West Susitna Access Reconnaissance Study
West Susitna Access to Resource Development

Transportation Analysis Report

Prepared for:

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Division of Program Development

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January 2014

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Acronyms

AAC	Alaska Administrative Code
AASHTO	American Association of State Highway and Transportation Officials
ADF&G	Alaska Department of Fish and Game
ADL	Alaska Division of Land
AEA	Alaska Energy Authority
AIDEA	Alaska Industrial Development and Export Authority
AMHT	Alaska Mental Health Trust
ANCSA	Alaska Native Claims Settlement Act
ARDF	Alaska Resource Data File
ARTEC	Alaska Railbelt Transmission and Electric Company
AS	Alaska Statute
ASCMCRA	Alaska Surface Coal Mining Control and Reclamation Act
ATV	all-terrain vehicle
bbl	barrels
BIF	best interest finding
BLM	U.S. Bureau of Land Management
bpd	barrels per day
CEA	Chugach Electric Association
CBM	Coalbed Methane
CIE	Cook Inlet Energy, LLC
CIRI	Cook Inlet Region, Inc.
CWA	Clean Water Act
DEM	digital elevation model
DGGS	Division of Geologic and Geophysical Surveys
DNR	Alaska Department of Natural Resources
DOF	Division of Forestry
DOG	Division of Oil and Gas
DOT&PF	Alaska Department of Transportation and Public Facilities
DPOR	Department of Parks and Outdoor Recreation
EIS	environmental impact statement
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FMU	Forest Management Unit
GIS	Geographic Information System
GMU	Game Management Unit
KPB	Kenai Peninsula Borough

KPEDD	Kenai Peninsula Economic Development District
LNG	liquid natural gas
mcf	million cubic feet
MEA	Matanuska Electric Association
Mgal	million gallons
ML&P	Municipal Light and Power
MLW	Mining, Land and Water
MOA	Municipality of Anchorage
MSB	Matanuska-Susitna Borough
MW	megawatt
NHCC	National Highway Construction Cost Index
NPR-A	National Petroleum Reserve – Alaska
NWI	National Wetlands Inventory
OPMP	Office of Project Management and Permitting
PGDHS	A Policy on Geometric Design of Highways and Streets
PGE	platinum group elements
ROD	Record of Decision
RM	river mile
SRR	State Recreation River
SRS	State Recreational Site
syngas	synthetic gas
UCG	underground coal gasification
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey

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EXECUTIVE SUMMARY

The Alaska Department of Transportation and Public Facilities' (DOT&PF) Roads to Resources Initiative originated the West Susitna Access Reconnaissance Study in early 2013. The purpose of this reconnaissance-level study is to evaluate and consider the need for surface access to resource development opportunities west of the Susitna River in Southcentral Alaska.

The Study Area is located in Southcentral Alaska, generally west of the Parks Highway, south of Denali National Park and Preserve, east of the Alaska Range, and north of Cook Inlet (including the Beluga/Tyonek area). The area covers nearly 6.2 million acres.

While nearly the size of Vermont, the Study Area has a diverse natural resources base. These natural resources include hardrock minerals, placer gold, coal, oil and gas, forestry/timber, agriculture, alternative energy options, and recreational resource opportunities, such as sportfishing and hunting. Surface access to most of this area, however, is minimal or non-existent.

This study aims to identify locations that may benefit from a proposed surface connection and evaluates the potential access routes. The objectives of this study report are to:

- Identify resource development opportunities west of the Susitna River.
- Identify one or more potential crossings of the Susitna River.
- Identify one or more potential transportation corridors to access identified resources.

The majority of the Study Area is not accessible by the existing road network. Access within most of the Study Area occurs primarily by air or river travel, or by snowmachine or ice roads during the winter months. Other types of travel modes include skiing and foot travel. Providing surface access to some of these natural resource-dense areas could facilitate further exploration, development, and use of these resources. Natural resource development in Alaska helps to create jobs and stimulate the economy. Creating access to resources also enables residents and visitors to use the land recreationally.

The first part of this study consisted of inventorying natural resources and existing infrastructure in the Study Area. Based on a constraints and opportunities analysis approach, ten broad preliminary corridor segments were delineated based on the locations of identified resource opportunities, environmental constraints, Susitna River crossing locations, and previously identified alignments. Initial centerlines were laid out within these corridor segments. Through a refinement process, several segments were dismissed for a variety of reasons, including redundancy, engineering challenges, prohibitive costs, etc. The remaining alignments were refined and combined to create four different access routes and one variant for consideration for providing access into the Susitna basin. Features of the proposed access routes are summarized in Table ES-1. The proposed access routes were evaluated based on a number of considerations, including "strengths" (e.g., acreages of resources made accessible) and "weaknesses" (e.g., engineering challenges). Both quantitative and qualitative measures were used to compare the access routes.

