their importance and applicability. The weighting should then be adjusted to reflect the views of the actual project stakeholders.

The objective is to subjectively rate each criterion and assign a score from 1 to 5 for each viewpoint, using the Likert scale below.

**Level of Importance**

- 1 – Not at all important
- 2 – Low importance
- 3 – Moderately important
- 4 – Very important
- 5 – Extremely important

Table 3.3-1 identifies the viewpoints, criteria, and the assigned weights for each criterion. Average weight for each criterion represents averaged importance across all viewpoints (right-most column). Preliminary weightings for each viewpoint were generated in a manner as objective as possible by a multidisciplinary group of SMEs. These weightings may change as public input is gathered for the project.

**Table 3.3-1: Interim Criteria Weighting by Viewpoint**

Federal	State	NSB	Community	Village Corp.	ASRC	Environmental NGO	Pro-Development NGO	Average Weight
Cultural Connectivity 2	Cultural Connectivity 4	Cultural Connectivity 5	Cultural Connectivity 5	Cultural Connectivity 5	Cultural Connectivity 5	Cultural Connectivity 2	Cultural Connectivity 4	Cultural Connectivity 4.00
Lower Costs 1	Lower Costs 3	Lower Costs 5	Lower Costs 5	Lower Costs 5	Lower Costs 5	Lower Costs 1	Lower Costs 5	Lower Costs 3.75
Preserve or Enhance Subsistence 3	Preserve or Enhance Subsistence 4	Preserve or Enhance Subsistence 5	Preserve or Enhance Subsistence 5	Preserve or Enhance Subsistence 5	Preserve or Enhance Subsistence 5	Preserve or Enhance Subsistence 3	Preserve or Enhance Subsistence 3	Preserve or Enhance Subsistence 4.13
Improve H&S Conditions 1	Improve H&S Conditions 4	Improve H&S Conditions 5	Improve H&S Conditions 5	Improve H&S Conditions 5	Improve H&S Conditions 5	Improve H&S Conditions 1	Improve H&S Conditions 4	Improve H&S Conditions 3.75
Improve Education Access Opportunities 1	Improve Education Access Opportunities 4	Improve Education Access Opportunities 5	Improve Education Access Opportunities 5	Improve Education Access Opportunities 5	Improve Education Access Opportunities 5	Improve Education Access Opportunities 1	Improve Education Access Opportunities 4	Improve Education Access Opportunities 3.75
Enhance Workforce Development 1	Enhance Workforce Development 5	Enhance Workforce Development 5	Enhance Workforce Development 5	Enhance Workforce Development 5	Enhance Workforce Development 5	Enhance Workforce Development 1	Enhance Workforce Development 5	Enhance Workforce Development 4.00
Land Status 5	Land Status 2	Land Status 5	Land Status 4	Land Status 5	Land Status 5	Land Status 1	Land Status 3	Land Status 3.75
Hydrology 4	Hydrology 4	Hydrology 3	Hydrology 3	Hydrology 3	Hydrology 3	Hydrology 5	Hydrology 3	Hydrology 3.50
Geoscience 3	Geoscience 4	Geoscience 4	Geoscience 3	Geoscience 3	Geoscience 3	Geoscience 4	Geoscience 3	Geoscience 3.38
Existing Infrastructure 4	Existing Infrastructure 2	Existing Infrastructure 4	Existing Infrastructure 4	Existing Infrastructure 3	Existing Infrastructure 3	Existing Infrastructure 1	Existing Infrastructure 3	Existing Infrastructure 3.00
Engineering 2	Engineering 3	Engineering 5	Engineering 3	Engineering 3	Engineering 3	Engineering 1	Engineering 4	Engineering 3.00
Cultural & Paleo Resources 4	Cultural & Paleo Resources 4	Cultural & Paleo Resources 5	Cultural & Paleo Resources 5	Cultural & Paleo Resources 5	Cultural & Paleo Resources 5	Cultural & Paleo Resources 3	Cultural & Paleo Resources 3	Cultural & Paleo Resources 4.25
Subsistence Patterns 3	Subsistence Patterns 4	Subsistence Patterns 5	Subsistence Patterns 5	Subsistence Patterns 5	Subsistence Patterns 5	Subsistence Patterns 2	Subsistence Patterns 3	Subsistence Patterns 4.00

Federal	State	NSB	Community	Village Corp.	ASRC	Environmental NGO	Pro-Development NGO	Average Weight
Wetlands 3	Wetlands 4	Wetlands 3	Wetlands 3	Wetlands 3	Wetlands 3	Wetlands 5	Wetlands 3	Wetlands 3.38
T&E Species 5	T&E Species 4	T&E Species 4	T&E Species 4	T&E Species 4	T&E Species 4	T&E Species 5	T&E Species 3	T&E Species 4.13
Fish & Fish Habitat 4	Fish & Fish Habitat 5	Fish & Fish Habitat 5	Fish & Fish Habitat 5	Fish & Fish Habitat 5	Fish & Fish Habitat 5	Fish & Fish Habitat 5	Fish & Fish Habitat 3	Fish & Fish Habitat 4.63
Avian Resources and Habitat 4	Avian Resources and Habitat 4	Avian Resources and Habitat 5	Migratory Birds 5	Migratory Birds 5	Migratory Birds 5	Migratory Birds 5	Migratory Birds 3	Migratory Birds 4.50
Construction Cost 1	Construction Cost 3	Construction Cost 5	Construction Cost 2	Construction Cost 2	Construction Cost 2	Construction Cost 1	Construction Cost 4	Construction Cost 2.50

### 3.4 Weighted Decision Matrix Evaluation

Criteria for each corridor were ranked using the scoring presented in Sections 3.2, and by applying the weighting factors developed in Section 3.3. The resulting Weighted Decision Matrix is shown in Table 3.4-1 below. As shown in the table, the matrix scored Corridor A – Coastal Route as the most advantageous option, followed by the Corridor B, and then Corridor C in descending order.

**Table 3.4-1: Interim Corridor Decision Matrix**

Criterion	Weight	Scores for Corridors					
		Corridor A – Coastal Route		Corridor B – Central Route		Corridor C – Eastern Route	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
<b>Supports Cultural Connectivity</b>	4.00	5	20.0	4	16.0	4	16.0
<b>Lowers Costs of Goods and Services</b>	3.75	5	18.8	5	18.8	5	18.8
<b>Preserves or Enhances Subsistence Traditions</b>	4.13	5	20.6	4	16.5	3	12.4
<b>Improves Health and Safety Conditions</b>	3.75	5	18.8	4	15.0	4	15.0
<b>Improves Access to Education Opportunities</b>	3.75	5	18.8	4	15.0	4	15.0
<b>Enhances Workforce Development</b>	4.00	5	20.0	4	16.0	4	16.0
<b>Land Status</b>	3.75	5	18.8	5	18.8	3	11.3
<b>Hydrology</b>	3.50	3	10.5	4	14.0	3	10.5
<b>Geoscience</b>	3.38	3	10.1	3	10.1	3	10.1
<b>Existing Infrastructure</b>	3.00	5	15.0	4	12.0	2	6.0
<b>Engineering</b>	3.00	4	12.0	4	12.0	3	9.0
<b>Cultural and Paleo Resources</b>	4.13	3	12.8	3	12.8	3	12.8

Criterion	Weight	Scores for Corridors					
		Corridor A – Coastal Route		Corridor B – Central Route		Corridor C – Eastern Route	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
<b>Subsistence Patterns</b>	4.00	4	16.0	3	12.0	2	8.0
<b>Wetlands</b>	3.38	4	13.5	3	10.1	2	6.8
<b>Threatened &amp; Endangered Species</b>	4.13	5	20.6	4	16.5	3	12.4
<b>Fish &amp; Fish Habitat</b>	4.63	4	18.5	4	18.5	3	13.9
<b>Avian Resources and Habitat</b>	4.50	3	13.5	3	13.5	3	13.5
<b>Construction Cost Estimate</b>	2.50	3	7.5	4	10.0	2	5.0
<b>TOTALS</b>			<b>285.6</b>		<b>257.5</b>		<b>212.3</b>

## 4.0 Conclusions, Recommendations, and Data Gaps

Based on the outcome of our preliminary analysis and comparison, it appears that Corridor A – Coastal Route is the most favorable route for the Atqasuk to Utqiagvik Road.

The alignment of Corridor A between about MP 29 and MP 67.5 (Utqiagvik) parallels the coastline and sets the stage for a road extension to Wainwright. As referenced in Table 2.3-1, an extension of Corridor A to Wainwright would link together three communities (Wainwright, Atqasuk, and Utqiagvik), and thereby enhance all of the benefits-related features of a road project identified in Section 1.4. In addition, connecting the three communities could open opportunities for development of a regional marine dock for freight and fuel deliveries. Simultaneously considering all three communities could result in adjustments to Corridor A routing presented in this report, primarily between MP 0 and MP 29. Accordingly, we recommend a follow-on study to simultaneously evaluate roads connecting Wainwright, Atqasuk, and Utqiagvik.

The road corridors presented in this report were developed without the benefit of stakeholder engagement. Before advancing the project further, a stakeholder engagement plan should be developed and implemented to solicit input specific to the project, and use the input to refine the project description and analysis.

The BLM is currently in the process of revising the Integrated Activity Plan (IAP) for the NPR-A. When the revision is completed, the IAP should be reviewed to assess whether any changes to stipulations or Best Management Practices (BMPs) affect the proposed Atqasuk to Utqiagvik Road.

Recommended follow-on studies and activities are listed in Table 4.0-1. The list is not comprehensive but provides guidance for initial steps necessary to fill data gaps and advance the project. In order to establish priorities, the lead-time, duration, and inter-relationship of these activities should to be established in a detailed project execution plan.

**Table 4.0-1: Recommended Follow-On Studies and Activities for Atqasuk to Utqiagvik Road**

Item	Objective	Purpose
<b>Corridor Routing</b>		
LIDAR	Obtain LIDAR survey of road corridor(s)	Support preliminary engineering, wetlands pre-mapping, etc.
Route Reconnaissance	Conduct visual reconnaissance overflight of road corridor(s) with subject matter experts.	Validate and refine route(s) selected during desktop analysis. First-hand observations of terrain features, river crossings, etc.
Project Scope	Expand desktop analysis to include roads connecting Wainwright, Atqasuk, and Utqiagvik.	Connecting all three communities by an all-season road would enhance all of the benefits-related features of the project, and could open opportunities for development of a regional marine dock for freight and fuel deliveries. Simultaneously considering all three communities could result in adjustments to the final routing.
<b>Engineering</b>		
Geotechnical Reconnaissance	Conduct reconnaissance to assess geotechnical and geological conditions.	Support planning for field studies, identify target areas for geotechnical exploration (potential borrow sources, river crossings, etc.).
Geotechnical Exploration	Geotechnical drilling program to characterize soil and permafrost conditions	Support engineering analyses for routing, river crossings, and material site development. Validate terrain unit mapping.
Hydrology Studies	Obtain hydrologic data for river and stream crossings.	Support engineering design and construction planning for bridges and culverts. Support ADF&G requirements for permits to work in waterbodies.
Conceptual Engineering	Perform conceptual-level engineering.	Support initial cost estimates, environmental documentation and financial planning.
Estimate Water Needs	Estimate construction and operational water needs.	Estimate construction water needs for construction-phase ice roads, and operational phase dust control. Support compliance with ADF&G requirements for water withdrawal and ADNR Permits for Temporary Water Use.
Preliminary Construction Execution Plan	Define construction approach and timeline.	Validate and refine cost estimate and schedule with regard to task sequencing, seasonality, logistics, and construction camps.
<b>Cultural</b>		
Cultural Resource Windshield Survey	Conduct visual reconnaissance overflight of road corridor(s) with archaeologists.	Support analyses for routing.
Cultural Resource Surveys	Complete field surveys of high-potential areas.	Support permitting and design of mitigation measures. Support preparation of Alaska Cultural Resource Permit (field studies investigation) and Section 106 Consultation per 36 CFR 800.
<b>Environmental</b>		
Wetlands	Conduct pre-mapping and field delineation of wetlands.	Support USACE Section 404/Section 401 permitting and design of mitigation measures.
Lake Studies	Identify and survey potential water sources.	Identify water sources for construction ice roads and dust control. Support construction cost estimates. Support permitting for temporary water use. Support preparation of permits for water withdrawal, temporary water use, water rights.

Item	Objective	Purpose
Fish Habitat	See Hydrology Studies. Obtain fisheries data and habitat information for stream-crossing method evaluation.	Support stream crossing method selection. Required by Title 16 of the Alaska Statutes. Both resident and anadromous fisheries evaluated. State has responsibilities related to protecting fisheries – rivers, lakes, and streams.
Bird Surveys	Identify nest locations for T&E eiders, and possibly loons.	Support permitting and compliance with Migratory Bird Treaty Act and Endangered Species Act Section 7. Support consultation requirements.
Environmental Evaluation Document	Conduct preliminary environmental evaluation and impacts analysis.	Prepare baseline information that can be used by federal agency. NEPA analysis and preparation of NEPA document (EA, EIS). Major federal permits will trigger NEPA.
<b>Regulatory</b>		
Stakeholder Strategy	Develop stakeholder strategy for engagement.	Support agency requirements for consultation (USFWS, BLM) as well as federal requirements for Environmental Justice (EO 12898, EO 13175)
Agency Coordination	Engage with local, state, and federal agencies.	Solicit agency input. Track development of BLM IAP/EIS for NPR-A. Consult with NSB.
Regulatory Strategy	Develop regulatory strategy for permitting.	Support timely permitting and early identification of potential permit stipulations.
<b>Finance</b>		
Finance	Identify potential funding sources for follow-on studies, engineering, and construction.	Support community desire for all-season road.
<b>Lands</b>		
Land Services	Develop detailed land ownership and boundary information along route(s).	Support right-of-entry permissions for field studies, ROW acquisition, etc.
Right of Way	Identify proposed route, and develop detailed project description.	Support preparation of ROW lease/grant agreements and land use permits.
Access Approvals	Fieldwork access approvals needed across NSB, Native, and federal lands.	NSB, BLM, ASRC, UIC, Atqasuk Corporation and other landowners require prior authorizations for conducting fieldwork on their lands.

Notes:

ADF&G = Alaska Department of Fish and Game  
 ADNR = Alaska Department of Natural Resources  
 ASRC = Arctic Slope Regional Corporation  
 BLM = United States Bureau of Land Management  
 CFR = Code of Federal Regulations  
 EA = Environmental Assessment  
 EIS = Environmental Impact Statement  
 EO = Executive Order  
 IAP = Integrated Activity Plan  
 LIDAR = Light Detecting and Ranging

NEPA = National Environmental Policy Act  
 NPR-A = National Petroleum Reserve - Alaska  
 NSB = North Slope Borough  
 ROW = right-of-way  
 Section 106 = Section 106 of the National Historic Preservation Act  
 Section 401/404 = Sections 401 and 404 of the Clean Water Act  
 UIC = Ukpqagvik Inupiat Corporation  
 USACE = United States Army Corps of Engineers  
 USFWS = United States Fish and Wildlife Service

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## **APPENDIX A**

### **SME Analysis**

- Technical Memorandum 1 – Land Status
- Technical Memorandum 2 – Hydrology
- Technical Memorandum 3 – Geology / Geotechnical
- Technical Memorandum 4 – Existing and Proposed Infrastructure
- Technical Memorandum 5 – Engineering
- Technical Memorandum 6 – Cultural Resources
- Technical Memorandum 7 – Paleontological Resources
- Technical Memorandum 8 – Subsistence Patterns
- Technical Memorandum 9 – Wetlands
- Technical Memorandum 10 – Threatened and Endangered Species
- Technical Memorandum 11 – Fisheries and Fish Habitat
- Technical Memorandum 12 – Birds
- Technical Memorandum 13 – Cost Estimates

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## **Technical Memorandum 1 – Land Status**

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## **Technical Memorandum 1 – Land Status**

**Prepared by:** Larry Clamp, GIS Department Manager

**Reviewed by:** Amanda Henry, Principal Scientist

**Date:** July 2019

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### **Overview**

The project area is located within Alaska’s North Slope Borough between the villages of Atqasuk and Utqiagvik. Land ownership within the project area can generally be separated into Native corporation lands, federal lands, and Native allotments (Figure TM1-1). Note that the land ownership and land status information presented in this memorandum is based on records readily available online from public sources. Additional work may be necessary in subsequent phases of the project to verify land ownership and obtain more detailed data on boundaries and land status.

### **Land Ownership**

#### ***Village Corporation Lands***

Village corporation lands within the project area include Ukpeaġvik Iñupiat Corporation (UIC) lands near Utqiagvik and Atqasuk Corporation lands near the village of Atqasuk. Figure TM1-1 shows the extent of UIC and Atqasuk Corporation lands.

UIC lands and Atqasuk Corporation lands were conveyed as part of the Alaska Native Claims Settlement Act (ANCSA). As part of ANCSA, the villages were allowed to select all the land in townships where the village was located and additional area, if necessary, to make up the acreage the village was entitled to (43 United States Code [USC] 1611).

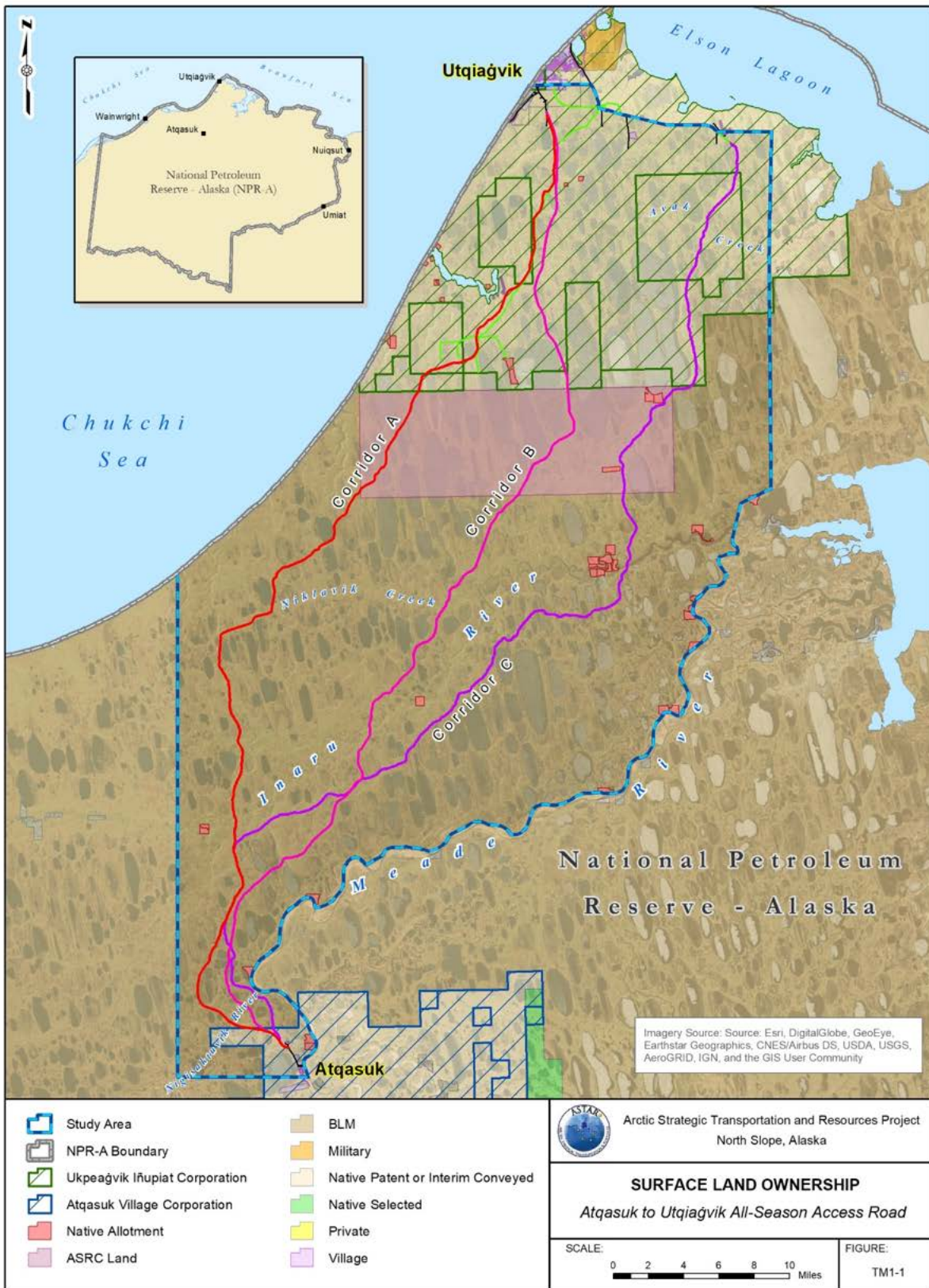
#### ***ASRC Lands***

Arctic Slope Regional Corporation (ASRC) owns surface lands immediately south of the UIC lands as shown on Figure TM1-1. As with all private properties, authorization must be obtained before accessing or performing work on these lands.

#### ***National Petroleum Reserve-Alaska***

The project corridor traverses a portion of the National Petroleum Reserve–Alaska (NPR–A), a vast 22.1 million acre area of land on Alaska’s North Slope owned by the U.S. government. The Bureau of Land Management (BLM) is responsible for managing the NPR–A. NPR–A is bounded by the Chukchi and Beaufort Seas to the north, the Colville River to the east, and is north of the Noatak National Preserve and the Gates of the Arctic National Park and Preserve (inset, Figure TM1-1). All lands within NPR–A are owned and managed by the federal government, with the exceptions of Native Allotments; Native corporation and village lands in the vicinity of Wainwright, Utqiagvik, Atqasuk, and Nuiqsut; and the Umiat Airfield surface estate, which is owned by Alaska Department of Transportation and Public Facilities.

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NPR-A includes several designated Special Areas where specific restrictions or stipulations may apply (BLM 2013). Special areas are Colville River Special Area, Utukok River Uplands Special Area, Teshekpuk Lake Special Area, Peard Bay Special Area, and Kasegaluk Lagoon Special Area. The project area only intersects one of these special areas; as shown on Figure TM1-2 the Teshekpuk Lake Special Area intersects with the project area east of Utqiagvik. Only one of the potential road corridors, Corridor C – Eastern Route, crosses a portion of the Teshekpuk Lake Special Area.

Also shown on Figure TM1-2 are setbacks around the Meade River, Inaru River, and Niklavik Creek. These setbacks are identified in the NPR-A Record of Decision (ROD) under Lease Stipulation/Best Management Practice (BMP) K-1 (BLM 2013). The BMP states that permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers within the setback distance. However, on a case-by-case basis, essential pipeline and road crossings will be permitted through the setback areas. Although the proposed Atqasuk to Utqiagvik Road is not related to oil and gas development or facilities, the ROD also states BMPs in the ROD are applicable for all authorized (not just oil and gas) activities in the planning area.

### **Native Allotments**

Figure TM1-1 shows Native Allotments within the project area. As with all private properties, authorization must be obtained before accessing or performing work on these lands. Typically, the United States Bureau of Indian Affairs (BIA) is the point of contact for contacting allottees to negotiate access across and to Native allotments. Within the study area, the Iñupiat Community of the Arctic Slope (ICAS) assists BIA in carrying out this function. ICAS is a recognized tribe under the Indian Reorganization Act of 1934 and represents the Iñupiat people of the Arctic Slope (ICAS 2019).

### **Current Oil and Gas Leases**

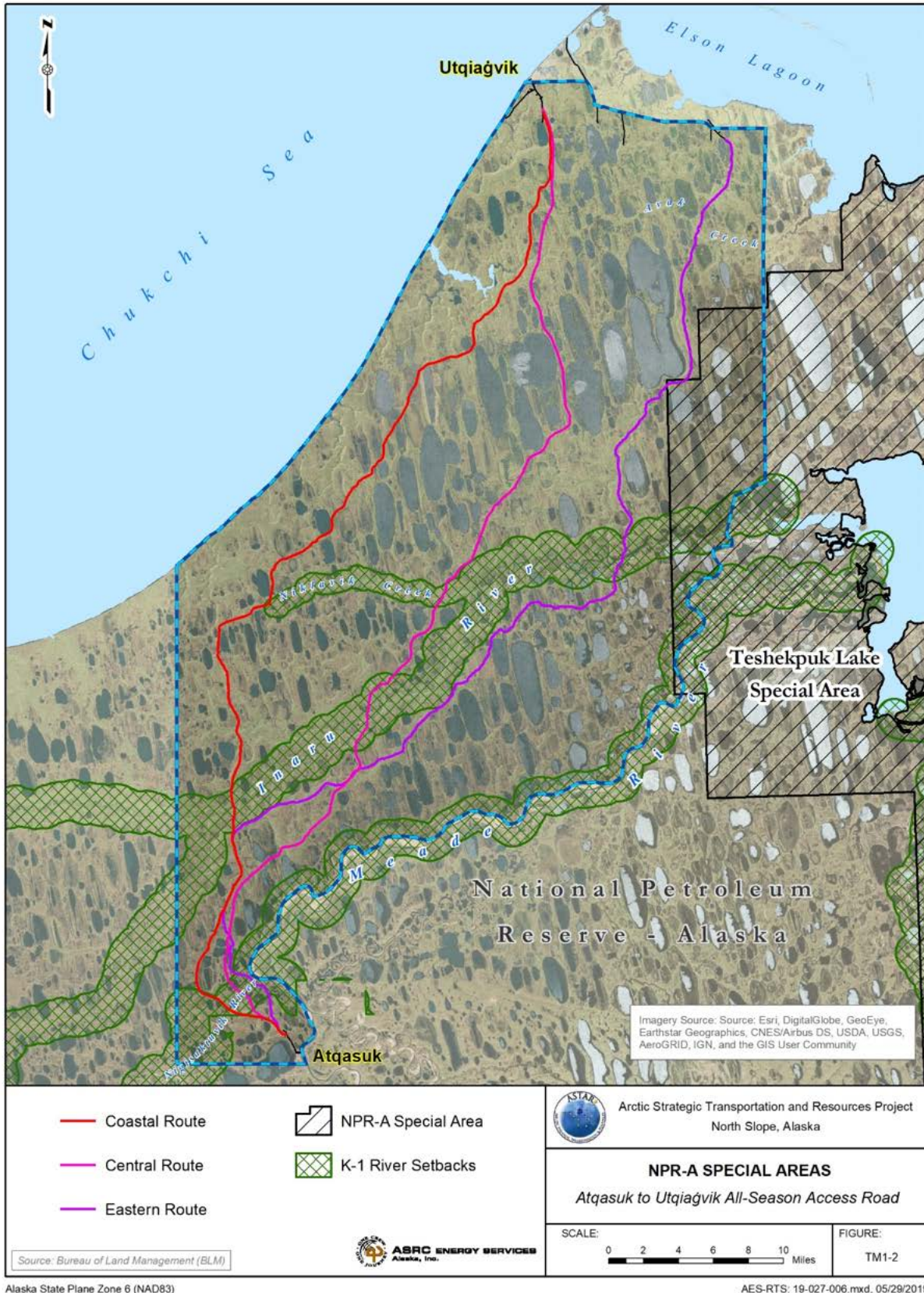
There are currently no oil and gas leases within the project area.

### **North Slope Borough**

The project area is within Alaska's North Slope Borough (NSB). The NSB, incorporated in 1972, is a Home Rule Borough and is the largest borough in Alaska. It covers nearly 88,000 square miles (more than 15 percent of the state's total land area).

The NSB government is funded by oil tax revenues, which uses these funds to provide public services. Utqiagvik is the NSB hub where main facilities and services are located, such as the NSB administrative offices (e.g., NSB Mayor's office), regional facilities support, search and rescue, and the regional hospital. The NSB has permitting and land management authority for activities within the region. Typically, permits must be obtained from NSB before initiating development or construction activities.

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The NSB also has zoning authority within its boundaries. Zones identified in NSB Title 19 include various districts specific to Barrow, Village Districts for communities outside Barrow and Conservation, Resource Development, Transportation, and Scientific Districts. Figure TM1-3 shows the various NSB zoning districts intersected by the potential road corridors. As shown on the figure, the Route A crosses a portion of the Reserve District for Utqiagvik and all of the routes cross Atqasuk Village District where they converge near the village. The Reserve District is intended to provide protection for environmental resources, local subsistence and recreational opportunities; and to act as a holding area for lands which require urban infrastructure such as roads, sewer, water and power before they can be developed (NSB 2019). The Village District governs the city limits of Atqasuk. The intent of the Village District is to accommodate uses that (1) reinforce traditional values and lifestyles; (2) are in accord with the Borough Comprehensive Plan, Capital Improvements Program, and Comprehensive Development Plan for the village; and (3) are in accord with the desires of the residents of the village (NSB 2019).

### **ANCSA 17(b) Easements**

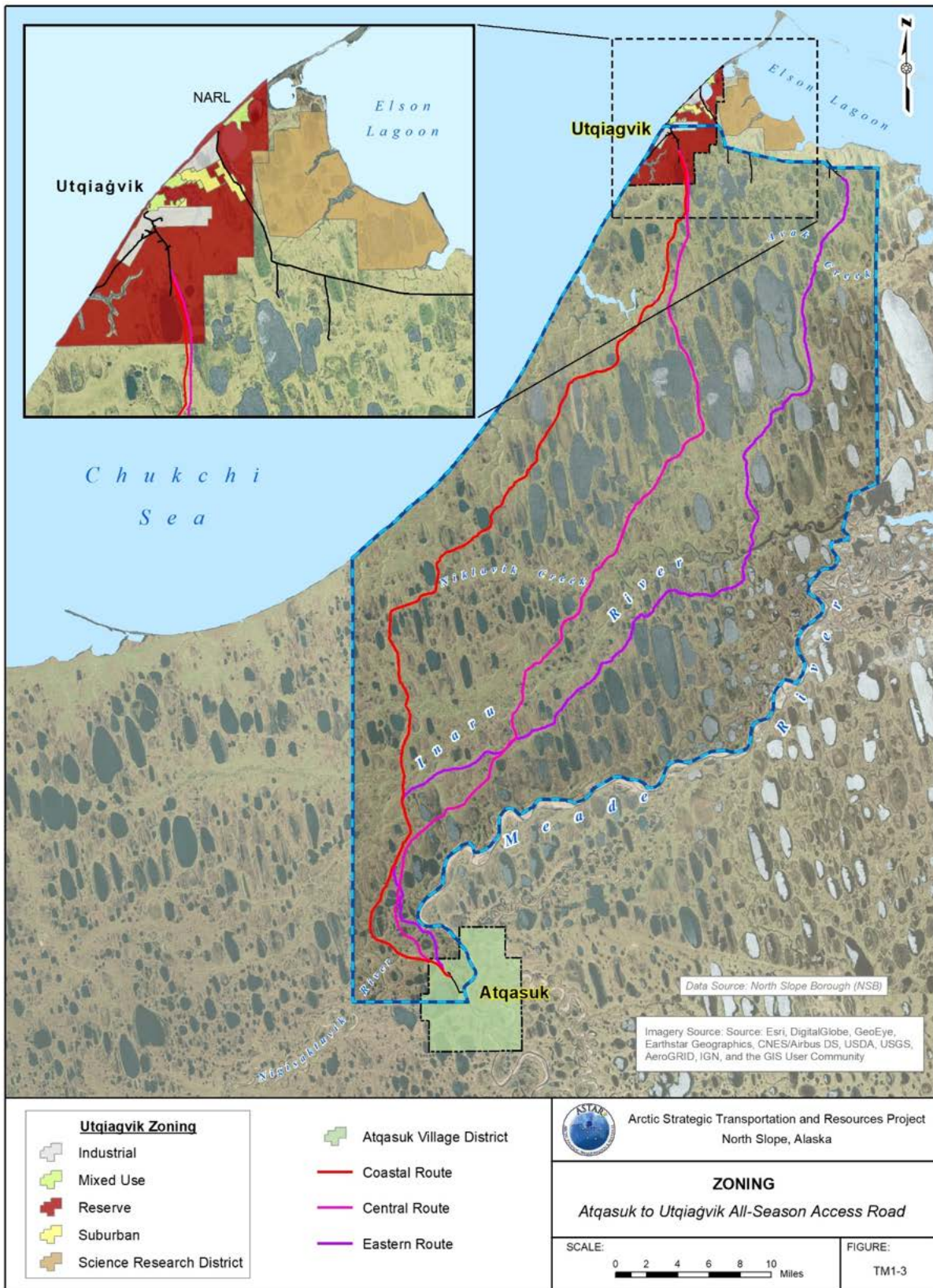
ANCSA 17(b) easements are rights reserved to the U.S. and may also be reserved to and from communities, airports, docks, marine coastline, groups of private holdings sufficient in number to constitute public use, and government facilities. They take the form of 60-foot wide roads, 25- and 50-foot wide trails, and one-acre sites for short-term uses. These rights are reserved when the BLM conveys land to an Alaska Native corporation under ANCSA. There are no 17(b) easements across public lands. The purpose of most 17(b) easements are reserved to allow the public to cross private property to reach public lands and major waterways (BLM 2019). Figure TM1-4 shows the alignments for ANCSA 17(b) easements near the project area. None of the proposed road corridors align with the 17(b) easements; however, they do intersect the easements in several locations.

### **Data Gaps**

Data gaps for land status include:

- More detailed analysis of land status and boundaries along the proposed road corridor will be needed as the project progresses.
- Consultation with the landowners and other stakeholders will be needed as the project progresses to gather input that could affect project outcomes, routing, and design. At a minimum, these stakeholders will include local residents, tribal organizations, UIC and Atqasuk Corporation, ASRC, BLM, NSB, and subsistence user co-management organizations.

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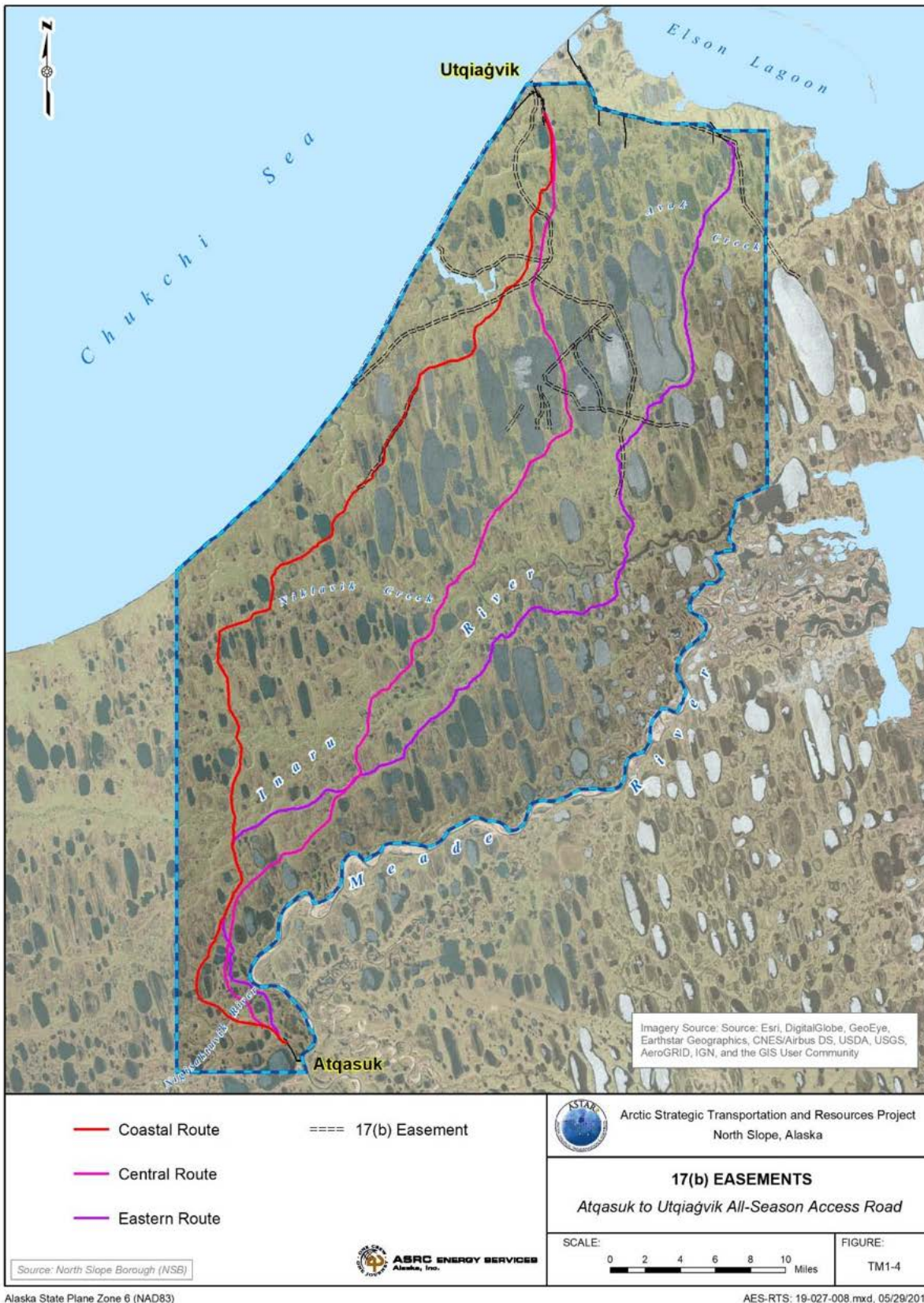


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## **Technical Memorandum 2 – Hydrology**

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## **Technical Memorandum 2 – Hydrology**

**Prepared by:** Larry Clamp, Geomorphologist  
**Reviewed by:** Paul Ramert, PE, Principal Civil Engineer  
**Date:** July 2019

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### **Overview**

This purpose of this memorandum is to provide high-level consideration of the hydrological features within the project area. Project area hydrology is a significant driver in the development of road route corridors and an understanding of the local hydrology is important for selection of stream and river crossing locations and types of crossing infrastructure, and overall design to enhance road stability and limit short- and long-term effects to the surrounding environment.

Hydrology studies provide inputs to engineering efforts as well as inputs for mitigating impacts to floodplains and channel morphology, with focus on maintaining the integrity of the project area's waterways and adjoining riparian habitat. They also assist in identifying potential hazards, location of gravel sources, and proper siting of project facilities, including appropriate location and types of waterway crossings.

Hydrology, and specifically the likely location of major crossings and the desire to avoid crossings whenever possible, was a large input to the route analysis and modifications performed for this study.

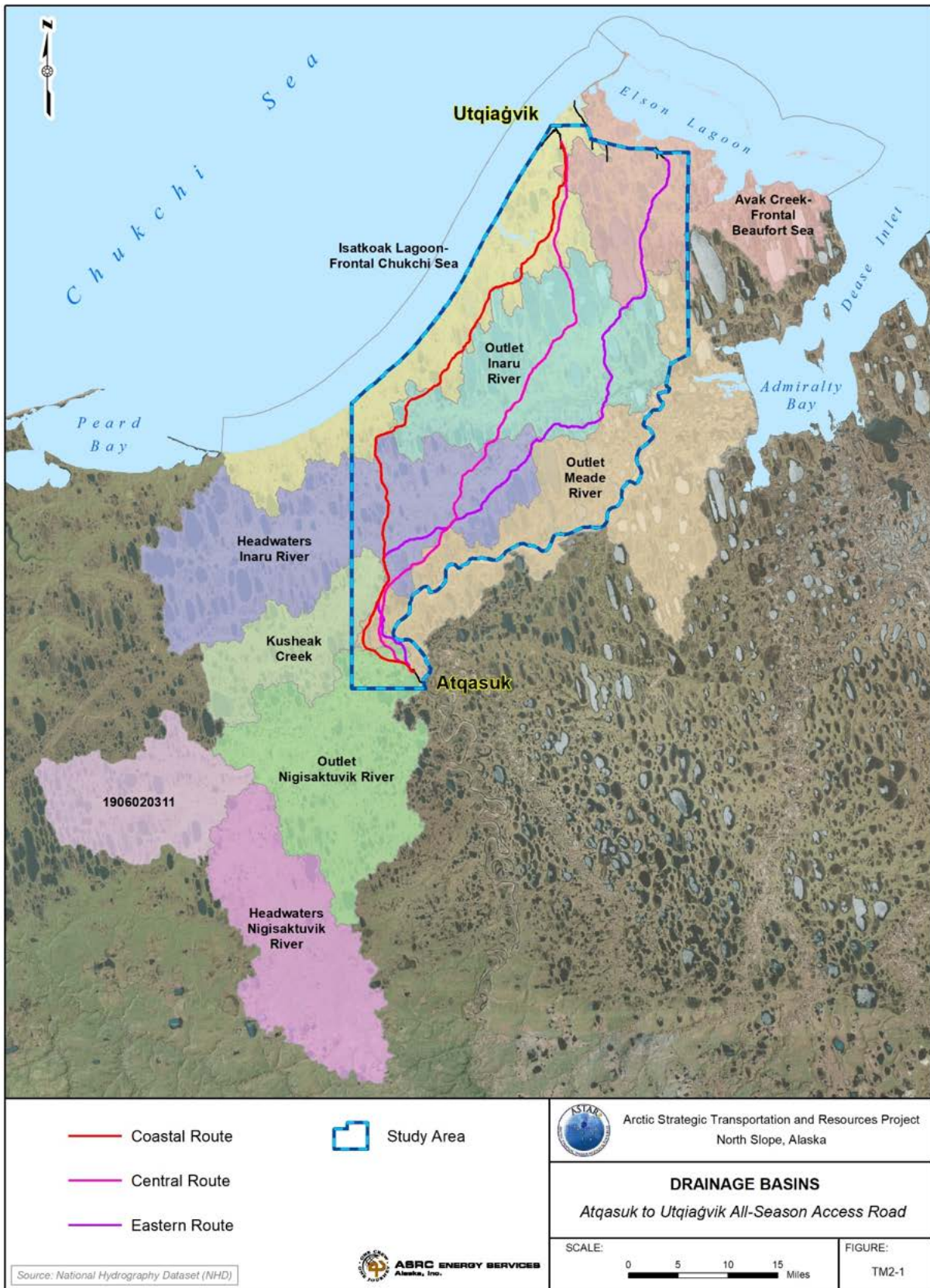
The project area is located within the Arctic Coastal Plain where hydrology is driven by the permafrost active layer that creates a system of interconnected ponds and palustrine wetlands through annual freeze/thaw cycles. Additional hydrologic processes that are derived from precipitation are based on snow accumulation from mid-September to mid-May and primarily rain during summer months, although snow may occur throughout the year. Snow on the ground is subject to extensive redistribution by the strong winds that are characteristic of the Alaskan Arctic (Rovaneck, et. al 1996). The hydrology of wetlands and ponds in the coastal plain is characterized by high summer evapotranspiration, which normally exceeds annual precipitation (Rovaneck, et. al 1996).

