WESTERN ALASKA ACCESS PLANNING STUDY

CORRIDOR STAGING AND ALTERNATIVES REPORT

December 2011

Prepared by:

DOWL HKM

Prepared for:
The State of Alaska
Department of Transportation and Public Facilities

WESTERN ALASKA ACCESS PLANNING STUDY
CORRIDOR STAGING AND ALTERNATIVES REPORT

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
Northern Region Planning
2301 Peger Road
Fairbanks, Alaska 99709
(907) 451-5150

Prepared by:

DOWL HKM
4041 B Street
Anchorage, Alaska 99503
(907) 562-2000

DOT&PF Project No. 60800

December 2011

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LIST OF ACRONYMS

DGGS .... Division of Geological and Geophysical Surveys
DNR .... State of Alaska Department of Natural Resources
DOT&PF .... State of Alaska Department of Transportation and Public Facilities
ROW .... right-of-way
WAAPS .... Western Alaska Access Planning Study

EXECUTIVE SUMMARY

In January 2010, DOWL HKM completed the Western Alaska Access Planning Study Corridor Planning Report. The report evaluated three routes to connect the Nome-Council Road to the road system in the Fairbanks area and recommended the Yukon River Corridor. The road would improve access between remote villages and connect to existing road networks near Fairbanks and Nome. It would support village sustainability by reducing the cost of living and providing greater opportunities for employment, particularly from expanded mining and other resource development. The Yukon River Corridor is shown in Figure E-1.

From October 2010 - March 2011, the Western Alaska Access Planning Study Corridor planning team visited villages and cities within and outside the study area, seeking input on the Corridor Planning Report recommendations. A separate Public Involvement Report and Executive Summary were published in April 2011 to document the comments received.

This Corridor Staging and Alternatives Report builds upon the initial 2010 Corridor Planning Report and the public input received to refine the alignment and to evaluate staging (or phasing) of the project and other ways to reduce costs.

The first stage, from Manley Hot Springs to Tanana, is estimated to cost from $69 million to $193 million, depending on which design standards are used. Fieldwork and mapping are needed to further refine project costs.

Yukon River Corridor Refinements

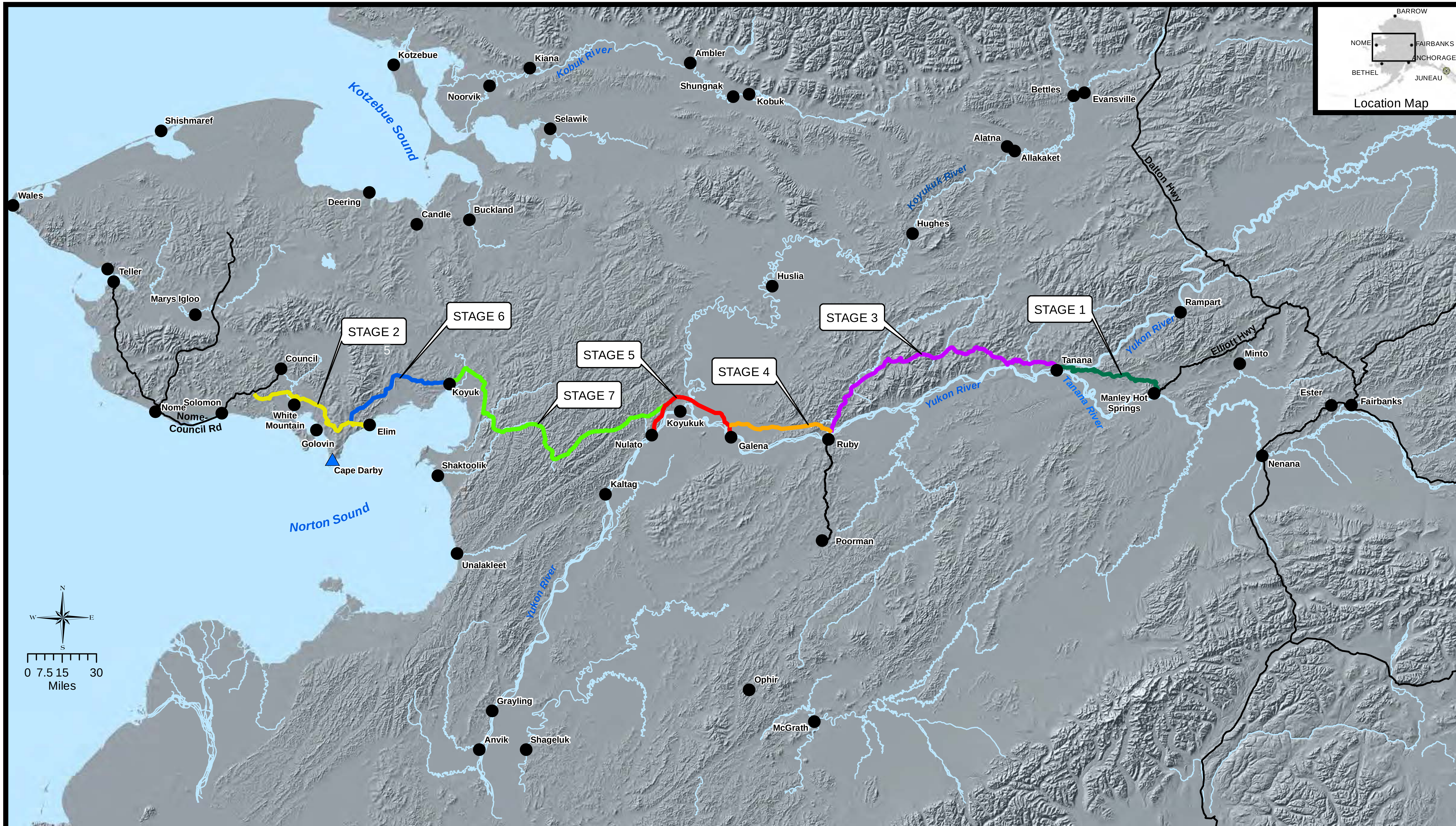
Based on public input received, the proposed Yukon River Corridor was refined on the east and west ends near Tanana and Council. The Manley Hot Springs to Tanana refinements were made because of local residents' requests to move the road away from an important subsistence area at Fish Lake. The refined route takes advantages of 15 miles of the existing Tofty Road, lowers construction costs, provides an existing Right of Way for part of the route, and reduces potential wetlands impacts. The refined Manley Hot Springs to Tanana route assumes that a bridge will not initially be constructed over the Yukon River and proposes a temporary ferry crossing just upstream of the confluence of the Yukon and Tanana Rivers.

Existing Tofty Road to be used for first 15 miles of Manley to Tanana Stage

The Council area refinements were made because of Council property owner opposition to the road running near Council. The refined route is also less mountainous than the original route, provides for much shorter future connecting roads to the villages of White Mountain, Golovin, and Elim, and would better accommodate a connection to a potential deep-water port at Cape Darby (between Golovin and Elim). The refined routes are shown in Figure E-1.

Yukon River Corridor Staging

Because of the high construction cost of building the entire 548 miles of the Yukon River Corridor and the competition for funding for other important road projects around Alaska, it is unlikely that the entire road could be built at one time. This report proposes functional road corridor stages with logical termini and independent utility that could be constructed as funding allows. Environmental documents, property acquisition, and design could be completed in



Communities	**Corridor Stages**	4 Ruby to Galena	
Water	1 Manley to Tanana	5 Galena to Nulato	
Existing Roads	2 Elim to N-C Highway	6 Koyuk to Elim	
Potential Deep Water Port	3 Tanana to Ruby	7 Nulato to Koyuk	

Sources:
Communities: DNR
Water: DNR
Existing Roads: ADOT

Coordinate System: NAD 1983 Alaska Albers

STATE OF ALASKA
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NORTHERN REGION

WESTERN ALASKA ACCESS PLANNING STUDY
STAGING / ALTERNATIVE ANALYSIS

REFINED YUKON RIVER CORRIDOR STAGES

DATE: August 26, 2011 | **Figure E-1**

\\anc-hg-fs01\Autocad\Projects\D60060\GIS\ENG\Figure E-1 R2B Refinements Stages.mxd Aug 26, 2011 10:20:20 AM User: cfelker stages for shorter roadway segments, thereby reducing the length of time before construction of the first stage could begin.

Figure E-1 shows a proposed staging plan, accounting for the refinements near Tanana and Council discussed above. Table E-1 shows the length in miles for each stage. Each stage provides direct access to communities at the beginning and ending points of each stage. It is assumed that communities between termini could be connected to the corridor with connector roads or seasonal use roads, if so desired.

Table E-1: Stage Distance

Stage	Distance (miles)
1. Manley Hot Springs to Tanana	54
2. Nome-Council Highway to Elim	58
3. Tanana to Ruby	134
4. Ruby to Galena	48
5. Galena to Nulato	54
6. Elim to Koyuk	58
7. Koyuk to Nulato	142
Total	**548**

Cost Reductions

A variety of cost reduction measures were examined to make the Yukon River Corridor, particularly the initial stage from Manley Hot Springs to Tanana, more affordable. Ideas ranged from reduced cross-sections and bridge types to use of alternative travel surfaces/modes such as ice roads, ice bridges, and ferries. Costs were reduced to make the project more affordable, but also because the initial traffic volumes may not justify the higher costs and larger scale of facilities that were initially considered. Over time, as traffic increases, a larger cross-section would become more justified and initial ice bridges and ferries over major rivers such as the Yukon and Koyukuk Rivers could be replaced by conventional bridges.

Table E-2 shows the range of costs identified for the various stages of the Yukon River Corridor, including a single lane 16-foot wide road with pullouts, a two-lane 24-foot-wide road, and a two-lane 30-foot-wide road. The 16-foot and 24-foot options assume a basic 5-foot structural section with 2:1 side slopes, and the 30-foot-wide road assumes a 6-foot structural section with 4:1 side slopes.

Table E-2: Stage Distance and Costs (in millions)

Stage	Distance (miles)	16-foot One-Lane Section w/Pullouts ($millions)	24-foot Two-Lane Section ($ millions)	30-foot Two-Lane Section ($millions)	Major Bridges ($millions)
1. Manley Hot Springs to Tanana	54	$69	$119	$193	$0
2. Nome-Council Highway to Elim	58	$107	$146	$252	$49
3. Tanana to Ruby	134	$218	$311	$526	$99
4. Ruby to Galena	48	$80	$111	$207	$0
5. Galena to Nulato	54	$86	$122	$217	$34
6. Elim to Koyuk	58	$108	$149	$254	$5
7. Koyuk to Nulato	142	$222	$320	$547	$34
Total	**548**	**$890**	**$1,279**	**$2,195**	**$221**

For the initial Manley Hot Springs to Tanana stage, the cost estimates assumes that crossing of the Yukon River would be provided by an ice bridge in winter and ferry/barge crossing in the summer. The Yukon River Bridge is proposed for Stage 3 in Table E-2, but could be a stand-alone project.

Stage 1 - Manley Hot Springs to Tanana Recommendations

The Manley Hot Springs to Tanana stage connects to the existing Elliott Highway near Manley Hot Springs and is about 150 miles from Fairbanks, a larger population center. It is 54 miles long and because 15 miles of the existing Tofty Road are used, can be constructed at lower cost than other stages. Figure E-2 shows the Manley Hot Springs segment.

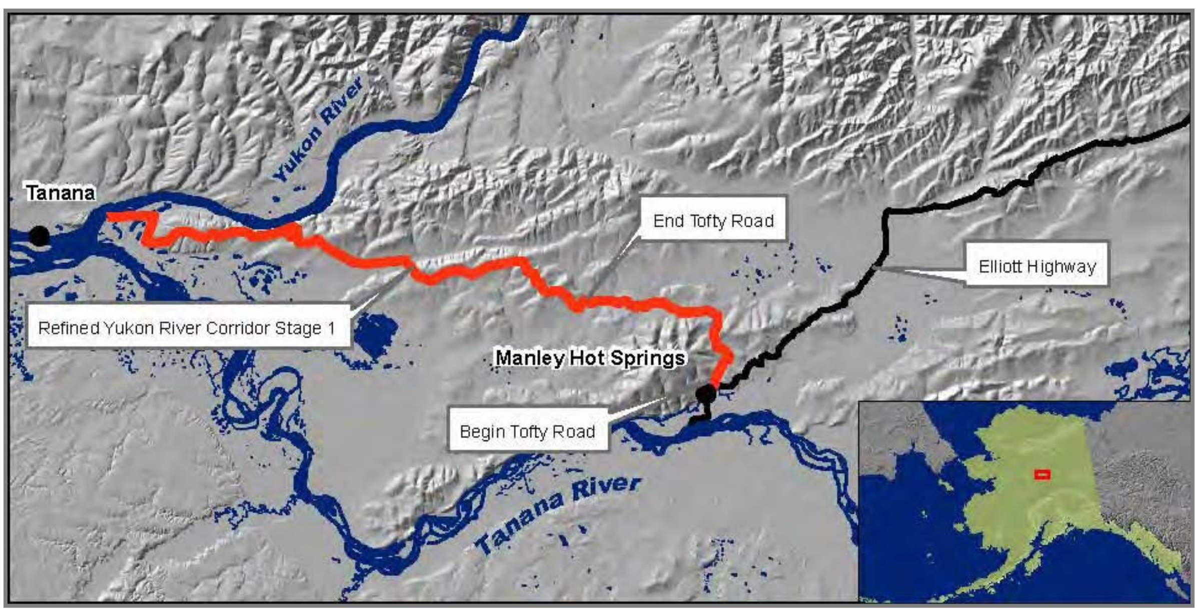


Figure E-2: Refined Yukon River Corridor Stage 1

A road from Manley Hot Springs to Tanana would reduce living costs for residents of Tanana. It could also create the opportunity to truck cargo and fuel to Tanana, where materials could be barged downriver to Yukon River villages, avoiding the shallow Tanana River waters downriver from Nenana. Relocation of some of the regional barge operations to Tanana could potentially lower costs for many Yukon River villages downstream of Tanana, enable use of higher capacity barges, and extend the barge season by up to one month. Road access to Tanana would also access mineralized areas, increasing the potential for mineral exploration and development and associated employment.

Table E-3 shows the costs of two Manley Hot Springs to Tanana options recommended for further study; a 16-foot single-lane road with pullouts, and a 24-foot two-lane road. Final road design standards and costs should be determined after additional engineering data and public input is obtained. Both options include:

- 5-foot-deep structural section
- 2:1 foreslopes
- No removal of organics beneath the road in tundra and wetlands areas
- Reduced width (20 feet) bridges at stream crossings
- Use of an ice bridge and ferry/barge at the crossing of the Yukon River

Table E-3: Stage 1 Manley Hot Spring to Tanana Cost Estimates

	Original Typical Section ($ millions)	24-foot Two-Lane Road ($ millions)	16-foot Single-Lane Road ($ millions)
Manley Hot Springs to Tanana	$193	$119	$69

Next Steps

Initial planning of access between Fairbanks to Nome relied on existing crude topographic mapping and no field verification of engineering and environmental conditions. The expansive study area required use of readily available data, such as United States Geological Survey mapping, that was often imprecise. Now that a final corridor has been selected, next steps should focus on a more precise review of the initial stage between Manley Hot Springs and Tanana, with better mapping, in-field investigations, and more stakeholder involvement, particularly by those most directly affected by the first stage between Manley Hot Springs and Tanana.

1.0 INTRODUCTION

In January 2010, DOWL HKM completed the Western Alaska Access Planning Study (WAAPS) Corridor Planning Report. The report evaluated three routes to connect the Nome-Council Road to the road system in the Fairbanks area. The recommended route from that report, the Yukon River Corridor, is shown in Figure 1. The road would improve access between remote villages, larger hub communities, and road networks near Fairbanks and Nome, and would reduce the cost of goods and services in remote villages, thereby supporting their continued sustainability. Road access will also allow for development of natural resources and alternative energy and provide business opportunities and jobs for villages along the route.

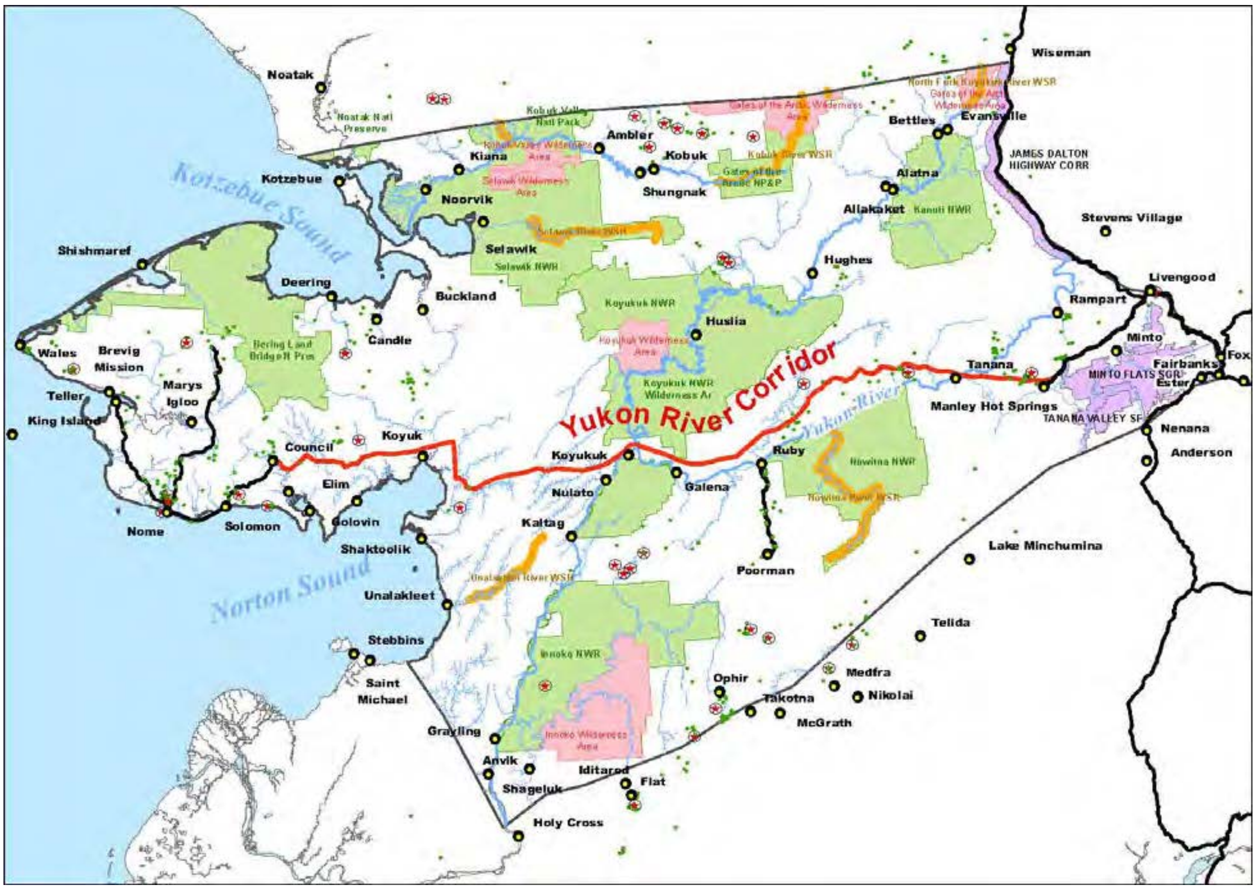


Figure 1: Original Yukon River Corridor
(WAAPS, Corridor Planning Report, DOWL HKM, January 2010)

Following the completion of the Corridor Planning Report, the WAAPS team visited villages near the proposed roadway and larger communities within and outside the study area, seeking input on the study recommendations. A separate Public Involvement Report and Executive Summary were published in April 2011 to document the comments received. The work completed on the Corridor Planning Report combined with the public comments on the project was used to refine the alignment and to evaluate staging (or phasing) of the project into segments with logical termini and independent utility. The resulting staging plan as documented herein will guide future transportation planning and project funding decisions in the implementation of the overall corridor. Specifically, this report documents:

- Refinements to the Yukon River Corridor alignment,
- Sequential staging of the project,
- Alternative construction techniques that achieve the objectives at a lower cost,
- Interim modal alternatives to defer or reduce costs, and
- Additional future routes that may be considered for future connection to the Yukon River Corridor.

This report summarizes these improved concepts and makes recommendations on the next steps that could be taken to continue work on the Yukon River Corridor.

2.0 ROUTE MODIFICATIONS

The following section discusses modifications to the east and west ends of the proposed Yukon River Corridor alignment near Tanana and Council that resulted from the public outreach. Even with these modifications, the Yukon River Corridor as presented in this report is not considered final and will be subject to changes as further study and public input are received. The corridor shown in this report represents the general location of the road, perhaps within a 3- to 5-mile margin of the final road location in some areas, and an even wider margin in other areas. Further route refinement will require more accurate topographic mapping and survey, geotechnical analysis, environmental analysis/fieldwork, and additional public involvement.

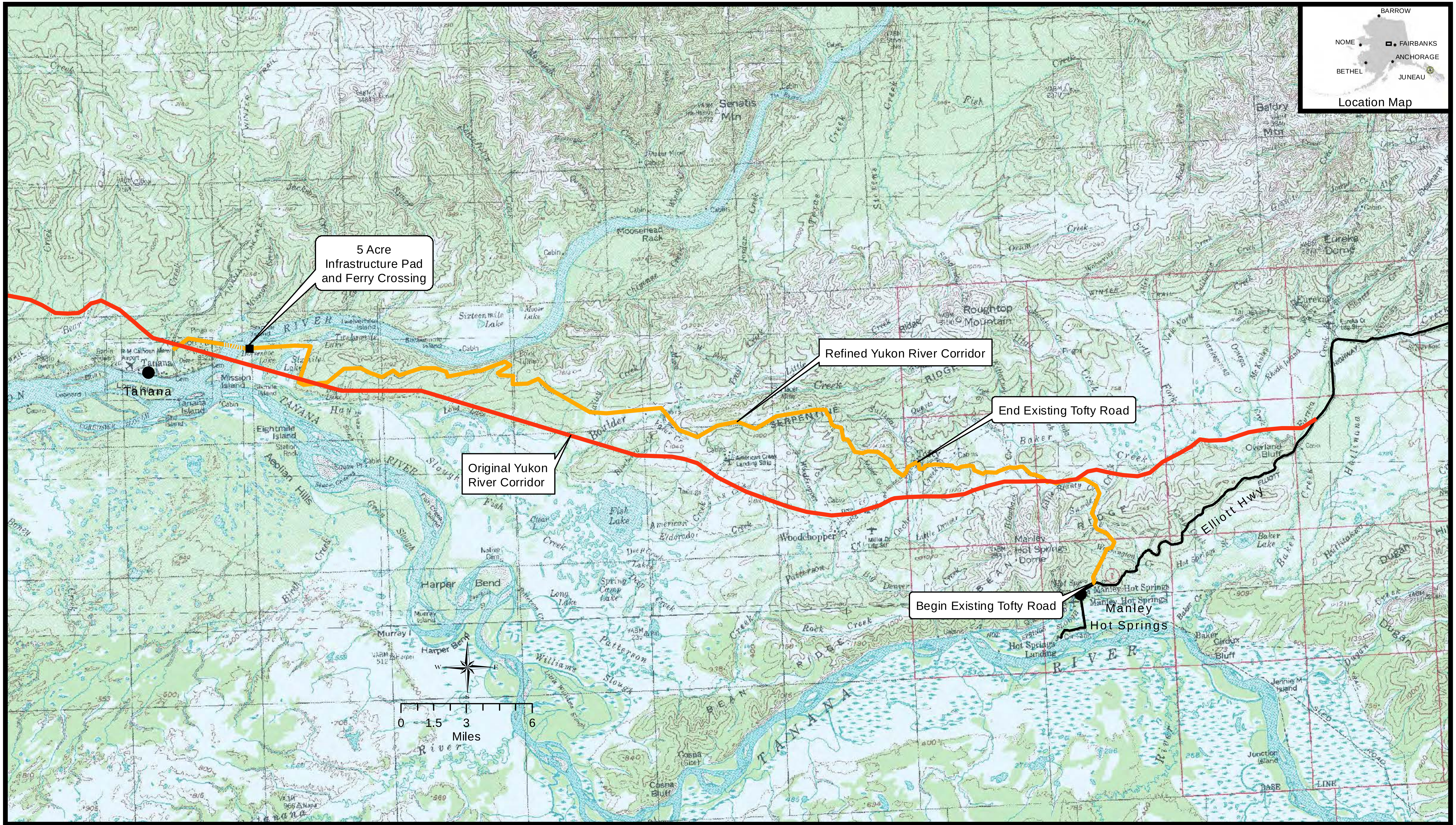
2.1 Manley Hot Springs to Tanana

The original alignment routed the roadway corridor nearby Fish Lake. Fish Lake is located approximately midway between the villages of Manley Hot Springs to the east and Tanana to the west, as shown on Figure 2, near the confluence of the Tanana and Yukon Rivers.

Existing Tofty Road

Existing Tofty Road

Fish Lake was identified by residents of both villages as an important subsistence area that should be avoided by the Yukon River Corridor to minimize impacts to this resource from outside hunting influence. Road construction in the Fish Lake area also has greater potential to encounter wetlands and presents additional environmental, cost, and construction impacts.



- Communities
- 5 Acre Infrastructure Pad
- Existing Roads
- Refined Yukon River Corridor
- Original Yukon River Corridor

Sources:
Communities: DNR
Existing Roads: DOT&PF

Coordinate System: NAD 1983 Alaska Albers

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MANLEY HOT SPRINGS TO TANANA
REVISED ALIGNMENT

DATE: October 31, 2011 | **Figure 2**

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The refined Manley Hot Springs to Tanana alignment is shifted north and constructed along the existing Tofty Road as much as feasible to take advantage of the existing right-of-way (ROW) and more stable road base. After reaching the end of the existing Tofty Road, the route climbs to the ridgeline, providing for construction on more suitable road foundation material than the low lands in the Fish Lake area.

Existing Tofty Road

Existing Tofty Road

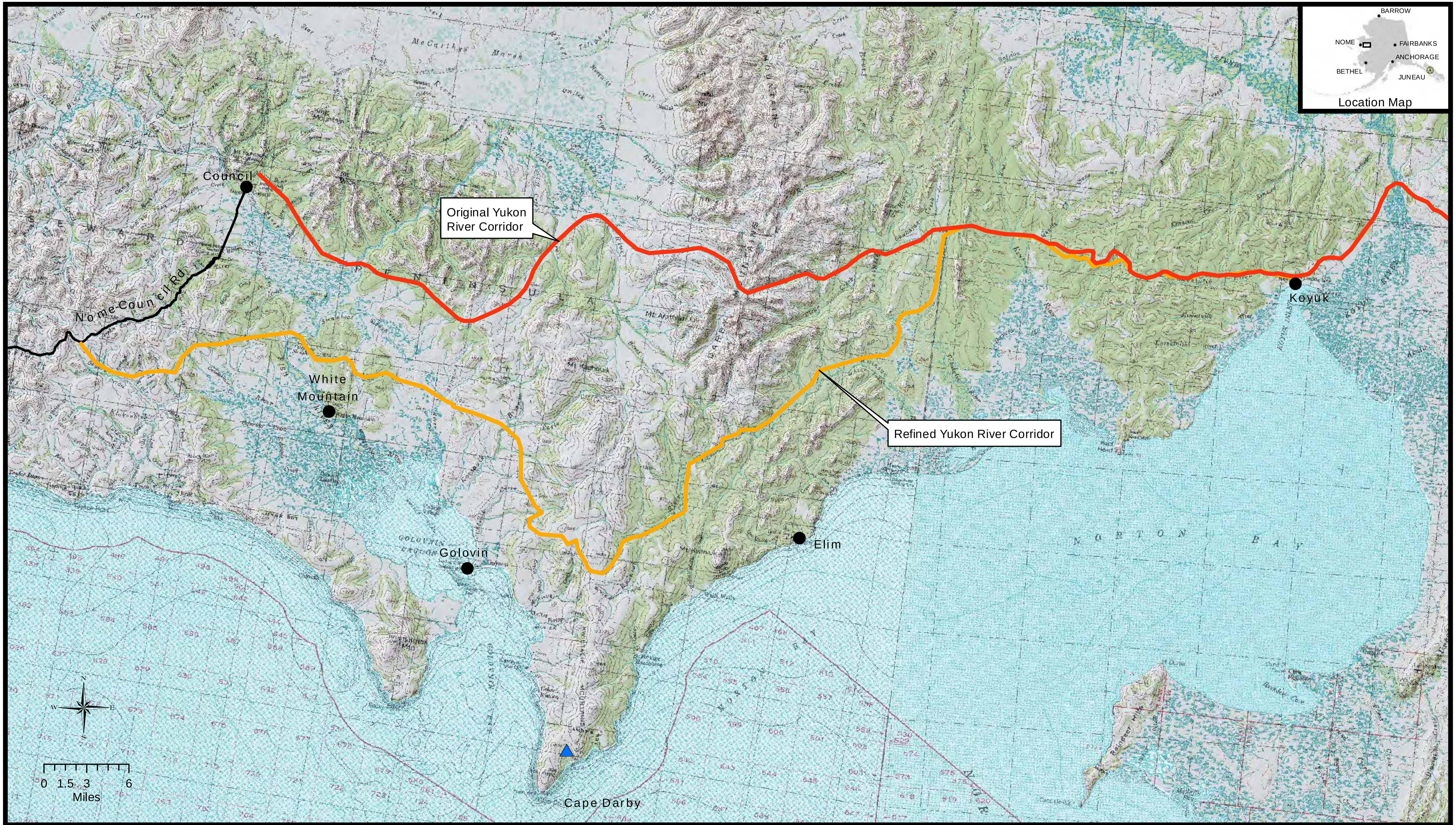
Additionally, the Tofty Road route is subject to winds over the top of the ridgelines, which if constructed properly, would allow the snow to blow over the roadway without drifting, thereby reducing snow removal maintenance costs. On the other hand, these areas may periodically experience significantly reduced visibility from blowing snow. The refined route over the Tofty Road reduces costs because the existing 15 miles of Tofty Road will only require resurfacing, minimal clearing, and minor drainage improvements.

The refined Manley Hot Springs to Tanana route assumes that a bridge will not initially be constructed over the Yukon River and shows a temporary ferry crossing just upstream of the confluence with the Tanana River. An appropriate bridge location can be determined at a later date that would likely be farther upstream where a shorter bridge span would be needed. An upstream bridge location would also move the bridge further away from the confluence of the Yukon and Tanana Rivers where more frequent ice jams will make siting a bridge more difficult.

2.2 Council to Koyuk Realignment

The original Yukon River Corridor alignment east of Nome connects Council directly to Koyuk. This segment crosses the Darby Mountains and does not route near the villages of White

Mountain, Golovin, and Elim. The Council Native Corporation has requested that the proposed roadway not go through the village of Council or encroach upon their lands. Based on the public comments obtained from these villages and an evaluation of the topography, a refined route is shown on Figure 3 that is less mountainous than the original route, and provides for much shorter future access roads to the villages of White Mountain, Golovin, and Elim. This route would connect the Yukon River Corridor to the Nome-Council Highway at a location outside of Council and would better accommodate a connection to a potential deep-water port at Cape Darby (between Golovin and Elim). Cape Darby has been identified as the best location for a deep-water port on the Norton Sound. This route would reduce the construction and maintenance costs of crossing the Darby Mountains, would avoid the Village of Council, and would more easily facilitate connection of port/village locations between Koyuk and Nome. However, it adds an additional 23 miles to the Council to Koyuk segment of road, compared to the original alignment.



- Communities
- Existing Roads
- Refined Yukon River Corridor
- Original Yukon River Corridor
- Potential Deep Water Port

Sources:
Communities: DNR
Existing Roads: DOT&PF

Coordinate System: NAD 1983 Alaska Albers

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COUNCIL TO KOYUK REFINED ALIGNMENT

DATE: November 18, 2011	**Figure 3**

3.0 STAGING ANALYSIS

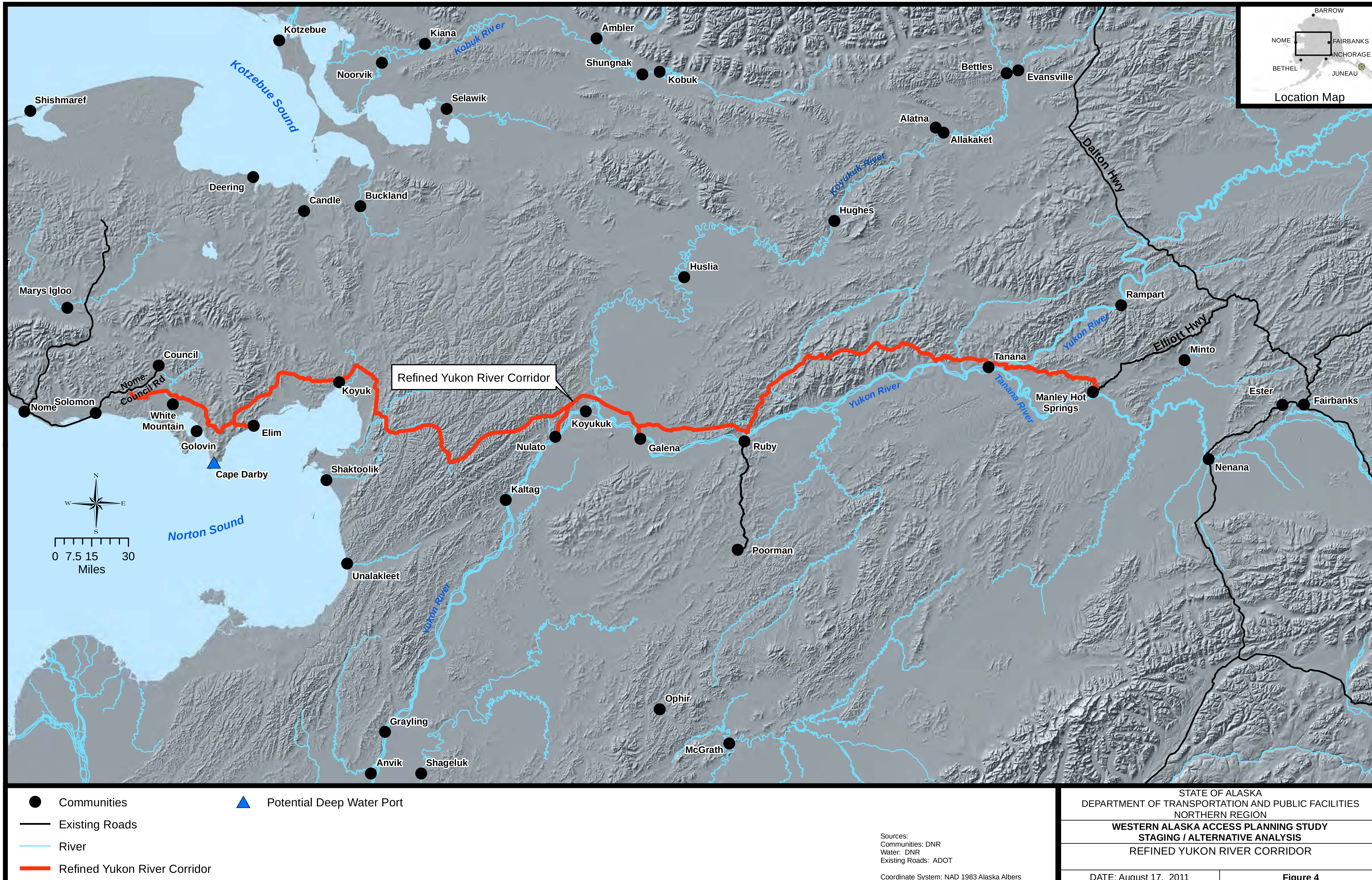
The 2010 Corridor Planning Report estimated the cost of constructing the 500-mile-long roadway at $2.7 billion dollars. Due to the high construction cost and competition for funding for projects around Alaska, it is unlikely that the funding to design and construct the entire project would be available all at once. Thus, this report proposes functional road corridor stages with logical termini and independent utility that could be constructed as funding permits. Environmental documents, property acquisition, and design could be completed in stages for shorter roadway segments, thereby reducing the length of time before construction of the first stage could begin.