Hydrology data for design and development must include measurement of spring breakup and summer flows. Breakup processes affect the type and location of project facilities and determine type, size, and placement of bridges and culverts. Thorough monitoring and assessment of breakup hydrology is critical for developing design criteria and long-term viability of projects within the project area drainages. The data gathered from this analysis are also vital for the safety of people and the environment.

### **Drainage Basins**

The project area lies in a hydraulically diverse and complex region whose drainage basins encompass nine individual 10-digit hydrologic unit codes (HUCs) that drain 3,164 square miles (mi<sup>2</sup>) (See Figure TM2-1 and Table TM2-1).

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**Table TM2-1. 10-Digit HUCs Located in Project Area**

10-Digit HUC	Drainage Area (mi <sup>2</sup> )
Headwaters Inaru River	442
Outlet Inaru River	315
Outlet Meade River	479
Headwaters Nigisaktuvik River	287
Outlet Nigisaktuvik River	318
Kucehak Creek	145
Avak Creek-Frontal Beaufort Sea	514
Isatkoak Lagoon-Frontal Chukchi Sea	471
1906020311 (unnamed)	192
<b>Total</b>	<b>3,164</b>

The Meade River comprises the largest river system in the study area with a total length of over 250 miles, 90 miles of which flows along the eastern edge of the project area. Its headwaters begin approximately 84 miles southwest of Atqasuk and it empties into the Beaufort Sea region at Admiralty Bay. Although the project area was designed to eliminate the need to cross the Meade (since doing so would, as a necessity, require two major crossings), its associated drainages nonetheless contribute 1,277 mi<sup>2</sup> to the overall project hydrology. The associated drainage HUCs are the Outlet Meade River, Outlet Nigisaktuvik River, Headwaters Nigisaktuvik River, and 1906020311 (unnamed). The Nigisaktuvik enters the Meade just north of Atqasuk, approximately 190 miles from the headwaters. The vast majority of Meade River

breakup activity occurs during the month of May.

The Inaru River is the second largest river system in the project area, with a drainage area of 902 mi<sup>2</sup> composed of three related HUCs intersecting the project area (Kucehak Creek, Headwaters Inaru River, and Outlet Inaru River). The Inaru River itself flows northeast almost 100 miles from its headwaters at Lake Itinik to its outlet in the Meade River Delta near the Beaufort Sea. Kucehak Creek flows into the Inaru approximately 33 miles downstream of the headwaters with Niklavik Creek also joining approximately 37 miles farther downstream. These three systems form the bulk of the Inaru watershed. The Inaru River represents the most significant river crossing in the project area. There is no current data that describes the type and duration of the breakup event on the Inaru River; however, its proximity and morphology is similar to the Meade River, therefore, breakup events should be similar.

Additional drainage HUCs within the project area are the Isatkoak Lagoon-Frontal Chukchi Sea and Avak Creek-Frontal Beaufort Sea. These consist of near coastal drainages flowing directly into the Chukchi and Beaufort Seas, respectively, and cover the remaining 985 mi<sup>2</sup> of hydrology within the project area. Many of the waterways contained in these HUCs appear to support intermittent runoff and can likely be avoided through route alignment modifications more easily than those encompassed in the drainages discussed above. Avak Creek presents perhaps the most significant crossing in these coastal areas, in part due to its designation as an anadromous waterway rather than hydrologic concerns.

All routes cross at least a portion of most of these drainages with the exception of the Headwaters of the Nigisaktuvik and 1906020311 (unnamed). In addition, Corridor B–Central Route does not enter the Kucehak Creek drainage, and Corridor C–Eastern Route is entirely beyond proximity to the Isatkoak Lagoon-Frontal Chukchi Sea drainage.

Some segments of each route closely follow the boundaries between drainage basins. Routing along such boundaries, when possible, can serve to limit cross drainage, and can reduce the number of equalization culverts needed for the road. The availability of larger-scale data to assist in refinement of these basin boundaries would provide valuable input to any future route modifications.

## Stream and River Crossings

For the purpose of this analysis, stream and river crossings were selected by intersecting route alignments with hydrologic Geographic Information Systems (GIS) flowlines contained in the National Hydrography Dataset (NHD) (USGS 2019a, USGS 2019b). This resulted in a point dataset representing each intersection, which was then further refined through desktop inspection using available aerial imagery and elevation information in the GIS environment. Additional information was then derived for each crossing from these same data sources, including stream/river name (if available), approximate crossing width, channel width, and route milepost at which the crossing is located. Crossings were then characterized as *Minor*, *Intermediate*, or *Major* using this information as well as a preliminary assessment as to whether the crossing can be traversed using culverts or whether it is likely to require a bridge.

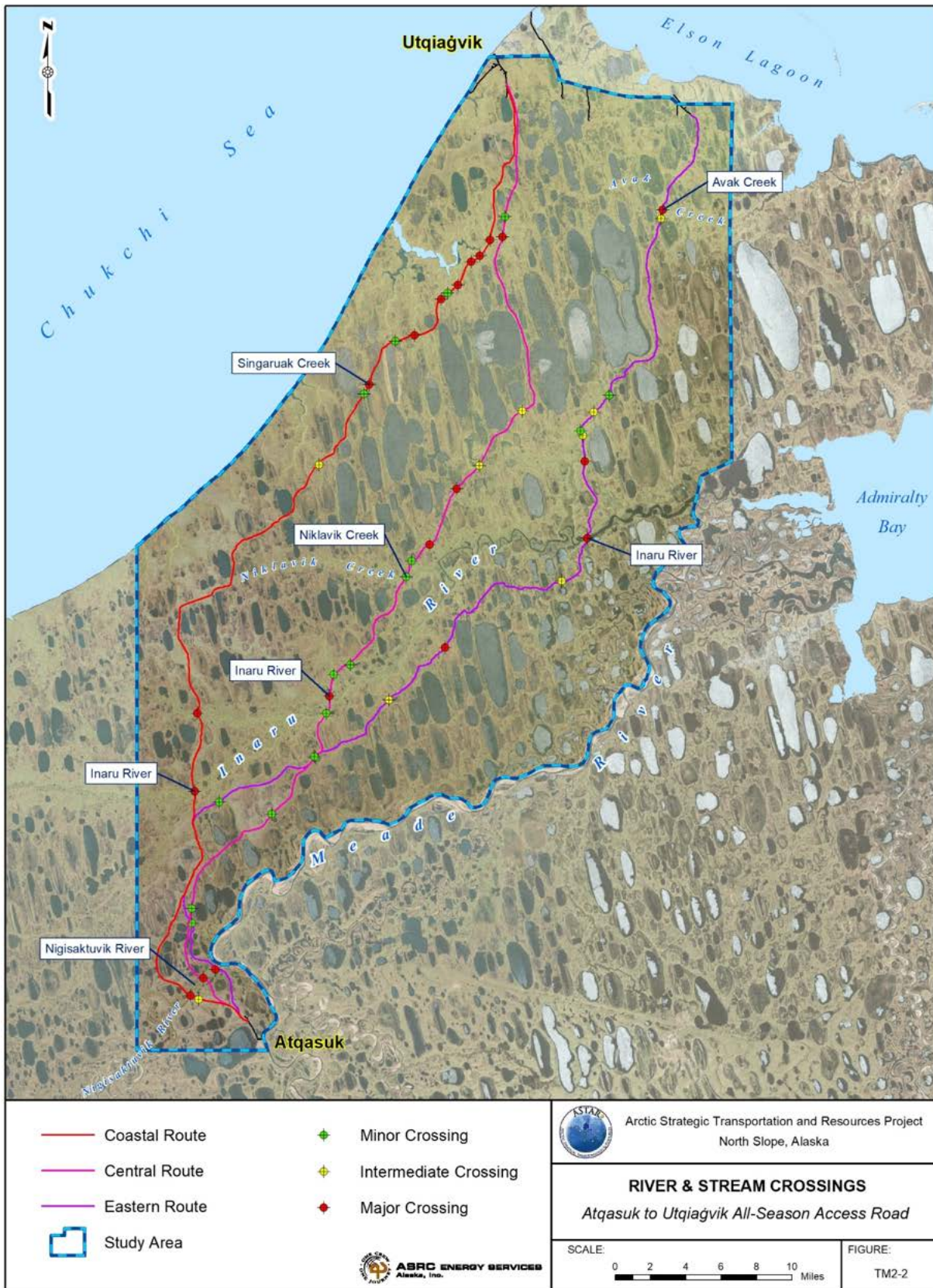
A crossing was initially classified by total width as *Minor* if less than 50 feet (ft); *Intermediate* if 50 to 100 ft; and *Major* if greater than 100 ft. Overall morphology, drainage area, channel width, and approach to the crossing were then considered along with engineering judgement to make a preliminary assessment of whether a culvert or bridge might be the appropriate drainage structure. This method was applied in the absence of actual field data in order to provide qualitative assessments as inputs to overall route comparisons. Linear measurements of crossing widths were also forwarded for use in cost estimates.

The need for equalizing culverts along each route was also considered and estimated at five per mile based on prior North Slope experience. The estimated number of crossings, as well as equalizing culverts, is presented in Table TM2-2.

**Table TM2-2. Stream and River Crossings Characterization**

Route	Minor Crossings <50 ft	Intermediate Crossings 50 to 100 ft	Major Crossings >100 ft	Equalization Culverts (5 per mile)
Corridor A – Coastal Route	3	2	10	338
Corridor B – Central Route	9	2	5	322
Corridor C – Eastern Route	5	5	5	368

All routes had similar numbers of identified crossings (15–16) but varied in overall character. The Coastal Route traversed the most *Major* crossings; the Central Route had a predominance of *Minor* crossings; and the Eastern Route was equally distributed but also contained the largest crossing among the route alternatives. In regard to maximum crossing width, the Coastal Route had an estimated 800 ft crossing, while the Central Route had one at 500 ft and the Eastern Route one at 1,025 ft. All routes require bridge crossings of the Nigisaktuvik and Inaru Rivers. Route crossings are shown in Figure TM2-2 and are tabulated in Tables TM2-3 through TM2-5.



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**Table TM2-3. Corridor A–Coastal Route Crossings**

Crossing Milepost	Stream/River Name	Total Width (ft)	Channel Width (ft)	Category	Assumed Structure Type
3.23		100	40	Intermediate	Bridge
3.73	Nigisaktuvik River	685	355	Major	Bridge
17.32	Inaru River	500	100	Major	Bridge
21.97		120	55	Major	Bridge
40.95		100	25	Intermediate	Culverts
45.95		10	5	Minor	Culverts
46.57	Singaruak Creek	165	30	Major	Bridge
49.64		50	5	Minor	Culverts
50.79		150	60	Major	Culverts
53.78		200	75	Major	Bridge
54.29		40	6	Minor	Culverts
55.05		150	20	Major	Culverts
56.60		110	30	Major	Culverts
57.22		150	65	Major	Bridge
58.31		800	100	Major	Bridge

**Table TM2-4. Corridor B–Central Route Crossings**

Crossing Milepost	Stream/River Name	Total Width (ft)	Channel Width (ft)	Category	Assumed Structure Type
3.70	Nigisaktuvik River	500	240	Major	Bridge
8.17		55	15	Minor	Culverts
15.78		60	5	Minor	Culverts
19.99		55	5	Minor	Culverts
22.90		50	5	Minor	Culverts
23.94	Inaru River	400	140	Major	Bridge
25.20		100	5	Minor	Culverts
26.35		75	5	Minor	Culverts
32.69	Niklavik Creek	50	20	Minor	Bridge
33.68		30	20	Minor	Culverts
35.12		200	75	Major	Bridge
38.70		250	10	Major	Culverts
40.58		100	50	Intermediate	Bridge
44.67		100	10	Intermediate	Culverts
55.43		320	85	Major	Bridge
56.59		40	5	Minor	Culverts

**Table TM 2-5. Corridor C–Eastern Route Crossings**

Crossing Milepost	Stream/River Name	Total Width (ft)	Channel Width (ft)	Category	Assumed Structure Type
3.92	Nigisaktuvik River	750	445	Major	Bridge
7.57		20	10	Minor	Culverts
15.91		65	30	Minor	Bridge
22.37		15	5	Minor	Culverts
28.12		65	50	Intermediate	Culverts
32.75		115	85	Major	Bridge
42.07		70	45	Intermediate	Culverts
45.40	Inaru River	1,025	825	Major	Bridge
50.21		140	5	Major	Culverts
51.70		100	40	Intermediate	Bridge
52.01		25	5	Minor	Culverts
53.39		80	50	Intermediate	Bridge
54.70		45	5	Minor	Culverts
66.78		75	15	Intermediate	Culverts
67.32	Avak Creek	190	75	Major	Bridge

Since these crossings were located based only on desktop analysis, there are potentially additional crossings that will be identified during project development and field surveys. Such surveys may also eliminate some crossings through realignment that is not evident from the desktop survey. The character of these crossings could also be modified based on collected data and field examination.

### Existing Data

Detailed hydrologic data, specifically in regard to discharge and channel morphology, is sparse within the study area. Shell Exploration and Production developed hydrology reports and data garnered during their 2008 through 2015 Chukchi Sea exploration efforts. The information is available via the North Slope Science Catalog, but may be located too far outside the study area to be of more than general use. The primary investigators for these studies in the project area were Arctic Hydrologic Consultants, who have published hydrologic assessments, river engineering evaluations, channel flood geometry reports, preliminary fluvial-geomorphic evaluations, and flood peak magnitude

Richard Kemnitz, retired Bureau of Land Management (BLM) Hydrologist, amassed a broad array of North Slope hydrology reports and data, including pre-design and ongoing monitoring data. Acquisition of additional data from BLM may be possible based on specific project footprints, alternatives, and other proposed development parameters. A request could be made to the BLM for this information with client approval for disclosure of a specific area of interest. Further assessment of any data received from BLM would then be necessary to ascertain applicability to project needs.

## Data Gaps

Data gaps for hydrology include:

- Site specific hydrologic studies for proposed crossings.
- Discharge and floodplain records to support project-specific design.
- High-resolution elevation data for drainage area characterization and calculations.

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## Technical Memorandum 3 – Geology/Geotechnical

**Prepared by:** Hans Hoffman, CPG, Associate Geological Engineer

**Reviewed by:** Paul Ramert, PE, Principal Civil Engineer

**Date:** July 2018

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### Overview

The project area is on Alaska's North Slope within the Arctic Coastal Plain physiographic province. The Arctic Coastal Plain extends from sea level to an elevation of about 600 feet and is characterized by gentle topography, ice-bonded permafrost, wet tundra, wind-oriented thaw lakes, and braided and beaded stream channels (Warhaftig, 1960). Terraces and steep riverbanks are found adjacent to major rivers. The ground surface elevation along the proposed road alignments varies from about 5 to 100 feet above sea level. A surficial geologic map is shown on Figures TM3-1, TM3-2, and TM3-3, along with the proposed Coastal, Central, and Eastern Route alternatives.

### Surficial Geology

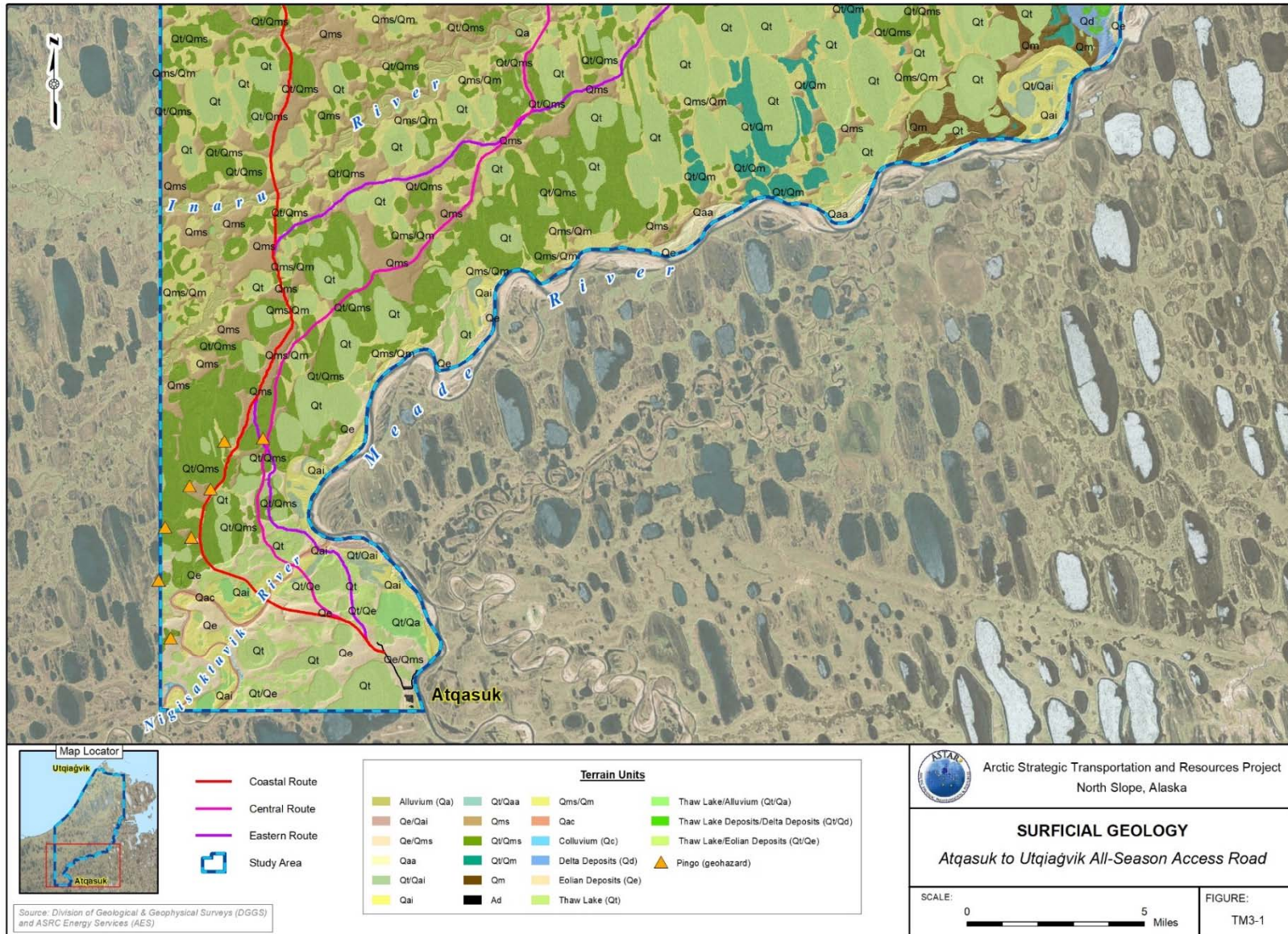
Surficial geology between Utqiagvik and Atqasuk is predominantly comprised of marine silts and sands with a lesser component of eolian sands. Detailed terrain unit mapping conducted in the study area delineates nine different geologic terrain units. Terrain units are intended to represent the basic soil profile within an estimated 20–30 feet of the surface. Where unit thickness is anticipated to be less than 20 feet thick, terrain units are expressed as a combination of individual units to represent the general vertical series to the interpreted depth of 20–30 feet. For example, thaw lake deposits (Qt) overlying marine silt (Qm) are expressed as Qt/Qm where the thaw lake basin is interpreted to be shallow. Terrain units intersected by the proposed alignments are described below.

***Undifferentiated Alluvium (Qa)*** - Undifferentiated alluvium consist of silt, organic silt, silty sand, stratified fine to medium-grained sand and gravelly sand, with lag deposits of coarse-grained sand and minor gravel occurring locally. Undifferentiated alluvium represents alluvial deposits along small streams including channel, low-lying active and inactive floodplains, and alluvial terraces that are not able to be differentiated at this map scale. Streams and floodplains with no discernible geologic features greater than 500 feet wide are represented by undifferentiated alluvium. Many streams characterized as undifferentiated alluvium are small beaded drainages that have low velocity flow, while others represent narrow, incised drainages in units such as eolian sand.

Undifferentiated alluvium is generally expected to be continuously frozen, however unfrozen taliks may be present beneath stream channels. Thaw settlement and frost heave potentials are generally low and unfrozen bearing strength is high within sand and gravel materials, while the frost heave potential is generally high and unfrozen bearing strength low in fine-grained materials.

Alluvium is generally a good source for granular construction materials; however, in this area these units may be predominantly comprised of finer-grained materials due to the low-energy depositional environment of the western Coastal Plain.

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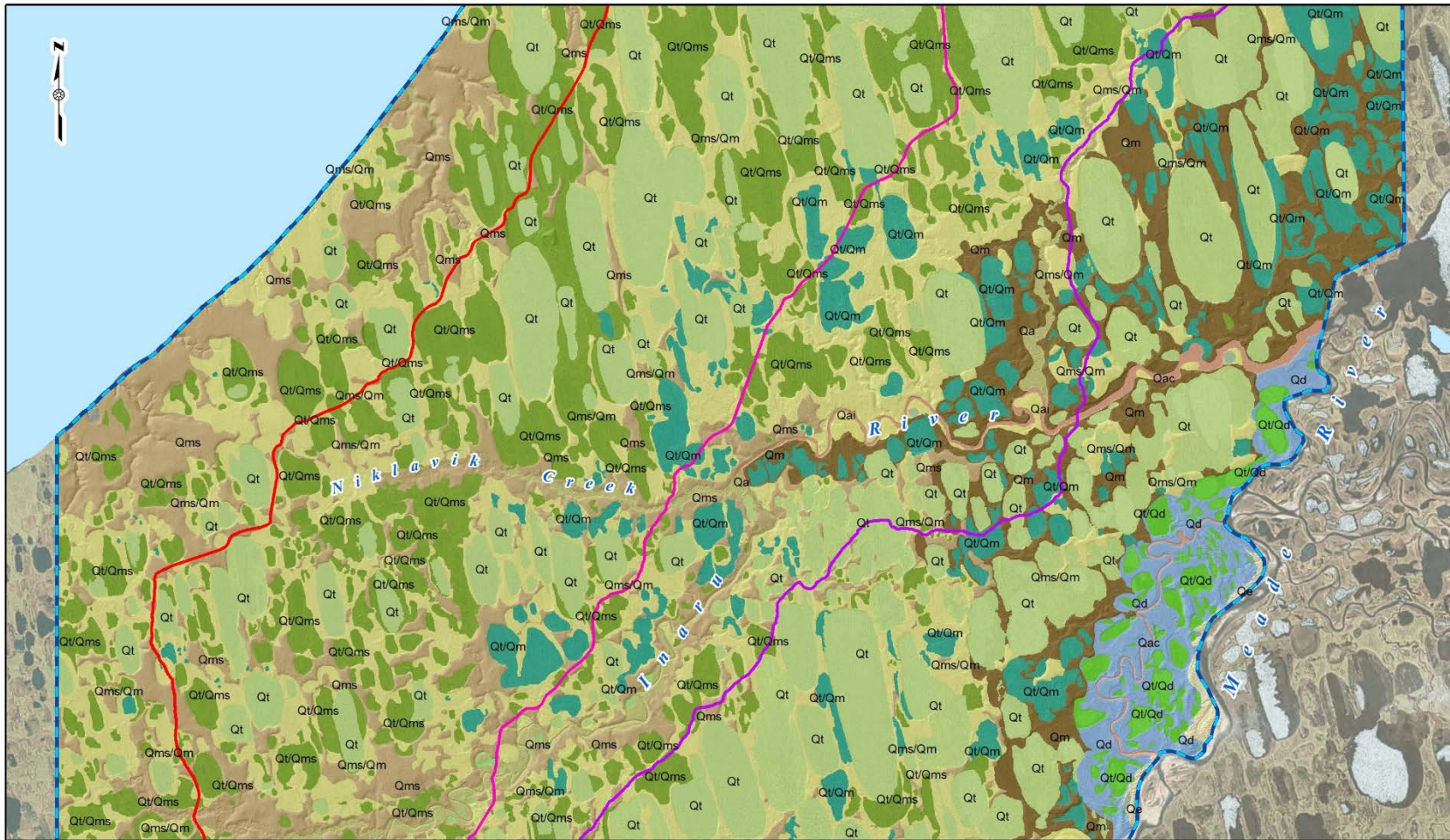


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- Coastal Route
- Central Route
- Eastern Route
- Study Area

Terrain Units			
Alluvium (Qa)	Qt/Qaa	Qm	Eolian Deposits (Qe)
Qaa	Qms	Qms/Qm	Thaw Lake (Qt)
Qt/Qai	Qt/Qms	Qac	Thaw Lake/Alluvium (Qt/Qa)
Qai	Qt/Qm	Delta Deposits (Qd)	Thaw Lake Deposits/Delta Deposits (Qt/Qd)



Arctic Strategic Transportation and Resources Project  
 North Slope, Alaska

**SURFICIAL GEOLOGY**  
 Atqasuk to Utqiagvik All-Season Access Road



FIGURE:  
 TM3-2

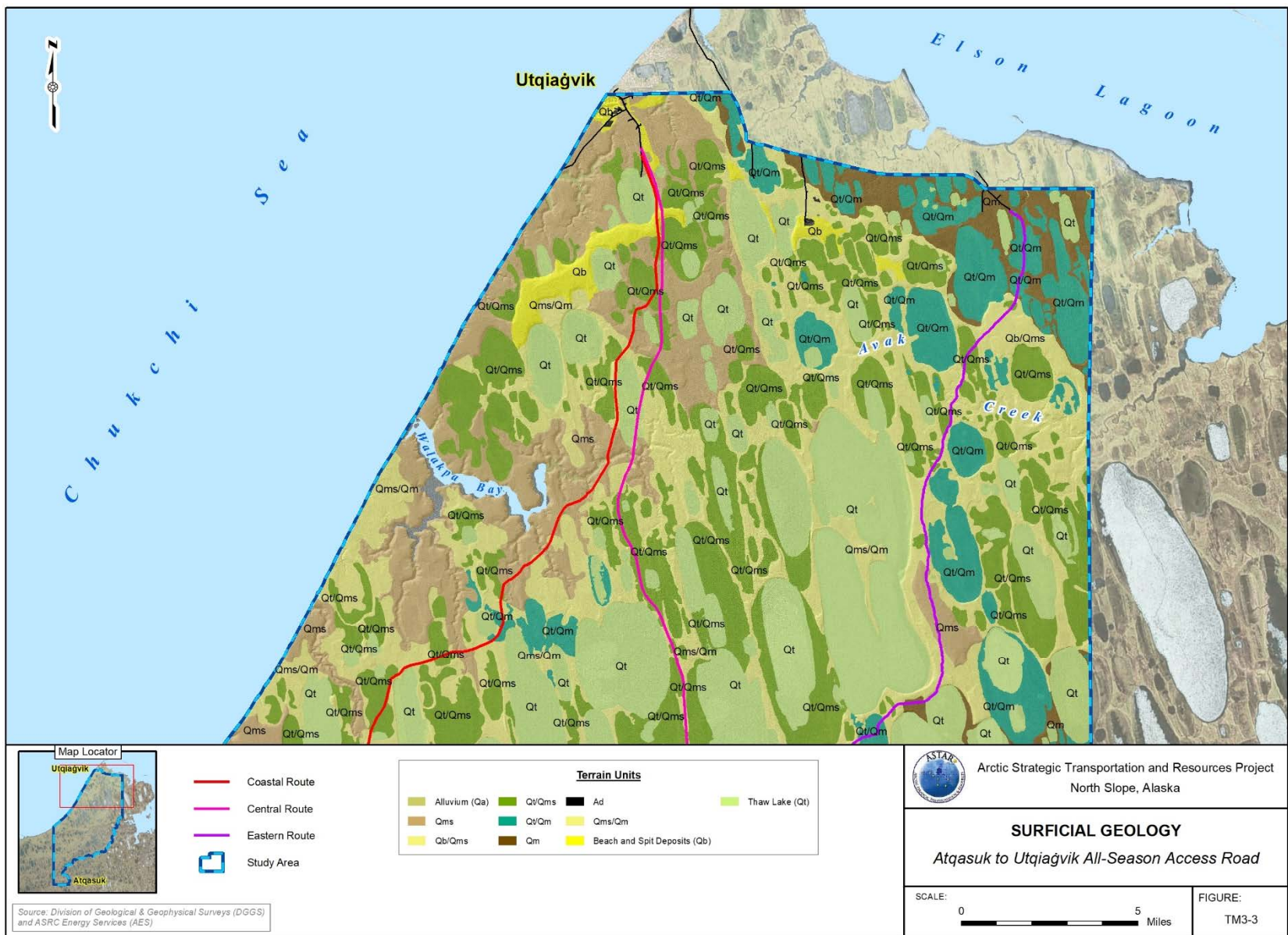
Source: Division of Geological & Geophysical Surveys (DGGs) and ASRC Energy Services (AES)

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**Active Floodplain (Qaa)** - Active floodplain deposits include areas adjacent to the active channel that appear to be active at least seasonally as defined by sparse vegetation, surficial pattern, and elevation similar to the active channel.

These deposits range in composition from silt and silty sand in small, sluggish streams to sand and gravel in higher energy, larger rivers. Active floodplain deposits are typically overlain by variable thicknesses of organic and fine-grained overbank deposits.

Active floodplain deposits are expected to be continuously frozen, but may have taliks locally. Thaw settlement and frost heave potentials are generally low and unfrozen bearing strength is high within the sand and gravel materials, while the frost heave potential is generally high and unfrozen bearing strength low in fine-grained materials.

These deposits may provide a source for granular material including sand and gravel, depending on local stream energy and grain size.

**Active Channel (Qac)** - Within the project area, active channel deposits range from silt and sand to sand and gravel. Active channels may prove a potential source for gravel, but fine to medium sand is more likely where streams cut through eolian deposits and marine sand.

Taliks are expected to extend below active layer depths beneath active channel deposits. Thaw settlement and frost heave potentials are generally low and unfrozen bearing strength is high within sand and gravel materials, while thaw settlement and frost heave potentials are generally high and unfrozen bearing strength low in fine-grained materials.

Though active channel deposits may contain sand and gravel, the likely mode of mining would be dredging which would present logistical, environmental, and regulatory challenges.

**Inactive Floodplain (Qai)** - Inactive floodplain deposits include areas that flood occasionally. Materials range in composition from silt and silty sand to sand and gravel. Inactive floodplains typically form older, higher surfaces than the current active floodplains. These deposits are overlain by organic, fine-grained overbank deposits and wind-blown silt and sand with thicknesses greater than within active floodplain deposits.

Inactive floodplain deposits are expected to be continuously frozen, with localized taliks under lakes. Thaw settlement and frost heave potentials are generally low and unfrozen bearing strength is high within sand and gravel materials, while the frost heave potential is generally high and unfrozen bearing strength low in fine-grained materials.

These deposits may provide a source for granular material, depending on local stream energy, grain size, and overburden thickness.

**Beach and Barrier Island Deposits (Qb)** - Beach and barrier island deposits are intermittently present along the modern coastline and to a lesser extent inland along wave-cut scarps, representing previous shorelines. Soils range from fine sand and silt to pebbly sand and silt and clay with boulders. Fine sand and pebbly sand are primarily anticipated. Beach deposits form low ridges, while barrier islands form discontinuous chains of ridges. Barrier island deposits are expected to be underlain by marine sand (Qms) and marine silt and clay (Qm). The marine silt and clay is expected to be encountered at an elevation of about 6.5 feet above sea level.

Paleo-beach and barrier island deposits are identified based on relatively linear to arcuate geometry on digital elevation models, proximity to wave-cut scarps, and a surface appearance indicating well to moderate draining

soils. The scarps were cut by erosion occurring at shorelines during times of high sea stands related to marine transgressions.

Beach and spit deposits may be locally unfrozen or thaw stable. Frost heave potential is relatively low and unfrozen bearing strength generally moderate. However, these deposits are likely underlain by materials that are not thaw stable.

These deposits have potential to provide sand and/or sand and gravel construction materials locally.

***Eolian Deposits (Qe)*** - Eolian deposits consist of well-sorted/poorly graded silt to fine sand composed of quartz and minor dark minerals, generally containing very little pebble-sized material. Thickness ranges from about 10 to nearly 100 feet. Large-scale cross bedding is present locally. The upper ten feet contains wind-blown silt along with wood and peat beds. This material is highly susceptible to wind erosion, resulting in blowouts, where the surficial organic cover is broken.

Eolian deposits are continuously frozen with ice-rich overburden. Thaw settlement potential varies with silt and ice contents. Silt-rich areas may be susceptible to frost heave, however the general bearing strength of the material is moderate to good. Thaw lakes and pingos are common within this unit, as are thaw slumps and slope instabilities along riverbanks. Thaw lakes within the eolian deposits appear to be more sandy than in other units. Interbedded layers of silt, sand, and organic material are anticipated within the thaw lakes.

The contact between the eolian deposits and the marine sand (Qms) are transitional. The surface of the marine sand is typically reworked by eolian processes.

Sand from this unit may be useable for some construction purposes.

***Marine Deposits, fine grained (Qm)*** - Marine deposits include primarily gray silt and clay along with minor amounts of fine sand and sandy silt. These deposits are generally present below elevations of 5–6 feet along the Beaufort Sea coastline. These deposits include erratic pebbles, cobbles, and boulders. The marine deposits are extensively reworked by thaw lake processes, and are expected to be overlain by 3–7 feet of peat.

Marine silt is expected to be continuously frozen. These deposits are susceptible to both thaw settlement and frost heave, and generally have low unfrozen bearing strength.

This unit is not expected to provide a source for granular construction materials.

***Marine Deposits, Sand (Qms)*** - Marine sand consists of estuarine sand and commonly overlies fine-grained marine deposits (Qm). Sand is typically fine grained and well sorted, however in the western portion of the project area, the sand is generally coarser, ranging from fine to medium, and can contain a significant amount of silt. The upper surface is reworked by wind and covered with pebble-lag sand.

The marine sand is generally separated from younger fine-grained marine deposits (Qm) by deposits of a former barrier island chain (Qb), and overlies older silt and clay marine units (Qm). Contacts between the marine sand and the marine silt and clay units are transitional, and the terrain unit classification (Qms/Qm) is used to designate the presence of the older marine unit within terrain mapping depths.

These deposits are expected to be continuously frozen, and may be susceptible to both thaw settlement and frost heave depending on silt and ice contents.

Sand from this unit may be useable for some construction purposes.

**Thaw Lake Deposits (Qt)** - Thaw lake deposits are common. These deposits contain a mixture of peat, organic silt, silt, and sand. A combination of lacustrine and eolian processes form interbedded layers of organic-rich deposits and eolian silt and sand. Thaw lakes form as ice within a deposit begins to thaw. This results in thaw-settlement, and further thermal degradation. A basin is formed, which then accumulates sequences of lacustrine, eolian, and organic material.

Thaw lakes have been distinguished based on interpretation of imagery and digital elevation models. If the basin is deeply incised such that the upper 20–30 feet of material would be comprised of thaw-lake related deposits, a single designator for terrain unit is used (Qt). Where thaw lakes are not deeply incised, but are interpreted to have greater than 5 feet of material thickness, a dual designator is used. The interpretation is made irrespective of water content of the thaw lake basin.

Thaw lake deposits are continuously frozen, though taliks are typically present beneath water bodies. The deposits form in ice-rich deposits, have a high potential for frost heave if thawed, and have low thawed bearing strength. Pingos are very common within drained thaw lake basins.

This unit does not have potential to provide granular construction materials.

Table TM3-1 provides the total length of each geologic terrain traversed by each alignment and general engineering characteristics for each unit.

As shown in Table TM3-1, Qms/Qm and Qms comprise a majority of the proposed routes. The Qms unit, while variable, has potential to provide construction materials as well as a thaw stable road base. The variability and presence of Qm will need to be investigated to ascertain suitability of materials. Geotechnical investigations may reveal Qb where Qms was interpreted, which would be beneficial to road construction and material site selection.

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**Table TM3-1. Terrain Unit Characteristics**

Terrain Unit	Abbr.	Length (miles)			Engineering Characteristics					
		Corridor A - Coastal Route	Corridor B - Central Route	Corridor C - Eastern Route	Frost Heave Potential	Thaw Settlement Potential	Thawed Bearing Strength	Suitability as Material Source	Useable Material	Potential Uses
Alluvium	Qa	0.11	0.71	0.15	Low	Low	High	Good	Sand and gravel	fill, concrete aggregate
Active Floodplain	Qaa	0.02	0.00	0.00	Low	Low	High	Good	Sand and gravel	fill, concrete aggregate
Active Channel	Qac	0.10	0.08	0.30	Low	Low	High	Good	Sand and gravel	fill, concrete aggregate
Inactive Floodplain	Qai	0.78	0.44	0.46	Low	Low	High	Good	Sand and gravel	fill, concrete aggregate
Beach and Barrier Island Deposits	Qb	0.05	0.15	0.00	Low	Low	Moderate	Good	fine-grained sand, sand with gravel may be present	bedding, slurry, fill
Beach and Barrier Island Deposits/Marine Deposits, sand	Qb/Qms	0.00	0.00	0.87	Low	Low	Moderate	Good	fine-grained sand, sand with gravel may be present	bedding, slurry, fill
Eolian Deposits	Qe	3.60	2.68	2.19	Moderate	Varies	Moderate	Good	fine-grained sand	bedding, slurry, fill
Eolian Deposits/Marine Deposits, sand	Qe/Qms	0.94	0.50	0.50	Moderate	Varies	Moderate	Good	fine-grained sand	bedding, slurry, fill
Marine Deposits, fine grained	Qm	0.00	0.00	6.79	High	High	Low	Poor	n/a	n/a
Marine Deposits, sand	Qms	27.90	15.39	18.16	Moderate	Moderate	Moderate	Moderate to Good	sand	bedding, slurry, fill
Marine Deposits, sand/Marine Deposits, fine grained	Qms/Qm	19.64	16.21	24.64	Moderate	Moderate	Varies	Moderate to Poor	sand	bedding, slurry, fill
Thaw Lake Deposits	Qt	1.48	3.39	5.65	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits/Alluvium	Qt/Qa	0.00	0.14	0.00	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits/Inactive Floodplain	Qt/Qai	0.00	0.13	0.01	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits/Eolian Deposits	Qt/Qe	0.31	1.38	1.45	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits/Marine Deposits, fine grained	Qt/Qm	0.52	2.13	5.34	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits/Marine Deposits, sand	Qt/Qms	12.10	21.04	7.10	High	High	Low	Poor	n/a	n/a
<b>Total</b>		<b>67.54</b>	<b>64.36</b>	<b>73.61</b>						

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## Geologic Hazards

Pingos are the primary geohazard in the project area. Pingos are steep-sided, ice-rich, conical mounds formed by the expansion of freezing water rising from hydrostatic or hydraulic pressure (Rowley et al 2015). Pingos typically have an ice-rich core with accompanying ice lenses near the top of the mound. Pingos are dynamic in nature and can grow to heights as high as 150 ft in the case of Ibyuk Pingo in Canada’s Western Arctic. Pingos can also shrink and even collapse on themselves often leaving crater-like depressions on the surface. Due to their dynamic nature, they pose a risk to infrastructure such as roads, pipelines, and foundations.

Pingos are easily mitigated with proper route selection since they often form in thaw lake basins, which are not favorable for construction in the first place. There are three pingos within 0.25 miles of the proposed alignments, with the closest being around 500 feet. While pingos can grow to be that large in diameter, it often takes decades or centuries to achieve that size, and the ones nearest the alignment appear relatively stable, as they do not have particularly steep sides nor crater-like depressions.