Figure 4 shows the refined Yukon River Corridor, accounting for the revisions discussed in Chapter 2.0. Figure 5 shows the refined Yukon River Corridor and the recommended construction sequence. Each stage provides direct access to communities at the beginning and ending points of each stage. It is assumed that communities between termini could be connected to the corridor with connector roads or seasonal use roads, if so desired. Table 1 shows the distances in miles for each stage.

Table 1: Stage Distance Summary

Stage	Distance (miles)
1. Manley Hot Springs to Tanana	54
2. Nome-Council Highway to Elim	58
3. Tanana to Ruby	134
4. Ruby to Galena	48
5. Galena to Nulato	54
6. Elim to Koyuk	58
7. Koyuk to Nulato	142
Total	**548**

As discussed in the previous Corridor Planning Report, all segments would enable more frequent deliveries, less expensive fuel and commodities, and more options for passenger travel at a lower cost. As these benefits apply to all stages of the project, they will not be repeated below in the discussion of individual stages.



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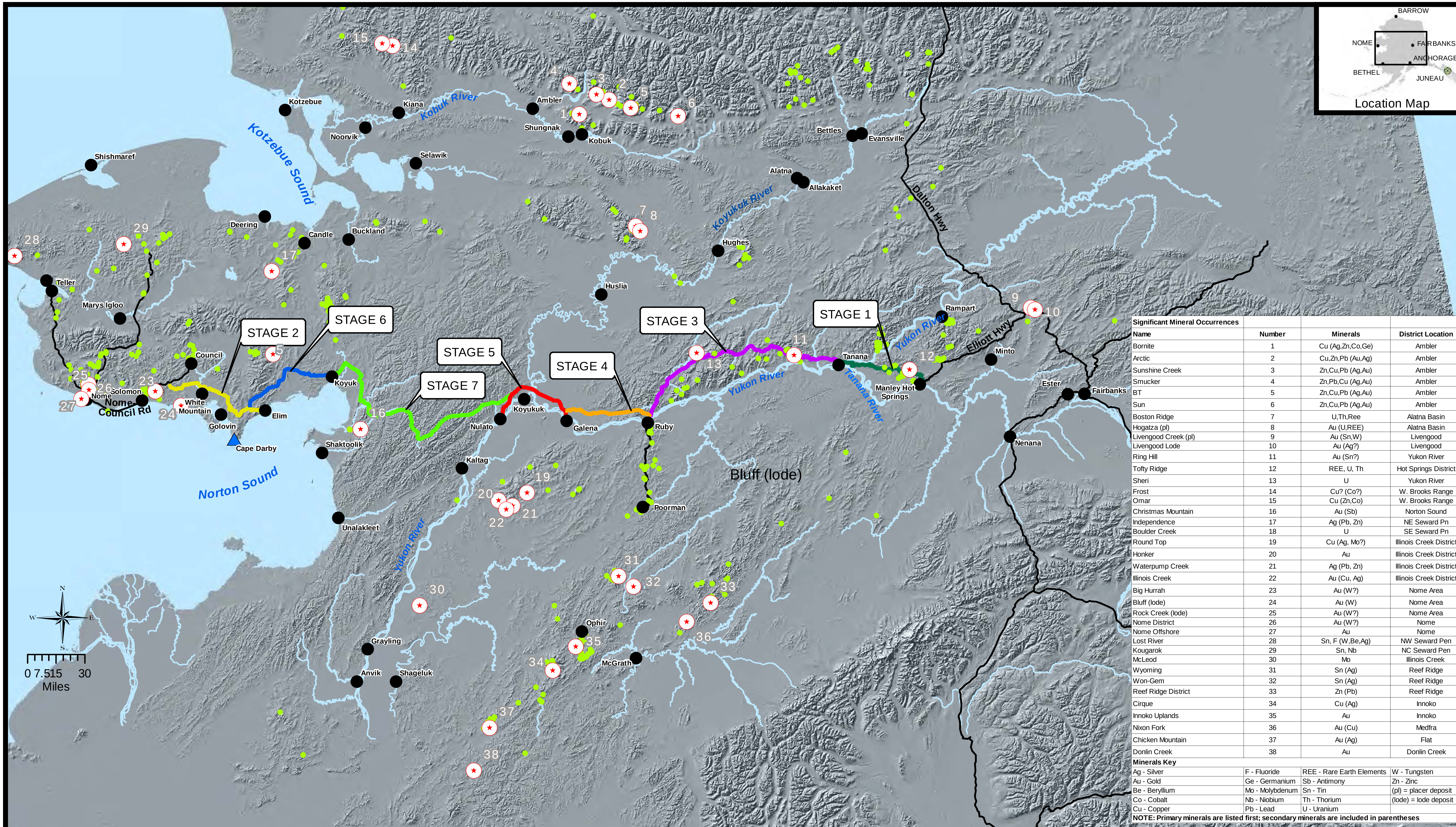

Significant Mineral Occurrences			
Name	**Number**	**Minerals**	**District Location**
Bornite	1	Cu (Ag,Zn,Co,Ge)	Ambler
Arctic	2	Cu,Zn,Pb (Au,Ag)	Ambler
Sunshine Creek	3	Zn,Cu,Pb (Ag,Au)	Ambler
Smucker	4	Zn,Pb,Cu (Ag,Au)	Ambler
BT	5	Zn,Cu,Pb (Ag,Au)	Ambler
Sun	6	Zn,Cu,Pb (Ag,Au)	Ambler
Boston Ridge	7	U,Th,Ree	Alatna Basin
Hogatza (pl)	8	Au (U,REE)	Alatna Basin
Livengood Creek (pl)	9	Au (Sn,W)	Livengood
Livengood Lode	10	Au (Ag?)	Livengood
Ring Hill	11	Au (Sn?)	Yukon River
Tofty Ridge	12	REE, U, Th	Hot Springs District
Sheri	13	U	Yukon River
Frost	14	Cu? (Co?)	W. Brooks Range
Omar	15	Cu (Zn,Co)	W. Brooks Range
Christmas Mountain	16	Au (Sb)	Norton Sound
Independence	17	Ag (Pb, Zn)	NE Seward Pn
Boulder Creek	18	U	SE Seward Pn
Round Top	19	Cu (Ag, Mo?)	Illinois Creek District
Honker	20	Au	Illinois Creek District
Waterpump Creek	21	Ag (Pb, Zn)	Illinois Creek District
Illinois Creek	22	Au (Cu, Ag)	Illinois Creek District
Big Hurrah	23	Au (W?)	Nome Area
Bluff (lode)	24	Au (W)	Nome Area
Rock Creek (lode)	25	Au (W?)	Nome Area
Nome District	26	Au (W?)	Nome
Nome Offshore	27	Au	Nome
Lost River	28	Sn, F (W,Be,Ag)	NW Seward Pen
Kougarok	29	Sn, Nb	NC Seward Pen
McLeod	30	Mo	Illinois Creek
Wyoming	31	Sn (Ag)	Reef Ridge
Won-Gem	32	Sn (Ag)	Reef Ridge
Reef Ridge District	33	Zn (Pb)	Reef Ridge
Cirque	34	Cu (Ag)	Innoko
Innoko Uplands	35	Au	Innoko
Nixon Fork	36	Au (Cu)	Medfra
Chicken Mountain	37	Au (Ag)	Flat
Donlin Creek	38	Au	Donlin Creek
Minerals Key			
Ag - Silver	F - Fluoride	REE - Rare Earth Elements	W - Tungsten
Au - Gold	Ge - Germanium	Sb - Antimony	Zn - Zinc
Be - Beryllium	Mo - Molybdenum	Sn - Tin	(pl) = placer deposit
Co - Cobalt	Nb - Niobium	Th - Thorium	(lode) = lode deposit
Cu - Copper	Pb - Lead	U - Uranium	
NOTE: Primary minerals are listed first; secondary minerals are included in parentheses			

Communities
Water
Existing Roads
Potential Deep Water Port
Significant Mineral Occurrence
Lesser Mineral Resources

Corridor Stages

1 Manley to Tanana
2 Elim to N-C Highway
3 Tanana to Ruby
4 Ruby to Galena
5 Galena to Nulato
6 Koyuk to Elim
7 Nulato to Koyuk

Sources:
Communities: DNR
Water: DNR
Existing Roads: ADOT

Coordinate System: NAD 1983 Alaska Albers

STATE OF ALASKA
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REFINED YUKON RIVER CORRIDOR STAGES

DATE: November 15, 2011

Figure 5

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3.1 Stage 1 - Manley Hot Springs to Tanana

The first stage identified for construction is between Manley Hot Springs and Tanana. This 54-mile stage of the project extends from the existing Elliott Highway road system and creates potential for increased barging capacity, extending the barging season, and potentially reducing barge-shipping costs along the Yukon River.

Barges serving Yukon River villages currently travel from the barge hub at Nenana via the Tanana River. The Tanana River between Nenana and its confluence with the Yukon River at the village of Tanana is approximately 165 miles long and contains many turns and narrow channels. Depending on river conditions, it takes between three and five days to travel one way between Nenana and Tanana. River conditions vary based on annual snowfall and daily summer temperature and precipitation. Occasionally, water levels at some locations along the Tanana River have been as low as 4.5 to 5 feet. As a result, shallow draft barges must be used, and during low water periods, even the shallow draft barges frequently cannot be loaded to maximum capacity. Water along the Tanana River is typically higher during the rainy season beginning in mid-July and ending in mid-August. Fully loaded barges cannot be employed reliably outside of these time windows.

The Yukon River has deeper, wider channels that allow for the use of a deep draft barges with significantly increased transport capacity. Tanana is the first city west of Nenana that has barge facilities on the Yukon River that would allow for the use of deep draft barges. A shallow draft barge provides for a gross capacity (including fuel for the barge itself) of 12,000 tons between Nenana and Tanana. By using a deep draft barge downstream of Tanana on the Yukon River the gross capacity can be doubled to 24,000 tons. Carrying twice the payload with little increase in fuel can provide for a significant savings in freight costs to Interior Alaskan villages. Trip frequency could be increased and costs to communities downriver could be decreased by eliminating six to ten days of travel time between Nenana and Tanana. This would also provide opportunities for communities and individuals downstream of Tanana to stockpile more fuel and goods for the winter, at lower prices. Barging out of Tanana can also increase the length of the barging season by three to four weeks; one week at the beginning of the season and two to three weeks at the end.

Additional economic analysis is needed to ascertain if trucking to Tanana and then barging downriver will be more favorable than barging from Nenana. It is assumed that hauling freight to Tanana would be accomplished by a tractor pulling a single trailer, as is typical on the Dalton Highway where double trailers are restricted. One barge company has indicated barging from Tanana would be preferable to barging from Nenana.

An additional benefit of the road connection to Tanana could be improved access to mineralized areas. During the summers of 2011 and 2012, the State of Alaska Department of Natural Resources (DNR) Division of Geological and Geophysical Surveys (DGGS) will be conducting a survey over a 300 square mile area to the west of Tanana, between Tanana and Ruby. The planned study area is shown on Figure 6. The study will:

1. Create a bedrock geologic map,
2. Create a surficial map of potential resources,
3. Map active faults in the area,
4. Map potential construction material sites, and
5. Map geologic hazards such as landslides, fault planes, solifluction (the slow downhill movement of saturated soils over a permanently frozen subsoil), and permafrost.

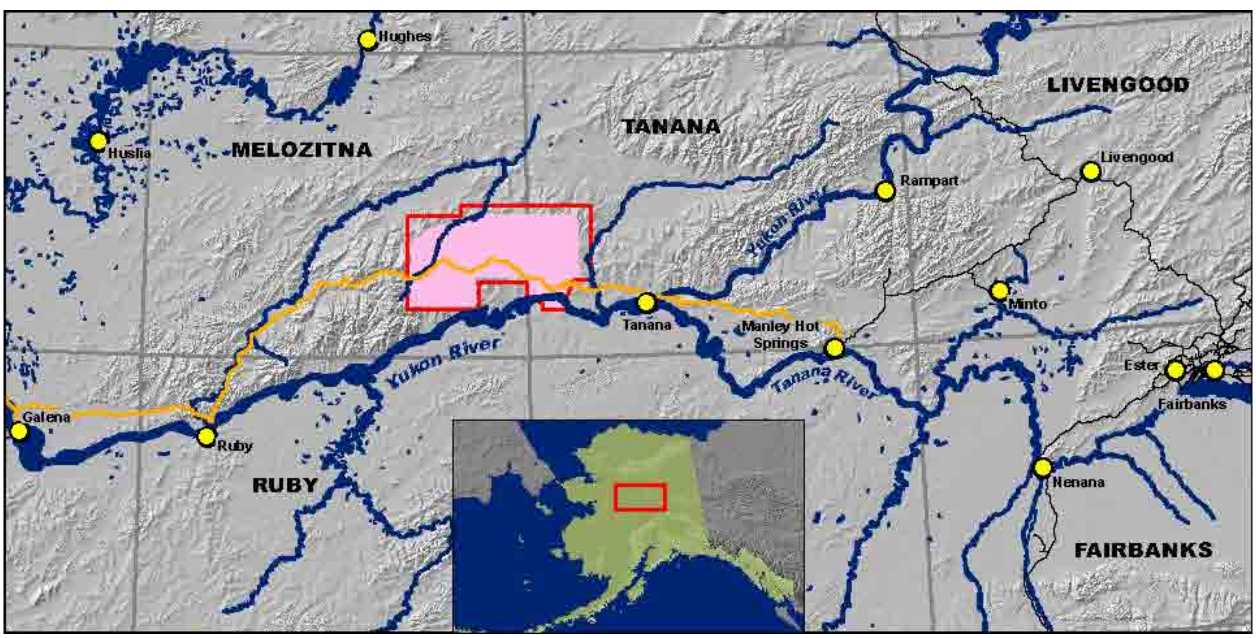


Figure 6: Geological and Geophysical Survey Area
(DNR DGGS 2010)

DNR has indicated that current mapping in the area is at reconnaissance levels and contains large areas with little to no data. While minerals have been found in the area, it has not been thoroughly explored and no lode sources have been located. The planned mapping project will provide a baseline for individual miners and mining companies to begin exploration. Depending on the results of this mapping and subsequent resource exploration, it may become desirable to extend Stage 1 beyond Tanana and into the mineralized areas.

Improved access between Manley Hot Springs and Tanana will improve access into the significant mineral deposits located in the Tofty Ridge mining area. Access will also encourage exploration and development of identified but unquantified mineral resources in the area.

The initial Manley Hot Springs to Tanana segment may not include construction of a bridge over the Yukon River. This major bridge is something that could be completed at a later date as a stand-alone project or within a separate stage. The bridge could be removed from this stage as a means of reducing costs and because alternatives to a bridge, such as a ferry, barge, and/or ice crossings of the Yukon River, could be used in the interim until traffic levels justify a bridge. Examples of where a ferry system has been used in lieu of a bridge can be found in Canada along the Dempster Highway at Fort McPherson and near Dawson City at a crossing of the Yukon River. A logical point to construct the bridge would be during Stage 3 of the corridor when the road is extended from Tanana west toward Ruby.

Local public sentiment in favor of a road from Manley Hot Springs to Tanana is strong as evidenced by the fact that the villages of Manley Hot Springs and Tanana have entered into an agreement for maintenance of a road between their respective communities and have indicated to the State that they have an interest in assuming maintenance costs, if the State of Alaska Department of Transportation and Public Facilities (DOT&PF) will pay for initial construction.

3.2 Stage 2 - Nome-Council Highway to Elim

The second stage of the project identified for construction is between the Nome-Council Highway and Elim. Constructing this 58-mile-long segment of the corridor, with community connector roads, could provide the villages of White Mountain, Golovin, and Elim with direct, year-round access to their hub community of Nome, as well as providing for better inter-village travel. This segment accesses one third of the communities adjacent to the proposed route along the third shortest segment of the project. According to the 2010 United States Census, the total population of the three villages is 676.

Stage 2 would also improve access to the Bluff mine, a known significant mineral occurrence identified in the 2010 Corridor Planning Study. The roadway corridor would provide exploration and development access to other mineral occurrences in this historically resource rich area. Finally, Stage 2 would route near the potential deep-water port facility at Cape Darby that could further reduce the cost of all goods and materials to the Seward Peninsula and provide a port for mining industry and other resource transport.

Stage 2 requires a major bridge over the Fish River.

It should be noted that Stages 2 and 3 may be constructed in reverse order if significant mineral development were discovered that required a road or if other economic development, population shifts, energy projects, or other factors change in the future.

3.3 Stage 3 - Tanana to Ruby

The proposed third stage of the corridor is between the villages of Tanana and Ruby. This stage will allow the 166 residents of Ruby access to Tanana, Manley Hot Springs, and ultimately the existing road system in the Fairbanks area and beyond. At 134 miles, Stage 3 is the second longest segment of the Yukon River Corridor project.

Stage 3 will provide for improved access to two significant mineral occurrences, the Ring Hill and Sheri deposits, as well as many smaller, unquantified mineral discoveries. The corridor passes through the proposed DNR geological and geophysical survey area currently planned for the summers of 2011 and 2012. The road could lead to a significant amount of increased exploration and development activity along the proposed Stage 3 segment, and could result in renewed interest and activity in the mines between Ruby and Poorman. Extending the road to Ruby and improving the existing road between Ruby and Poorman could also spur interest in extending the corridor to the Donlin Creek mine area.

The village of Ruby is currently in the planning stages of constructing a new barge port facility and tank farm to the west of the village. These facilities will allow the village to strategically purchase and store larger quantities of fuel when prices are lower. This same strategy could be employed if fuel is hauled into the village by truck. The proposed barge port can also serve as a seasonal ferry terminal in lieu of an additional bridge over the Yukon River.

At this time, it is assumed that a bridge crossing over the Yukon River to Ruby will not be constructed. Access over the river will be by ferry and/or ice road as discussed in Chapter 5.0, Interim Modal Alternatives. It does include major bridges over the Yukon and Melozitna Rivers.

3.4 Stage 4 - Ruby to Galena

At 48 miles in length, Stage 4 of the Yukon River Corridor is the shortest stage of the project and will provide access between Ruby and Galena and access for the 470 residents of Galena to the national highway system.

Compared to most remote Alaska villages, Galena has significant infrastructure in place as a result of the former Galena Air Force Base. The base facilities have been converted into the Galena Interior Learning Academy, a boarding high school and vocational school attended by students from many of the surrounding villages as well as villages from all over Alaska. A roadway interconnecting these neighboring villages would allow for students and families to visit more regularly and would bolster use of the Academy from surrounding villages. Road access would enable families to maintain the strong social relationships that are an important aspect of the culture in interior Alaskan villages.

The additional infrastructure in place in Galena could also provide additional opportunities such as bulk sale or storage of fuel and other commodities to neighboring villages. Four tank farms in Galena could provide several years worth of storage, allowing for larger purchases of fuel at lower prices. Galena could be a potential point of sale for bulk fuel, or tank space could be "leased" by other Yukon River villages. Should the tank farm currently being planned for Ruby not come to fruition, the existing tanks in Galena would provide the additional capacity to store fuel needed by neighboring villages, and constructing Stage 4 would further enhance the ability to deliver fuel from Galena.

Galena also currently has 33,000 square feet of unused dry storage space that could potentially be used for storage not only by Galena but by neighboring villages as well. Residents in Galena are very concerned about the cost of living, not only in their village but in their neighboring communities, and expressed willingness to do what they can to help the continued sustainability of all neighboring villages.

The road would also provide opportunities for further mineral exploration west of Ruby in this mineral-rich area.

3.5 Stage 5 - Galena to Nulato

The proposed fifth stage of the Yukon River Corridor is between the villages of Nulato and Galena; this stage will also allow for access to the village of Koyukuk. Stage 5 is the second shortest along the length of the Yukon River Corridor at 54 miles.

All of the benefits of access to Galena noted in Stage 4 apply to this stage as well. In addition, local residents noted that evidence of coal deposits have been found in the mountains surrounding Nulato. The roadway would provide additional access to determine if this resource has development potential.

Although not included in this project, Stage 5 of the Yukon River Corridor would also facilitate a future 36-mile road connection to the village of Kaltag, providing hub access for yet another community along the Yukon River. At this time, Kaltag has other connection priorities that will be discussed later in this report.

Stage 5 includes a major bridge over the Koyukuk River.

3.6 Stage 6 - Elim to Koyuk

The proposed sixth stage is between the villages of Elim and Koyuk. This stage of the project will complete the connection of Western Alaskan coastal villages along the route to the regional hub of Nome and provides community accessibility for Koyuk and its neighboring villages. As with Stage 2, this stage of the project could facilitate further resource exploration, including at the Boulder Creek site as well as lesser, unquantified mineral sites. Public sentiment in Elim has been strongly against exploration/development of the Boulder Creek deposit, and one of the reasons for the public desiring to shift the alignment southward (closer to their village) was to lengthen the distance to Boulder Creek, thereby making access more difficult and expensive.

3.7 Stage 7 - Koyuk to Nulato

The proposed final stage of the Yukon River Corridor is between the villages of Koyuk and Nulato. It is the longest stage of the corridor at 142 miles and directly connects the villages of

Koyuk and Nulato without serving any intermediate villages. This stage of the project will complete connection of the western Alaska coastal villages to the existing road system in Fairbanks and beyond. The roadway could improve access for the Christmas Mountain mine deposit to the south of the proposed corridor. The roadway would also improve access for additional exploration of coal beds in the mountains surrounding Nulato. Stage 7 includes a major bridge over the Koyuk River.

4.0 ALTERNATIVE CONSTRUCTION CRITERIA

As previously discussed, financing a project of this magnitude will likely require phasing the project into at least seven stages (see Chapter 3.0 of this report) and also the use of alternative construction criteria that could lower initial costs. The following section discusses alternative criteria and cross-sections that could lower construction costs, yet meet the needs for the relatively low volumes of traffic that are projected to initially use this corridor. Over time, as traffic builds, the cross-section would expand as needed. For the purposes of this evaluation, an average single section depth was assumed for the length of the corridor. In reality, the section depths will vary depending on the underlying material. The appropriate section depths would be determined during later field studies when site-specific geological conditions can be assessed.

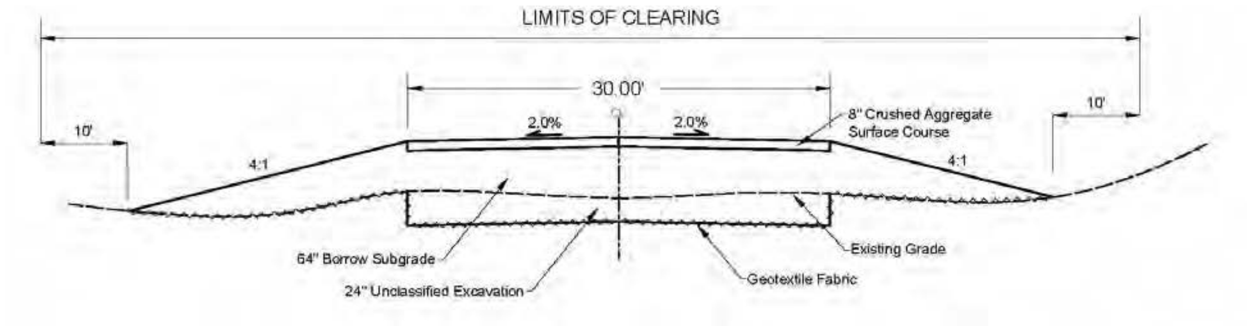
For purposes of comparison, Table 2 shows the shoulder-to-shoulder width of other Alaskan highways.

Table 2: Highway Widths

Highway/Road	Shoulder-to-Shoulder Width (feet)	Average Width (feet)
Yukon River Corridor	16-30	
Nome-Council Road	28-30	
Denali Highway	23	
Taylor Highway	18-33	24.7
Elliott Highway (Fox to Dalton Hwy)	30-34	31.7
Elliott Highway (Dalton Hwy to Manley Hot Springs)	18-29	23.1
Richardson Highway	23-78	37.0
Parks Highway	32-79	42.1
Dalton Highway	24-47	31.5
Glenn Highway	24-50	36.5
Tofty Road	19	
Tok Cutoff	24-54	36.3

4.1 Original Cross-Section

The typical road cross-section in the January 2010 Corridor Planning Report includes a 30-foot-wide road, with 4:1 side slopes. The road is topped with 8 inches of crushed aggregate surface course, over 64 inches of subbase material. The cross-section assumes an average of 24 inches of excavation of existing soils along the roadway alignment. This section is shown in Figure 7.



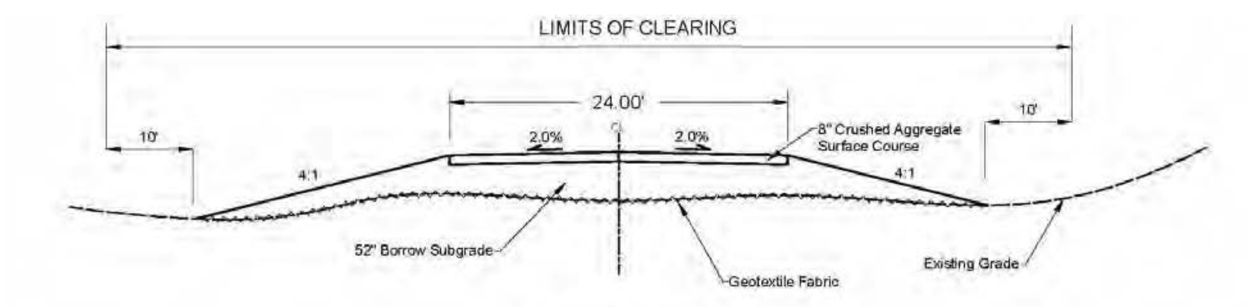
Original Typical Section

Figure 7: Original Typical Section

4.2 Revised Cross-Sections

4.2.1 24-Foot Width, 5-Foot Section

The first typical section reduction measure evaluated was a reduction in the overall structural cross-section of the roadway from 6 feet (64 inches of subbase with 8 inches of surface course) to 5 feet (52 inches of subbase and 8 inches of surface course) and reducing the width from 30 feet to 24 feet. This typical section is shown in Figure 8. This results in a 32% reduction in borrow cost, or $547,000 less per mile. A 5-foot cross-section has been used successfully on roadways such as the Dalton Highway that traverse similar terrain and permafrost-rich areas. This reduction in average cross-section thickness would likely increase the long-term maintenance cost of the road. Maintenance cost increases as a result of reduced section thickness would be partially or wholly offset by reduced maintenance costs to maintain a 6-foot-narrower road.



24' Wide, 5' Section

Figure 8: 24-Foot Width - 5-Foot Section

4.2.2 16-Foot Width, 5-Foot Section

The second typical section reduction measure evaluated was a reduction in the width of the overall roadway from a 30-foot 2-lane driving surface to a single lane 16-foot-wide driving surface with pullouts every quarter of a mile. This typical section is shown in Figure 9. This results in a 65% reduction in borrow, or $1,105,000 less per mile. This reduction in roadway width would impact several design criteria, including sight distance, the need to lengthen horizontal and vertical curves, and the design speeds of the roadway.

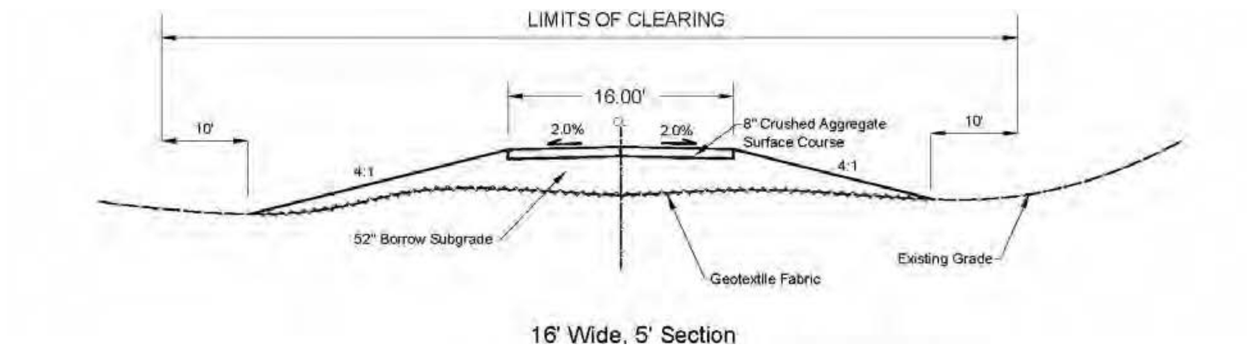


Figure 9: 16-Foot Width - 5-Foot Section

4.2.3 24-Foot-Width Winter Road, 2-Foot Section

The third typical section reduction measure evaluated is to construct a winter road. This option consists of constructing a 2-foot-thick by 24-foot-wide roadway on top of geotextile material. This typical section is shown in Figure 10. This alternative would only be suitable for road segments over stable underlying soils, and it would not allow for summer travel along the roadway due to potential damage to the subgrade by vehicle loads. Once the ground is frozen, vehicles could begin using the winter road after creek crossings have been appropriately filled. This alternative would result in a 58% reduction in borrow, or $997,000 less per mile.

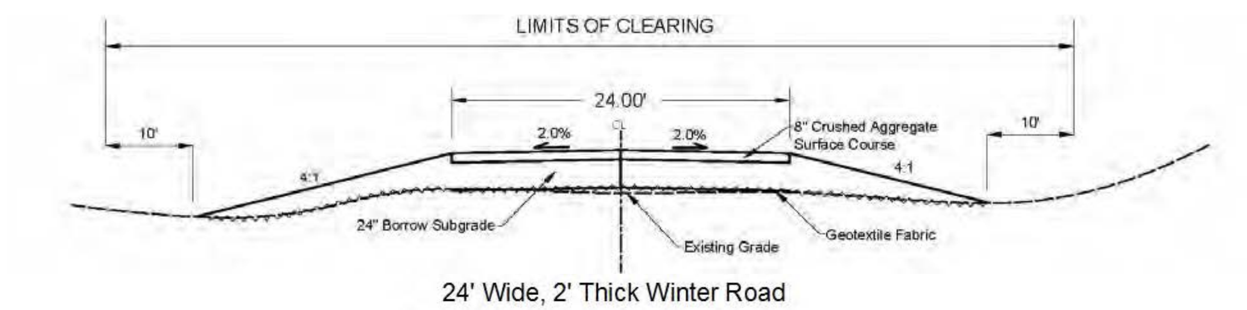


Figure 10: 24-Foot Width Winter Road - 2-Foot Section

A winter road of this type would likely also require extensive pre-season maintenance due to differential settlement, erosion, and other factors. Stockpiled embankment would be needed at strategic locations for seasonal embankment repairs. These additional maintenance expenses have not been included in the estimate at this time. Constructability and feasibility of maintenance are serious concerns, as much of the route lies on ice-rich soils.

Because this alternative provides only seasonal access, higher maintenance costs, and less construction cost saving than the 16-foot road option, it is dropped from further consideration in this report.

4.2.4 2:1 Foreslopes

An average per-mile construction cost savings of approximately 15% could be made by steepening the foreslopes from 4:1 to 2:1. The 2:1 foreslope grade will closely resemble those on the Dalton Highway. Tables 3 and 4 show the cost reduction per mile as a result of modifying the typical sections as described above, as well as the overall project cost and savings of steepening the foreslopes. Additional information on the tables and full segment breakout costs can be found in Appendix A "Construction Cost Estimate." Figures 11 through 13 show the typical sections with the revised 2:1 foreslopes.

Table 3: Typical Section Per-Mile Cost Reductions

Section	Per-Mile Cost ($ millions) Foreslope 4:1	Per-Mile Cost ($ millions) Foreslope 2:1	Savings
Original Typical Section	$3.3	$2.8	15%
24-Foot Width - 5-Foot Section	$2.4	$2.0	17%
16-Foot Width - 5-Foot Section	$1.5	$1.3	13%

Notes: 1. Does not include bridge costs.
2. Does not include reduced excavation over tundra and wetlands.

Table 4: Typical Section Corridor Cost Reductions

Section	Total Construction Cost ($ millions) Foreslope 4:1	Total Construction Cost ($ millions) Foreslope 2:1	Savings from Steepened Foreslope
Original Typical Section	$2,195	$1,747	20%
24-Foot Width - 5-Foot Section	$1,893	$1,279	32%
16-Foot Width - 5-Foot Section	$1,430	$ 890	38%

Notes: 1. Includes reduced width minor bridges and Bailey bridges for minor river and stream crossings.
2. Does not include major bridge costs.
3. Includes reduced excavation over tundra and wetlands.