## Existing and Potential Gravel Mine Sites

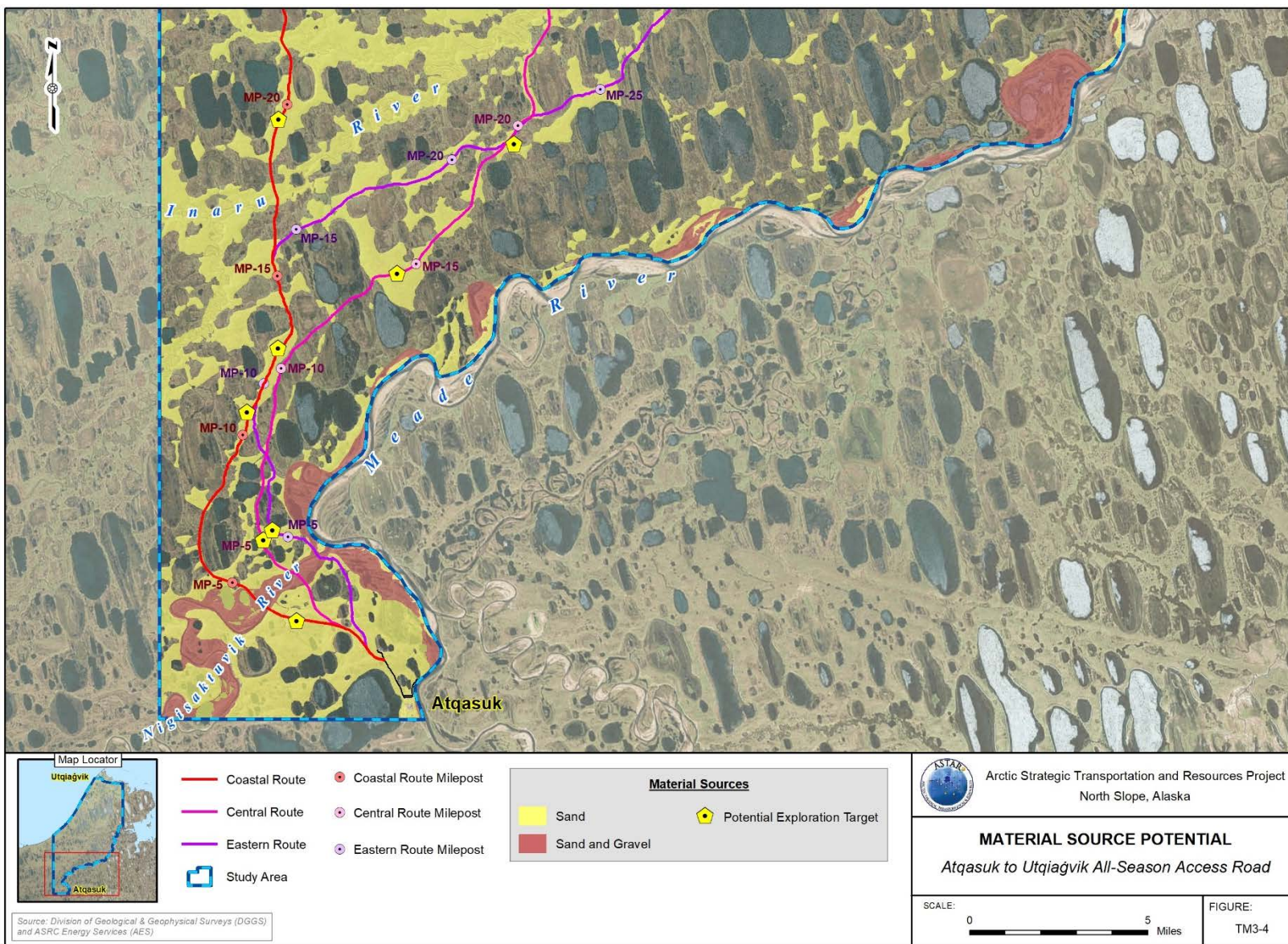
Ideally, a suitable material source will be located approximately every 10 miles along the proposed road alignment. Figures TM3-4, TM3-5, and TM3-6 highlight the terrain units with the best potential for sand and gravel, and propose specific exploration targets close to the alignments. The 10-mile spacing was taken into consideration when selecting the targets and it is apparent some targets are better than others.

There are three existing gravel mines near Utqiagvik (Figure TM3-6). SKW Eskimos, Inc., operates a pit on land owned by the City of Barrow, “City Pit”, located at the southwest end of the airstrip. The City Pit produces a silty-sandy-gravel material. The pit is reaching the end of its useful life, although expansion is possible with a potential yield of up to an additional million cubic yards. The Alaska Department of Transportation & Public Facilities (ADOT&PF) mined a pit on state land located between the airstrip and the SKW pit for construction of the airstrip. This pit is reported to have minimal materials remaining on state land with limited expansion opportunities due to Emaiksoun Road bounding the property on the east. Ukpeagvik Inupiat Corporation (UIC) operates a pit, “UIC Pit”, located four miles southeast of Barrow located off Eastfield Road near the landfill. The UIC Pit produces a silty-sand material with less coarse aggregate. The material quality is reported to contain more fines than the City Pit. None of the existing sources produce non-frost susceptible gravel because of the higher silt content and limited coarse aggregate.

Potential material sources will likely be derived from the coarser fractions of ancient beach deposits, marine sands, eolian sands, and inactive alluvial deposits. The first ten miles of each route cross similar terrains and have similar material source potential. The coastal route targets a large sand unit for a material site near MP 3, but the inactive floodplain of the Nigisaktuvik River may provide materials near MP 4. The Central and Eastern routes target a smaller sand unit near their respective MP 5, however, as with the Coastal Route, the inactive floodplains near their respective MP 4 may be a good target as well.

In March 2019, the John D. Dingell, Jr. Conservation, Management, and Recreation Act was signed into law, and included a provision to convey subsurface rights for 22 Sections held by the United States to UIC within one year after the date of enactment. These sections, shown on (Figure TM3-6) appear to contain ancient beach deposits and marine sands, which could provide suitable construction materials.

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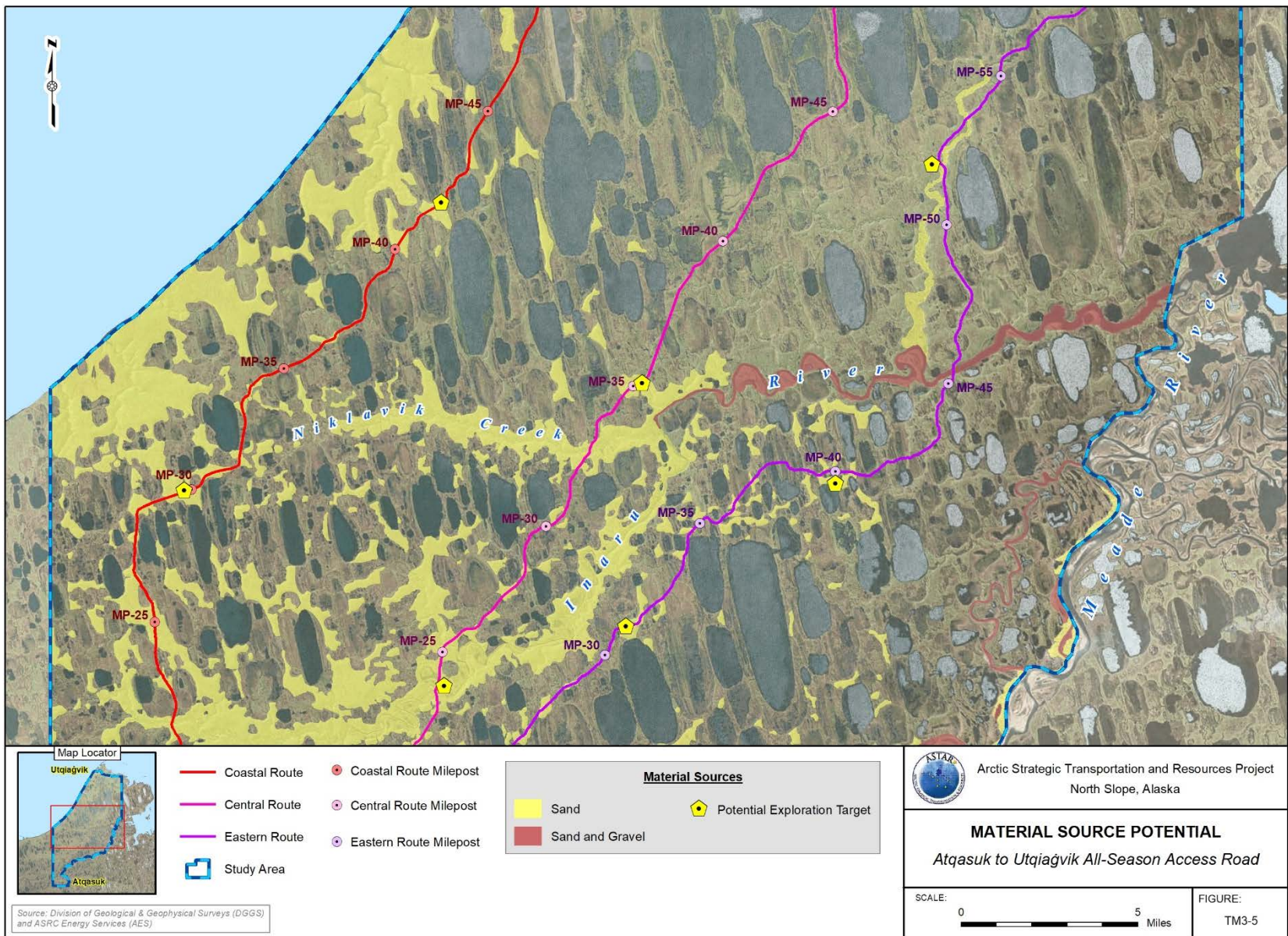


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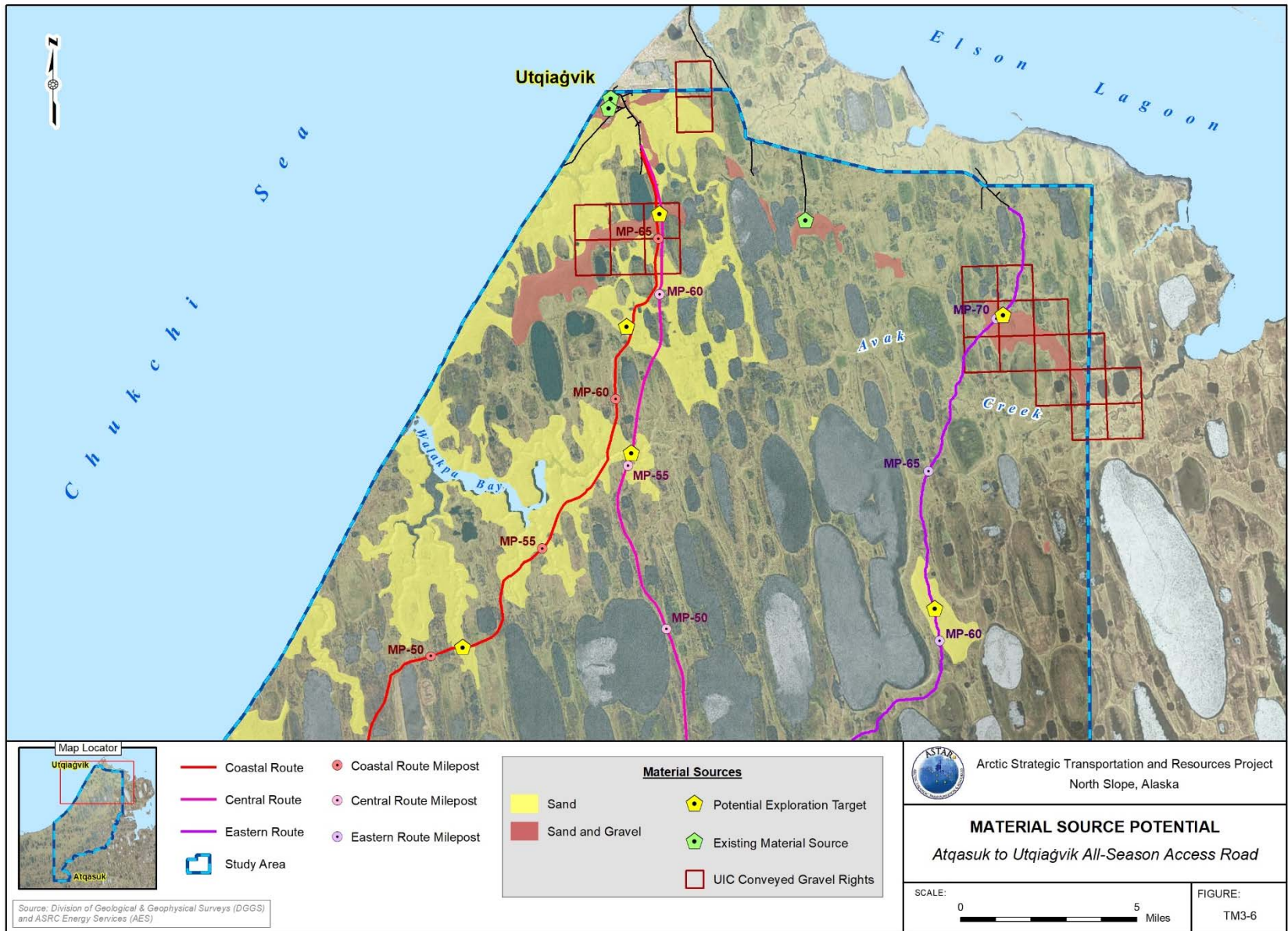


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**Coastal Route** - In general, the Coastal Route has better material source potential due to the terrains being coarser and traversing a greater percentage of Qms vs Qms/Qm or Qm. The only exception to this would be the upper reaches of the Inaru, where the Central and Eastern Routes may have better material quality.

**Central Route** - The Central Route is similar to the Coastal Route at the beginning and end, but deviates significantly between MPs 11 and 54. There is a low probability of finding a good material source between MPs 35 and 55, and a moderately low probability of finding a good material source between MPs 25 and 35. This is due to the increased presence of thaw lake basins and lack of sufficient marine sand. The lack of a viable material source in this region could prove to be a challenge for this route.

**Eastern Route** - The Eastern Route has fairly significant deposits of Qai, Qe, and Qms between MPs 0 and 25. There are isolated pockets of Qms that may yield material between MPs 25 and 40. There is considerable Qms/Qm between MPs 20 and 40, but as with the Central Route, the suitability of materials is dependent on the proportion and quality of sand vs finer materials. The inactive floodplain of the Inaru River should be investigated, but does not appear to be a significant source of materials in the vicinity of the crossing near MP 45. There is a significant deposit of Qms at MP 60, which could provide suitable materials. The best opportunity for materials occurs near the end of the route at MP 70 where an ancient beach deposit exists.

## Data Gaps

Data gaps for geology/geotechnical include:

- Conduct reconnaissance to assess geotechnical and geological conditions
- Determine suitability of Qai and Qms for material sources
- Delineate sufficient resources for gravel road construction

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<sup>1</sup> Sources that support terrain unit mapping are not referred to in the text.

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## **Technical Memorandum 4 – Existing and Proposed Infrastructure**

**Prepared by:** Paul Ramert, PE, Principal Civil Engineer

**Reviewed by:** Hans Hoffman, CPG, Associate Geologic Engineer

**Date:** July 2019

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### **Overview**

The following briefly describes existing infrastructure that lies between the termini of the proposed Atqasuk to Utqiagvik Road, including the Barrow Gas Fields, National Petroleum Reserve – Alaska (NPR-A) Legacy Wells, winter trails, and the Rogers-Post Site. Proposed infrastructure that could be constructed in the reasonably foreseeable future is also described; this includes the Atqasuk Transmission Line and the Arctic Slope Telephone Association Cooperative (ASTAC) Fiber Optic Line.

### **Existing Infrastructure**

#### ***Barrow Gas Fields***

The Barrow Gas Fields (BGF) provide natural gas to the community of Utqiagvik for power generation, heating for the majority of homes in the community, and cooking. BGF consists of four fields, South Barrow Gas Field, East Barrow Gas Field, Sikiluk, and Walakpa Gas Field. The North Slope Borough (NSB) owns the gas field wells, pipelines, buildings, equipment, and related infrastructure, including the right to access, explore, develop, and produce subsurface hydrocarbons. The gas fields are currently operated and maintained under a contract with CONAM Construction Co./Tikigaq Native Corporation, a Joint Venture.

The East Barrow Gas Field is accessible via existing gravel roads. The Walakpa Gas Field is currently accessed by helicopter and/or a Rolligon trail. The South Barrow Gas Field has both gravel road accessible locations, and some wells only accessible by trails. Figure TM4-1 shows the layout of Barrow Gas Fields infrastructure in relation to the proposed Atqasuk to Utqiagvik Road alignment alternatives. Note that both Corridors A and B will require utility crossings of the Walakpa Gathering Line.

Federal contractors discovered the three fields on separate expeditions in the region between the late 1940s and 1980s. The fields have generally required minimal development, aside from a \$92 million rejuvenation program launched in 2011 to combat declining production (Lidji 2018).

Infrastructure for the gas fields consists of wells, well houses on the tundra, infield pipelines, several structures comprising the Walakpa Gas Field Complex, and a Central Processing Facility located at the South Barrow Gasfield. The 6-inch infield gas pipelines are typically mounted on vertical support members that extend several feet above the tundra surface.

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**NPR-A Legacy Wells**

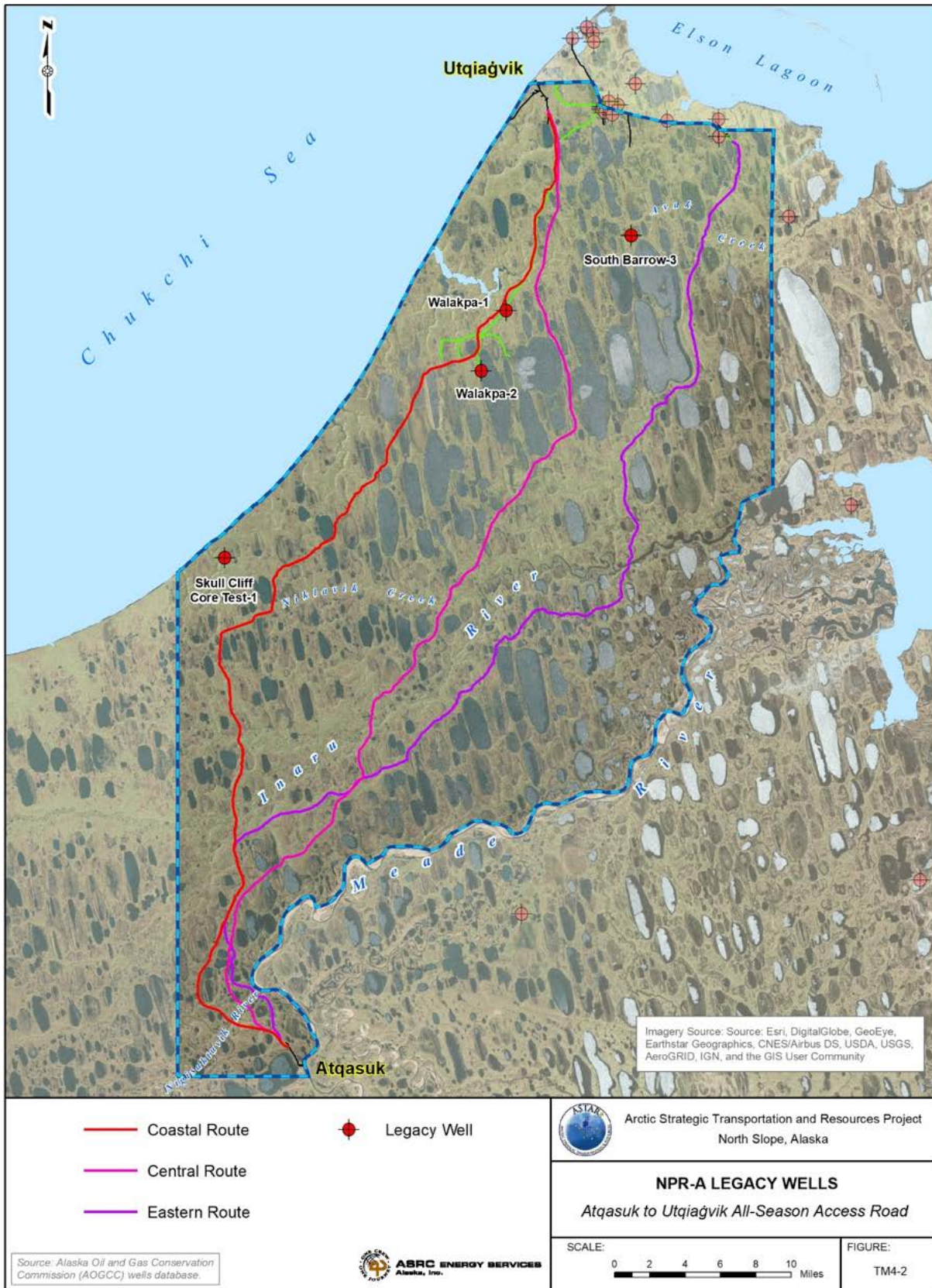
Legacy wells were drilled within and adjacent to the NPR-A prior to 1982, when the Bureau of Land Management (BLM) held its first lease sale. A total of 136 test holes were drilled under two distinct drilling periods, both sponsored by the U.S. Government to explore for oil and gas resources. In the first period, from 1944 to 1952, the U.S. Navy drilled 91 holes, locating eight small oil and gas fields (Fish Creek, Gubik, Meade, Simpson Peninsula, South Barrow, Square Lake, Umiat and Wolf Creek). In the second period, from 1975 to 1981, Husky Oil Corporation, working under contract for both the U.S. Navy and U.S. Geological Survey (USGS), drilled 36 holes. The remaining 9 holes were drilled in the Barrow area between 1953 and 1974. These holes are categorized as an exploratory oil well, core test, or temperature monitoring well. In 1982, the BLM inherited the responsibility to assess, plug, and clean up the wells that the U.S. Navy and USGS left behind (BLM 2019).

Several of the NPR-A Legacy Wells are situated along the potential road alignments: South Barrow #3, Walakpa #1 and #2, and Skull Cliff Core Test #1 (Figure TM4-2). The disposition of these wells is summarized in Table TM4-1 (BLM 2013b).

**Table TM4-1. NPR-A Legacy Wells within Project Area**

Name	Subsurface Risk	Surface Risk	BLM Strategic Plan Action	Well Category
South Barrow #3	Moderate	Moderate	Barrow Area Phase 1 Plug & remove solid waste	Cased well
Walakpa #1 and #2	NA	NA	No Action	Transferred to NSB by Barrow Gas Field Transfer Act
Skull Cliff Core Test #1	Moderate	High	Monitor, surface cleanup by PRP	Cased well

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The South Barrow #3 well is located approximately 10 miles south of Utqiagvik. This well is on lands owned by Ukpeaġvik Iñupiat Corporation (UIC), with the oil and gas reserved to NSB. However, the well remains in Federal ownership, as it was specifically excluded from conveyance in the Barrow Transfer Act of 1984 (BLM 2013a). Figure TM4-3 shows a photograph of the South Barrow #3 location. The site requires removal of solid waste and the well requires plugging.

**Figure TM4-3. South Barrow #3 has a concrete cellar and steel beams stacked on pilings that were cemented into the cellar. The well is cut off at ground level inside the cellar (BLM 2013a).**



The Walaka #1 and #2 wells were conveyed to the NSB in the Barrow Gas Field Transfer Act of 1984. The act conveyed specific oil and gas estates along with the wells, facilities, pipelines, and equipment to the NSB (BLM 2013a). No action is required for these well sites.

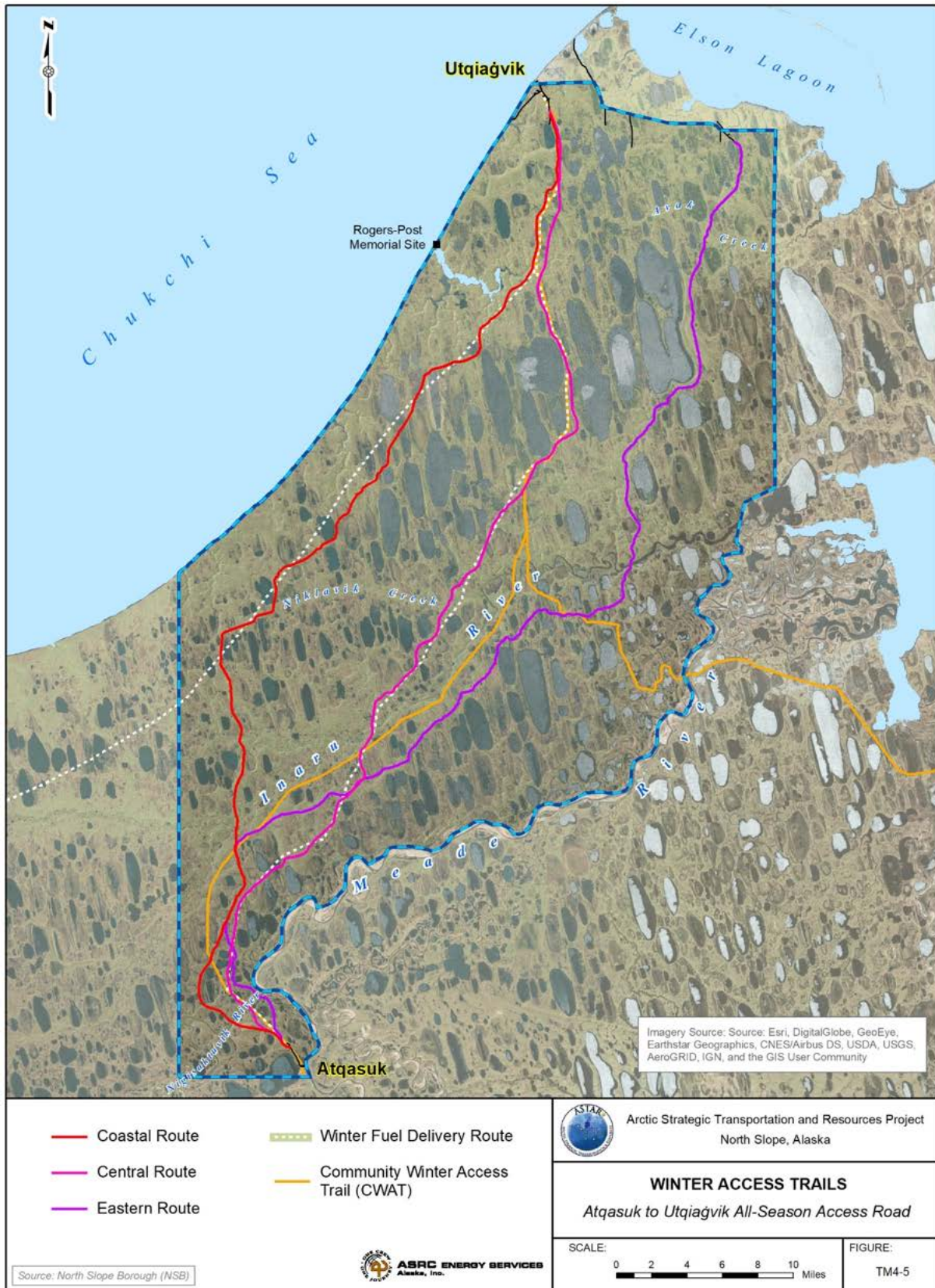
Skull Cliff Core Test #1 is approximately 1 mile from the Chukchi Sea coastline, 30 miles southwest of Utqiagvik, and 60 miles east of Wainwright. A large area of activity roughly 150 feet by 200 feet is evidenced by about 200 drums, metal tracks, wood debris and various other metal hardware that litter the site. There are no known contaminants at the site, however, the large amount of solid waste is considered a public safety risk to local residents and needs to be removed. No cement plugs were set in Skull Cliff Core Test #1. The moderate subsurface risk ranking is due to approximately 54 feet of diesel (approximately 16 barrels) sitting on top of drilling muds within the wellbore. A cut plug prevents water from entering the wellbore and overtopping the casing (BLM 2013a). Figure TM4-4 shows the wellhead and surrounding area.

**Figure TM4-4. Skull Cliff Core Test #1 and cellar. Note wooden plug at top of well casing and drums scattered around the site.**



### ***Winter Trails***

The Community Winter Access Trail (CWAT) between Utqiagvik and Atqasuk is a seasonally constructed snow trail first established in winter 2017/2018 that allows residents to transport goods, services, and passengers between the two communities. The trail has no permanent infrastructure components; however, trail markers are installed each winter. In addition to the CWAT, there are historical winter trail alignments between Utqiagvik and Atqasuk, and Utqiagvik and Wainwright. Before the CWAT was established, the winter trail between Utqiagvik and Atqasuk was periodically used for gravel hauling and fuel hauling. Figure TM4-5 shows the CWAT and the historical winter trail alignments.



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### ***Rogers-Post Site***

The Rogers-Post Site is the location of a plane crash that killed humorist Will Rogers and aviator Wiley Post on August 15, 1935, during an aerial tour of Alaska. The site, listed on the National Register of Historic Places, is about 11 miles southwest of Utqiagvik, on the north side of Walakpa Bay near the mouth of Walakpa River. Two concrete monuments are located at the site as shown in Figure TM4-6, and the site location is shown on Figure TM4-5.

**Figure TM4-6. Two monuments mark the Rogers-Post Site (photo from National Register collection)**



### **Proposed Infrastructure**

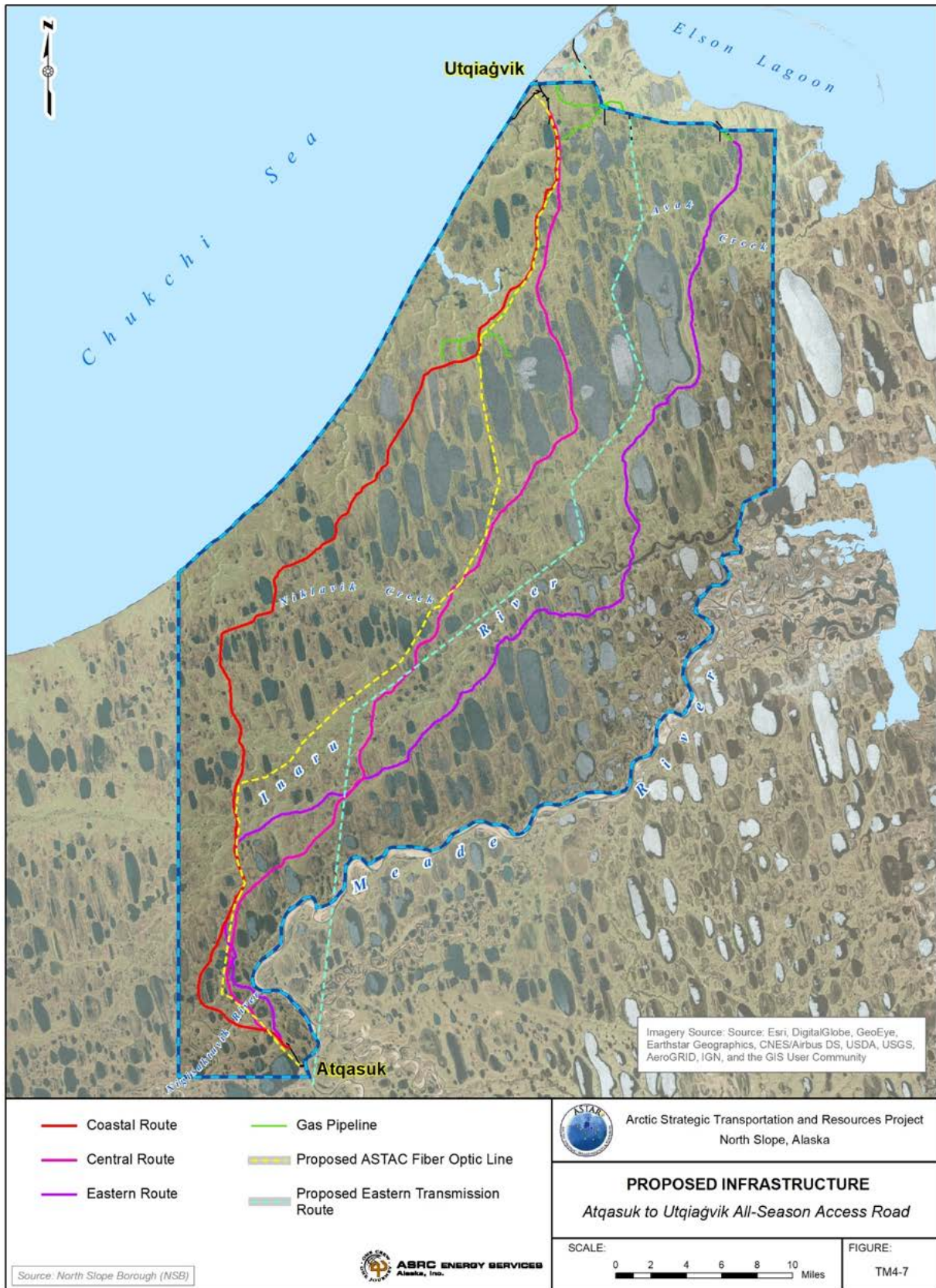
#### ***Atqasuk Transmission Line***

The escalating cost of imported diesel prompted the NSB to explore alternative energy, which focused on a proposed electrical intertie between Utqiagvik and Atqasuk. The intertie was envisioned as a method to reduce Atqasuk’s fuel needs, by displacing local diesel consumption with natural gas-fired power generation from Utqiagvik to meet both power and space heating requirements. Two feasibility studies commissioned by the NSB concluded that it is technically and economically feasible to build a transmission line with minimal social and environmental impact (Sakeagak 2013). The line was recommended as a pole-mounted 69 kV transmission line. The route shown on Figure TM4-7 was considered the preferred route for the line.

#### ***ASTAC Fiber Optic Line***

In January 2018, ASTAC presented information to the NSB Planning Commission about a possible fiber optic line between Utqiagvik and Atqasuk to provide the community of Atqasuk with high-speed internet access and communications. The proposed route presented by ASTAC is shown on Figure TM4-7.

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Bureau of Land Management (BLM). 2013a. National Petroleum Reserve in Alaska: Legacy Wells Summary Report 2013. Bureau of Land Management Open File Report. Anchorage.

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Lidji, Eric. 2018. “The Producers 2018: Barrow gas field remains steady.” *Petroleum News*. Vol. 23, No. 45. November 11.

Sakeagak, Charlie. 2013. Barrow to Atqasuk Transmission Line. Paper presented by North Slope Borough Department of Public Works at the 2013 Rural Energy Conference. [http://www.akruralenergy.org/2013/2013\\_REC\\_Barrow%20to%20Atqasuk%20Transmission%20Line.pdf](http://www.akruralenergy.org/2013/2013_REC_Barrow%20to%20Atqasuk%20Transmission%20Line.pdf) (Accessed April 15, 2019).

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## **Technical Memorandum 5 – Engineering**

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**Technical Memorandum 5 – Engineering Considerations**

**Prepared by:** Paul Ramert, PE, Principal Civil Engineer  
**Reviewed by:** Hans Hoffman, CPG, Associate Geologic Engineer  
**Date:** July 2019

**Overview**

This memorandum provides a general overview of engineering considerations relevant to the proposed Atqasuk to Utqiagvik Road, including preliminary roadway design criteria, estimates of granular material required, major drainage structures, and related information. As listed in Table TM5-1 and depicted on Figure TM5-1, three route alignments have been identified for consideration.

**Table TM5-1. Preliminary Road Alignment Alternatives**

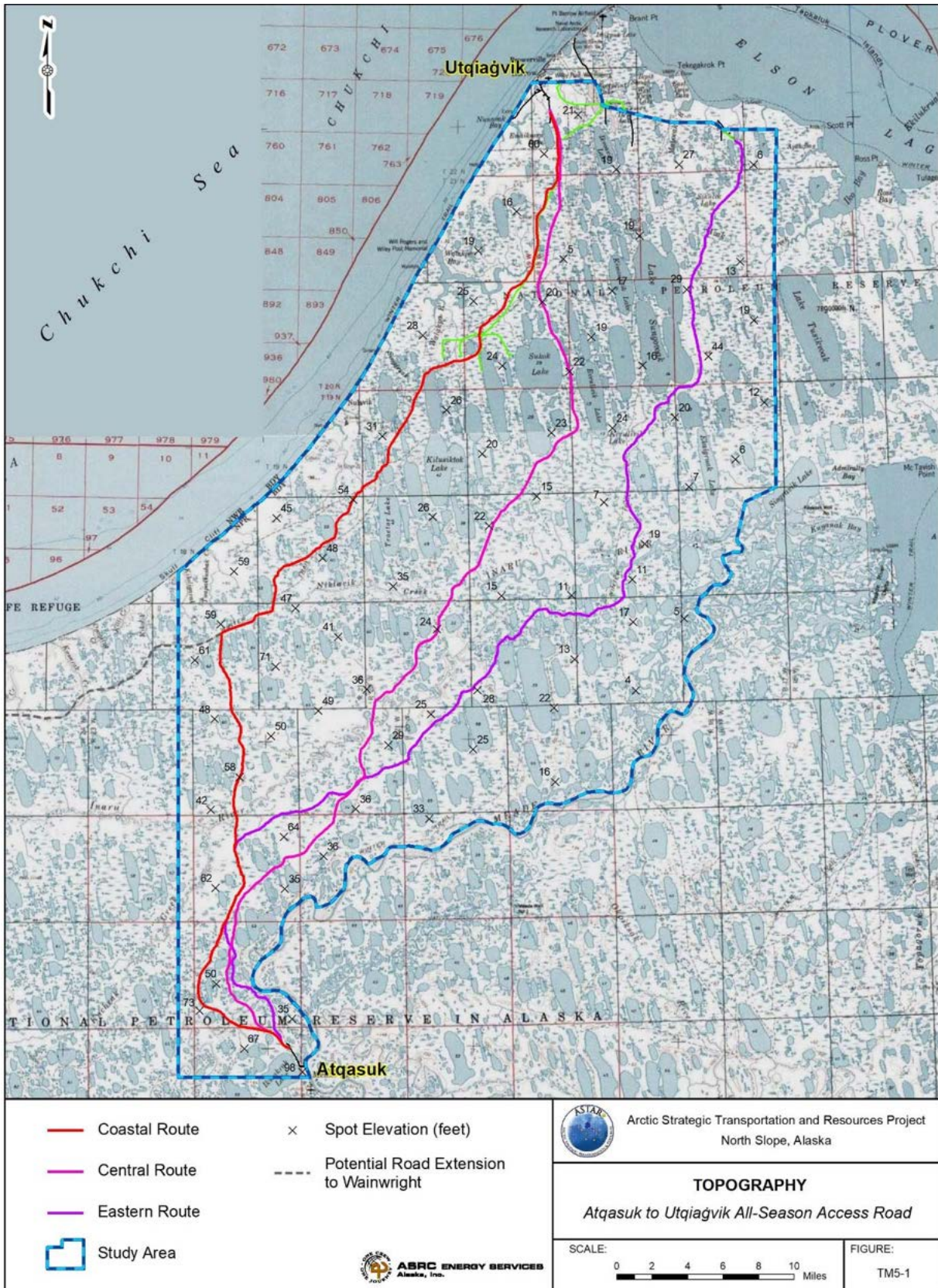
Road Alignment	Length (miles)	Southern Terminus	Northern Terminus	Elevation-min./max. (ft MSL)	Named River Crossings <sup>1</sup>
Route A – Coastal Route	67.5	Atqasuk Landfill Road	Emaiksoun Road	20 / 91	Nigisaktuvik River, Inaru River, Singaruak Creek
Route B – Central Route	64.4	Atqasuk Landfill Road	Emaiksoun Road	15 / 89	Nigisaktuvik River, Inaru River, Niklavik Creek
Route C – Eastern Route	73.6	Atqasuk Landfill Road	end of Eastfield Road	5 / 86	Nigisaktuvik River, Inaru River, Avak Creek

Note that each route alternative crosses other unnamed streams and rivers. Please refer to Tech Memo 2 – Hydrology for additional information on drainage crossings

**Topography**

The terrain is characterized by relatively flat arctic tundra, although terraces and steep river banks are found adjacent to larger rivers and streams. The ground surface elevation within the project area varies from about 5 to 100 feet above sea level as shown on Figure TM5-1. Elevation profiles and major crossings for each route are shown on Figure TM5-2.