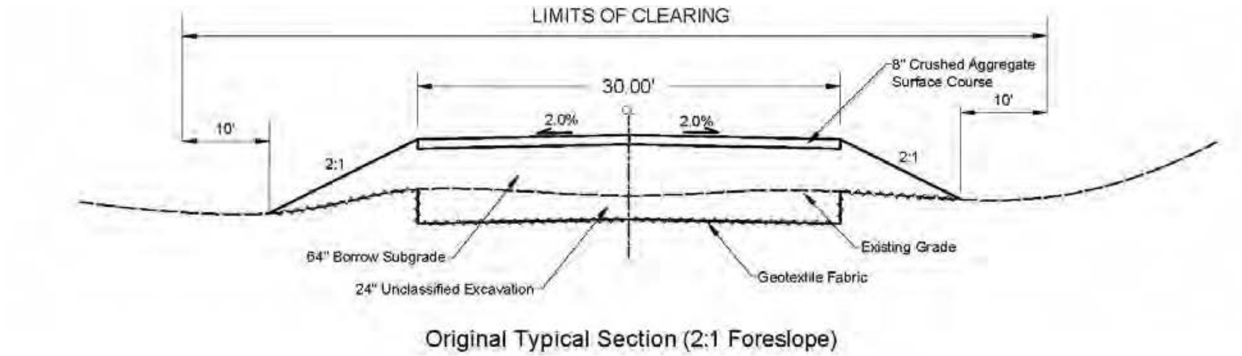


Figure 11: Original Typical Section (2:1 Foreslopes)

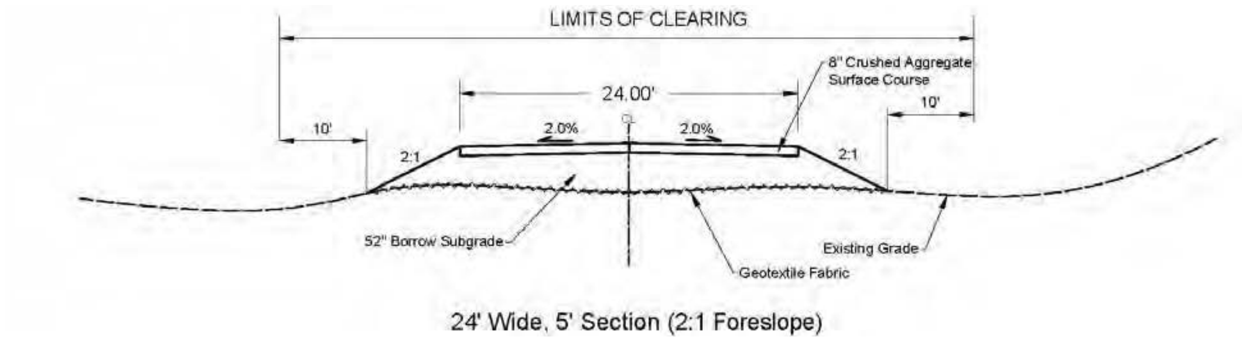


Figure 12: 24-Foot Width - 5-Foot Section (2:1 Foreslopes)

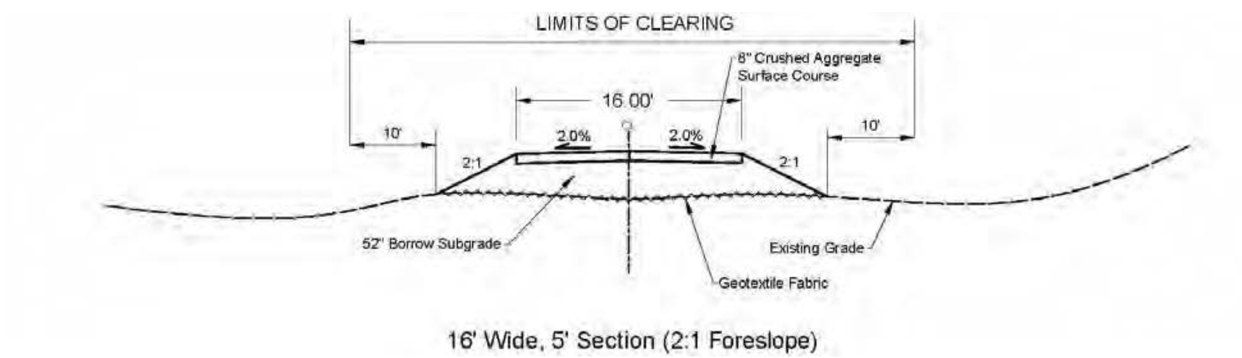


Figure 13: 16-Foot Width - 5-Foot Section (2:1 Foreslopes)

Excavation. Another cost reduction could be accomplished by eliminating the excavation that occurs within the roadway footprint. The original estimate assumed that a 2-foot-thick by 30-foot-wide layer of existing material would be removed from beneath the roadway cross-section because it would be unsuitable for use as a structural part of the roadway cross-section.

Eliminating the excavation in ice-rich soils allows for use of the native materials as an insulating layer over permafrost. Excavation would be primarily in steeper terrain where no permafrost is present. Depending on what the underlying soils are, eliminating the excavation could result in increased maintenance over the lifetime of the road. Elimination of the unsuitable excavation results in the cost reduction shown in Table 5.

Table 5: Typical Section Cost Reductions from Elimination of Unsuitable Excavation (with 2:1 Foreslopes)

Section	Excavation Savings ($/mile)
Original Typical Section	$120,000
24-Foot Width - 5-Foot Section	$100,000
16-Foot Width - 5-Foot Section	$70,000

4.3 Bridges

The estimate for bridges is separated into major river crossings, minor river crossings, and stream crossings. Major river crossings are proposed at the Yukon and Koyukuk Rivers. Appendix B, "Bridge Construction Cost Determination," shows the Yukon River crossing width at 5,000 feet and the Koyukuk River crossing width at 2,000 feet. Minor river crossings are shown to be 150 feet wide on average, and stream crossings are 80 feet on average. Construction costs used $375 per square foot as the average cost, and all bridges were assumed to be 30 feet wide to match the ultimate road width.

As with the typical road cross-section, the most obvious and easiest way to quantify a reduced construction cost estimate for bridges is through reduction in the amount of construction materials required. Reducing the width of the major and minor river crossings to a single lane was ruled out due to the operational challenges including maintenance of signals at either end, cost of signal operation, delays to users, potential safety issues associated with trucks having to back off the bridge in emergency conditions, challenges with constructing a one-lane bridge of this length, and even the negative public reaction to spending millions of construction dollars on a bridge with these built-in limitations.

Reducing the width of the minor river crossings was ruled out for the same reasons as the major river crossing. The practicality of reduced width bridges for major and minor bridges could be reexamined as each segment is being designed.

The stream crossings, with an average span of 80 feet long, offer an opportunity for one-way travel over a narrow bridge that could accomplished with signage but without lights and signals. The construction cost savings for the stream crossings consists of reducing the bridge width from 30 feet to 20 feet. Twenty feet was used as a minimum to allow for oversized loads, and for comfortable passage by standard tractor trailer combinations and emergency vehicles. A 20-foot width would also allow most cars, sport utility vehicles, and pickup trucks to pass on the bridge in emergency situations.

Reducing the width by 10 feet for the 194 major river and stream crossing bridges on the Yukon River Corridor results in a $100 million construction cost savings. Savings could also be realized by constructing Bailey Bridges or a similar type of prefabricated bridge. An 80-foot-long, single-lane Bailey Bridge costs approximately $400,000 and their use could result in an overall savings of $174 million.

4.4 Summary of Cost Reduction Options

Table 6 summarizes the original typical section construction cost for each stage. It also presents cost reductions resulting from modifying the typical sections as shown in Figures 11 through 13. Table 6 also presents additional savings beyond the typical section cost reductions that can be made by modifying the bridge types and widths to a combination of 20-foot-wide bridges over minor rivers and Bailey bridges over minor streams.

The cost to construct the first stage between Manley Hot Springs and Tanana has been further reduced to account for the existing Tofty Road section. The Yukon River Corridor will follow Tofty Road for the first 15 miles. The existing Tofty Road will require minor improvements such as clearing for sight distance, resurfacing with surface course aggregate, construction of pullouts, and minor drainage improvements.

Table 6: Stage and Bridge Costs

Stage	Distance	Single 16-foot Lane w/Pullouts	Two Lane, 24-foot Width	Two Lane, 30-foot Width	Original Section	Major Bridges
1. Manley Hot Springs to Tanana	54	$69	$119	$165	$193	$0[5]
2. Nome-Council Highway to Elim	58	$107	$146	$197	$252	$49
3. Tanana to Ruby	134	$218	$311	$420	$526	$99[5]
4. Ruby to Galena	48	$80	$111	$158	$207	$0
5. Galena to Nulato	54	$86	$122	$171	$217	$34
6. Elim to Koyuk	58	$108	$149	$195	$254	$5
7. Koyuk to Nulato	142	$222	$320	$441	$547	$34
Total	**548**	**$890**	**$1,279**	**$1,747**	**$2,195**	**$221**

Notes:

1. All costs are in millions of dollars.
2. Stage costs include reduced width minor bridges and Bailey bridges for minor river and stream crossings.
3. Stage costs assume no excavation over tundra and ice-rich soils.
4. Stage costs include development of maintenance infrastructure.
5. Stage costs do not include cost of major bridges. The cost of the Yukon River Bridge at Tanana is shown in the third stage. It is assumed this bridge will likely be a project that occurs sometime between completion of Stage 1 and beginning Stage 3.

5.0 INTERIM MODAL ALTERNATIVES

Interim modal alternatives are travel options other than standard roads/bridges that may be used for sections of the proposed Yukon River Corridor. Modal alternatives have the potential to achieve some or all of the project objectives at a reduced initial cost. These modal alternatives could connect the more developed sections of roadway, initiate route utilization, and reduce capital construction costs until a road can be developed. Most interim modal alternatives require increased maintenance and operations expense and less capital expense than road construction, and most are only available on a seasonal basis.

Interim modal alternatives evaluated include:

- **Ice Road - Over Land**: A compacted snow roadway topped with sprayed water to create an ice surface for driving.
- **Snow Road**: A compacted snow roadway. Similar to the ice road over land, but without additional ice on top of the snow.
- **Ice Road - Over Water**: A groomed and strengthened driving surface over an existing frozen waterway, such as a river or lake. An ice road over water melts away in the spring and has relatively little impact on surrounding land.
- **Ice Bridge**: A crossing over a frozen waterway, typically strengthened by using flooding or spraying of water to make the ice thicker. It tends to be wider than an ice road.
- **Ferry Service - River Crossing**: A boat providing river crossing for vehicles and passengers.
- **Ferry Service - Inter-Community**: A boat with passenger accommodations that would travel up and down a river route, providing point-to-point service. The ferry may have vehicle and/or cargo accommodations.
- **Barge Service - Enhanced**: These large boats are designed to carry cargo, and are pushed by tugs. Currently used along the Yukon River Corridor, enhancements might encourage different or more frequent routing than already used along the Yukon River.

Each of these options has different features that warrant review:

- Construction methods
- Where they are currently used successfully,
- Seasonal concerns, and
- Limitations.

Hovercraft are not considered practical, except possibly as an alternative to a barge or ferry at a river crossing. A successful program in the Bethel area provides passenger and cargo service along a length of the Kuskokwim River, partially supported with bypass mail subsidies. Villages along the Yukon River Corridor are fewer in number and are spread out over a greater distance, making hovercraft service along the length of the Yukon River impractical.

5.1 Ice Roads Over Land

How do you build an ice road over land?

An ice road over land is generally built by compacting snow, then flooding the area or spraying water on the surface to create an ice layer. Pre-season reconnaissance would include ROW acquisition and clearing, ground cover analysis, and accounting for streams and drainage.

Once ROW is established and cleared, gravel roadway sections would be constructed along the route in select areas that are thaw stable and located in areas with good natural drainage. The objective is to create a surface that can be groomed and developed easier in the winter season, reducing the time and costs of annual ice road development.

Where are ice roads over land successfully used now?

- Alaska's North Slope producers build ice roads for heavy equipment, fuel and supply movements during the winter season.
- Nuna Logistics' 235 miles of ice roads include portages over land between rivers and lakes. This is a private road used for mine access from Yellowknife to Diavik Diamond Mine in Canada's Northwest Territories.

What are the seasonal limitations with this mode?

Like ice roads over rivers, ice roads over land would generally be available between mid-December and April.

What are the other limitations of this mode?

Ice roads over land are generally built over flat terrain in areas where water is plentiful. Ice roads are impractical in the hilly terrain that is found over much of the WAAPS corridor. On Alaska's North Slope, the tundra provides numerous ponds to draft from. In Northwest Territories, the ice road builders utilize tundra ponds and nearby rivers. Sections of ice road "over land" will often be over lakes and ponds, which will need to be frozen to adequate depth to use. Drainages that serve fish may need to be broken up to remove blockages that inhibit fish passage and for area drainage purposes.

Before traveling across the tundra, minimum standards for frozen ground and snow must be met. Historically, this was called the "6 and 12 rule"; 6 inches of snow and 12 inches of frozen ground. The DNR manages the ice road program, and has developed variable standards based on measurable factors that would impact ground cover. Sturdier vegetation can withstand a shallower freeze and/or less snow, where more fragile vegetation would require a deeper freeze and/or more snow cover.

5.2 Snow Roads

How do you build a snow road?

Construction of a snow road entails the compacting of existing snow and filling ditches to provide a smooth driving surface. Ice bridges may be used over waterways. Pre-packing existing snow with wide-tire vehicles can speed up freezing of the underlying ground and make the snow road available for use earlier in the winter. In lieu of snow, ice chips from a frozen lake can be used to create the road.

Like ice roads across land, snow roads require ROW acquisition, clearing, and ground preparation.

Where are snow roads successfully used now?

- Bettles maintains a 29.2-mile snow road to the Dalton Highway for delivery of fuel and other bulk items, and it is generally open from mid-January through March.
- Snow roads are also successfully used between Eureka and Rampart and connect the communities of Tetlin, Lake Minchumina, and Healy Lake to Alaska's road system.

What are the seasonal concerns with this mode?

Like ice roads, snow roads would generally be available between mid-December and April. Winter conditions must be conducive to building the road. For the Bettles snow road, there must be 2 feet of ground frost before beginning construction.

What are the other limitations of this mode?

A snow road might not be as well developed for very heavy loads as an ice road. Snow-fill in drainages that serve fish would need to be broken up to remove any blockages or constrictions that inhibit fish passage and for area drainage purposes.

5.3 Ice Roads Over Water

How do you build an ice road over water?

Ice roads over water utilize the frozen waterway as a driving surface. Once a minimum ice thickness is met, work can begin. In Canada's Northwest Territories, workers on foot need a minimum of 4 inches of ice, snowmobiles must have 6 inches, and small vehicles must have 8 inches; use of light track vehicles is recommended.

Ice can be thickened by auguring a hole and allowing flooding, or by using spray nozzles to distribute the ice evenly across surfaces. To reduce costs, Canada's Northwest Territories typically uses this method only at the ice bridges.

Ice roads over rivers avoid a number of challenges that a similar road over ground would endure. Generally:

- Ice roads over waterways do not require clearance of the ROW.
- Ice roads over waterways can be as wide as the waterway allows. Drifting snow will not impact drive lanes as significantly as on a narrower land ice road.
- Sufficient space is available for cleared snow, and plowing and snow deposits do not impact vegetation.
- Permitting is easier. Ice roads on rivers do not impact fish passage.

Where are ice roads used successfully?

- Canada's Northwest Territories, in the Beaufort Delta along the Mackenzie and Peel Rivers. The system extends about 170 miles, is 100 feet wide, and provides point to point access for communities along the route.
- Alaska's Kuskokwim River supports an ice road in the Bethel area, providing intra-village access.
- Nuna Logistics constructs about 235 miles of ice roads on rivers from Yellowknife to Diavik Diamond Mine in Canada's Northwest Territories. This is a private road used for mine access. It is generally over lakes, with snow roads in between.
- An ice road serves Noorvik, Kiana, and surrounding communities to Kotzebue. This ice road is only used late in the season to allow for one major shopping trip into Kotzebue by residents of the surrounding villages. By constructing and using the road later into the winter or even approaching spring, residents realize a savings in not having to maintain the ice road throughout the length of the winter season.
- Big Lake and Flat Lake outside of Wasilla have an extensive ice road system providing access to many recreational cabins and homes that are land-locked during summer months.

What are the seasonal concerns with this mode?

Ice roads over water can generally be available from mid-December through March. A late fall or early spring can reduce the functionality of an ice road, and warmer-than-usual winter temperatures can result in load limits. As with any road, grooming and snow removal operations are required; however, these factors can be reduced with construction techniques, such as berms or wider road width, to accommodate drifting snow. Stream and river crossings can develop over flow conditions later in winter as temperatures rise.

What are the other limitations of this mode?

Vehicle speed has a significant impact on ice roads over water. Moving vehicles deflect the ice, and create a wave in the water under the ice. If the water is deep, the wave can generally travel faster than the vehicle, reducing stress on ice. If the water is shallow, the wave will have more impact on the ice, and cause more stress. It is extremely important to limit speeds over shallow water. When the ice road exits the waterway and crosses the riverbank, it should cross at a 45-degree angle to minimize stress on the ice.

An additional limitation of this modal alternative is that rivers in Alaska do not freeze the same way every year. Some years the ice may freeze in such a manner that it is nearly level and ready for vehicles immediately. Other years, a river's surface appear to be a boulder field with many large chunks of ice protruding from the surface, making travel nearly impossible.

5.4 Ice Bridges

How do you build an ice bridge?

The river's natural ice is groomed, and then additional ice depth can be created by flooding or spraying water over the area. Bridges are generally built thicker and wider than ice roads to account for the impacts of shallow water along shore. Shore approaches should be built at 45-degree angles where possible to minimize the impacts of shallow water on the ice bridge.

Though they do not have published standards, Bettles assumes two feet of ice depth is adequate for fuel trucks and graders. Five feet would be required for larger equipment, such as a D-11 bulldozer.

Where are ice bridges successfully used now?

Canada's Northwest Territories uses ice bridges for seasonal river crossings at Fort McPherson and at the Arctic Red River. These bridges are about 130 feet wide, and crossings are served by ferries during the summer. The Bettles snow road also uses ice bridges at stream and river crossings.

What are the seasonal concerns with this mode?

Like ice roads over rivers, ice bridges would generally be available between mid-December and March. Overflow conditions can occur later in winter as temperatures rise. When used in combination with a ferry, there is still a shoulder season in spring and late fall when the crossing would be unavailable. Occasionally winter weather may be too warm to build an ice bridge.

What are the other limitations of this mode?

See "ICE ROADS - What are the other limitations of this mode?" for a discussion on the impacts of building ice accommodations over shallow water.

5.5 Ferry Service - River Crossing

How do you build a river-crossing ferry system?

Ferries are not generally an "off-the-shelf" item. They tend to be designed and constructed for the customer's specific needs, and capital outlay can vary greatly.

In addition to the craft, ferries require shore-side development to facilitate loading of passengers and cargo. Ferries require significant personnel to operate the vessel and handle administrative and maintenance functions.

Where are ferries used for river crossings?

Canada's Northwest Territories operates ferry crossings along the Dempster Highway at:

- Fort McPherson, using a cable ferry, and
- The confluence of the Mackenzie River and Arctic Red River (Mile 378) using a powered ferry.

The ferries run from 9 a.m. to 12:30 a.m. from June to the middle of October and are replaced by ice bridges in the winter.