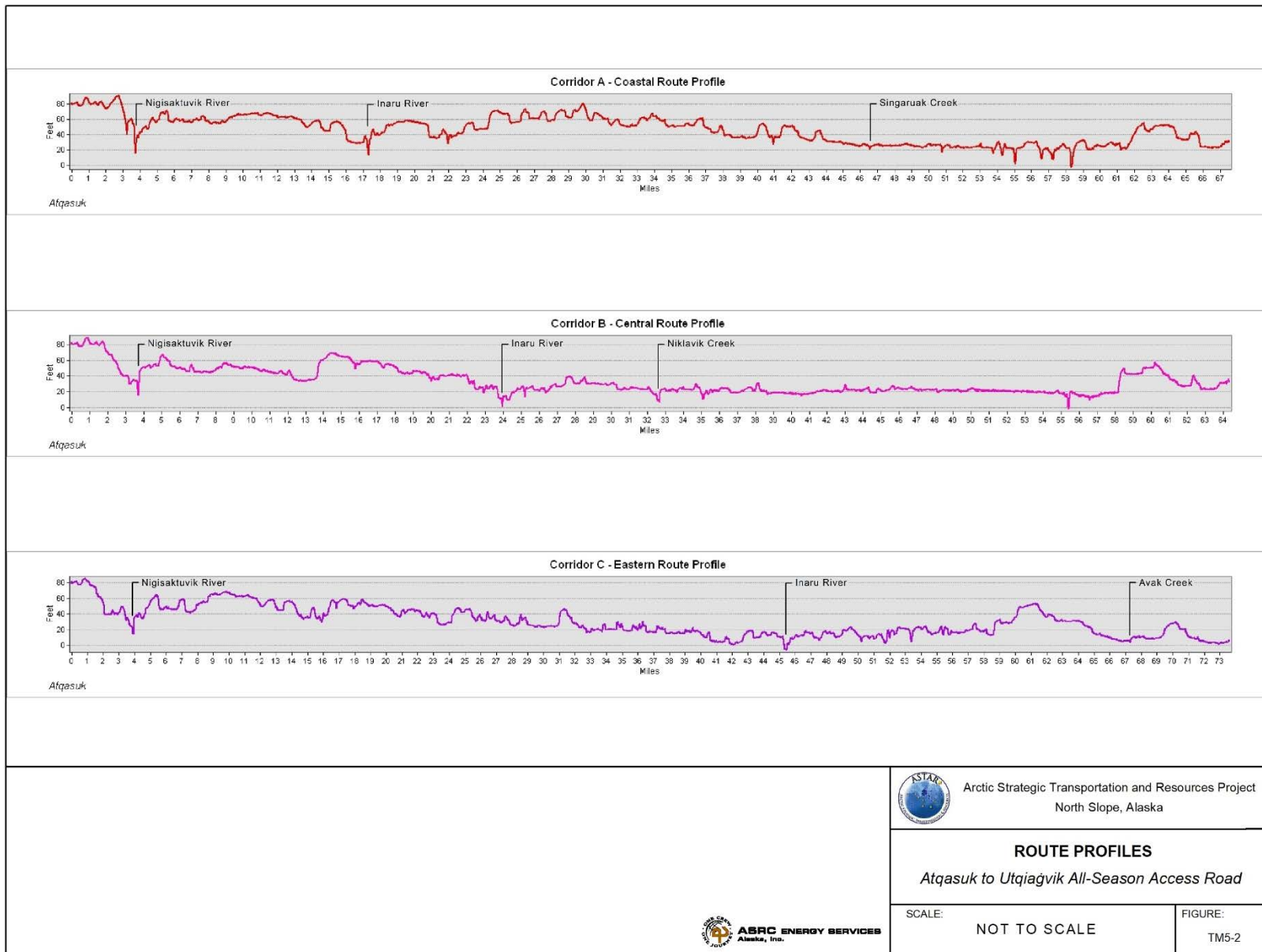
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## Design Criteria

General design criteria for the proposed road are presented in Table TM5-2. These roadway design criteria are derived primarily from guidance published by the American Association of State Highway and Transportation Officials (AASHTO), the U.S. Forest Service (USFS), and the Alaska Department of Transportation and Public Facilities (ADOT&PF).

### **Functional Classification and Subclass**

The proposed road is classified as a low-volume local road serving a rural area (i.e. western North Slope). By definition, a low-volume local road is a local road that has a design average daily traffic (ADT) volume of 2,000 vehicles per day or less (AASHTO 2019). The road’s primary function is to allow movement of goods and services between Utqiagvik and Atqasuk.

**Table TM5-2. Preliminary Roadway Design Criteria**

Element	Atqasuk to Utqiagvik Road	Criteria/Guidance/Rationale
Project Type/ Area Type	New Construction/ Rural Area	AASHTO 2019, page 1-2
Functional Classification	Low-Volume Local Road	AASHTO 2019, page 1-1
Functional Subclass	Rural Industrial/Commercial Access Road	AASHTO 2019, page 2-2
Surfacing	Unpaved	AASHTO 2019, page 2-5 and 4-37
Number of Lanes	1 with Turnouts at Regular Intervals for Two-Way Single-Lane Road or 2 for Double-Lane Road	AASHTO 2019, page 4-40  AASHTO 2019, page 4-2
Projected AADT	>100 vehicles per day	AASHTO 2019, page 2-8
Estimated % Commercial Truck	<10%	
Design Speed/Operating Speed	Two-Way Single-Lane Road: 30 mph  Double-Lane Road: 45–50 mph	AASHTO 2019, page 4-39  AASHTO 2019, page 4-3
Grade Limitations	Two-Way Single-Lane Road: 30 mph – Level, 0–7% 20 mph – Rolling, 7–11% Double-Lane Road: 50 mph – Level, 0–4% 40 mph – Level, 4–7% 30 mph – Rolling, 7–10%	AASHTO 2011, page 3–119, 5–26, 5–33. (Steeper grades may necessitate lower design speeds.)
Design Vehicle	22,000 lbs/standard axle	A 22,000 lb axle loading should cover a wide range of transportation needs including moving heavy equipment on multi-axle heavy haul trailers.
Maximum Axle Loadings	22,000 lbs/trunnion axle (winter only)	
Clear Zone	6 ft is recommended, 0 ft is allowed	AASHTO 2019, page 4-35

Element	Atqasuk to Utqiagvik Road	Criteria/Guidance/Rationale
<b>Design Flood</b>	50-year return period (2% exceedance probability)	ADOT&PF 2006, page 7–30
<b>Scour Protection</b>	Designed for 100-year return period (1% exceedance probability). Checked at 500-year return period (0.2% exceedance probability)	ADOT&PF 2006, page 7–30
<b>Cross-Drainage Culvert</b>	24-inch dia. or greater for round culverts (equivalent pipe-arch culverts min. span-to-rise of 29 inches by 18 inches). 36-inch dia. or greater round culverts in icing problem areas	ADOT&PF 2018 ADOT&PF 2006, pages 9-4 and 9-6
<b>Culverts &gt;100 ft</b>	36-inch dia. or greater	ADOT&PF 2006, page 9–6
<b>Headwater to depth ratio (Hw/D)</b>	1.0 at design flow No greater than 1.5 allowable	ADOT&PF 2006, pages 9–4 and 9–5
<b>Minimum and Maximum Cover over Culverts</b>	Varies	ADOT&PF 2013, Standard Drawing D-04.21
<b>Fish Passage</b>	Tier 1. Stream Simulation Design	ADF&G 2001, page 12, McDonald & Associates 1994, Behlke et al. 1991
<b>Bridge Live Load</b>	AASHTO HL-93	AASHTO (2012) LRFD Bridge Design Specifications

NOTES:

AADT	Average annual daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ADF&G	Alaska Department of Fish and Game
ADOT&PF	Alaska Department of Transportation and Public Facilities
dia.	diameter
ft	feet
Hw/D	headwater to depth
lbs	pounds
LRFD	Load and Resistance Factor Design
mph	miles per hour

The functional classification of very low-volume roads is further subdivided into several subclasses. For this project, the applicable subclass is Rural Industrial/Commercial Access Road, taking into consideration that trucks and other heavy vehicles are important in the design.

The primary design guidance for very low-volume roads is provided in AASHTO’s *Guidelines for Geometric Design of Low-Volume Local Roads* (2019). This guidance enables designers for projects on low-volume local roads to apply less restrictive design criteria than that generally used for higher volume roads. The guidelines discourage widening of lanes and shoulders, changes in horizontal and vertical alignment, and roadside improvements except in situations where such improvements are likely to provide substantial safety benefits. Thus, projects designed in accordance with these guidelines are less likely to negatively impact the environment, roadway and roadside aesthetics, existing development, historic and archaeological sites, and wildlife.

**Surfacing**

Like many rural access roads, roads on the North Slope are unpaved. Paving is generally avoided, since asphalt surfaces absorb greater solar radiation than gravel surfaces, leading to deeper thaw and degradation of permafrost

in the road subgrade. Unpaved roads are intended to operate at low to moderate speeds, normally 45 miles per hours (mph) or less (AASHTO 2019).

**Number of Lanes and Average Annual Daily Traffic**

The following general guidelines apply when making decisions regarding the number of lanes for a very low-volume local road (USFS 2011):

- Where the ADT for the design life is less than 100, a single-lane road is generally preferable.
- Where the ADT for the design life is 100 to 250, a double-lane road should be considered.
- Where the estimated ADT for the design life is over 250, a double-lane road is generally the minimum design standard.

Design widths should be established in accordance with the USFS guidelines (2011) for single-lane roads or the AASHTO guidelines (2019) for double-lane roads.

Average annual daily traffic (AADT) for Utqiagvik and Atqasuk streets was considered in developing the design criteria for this project. Table TM5-3 presents 2016 AADT data provided by ADOT&PF (2019) based on actual counts. As shown in the table, 2016 daily traffic counts for Utqiagvik roads range from 373 to 4,656 vehicles per day; and for Atqasuk roads range from 15 to 20 vehicles per day. Using the average for all of the AADT data listed, and assuming 10% of this traffic might travel daily between the two communities, we have estimated an AADT greater than 100 vehicles per day for the proposed Atqasuk to Utqiagvik Road over the design life of the project. We have also assumed that about 10% of the AADT would be truck traffic to account for deliveries of fuel, gravel, freight, and similar goods. Based on this traffic volume, we assume that a double-lane road will be the design standard.

**Table TM5-3. AADT for Utqiagvik and Atqasuk Streets**

Locale	Route Name	2016 AADT	Locale	Route Name	2016 AADT
Utqiagvik	Stevenson Street, MP 0.245 to 4.013	1,362	Utqiagvik	Yugit Street, MP 0.000 to 0.543	1,541
Utqiagvik	Stevenson Street, MP 0.000 to 0.512	1,363	Utqiagvik	A Avenue MP 0.000 to 0.418	373
Utqiagvik	Cakeatter Road, MP 0.967 to 1.823	419	Utqiagvik	Okpik Street, MP 0.000 to 0.879	1,481
Utqiagvik	Ahkovak Street, MP 0.000 to 0.771	2,832	Utqiagvik	Momegana Street, MP 0.000 to 0.294	1,276
Utqiagvik	Ahkovak Street, MP 0.771 to 1.359	1,584	Utqiagvik	Agvik Street, MP 0.000 to 0.270	585
Utqiagvik	Ahkovak Street, MP 1.359 to 1.722	1,551	Utqiagvik	Kiogak Street, MP 0.000 to 0.337	1,690
Utqiagvik	Laura Madison Street, MP 0.235 to 0.950	2,866	Utqiagvik	Pisokak Street, MP 0.000 to 0.301	782
Utqiagvik	Laura Madison Street, MP 0.000 to 0.235	3,403	Utqiagvik	Apayauk Street, MP 0.000 to 0.102	1,080
Utqiagvik	Eben Hopson Street, MP 0.363 to 0.510	3,819	Utqiagvik	Church Street, MP 0.000 to 0.131	1,283
Utqiagvik	Eben Hopson Street, MP 0.000 to 0.363	4,656	Utqiagvik	Hopson Street, MP 0.000 to 0.142	2,656
Utqiagvik	Karluk Street, MP 0.000 to 0.695	806	Atqasuk	Nashaknik Street, MP 0.000 to 1.025	15
Utqiagvik	Northstar Street, MP 0.000 to 0.385	1,981	Atqasuk	Noyokok Street, MP 0.000 to 0.095	20

1. 2017 AADT values are ADOT&PF estimates based on 2016 actual counts.

### Double-Lane Road

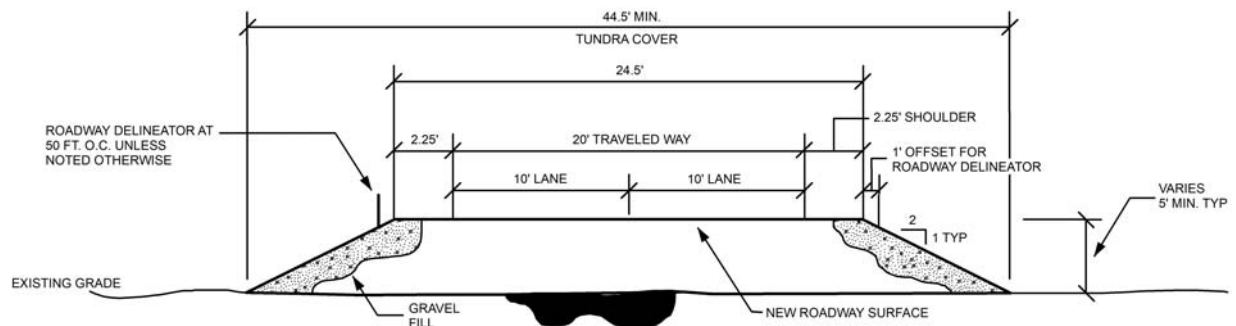
When compared with a single-lane road, a double-lane road allows higher design speeds and is much less constrained in the size and weight of loads that can be safely transported. Widths for industrial/commercial access roads consider more frequent use by trucks, wider loads, and transport of pre-fabricated construction modules for housing and other structures. The ability of heavy vehicles in opposing directions of travel to safely pass one another is another important design consideration. Pullout areas should be incorporated into the design at selected areas to facilitate subsistence hunting, fishing, trapping, and food gathering.

### Typical Section

For the industrial/commercial subclass, AASHTO guidelines (2019) list a total roadway width of 23.0 to 24.5 feet (ft) (including shoulders) for a 45 to 50 mph design speed, although designers are afforded great discretion in determining road widths based on the actual widths of vehicles expected to use the road. For this case, we recommend a total roadway width of 24.5 feet and side slopes of 2H:1V as shown on Figure TM5-3.

This width will accommodate routine truck traffic as well as oversize construction equipment commonly used in the villages, including two-way traffic for CAT D300E articulated dump trucks (approx. 10-ft wide including drivers side mirror), wheeled cranes (13- to 14-ft wide), and truckable modules (20-ft wide).

Figure TM5-3. Typical Gravel Double-Lane Road Section



### Design Speed and Grade Limitations

AASHTO (2019) states double-lane unpaved roads are designed to operate at low to moderate speeds. Design speeds for unpaved roads should normally be 45 mph or less, but may occasionally be as high as 50 mph in situations where the designer considers it appropriate. This design speed should be decreased in rolling terrain as outlined in Table TM5-2.

### Design Vehicle

Apart from standard cars and pickup trucks, the majority of the anticipated traffic will be commercial delivery trucks, moderately-sized construction equipment, and occasional heavy haul vehicles. Heavy haul vehicles might include the typical “lowboys” used to haul common earth moving machines (Figure TM5-4) or articulated dump trucks for gravel hauling similar to a CAT D300 (Figure TM5-5).

**Figure TM5-4. Typical Tractor Truck and Lowboy for Hauling Heavy Equipment**



**Figure TM5-5. CAT D300 articulated dump truck used for gravel hauling.**



A critical vehicle is defined as a vehicle type, typically the largest on a road by weight, size, or unique configuration, whose limited use on the road is necessary to fulfill the road management objectives. For the Utqiagvik to Atqasuk Road, we recommend that the critical vehicle be based on allowable loading. Establishing the loading requirements enables the road cross-section to be designed to carry this load based on the depth of section and available materials. For an industrial/commercial access road, the recommended vehicle loading is a 22,000-pound (lb) load per axle with standard axles. A 22,000-lb loading will cover a wide range of transportation needs, including moving heavy oilfield equipment using multi-axle, heavy haul trailers. The basic truck/trailer would be the standard 8.5-ft width, but loads considerably wider (such as modularized equipment that can be 20 ft in width) could be carried on the proposed typical section. The use of trunnion axles will accommodate significantly higher axle capacity and are also recommended, but should be prohibited from use when the ground is not frozen to minimize impacts to the structural section.

Bridges require additional loading considerations. The length of a bridge is important in determining the total weight it can carry. Shorter bridge spans may only carry part of the total load at any one time, whereas longer

bridge spans will carry the entire load at once, so the gross vehicle weight must be considered. A CAT D9 dozer shipping weight is about 108,000 lbs; gross weight of the rig and load can exceed 164,000 lbs.

### **Structural Section**

Roads in permafrost areas will ideally be built with a structural section that is both structurally adequate for the anticipated loads and thermally adequate to prevent thawing of the subgrade soil. In order to fully protect the permafrost beneath the core of a road in Northern Alaska, sections on the order of 5 to 6 ft thick are typically required, or 2 to 6 inches of high strength polystyrene insulation is commonly included in the section to reduce thaw penetration and the amount of gravel needed. A 2-inch thick layer of polystyrene is roughly the equivalent of 1 foot thickness of gravel. During subsequent stages of design, the road alignment and structural section will be optimized considering climatic conditions in the project area (e.g., snow drifting, precipitation, wind, and orientation), as well as physical factors (e.g. terrain unit, surface drainage, and soil saturation).

### **Clear Zone**

The clear zone is the total roadside border area, starting at the edge of the traveled way, available for use by errant vehicles. This area may consist of the shoulder, a recoverable slope, a non-recoverable slope, and/or clear runout area. Simply stated, it is an unobstructed, relatively flat area beyond the edge of the traveled way that allows a driver to stop safely or regain control of a vehicle that leaves the traveled way. Note that slopes steeper than 3H:1V are not considered traversable and are thus not considered part of the clear zone.

Provision for roadside clear zones, flatter slopes, or traffic barriers is generally inconsistent with the economic decision to build and maintain an unpaved surface (AASHTO 2019). The AASHTO design guideline for roadside clear zone width is a 6-ft or more clear recovery area if the clear zone is considered low cost (right-of-way needed, terrain, etc.) and has minimum environmental impacts. If the impacts are considered impractical, clear zones from 0 to 6 ft may be used.

In order to protect the underlying permafrost, roads on the Coastal Plain of the North Slope are most often constructed of thick embankments (typically 5 ft or greater thickness) with relatively steep side slopes (typically 2H:1V). This type of road section limits the clear zone to the shoulder only. For the double-lane road section described above, the clear zone is therefore limited to 2.25 ft for standard vehicles.

### **Material Needs and Haul Distances**

For the full 5-ft thick gravel section depicted in Figure TM5-3, a minimum of 33,634 cubic yards (cy) of gravel would be needed for each mile of road across relatively flat terrain; in uneven terrain, this volume would increase. Generally, the objectives for a remote road construction project are to locate a material site every 10 miles or so and to prove up about 1 million cy of suitable material at each site to allow for construction and long-term maintenance (ADOT&PF 2010). Since suitable material is scarce in the NPR-A, haul distances between material sites may have to be increased, thereby increasing the cost of construction and maintenance.

### **Alternative Road Configurations**

As the project progresses, a number of alternatives should be considered and evaluated for the proposed road:

- If more detailed analysis indicates that projected AADT will be less than 100 vehicles per day over the design life of the project, then a two-way single-lane road with inter-visible turnouts should be considered. The maximum recommended spacing between turnouts is 1,000 feet.

- If desired, the project could be expanded to include a road segment that branches off from the Utqiagvik-to-Atqasuk alignment to extend to Wainwright, linking all three villages by year-round road (Figure TM5-1).
- If quality gravel is scarce or unavailable for the project, other potential design alternatives should be considered, such as sands and silts in combination with synthetic geofabrics and geomembranes, insulating materials, or chemical and mineral binders.
- Use of insulation in the road cross section may offer the potential for significant reduction in gravel required. By adding a 4-inch thick layer of insulation, the thickness of overlay needed to prevent permafrost thaw can be reduced by about two feet, and inferior material that would be kept frozen, such as frozen silty sand, can be incorporated into the lower portion of the embankment.

### **Roadway Bridge and Culvert Criteria**

Bridges, culverts, and hydraulic calculations in support of crossing structures will be consistent with the *Alaska Highway Preconstruction Manual* (HPM) (ADOT&PF 2005) and *Alaska Highway Drainage Manual* (HDM) (ADOT&PF 2006).

In addition, the Record of Decision (ROD) for the NPR-A Best Management Practice (BMP) E-6 (Bureau of Land Management [BLM] 2013) states that:

- Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.
- Bridges, rather than culverts, are the preferred method for crossing rivers.
- Culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.

Two-way, single-lane bridges should be designed with removable side rails to accommodate transport of over-wide loads.

**Design Flood** - The HPM and HDM list a 50-year return period (2 percent exceedance probability) as the design flood for bridges on all highways and culverts on primary highways and secondary highways of high importance. Culverts and bridges in designated flood hazard areas are designed for the 100-year return period (1 percent exceedance probability); however, no Flood Hazard areas are mapped in the project area. Scour protection will be designed for the 100-year return period and checked at the 500-year return period (0.2 percent exceedance probability) as required by HPM and HDM.

**Culvert Sizes** - HPM and HDM require 24-inch diameter or greater for round cross-drainage culverts or equivalent pipe-arch culverts with a minimum span-to-rise of 29 inches by 18 inches. For round culverts over 100 ft long, 36-inch diameter or greater is required. A minimum diameter of 36 inches is also recommended where icing is likely. Culverts shall be designed for a maximum headwater to depth (Hw/D) ratio of 1.0 at the design flow, and an allowable Hw/D no greater than 1.5.

**Bridge Design Live Load** - The design live load is based on AASHTO HL-93 (2017) live load and vehicle loading previously discussed. Span lengths and total length of bridges are important parameters in evaluating capacity to support loading. Shorter bridge spans might carry only part of the load at any one time, whereas longer bridges carry the entire load at once; thus, gross vehicle weight and geometry must be considered.

**Fish Passage** - BMP E-14 (BLM 2013) states that:

- To ensure that crossings provide for fish passage, all proposed crossing designs shall adhere to the BMPs outlined in *Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain* by McDonald et al. (1994), *Fundamentals of Culvert Design for Passage of Weak-Swimming Fish* by Behlke et al. (1991), and other generally accepted best management procedures prescribed by the BLM authorized officer.
- At least three years of hydrologic and fish data shall be collected by the lessee for any proposed crossing of a stream whose structure is designed to occur, wholly or partially, below the stream's ordinary high watermark. These data shall include, but is not limited to, the range of water levels (highest and lowest) at the location of the planned crossing, and the seasonal distribution and composition of fish populations using the stream.

Based on Technical Memorandum 11, two of the drainages (Avak Creek and Inaru River) are listed as anadromous streams in the ADF&G's Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes database. Crossings at these drainages will likely require fish passage bridges.

For the river and stream crossings along the routes where there is no documentation of fish use at the specific alignment crossings, the crossing site will require fish surveys. ADF&G will assume that every significant stream or river is fish-bearing unless fish surveys show otherwise. Any culvert or cross drainage structure proposed for fish-bearing rivers and streams will be required to maintain fish passage in accordance with Alaska Statute. Before permitting and final design are completed, three years of field studies will be required to verify and update this preliminary list of fish-bearing streams.

Technical Memorandum 2 provides a list of the crossings for each route, the approximate crossing width, and the presumed drainage structure required (bridge or culvert[s]).

## **BLM Stipulations and Best Management Practices for Roads in NPR-A**

In addition to BMPs E-6 and E-14 pertaining to bridges and culverts, the ROD for NPR-A (BLM 2013) includes several additional performance-based stipulations and BMPs relating directly to roads. Note that these standards apply only to Federal lands, (and do not necessarily apply to Native-owned lands within the project area). Below are excerpts from the ROD that pertain directly to permanent gravel roads. Note, however, that this is not an exhaustive list of every stipulation or BMP that could apply to roads. For example, other stipulations or BMPs related to air quality, biological surveys, cultural surveys, threatened and endangered species, etc. could indirectly or directly have implications for permanent roads. In addition, some of the stipulations listed below are directed toward oil and gas leaseholders (e.g. BMP G-1), and may not apply to roads constructed by the NSB or Native Corporations for purposes not directly related to oil and gas development.

- To protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of road construction on air, land, water, fish, and wildlife resources, BMP E-1 states that all roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas. The BLM authorized officer will consult with appropriate Federal, State, and NSB regulatory and resources agencies prior to approving construction of roads.
- To protect fish-bearing water bodies, water quality, and aquatic habitats, BMP E-2 states that roads are prohibited upon or within 500 ft as measured from the ordinary high water mark of fish-bearing water bodies. Essential road crossings will be permitted on a case-by-case basis.

- To minimize impacts of the development footprint, BMP E-5 states that facilities shall be designed and located to minimize the development footprint. Issues and methods that are to be considered include integration of airstrips with roads and use of gravel-reduction technologies (e.g., insulated or pile-supported pads).
- To minimize the take of species, particularly those listed under the Endangered Species Act and BLM Special Status Species, from direct or indirect interaction with oil and gas facilities, BMP E-11 states that aerial surveys for Spectacled and/or Steller's Eiders habitats should be conducted at least three years prior to the authorization of construction, if such construction is within the US Fish and Wildlife Service (USFWS) North Slope eider survey area and at least one year outside that area.

If Spectacled and/or Steller's Eiders are determined to be present within the proposed development area, the applicant shall work with the USFWS and BLM early in the design process to site roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, location of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and management of high noise levels.

- For Yellow-billed Loon habitats, aerial surveys shall be conducted by the lessee for at least three years before authorization of construction of facilities proposed for development which are within 1 mi of a lake 25 acres or larger in size. Should Yellow-billed Loons be present, the design and location of facilities must be such that disturbance is minimized. The default standard mitigation is a 1 mi buffer around all recorded nest sites and a minimum 1,625 ft buffer around the remainder of the shoreline. Development is generally prohibited within buffers unless no other option exists.
- To provide information to be used in monitoring and assessing wildlife movements during and after construction, BMP E-19 states that ArcGIS-compatible shapefiles of all new infrastructure shall be provided to the BLM authorized officer within six months of construction completion. Shapefiles of proposed locations shall be provided during the planning and permitting phase. Roads may be represented as lines, but require ancillary data to denote width.
- To ensure long-term reclamation of land to its previous condition and use, BMP G-1 states that prior to final abandonment, infrastructure shall be reclaimed to ensure eventual restoration of ecosystem function. The leaseholder shall develop and implement an abandonment and reclamation plan approved by the BLM.
- To minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing, or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values, BMP K-1 states that roads are prohibited in the streambed and adjacent to rivers listed in the ROD at setback distances specified. Essential road crossings perpendicular to the main channel will be permitted through setback areas. Refer to Figure 2-2 in this report or to pages 73 to 77 of the BLM ROD for specific river setbacks.
- To minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities, BMP K-2 states that roads are prohibited on the lake or lakebed and within 0.25 mi of the ordinary high water mark of any deep lake as determined to be in Lake Zone III (i.e., depth greater than 13 ft; Mellor 1985).

On a case-by-case basis in consultation with Federal, State, and NSB regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential road crossings may be considered through the permitting process in these areas where the lessee can demonstrate on a site-specific basis that impacts will be minimal.

## Operations and Maintenance

Following construction, the road will require ongoing operations and maintenance (O&M) during its operational life. Maintenance issues could include permafrost subsidence, gravel-surface wear, surface treatment, erosion, icing, and snow drifting. The maintenance crew will be responsible for maintaining the gravel road, bridges, and culverts, dust mitigation, and for snow plowing over approximately 60 to 70 mi of road.

Typical heavy equipment at each maintenance facility could include a grader with sloper and boss plow; snow plow with belly blade; job truck with 3,500 lb crane, compressor, small fuel tank, and tools; D6 dozer; loader with 4 to 6 cubic yards (cy) bucket and various other attachments (forks, snowblower, etc.); and tractor with various trailers (6,000-gallon tanker trailer, high deck trailer, lowboy trailer).

Some of the material sites developed during the construction phase must remain open for the O&M phase to provide material for maintenance and upgrades. For the Dalton Highway, ADOT&PF estimates that over a 50-year period, 34,000 cy of material will be needed to rehabilitate and maintain each mile of gravel road (Northern Region ADOT&PF Staff 2013).

## Data Gaps

Following is a list of data gaps that will need to be filled to advance the project to the next phases of design.

- To facilitate geometric design and optimizing alignment of the road, a detailed topographic survey data along the corridor(s) will be required. This data is typically acquired using a fixed-wing aircraft equipped with Light Detection and Ranging (LIDAR) equipment. The LIDAR data will be used to generate a digital 3-dimensional representation of the corridor.
- Field reconnaissance should be performed to view, evaluate, and refine potential locations for river crossings.
- Geotechnical reconnaissance and subsurface investigations should be performed to identify and prove up potential material sources.
- Geotechnical investigations should be performed along the preferred alignment to validate and refine terrain unit maps, and provide data to support road and bridge design.
- Hydrology data should be collected at all river crossings to support design of bridges and culverts.
- Fish monitoring data should be collected at proposed crossings for a period of 3 years.
- Aerial surveys for Spectacled and/or Steller's Eiders habitats and Yellow-billed Loon habitats should be conducted at least 3 years prior to the authorization of construction.

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## **Technical Memorandum 6 – Cultural Resources**

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## **Technical Memorandum 6 – Cultural Resources**

**Prepared by:** Ranna Wells, MA, RPA, Archaeologist  
**Reviewed by:** Shannon Mason, Environmental Scientist  
**Date:** July 2019

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### **Cultural Resources**

The purpose of this memorandum is to provide an inventory and assessment of cultural resources within and near the project area that could potentially be affected by project activities. Prior to ground-disturbing activity, a permittee must assess whether there are known cultural resources present, evaluate potential impacts to cultural resources, and maintain communication with the lead federal permitting agency and the Alaska State Historic Preservation Office (SHPO).

Cultural resources of concern in this report are those that may have historical and/or traditional value. They are physical resources associated with people, a society, or multiple societies. They consist of both built and natural parts of the physical environment and have some cultural value to one or more sociocultural groups (King 1998). Cultural resources exhibiting evidence of past human activity include sites, features, or artifacts.

Historic Properties are a special subset of cultural resources. A Historic Property is a cultural resource, generally 50 years of age or older, included in or eligible for inclusion in the National Register of Historic Places (National Register). A Historic Property may be a prehistoric or historic district, site, building, structure, or object. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization. In order to qualify as a historic property, a cultural resource must meet one or more of the National Register criteria (36 CFR 800; NPS 2002). These criteria are:

- Association with one or more important historic events.
- Association with a person or people who are historically significant. The property illustrates the person's or people's importance or important achievements.
- Association with historically significant design, craftsmanship, or construction.
- Potential to provide information to answer important research questions regarding the understanding of the past (NPS 2002).

### **Regulatory Background**

The proposed project has potential to affect Historic Properties such as historic structures, archaeological sites, historic and prehistoric districts, Traditional Cultural Properties, or traditional land use areas. Federal, state, and North Slope Borough (NSB) ordinances, laws, and policies are in place to protect Historic Properties on the North Slope (Table TM6-1).

**Table TM6-1. Management of Cultural and Historic Resources**

Government Level	Scope	Applicable Laws, Policies, and Ordinances
Federal	Federal Undertaking	National Historic Preservation Act, Section 106 National Environmental Policy Act Archaeological Resource Protection Act Antiquities Act of 1906 Native American Graves Protection and Repatriation Act
State, Alaska OHA, Department of Natural Resources	State Undertaking	Alaska Historic Preservation Act (AS 41.35) Alaska Administrative Code (11 AAC 16)
North Slope Borough	Borough	NSBMC § 19.50.030(F) and § 19.60.040(K)

AAC = Alaska Administrative Code  
 AS = Alaska Statute  
 NSBMC = North Slope Borough Municipal Code  
 OHA = Office of History and Archaeology

The primary laws/policies relevant to the proposed project include Section 106 of the National Historic Preservation Act (Section 106), the Alaska Historic Preservation Act (AHPA), and the NSB Iñupiat History, Language, and Culture Division’s (IHLC) Traditional Land Use Inventory (TLUI) clearance process. Since federally managed lands fall within the study area (National Petroleum Reserve–Alaska [NPR-A]), the Native American Graves Protection and Repatriation Act (NAGPRA) will apply. The list below is a synopsis of each applicable policy and how it relates to the proposed project:

- Section 106 mandates evaluation of adverse effects to Historic Properties resulting from any activity requiring a federal permit, receiving federal funding, or conducted on federally managed lands.
- The NAGPRA of 1990 establishes a process in which museums and federal agencies return certain Native American cultural items to lineal descendants, Indian tribes, and Native Hawaiian organizations. These cultural items may include human remains, funerary objects, sacred objects, and objects of cultural patrimony. NAGPRA applies to federal and tribal lands.
- The AHPA protects cultural resources on state land by ensuring those resources that may be adversely affected are properly documented and that any mitigation measures (if necessary) are conducted in a timely and expeditious manner. The state’s process essentially mirrors Section 106. The AHPA is initiated by state undertakings.
- The IHLC has standardized procedures for protecting traditional activities and historical, archaeological, and traditional cultural values. This includes the completion of two forms: Form 500 – Certificate of IHLC/TLUI Clearance Application and Form 600 – IHLC Resource Request Application (NSB 2017).

Due to federal permitting requirements, the proposed project will likely fall under the purview of Section 106, which states any federal undertaking must take into consideration its impacts to Historic Properties. A federal undertaking includes projects occurring on federal lands, requiring a permit from a federal agency, or obtaining funding from a federal source. Section 106 mandates evaluation of adverse effects to historic properties resulting from any activity requiring a federal permit, receiving federal funding, or conducted on federally managed lands.

The proposed project will also be permitted by NSB. The project therefore falls under the purview of Title 19 of the North Slope Borough Municipal Code (NSBMC), which states, “development must not disturb traditional subsistence activities or values at historic, archaeological and cultural sites” (NSBMC 19.50.030[F] and

19.60.040[K]). The NSB IHLC has standardized procedures for protecting traditional activities and historical, archaeological, and traditional cultural values. This includes the completion of two forms: Form 500 – Certificate of IHLC/TLUI Clearance Application and Form 600 – IHLC Resource Request Application (NSB 2017).

### **Cultural Resource Sites**

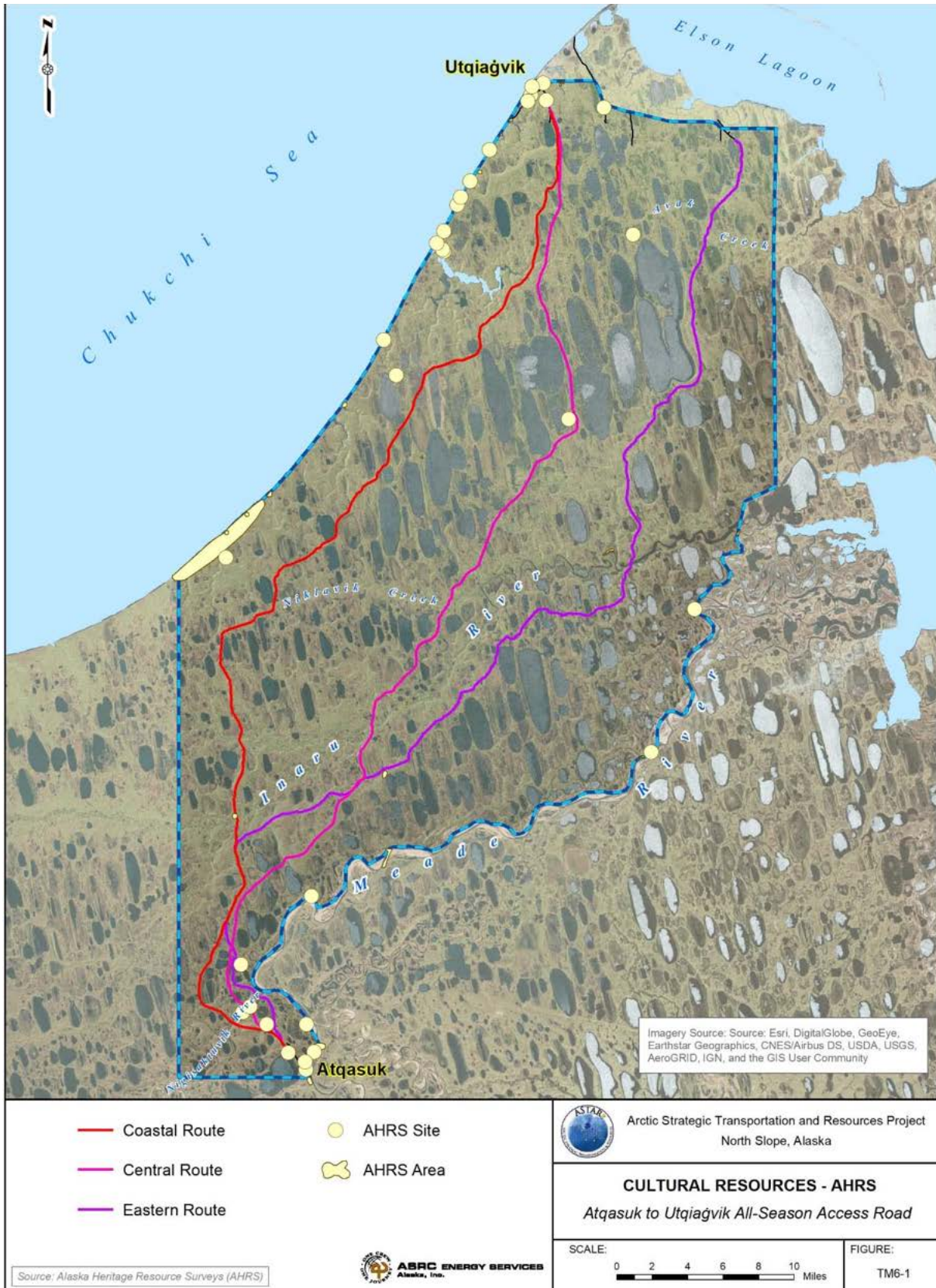
The following is a summary of data available for cultural resource sites and surveys within and near the project area. The summary includes a description of specific databases available for review and a discussion of the types of sites and surveys found within or near the project area.

For purposes of this desktop study, AES Alaska reviewed the Alaska Heritage Resource Survey (AHRS) database, maintained by the State of Alaska, Office of History and Archaeology (OHA), and the TLUI for previous cultural resource research and relevant literature for the project area. The information below is only as complete as the data that are publicly available, as some reports in the AHRS database have been labelled as “proprietary” and are therefore not available for review.

Both the State of Alaska and the NSB maintain records on cultural resources. The AHRS is a long-term database of prehistoric, historic, and modern cultural resources (archaeological sites, buildings, structures, objects or locations, etc.) and some paleontological sites (OHA 2019).

A review of the AHRS database in March 2019 revealed 36 sites within the project area, some of which are within road corridors: XMR-00055 is within the corridor for the Coastal Route at the Inaru River Crossing; site XMR-00185 is within the corridor on the Central Route and at the Nigasaktuvik River Crossing; and, XMR-00056 is within the Eastern Route corridor. The sites are a mixture of prehistoric and historic resources and are representative of the long history and continued use of the area (see Figure TM6-1 and Table TM6-1).