The Yukon Territory's Highways and Public Works Department currently manages George Black Ferry, which crosses the Yukon River near the community of Dawson City. It runs 24 hours a day between mid-May and mid-September, except during scheduled maintenance early Wednesday mornings. During the shoulder season between mid-September and mid-October, the ferry usually runs about 12 hours per day. The average crossing time is 6 to 7 minutes.

What are the seasonal concerns?

The river will need to be almost ice-free in order for the ferry to run. When used in combination with an ice bridge, there is still a shoulder season in spring and late fall where the crossing will be unavailable.

What are other limitations?

Besides the seasonal limitations mentioned above, a river-crossing ferry would only be able to carry a limited number of vehicles and passengers at a time and would only operate certain hours of the day if traffic volumes are low.

5.6 Ferry Service - Inter-Community

How do you build an inter-community ferry system?

See "How do you build a river-crossing ferry system" discussion above.

Where are ferries used for inter-community transportation?

Alaska's inter-community ferries consist of the Marine Highway System that operates in ocean waters, a very different operation than would occur along the Yukon River.

What are the seasonal concerns?

Ferry operation requires ice-free waterways, and the season would generally be limited to mid- to late May through September.

What are other limitations?

Ferries are limited by how much they can carry, and how fast they can carry it. Ferry speeds vary greatly depending on current speed, size of ferry, and engine power. Ferry schedules limit when passengers and cargo can travel. Shallower rivers (such as areas of the Tanana) would require ferries with less draft, generally meaning they can carry less weight on the same square footage of deck.

5.7 Enhanced Barge Service

How do you establish a barge system?

To a large degree, Alaska barge operators have a history of adapting to market forces and limited on-shore infrastructure. Existing equipment operates with limited shore-side improvements. Ports or docks are not required, but barge landings are necessary. In most cases these landings exist and may only require slight improvements to accommodate deeper draft barges.

Where are barges used successfully?

Barges serve the Yukon River, and shallow draft barges are able to serve the Tanana River upriver to Nenana. For the Interior Region, Nenana is considered a regional barge hub, with current Parks Highway road service and daily rail freight service. The villages of Galena, Tanana, and Koyukuk serve as sub-regional hubs for the barge system. Nome is a regional hub for the Northwest Arctic Region and is served by ocean-going barges.

What are the seasonal concerns with this mode?

Seasonal concerns would be the same as those for ferry service.

What are the other limitations of this mode?

Barges are limited by how much they can carry. The larger barges (with more capacity) have a deeper draft, and are not able to navigate shallower parts of the Tanana River, but would be able to operate out of Tanana on the Yukon River. A shallow draft barge is limited to 12,000 tons under optimal river conditions, compared to 24,000 tons by a deep draft barge.

6.0 ADDITIONAL ROUTES

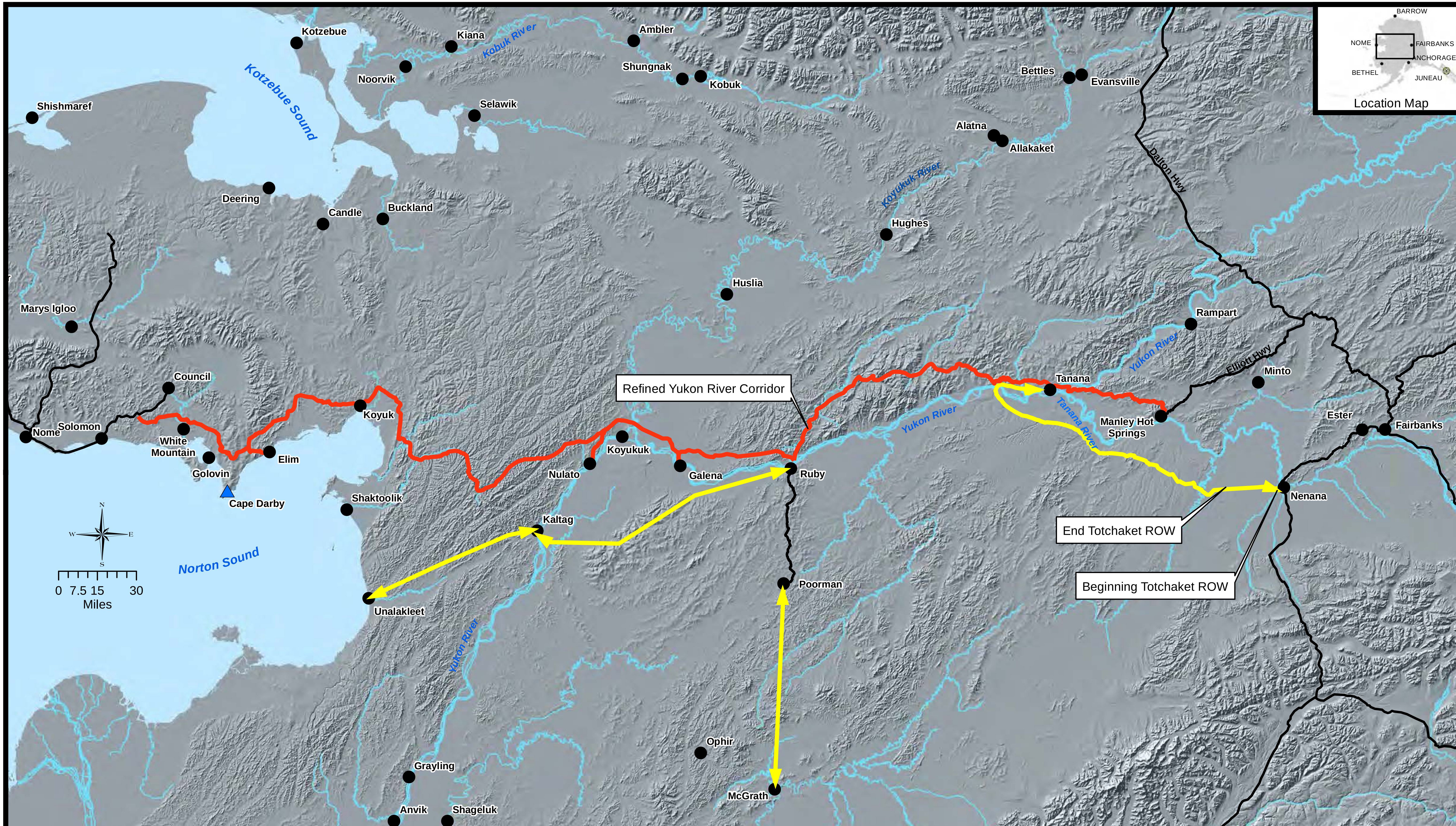
During the course of the public involvement process, strong sentiment was expressed at several villages for additional connections or roads to consider in addition to the main Yukon River Corridor. Figure 14 shows the locations of the additional connections that received strong support.

6.1 Nenana to Tanana (Totchaket Road)

The City of Nenana has acquired ROW for the approximately 23-mile Totchaket Road, extending to the west from Nenana. The city also has a shovel-ready design package for the roadway, including permits and drawings. To date three minor river crossings have been constructed, but no roadways have yet been built. The City of Nenana has submitted a legislative funding request to construct the primary crossing over the Nenana River. The legislature has not yet fully funded construction of the roadway, and the Nenana River crossing remains unfunded. The bridge is the most significant cost hurdle.

Residents of Nenana have requested that a link between Nenana and Tanana be evaluated as a potential first stage of the project in place of the Manley Hot Springs to TananaCorridor. This would allow the State to utilize the existing 23 miles of ROW and would also provide access to agricultural land outside of Nenana. This route would also further support Doyon Limited's exploration for gas reserves in the area.

The project team examined available aerial photography and topographic mapping to evaluate the Nenana to Tanana connection. There are a significant amount of wetlands which present environmental, design, permitting, construction, and maintenance challenges. The length of the route between Nenana and Tanana is approximately 150 miles and would require seven significant river crossings. The estimated construction cost of the route ranges from $395 to $743 million, including all road, bridge, and maintenance infrastructure costs. The added length, cost, and complexity of beginning the Yukon River Corridor at Nenana instead of Manley Hot Springs is not consistent with the objectives of this project. As noted earlier in this report, the Manley Hot Springs to Tanana route would cost from $69 million to $193 million.



Communities
Existing Roads
River
Potential Deep Water Port
Yukon River Corridor with Refinements
Other Suggested Corridors

Sources:
Communities: DNR
Water: DNR
Existing Roads: ADOT

Coordinate System: NAD 1983 Alaska Albers

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
NORTHERN REGION

WESTERN ALASKA ACCESS PLANNING STUDY
STAGING / ALTERNATIVE ANALYSIS

REFINED YUKON RIVER CORRIDOR
AND OTHER CORRIDORS SUGGESTED BY THE PUBLIC

DATE: August 18, 2011 | **Figure 14**

P:\Projects\D60060\GIS\ENG\R2B with Other Identified Routes.mxd Aug 18, 2011 11:39:16 AM User: clelker

A more cost effective future option for a road link from Nanana would be to construct a new segment of roadway between Nenana and Manley Hot Springs. This route would utilize the existing 23 miles of ROW already acquired and would have a total length of approximately 69 miles. The route would require three significant river crossings over the Nenana, Kantishna, and Tanana Rivers. The cost of constructing this route is $344 million, including all road, bridge, and maintenance infrastructure costs.

This option warrants consideration as a future link once access from Manley to Tanana has been established. It could provide savings for trucking goods into villages along the Yukon River Corridor. A direct haul to Tanana from Fairbanks would be 15 miles shorter, one way, if driven through Nenana instead of Manley Hot Springs. If goods were being shipped to Tanana from Anchorage, access via a route from Nenana would save approximately 125 miles, one way versus continuing north through Fairbanks and Manley Hot Springs.

6.2 Ruby to McGrath

Many residents in both Ruby and Galena expressed a desire to see a future roadway connection between Ruby and McGrath. McGrath is a village on the Kuskokwim River that is experiencing increased difficulties in obtaining sufficient fuel supplies to last through the winter because decreasing water levels on the Kuskokwim River limit barge access. The village of McGrath can typically only get one shallow draft barge per summer into the town, and if the trip is not properly scheduled to coincide with periods of time when the water levels are higher, it is sometimes infeasible to get even a single barge into the village for fuel delivery.

A mining road exists between Ruby and Poorman to the south that the State maintains via a contract with the village of Ruby. With the decline in mining activity in the area, the road is not maintained at the same level it has been in the past. The existing road could be repaired and a road extended from its terminus to McGrath. This could be done as either a permanent road, an overland ice road, or a snow road. Providing access into McGrath would ensure that fuel does not have to be flown in if a barge is unable to reach the village during the summer, and would result in a substantial decrease in fuel costs. It would also provide residents of McGrath and its neighboring villages with access to the Alaska Highway System via the Yukon River Corridor. Additionally, many mineralized areas along the road to Poorman could see increased activity and exploration with improvements and extension of the road. This link would also bring into consideration the construction of a spur road to the Donlin Creek Mine.

6.3 Kaltag to Unalakleet

Residents in both Kaltag and Unalakleet expressed strong interest in constructing a roadway corridor between the two communities. A roadway between these villages would allow for freight and fuel to be barged to Unalakleet and then trucked to Kaltag, and would provide an opportunity for barging fuel and goods upstream from Kaltag. The project would ultimately reduce the cost of fuel and goods to interior villages and provide a link for residents of Unalakleet and other coastal villages to the Alaska Highway System via the Yukon River Corridor.

A Kaltag to Unalakleet road is currently the top priority in the Long-Range Transportation Plans for both Unalakleet and Kaltag, and both villages have an agreement in place to work together toward the construction of this corridor. It should be noted that the route follows a federally-designated Wild and Scenic River, which could potentially create many constraints or require relocation of the proposed route altogether.

6.4 Yukon-Koyukuk Bypass

Some residents in Koyukuk expressed concern over the proposed Yukon River Corridor cutting through their traditional hunting and trapping land, and asked if it would be feasible to relocate the roadway corridor to the south side of the Yukon beginning at Ruby, and connect back to the north side at Koyukuk. Wildlife refuges on the south side of the Yukon make connecting the bypass to Koyukuk problematic. A more likely location to reconnect the corridor back to the north side of the Yukon River is Kaltag. This route would provide access to Round Top, Honker, Waterpump Creek, and Illinois Creek mines but it would also provide significantly less community access to the corridor. While this route does protect subsistence lands, a vital concern of all communities along the Yukon RiverCorridor, it does not provide road access for the villages of Galena, Koyukuk, and Nulato. Furthermore, the wetlands on the south side of the Yukon River will make obtaining environmental permits very difficult, and the typical section will be difficult and costly to build and maintain. The route would also require two new bridges over the Yukon instead of a single bridge over the Koyukuk. These additional access, design, environmental, maintenance, and cost issues do not make this a viable alternative.

7.0 RECOMMENDATIONS/NEXT STEPS

7.1 Recommendations

Staging. Assuming funding limitations require staging the Yukon River Corridor, this report recommends the following project stages:

Table 7: Yukon River Corridor Staging

Stage	Termini	Distance (miles)
1	Manley Hot Springs to Tanana	54
2	Nome-Council Highway to Elim	58
3	Tanana to Ruby	134
4	Ruby to Galena	48
5	Galena to Nulato	54
6	Elim to Koyuk	58
7	Koyuk to Nulato	142
	Total	**548**

Stage 1, from Manley Hot Springs to Tanana, is the highest priority stage, for several reasons. It is one of the shorter, less expensive stages, making it more affordable during the initial years of use when traffic volumes will be lower. It takes advantage of existing Right of Way and improvements along Tofty Road, further reducing costs. It connects to the existing Elliott Highway near Manley Hot Springs and is about 150 miles from Fairbanks, a larger population center.

Not only does Stage 1 reduce living costs for residents of Tanana, it also creates opportunities to truck cargo and fuel to Tanana, where materials could be barged downriver to Yukon River villages avoiding the shallow Tanana River waters downriver from Nenana. This would lower costs all along the Yukon River by enabling barge operators to use higher-capacity barges, and would extend the barge season by up to one month. Road access to Tanana will also access mineralized areas, increasing the potential for mineral exploration and development and generating associated employment.

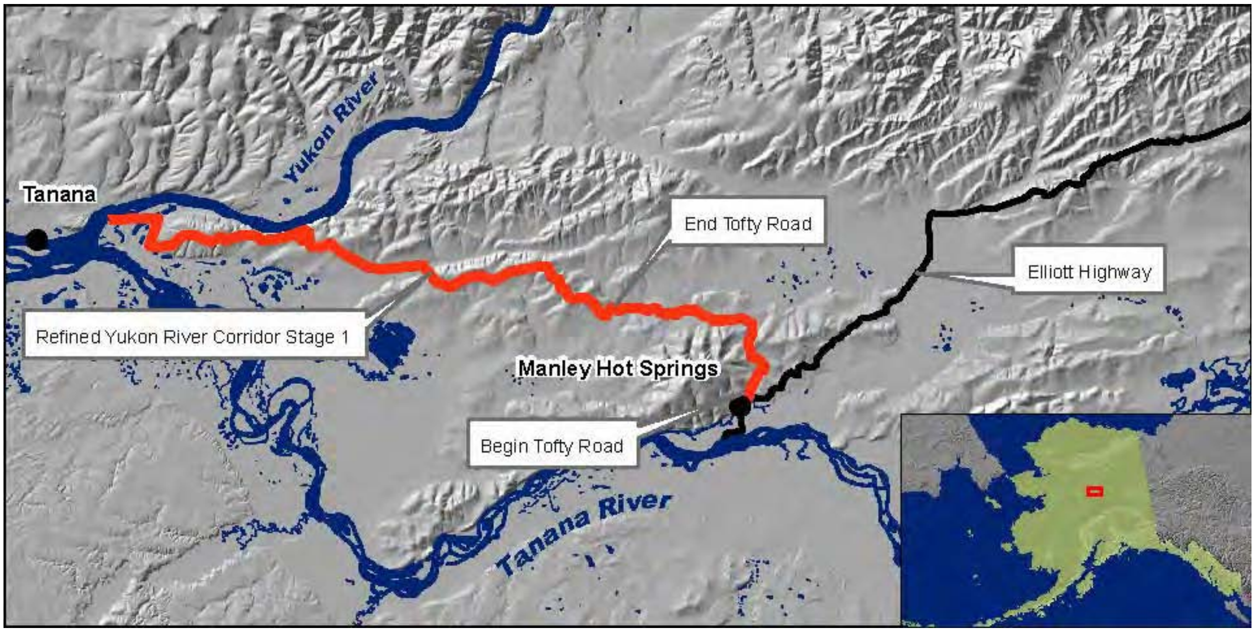


Figure 15: Refined Yukon River Corridor Stage 1 - Manley Hot Springs to Tanana

Interim Modal Alternatives. Various interim modal alternatives were presented in this report. The most applicable alternatives recommended for Stage 1 are an ice bridge crossing of the Yukon River during winter and a ferry/barge crossing in the remainder of the year.

Recommended Stage 1 Cost Reductions. Construction of Stage 1, from Manley Hot Springs to Tanana, with a 30-foot-wide and 6-foot-deep structural section with 4:1 foreslopes is estimated to cost $193 million. This cost is likely to be unaffordable, and the road can be scaled back using more affordable road design criteria, particularly since the road will initially have lower volumes of traffic.

Table 8 shows two recommended options for Stage 1 cost reductions, two-lane and single-lane options. Final road design standards and costs should be determined in a later phase after better engineering data and public input is obtained.