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Alaska State Plane Zone 6 (NAD83)

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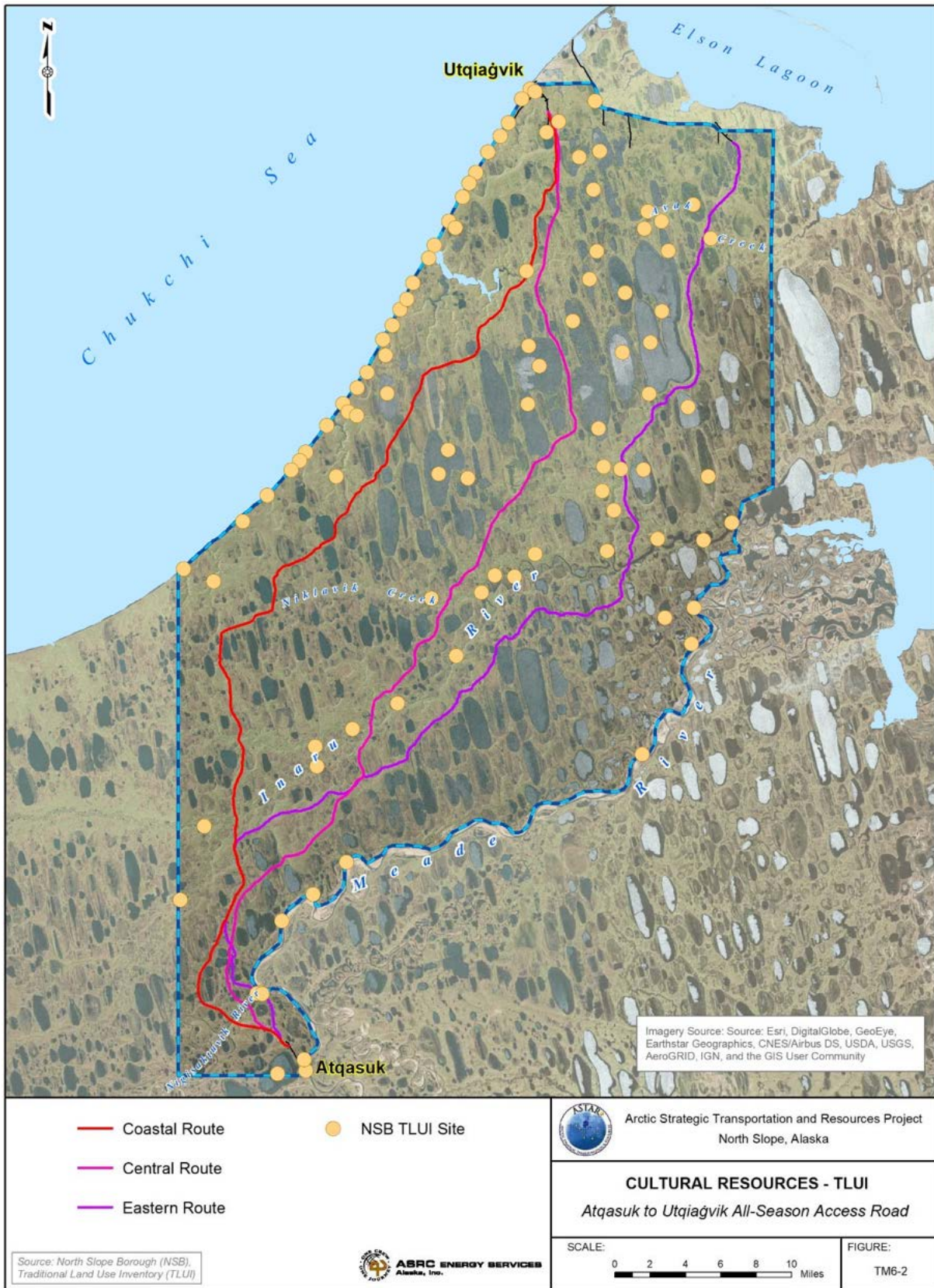
**Table TM6-2. AHRs Sites Identified within Project Area**

AHRs Number	Name	Site Description	Time Period	National Register Status
BAR-00003	Kugusugaruk Site	Birnirk site containing a large number of burials and six houses.	prehistoric	eligible
BAR-00005	Rogers-Post Site	Two historic monuments mark the location where Will Rogers and Wiley Post were killed in a plane crash in 1935.	historic	listed
BAR-00010	Napawrax	Prehistoric camp also known as "Nunaktuau."	prehistoric	n/a
BAR-00013	Walakpa Site (Ualiqpaa)	15 surface houses structures and a large well stratified prehistoric component. Represents the most complete series of cultural development in northern Alaska.	historic/ prehistoric	eligible
BAR-00014	Coffin Site	Site with assemblage representing Late Denbigh, transitional into Choris.	prehistoric	n/a
BAR-00037	North Nunavak	Burials.	prehistoric	n/a
BAR-00038	South Nunavak	Burials.	prehistoric	n/a
BAR-00039	BAR-00039	Scattered human skeletal remains on the shoreline. This concentration is from a 1925 reburial.	prehistoric	n/a
BAR-00040	BAR-00040	Human Burials.	prehistoric	n/a
BAR-00042	Location One, Reburial Site	Reburial.	not reported	n/a
BAR-00043	Location Two, Reburial Site	Reburial.	not reported	n/a
BAR-00044	"Hollywood" Reburial Site	No AHRs description.	historic	n/a
BAR-00087	Grave Site	Human Burial.	historic	n/a
BAR-00091	Kahroak Site	Small surface site containing projectile points, burins, burin spalls, large blade tools, and a cache of 32 cores.	prehistoric	n/a
BAR-00097	BAR-097	A single square house pit observed from air.	prehistoric	n/a
BAR-00120	BAR-00120	Camp with a least two can dumps, old bucket, boiler, and a section of Marston matting. Appears to represent two time periods.	historic	not eligible
BAR-00130	South Barrow Test Well 2	Well housed inside a wooden box inside a concrete well cellar, along with associated debris.	historic	eligible
XMR-00003	XMR-00003	Two components on a Meade River terrace. Items collected include a glass bead, shell bead, microblade, side blade, flakes, and a biface.	prehistoric	n/a
XMR-00007	XMR-00007	Heat-fractured cobbles and one flake nodule of chalcedony on a high terrace west of current river bluff.	prehistoric	n/a
XMR-00010	XMR-00010	Cache pit with caribou bone in and around it near lakeshore.	historic	n/a
XMR-00035	XMR-00035	Cache pit on a flat area of a terrace slope.	historic	n/a
XMR-00037	XMR-00037	Flake scatter eroding from bank in active dune area.	prehistoric	n/a

AHRS Number	Name	Site Description	Time Period	National Register Status
XMR-00039	XMR-00039	2 flakes found in a blowout on a riverine terrace.	prehistoric	n/a
XMR-00041	XMR-00041	43 house pits spread over a riverine terrace above Meade River. This site has been disturbed by vandalism and occasional historic use.	prehistoric	n/a
XMR-00071	Qaglugruaq	Archaeological features (including house pits and cellars), historic debris, and evidence of recent camping.	prehistoric	n/a
XMR-00072	Aatut North	This site consists of 21 major archaeological features (many of which are old houses) and evidence of recent use.	prehistoric	n/a
XMR-00076	Payugvik	26 house ruins, numerous storage pits, and a modern cabin. Artifacts were noted eroding from the riverbank.	historic/ prehistoric	n/a
XMR-00077	Pulayaaq	Sod house ruins and associated features were noted along; miscellaneous historic artifacts; human burial.	historic/ prehistoric	n/a
XMR-00079	Iviksuk	Numerous house ruins and associated features, camping areas, and historic debris.	historic	n/a
XMR-00084	Kilusiktok	20th century camp debris, cartridges, etc. Contains a layer of prehistoric burnt bone.	historic/ prehistoric	n/a
XMR-00089	Skull Cliff Core Test 1	The Navy drilled the core test in 1949 and is classified as a dry hole.	historic	eligible
XMR-00095	XMR-00095	A large stake on a sand dune. Possible grave marker.	historic	n/a
XMR-00184	Isolated Surface Flakes	Two chert flakes on the surface of a rise.	prehistoric	n/a
XMR-00185*	55-Gal Drums And Can Scatters	Approximately one-acre area containing 11 55-gallon drums and three loci of a large discontinuous can scatter.	historic	n/a
XMR-00186	Two Isolated 55-Gallon Drums	Two isolated 55-gallon drums, on end, spaced 1,000 feet apart.	prehistoric	n/a
XMR-00187	Can and Household Item Dump	Contains 55-gallon drums, metal generator, stove, and discontinuous can scatter.	historic	n/a

\* site located within the road corridor  
AHRS – Alaska Heritage Resource Survey

The TLUI maintained by the NSB IHLC department is a database of prehistoric, historic, and traditional cultural resource locations that contribute to the understanding of the historical record of the land, people, and villages of the NSB. TLUI data include information on cultural resource sites that may or may not be included on the state-maintained AHRS database. The TLUI data were reviewed May 2019. The following is a map (Figure TM6-2) and table (Table TM6-2) of TLUI sites within the project area. Four of these sites are within the road corridor: TLUIBAR065 is within the corridor of the Coastal Route and TLUIXMR034, TLUIXMR036, and TLUIXMR149 are within the Eastern Route corridor.



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**Table TM6-3. TLUI Sites Identified within Project Area**

TLUI Key	Place Name	Site Description
TLUIBAR060	Itivliq	Part of the other <i>itivliq</i> , or portage place, to the east. The site is a place on a trail where people carry <i>qayaks</i> , or sealskin-covered hunting boats, overland and camp as they are going inland.
TLUIBAR061	Avvaum Kuufa	Avvaq River. Summer gillnet fishing for broad whitefish and least cisco. Summer and fall caribou hunting area.
TLUIBAR062	Nauyalik	Nauyalik Lake. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when traveling inland for summer fishing and hunting.
TLUIBAR063	Sirruqqaq	In Iñupiaq, <i>sirruqqaq</i> means a new opening of water for passage through a lake. Fishing and caribou hunting area. Winter fox trapping area. A cabin here is owned by the Eben Hopson family.
TLUIBAR065	Ualiqpaam Kuubuuraafa	Ualiqpa Creek. Hunting and trapping area.
TLUIBAR066	Nauyalaq	Nauyalaq Lake. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when travelling inland for summer fishing and hunting.
TLUIBAR067	Qimuksiq	Qimuksiq Lake, located at Sungugruaq. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when traveling inland for summer hunting and fishing.
TLUIBAR068	Uqatubaq	Uqatugaq Island, located inside Sungugruaq Lake. Fishing and caribou hunting area. Fox trapping area.
TLUIBAR069	Sukalaq	Sukalaq Lake. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when traveling inland for summer fishing and hunting.
TLUIBAR071	Ikpitchiam Nuvua	Ikpitchiaq Point. Point of land located on Ikpitchiaq Lake. Hunting and fishing area.
TLUIBAR072	Sungubruaq	Sungugruaq lake. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when traveling inland for summer fishing and hunting. Summer and winter gillnet fishing for least cisco and grayling. Winter fox trapping area. Summer and fall caribou hunting area. Nesting area.
TLUIBAR073	Ivrulivik	Ivrulivik Lake. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when traveling inland for summer fishing and hunting. A stopover place for hunters traveling inland.
TLUIBAR074	Ikpitchiaq	Ikpitchiaq Lake. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when traveling inland for summer fishing and hunting. A stopover place for hunters traveling inland.
TLUIBAR076	Sukaq	Sukaq Lake. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when traveling inland for summer fishing and hunting. A stopover place for hunters traveling inland.
TLUIBAR077	Ikkalbuayaaq	Ikkalguayaaq Lake. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when travelling inland for summer fishing and hunting. Fishing area for many types of fish.
TLUIBAR120	Ipiqsuaq	Spring geese and seal hunting area. Summer hunting of walrus, ringed seal, and bearded seal off the coast.
TLUIBAR121	Natibnaq	Place name is flat land, or flat terrain, in Iñupiaq. Area used for spring camping and geese hunting. Summer hunting area for walrus, ringed seal, and bearded seal off the coast.
TLUIBAR122	Ualiqpa	Place named "west side" in Iñupiaq. This place is popularly known as monument. It is an historic and archaeological site which qualifies as a landmark on the National Register of Historic Places. Old graves and sod houses remain.
TLUIBAR123	Igluluk	Place name means "old sod house ruins". Graves and ruins are found in this area. Spring camping area. Hunting for walrus, ringed seal, and bearded seal off the coast during the summer months.

TLUI Key	Place Name	Site Description
TLUIBAR124	Ibeivik	“Breeding area” in Iñupiaq. Summer camping area. Hunting area for walrus, ringed seal, and bearded seal. Winter fox trapping area.
TLUIBAR125	Kuububruk	Place named for a small ravine. Summer camping and abundant hunting of walrus, ringed seal, and bearded seal off the coast.
TLUIBAR126	Saatkunnak	Spring camping and hunting area for ducks and seals. Summer and fall hunting area for walrus, ringed seal, bearded seal, and caribou.
TLUIBAR127	Sieibabruaq	Old sod house ruins, one of which belonged to Tabbaq. Good summer camping and hunting area for walrus, ringed seal, and bearded seal off the coast. Active whaling offshore. Cellars in this area have eroded.
TLUIBAR128	Sieibabruam Kuubuurafa	Sinigagruaq Creek. Summer camping and hunting area.
TLUIBAR129	Qabliik	Qagliik means men's snow pants, or trousers with fur inside. Summer camping and hunting area for caribou. Summer hunting for walrus, ringed seal, and bearded seal off the coast.
TLUIBAR130	Tasibruaq	Tasigruaq Lake. Place once frequented by reindeer herders. Fishing, trapping, and hunting area.
TLUIBAR131	Umiaqtubvik	Umiaqtugvik Lake. Place name means a place to go boating. Fishing, trapping, and caribou hunting area.
TLUIBAR132	Nullabvik	Nullagvik means “a camping or stopover place”. Well known summer camping and hunting area for walrus, ringed seal, and bearded seal. Spring whaling offshore. Duck and brant hunting area. Coastline bluffs on the east side.
TLUIBAR133	Nullabvium Kuubuurafa	Nullagvik Creek. Spring duck and brant hunting area. Summer camping area.
TLUIBAR134	Sieibat Ualliit	Place name means “the western side of the coastline bluffs”. Summer camping and hunting area. Good hunting area for brant and duck. Abundant hunting of walrus, ringed seal, and bearded seal in the summer. Spring whaling off the coast.
TLUIBAR135	Sieibat	Place name means coastline bluff. Summer camping and hunting area for walrus and ringed and bearded seals. Spring whaling off the coast.
TLUIBAR136	Sikulium Nuvua	Sikulik point. Fishing, trapping, and hunting area.
TLUIBAR142	Uluuraq	Trapping area. Seal summer camp.
TLUIBAR143	Igniviq	Trapping area. Seal summer camp.
TLUIBAR144	Sunnugruak	Nate Neakok's family camps here every summer for fishing by humpback whitefish and Arctic grayling gillnets. White fox trapping area. Nesting area. The old <i>ikkigaks</i> serves as land markers in following the trail.
TLUIBAR147	Kagliik	Place name is Iñupiaq for “two forks”, like trousers. Camping and seal hunting area.
TLUIXMR001	Qaviarat	Place name means “fine sand”. A fishing and hunting area located on both sides of the Kuulugruaq, about two miles below the confluence of the Uqpiksuu. On the west side of the river are several ice cellars and house pits.
TLUIXMR024	Imaabvik	Iñupiaq place name means “a place where one has fallen into the water”. Winter fishing area for broad whitefish, grayling, least cisco, humpback whitefish, and burbot. Winter fox trapping area. Caribou hunting area. An abundance of salmonberries in the summer.
TLUIXMR025	Kuutchiam Paafa	Entry or mouth of the Kuutchiaq River. Fishing and hunting area.

TLUI Key	Place Name	Site Description
TLUIXMR027	Aiviq	Winter trapping area. A popular fish camp with fishing for grayling, humpback whitefish, least cisco, broad whitefish, and burbot. Nesting area. Caribou hunting area.
TLUIXMR029	Kuutchiaq	Kuutchiaq River. Kuutchiaq is Iñupiaq term for a newly formed river. Fishing and hunting area. Whyborn Nungasak has a cabin here.
TLUIXMR030	Qablubruaq	This site is located on a <i>qaglu</i> , which means deep water area. Its original name was qalugruaq. A good fishing and hunting site located on the west bank of the Kuulugruaq, approximately seven miles downstream from the confluence of the Nigisaqtugvik River.
TLUIXMR032	Nasiqsrubvik	Entry or mouth of the Nigisaqtugvik River. Iñupiaq place name means a “high vantage point to go scout out game”. Caribou hunting area.
TLUIXMR033	Nibisaqtubvium Paafa	Entry or mouth of the Nigisaqtugvik River. Fishing, trapping, caribou, and geese hunting area. Old cellars remain in this area. Old cellars remain in this area.
TLUIXMR034	Nibisaqtubvik	Located at the north of the river. In Iñupiaq, <i>nibisaqtubvik</i> means, “where you go eat hearty”. Old sod house ruins that used to belong to the families of Uniiyaq Nasukpauraq. Okpeaha's parents fishing area. Trapping area. Some old cellars are located at the mouth of the river. Geese.
TLUIXMR036	Alliq	Alliq River. <i>Alliq</i> means at the bottom or other side of (in reference to the Nigisaqtugvik River). Fishing area for grayling, broad whitefish, least cisco, and humpback whitefish. Camping and hunting area.
TLUIXMR042	Atqasuk	This is the modern village site of Atqasuk, re-established on the Meade River in 1972 by the Alaska Native Claims Settlement Act. The original name of the site was Qingagnaak because the bend in the river at this site looks like a nose. Fishing area.
TLUIXMR043	Imabruaq	Imagruaq Lake. Iñupiaq place name means big water. Located close to Atqasuk, this lake is surrounded by salmonberries.
TLUIXMR084	Napaqsrq	<i>Napaqsrq</i> is the Iñupiaq term for an upright pole or tower. A tower is still standing, used by hunters as a landmark. Summer hunting area off the coast for walrus and ringed and bearded seals.
TLUIXMR085	Usuabruk	Usuagruk is an old site, with sod house ruins belonging to Kisisaq and Alagiasq. Summer camping area and hunting area off the coast for walrus and ringed and bearded seals.
TLUIXMR086	Nullabvium kuubuurafa	Nullagvik Creek. Spring duck and brant hunting area. Summer camping area.
TLUIXMR087	Sikulik	Sikulik Lake. Fishing, trapping, and hunting area.
TLUIXMR088	Uluuraq	Place name means an <i>ulu</i> , or woman's knife. Summer camping area and hunting area off the coast for walrus, ringed seal, and bearded seal.
TLUIXMR089	Abnaatchiabruaq	Place name derived from Agnaatchiagruaq, a shaman who is buried here. Caribou hunting area.
TLUIXMR091	Qikuligaabruk	Place name means a place with many seal holes. Summer hunting area off the coast for walrus and ringed and bearded seals. Caribou hunting area.
TLUIXMR092	Tuapaktusuum kuubuurafa	Tuapaktusuk Creek. A historic site. Summer camping and caribou hunting area. A reindeer herding and grazing area.
TLUIXMR095	Niblaivik	Niglaivik River. A tributary of the Kuugaagruk, geese nesting area and hunting area. Winter fishing area for Arctic grayling.
TLUIXMR097	Naullat	Land feature is shaped like a spear. Fishing area with an abundance of grayling. Spring geese hunting area. Camping area.

TLUI Key	Place Name	Site Description
TLUIXMR098	Nimibiaq	Place name means shaped like a snake, in reference to the river.
TLUIXMR099	Kuugaabruk	Fishing along the river for broad whitefish, grayling, arctic cisco, humpback whitefish, least cisco, and burbot. Trapping area for fox. Spring geese hunting area. Caribou hunting area.
TLUIXMR100	Sukam kuubuurafa	Sukaq Creek. Trapping and hunting area.
TLUIXMR101	Maniqtuut	Spring geese hunting area. Fishing and caribou hunting area.
TLUIXMR102	Iviksulugruaq	Iviksulugruaq Lake. Well known fishing area for broad whitefish, grayling, humpback whitefish, arctic cisco, and burbot. Geese hunting area. Trapping and hunting area. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when traveling inland for summer fish
TLUIXMR103	Ikkalubruaq	Ikkalgugruaq Lake. Fishing area for many types of fish. Part of the Kumaktuyuniq traditional <i>qayaq</i> trail when traveling inland for summer fishing and hunting.
TLUIXMR104	Afmalubruum kuubuurafa	Angmalugruk Creek. Fishing for grayling, least cisco, and broad whitefish. Trapping area for fox. Geese and caribou hunting area.
TLUIXMR106	Iqixaaluk	Iqilaaluk Creek. Fishing, trapping, and hunting area.
TLUIXMR112	Uyabaabvik	Place name means an area where there are rocks or stones. Fishing area for many types of fish. Geese hunting area. Trapping and hunting area.
TLUIXMR115	Kuugaabruk	Fishing along the river for broad whitefish, grayling, arctic cisco, humpback whitefish, least cisco, and burbot. Trapping area for fox. Spring geese hunting area. Caribou hunting area.
TLUIXMR116	Iviksuk	This area qualifies as a historic site. There are old sod house ruins of Keerik, Okpeaha, Uniiya, and Nasukpaurak. A cabin belongs to Ina Kalayauk of Utqiagvik. An old cellar is located on the mouth of the river. At times, many cabins are pitched here.
TLUIXMR117	Pifubruugaabruich	Iñupiaq place name given to these high bluffs. Fishing area for grayling, least cisco, humpback whitefish, burbot, and broad whitefish. Trapping area for fox. Spring geese hunting area. Caribou hunting area. Cabin owned by Joseph Nashaknik.
TLUIXMR118	Pifubruugaabruk	Iñupiaq name given to the bluffs here. Fishing area for many types of fish. Trapping area for fox. Spring geese hunting area. Caribou hunting area. Cabins located here are owned by Calvin Panigeo, Alfred Leavitt, and William Hopson.
TLUIXMR119	Niblaivigum paafa	Mouth of the Niglaivik River, a tributary of the Kuugaagruk. Place name means a place where geese raise their young, and a place to hunt geese. Good fishing area for grayling, arctic cisco, humpback whitefish, broad whitefish, and burbot.
TLUIXMR120	Payugvik	This site is an important historic and contemporary hunting and fishing site with modern fish camps, caches of fishing equipment and camping gear, and a plywood shelter cabin. Close to the Utqiagvik -Atqasuk trail, travelers often stop here.
TLUIXMR121	Akiqti	Akiqti River. The Akiqti River flows into the Payugvik River. Fishing area for broad whitefish, grayling, and least cisco. This is a place where one should not sleep overnight.
TLUIXMR145	No data provided in the TLUI database	No data provided in the TLUI database.
TLUIXMR147	No data provided in the TLUI database.	No data provided in the TLUI database.

TLUI Key	Place Name	Site Description
TLUIXMR149	Agmalugruk	Good fishing area for Ikalusaak, Anaagluk, and Sulukpaugak in the fall. Camping and hunting site. Two cellars belong to Mark Ahsoak and Nate Olemaun
TLUIXMR150	Kaleak	Good fishing area near the mouth. Trapping area. A popular geese hunting and camping in the spring.
TLUIXMR153	Nimigiak	Hunting and camping area
No data provided in the TLUI database.	Qifabnaak	Added June 1, 2017

### Data Gaps

Until a detailed survey is conducted within the project area, much of the land within the project area remains unresearched and unsurveyed for cultural resources. Archaeologists should conduct a visual reconnaissance overflight of the potential road corridor, followed by complete field surveys and testing of high-potential areas along the preferred corridor.

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## **Technical Memorandum 7 – Paleontological Resources**

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**Technical Memorandum 7 – Paleontological Resources**

**Prepared by:** Ranna Wells, MA, RPA, Archaeologist

**Reviewed by:** Daniel Thompson, MA, Archaeologist

**Date:** July 2019

**Paleontological Resources**

Paleontology is the study of fossils and ancient life forms. A paleontological resource is any “fossilized remains, traces, or imprints of organisms, preserved in or on the earth’s crust, that are of paleontological interest and provide information about the history of life on earth,” but that does not include archaeological items or other cultural items (Paleontological Resources Protection Act of 2009 [PRPA]) . Examples of paleontological resources found in Alaska include fossils of dinosaurs, clams, trilobites, microorganisms, or mammals, such as mammoths.

**Regulatory Background**

Like cultural resource sites, paleontological sites are protected by federal, state, and local laws and policies (Table TM7-1).

**Table TM7-1. Management of Paleontological Resources**

Government Level	Scope	Applicable Laws, Policies, and Ordinances
Federal	Federal lands	PRPA 2009
State, Alaska OHA, Department of Natural Resources	State Undertaking	Alaska Historic Preservation Act (AS 41.35) Alaska Administrative Code (11 AAC 16)
North Slope Borough	Borough	NSBMC § 19.50.030(F) and § 19.60.040(K)

AS = Alaska Statute  
NSBMC = North Slope Borough Municipal Code  
OHA = Office of History and Archaeology  
PRPA = Paleontological Resources Protection Act

**Federal Laws and Policies**

Paleontological resources on federal lands are owned by the United States (Board of Regents of the University of Oklahoma 2005, Bureau of Land Management [BLM] 2001). The PRPA affirms that it is the responsibility of federal land-managing authorities to manage and protect paleontological resources on federal lands. This act provides guidelines for the collection of paleontological resources and collection permits; curation of the resources; and civil and criminal penalties for unauthorized removal, transport, or damage to the resources. The act also requires that federal agencies develop regulations, establish public awareness and education programs, and inventory and monitor federal lands. At this point, BLM has not implemented regulations to manage paleontological resources on BLM-managed lands. Impacts to paleontological resources are included in the National Environmental Policy Act (NEPA) process. On BLM lands, such as the National Petroleum Reserve—Alaska, it is BLM policy to consider potential impacts to paleontological resources from federal actions (BLM 2008). A desktop study analysis may suffice for an impact analysis, and is often accepted in Alaska. However, in an area known to be sensitive or known to have paleontological resources, BLM may require a field study.

### **State Laws and Policies**

In Alaska, paleontological sites are managed together with cultural resources (Alaska Preservation Plan). Therefore, paleontological resources are protected under the Alaska Historic Preservation Act (AHPA). The AHPA (Alaska Statute 41.35) protects paleontological resources on state land by ensuring those resources that may be adversely affected are properly documented and that any mitigation measures (if necessary) are conducted in a timely and expeditious manner.

### **North Slope Borough**

While paleontological remains are not explicitly mentioned in the North Slope Borough (NSB) Comprehensive Plan (2019), NSB Municipal Code Title 19, or through the NSB Iñupiat Heritage, Language, and Culture Division (IHLC 2019), it may be assumed that paleontological resources are treated along with cultural resources. For example, the NSB development permit renewal for the Toolik Field Station stipulated, “Should any cultural, archeological or paleontological resource materials (including, but not limited to artifacts, house mounds, grave sites, ice cellars, and fossilized animal remains) be discovered in the course of activities conducted under this permit, the site shall not be disturbed and the NSB IHLC shall be promptly notified at (907) 852-0422. NSBMC 19.70.050(E) through (G), NSBCMP 2.4.3(e) through (g) (NSB 1999).”

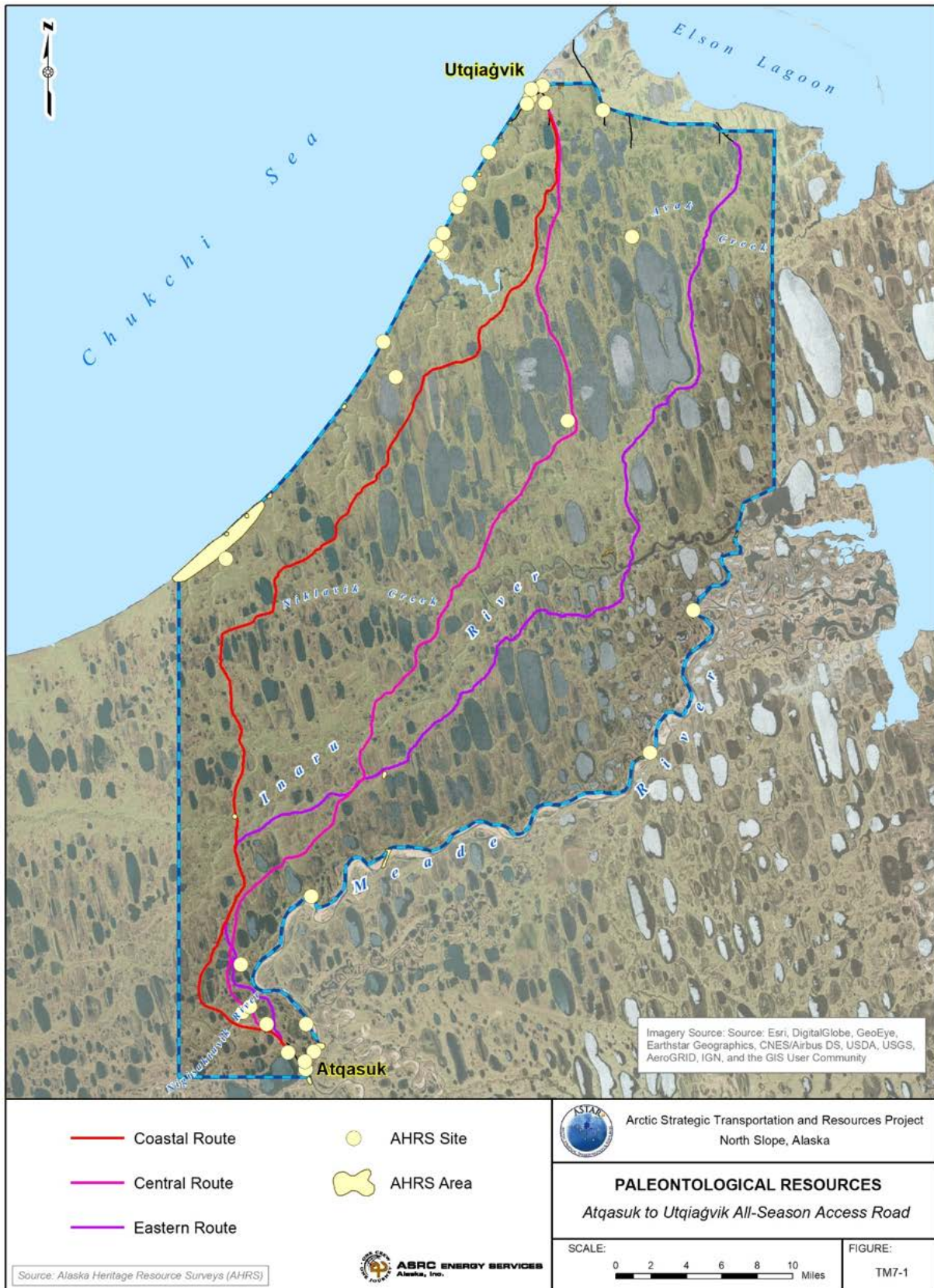
### **Paleontological Resource Sites**

The following is a summary of data available for paleontological sites and surveys within and near the project area. The summary includes a description of specific databases available for review and a discussion of the types of sites and surveys found within or near the project area.

For purposes of this desktop study, AES Alaska reviewed the Alaska Heritage Resource Survey (AHRs) database, maintained by the State of Alaska, Office of History and Archaeology (OHA), for previous cultural resource research and relevant literature for the project area (OHA 2019). The information below is only as complete as the data that are publicly available, as some reports in the AHRs database have been labelled as “proprietary” and are therefore not available for review.

The Alaska OHA records paleontological sites within Alaska in the AHRs database. However, the AHRs is a database used by cultural resource professionals for the documentation and recording of cultural resources (i.e., resources attributed to humans and human use) and not necessarily for paleontological resources. Therefore, paleontological data collected and reported to the OHA are not consistent and not always complete.

Typically, concentrations of paleontological sites are recorded along rivers and ridgelines that have significant cut-banks and land cuts revealing deep stratigraphic levels. The highest concentration of recorded paleontological sites is associated with areas immediately adjacent to the Colville River drainage system within NPR-A (Figure TM7-1). The absence of paleontological sites in other areas may be more a result of sites not found and/or reported in those areas rather than the lack of resources there. A search of the AHRs database in April 2019 revealed 24 paleontological sites within the project area and four within a 3-mile buffer of the project area (Table TM7-2).



Alaska State Plane Zone 6 (NAD83)

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**Table TM7-2 Paleontological Sites**

AHRS Number	Name	Site Description	Zone**
BAR-00025	PA, M7163	Bivalves	project area
BAR-00027	PA, 7228/7229	Pelecypods	project area
BAR-00029	PA, M7429	Bivalves, Gastropods	project area
BAR-00030	PA, M7431	Bivalves, Gastropods	project area
BAR-00031	PA, *7228	Reported by Lindsey	project area
BAR-00035	PA, V-7	Mammoth remains in Pleistocene formation; unconsolidated sands and silts without marine fauna.	project area
XMR-00052	PA, M865	Gastropods	project area
XMR-00055*	PA, M7175	Gastropods, Pelecypods	project area
XMR-00056*	PA, M7173	Pelecypods	project area
XMR-00057	PA, L-1-53	Ferns, Cycad, Conifers, Angiosperm	project area
XMR-00059	PA, 15929	Gastropods, Pelecypods	project area
XMR-00061	PA, M7174	Gastropods, Pelecypods	project area
XMR-00062	PA, M7314/M7315	Pelecypods	project area
XMR-00063	PA, M7170/A	Gastropods, Pelecypods	project area
XMR-00064	PA, M7313	Gastropods, Pelecypods	project area
XMR-00065	PA, M7169	Gastropods, Pelecypods	project area
XMR-00067	PA, 3627/M3524/4	Gastropods, Pelecypods	project area
XMR-00066	PA, M7312	Pelecypods	buffered

\* site located within the road corridor

## Data Gaps

Much of the project area remains unresearched and unsurveyed for paleontological resources. Concurrent with cultural resources studies, a survey for paleontological resources should be conducted along the preferred route, particularly along riverbanks and ridgelines.

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## **Technical Memorandum 8 – Subsistence Patterns**

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## Technical Memorandum 8 – Subsistence

**Prepared by:** Shannon Mason, Environmental Scientist, and Ranna Wells, MA, RPA

**Reviewed by:** Inuuteq Stotts, MA

**Date:** July 2019

### Overview

Subsistence is an essential component of Iñupiat culture – it is a means of sustaining and maintaining cultural values and Traditional Knowledge (TK). For the Iñupiat of northern Alaska, subsistence is a way of life that has developed over generations, and is adapted to the unique conditions of Arctic Alaska. The North Slope Borough (NSB) zoning and land use code (Title 19) defines subsistence as “an activity performed in support of the basic beliefs and nutritional needs of North Slope Borough residents and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities” (NSB 2018).

Subsistence is based on cooperation and sharing at a familial and community level, serving to strengthen and continue those bonds. Harvest sharing is an integral aspect of the subsistence way of life for many North Slope residents. The subsistence harvest is often shared among communities that do not have access to the same resources. Hunters also share their harvest with elders and other members of the community (Bacon et al. 2011).

### Regulatory Drivers

The use, access, and trading of subsistence resources is regulated by federal and state laws (Table TM8-1). At a local level, protection of these resources may be addressed through ordinances, land use stipulations, subsistence user co-management organizations, and the National Petroleum Reserve – Alaska (NPR-A) Subsistence Advisory Panel.

**Table TM8-1 Management of Subsistence Resources**

Government Level	Scope	Applicable Laws, Policies, and Ordinances
Federal, ANILCA, US Department of the Interior	Federal land	Subsistence use (§ 810(a))
State, ADF&G, Office of Subsistence Management	State land	Subsistence Use and Allocation of Fish and Game (AS 16.05.258)
North Slope Borough	Borough land	NSBMC § 19.50.030(F) and § 19.60.040(K)

ANILCA = Alaska National Interest Lands Conservation Act  
ADF&G = Alaska Department of Fish and Game  
AS = Alaska Statute  
NSBMC = North Slope Borough Municipal Code

### Alaska National Interest Lands Conservation Act

With the passage of the Alaska National Interest Lands Conservation Act (ANILCA) in 1980, the state of Alaska was mandated to maintain subsistence hunting and fishing preferences for rural residents on federal public lands. This was accomplished through the creation of local and regional advisory committees and by providing for state management of wildlife on federal land, provided that the state subsistence policy complies with federal standards (Alaskool nd). Section 810(a) of ANILCA requires an evaluation of subsistence uses and needs be completed for

any federal determination to “withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands.” ANILCA requires that this evaluation include findings on:

- The effect of use, occupancy, or disposition on subsistence uses and needs;
- The availability of other lands for the purpose sought to be achieved;
- Other alternatives that would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes.

ANILCA §810(a) provides no “withdrawal, reservation, lease, permit, or other use, occupancy or disposition of the public lands which would significantly restrict subsistence uses shall be effected” until the federal agency gives the required notice and holds a hearing (16 USC §3210[a]).

### **Bureau of Land Management National Petroleum Reserve — Alaska Integrated Activity Plan**

The Bureau of Land Management (BLM) NPR-A Integrated Activity Plan (IAP) determines the required operating procedures, best management practices, and appropriate stipulations for all BLM-managed lands in the project area.

To ensure local participation in the decision-making process as it relates to subsistence use in the NPR-A, the BLM established a local subsistence advisory panel. The panel is responsible for reviewing resource-related development plans within the planning area and issuing recommendations to the BLM regarding whether the plans adequately consider subsistence (BLM 2012):

- By providing recommendations to the BLM concerning planning, research, monitoring, and assessment activities needed to facilitate responsible development and to protect subsistence resources and uses in the NPR-A;
- By identifying potential conflicts between subsistence use and other resource uses;
- By informing local communities about agency actions affecting subsistence resources and uses in the planning area;
- By informing agencies of panel activities;
- By working with the NSB to maintain a repository of subsistence information concerning the planning area for use by local communities and agencies.

### **Alaska Department of Fish and Game**

Subsistence use and allocation of subsistence resources are addressed in AS 16.05.258 and are regulated by the United States Fish and Wildlife Service (USFWS), Office of Subsistence Management and the Alaska Department of Fish and Game (ADF&G). Under AS 16.05.258(b), the state boards of game and fisheries provide a reasonable opportunity for subsistence uses before other uses, referred to as the “subsistence preference” or “subsistence priority.” Furthermore, the customary and traditional use of fish and game is protected by Alaska state law. The determination of whether or not a fish and game resource is associated with customary and traditional uses, and thus to a subsistence preference, falls to the boards of fisheries and game (ADF&G 2019a).

### **North Slope Borough**

The proposed project will also be authorized by the NSB. The project therefore falls under the purview of Title 19 of the NSBMC, which states, “development must not disturb traditional subsistence activities or values at historic, archaeological and cultural sites” (NSBMC 19.50.030[F] and 19.60.040[K]).

Subsistence resources and activities form the foundation of village culture and the economic base within the NSB. As such, the NSB Comprehensive Plan identifies potential impacts to subsistence resources and activities (NSB 2019a). Through the NSB Comprehensive Plan and land management regulations, potential impacts from certain exploration and development activities require NSB approvals. The land management powers of the NSB can be asserted to the fullest extent permissible under law so outstanding concerns regarding subsistence activities can be addressed (ADNR 2018; NSB 2019a). Sample stipulations the NSB may require include the implementation of a Subsistence Mitigation Program, which will assist in mitigation of adverse impacts to subsistence activities and hiring of local subsistence representatives to work as guides and monitors.

## **Subsistence Resources**

Data available about subsistence resources are often not consistent or thorough. Data gaps, inconsistent surveys and survey methods, and misidentification of resources are just some of the problems associated with many studies that involve subsistence. Therefore, the discussion below should not be viewed as an exhaustive report of all the subsistence resources used. The types and quantities of subsistence harvests will vary depending on a number of outside factors, including resource availability, weather, and the availability of subsistence participants (Bacon et al. 2011).

## **Subsistence Areas**

The following sections describe the types of subsistence resources and activities specific to Atqasuk and Utqiagvik. Although the project area does not include offshore locations, any discussion of subsistence and North Slope whaling communities would be remiss if it did not include details regarding marine mammals.

### ***Atqasuk***

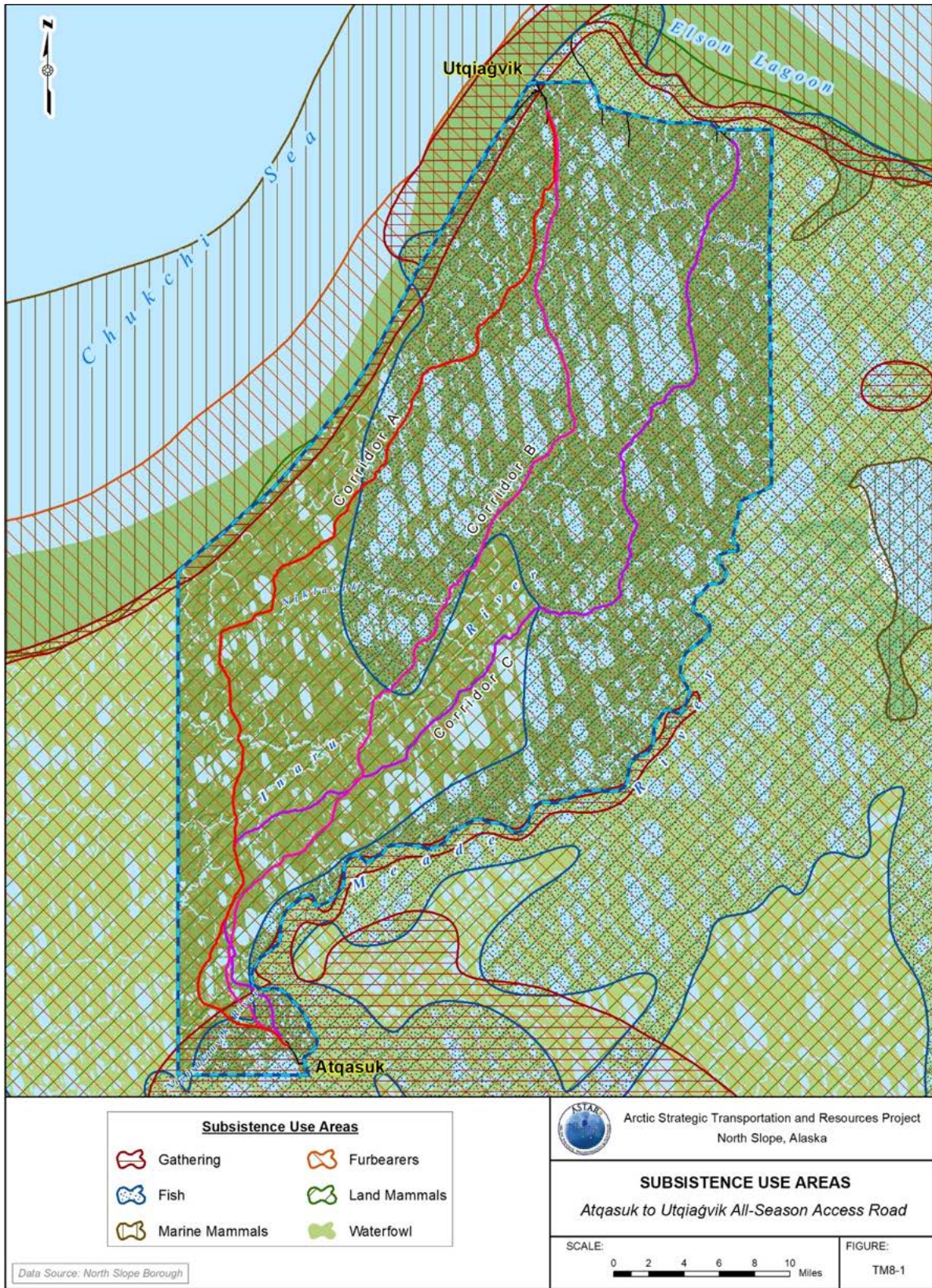
The community of Atqasuk is located approximately 60 miles southwest of Utqiagvik. It is inland from the Arctic Ocean, on the Meade River. Atqasuk was established in 1976 by families from Utqiagvik and currently has about 261 residents (NSB 2019c). They chose a site known as Tigaluk, which had been used historically as a base camp for interior hunting. The economy in Atqasuk is predominantly subsistence-based, relying mainly on fishing and caribou hunting (NSB 2019a) Subsistence use areas for Atqasuk are shown on Figure TM8-1.

Marine Mammals: Atqasuk residents travel to Utqiagvik to participate in bowhead whaling. Other marine resources are obtained through barter or gift-giving between NSB communities. The NSB Department of Wildlife Management (DWM) reported a June 1998 harvest of three bearded seals by Atqasuk residents. No other marine mammals were reported as harvested by Atqasuk residents between 1994 and 2003 (Bacon et al. 2011). Polar bears are also found in the vicinity (NSB 2017a).

Land Mammals: Caribou are the principle terrestrial subsistence resource for Atqasuk, and are harvested year round. Other land mammals available to Atqasuk residents are moose, brown bear, lynx, and porcupine. Furbearers including ground squirrel, weasel, wolverine, fox and wolf are harvested for their warm skins, sometimes incorporated into locally made clothing and crafts (Bacon et al. 2011, NSB 2017a).

Fish: Atqasuk residents rely heavily on the fish of the Meade River drainage, particularly several species of whitefish, Arctic grayling, and burbot. Gillnets are used at summer fish camps to harvest humpback and broad whitefish and grayling. Gillnets are also set beneath the ice in fall and winter. Ice fishing for burbot is done with jigs in spring and fall. Smaller amounts of Arctic char, chum, Chinook salmon, least cisco and rainbow smelt are also caught for subsistence purposes (Bacon et al. 2011, NSB 2017a).

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**Birds:** Bird hunting is mainly a spring activity. Both rock and willow ptarmigan are harvested, but waterfowl is the dominant avian resource. Of the various ducks, geese and swans that are subsistence hunted, the main target species is white-fronted goose. Mallards, Tundra swan, Northern pintails, ravens, and green-winged teal are also common species in the Atqasuk area (Bacon et al. 2011, NSB 2017a).

**Plants:** The main plant resources harvested by Atqasuk residents are blueberries and salmonberries. Cranberries, blackberries, wild spinach, and Labrador tea are also gathered by community members (Bacon et al. 2011, NSB 2017a).

### ***Utqiagvik***

The community of Utqiagvik is the largest NSB city with approximately 5,256 residents as of 2015 (NSB 2019c). Utqiagvik is located on the Chukchi and Beaufort Sea coasts, in the Arctic Ocean. It is the northernmost community in the United States, and the regional hub for transportation, economics, and administration (NSB 2019b). Utqiagvik residents reported on over sixty different resources for Bacon et. al.'s 2009 study (2011), indicating that a large portion of the available subsistence resources are in use (Bacon et al. 2011). The subsistence use areas for Utqiagvik residents are depicted in Figure TM8-1.

**Marine Mammals:** Hunting for bowhead whale is a critical cultural tradition and subsistence activity in Utqiagvik. Whaling takes place in the spring and fall, with much of the harvest distributed to other communities and shared at the Nalukataq celebration in June. Between 1998 and 2003, Utqiagvik residents harvested an average of 22 bowhead whales per year. Walrus, bearded, ringed, and spotted seal are hunted, as are polar bears (Bacon et al. 2011).

**Land Mammals:** Caribou is one of the most consistently eaten subsistence foods. More residents participate in caribou hunting than any other hunting activity. Animals are predominantly harvested from the Teshekpuk Herd. Brown bear, arctic and cross fox, ground squirrel, weasels, wolves and wolverines are also taken for subsistence purposes (Bacon et al. 2011).

**Fish:** Fishing is one of the most popular subsistence activities among Utqiagvik residents (Brown et al 2016), given their access to both inland water sources and the ocean. Broad whitefish are the most commonly caught, mostly during the fall. The Arctic grayling is second most important in subsistence fishing. Char, flounders, northern pike, lake trout, burbot, smelt, halibut, least cisco, and chum, Chinook, pink, coho, and sockeye salmon are also available for subsistence harvest (Bacon et al. 2011, ADFG 2019b).

**Birds:** A variety of waterfowl are harvested by Utqiagvik residents. King and common eiders, and greater white-fronted geese are the most common, while other species of waterfowl including brant, pintail and long-tailed ducks, eiders, and snow goose are harvested in lesser amounts. Ptarmigan species and snowy owls are also harvested by the residents of Utqiagvik (Bacon et al. 2011).

**Plants:** Plants are gathered to a lesser extent. Blueberries and salmonberries are the most commonly collected, but crowberries and cranberries are harvested in smaller amounts. Other plants gathered by Utqiagvik residents are wild rhubarb and spinach, willow leaves, and assorted roots (Bacon et al. 2011).

**Invertebrates:** Clams are also harvested as a subsistence resource by the residents of Utqiagvik (Bacon et al. 2011).

Existing data on subsistence resources for the project area are available publicly through the ADF&G Community Subsistence Information System, the repository of Alaska community harvest information gathered by ADF&G Division of Subsistence, the NSB website, and the Alaska Resources Library and Information Services (ARLIS). Below is a description of the most relevant and recent subsistence studies to the project area.

## North Slope Borough Studies

The NSB sponsors numerous subsistence-related studies and research projects, some through the Division of Wildlife Management (DWM). Most of these research studies are available on their website at: <http://www.north-slope.org/departments/wildlife-management/studies-and-research-projects>. The DWM facilitates sustainable use of fish and wildlife population through research, leadership, and advocacy. Below is a summary of the most recent and relevant studies:

- **Spatial Analysis of Subsistence with Geographical Positioning System:** This study was created in response to requests by village political leaders and other North Slope leaders and hunters for the need to document patterns of subsistence use. NSB researchers collected baseline data, including travel routes and areas subsistence hunters currently use to harvest subsistence resources. The study area included nearshore and offshore areas, all of NPR-A, and state and private lands adjacent to NPR-A near the villages of Point Lay, Anaktuvuk Pass, and Nuiqsut. This study was prepared for the State of Alaska Department of Commerce, Community and Economic Development, and was in part paid for with NPR-A Program funds (NSB 2015a).
- **Estimates of Subsistence Harvest for Villages on the North Slope of Alaska, 1994—2003:** This study included a series of household interviews and was conducted by interviewers who were residents of the community in which survey was conducted. Two types of surveys were conducted – a one-year recall survey and a six-month recall survey. The researchers noted several issues that arose during this project, including: inconsistent survey structure, gaps in data collection and misidentification of harvested resources and some inherent problems typical of recall surveys; and large gaps in data for the time period covered by the report as a result of inadequate funding and frequent turnover of personnel hired to complete surveys. The survey in Nuiqsut focused on resources harvested, total harvest by month, how many animals were reported to be harvested during survey periods of 1995—1996 and 2000—2001 (Bacon et al 2011).
- **2015 Economic Profile and Census Report:** This is the fifth publication of NSB’s Economic Profile and Census Report. In the 2015 survey, issued by NSB in consultation with the DWM and Health Departments, subsistence questions were added that specifically address harvest of certain species (caribou, ringed seal, bearded seal, and walrus), food security, and safety. The results of this report indicate nearly all NSB communities are undergoing stresses in their ability to sustain their subsistence activities (NSB 2016).
- **Atqasuk Comprehensive Plan:** The Atqasuk Comprehensive Plan includes a summary of subsistence resources, procurement, and the seasonal round. It also addresses vulnerabilities to subsistence, including costs, industry impact, safety, climate change, activities affecting migration, and wage income (NSB 2017a).
- **Barrow Comprehensive Plan:** The Barrow Comprehensive Plan summarizes subsistence activities during the seasonal round. The emphasis is on whaling, which requires preparation year around. The plan also discusses some goals for subsistence including increasing language fluency, and the protection of areas where traditional fishing, gathering and hunting occurs (NSB 2015b). (Barrow has since been re-named Utqiagvik).

The DWM also conducts research on the health assessment of subsistence resources (available here: <http://www.north-slope.org/departments/wildlife-management/studies-and-research-projects/health-assessment-of-subsistence-resources>). The DWM initiated a comprehensive health assessment program that includes studies on bowhead whales, fish, seals, walruses, contaminants and nutrition, and stranded marine mammals, among others. The emphasis on health studies is a reflection of NSB residents’ concerns over contamination of subsistence resources. The DWM has focused its research on documenting contaminant levels in various tissues

and comparing them to other areas of the Arctic. They have also conducted some disease screening, diet analysis, and other studies on the health of Arctic animals within the region (NSB 2017b).

### **Alaska Department of Fish and Game Studies**

The ADF&G – Community Subsistence Information System is the repository of Alaska community harvest information gathered by ADF&G, Division of Subsistence. For Atqasuk, 2006 is the most recent year with data available on caribou harvesting. Utqiagvik resource data for a variety of subsistence species (bird, fish, terrestrial and sea mammals, other marine species, and plants) has been updated as recently as 2014 (ADF&G 2019b). The following ADF&G studies are also available for Atqasuk and Utqiagvik:

- **Monitoring of Annual Caribou Harvests in the National Petroleum Reserve in Alaska: Atqasuk, Barrow, and Nuiqsut, 2003-2007:** This is a summary of a five-year community-based research project conducted cooperatively by ADF&G Division of Subsistence, the Inupiat Community of the Arctic Slope, and BLM. The research includes harvest surveys and respondent interviews and seeks to document harvests of caribou, caribou harvest areas, and select contextual information in the three North Slope communities from 2003 through 2007 (Braem et al 2011).
- **Harvests and Uses of Wild Resources in four Interior Alaska Communities and three Arctic Alaska Communities:** The report includes a summary of research conducted on 2014 harvests and uses of wild food by seven communities in Alaska’s Interior and North Slope, including Utqiagvik. Households answered questions about their harvest and use of fish, wildlife, and wild plants in 2014. The research was a combination of ethnographic key respondent interviews and household surveys. Researchers estimated annual harvests and uses of wild fish, wildlife, and plant resources in a 12-month study period by residents. Areas used for hunting, fishing, and gathering were mapped. Researchers collected demographic and income information; evaluated trends in wild resource harvests; and documented TK observations regarding wild resources. The research was conducted by ADF&G Division of Subsistence, the Native Village of Nuiqsut, and village councils for other participating villages (Brown et al 2016).
- **Revised Options for Amounts Reasonably Necessary for Subsistence Uses of the Teshekpuk Caribou Herd:** This report provides revised options for amounts reasonably necessary for subsistence for the Teshekpuk Caribou herd. Between 1984 and 2016, biologists estimate that the herd grew from 11,822 to 41,542 animals. Residents of the communities of Utqiagvik, Atqasuk, and Nuiqsut are the primary users of the Teshekpuk caribou herd (Braem 2017).

### **Other Studies**

In 2004, NSB DWM and Minerals Management Service (now Bureau of Ocean and Energy Management) contracted Stephen R. Braund and Associates (SRB&A) to conduct subsistence mapping studies in Utqiagvik, Nuiqsut, and Kaktovik. The study was designed to develop GIS describing regional subsistence patterns and measuring change in these patterns over time. The result of the research is a comprehensive report that includes discussions of subsistence resources and procurement, subsistence use areas (including maps and figures), preferred use areas, transportation methods and routes, duration of trips, gear/weapons used, numbers harvested, number of participants, hunting and fishing camps, months of effort, and kill sites (SRB&A 2010).

### **Native Use Areas (Camps and Cabins)**

NSB maintains information on reported camps and “fixed” campsites within its boundaries. A “fixed campsite” is defined as a site with a long history of camping, or where a cabin has been constructed. Temporary campsites are not included in the database. Some campsites are now abandoned, while others have more recent structures built on top of or nearby the original site. The location of a camp or campsite indicates an area of successful hunting and/or fishing, both currently and historically/traditionally. Subsistence users often travel long distances

to use these cabins and camps, and can travel over 100 miles from them in a day to use other subsistence locations (SRB&A 1993).

Camp and cabin locations (Figure TM8-2) obtained from NSB are focused on current sites and completed structures. The database is unlikely to account for all existing camp and cabin structures that are in current use for subsistence activities. This information should be primarily used to identify the density of subsistence use.

The majority of subsistence cabins and campsites are adjacent to water, such as major streams, rivers, and lakes. Proposed routes run parallel to portions of two major streams in the project area, the Meade and Inaru Rivers, and cross the Nigisaktuvik River and Niklavik Creek. Subsistence cabins and camps can also be found along the coast, or in the interior, away from water bodies. These sites may correspond with winter trails, or the migration routes of waterfowl or caribou.

The highest density of NSB documented camps or cabins in the project area are concentrated in the following locations:

- Approximately 1 mile northeast of Atqasuk, along the Meade River
- Approximately 28 miles south of Utqiagvik on the Inaru River, near the confluence of Ekilaaluk Creek.

### **Limitations on Industrial Activities Associated with Camps and Cabins**

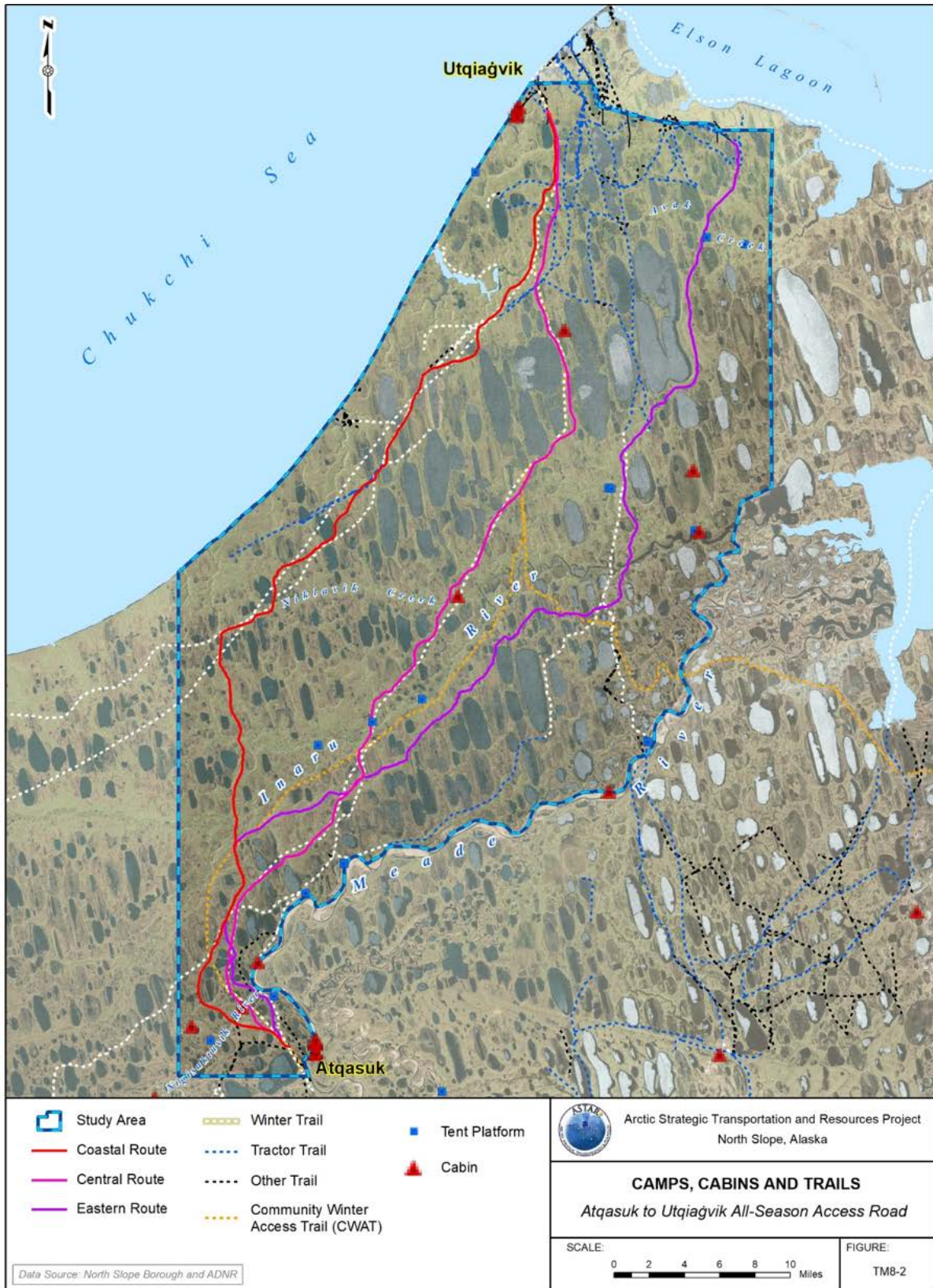
Within the proposed project area, there are limitations on activities in the proximity of subsistence camps and cabins. BLM (2018) determined that the Best Management Practice for these properties in NPR-A is avoidance. An officer of the appropriate Native Tribal government will make the determination, depending on the type of industry proposed and density of subsistence activities in the area. BLM also requires that there be a minimum of aircraft disturbance in areas where there are known subsistence camps and cabins (BLM 2016).

### **Historic and Contemporary Subsistence Use Areas**

#### ***Background***

Subsistence areas used by North Slope residents for subsistence can be classified into three distinct categories: ocean environment, coastal environment, and inland environment. These areas are used by subsistence hunters in unique ways, although the resources used at each location may overlap. The ocean provides an excellent variety of subsistence species, including mammals, birds, fish, and crustaceans. The coastal environment sees the harvest of caribou in addition to smaller terrestrial mammals, birds, plants, wood, and fish. When inland, subsistence users harvest caribou, fish, birds, furbearing mammals, and plant resources (Bacon et al. 2011; SRB&A 1993).

North Slope residents subsistence hunt close to villages, but sometimes will travel great distances to procure their subsistence resources. For example, Utqiagvik residents travel northeast and southwest along the coast for caribou, and also travel inland for caribou and furbearing mammals. Some residents have reported traveling more than 150 miles to the headwaters of the Meade and Ikpikpuk rivers and to the Colville River. Beginning in the 1960s, the introduction of snowmachines and all-terrain vehicles into the region greatly increased the travel efficiency, allowing participants to travel farther, faster, than they previously had with dog traction (SRB&A 1993; Tremont 1987).



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## ***Subsistence Areas***

**Historic Trails:** Many rural trails including ones for mail, mining routes, and other historic transportation routes have been designated as Revised Statute (RS) 2477 trails. An RS 2477 trail may include historic or prolonged use of the area. A search of Alaska Mapper (ADNR 2019) yielded no RS 2477 trails in the project area.

There are trails in the project area that have been labeled as potential and historic transportation routes, but have not been assigned AHRS numbers or RS2477 status (ADNR 1993, 2019). They are depicted on a State of Alaska, ADNR map that was published in 1993 (ADNR 1993). The original inventory of the routes compiled in the map was performed by the Alaska Department of Transportation and Public Facilities (ADOT&PF) in 1973. A historic transportation route between Atqasuk and Utqiaġvik is included, as well as another, potential route (ADNR 1993).

Another map of the historic subsistence routes used by both Atqasuk and Utqiaġvik in NPR-A is found in Tremont (1987). One on the Inaru River appears to parallel the historic route depicted in the ADNR map. Both winter trails and summer water access routes are depicted, as are areas of intense snow machine use south of Atqasuk (Tremont 1987).

Over time, some of the historically used subsistence trails have fallen out of use, although some may still receive sporadic usage. Regardless of their level of use, the “Iñupiat consider all of these routes as part of their cultural heritage and realm of activities” (Tremont 1987).

**Summer Trails:** Tundra becomes marsh-like and wet once the snow has melted, making travel on the North Slope in summertime difficult. Subsistence users travel overland less frequently, or for shorter distances during this time than they do in the winter months, using watercraft and, to some extent, aircraft, to access subsistence areas. The generalized access routes in Tremont (1987) appear to closely follow rivers.

**Winter Trails:** The locations of winter subsistence trails are dependent upon local travel patterns; subsistence harvest ranges; and social, physical, and climatic factors that guide their development (Tremont 1987). The north-south winter trail that generally follows the Meade and Inaru Rivers between Atqasuk and Utqiaġvik is one of several Tremont (1987) details in the general project area.

Many of these trails appear to parallel the historic transportation routes labeled by ADNR (Figure TM8-2; ADNR 1993). The winter trails not only provide access routes among communities, but they also provide greater ease of access for subsistence users to cabins and campsites. They allow for easier access to subsistence resources in winter, such as caribou, fish, and furbearing mammals. These winter trails are actively used by North Slope residents, who travel them via snowmachine and sled (ADOT&PF 2004).

**GPS Trails:** More recently, selected hunters have carried GPS units to track their movements while performing subsistence activities throughout the NSB. Both summer and winter routes were tracked- aquatic, inland and sea ice. The area between Atqasuk and Utqiaġvik is densely marked with GPS trails (Harcharek 2015).

**Communities:** The travel patterns of each village are characterized by the geographic or climatic condition of the arctic region in which the village is located. The following is a brief discussion of the major subsistence-use areas within each community of the NSB.

**Atqasuk:** The main Atqasuk subsistence route was originally a trail that led inland to the now abandoned community of Tugaluk. Atqasuk residents focus their subsistence travel patterns on the Meade River, which is used intensively throughout its length. Atqasuk residents occasionally travel as far upstream as the headwaters. Other rivers comprising an important component of the community’s subsistence zone include the Usuktuk, Shaningarok, Nigisaktuvik, and Inaru river drainages (Tremont 1987).

*Utqiagvik*: Utqiagvik residents' subsistence-use travel extends from Nuiqsut in the east to Wainwright in the west, and the Colville River in the south to the Beaufort Sea in the north. This is the largest subsistence-harvest zone of the NSB. One of the most frequently used travel routes is the route from Admiralty Bay via the Inaru River (Tremont 1987).

## Data Gaps

This document should be updated as new data are made available. Studies are continually being made available as research is finalized. Therefore, resources such as the NSB website, ARLIS, and ADF&G websites should be checked periodically to see if new data are available for the project area. In addition, the data gap analysis will need to be revised if the project area is changed and/or expanded.

Data gaps for subsistence resources will be identified by the land managing or permitting agency/ies, in conjunction with consultation with local village, tribal entities, and NSB. Early and frequent consultation with these entities will identify data gaps and will facilitate a smooth process.

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## **Technical Memorandum 9 – Wetlands**

**Prepared by:** Joe Christopher, PWS

**Reviewed by:** Paul Ramert, P.E.

**Date:** July 2019

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### **Overview**

The project area (Figure TM9-1) is located within Alaska’s North Slope Borough between the villages of Atqasuk and Utqiagvik within the northwest National Petroleum Reserve—Alaska (NPR-A). The landscape in the project area is dominated by palustrine patterned ground wetlands underlain by permafrost. The annual thaw cycle in the permafrost active layer drives wetland development in the region. The active layer forms a varied landscape of both high and low centered polygons and numerous tundra ponds and lakes. Wetlands vegetation is dominated by low and dwarf facultative shrubs in drier areas, and obligate sedge grasses in areas with a longer duration of standing water. Soil in this area is typical of the Arctic Coastal Plain physiographic province and is composed of thick layers of low permeability organics underlain by ice rich organic and low chroma (dark) mineral soils.

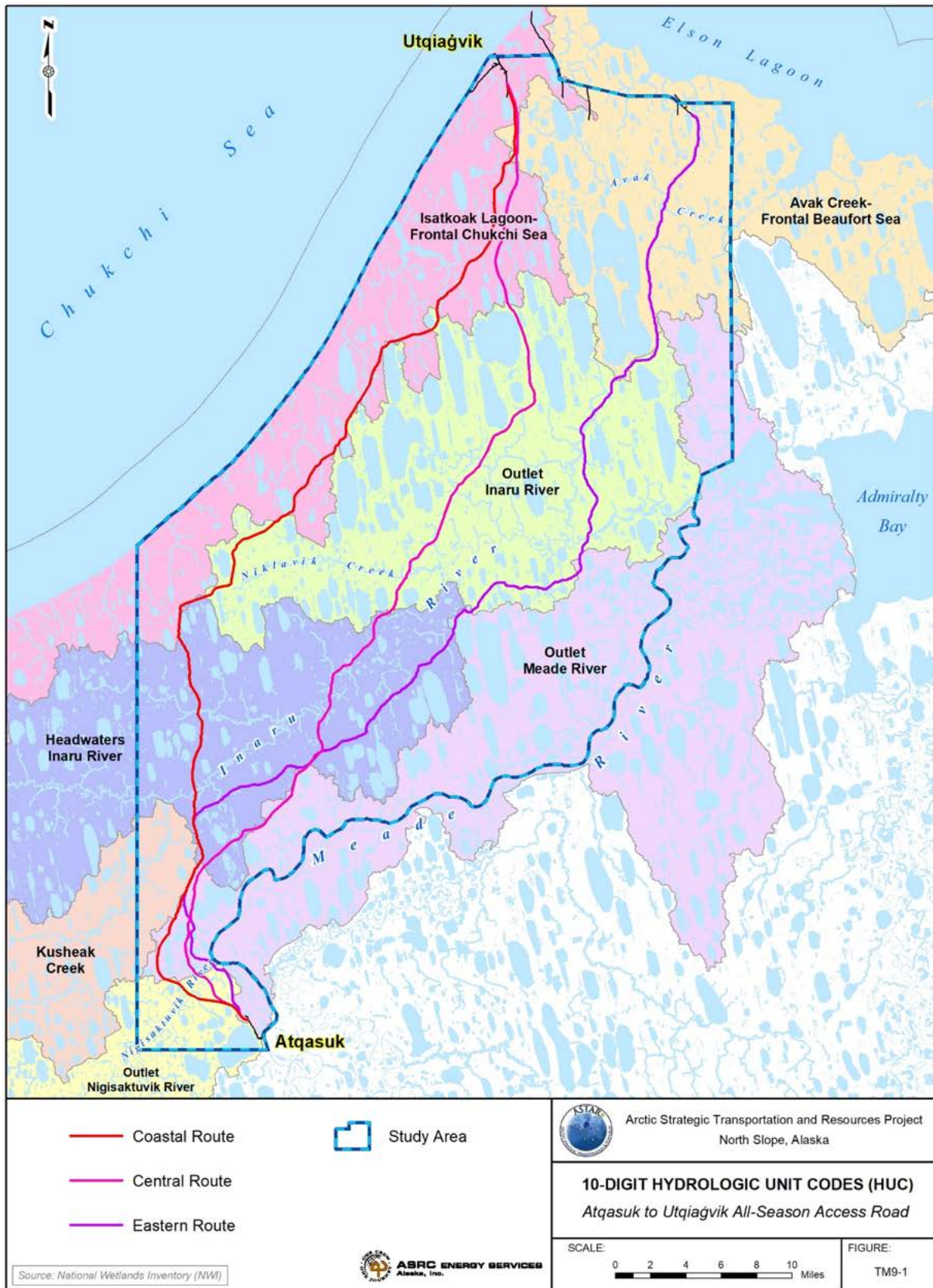
Wetlands within the study area, and the corridors analyzed, were based on United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) Mapping (NWI 2019). Small areas of the study area where no NWI mapping exists was inferred based upon aerial photography and best professional judgment.

Each corridor was evaluated using the U.S. Army Corps of Engineers (USACE) Compensatory Mitigation Thought Process (Thought Process) (USACE 2018) to assess the most beneficial alternative with respect to Clean Water Act (CWA) Section 404 permitting. The USACE utilizes Thought Process as an objective and defensible method to determine if compensatory mitigation may be necessary. By evaluating the wetlands habitats in each corridor against the requirements of the Thought Process, it is possible to estimate which alternative would be more favorable, and less costly to permit with respect to compensatory mitigation.

### **Total Wetlands/Uplands Acres within Each Corridor**

The wetlands and uplands within each Corridor were estimated using NWI mapping (Figure TM9-2). The corridors consist of a 1,000-foot buffer on each side of the route centerline. Table TM9-1 shows the total wetlands and uplands calculated in this analysis. Please note that natural uplands and disturbed uplands were separated out in order to identify which corridors are associated with a greater anthropogenic disturbance. Existing Anthropogenic disturbance is an important feature to identify when determining if a watershed is disturbed, and is a required parameter in step two of the Thought Process.

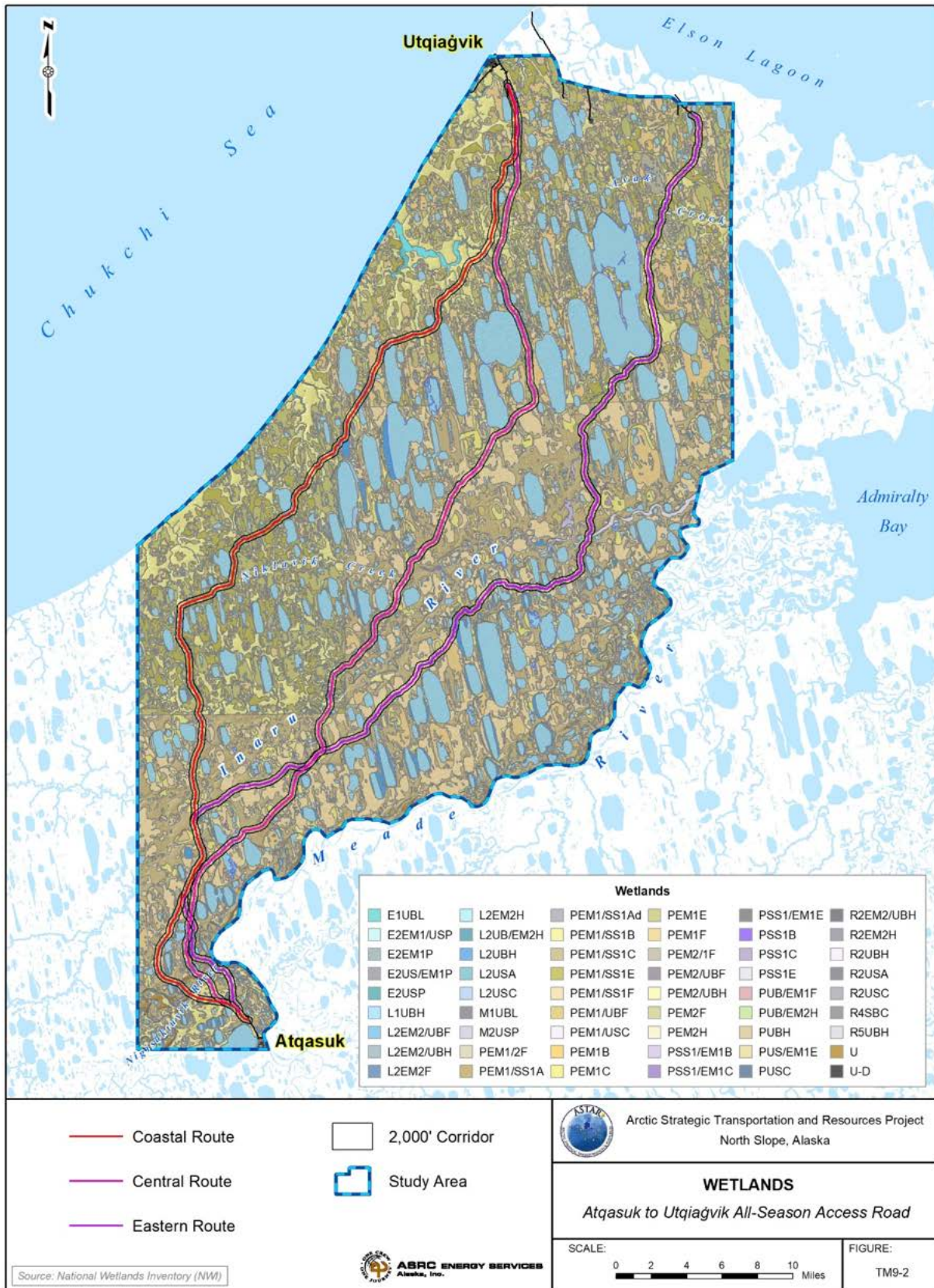
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**Table TM9-1. Total Wetlands/Uplands per Corridor**

Corridor	Palustrine Emergent / Shrub Wetlands	Streams / Lakes/ Ponds	Uplands Natural	Uplands Disturbed	Totals
Corridor A – Coastal Route	659	151	41	8	859
Corridor B – Central Route	575	181	20	7	783
Corridor C – Eastern Route	576	142	19	8	745
Totals	1,810	474	80	23	2,387

### Compensatory Mitigation

The total fill placement in each corridor was evaluated using the USACE Alaska District’s Thought Process (USACE 2018) to determine if compensatory mitigation may be necessary, and if so, how much compensatory mitigation would be needed. This information can be used to assist in determining the corridor that would meet permitting requirements of Clean Water Act Section 404, and have the least cost for construction with respect to compensatory mitigation.

The Thought Process provides a crosswalk from the implementing regulations provided in 33 Code of Federal Regulations (CFR) Part 320.4(r)(2) to Alaska District internal guidance regarding the need for compensatory mitigation.

Alaska District internal guidance provides six instances where compensatory mitigation may be required. They are as follows:

1. Project occurs in rare, difficult to replace or threatened wetlands, or areas of designated critical habitat;
2. Project places fill material in more than a 1/10<sup>th</sup> acre of wetlands or other waters of the United States and/or 300 linear feet of stream, AND the watershed condition is such that compensatory mitigation is necessary;
3. Fill is placed within intertidal waters associated with special aquatic sites;
4. Fill is placed in fish-bearing waters, or wetlands within 500 feet of such waters when impacts are determined to be more than minimal;
5. The project is federally funded;
6. Project is large scale with adverse aquatic resource impacts.

The analysis of each corridor using the above Alaska District Crosswalk guidance is provided below.

#### ***Rare or Difficult to Replace Wetlands or Wetlands located in Designated Critical Habitat***

The *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region (Version 2.0)* (USACE Alaska District 2007) identifies that wetlands occupy as much as 83 percent of the land area of the Arctic Coastal Plain; therefore, wetlands in the Project area are not rare. In addition, the project area is not under wide scale threat from development.

The USFWS Polar Bear Critical Habitat (PBCH) mapping was reviewed to determine the potential presence of PBCH in each proposed route. Based on this analysis, a 51-acre section of Corridor C, near its confluence with the Utqiagvik road system, is located in an area designated as critical habitat.

The USFWS considers pendant grass (*Arctophila fulva*) a high-value vascular plant important to Spectacled and Stellar’s eider nesting and foraging habitat. National Land Cover Database (NSSI 2013) data was used to determine the existence and concentration of pendant grass in each proposed corridor. Corridor A has the least amount of pendant grass, while Corridor B contains the most pendant grass (see Table TM9-2, below).

Based on our analysis, Corridor C appears to contain the highest concentration of PBCH, or hard to replace wetlands; Corridor A contains the least amount of hard to replace wetlands.

Table TM9-2, below, provides a summary of each corridor with respect to rare, difficult to replace wetlands, and/or wetlands located in areas of critical habitat.

**Table TM9-2. Fill Placement in Special Habitat Areas**

Corridor	Rare Wetlands (Acres)	Threatened Wetlands (Acres)	Polar Bear Critical Habitat (Acres)	Difficult to Replace Wetlands (Acres)	Total Estimated Area (Acres)
Corridor A	0.00	0.00	0	58	58
Corridor B	0.00	0.00	0	86	86
Corridor C	0.00	0.00	51	63	114

**Current Watershed Condition and Proposed Impacts**

The project area includes portions of seven 10-digit Hydrologic Unit Code (HUC) watersheds (Table TM9-3).

**Table TM9-3. HUCs within Proposed Routes**

Watershed (10-Digit HUC)
Avak Creek-Frontal Beaufort Sea
Headwaters Inaru River
Isatkoak Lagoon-Frontal Chukchi Sea
Kusheak Creek
Outlet Inaru River
Outlet Meade River
Outlet Nigisaktuvik River

These seven 10-digit HUCs have experienced <0.01% disturbance from previous anthropogenic activities; therefore, they are not currently considered disturbed or degraded. The 10-digit HUC identification of these watersheds and the existing percent disturbance are shown in Table TM9-4.

**Table TM9-4. Existing Fill Placement**

Watershed (10-Digit HUC)	Total Watershed Acres	Existing Fill (Acres)	Existing Fill (%)
Avak Creek-Frontal Beaufort Sea	328,875	18.0	0.005
Headwaters Inaru River	282,939	0.0	<0.005
Isatkoak Lagoon-Frontal Chukchi Sea	301,239	15.0	<0.005
Kusheak Creek	92,988	0.0	<0.005
Outlet Inaru River	201,669	0.0	<0.005
Outlet Meade River	306,789	8.0	<0.005
Outlet Nigisaktuvik River	203,678	8.0	<0.005

Table TM9-5A to TM9-5C show the proposed total permanent fill acres in each 10-digit HUC for the three routes, combined with existing fill from Table TM9-4. The proposed fill acreage is based upon the 44.5-foot wide typical section and road length described in TM5. As presented below, none of the proposed road alignments result in new individual watershed impacts or cumulative impacts across all watersheds of greater than 0.10 percent, which indicates the watersheds are not currently degraded, and would likely not become degraded if any of the routes were constructed.

**Table TM9-5A. Total Watershed Fill for Corridor A – Coastal Route**

Watershed (10-digit)	Total Watershed Acres	Existing Fill (%)	Corridor A Fill (Acres)	Corridor A Fill (%)	Total Watershed Fill (%)
Avak Creek-Frontal Beaufort Sea	328,875	0.005	11.2	<0.005	0.009
Headwaters Inaru River	282,939	<0.005	80.8	0.029	0.029
Isatkoak Lagoon-Frontal Chukchi Sea	301,239	<0.005	152	0.050	0.055
Kusheak Creek	92,988	<0.005	3.28	<0.005	<0.005
Outlet Inaru River	201,669	<0.005	51.1	0.018	<0.005
Outlet Meade River	306,789	<0.005	42.3	0.014	0.017
Outlet Nigisaktuvik River	203,678	<0.005	23.4	0.012	0.016
<b>Cumulative Percent Impact</b>					<b>0.024</b>

**Table TM9-5B. Total Watershed Fill for Corridor B – Central Route**

Watershed (10-digit)	Total Watershed Acres	Existing Fill (%)	Corridor B Fill (Acres)	Corridor B Fill (%)	Total Watershed Fill (%)
Avak Creek-Frontal Beaufort Sea	328,875	0.005	13.6	<0.005	0.010
Headwaters Inaru River	282,939	<0.005	81.3	0.005	0.005
Isatkoak Lagoon-Frontal Chukchi Sea	301,239	<0.005	56.2	0.005	0.010
Outlet Inaru River	201,669	<0.005	115	0.007	0.007
Outlet Meade River	306,789	<0.005	65.0	<0.005	0.007
Outlet Nigisaktuvik River	203,678	<0.005	16.1	0.007	0.011
<b>Cumulative Percent Impact</b>					<b>0.024</b>

**Table TM9-5C. Total Watershed Fill for Corridor C – Eastern Route**

Watershed (10-digit)	Total Watershed Acres	Existing Fill (%)	Corridor C Fill (Acres)	Corridor C Fill (%)	Total Watershed Fill (%)
Avak Creek-Frontal Beaufort Sea	328,875	0.005	84.9	0.026	0.031
Headwaters Inaru River	282,939	<0.005	122	0.043	0.043
Kusheak Creek	92,988	<0.005	2.72	<0.005	<0.005
Outlet Inaru River	201,669	<0.005	112	0.055	0.055
Outlet Meade River	306,789	<0.005	62.5	0.020	0.023
Outlet Nigisaktuvik River	203,678	<0.005	13.3	0.007	0.010
<b>Cumulative Percent Impact</b>					<b>0.030</b>

**Intertidal Waters**

None of the corridors would include permanent fill placement in intertidal waters associated with special aquatic sites.

**Fill Placed in Fish-Bearing Streams and their Adjacent Wetlands**

Table TM9-6 shows the acreage in each corridor associated with fish-bearing waters and jurisdictional wetlands within 500 feet of fish-bearing waters. The location of fish-bearing waters was determined based on Alaska Department of Fish & Game (ADF&G) Anadromous Waters Catalogue (AWC) (ADF&G 2019). In addition, lakes over 20 acres in size that were not in the ADF&G AWC were assumed to have resident fish.

**Table TM9-6. Fill Associated with Fish-Bearing Waters and Wetlands within 500 feet of Fish-Bearing Waters**

Corridor	Fill (Acres)
Corridor A	184
Corridor B	214
Corridor C	124

**Federal Funding**

At this point, it is uncertain where project funding would originate. According to Executive Order 11990, compensatory mitigation would be necessary for portions of the project that receive federal funding in order to meet the national

policy goal of no net loss of wetlands. This alternatives evaluation should be reevaluated once the funding sources are known.