Table 8: Stage 1 Construction Cost Reductions for Dual- and Single-Lane Roads

	Original Typical Section ($ millions)	24-foot Two-Lane Road ($ millions)	16-foot Single-Lane Road ($ millions)
1. Manley Hot Springs to Tanana	$193	$119	$69

Construction of the Stage 1 two-lane option from Manley Hot Springs to Tanana, without a bridge across the Yukon River, is estimated to cost $119 million and includes:

- 24-foot-wide two-lane road
- 5-foot-deep structural section
- 2:1 foreslopes
- No excavation of organics over tundra or wetlands
- Reduced width (20 feet) bridges at stream crossings

Construction of the Stage 1 single-lane option from Manley Hot Springs to Tanana, without a bridge across the Yukon River, is estimated to cost $69 million and includes:

- 16-foot single-lane road with pullouts every 0.25 mile
- 5-foot-deep structural section
- 2:1 foreslopes
- No excavation of organics over tundra and wetlands
- Reduced width (20 feet) bridges at stream crossings

Cost Reductions - All Stages. Table 9 shows the affect of the above cost reductions for all stages of the project, for both the single- and two-lane options.

Table 9: Dual- and Single-Lane Construction Cost Summary Comparison

Stage	Original Section ($million)	Two Lane, 30-foot Width ($million)	Two Lane, 24-foot Width ($million)	Single 16-foot Lane w/Pullouts ($million)
1. Manley Hot Springs to Tanana	$193	$165	$119	$69
2. Nome-Council Highway to Elim	$252	$197	$146	$107
3. Tanana to Ruby	$526	$420	$311	$218
4. Ruby to Galena	$207	$158	$111	$80
5. Galena to Nulato	$217	$171	$122	$86
6. Elim to Kyouk	$254	$195	$149	$108
7. Koyuk to Nulato	$547	$441	$320	$222
Total	**$2,195**	**$1,747**	**$1,279**	**$890**

Notes: 1. Includes reduced width minor bridges and Bailey bridges for minor river and stream crossings.
2. Does not include major bridge costs.
3. Includes reduced excavation over tundra and wetlands.

7.2 Next Steps

Initial planning of access between Fairbanks to Nome relied on existing crude topographic mapping and no field verification of engineering and environmental conditions. It also focused on 3 alternative routes each over 500 miles, necessitating a broad review using readily available data that was often imprecise. Now that a final corridor has been selected, next steps should focus on a more precise review of the initial stage between Manley Hot Springs and Tanana, with better mapping, in-field investigations, and more stakeholder involvement, particularly by those most directly affected by the first stage between Manley Hot Springs and Tanana.

Depending on funding constraints, the next steps should include:

1. **Route Mapping.** The existing topographic mapping is limited to United States Geological Survey mapping, which is suitable for high-level planning, but not for final corridor definition. This task would include aerial photography and topographic mapping of the corridor area so that more detailed engineering, environmental studies, and route refinement can occur.

2. **Field Studies.** Additional engineering and environmental fieldwork would help to further refine the route and site geology and material sources and environmentally sensitive areas that should be avoided or which should be addressed in future phases.

3. **Engineering and Environmental Analysis.** This task would use the mapping and fieldwork, supported by office research, to further define the corridor location, preferable river/stream crossing locations, environmental issues, maintenance facilities, and costs.

4. **ROW.** This task would define landownership of the recommended alignment and the costs, process, and timeframe required to acquire the property.

5. **Public Involvement.** The public and key stakeholder groups, in particular Manley Hot Springs, Tanana, Native entities, and mining interests, should be involved as the route is refined and environmental issues are identified.

APPENDIX A

Construction Cost Estimate

1123.60060.01 WESTERN ALASKA ACCESS PLANNING STUDY
PLANNING LEVEL CONSTRUCTION COST ESTIMATE - FULL BUILD OUT WITH 4:1 FORESLOPES
ATTACHMENT A1 - QUANTITIES & BASE COSTS FOR PAY ITEMS

Typical Section Assumptions for Cost Estimates	Notes
30-foot roadway surface	Minimum 20-foot surface per AASHTO; 30-foot roadway width matches current Northern Region planning assumptions for new roads and existing Northern Region roads with the same functional classification.
6-foot total section	Section thickness will vary along length of road, depending upon soils. Two additional feet of overburden material included to account for approximately 2' material consolidation.
8" crushed aggregate surface course over 64" embankment fill	8" surface will not vary; embankment fill thickness will vary to meet total section thickness needs along road. Where borrow is readily available, it shall be used. However, it is anticipated that borrow may not be readily available along the full length of the route, in which case subbase may be offered as an alternative at a higher cost.
Geogrid under entire section (toe to toe)	Geogrid offers heartier strength and stiffness than *Geotextile, Stabilization* , however its use can be avoided if existing soils are expected to be only moderately poor, in which case a stabilization geotextile would more likely be employed at a lower cost.
2-foot excavation depth[1]	Conservative assumption for cost estimating purposes - thaw stability will vary along the length of road. There will be areas (eg. tundra and wetlands) where there will be no excavation and the organic mat left in place.
4:1 side slopes	Geotechnical recommended minimum due to anticipated permafrost.

Estimated Per-Mile Costs for Typical Section Pay Items					
Pay Item No.	**Item Description**	**Unit**	**Quantity per Mile**	**Final Unit Costs used in Estimates[2]**	**Cost per Mile**
201(3A)	Clearing and Grubbing	Acre	10	$10,000	$100,000
203(3)	Unclassified Excavation	CY	11,733	$20	$234,670
301(3)	Aggregate Surface Course	CY	3,911	$40	$156,440
203(6)	Borrow	CY	68,053	$25	$1,701,300
634(1)	Geogrid	SY	38,720	$8	$309,760
640(1)	Mobilization & Demobilization	LS	1	10% of Construction Cost (incl. contingency)	$300,260
-	Contingency	-	-	20% of Construction Cost	$500,434
				TOTAL BASE COST PER MILE	**$3,302,864**
				FOR WAAPS COST ESTIMATES USE:	**$3.3 million per mile**

Notes

[1]Per mile planning costs above do not account for reduced costs where no excavation is necessary over tundra and wetlands. Reduced excavation costs are accounted for in the phase costs presented in Attachments A9 through A10.

[2]Unit Costs used in final cost estimates are based on DOWL HKM design estimates, historic bid prices, and discussion with Northern Region design/engineering staff.

1123.60060.01 WESTERN ALASKA ACCESS PLANNING STUDY
PLANNING LEVEL CONSTRUCTION COST ESTIMATE - FULL BUILD OUT WITH 2:1 FORESLOPES
ATTACHMENT A2 - QUANTITIES & BASE COSTS FOR PAY ITEMS

Typical Section Assumptions for Cost Estimates	Notes
30-foot roadway surface	Minimum 20-foot surface per AASHTO; 30-foot roadway width matches current Northern Region planning assumptions for new roads and existing Northern Region roads with the same functional classification.
6-foot total section	Section thickness will vary along length of road, depending upon soils. Two additional feet of overburden material included to account for approximately 2' material consolidation.
8" crushed aggregate surface course over 64" embankment fill	8" surface will not vary; embankment fill thickness will vary to meet total section thickness needs along road. Where Borrow is readily available, it shall be used. However, it is anticipated that borrow may not be readily available along the full length of the route, in which case Subbase may be offered as an alternative at a higher cost.
Geogrid under entire section (toe to toe)	Geogrid offers heartier strength and stiffness than *Geotextile, Stabilization* , however its use can be avoided if existing soils are expected to be only moderately poor, in which case a stabilization geotextile would more likely be employed at a lower cost.
2-foot excavation depth[1]	Conservative assumption for cost estimating purposes - thaw stability will vary along the length of road. There will be areas (eg. tundra and wetlands) where there will be no excavation and the organic mat left in place.
2:1 side slopes	Geotechnical recommended minimum due to anticipated permafrost.

Estimated Per-Mile Costs for Typical Section Pay Items					
Pay Item No.	**Item Description**	**Unit**	**Quantity per Mile**	**Final Unit Costs used in Estimates[1]**	**Cost per Mile**
201(3A)	Clearing and Grubbing	Acre	8	$10,000	$80,000
203(3)	Unclassified Excavation	CY	11,733	$20	$234,670
301(3)	Aggregate Surface Course	CY	3,911	$40	$156,440
203(6)	Borrow	CY	55,538	$25	$1,388,400
634(1)	Geogrid	SY	29,333	$8	$234,667
640(1)	Mobilization & Demobilization	LS	1	10% of Construction Cost (incl. contingency)	$251,301
-	Contingency	-	-	20% of Construction Cost	$418,835
				TOTAL BASE COST PER MILE	**$2,764,313**
				FOR WAAPS COST ESTIMATES USE:	**$2.8 million per mile**

Notes

[1]Per mile planning costs above do not account for reduced costs where no excavation is necessary over tundra and wetlands. Reduced excavation costs are accounted for in the phase costs presented in Attachments A9 through A10.

[2]Unit Costs used in final cost estimates are based on DOWL HKM design estimates, historic bid prices, and discussion with Northern Region design/engineering staff.

PLANNING LEVEL CONSTRUCTION COST ESTIMATE - REDUCED WIDTH SECTION (24') WITH 2:1 FORESLOPES
ATTACHMENT A3 - QUANTITIES & BASE COSTS FOR PAY ITEMS

Typical Section Assumptions for Cost Estimates	Notes
24-foot roadway surface	Minimum 20-foot surface per AASHTO; 24-foot roadway width will allow for two opposing vehicles to pass by one another.
5-foot total section	Section thickness will vary along length of road, depending upon soils. Two additional feet of overburden material included to account for approximately 2' material consolidation.
8" crushed aggregate surface course over 52" embankment fill	8" surface will not vary; embankment fill thickness will vary to meet total section thickness needs along road. Where Borrow is readily available, it shall be used. However, it is anticipated that borrow may not be readily available along the full length of the route, in which case Subbase may be offered as an alternative at a higher cost.
Geogrid under entire section (toe to toe)	Geogrid offers heartier strength and stiffness than *Geotextile, Stabilization* , however its use can be avoided if existing soils are expected to be only moderately poor, in which case a stabilization geotextile would more likely be employed at a lower cost.
2-foot excavation depth[1]	Conservative assumption for cost estimating purposes - thaw stability will vary along the length of road. There will be areas (eg. tundra and wetlands) where there will be no excavation and the organic mat left in place.
2:1 side slopes	Geotechnical recommended minimum due to anticipated permafrost.

Estimated Per-Mile Costs for Typical Section Pay Items					
Pay Item No.	**Item Description**	**Unit**	**Quantity per Mile**	**Final Unit Costs used in Estimates[1]**	**Cost per Mile**
201(3A)	Clearing and Grubbing	Acre	7	$10,000	$70,000
203(3)	Unclassified Excavation	CY	9,387	$20	$187,740
301(3)	Aggregate Surface Course	CY	3,129	$40	$125,160
203(6)	Borrow	CY	37,938	$25	$948,444
634(1)	Geogrid	SY	23,467	$8	$187,736
640(1)	Mobilization & Demobilization	LS	1	10% of Construction Cost (incl. contingency)	$182,290
-	Contingency	-	-	20% of Construction Cost	$303,816
				TOTAL BASE COST PER MILE	**$2,005,186**
				FOR WAAPS COST ESTIMATES USE:	**$2.0 million per mile**

Notes

[1]Per mile planning costs above do not account for reduced costs where no excavation is necessary over tundra and wetlands. Reduced excavation costs are accounted for in the phase costs presented in Attachments A9 through A10.

[2]Unit Costs used in final cost estimates are based on DOWL HKM design estimates, historic bid prices, and discussion with Northern Region design/engineering staff.

PLANNING LEVEL CONSTRUCTION COST ESTIMATE - 16' ONE LANE ROAD WITH PULLOUTS AND 2:1 FORESLOPES
ATTACHMENT A4 - QUANTITIES & BASE COSTS FOR PAY ITEMS

Typical Section Assumptions for Cost Estimates	Notes
16-foot roadway surface	Minimum 20-foot surface per AASHTO; 16-foot roadway surface for a single lane of travel with 200' long, 14-feet wide pullouts every 1/4 mile for passing. Pullout tapers at 8:1
5-foot total section	Section thickness will vary along length of road, depending upon soils.
8" crushed aggregate surface course over 52" embankment fill	8" surface will not vary; embankment fill thickness will vary to meet total section thickness needs along road. Where Borrow is readily available, it shall be used. However, it is anticipated that borrow may not be readily available along the full length of the route, in which case Subbase may be offered as an alternative at a higher cost.
Geogrid under entire section (toe to toe)	Geogrid offers heartier strength and stiffness than *Geotextile, Stabilization* , however its use can be avoided if existing soils are expected to be only moderately poor, in which case a stabilization geotextile would more likely be employed at a lower cost.
2-foot excavation depth[1]	Conservative assumption for cost estimating purposes - thaw stability will vary along the length of road. There will be areas (eg. tundra and wetlands) where there will be no excavation and the organic mat left in place.
2:1 side slopes	Geotechnical recommended minimum due to anticipated permafrost.

Estimated Per-Mile Costs for Typical Section Pay Items					
Pay Item No.	Item Description	Unit	Quantity per Mile	Final Unit Costs used in Estimates[1]	Cost per Mile
201(3A)	Clearing and Grubbing	Acre	6	$10,000	$60,000
203(3)	Unclassified Excavation	CY	6,805	$20	$136,100
301(3)	Aggregate Surface Course	CY	2,451	$40	$98,040
203(6)	Borrow	CY	20,314	$25	$507,852
634(1)	Geogrid	SY	20,068	$8	$160,544
640(1)	Mobilization & Demobilization	LS	1	10% of Construction Cost (incl. contingency)	$115,504
-	Contingency	-	-	20% of Construction Cost	$192,507
				TOTAL BASE COST PER MILE	**$1,270,547**
				FOR WAAPS COST ESTIMATES USE:	**$1.3 million per mile**

Notes

[1]Per mile planning costs above do not account for reduced costs where no excavation is necessary over tundra and wetlands. Reduced excavation costs are accounted for in the phase costs presented in Attachments A9 through A10.

[2]Unit Costs used in final cost estimates are based on DOWL HKM design estimates, historic bid prices, and discussion with Northern Region design/engineering staff.

PLANNING LEVEL CONSTRUCTION COST ESTIMATE - WINTER ROAD WITH 2:1 FORESLOPES
ATTACHMENT A5 - QUANTITIES & BASE COSTS FOR PAY ITEMS

Typical Section Assumptions for Cost Estimates	Notes
24-foot roadway surface	Minimum 20-foot surface per AASHTO; 24-foot roadway width will allow for two opposing vehicles to pass by one another and upgradeable to a year round use at a future time.
2-foot total section	Section thickness will vary along length of road, depending upon soils. Two additional feet of overburden material included to account for approximately 2' material consolidation.
24" embankment fill	The intent of this section is for winter use only but also as a section that could be built upon later. No surface aggregate course will be used and just a minimal 24" embankment.
Geogrid under entire section (toe to toe)	Geogrid offers heartier strength and stiffness than *Geotextile, Stabilization* , however its use can be avoided if existing soils are expected to be only moderately poor, in which case a stabilization geotextile would more likely be employed at a lower cost.
No excavation	Fill will be placed on top of geogrid and on top of cleared, existing ground surface.
2:1 side slopes	Geotechnical recommended minimum due to anticipated permafrost.

Estimated Per-Mile Costs for Typical Section Pay Items					
Pay Item No.	Item Description	Unit	Quantity per Mile	Final Unit Costs used in Estimates[1]	Cost per Mile
201(3A)	Clearing and Grubbing	Acre	6	$10,000	$60,000
203(6)	Borrow	CY	23,467	$25	$586,667
634(1)	Geogrid	SY	18,774	$8	$150,192
640(1)	Mobilization & Demobilization	LS	1	10% of Construction Cost (incl. contingency)	$95,623
-	Contingency	-	-	20% of Construction Cost	$159,372
				TOTAL BASE COST PER MILE	**$1,051,853**
				FOR WAAPS COST ESTIMATES USE:	**$1.1 million per mile**

Notes

[1]Unit Costs used in final cost estimates are based on DOWL HKM design estimates, historic bid prices, and discussion with Northern Region design/engineering staff.

PLANNING LEVEL CONSTRUCTION COST ESTIMATE - TOFTY ROAD REHAB
ATTACHMENT A6 - QUANTITIES & BASE COSTS FOR PAY ITEMS

Typical Section Assumptions for Cost Estimates	Notes
16-foot roadway surface	Minimum 20-foot surface per AASHTO; 16-foot roadway surface for a single lane of travel with 200' long, 14-feet wide pullouts every 1/4 mile for passing. Pullout tapers at 8:1
5-foot total section	Section thickness will vary along length of road, depending upon soils. Only needed at pullout locations where road is widened for passing.
8" crushed aggregate surface course over 52" embankment fill	8" surface will not vary; embankment fill thickness will vary to meet total section thickness needs along road. Full length of existing road will be resurfaced. Embankment only needed at pullouts.
5-foot excavation depth	Excavtion required only where pullouts are constructed. Thick section necessary to support load of a full tractor-trailer.
2:1 side slopes	Geotechnical recommended minimum due to anticipated permafrost.

Estimated Per-Mile Costs for Typical Section Pay Items					
Pay Item No.	**Item Description**	**Unit**	**Quantity per Mile**	**Final Unit Costs used in Estimates[1]**	**Cost per Mile**
201(3A)	Clearing and Grubbing	Acre	5	$10,000	$50,000
203(3)	Unclassified Excavation	CY	958	$20	$19,160
301(3)	Aggregate Surface Course	CY	2,451	$40	$98,040
203(6)	Borrow	CY	3,236	$25	$80,889
640(1)	Mobilization & Demobilization	LS	1	10% of Construction Cost (incl. contingency)	$29,771
-	Contingency	-	-	20% of Construction Cost	$49,618
				TOTAL BASE COST PER MILE	**$327,477**
				FOR WAAPS COST ESTIMATES USE:	**$0.35 million per mile**

Notes
[1]Unit Costs used in final cost estimates are based on DOWL HKM design estimates, historic bid prices, and discussion with Northern Region design/engineering staff.