### ***Project Scale and Impact Severity***

Constructing any of the proposed routes would likely be considered a large project, and would most likely require an Environmental Impact Statement prior to receiving a federal Right-of Way from BLM, or a CWA Permit from the USACE. However, the size of the project relative to the scale of the affected watersheds appears to be minimal. Based on other recently authorized projects of comparable size in the NPR-A, the overall wetlands fill would likely be considered minimal.

### **Conclusion**

Based on our application of the Thought Process and estimation of wetlands impacts, it appears that Corridor A has the most wetlands; however, it also possesses the most uplands, as it is larger than the other two corridors. Corridor B and C have similar wetlands and uplands acreage. Corridor A appears to traverse the upper portions of each watershed. A detailed wetland delineation is recommended to determine the boundary and extent of wetlands and natural uplands. The selection of Corridor A for the Atqasuk to Utqiagvik road would most likely afford a greater opportunity to avoid wetlands, and reduce any potential mitigation costs.

While none of the corridors are located in an area with scarce or unique wetlands habitats, Corridor C contains the greatest concentration of designated critical habitat and wetlands that resource agencies may consider more valuable or harder to replace. Therefore, this route selection could result in greater potential for compensatory mitigation. Additional work would be necessary to positively identify the precise location and extent of pendant grass in all proposed routes.

None of the corridors are located in a degraded watershed, and constructing any of the three routes does not result in watershed degradation. However, Corridor C would result in the most cumulative impacts across all watersheds.

Each of the corridors have similar concentration of fish-bearing habitat. Corridor B appears to contain the most fish-bearing habitat, followed by Corridor A and then Corridor C. A fish sampling study is recommended to confirm the presence of fish.

At the current time a founding source has not been designated; therefore, no conclusions can be made as to which route would require mitigation based on that criteria.

Each of the routes would probably require an Environmental Impact Statement led by BLM with the USACE acting as a cooperating agency. However, each route is similar in size and nature to roads approved for Oil and Gas development in the NPR-A. The NEPA documents prepared for those projects determined wetlands would experience long-term minor impacts. Therefore, it is assumed a similar finding would be determined and the routes may not require compensatory mitigation for wetlands impacts.

### **Data Gaps**

Data gaps for wetlands and wetlands impacts include:

- Wetland delineation for the selected route
- Fish and pendant grass survey
- Determine if federal funding would be part of the project

## References

Alaska Department of Fish and Game (ADF&G). 2018. Alaska Department of Fish and Game, Anadromous Water Catalog. Downloadable Data. <https://www.adfg.alaska.gov/sf/SARR/AWC/> (Accessed April 19, 2019)

North Slope Science Initiative (NSSI). 2013. Landcover Mapping for the North Slope of Alaska. Downloadable Data. <http://catalog.northslopescience.org/catalog/entries/8309-nssi-landcover-gis-data-landcover-vegetation>

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———. 2018. *Alaska District Compensatory Mitigation Thought Process*. Revised September 18, 2018.

United States Fish & Wildlife Service (USFWS). 2019. National Wetlands Inventory (NWI) Downloadable Data Collection. (Accessed April 19, 2019). <https://www.fws.gov/wetlands/>

## **Technical Memorandum 10 – Threatened & Endangered Species**

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**Technical Memorandum 10 – Threatened and Endangered Species**

**Prepared by:** Kiel Kenning, Environmental Scientist

**Reviewed by:** Stewart Seaberg, Principal Biologist

**Date:** July 2019

**Overview**

The Endangered Species Act (ESA) of 1973 provides a process by which animal or plant populations that are in jeopardy of extinction throughout all or a significant portion of their range can be listed as threatened or endangered to protect the species and its critical habitat. A threatened species is an animal or plant species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. An endangered species is a species that is in danger of extinction throughout all or a significant portion of its range. Critical habitat consists of designated areas that are essential to the conservation and continued existence of the species.

**Regulatory Drivers**

Under the ESA, the taking of a listed species is prohibited without an authorization such as a Letter of Authorization or Incidental Harassment Authorization, issued by the agency that has jurisdiction over that species. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. This may include significant habitat modification or degradation if it kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Table TM10-1 lists the species, listing agency, and status of species that could potentially occur in the proposed project area.

**Table TM10-1. Species, Listing Agency, and Status of Species Found In the Proposed Project Area**

Species	Listing Agency	Status
Polar Bear ( <i>Ursus maritimus</i> )	USFWS	Threatened
Spectacled Eider ( <i>Somateria fischeri</i> )	USFWS	Threatened
Steller's Eider ( <i>Polysticta stelleri</i> )	USFWS	Threatened

As sea ice comprises the principal habitat of polar bears, the species is protected under the Marine Mammal Protection Act. Requirements of this act generally prohibit the take or import of marine mammals and their parts or products.

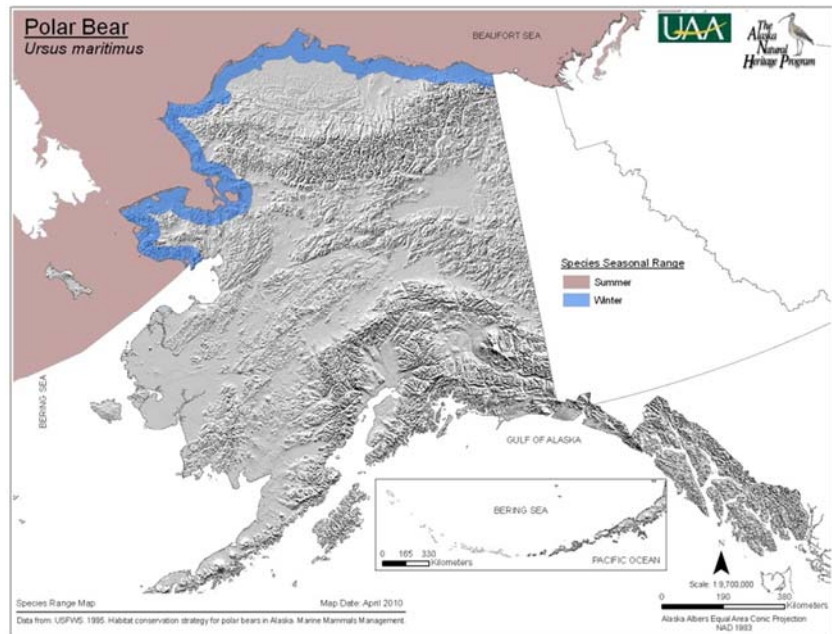
**Polar Bears**

Polar bears have a circumpolar range in the Northern Hemisphere that is determined primarily by seasonal ice. Polar bears generally live on the pack ice, following the advancing and retreating ice edge, as this is the most productive area for hunting seals. A map showing the range of polar bears along Alaska’s northern coast is presented as Figure TM10-1. Only pregnant females den to bear their young. Dens are generally located on the mainland near cliffs or riverbanks where the snow accumulates to sufficient depths, or in areas of stable pack ice with snow depths adequate for denning sites. Females enter dens during October through November, exiting in March through April.

Declining sea ice in the arctic marine environment may lead to changes in polar bear use of their terrestrial environment. Sea ice must be stable for ice denning to be successful. Therefore, if the quality of sea ice decreases, more females may den on land (Durner et al. 2006). An estimate of greater than 60 percent of females from the Southern Beaufort Sea population currently den on land, while the remaining females den on drifting pack ice (Fischbach et al. 2007). Climate change may also affect the quality of denning habitat on coastal or island bluffs due to rapid erosion and slope failure caused by melting permafrost (Durner et al. 2006).

The polar bear was listed by the USFWS as a threatened species under the ESA on May 15, 2008 (USFWS 2008).

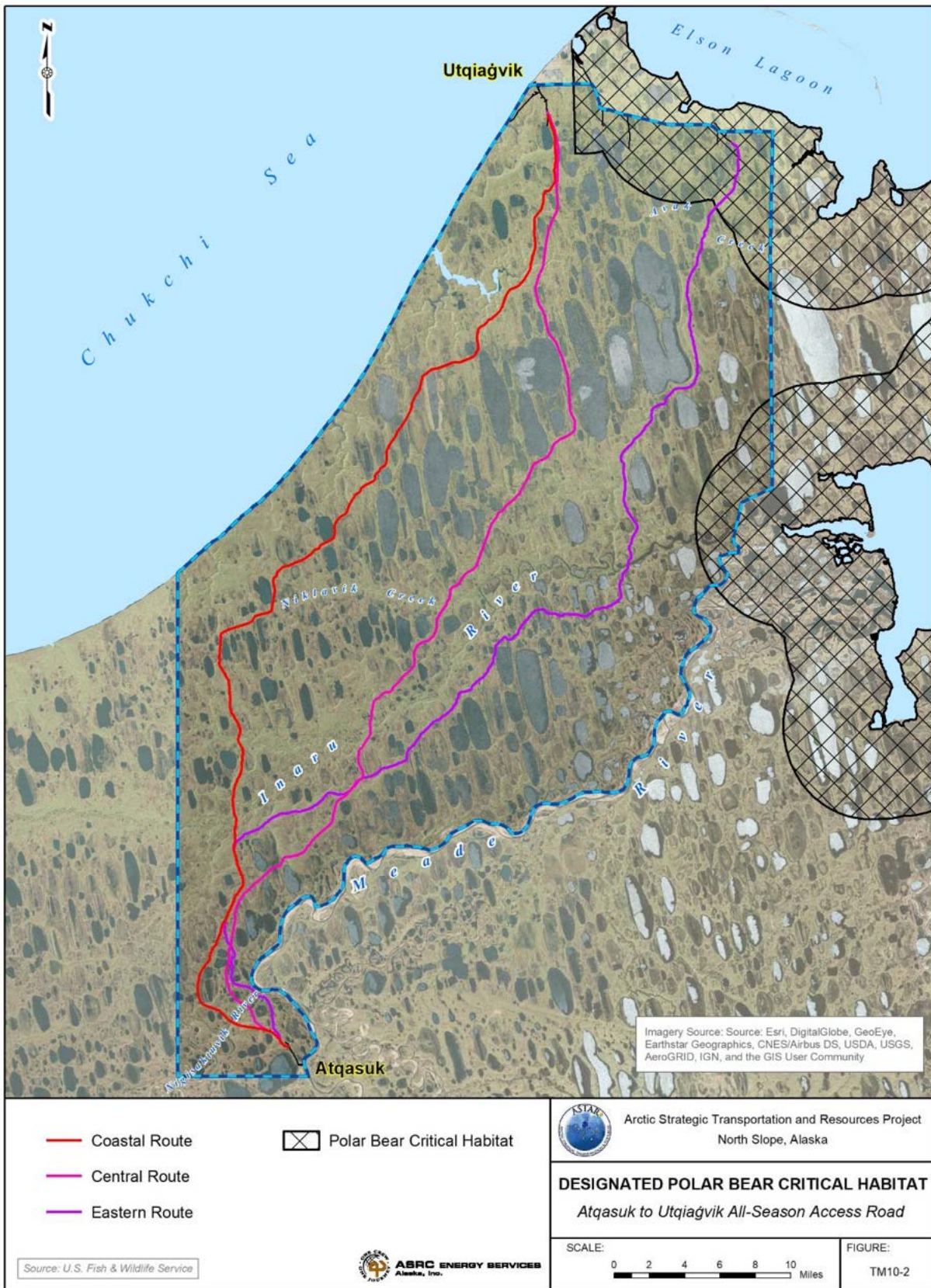
The USFWS published a final rule on December 7, 2010, designating critical habitat for the polar bear, effective January 6, 2011 (USFWS 2010a). The rule designated critical habitat encompassing three units: Unit 1–sea ice, Unit 2–terrestrial denning habitat, and Unit 3–barrier island habitat. The total area designated covers 187,157 square miles (mi<sup>2</sup>) of which about 96 percent is sea ice habitat.



**Figure TM10- 1. Map showing the range of polar bears along Alaska's north and northwest coasts (AKNHP 2010).**

The sea ice critical habitat is located over the continental shelf, and includes ice over water up to 984 feet (ft) in depth extending to the outer limits of the US Exclusive Economic Zone, 200 miles (mi) from shore. Terrestrial denning habitat includes lands within 20 mi of the northern coast of Alaska between the Canadian border and the Kavik River and within 5 mi between the Kavik River and Utqiagvik. The barrier island critical habitat includes coastal barrier islands and spits along Alaska's northern coast, and water, sea ice, and land within 1 mi of the barrier islands. The Utqiagvik townsite is excluded from the critical habitat designation.

The northerly portion of the project overlaps with polar bear critical denning habitat (Figure TM10-2). Any active polar dens found within the BLM NPR-A land in the project area would be subject to the prohibition of any activities that could potentially disturb dens within 1 mile of active polar bear dens (BLM 2013).



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## Steller's Eiders

The Steller's eider is a small sea duck with a Holarctic distribution in Russia and Alaska. Three distinct breeding populations are recognized; the Alaska breeding population, the Russian Atlantic breeding population, and the Russian-Pacific breeding population. These breeding populations mix in wintering area such as the Bering Sea. A map showing the range of the Steller's eider is presented as Figure TM10-3.

The Alaska breeding population of the Steller's eider was listed as a threatened species under the ESA on June 11, 1997 based on the observed contraction in the breeding range in Alaska and the resulting increased vulnerability of the remaining breeding population (USFWS 1997). Potential causes to the decline in population include hunting, ingestion of lead shot, predation, and changes in the marine environment that may be affecting eider food resources.

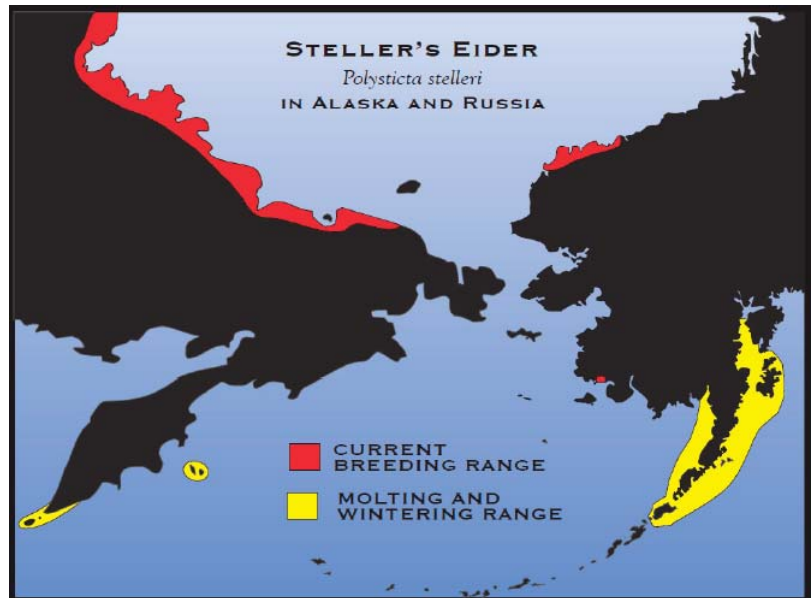


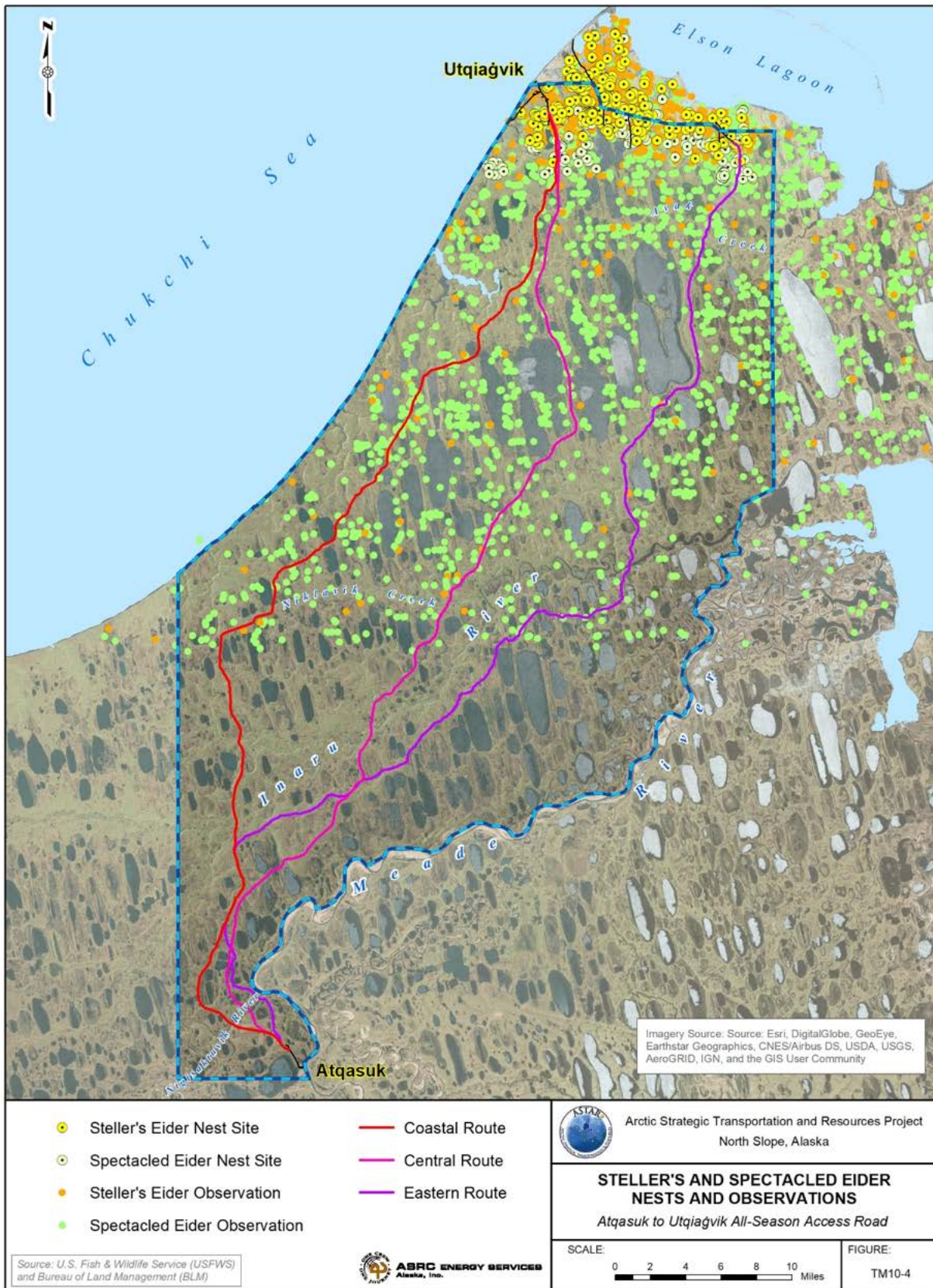
Figure TM10- 3. Range of the Steller's eider in the Pacific (USFWS 2010c)

Approximately 2,830 square miles of land and coastal waters in five units were designated as critical habitat for the Alaskan breeding population of Steller's eiders in 2001 (USFWS 2001b). These areas include the Yukon-Kuskokwim Delta, staging areas in the Kuskokwim Shoals, and molting areas near the Seal Islands, Nelson Lagoon, and Izembek Lagoon on the Alaska Peninsula.

The largest concentration of breeding Steller's eiders in Alaska is found around Utqiagvik, which is considered the core of the nesting area (USFWS 2002). Steller's eiders begin migrating to this area in late May through early June where their population counts have ranged from zero to 240 Steller's eiders, since breeding pair surveys began in 1999 (Graff 2018). In early June to July as nesting begins, Steller's eiders commonly use Shallow *Carex* and Shallow *Arctophila* ponds for nesting habitat around Utqiagvik (Safine 2011, Graff 2018). Hatching generally occurs in mid to late July and Steller's eiders and their broods forage on insect larvae and beetle species in emergent vegetation in shallow ponds. Steller's eiders move to coastal marine water as broods fledge in mid-August to early September. Males and unsuccessful hens leave the tundra earlier, being found at small ponds on the tundra nesting ground until the middle or end of July, at which time they move to coastal waters (Rojek 2008). In successful years, males move to near shore waters prior to molting body feathers and forage prior to fall migration.

Figure TM10-4 illustrates Steller's eider nests and observations in the project area. Active Steller's eiders nests are subject to a 656 ft buffer from June 1 through August 15 within the NPR-A (BLM 2013).

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## Spectacled Eiders

The spectacled eider is a sea duck that inhabits the northern extent of the Pacific Ocean in the Chukchi and Bering Seas. Three primary breeding populations have been identified; the Russian arctic population, the Arctic Coastal Plain of Alaska population, and the Yukon-Kuskokwim Delta population in western Alaska. A map showing the range of spectacled eiders is presented as Figure TM10-5.

The spectacled eider was listed as threatened throughout its range under the ESA May 10, 1993 (USFWS 1993). Possible causes for the declines in the populations were due to exposure to lead shot, increased predation, and changes in forage quality in wintering areas of the Bering Sea (USFWS 2002).

Critical habitat for spectacled eiders was designated by the USFWS in 2001 (USFWS 2001a) and is composed of nesting habitat in the Delta, molting areas in Norton Sound and Ledyard Bay, and wintering habitat south of St. Lawrence Island. Ledyard Bay, located between Point Hope and Wainwright, is the only area on the North Slope listed as critical habitat for the spectacled eider, as it is a principal molting area. Other important molting and staging areas in the Chukchi Sea include Peard Bay and Kasegaluk Lagoon (Petersen et al. 1999).

The highest densities of spectacled eiders on the Arctic Coastal Plain of Alaska have been found northeast of Teshekpuk Lake, the Prudhoe/Kuparuk area, and around Utqiagvik (Larned et al. 2010, 2011). Spectacled eider breeding populations arrive in the area in late May or early June and nest in coastal wetlands near relatively shallow lakes and ponded areas dominated by emergent vegetation. Males depart the nesting grounds once females begin to incubate their clutch of eggs from mid- to late June. Depending upon breeding success, females will leave nesting areas between late June and early September.

The closest critical habitat designation for spectacled eiders is located approximately 250 miles away from the project area. While there is no critical habitat designation within the project area, there is a known breeding spectacled eider population around Utqiagvik. This breeding population has fluctuated from 24 to 221 spectacled eiders in a breeding season, since surveys began in 1999 (Graff 2018).

Figure TM10-4 illustrates spectacled eider nests and observations in the project area. Active spectacled eiders are subject to a 656 ft buffer from June 1 through August 15 within the NPR-A (BLM 2013).

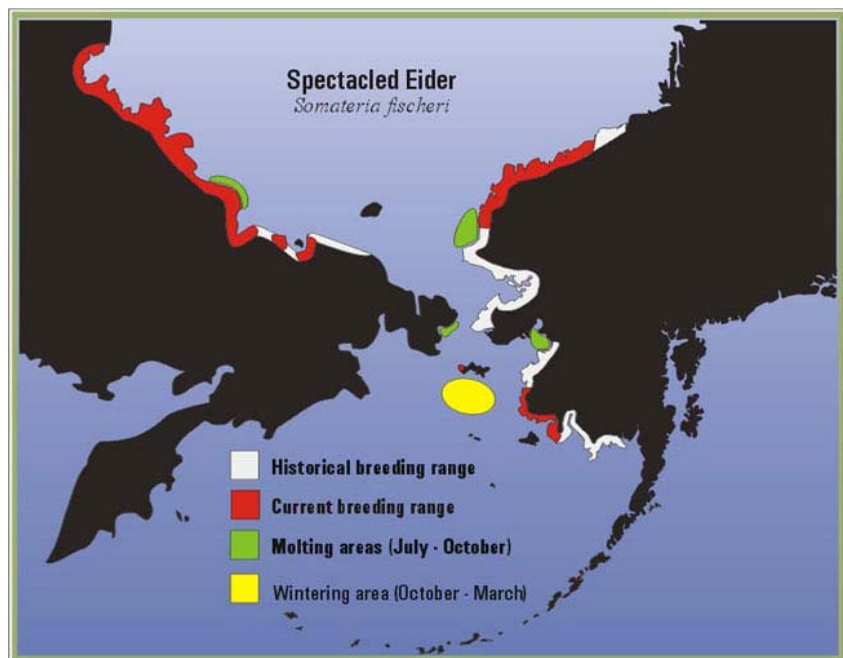


Figure TM10-5. Range of the Spectacled Eider in the Pacific (USFWS 2010b)

## Existing Data

U.S. Geological Survey and USFWS has maintained a database of polar bear denning locations dating back to 1910 throughout the Arctic Coastal Plain (ACP). In recent years, Forward-looking Infrared has been used to detect active polar bear dens. These devices can be mounted to aircrafts or hand held and can have up to a 90 percent detection rate of polar bear dens (Amstrup et al. 2004). This technology is widely used to detect polar bear denning locations within the ACP and is used to detect yearly polar bear denning locations for winter projects.

Since 1991, foot surveys of Steller's eiders breeding biology around the Utqiagvik area have been conducted by the USFWS Ecological Services Fairbanks Field office and the North Slope Borough Wildlife Department. Yearly breeding pair ground surveys in the Utqiagvik area and aerial studies known as the Barrow Triangle Surveys done by ABR, Inc. began in 1999. The project area is also included in the waterfowl breeding population survey area, conducted regularly by USFWS. These studies have allowed for the documentation of the abundance and distribution of both Steller's and spectacled eiders and avian predators in the Utqiagvik area.

## Data Gaps

While yearly survey data exists, denning and nesting locations are dynamic and historical data may not reflect denning and nesting found during project construction. Most existing data sources will only provide general distribution or broad scale information for ESA listed species.

Due to a large portion of the proposed project being on BLM lands, there are established guidelines for bird and polar bear surveys. The BLM NPR-A Integrated Activity Plan/ Environmental Impact Statement establishes that development in the NPR-A would require:

- Surveys conducted for potential polar bear dens before initiating activities around coastal habitat between October 30 and April 15.
- 3 years of pre-disturbance aerial surveys for Steller's and spectacled eiders. Results of these surveys may require additional ground nest surveys.
- USFWS approved Steller's and spectacled eiders ground nest surveys would be conducted prior to development during mid-June.

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## **Technical Memorandum 11 – Fisheries and Fish Habitat**

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## **Technical Memorandum 11 – Fisheries and Fish Habitat**

**Prepared by:** Shannon Mason, Environmental Scientist

**Reviewed by:** Stewart Seaberg, Principal Biologist

**Date:** July 2019

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### **Overview**

Fishery resources have not been systematically documented in much of the proposed project area, whose surface is covered by many small lakes and streams.

The proposed project area includes many waters that have either been classified as anadromous or that are likely to possess anadromous fish presence. Originating in Atqasuk, the proposed routes cross the Nigisaktuvuk River, a tributary of the Meade River, and the Inaru River. The confluence of the Nigisaktuvuk and Meade Rivers lies just to the east of the Eastern Route, which draws near to the Meade River multiple times in its southern section. Conversely, the Coastal and Central Routes parallel the Inaru River. The Central and Eastern Routes cross Avak Creek. Each proposed route approaches large lakes whose waters appear to be seasonally connected to the ocean. In addition, the project area encompasses numerous smaller streams and lakes, in which summer fish distribution should be expected.

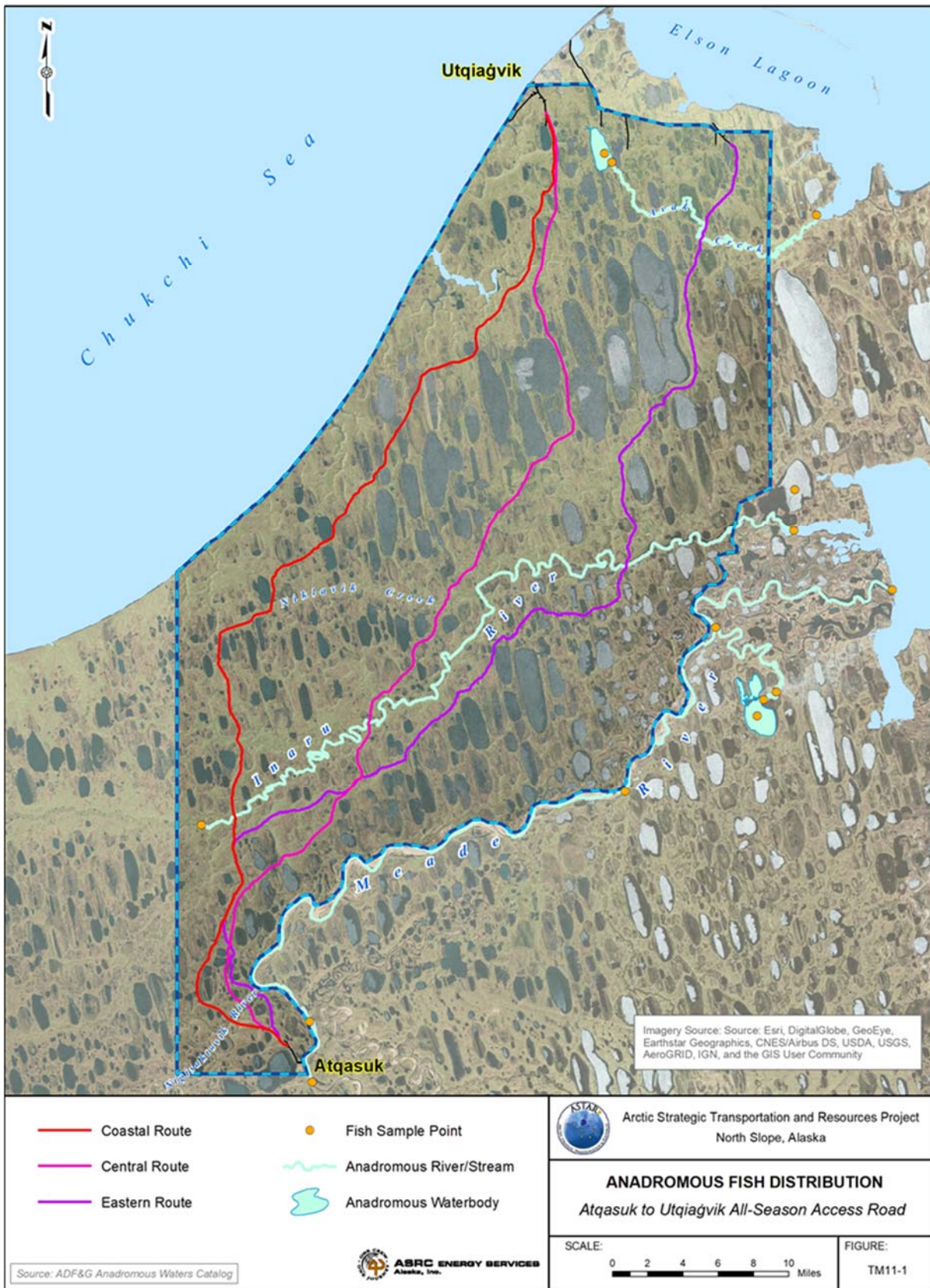
Broad whitefish (*Coregonus nasus*) and least cisco (*Coregonus sardinella*) are common in all major streams in the project area, including the Inaru River (Bradley et al 2016). Sockeye salmon (*Oncorhynchus nerka*), broad whitefish, and least cisco were observed in Avak Creek (Johnson and Blossom 2017). The Nigisaktuvuk River may host some of the same fish species as the Meade River, including chum salmon (*Oncorhynchus keta*), humpback whitefish (*Coregonus pidschian*), and rainbow smelt (*Osmerus mordax*). Common freshwater fishes such as burbot (*Lota lota*) and rainbow smelt have been found in the Meade River and other area streams (Bradley et al 2016). Arctic grayling (*Thymallus arcticus*) and ninespine stickleback (*Pungitius pungitius*) have been widely documented in small streams throughout the area (ADF&G 2019), and are expected to be present in lakes. Since fish are presumed to be distributed throughout the project area during the summer, all project-related activities should be conducted in a manner that protects these important fish resources and habitats.

The study area is shown on Figure TM11-1, along with existing winter trails and potential route alternatives for the proposed gravel road.

### **Regulatory Drivers**

Within State of Alaska North Slope Areawide Oil and Gas Leases, fish related mitigation measures have established stream buffers prohibiting the siting of oil and gas facilities within 500 feet of all fish-bearing waterbodies. Facilities may be sited within these buffers if it can be demonstrated site locations outside these buffers are not practicable, or a location inside the buffer is environmentally preferred. Although this project is not considered an oil and gas infrastructure project, the Alaska Department of Natural Resources (ADNR) may recommend similar setbacks be maintained for this project.

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### **Title 41 Fish Habitat Permits**

The Alaska Department of Fish and Game (ADF&G) has statutory responsibility for protecting freshwater anadromous fish habitat under Alaska Statute (AS) 16.05.871. A Fish Habitat Permit from ADF&G is required for any activity using or changing the natural flow of a lake or stream that ADF&G has specified as supporting anadromous fish (Figure TM11-1). This includes water withdrawals, discharges, diversions, construction, and operation of equipment within and on the frozen surfaces of specified anadromous fish streams.

ADF&G also has authority to ensure free passage of fish is maintained in accordance with AS 16.05.841. This means any activity that could impede free and efficient passage of fish could require a Fish Habitat Permit from ADF&G. Drainage structures, such as culverts and bridges, are required to provide fish passage and meet ADF&G fish passage criteria.

Potential concerns over road construction and the effects on fish include the following:

- Surface water withdrawal during construction and operations
- Fish passage (bridges, culverts, and stream diversion)
- Habitat impacts (stream crossings and streambank or streambed disturbance)
- Water quality impacts (in-water equipment operation, stream flow diversions, and erosion control)

### **Temporary Water Use Authorizations**

ADNR requires a Temporary Water Use Authorization (TWUA) in accordance with 11 Alaska Administrative Code (AAC) 93.220 for withdrawal of greater than 5,000 gallons of water from any single water source in a calendar year. Surface water withdrawals are generally permitted from North Slope rivers, streams, and lakes during the ice-free months. Winter water withdrawals are generally limited to lakes and are not typically permitted from surface-flowing rivers and streams in order to protect important overwintering fish habitat.

Winter water withdrawal from freshwater lakes to facilitate construction of ice roads and pads is a common North Slope practice. Because of this, ADNR and ADF&G have developed winter water withdrawal guidelines for North Slope lakes as summarized in Table TM11-1.

**Table TM11-1. North Slope Water Withdrawal Guidelines**

<b>If</b>	<b>Then</b>
No fish present	20% of lake volume available for withdrawal
Non-sensitive fish present*	30% of lake volume deeper than 5 feet available for withdrawal
Sensitive fish present	15% of lake volume deeper than 7 feet available for withdrawal

\*Non-sensitive fish are Alaska blackfish and ninespine stickleback, all other fish species are considered sensitive

### **Essential Fish Habitat**

One federal law applies directly to fish and fish habitat. The Magnuson-Stevens Fishery Conservation and Management Act requires consultation with the National Marine Fisheries Service (NMFS) for all Federal activities that may adversely impact Essential Fish Habitat (EFH). Activities that require a federal authorization or use federal funding require EFH consultation in accordance with EFH regulations.

EFH is defined as waters and substrate necessary to support fish spawning, breeding, feeding, or growth to maturity. This includes waters used by certain fish species and may include areas historically used by fish (NPFMC 2009). In Alaska, EFH only applies to the five species of Pacific salmon.

NMFS has adopted ADF&G’s Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes (Johnson and Blossom 2017) as the specified anadromous fish streams under EFH jurisdiction. Only rivers, lakes, and streams specified in ADF&G’s Anadromous Waters Catalog (AWC) are considered EFH for Alaska’s freshwaters.

### Existing Data

Fish populations in this region of the North Slope have been assessed since the mid-1970s. Although some sampling was conducted on streams in the proposed project area (ADF&G 2019), effort was focused upon larger drainages and lakes to the east of the project area (Netsch 1977).

More recent studies have concentrated on the life history, movements, and harvest of broad whitefish because of their importance to the subsistence fishery (Fuller and George 1997, Morris 2006). While least cisco are the most widely distributed fish of the whitefish family on the North Slope, a subsistence harvest study found that broad whitefish comprised 77 percent of the total fish harvest in Utqiagvik over a three year period (Braund and Associates 1993). Arctic grayling are also heavily harvested by residents of Atqasuk (Bacon et al 2009).

In 2010, the North Slope Borough (NSB) published a study on Traditional Ecological Knowledge of North Slope fish and associated social and cultural practices (Brewster and George 2010). Subsistence fishing has engendered a wealth of Iñupiaq knowledge about whitefish and related species in waters in the vicinity of the proposed project. For example, the Iñupiat have identified many of the large fish congregation areas and migratory routes and placed their fishing camps accordingly.

From 2012 to 2015, ADF&G conducted fish and aquatic resources studies in the Meade River system, with one site by the Inaru River (Bradley et al 2016). Fish, macroinvertebrates, phytoplankton, and water quality were sampled, with fish movements tracked by radiotelemetry.

In 2017, ADF&G electrofished several small streams within the proposed project area (ADF&G 2019).

In general, fisheries survey data has been assembled in two datasets maintained by ADF&G. ADF&G has compiled data on anadromous fishes statewide in the AWC, while resident fish data are compiled in the Alaska Freshwater Fish Inventory (ADF&G 2019). Within the project area, two streams and one lake have been cataloged by the AWC as the specified anadromous fish streams under EFH jurisdiction (Table TM11-2).

**Table TM11-2. Anadromous Fish Streams and Lakes in Project Area<sup>1</sup>**

Name	AWC Number	Fish Species
Inaru River	330-00-10930	Wrs
Ikroagvik Lake	333-00-10931-0050	S, BC,LC
Avak Creek	333-00-10931	S, BC, LC

<sup>1</sup> Johnson and Blossom 2017

BC = broad whitefish, LC = least cisco, r = rearing, S = sockeye salmon, s = spawning, W = Whitefish, undifferentiated

The sustainable management of the subsistence fishery is a key concern of NSB and ADF&G. Moreover, EFH seems to be increasing as climactic conditions become more conducive to salmon populations in the area (Brewster

and George 2010, Milman 2018). For example, sockeye salmon appear to have only recently occurred in Ikroagvik Lake and Avak Creek (Carroll 2012).

## Data Gaps

Data on fish presence, distribution, or abundance has not been systematically collected on most reaches and lakes in the project area. The Inaru River, Ikroagvik Lake, and Avak Creek are specified anadromous fish streams, but site-specific data on anadromous fish use within project area streams is limited to one sampling site on the Inaru River.

The tributary to the Meade River, the Nigisaktuvik River, has not been surveyed, although the distribution of camps would indicate that it may host some of the same anadromous species as the Meade River.

Fish surveys commonly document fish resources in areas that have not been previously surveyed. Since much of the project area has not been surveyed for fish use, regulatory agencies are likely to require fish distribution surveys and stream habitat assessments at road crossing locations. These surveys are typically required to support the National Environmental Policy Act alternative analysis and to establish stream setbacks from fish-bearing waters.

Fish surveys may also be required to document the presence of anadromous fish to potentially establish regulatory authority for ADF&G Fish Habitat Permits and NMFS EFH consultation. Agencies may require fish surveys to document anadromous fish habitat in currently unspecified streams for the placement of permanent facilities such as drainage structures (bridges and culverts). Fish studies likely required are summarized in Table TM11-3.

**Table TM11-3. Fish Study Recommendations**

Regulatory Driver	Requirement	Timing (Years)	Topic
TWUA Permitting	Fisheries and bathymetric sampling	1	Water Quality and Fisheries
ADF&G Title 16 Permitting	Fisheries sampling to document fish species	1	Water Quality and Fisheries

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## **Technical Memorandum 12 – Avian Resources and Habitat**

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**Technical Memorandum 12 – Avian Resources and Habitat**

**Prepared by:** Kiel Kenning, Environmental Scientist

**Reviewed by:** Stewart Seaberg, Principal Biologist

**Date:** July 2019

**Overview**

Avian resources are an important biological and subsistence resource in the proposed project area. The North Slope supports a large seasonal abundance of avian resources including important breeding populations of over 90 species of migratory and resident birds. The migrant birds come primarily from the Trans-Beringian and Pacific flyways, although some species travel much farther (e.g. bar-tailed godwits [*Limosa lapponica*] from New Zealand). As these are seasonal summer inhabitants that use the area as nesting habitat, impacts to bird resources in the area can effect bird abundance in other parts of the world.

**Regulatory Drivers**

Birds, nests, and avian habitats are protected from disturbance through a variety of federal regulations. Almost all bird species inhabiting the North Slope are protected from impacts by the Migratory Bird Treaty Act (MBTA). The MBTA protects actively nesting birds from disturbance on both federal and state lands. Regulatory agencies can restrict ground disturbance during nesting periods, typically June 1 and July 31 (USFWS 2017). A list of migratory birds protected under the MBTA that have the potential to occur in the project area generated from the United States Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) tool is listed in Table TM12-1. Birds of Conservation Concern (BCC) are birds that have noted population declines or overabundance, restricted populations, and dependence on vulnerable habitats. Birds that warrant special attention are birds that are not listed as BCC in the proposed project area, but warrant special attention because of the Bald & Golden Eagle Protection Act or for potential susceptibilities in offshore areas from certain types of development or activities.

**Table TM12-1. Species, Status of Species, and Breeding Season in the Project Area**

Species	Bird of Conservation Concern (BCC)	Warrants Special Attention	Breeding Season
American Golden-plover ( <i>Pluvialis dominica</i> )	X		Breeds May 20 to Aug 15
Arctic Tern ( <i>Sterna paradisaea</i> )		X	Breeds May 20 to Aug 15
Bald Eagle ( <i>Haliaeetus leucocephalus</i> )		X	Breeds Feb 1 to Sep 30
Bar-tailed Godwit ( <i>Limosa lapponica</i> )	X		Breeds May 15 to Aug 15
Black Guillemot ( <i>Cephus grille</i> )		X	Breeds May 15 to Sep 10
Black Scoter ( <i>Melanitta nigra</i> )		X	Breeds elsewhere
Black-legged Kittiwake ( <i>Rissa tridactyla</i> )		X	Breeds elsewhere
Buff-breasted Sandpiper ( <i>Calidris subruficollis</i> )	X		Breeds June 10 to Aug 20
Common Eider ( <i>Somateria mollissima</i> )		X	Breeds June 1 to Sep 30
Common Loon ( <i>Gavia immer</i> )		X	Breeds Apr 15 to Oct 31

Species	Bird of Conservation Concern (BCC)	Warrants Special Attention	Breeding Season
Common Murre ( <i>Uria aalge</i> )		X	Breeds Apr 15 to Aug 15
Dunlin ( <i>Calidris alpina arctica</i> )	X		Breeds May 20 to Jul 20
Great Black-backed Gull ( <i>Larus marinus</i> )		X	Breeds Apr 15 to Aug 20
Herring Gull ( <i>Larus argentatus</i> )		X	Breeds Apr 20 to Aug 31
Ivory Gull ( <i>Pagophila eburnea</i> )	X		Breeds elsewhere
Long-tailed Duck ( <i>Clangula hyemalis</i> )		X	Breeds elsewhere
Parasitic Jaeger ( <i>Stercorarius parasiticus</i> )		X	Breeds elsewhere
Pomarine Jaeger ( <i>Stercorarius pomarinus</i> )		X	Breeds elsewhere
Red Phalarope ( <i>Phalaropus fulicarius</i> )		X	Breeds elsewhere
Red-breasted Merganser ( <i>Mergus serrator</i> )		X	Breeds elsewhere
Red-necked Phalarope ( <i>Phalaropus lobatus</i> )		X	Breeds elsewhere
Red-throated Loon ( <i>Gavia stellata</i> )	X		Breeds May 1 to Sep 30
Ross's Gull ( <i>Rhodostethia rosea</i> )	X		Breeds elsewhere
Semipalmated Sandpiper ( <i>Calidris pusilla</i> )	X		Breeds June 10 to Aug 20
Snowy Owl ( <i>Bubo scandiacus</i> )	X		Breeds May 15 to Sep 30
Surf Scoter ( <i>Melanitta perspicillata</i> )		X	Breeds elsewhere
Thick-billed Murre ( <i>Uria lomvia</i> )		X	Breeds Apr 15 to Aug 15
Whimbrel ( <i>Numenius phaeopus</i> )	X		Breeds May 10 to Aug 20
White-winged Scoter ( <i>Melanitta fusca</i> )		X	Breeds elsewhere
Yellow-billed Loon ( <i>Gavia adamsii</i> )	X		Breeds June 1 to Sep 20

On October 1, 2014, the USFWS published their 12-month finding on the petition to list the yellow-billed loon under the Endangered Species Act (ESA). The USFWS concluded that listing the yellow-billed loon as threatened or endangered was not warranted at this time. While the yellow-billed loon is not protected under the ESA, the U.S. Bureau of Land Management (BLM) NPR-A National Petroleum Reserve Alaska (NPR-A) Integrated Activity Plan (IAP) / Environmental Impact Statement (EIS) set guidelines that require all recorded nesting sites to have a 1-mile buffer and an additional 1,625 foot buffer around the remaining shoreline (BLM 2013).

The USFWS listed both the spectacled eider and Steller’s eider as threatened species under the ESA. Active eider nests have activity restrictions within 656 foot from June 1 through August 15 (BLM 2013).

### Existing Data

The project area is included in the Arctic Coastal Plain waterfowl breeding population survey area, conducted regularly by USFWS. The survey provides an indication of species of waterfowl present in the area and a measure of relative abundance of waterfowl nesting. The survey suggests waterfowl are common near the project.

The BLM NPR-A IAP/EIS produced several maps of bird densities (BLM 2013). These bird density maps could be useful for discussions during project development. Graphics are available at the project website (<https://eplanning.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=dispatchToPatternPage&currentPageId=14702>).

Since 1991, foot surveys of Steller's eiders breeding biology around the Utqiagvik area have been conducted by the USFWS Ecological Services Fairbanks Field office and the North Slope Borough Wildlife Department. Yearly breeding pair ground surveys in the Utqiagvik area and aerial studies known as the Barrow Triangle Surveys done by ABR, Inc. began in 1999. The project area is also included in the Arctic Coastal Plain waterfowl breeding population survey area, conducted regularly by USFWS. These studies have allowed for the documentation of the abundance and distribution of both Steller's and spectacled eiders and avian predators in the Utqiagvik area.

## Data Gaps

While yearly survey data exists, nesting locations are dynamic and historic nesting data may not reflect nesting found during construction. Most existing data sources will only provide a general distribution or broad scale information.

Due to the project being on BLM lands, there is established guidelines for bird surveys. The BLM NPR-A IAP/EIS establishes that development in the NPR-A would require:

- Three years of pre-disturbance aerial surveys for Steller's and spectacled eiders. Results of these surveys may require additional ground nest surveys.
- USFWS approved Steller's and spectacled eiders ground nest surveys would be conducted prior to development during mid-June.
- Three years of pre-disturbance aerial surveys for proposed development within 1 mile of lakes 25 acres or larger for yellow-billed loons. These surveys include shorelines of lakes 25 acres or larger during nesting and brood rearing of yellow-billed loons during late June and August following accepted BLM protocol.

## Development Considerations

Permitting issues associated with infrastructure development focus on avoidance of disturbing all nesting migratory birds. To avoid disturbing nesting birds, the USFWS recommends vegetation clearing or ground disturbing activities not occur during the period from June 1 through July 31 on the North Slope (USFWS 2017). If limited clearing/ground disturbance is necessary, it is recommended a nest clearing survey take place immediately prior to ground disturbance to ensure no take of migratory bird nests occurs. It is typical of North Slope operations to conduct these activities in the winter.

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## **Technical Memorandum 13 – Cost Estimates**

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## **Technical Memorandum 13 – Construction Cost Estimate**

**Prepared by:** Hans Hoffman, CPG, Associate Geologic Engineer

**Reviewed by:** Paul Ramert, PE, Principal Civil Engineer

**Date:** July 2019

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### **Overview**

AES Alaska developed this Class 5 cost estimate for construction of the Atqasuk to Utqiagvik Road. A Class 5 cost estimate is based on 0 to 2 percent of a complete project definition and is primarily used for concept screening. Typically, the estimate is made from known costs of similar projects already completed. A Class 5 cost estimate has typical ranges of minus 20 to minus 50 percent on the low side and plus 30 to plus 100 on the high side (AACE International 2005). This range allows for uncertainties in project definition, site conditions, location, and quality of granular material sources, and project alignment.

Construction costs are those direct costs incurred in constructing the road, such as those for materials, labor, camps, and equipment. Other costs for implementation of the project, such as costs for engineering, legal counsel, right-of-way acquisition, environmental studies and mitigation, permitting, inspectors, owner representation and oversight, fees, taxes, and interest during construction are not included. Also excluded are annual costs such as operations and maintenance and debt service.

### **Basis of Estimate**

This cost estimate is based on cost components extracted from similar studies and previously completed road construction projects in Alaska. The estimate is based on the following key assumptions:

- The route length for the new road is 67.5 miles (mi) for Corridor A, 64.4 mi for Corridor B, or 73.6 mi for Corridor C.
- The road is constructed of granular embankment fill with a total roadway surface width of 24.5 feet (ft) and side slopes of 2H:1V. The minimum thickness of the embankment is 5 ft without insulation or 3.5 ft with 4 inches insulation.
- For this study, \$4.8 million per mile was used for estimating roadway costs. This cost is based on recent roadway extensions by the oil industry as well as the remoteness of the project and the likely scarcity of high quality of granular construction materials. Culverts are included in the per mile roadway estimate, and bridge costs are estimated independently at \$15,000 per foot length.
- A geotechnical reconnaissance and subsurface exploration will be required to identify potential granular material sources. For this estimate, we have assumed suitable construction materials are available along the route at reasonable intervals (every 5 to 10 miles). Technical Memorandum 3 identifies geologic terrain units that may represent possible sources of construction materials.
- Embankment will be mined, hauled, and placed during winter months, then allowed to thaw and drain during the first summer, followed by fall regrading and compaction.
- Drainage structures are listed in Technical Memorandum 2 by route. All bridges are single-lane with a deck width of 18 feet, with vehicle pullouts on each approach. Design live loads are based on a Cat D300 dump truck with a 35-ton payload.

- During construction, workers will be housed in commercially available accommodations in Utqiagvik and Atqasuk, and temporary construction camp(s) near the mid-point along the route.
- All costs are based on 2019 dollars with no escalation.

Based on these assumptions, Table TM13-1 lists the estimated roadway and bridge costs for each corridor.

**Table TM13-1. Estimated Cost for Atqasuk to Utqiagvik Routes**

Route	Road Length (miles)	Roadway Cost <sup>1</sup> (million)	Bridges (feet)	Bridge Cost <sup>2</sup> (million)	Total Cost (million)
Corridor A – Coastal Route	67.5	\$324	2,720	\$41	\$365
Corridor B – Central Route	64.4	\$309	1,570	\$24	\$333
Corridor C – Eastern Route	73.6	\$353	2,325	\$35	\$388

1. Calculated at \$4.8 million per mile. Unit cost includes culverts.
2. Calculated at \$15,000 per foot of bridge length.

### Comparable Cost Summary

The total estimated capital cost for construction of the road is \$333 to \$388 million, depending on the route selected and the number/length of bridges. This equates to an average cost estimate of \$5.2 to \$5.4 million per mile. This per mile cost falls within the range of other rural road project cost estimates of similar design and planning stage as listed below in Table TM13-2.

**Table TM13-2. Comparison Cost for Similar Alaskan Rural Road Projects**

Project	Total Cost (million)	Cost/Mile (million)	Significant Challenges
Juneau Access <sup>2</sup>	\$430	\$8.4	Blasting/Tunnels/Slope Stabilization
Cape Blossom Road <sup>3</sup>	\$46	\$6.2	Gravel Sources
Western Area Access <sup>4</sup>	\$2,920	\$5.9	Gravel Sources and Remoteness
Atqasuk to Utqiagvik Road	\$333-388	\$5.2-5.4	Gravel Sources and Remoteness
Foothills West (Road to Umiat) <sup>5</sup>	\$280-400	\$4.2-5.4	Gravel Sources and River Crossings
Ambler Access <sup>6</sup>	\$465	\$2.2	Remote
Road to Tanana <sup>7</sup>	\$11	\$1.7	None
Izembek Road <sup>8</sup>	\$39	\$2.2	None

1. Numbers have been escalated to 2019 dollars
2. <https://www.nytimes.com/2008/06/06/us/06road.html>
3. <https://www.adn.com/alaska-news/rural-alaska/2017/06/11/after-decades-wait-construction-is-set-to-begin-on-kotzebues-cape-blossom-road-this-summer/>
4. [http://dot.alaska.gov/nreg/westernaccess/documents/corridor\\_planning\\_report\\_appx\\_d.pdf](http://dot.alaska.gov/nreg/westernaccess/documents/corridor_planning_report_appx_d.pdf)
5. H. Conley. 2013. Arctic Economics in the 21st Century: The Benefits and Costs of Cold. Center for Strategic and International Studies.
6. <https://www.adn.com/arctic/article/ambler-mine-road-projects-dependent-each-other/2013/11/07/>
7. <http://www.alaskajournal.com/Alaska-Journal-of-Commerce/February-Issue-3-2014/Roads-to-Resources-adds-West-Susitna-stalls-other-projects/>
8. [https://www.fws.gov/uploadedFiles/Region\\_7/NWRS/Zone\\_1/Izembek/PDF/rod\\_signed.pdf](https://www.fws.gov/uploadedFiles/Region_7/NWRS/Zone_1/Izembek/PDF/rod_signed.pdf) The Izembek Road was constructed under two separate contracts totaling \$36M. An additional \$10M to \$20M of construction claims are pending.

## Data Gaps

Following is a list of data gaps that will need to be filled as the project progresses to the next phases.

- Material sources should be identified and investigated to prove up sufficient quantities of gravel for road construction and maintenance.
- Hydrology studies should be initiated to confirm crossing locations and collect data to support engineering design and construction planning for bridges and culverts.
- Preliminary engineering should be completed to support cost estimates, environmental documentation, and financial planning.
- A preliminary construction execution plan should be developed to help refine subsequent versions of the cost estimate.

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**APPENDIX B**  
Raster Analysis

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## Appendix B - Atqasuk to Utqiagvik All-Season Access Road Spatial Analysis

### Introduction

Geographic Information Systems (GIS) methods were used in route alignment selection in order to establish baseline alignments from which additional routing modifications and evaluation could be made by Subject Matter Experts (SME). Following guidelines presented in the Assessment of Potential Tools for Cumulative Benefits Analysis (July 2018) Stage 3 methodology, SMEs were consulted to define a study area for constraining the extent of the analysis; identification and procurement of appropriate data; scaling and weighting of analysis inputs; and subsequent modification of analysis outputs.

The specifics of this process are described in the following sections.

### Analysis Type

Project type (road route alignment) and SME consultation indicated a linear analysis utilizing ESRI's GIS geoprocessing tools for initial route development as the appropriate approach. Subsequent modifications to analysis outputs were performed using heads-up digitizing in the ArcMap desktop application. Once alignments were established, additional data (such as route corridors and river crossings) were derived to assist in route evaluation and comparison.

### Analysis Approach and Tools

GIS evaluation and SME consultation for this study established a Path-Distance analysis as the most appropriate approach for developing route alignments. This approach is used in GIS to perform distance analysis by using raster inputs to define the cost of moving through a geographic area between two, or more, identified points. "Cost" in GIS analysis is used to define the level-of-effort needed to move from one pixel cell to another in a raster. Cost can be associated with a variety of inputs, including monetary measures, time, vertical movement, cultural constraints, etc.

Because costs can be associated with often disparate types of data, it is necessary to scale inputs across a common range of values, such as 1 to 5, with 1 being low cost and 5 being high. SMEs are valuable in this exercise wherein their particular expertise is used to define the associated costs of crossing certain spatial feature types for which they are skilled at evaluating. For instance, an engineer can assign a measure of difficulty for road construction based on slope by categorizing percentage of slope classes then assigning those classes a value from 1 to 5 based on degree of difficulty to construct, thus establishing a slope "cost" for analysis input. In like manner, a biologist can categorize critical habitats or known bird nesting sites and scale those areas from 1 to 5 based on ability or advisability of constructing a road in proximity to them.

Individual cost inputs must then be consolidated into a single, overall cost raster. This is done by using the *Raster Calculator* contained in ESRI's *Spatial Analyst Tools*. The individual inputs (e.g. slope, habitat, nesting sites, etc.) must be weighted in consideration of their importance to the overall analysis and these weights used in the *Raster Calculator*. A pairwise comparison survey of inputs was used in conjunction with the *Analytic Hierarchy Process* (AHP) to obtain weights for this analysis. This is described in more detail later in this document.

The Path-Distance tools available through the *Spatial Analyst* extension incorporate both the cost raster and topographic values (vertical and horizontal distances as obtained from a digital elevation model for the

area) to build the raster inputs needed for path (route alignment) development. Once these datasets are derived, the *Cost Path As Polyline* tool is used to find the least-cost distance between defined points or areas.

These points or areas are identified as either a “source” or a “destination.” The source can be thought of as the place of interest to which routing processes must flow. For this study, this was the beginning point for routes at the village of Atqasuk. A destination is a terminal point to which a route is desired from the source. In this case, the final destinations were points located at existing roads in Utqiagvik. However, in order to create more refined routes, additional sources and destinations were also created for identified crossing locations along the Inaru River and separate analyses run for each set of sources and destinations.

The products of these analyses were discrete line segments from each source to each destination that were then merged into single route alignments. These were then attributed with specific corridor-route names and utilized in other geoprocesses, such as buffering to generate study corridors, creation of measured lines, and development of route mileposts.

## Analysis Data Creation

Before analysis input data could be created, the following process components were considered:

- **Determination of an appropriate coordinate system.** Alaska State Plane Zone 6, NAD83 (feet) was utilized due to its good conformity to the study area.
- **Establishment of analysis area.** A polygon was developed to limit analysis to areas bounded as shown in Figure 1.1-1.
- **Development of a required/suggested dataset list from SME consultation.**
  - Specific data types (wetlands, eider habitat, cultural sites, terrain units, etc.)
  - Recommended data sources (NWI, USFWS, AHRS, DGGS, etc.)
- **Research availability of data and procurement of data as available.**
- **Preparation of the data for use in spatial analysis.**
- **Establishment of coarsest dataset to define pixel resolution for analysis inputs.** This was determined to be the digital elevation data available for the area, which was at 5-meter resolution.
- **Determination of appropriate data handling needed based on type, such as:**
  - Clipping or selecting to constrain data to the analysis area
  - Identifying attributes by which to scale
  - Buffering of features to specified widths
  - Reclassifying of raster data

Table B-1 below shows the data considered for use in analysis and the results of data evaluation, including reasons for not including certain suggested data. Since the primary use of this data was for route determination, the primary factor for inclusion of data was whether or not it affected routing itself. Exclusion of data did not indicate it was unimportant in overall project development, only that it would not likely affect the routing of alignments in the initial stages of routing studies.

**Table B-1. Data Considered For Route Analysis**

Analysis Layer	Potential Inputs	SME	Source	Use ?	Notes
Ecological	Wetlands <ul style="list-style-type: none"> <li>Eider habitat</li> <li>Polar Bear Critical Habitat</li> <li><i>Arctophila fulva</i></li> <li>Impacted wetlands</li> <li>Wetlands within 500-ft of Fish-bearing Waters</li> </ul>	Joe Christopher	National Wetlands Inventory (NWI); USFWS; North Slope Science Initiative Landcover dataset (2013); ADF&G Anadromous Waters Catalog	Yes	<ul style="list-style-type: none"> <li>Scale wetlands by type based on suitability of routing through those wetlands.</li> <li>Apply “high cost” VALUE to areas within the Polar Bear Critical Habitat.</li> <li>Apply 500-ft buffer around rivers and the edges of lakes &gt;25 acres and scale by presence/absence of buffer. Since there are no comprehensive fish surveys for the study area, assume these are potential fish-bearing waterbodies.</li> <li>Find areas of <i>Arctophila fulva</i> using NSSI landcover data and apply “high cost” VALUE to those areas.</li> </ul>
	Threatened & Endangered (T&E) Species <ul style="list-style-type: none"> <li>Yellow-billed Loons</li> <li>Eiders</li> </ul>	Kiel Kenning	BLM; USFWS	Yes	<ul style="list-style-type: none"> <li>Apply 1-mile buffer around loon nesting sites and 1,625-ft buffer around the edges of lakes &gt;25 acres and scale by presence/absence of buffer.</li> <li>Apply 200-m buffer around nesting sites and scale by presence/absence of buffer.</li> </ul>
	Fisheries & Fish Habitat	Shannon Mason / Stewart Seaberg	ADF&G	No	No ADF&G limitations for routing; use in wetlands data compilation only.
	Polar Bear denning sites	Kiel Kenning	USFWS	No	Only need to consider existing sites, which differ yearly, so no limitation to route planning.
Engineering	Slope	Paul Ramert	Digital Elevation Model (DEM)	Yes	Use slope as percentage and categorize by ranges.
	Bridges	Paul Ramert	None	No	No existing bridges in area.
	Material Sources	Paul Ramert	AES/DGGS	Yes	Material sources currently under examination so difficult to incorporate at this time. Consider routing through UIC conveyed areas.
	Existing O&G Wells	Paul Ramert	AOGCC	No	No significant reason to consider for routing.
	Historic Wells	Paul Ramert	AOGCC	No	No significant reason to consider for routing.
Geotech	Terrain Units	Hans Hoffman	AES/DGGS	Yes	Scale units based on favorability for routing.

Analysis Layer	Potential Inputs	SME	Source	Use ?	Notes
	Geohazards	Hans Hoffman	AES / DGGS	Yes	500-ft avoidance buffers around pingos and scale by presence/absence of buffer.
	Materials (sand & gravel)	Hans Hoffman	AES / DGGS	No	Material sources currently under examination so difficult to incorporate at this time.
Hydrology	Crossings	Larry Clamp / Hans Hoffman	AES	Yes	Use crossing points as “source” and “destination” inputs.
	Lakes & Rivers	Larry Clamp	National Hydrography Dataset (NHD); National Wetlands Inventory (NWI)	Yes	Give lakes & rivers “high cost” value.
Land Status	Land Ownership	Paul Ramert	ADNR; BLM	No	Only BLM and Native lands in area, beside allotments. No need to consider for routing at this point.
	Native Allotments	Paul Ramert	ADNR; BLM	Yes	500-ft avoidance buffers around each and scale by presence/absence of buffer.
	Zoning	Paul Ramert	NSB	No	Does not pose a limitation to routing.
	17B Easements	Paul Ramert	NSB	No	Do not use as input, but perhaps examine proximity to derived routes.
	ROWs	Paul Ramert	ADNR; BLM	No	None in area.
	Leases	Paul Ramert	ADNR; BLM	No	No leases in area.
Regulatory	ADEC Contaminated Sites	Stewart Seaberg	ADEC	Yes	500-ft avoidance buffers around sites and scale by presence/absence of buffer.
	Polar Bear Critical Habitat	Kiel Kenning	USFWS	No	Does not need to be considered separately from wetlands, considered appropriately within the wetlands inputs.
	Teshekpuk Lake Special Area	Paul Ramert / Stewart Seaberg	BLM – NPR-A ROD	No	Does not pose a limitation to routing.
	VRM Management Classes	Paul Ramert / Stewart Seaberg	BLM – NPR-A ROD	No	Does not pose a limitation to routing.
	Areas Unavailable to Leasing	Paul Ramert/Stewart Seaberg	BLM – NPR-A ROD	No	None in this area.

Analysis Layer	Potential Inputs	SME	Source	Use ?	Notes
	K1 River Buffers	Paul Ramert / Stewart Seaberg	BLM – NPR-A ROD	Yes	Scale based on presence or absence of K1 areas.
	Brant Survey Area	Paul Ramert / Stewart Seaberg	BLM – NPR-A ROD	No	None in this area.
	Deep Water Lakes and 400 meter Buffers	Paul Ramert / Stewart Seaberg	BLM – NPR-A ROD	Yes	Scale based on presence or absence of specified lakes and buffers.
<b>Sociocultural</b>	Subsistence Use	Ranna Wells	NSB	No	Entire area is used for subsistence so difficult to incorporate into routing analysis.
	Camps & Cabins	Ranna Wells	NSB	Yes	500-ft avoidance buffers around each and scale by presence/absence of buffer.
	Traditional Land Use Inventory (TLUI)	Ranna Wells	NSB	No	Data not available at time of analysis. Likely to be coincident to AHRS sites and Native allotments.
	AHRS Cultural Sites	Ranna Wells	AHRS	Yes	500-ft avoidance buffers around each and scale by presence/absence of buffer.

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It should be noted that the “Analysis Layer” column denotes the name of the individual raster layer subsequently built from the inputs defined in the other columns. These individual raster layers are later combined in the process to create the overall cost raster.

In addition to these datasets, a 5-meter resolution raster Digital Elevation Model (DEM) developed from files available from the Arctic DEM project (<https://www.pgc.umn.edu/data/arcticdem/>) was used for topographic inputs to the Path-Distance geoprocessing of route alignments.

## Data Preparation

All data passed on for use in the analysis were vector shapefiles, with the exception of slope, which was derived from the raster DEM. Features were buffered to assigned distances as necessary (see Table B-1), and all were projected to the same coordinate system and clipped to the analysis area to ensure data congruency. A “VALUE” field was added to each shapefile to store the scaled value for each attribute.

The slope data was created using the clipped DEM and running it through the *Surface>Slope* (percent) tool under *Spatial Analyst Tools*.

## Data Scaling

SMEs were then asked to assign scaled values to appropriate attributes using a common scale by which all data attributes could be evaluated based on relative “cost” as described above. These were stored in the previously created “VALUE” field of the relevant dataset. The following scale was used for this step:

**Table B-2. Common Scale for Data**

VALUE	Definition
0	No hindrance for routing
1	Extremely favorable for routing
2	Very favorable for routing
3	Moderately favorable for routing
4	Low favorability for routing
5	Not at all favorable for routing

Specific values for each data input are shown in Tables B-3 through B-5

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**Table B-3. Specific Scales for Data**

Analysis Layer	Layer Weight	Sublayer Weights	Layer Input(s)	Attribute	Value
Ecological	13%	Wetlands - 25%	National Wetlands Inventory (NWI) polygons	Permanently Flooded (H)	5
			National Wetlands Inventory (NWI) polygons	Palustrine -Unconsolidated Bottom (PUB)	5
			National Wetlands Inventory (NWI) polygons	All other wetlands	2
			National Wetlands Inventory (NWI) polygons	Upland (U)	0
			NSSI Landcover	<i>Arctophilla Fulva</i> (Pendant Grass)	5
			NWI lake polygons/NHD areas/ADF&G AWC	500-ft Buffer of Fish-Bearing Waterbodies	5
			USFWS Polar Bear Critical Habitat (PBCH) polygons	Areas designated as PBCH	5
		T&E Species - 75%	Arctic LCC Yellow-Billed Loon Database	Presence or Absence of 1-mile buffer of nest sites	0 or 3
			NWI lake polygons	Presence or Absence of 500-m (1,625-ft) Buffer of Lakes	3
			Arctic LCC Eider Database	Presence or Absence of 200-m (656-ft) Buffer of Nest Sites	3
			NSSI Landcover	Presence or Absence of 200-m (656-ft) Buffer of NSSI <i>Arcotphila Fulva</i> (Pendant Grass) polygons	3
Engineering	3%		Slope	See Table B-4	0-5
Geoscience	3%		DGGS (AES) Geohazards	Presence or Absence of 500-ft Buffer around Pingos.	0 or 5
			DGGS (AES) Terrain Units	See Table B-5	1-5
Hydrology	23%		Presence or Absence of Lakes & Rivers	Presence or Absence of Channel or Lake	0 or 5
Regulatory	15%	ADEC - 90%	ADEC Contaminated Sites	Presence or Absence of 500-ft Buffer	0 or 5
		NPR-A ROD EIS - 10%	K1 River Buffers	Presence or Absence	0 or 3
			E2 500-ft setbacks	Presence or Absence of 500-ft Buffer	0 or 2
			Deep water lakes 400-meter setbacks	Presence or Absence	0 or 3
Sociocultural	43%		AHRS	Presence or Absence of 500-ft Buffer	0 or 5
			Camps & Cabins	Presence or Absence of 500-ft Buffer	0 or 5
			Native Allotments	Presence or Absence of 500-ft Buffer	0 or 5

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**Table B-4. Scales for Slope Data**

Value	Slope
0	0%
1	0.1 to 2%
2	2.1 to 3%
3	3.1 to 4%
4	4.1 to 6%
5	> 6%

**Table B-5. Scales for Terrain Units Data**

VALUE	Terrain Unit
1	Ad
5	Pingo
5	Qa
5	Qaa
5	Qac
5	Qai
1	Qb
1	Qb/Qms
2	Qc
4	Qd
2	Qe
3	Qe/Qai
2	Qe/Qms
4	Qm
2	Qms
3	Qms/Qm
5	Qt
5	Qt/Qa
5	Qt/Qaa
5	Qt/Qai
5	Qt/Qd
4	Qt/Qe
5	Qt/Qm
4	Qt/Qms

After assigning scaled values, vector datasets were converted to rasters with a resolution of 5-meters (again, the same as the elevation data, which was coarsest dataset) using VALUES field.

Slope data was converted to the common 0 to 5 scale by using the Reclassify tool in *Spatial Analyst*>*Reclass* using the slope scale values presented in Table B-3.

## Data Weighting

Once data were converted to rasters, weighting values were needed to provide each input layer with an appropriate level of importance to the overall cost layer. Specific values for weighting of data layers are provided in Table B-3.

Please note that “Sublayer Weighting” is given for individual layers that were composed of more complex data inputs. These had to first be compiled into a second-level raster based on their scales and weights before they could be used in creation of the first-level raster. For instance, Wetlands and T&E rasters were combined into a single raster to create the Ecological raster using weights of 25% and 75%, respectively. This same process was required to create the Regulatory raster from its associated sublayers. Weights for sublayer inputs were derived by SME estimation.

Weights for combining “Analysis Layer” rasters into a single cost raster for use in the Path-Distance tools were derived through group consensus using a pairwise comparison survey as shown in Figure B-3.

**FIGURE B-3 – Pairwise Comparison Survey**

	Layer 1	Extremely More Important	Very Strongly More Important	Strongly More Important	Moderately More Important	Equally Important	Moderately More Important	Strongly More Important	Very Strongly More Important	Extremely More Important	Layer 2
1	Ecological	9	7	5	3	1	3	5	7	9	Geoscience
2	Ecological	9	7	5	3	1	3	5	7	9	Hydrology
3	Ecological	9	7	5	3	1	3	5	7	9	Regulatory
4	Ecological	9	7	5	3	1	3	5	7	9	Sociocultural
5	Ecological	9	7	5	3	1	3	5	7	9	Slope
6	Geoscience	9	7	5	3	1	3	5	7	9	Hydrology
7	Geoscience	9	7	5	3	1	3	5	7	9	Regulatory
8	Geoscience	9	7	5	3	1	3	5	7	9	Sociocultural
9	Geoscience	9	7	5	3	1	3	5	7	9	Slope
10	Hydrology	9	7	5	3	1	3	5	7	9	Regulatory
11	Hydrology	9	7	5	3	1	3	5	7	9	Sociocultural
12	Hydrology	9	7	5	3	1	3	5	7	9	Slope
13	Regulatory	9	7	5	3	1	3	5	7	9	Sociocultural
14	Regulatory	9	7	5	3	1	3	5	7	9	Slope
15	Sociocultural	9	7	5	3	1	3	5	7	9	Slope

Highlighted cells represent the values assigned during the group discussion with SMEs.

Results from this survey were then run through the Analytic Hierarchy Process (AHP) to derive the weights as show in Table B-4.

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**Table B-6. Analysis Layer Input Weights**

Layer	Weight
Sociocultural	43%
Hydrology	23%
Regulatory	15%
Ecological	13%
Geoscience	3%
Slope	3%
	100%

## Cost Raster Creation

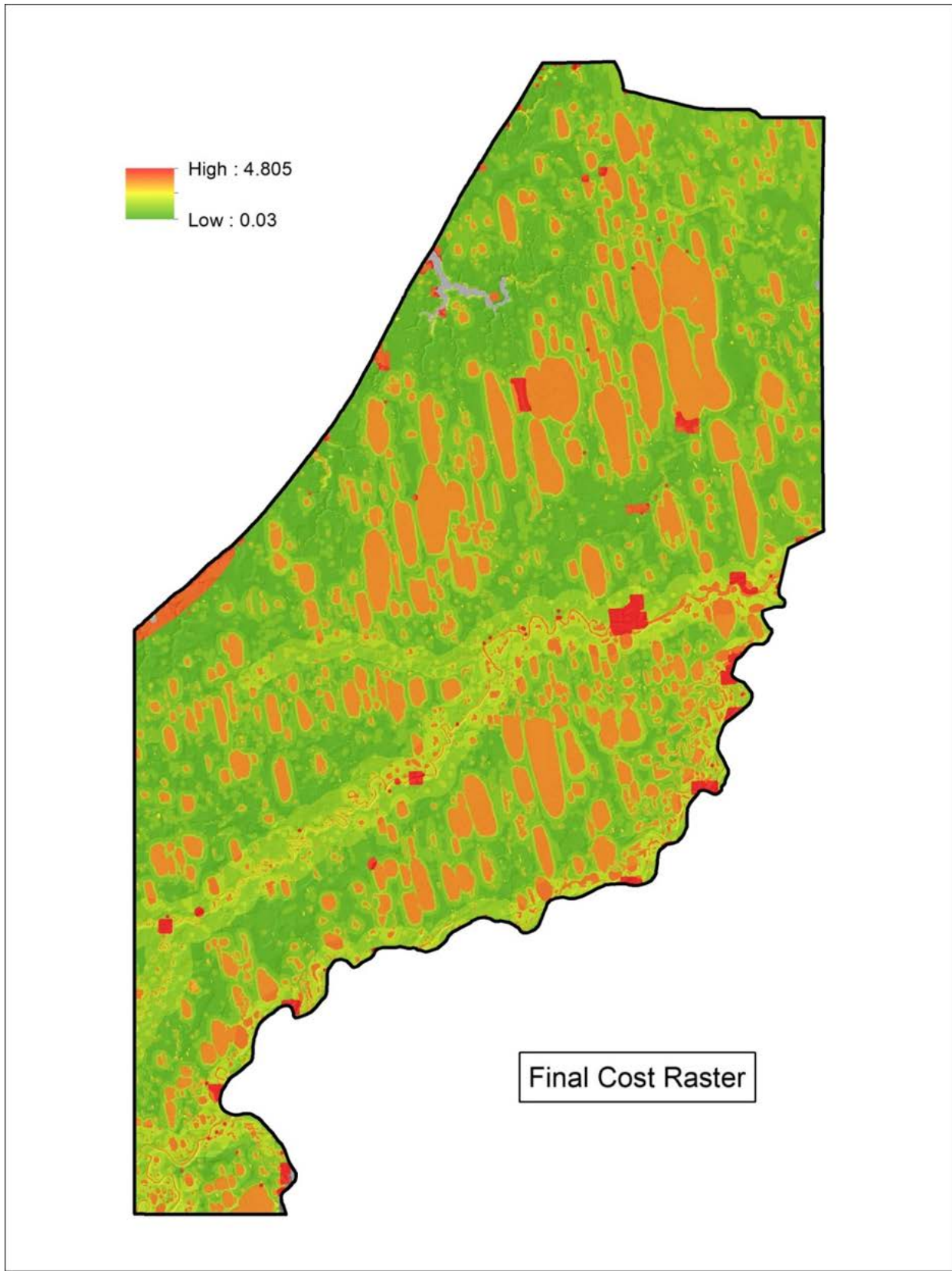
The *Map Algebra>Raster Calculator* contained in ESRI’s *Spatial Analyst Tools* was then used to combine the Analysis Layer rasters, using their assigned weights, into the final cost raster using the following equation:

$$\frac{(Sociocultural \times 0.43) + (Hydrology \times 0.23) + (Regulatory \times 0.15) + (Ecological \times 0.13) + (Geoscience \times 0.03) + (Slope \times 0.03)}{6} = COST$$

The sum of the raster products area divided by the total number of raster inputs to derive an average value for the pixels. The resulting raster is shown in Figure B-2.

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**Figure B-2. Final Cost Raster**



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## Create Analysis Points

Shapefiles were created for the different points needed to run the Path-Distance tools. The source point was determined by SME input to be a location along Landfill Road in Atqasuk. In like manner, terminal points for routes were selected along Emaiksoun Road and East Gas Field Road in Utqiagvik. Likely locations for stream and river crossings were selected by SMEs and points placed at each, near the channel centerline.

## Running the Path-Distance Tools

The cost raster, DEM, and analysis points were used in the *Spatial Analyst>Distance>Path Distance* tools to derive the *Distance* (source) and *Backlink* rasters required for use in the *Cost Path As Polyline* tool. An example of a *Distance* (source) is shown in Figure B-3. Distance and Backlink rasters were created for each source location, namely for Atqasuk and every river crossing location.

Once these raster were built, the *Cost Path As Polyline* tool was run to create a line segment from each source to each destination. For instance, lines were created from Atqasuk using the raster built using the Atqasuk point as the source and the three identified crossings of the Nigisaktuvik River (destination points). Then points for reach river crossing were used as sources to build subsequent Distance and Backlink rasters that, in in turn, were used to create additional segments. This process was repeated until the final destinations in Utqiagvik were reached.

## Final GIS Data Development

Once the line segments were produced from the *Cost Path As Polyline* tool, the following processes were performed to create final datasets used in corridor assessment and evaluation.

- Individual segments were merged into single lines for each route and named.
- Route lines were intersected with National Hydrography Dataset (NHD) flowlines to create points and determine initial stream and river crossing locations in addition to those selected for route development. These points were then adjusted as necessary according to aerial imagery and other desktop inputs.
- Routes were adjusted to better align to crossings (approaches and perpendicularity to flow), address known conflicts, and based on SME evaluation.
- Measured lines created for further location of features along routes as necessary.
- Route mileposts were created.
- Buffers of routes were generated 1,000' on either side of route lines to create 2,000' study corridors.

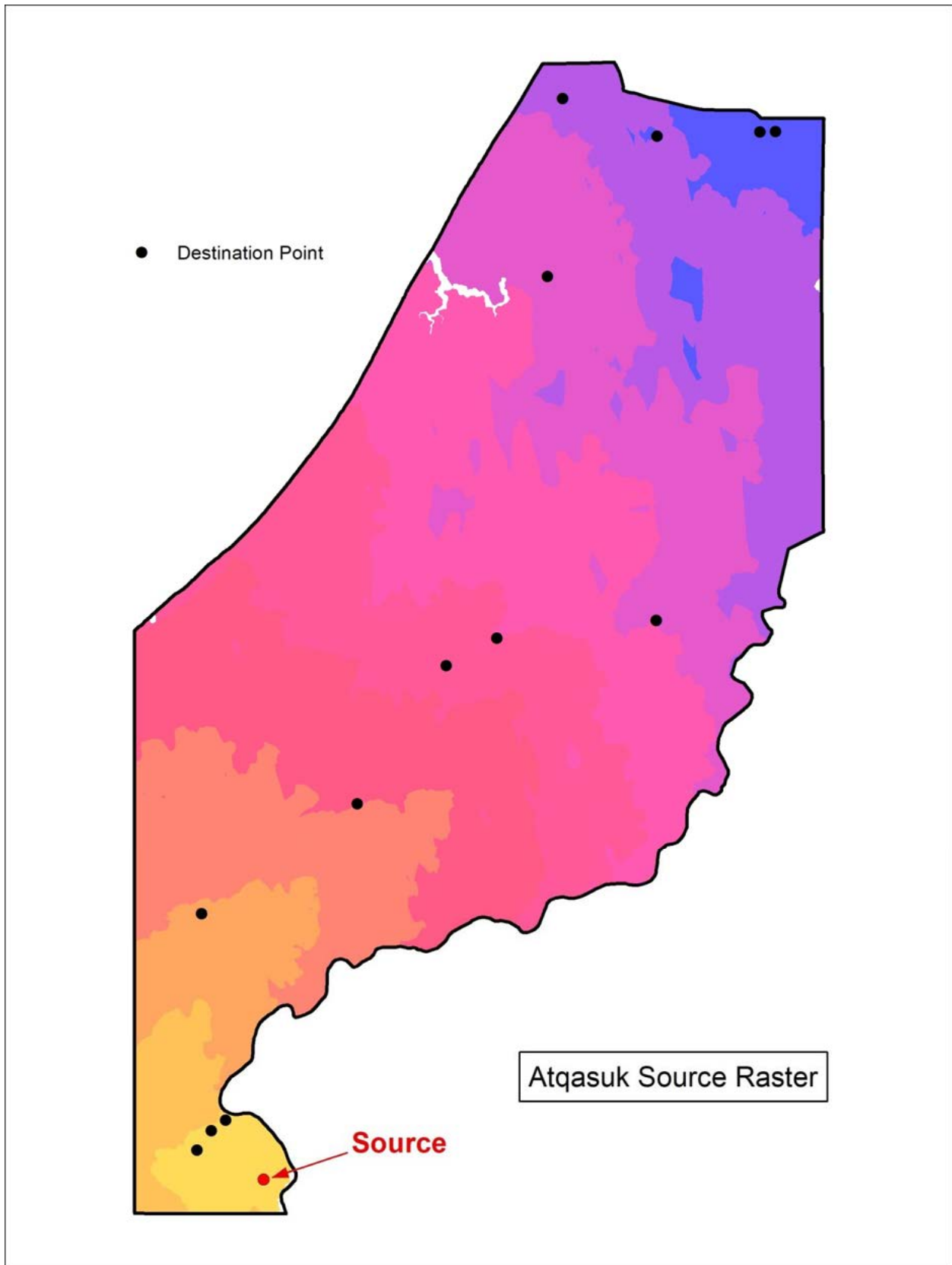
## Additional Analysis

Additional GIS analyses were then performed using these datasets, including:

- Characterization of river crossings (measurement of total width, channel width, and assessment of potential crossing infrastructure type needed).
- Evaluation of wetlands impacts by acreage calculations within corridors.
- Determination of mileage of terrain units crossed (using linear referencing).

- Examination of proximity to:
  - Cultural of paleontological sites
  - Existing facilities
  - Proposed facilities
  - Well sites

Figure B-3. *Distance (Source)* Raster Example



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Project File

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QC REVIEWER

A handwritten signature in black ink, appearing to read 'A. Henry', is written over a horizontal line.

Amanda Henry  
Principal Scientist / Operations Manager

Technical Editor: ASH