WESTERN ALASKA ACCESS PLANNING STUDY

ATTACHMENT A7 - PLANNING LEVEL PHASE CONSTRUCTION COST ESTIMATE FOR FULL BUILDOUT WITH 4:1 FORESLOPES

Construction Costs in 2011 Dollars for Full Buildout (4:1 Foreslopes)							
Route	**Phase 1 - Manley to Tanana**	**Phase 2 - N-C Hwy to Elim**	**Phase 3 - Tanana to Ruby**	**Phase 4 -Ruby to Galena**	**Phase 5 - Galena to Nulato**	**Phase 6 - Elim to Koyuk**	**Phase 7 - Koyuk to Nulato**
Proposed new length of road (mi)	54	58	134	48	54	58	142
Roadway Cost ($millions)	$178.2	$191.4	$442.2	$158.4	$178.2	$191.4	$468.6
Bridge Costs ($millions)	$2.6	$100.2	$161.4	$39.4	$64.0	$58.6	$94.6
Maintenance Infrastructure Cost ($millions)	$12.0	$9.0	$21.0	$9.0	$9.0	$9.0	$18.0
Total Construction Cost ($millions)	$192.8	$300.6	$624.6	$206.8	$251.2	$259.0	$581.2
Average Cost/Mile ($M/mi)	$3.6	$5.2	$4.7	$4.3	$4.7	$4.5	$4.1

Notes

1. It is assumed that the bridge over the Yukon River will not be constructed with Phase 1 of the project. The bridge cost is included in Phase 3 though the bridge will likely be constructed on its own when there is sufficient traffic to warrant construction.
2. The construction cost includes the cost of constructing the roadway (including mobilization), construction engineering, bridges, maintenance infrastructure, and contingency costs.

WESTERN ALASKA ACCESS PLANNING STUDY

ATTACHMENT A8 - PLANNING LEVEL PHASE CONSTRUCTION COST ESTIMATE FOR FULL BUILDOUT WITH 2:1 FORESLOPES

Construction Costs in 2011 Dollars for Full Buildout (2:1 Foreslopes)							
Route	Phase 1 - Manley to Tanana	Phase 2 - N-C Hwy to Elim	Phase 3 - Tanana to Ruby	Phase 4 -Ruby to Galena	Phase 5 - Galena to Nulato	Phase 6 - Elim to Koyuk	Phase 7 - Koyuk to Nulato
Proposed new length of road (mi)	54	58	134	48	54	58	142
Roadway Cost ($millions)	$151.2	$162.4	$375.2	$134.4	$151.2	$162.4	$397.6
Bridge Costs ($millions)	$1.7	$74.5	$122.7	$14.2	$45.1	$29.1	$59.6
Maintenance Infrastructure Cost ($millions)	$12.0	$9.0	$21.0	$9.0	$9.0	$9.0	$18.0
Total Construction Cost ($millions)	$164.9	$245.9	$518.9	$157.6	$205.3	$200.5	$475.2
Average Cost/Mile ($M/mi)	$3.1	$4.2	$3.9	$3.3	$3.8	$3.5	$3.3

Notes

1. It is assumed that the bridge over the Yukon River will not be constructed with Phase 1 of the project. The bridge cost is included in Phase 3 though the bridge will likely be. constructed on its own when there is sufficient traffic to warrant construction.
2. The construction cost includes the cost of constructing the roadway (including mobilization), construction engineering, bridges, maintenance infrastructure, and contingency costs.
3. Assumes reduced width bridges for minor river crossings and Bailey bridges for stream crossings.

WESTERN ALASKA ACCESS PLANNING STUDY

ATTACHMENT A9 - PLANNING LEVEL PHASE CONSTRUCTION COST ESTIMATE FOR 24' ROAD WITH 2:1 FORESLOPES

Construction Costs in 2011 Dollars for 24' Section (2:1 Foreslopes)							
Route	Phase 1 - Manley to Tanana	Phase 2 - N-C Hwy to Elim	Phase 3 - Tanana to Ruby	Phase 4 -Ruby to Galena	Phase 5 - Galena to Nulato	Phase 6 - Elim to Koyuk	Phase 7 - Koyuk to Nulato
Proposed new length of road (mi)	54	58	134	48	54	58	142
Roadway Cost ($millions)	$105.6	$111.3	$266.9	$88.1	$102.2	$116.0	$276.1
Bridge Costs ($millions)	$1.7	$74.5	$122.7	$14.2	$45.1	$29.1	$59.6
Maintenance Infrastructure Cost ($millions)	$12.0	$9.0	$21.0	$9.0	$9.0	$9.0	$18.0
Total Construction Cost ($millions)	$119.3	$194.8	$410.5	$111.3	$156.3	$154.1	$353.8
Average Cost/Mile ($M/mi)	$2.2	$3.4	$3.1	$2.3	$2.9	$2.7	$2.5

Notes

1. It is assumed that the bridge over the Yukon River will not be constructed with Phase 1 of the project. The bridge cost is included in Phase 3 though the bridge will likely be. constructed on its own when there is sufficient traffic to warrant construction.
2. The construction cost includes the cost of constructing the roadway (including mobilization), construction engineering, bridges, maintenance infrastructure, and contingency costs.
3. Assumes no excavation of organics over tundra.
4. Assumes reduced width bridges for minor river crossings and Bailey bridges for stream crossings.

WESTERN ALASKA ACCESS PLANNING STUDY

ATTACHMENT A10 - PLANNING LEVEL PHASE CONSTRUCTION COST ESTIMATE FOR 16' ROAD WITH PULLOUTS & 2:1 FORESLOPES

Construction Costs in 2011 Dollars for One Lane Section w/ Pullouts (2:1 Foreslopes)							
Route	**Phase 1 - Manley to Tanana**	**Phase 2 - N-C Hwy to Elim**	**Phase 3 - Tanana to Ruby**	**Phase 4 -Ruby to Galena**	**Phase 5 - Galena to Nulato**	**Phase 6 - Elim to Koyuk**	**Phase 7 - Koyuk to Nulato**
Proposed new length of road (mi)	54	58	134	48	54	58	142
Roadway Cost ($millions)	$54.9	$72.0	$173.4	$56.7	$66.0	$75.4	$178.9
Bridge Costs ($millions)	$1.7	$74.5	$122.7	$14.2	$45.1	$29.1	$59.6
Maintenance Infrastructure Cost ($millions)	$12.0	$9.0	$21.0	$9.0	$9.0	$9.0	$18.0
Total Construction Cost ($millions)	$68.6	$155.5	$317.0	$79.9	$120.1	$113.5	$256.5
Average Cost/Mile ($M/mi)	$1.3	$2.7	$2.4	$1.7	$2.2	$2.0	$1.8

Notes

1. It is assumed that the bridge over the Yukon River will not be constructed with Phase 1 of the project. The bridge cost is included in Phase 3 though the bridge will likely be. constructed on its own when there is sufficient traffic to warrant construction.
2. The construction cost includes the cost of constructing the roadway (including mobilization), construction engineering, bridges, maintenance infrastructure, and contingency costs.
3. Assumes no excavation of organics over tundra.
4. Assumes reduced width bridges for minor river crossings and Bailey bridges for stream crossings.

WESTERN ALASKA ACCESS PLANNING STUDY
PLANNING LEVEL COST ESTIMATE
ATTACHMENT A11 - M & O STATION & EQUIPMENT COST DETERMINATION

Route	Length (mi)	No. of MS Needed	Cost to Construct & Equip ($ Mil each)	Total Cost ($ Mil)
PHASE 1	54	1	$12.0	**$12.0**
PHASE 2	58	1	$9.0	**$9.0**
PHASE 3	134	2	$9.0 / $12.0	**$21.0**
PHASE 4	48	1	$9.0	**$9.0**
PHASE 5	54	1	$9.0	**$9.0**
PHASE 6	58	1	$9.0	**$9.0**
PHASE 7	142	2	$9.0	**$18.0**

Assumptions

1. The number of maintenance stations needed assumes that a station would be placed at each end of the route with stations between termini spaced approximately every 60 miles.
2. It is assumed that existing maintenance stations are currently maintaining their maximum highway mileage and could not take on additional maintenance for the new route.
3. The up-front cost of each maintenance station assumes $7 million to construct and $2 million to equip, a total of $9 million per station. The Phase 1 and one of the two Phase 3 maintenance stations assume $9 million to construct and $3 million to equip for a total of $12 million. This accounts for additional space needed for the landing craft type ferries for the Yukon Crossings at Tanana and Ruby.
4. The second maintenance station in Phase 3 is for a landing craft, storage facility, and staging area necessary for barging goods across the Yukon River to Tanana and Ruby respectively.

APPENDIX B

Bridge Construction Cost Determination

WESTERN ALASKA ACCESS PLANNING STUDY
PLANNING LEVEL CONSTRUCTION COST ESTIMATE
ATTACHMENT B1 - BRIDGE COST DETERMINATION FOR FULL WIDTH BRIDGES

Bridge Costs in 2011 Dollars									
River	**Yukon**	**Tanana**	**Fish, Koyuk**	**Koyukuk**	**Nenana, Kantishna**	**Kachauik, Melozitna**	**Tanana Trib, Yuonglik, Tubutulik**	**Minor River Crossing**	**Stream Crossing**
Deck Dimensions	5000 ft x 30 ft	2200 ft x 30 ft	1,750 ft x 30 ft	2000 ft x 30 ft	1200 ft x 30 ft	800 ft x 30 ft	300 ft x 30 ft	150 ft x 30 ft	80 ft x 30 ft
Deck Area (SF)	150,000	66,000	52,500	60,000	36,000	24,000	9,000	4,500	2,400
Cost per SF (2011)	$375	$375	$375	$375	$375	$375	$375	$375	$375
Base Cost ($ Mil)	$56.3	$24.8	$19.7	$22.5	$13.5	$9.0	$3.4	$1.7	$0.9
+ Roadway Items @ 15%	$8.44	$3.71	$2.95	$3.38	$2.03	$1.35	$0.51	$0.25	$0.14
+ Mobilization @ 10%	$6.47	$2.85	$2.26	$2.59	$1.55	$1.04	$0.39	$0.19	$0.10
+ Contingency @ 20%	$14.23	$6.26	$4.98	$5.69	$3.42	$2.28	$0.85	$0.43	$0.23
2011 Cost of Bridge ($ Mil)	**$85**	**$38**	**$30**	**$34**	**$20**	**$14**	**$5**	**$2.6**	**$1.37**

Assumptions

1. The bridge span required at each minor river crossing is assumed to be an average of 150 feet.
2. The bridge span required at each stream crossing is assumed to be an average of 80 feet.
3. Bridge width of 30 ft matches full build out road width; assumes two-12 ft lanes, two-1.5 ft shoulders, and two-1.5 ft bridge rails.
4. Some roadway items related to bridge construction assumed to be included in the road construction cost estimate, but a factor has been left in for bridge-specific construction needs.
5. Mobilization of bridge construction equipment assumed separate from road construction equipment.

WESTERN ALASKA ACCESS PLANNING STUDY
PLANNING LEVEL CONSTRUCTION COST ESTIMATE
ATTACHMENT B2 - BRIDGE COST DETERMINATION FOR REDUCED WIDTH & BAILEY BRIDGES

Bridge Costs in 2011 Dollars									
River	**Yukon**	**Tanana**	**Fish, Koyuk**	**Koyukuk**	**Nenana, Kantishna**	**Kachauik, Melozitna**	**Tanana Trib, Yuonglik, Tubutulik**	**Minor River Crossing**	**Stream Crossing**
Deck Dimensions	5000 ft x 30 ft	2200 ft x 30 ft	1,750 ft x 30 ft	2000 ft x 30 ft	1200 ft x 30 ft	800 ft x 30 ft	300 ft x 30 ft	150 ft x 20 ft	80 ft x 20 ft
Deck Area (SF)	150,000	66,000	52,500	60,000	36,000	24,000	9,000	3,000	1,600
Cost per SF (2011)	$375	$375	$375	$375	$375	$375	$375	$375	--
Base Cost ($ Mil)	$56.3	$24.8	$19.7	$22.5	$13.5	$9.0	$3.4	$1.1	$0.4
+ Roadway Items @ 15%	$8.44	$3.71	$2.95	$3.38	$2.03	$1.35	$0.51	$0.17	--
+ Mobilization @ 10%	$6.47	$2.85	$2.26	$2.59	$1.55	$1.04	$0.39	$0.13	$0.04
+ Contingency @ 20%	$14.23	$6.26	$4.98	$5.69	$3.42	$2.28	$0.85	$0.28	$0.08
2011 Cost of Bridge ($ Mil)	**$85**	**$38**	**$30**	**$34**	**$20**	**$14**	**$5**	**$1.7**	**$0.46**

Assumptions

1. The bridge span required at each minor river crossing is assumed to be an average of 150 feet.
2. The bridge span required at each stream crossing is assumed to be an average of 80 feet.
3. Bridge width of 30 ft matches full build out road width; assumes two-12 ft lanes, two-1.5 ft shoulders, and two-1.5 ft bridge rails.
4. Some roadway items related to bridge construction assumed to be included in the road construction cost estimate, but a factor has been left in for bridge-specific construction needs.
5. Mobilization of bridge construction equipment assumed separate from road construction equipment.

WESTERN ALASKA ACCESS PLANNING STUDY
PLANNING LEVEL CONSTRUCTION COST ESTIMATE
ATTACHMENT B3 - FULL BUILD OUT BRIDGE COST SUMMARY

		Construction Costs in 2011 Dollars							
Route		**Phase 1 - Manley to Tanana**	**Phase 2 - N-C Hwy to Elim**	**Phase 3 - Tanana to Ruby**	**Phase 4 -Ruby to Galena**	**Phase 5 - Galena to Nulato**	**Phase 6 - Elim to Koyuk**	**Phase 7 - Koyuk to Nulato**	**Potential - Nenana to Manley**
BRIDGES	Number of Major River Crossings	0	3	2	0	1	1	1	3
	Cost - Major Crossings ($ M)[2]	$0.0	$48.7	$99.0	$0.0	$34.2	$5.1	$34.2	$78.6
	Number of Minor River Crossings[3]	1	10	3	1	1	7	6	1
	Cost - Minor Crossings ($ M)[2]	$2.6	$25.6	$7.7	$2.6	$2.6	$17.9	$15.4	$2.6
	Number of Stream Crossings[3]	0	19	40	27	20	26	33	8
	Cost - Stream Crossings ($ M)[2]	$0.0	$26.0	$54.6	$36.9	$27.3	$35.5	$45.1	$10.9
	Total Water Crossings Cost ($ M)	$2.6	$100.2	$161.4	$39.4	$64.0	$58.6	$94.6	$92.0
TOTAL BRIDGE COST ($ M)[5]		**$2.6**	**$100.2**	**$161.4**	**$39.4**	**$64.0**	**$58.6**	**$94.6**	**$92.0**

Notes

1. Road construction cost estimates are detailed in Appendix A.
2. Bridge construction cost estimates are detailed in Attachment B1.
3. Number of minor river and stream crossings derived from an atlas overlay Digital Raster Graphics (DRG) maps, composed of scanned images of the 1:250k,1:64k,1:25k, and 1:24k U.S. Geological Survey (USGS) standard series topographic maps in Google Earth.
    1. Minor crossings were assumed to be those with a width less than 150' and more than 80'.
    2. Stream crossings were assumed to be those with a measured width less than 80'.
4. M&O Capital cost estimates are detailed in Attachment A11 in Appendix A.
5. All cost estimates presented in 2011 dollars.

WESTERN ALASKA ACCESS PLANNING STUDY
PLANNING LEVEL CONSTRUCTION COST ESTIMATE
ATTACHMENT B4 - REDUCED WIDTH MINOR BRIDGE COST SUMMARY

		Construction Costs in 2011 Dollars							
Route		Phase 1 - Manley to Tanana	Phase 2 - N-C Hwy to Elim	Phase 3 - Tanana to Ruby	Phase 4 -Ruby to Galena	Phase 5 - Galena to Nulato	Phase 6 - Elim to Koyuk	Phase 7 - Koyuk to Nulato	Potential - Nenana to Manley
BRIDGES	Number of Major River Crossings	0	3	2	0	1	1	1	3
	Cost - Major Crossings ($ M)[2]	$0.0	$48.7	$99.0	$0.0	$34.2	$5.1	$34.2	$78.6
	Number of Minor River Crossings[3]	1	10	3	1	1	7	6	1
	Cost - Minor Crossings ($ M)[2]	$1.7	$17.1	$5.1	$1.7	$1.7	$12.0	$10.2	$1.7
	Number of Stream Crossings[3]	0	19	40	27	20	26	33	8
	Cost - Stream Crossings ($ M)[2]	$0.0	$8.8	$18.5	$12.5	$9.2	$12.0	$15.2	$3.7
	Total Water Crossings Cost ($ M)	$1.7	$74.5	$122.7	$14.2	$45.1	$29.1	$59.6	$84.0
TOTAL BRIDGE COST ($ M)[5]		**$1.7**	**$74.5**	**$122.7**	**$14.2**	**$45.1**	**$29.1**	**$59.6**	**$84.0**

Notes

1. Road construction cost estimates are detailed in Appendix A.
2. Reduced width bridge construction cost estimates are detailed in Attachment B2.
3. Number of minor river and stream crossings derived from an atlas overlay Digital Raster Graphics (DRG) maps, composed of scanned images of the 1:250k,1:64k,1:25k, and 1:24k U.S. Geological Survey (USGS) standard series topographic maps in Google Earth.
    1. Minor crossings were assumed to be those with a width less than 150' and more than 80'.
    2. Stream crossings were assumed to be those with a measured width less than 80'.
4. M&O Capital cost estimates are detailed in Attachment A11 in Appendix A.
5. All cost estimates presented in 2011 dollars.

WESTERN ALASKA
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