The study team also collected additional existing information to help quantify the resource potential of the areas to be accessed. Potential resource values have been incorporated into the respective resource sections of this report, primarily in Section 2. There are some limitations to the assumed resource values. For instance, the use of lease acreage and claims as a proxy for resource potential should not be taken to imply that all of that acreage would be developed, as most of the holdings are for exploration at this time. Likewise, acreages designated by DNR as potential for agricultural use may not be fully utilized for crops. In terms of mineral potential, a caveat is that this runs the risk of

under- or over-stating the actual potential of other areas that are not currently leased for exploration. A thorough economic benefits and impacts analysis has not been completed for this project. However, a separate document has also been prepared that considers the economic benefits of proposed access into the West Susitna Study Area (see Appendix F).

Given the wide variety of potential resource development opportunities within the Study Area, there is no single target point (destination) for the proposed access routes. As such, several possible routes have been identified, each having different origins and destinations, as indicated in the following table. Depending on the priority, availability of funding, and timing of access needs, multiple routes could be chosen and combined or added to other routes in subsequent phases. For example, for the routes destined for the mining area in the Tordrillo Mountains, another one of the alignments could be added to provide access to the Beluga area if both locations are shown to warrant access.

Table ES-1. Proposed Access Routes Summary

	North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
General origin	Petersville Rd	Oil Well Rd	Little Su River Rd	Little Su River Rd	Willow area
General destination	Upper Skwentna mineralized area	Upper Skwentna mineralized area	Upper Skwentna mineralized area	Beluga/ Tyonek	Oil Well Rd
Amount of resources accessed					
Hardrock minerals	Medium	High	Highest	Lowest	Low
Placer gold mining	Medium	High	Highest	Lowest	Lowest
Coal	Medium	Medium	High	Highest	Lowest
Oil and gas	Lowest	Medium	Medium	High	Highest
Forestry/timber	Low	High	Highest	Low	Medium
Agriculture	Lowest	Lowest	Medium	Lowest	Highest
Recreation	Low	Lowest	Medium	Highest	Low
Length (miles)	78.8	71.6	107.9	63.8	33.5
New Bridges (#)					
Conventional [1]	9	12	20	11	1
Long Span[2]	4	6	4	2	2
Total	13	18	24	13	3
New bridge crossings greater than 1,000 feet	1,150 (Yentna)	1,200 (Yentna) 1,200 (Hayes)	1,200 (Hayes) 1,640 (Susitna)	1,640 (Susitna)	1,200 (Susitna)
New Culverts (#)					
Large [3]	12	12	14	6	2
Small [4]	37	26	40	12	11
Minor Drainage [5]	316	292	440	260	136
Cost Estimate (millions)					
Subtotal[6]	$147.6	$188.3	$187.4	$106.9	$72.2
Total [7]	$376.4	$504.3	$453.2	$257.8	$216.9
Total per mile [8]	$4.6	$6.3	$4.2	$4.0	$5.2

* A *Goeller scorecard* is a commonly used method of comparatively displaying pros and cons. The Goeller scorecard was used in this reconnaissance study to display the impacts of the reconnaissance-level proposed access routes. This method displays the impacts of each option, which is expressed in its 'natural' units. In this study, examples of natural units are feet, miles, number of creek crossings, acreages, and monetary value. In the tables, each row represents one impact and each column represents an access route option. Colored shading is used to comparatively indicate the more or less favorable metrics. The color shading was intended to make it easier for a decision-maker or reader to identify patterns or to come to conclusions. In some cases, values were relatively similar so there may be more than one option shaded the same color within the same row. No behind-the-scenes normalization or ranking was applied.

Green = Proposed access route(s) with the fewest number of roadway miles, bridges, culverts, and/or costs. Also, indicates highest amount of resources made accessible.

Red = Proposed access route(s) with the greatest number of roadway miles, bridges, culverts, and/or costs. Also, indicates least amount of resources made accessible.

Assumptions:

[1] Conventional bridges are considered less than 300 feet in length.

[2] Long span bridges are 300 feet or longer.

[3] A culvert approximately 96 feet or longer.

[4] Small culverts and minor drainage culverts have an assumed length of approximately 50 feet.

[5] An additional four culverts per mile to accommodate minor drainage patterns.

[6] Subtotal cost estimate for new proposed access roadways includes clearing, earthwork, structures, stream and river crossings (including culverts), guardrail and retaining walls, and miscellaneous items such as topsoil, seeding, geotextile and signing.

[7] Total cost estimate includes drainage measures, erosion and pollution, surveying, environmental studies and permits, existing road upgrades, construction, mobilization, right-of-way (ROW) acquisition, contingency, design, and utilities.

[8] Total per mile includes only the proposed access routes and does not include existing roadways or cost to upgrade them.

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1 INTRODUCTION

1.1 Study Overview

In January 2013, the Alaska Department of Transportation and Public Facilities (DOT&PF) contracted with HDR Alaska, Inc. and its consultant team to conduct the *West Susitna Access Reconnaissance Study*. The purpose of this study is to evaluate and consider the need for surface access to resource development opportunities west of the Susitna River in Southcentral Alaska. The Study Area is natural-resources dense, and this study aims to identify locations that may benefit from a proposed surface connection. The objectives of this study are to:

- Identify resource development opportunities west of the Susitna River.
- Identify one or more potential crossing(s) of the Susitna River.
- Identify one or more potential transportation corridor(s) to access identified resources.

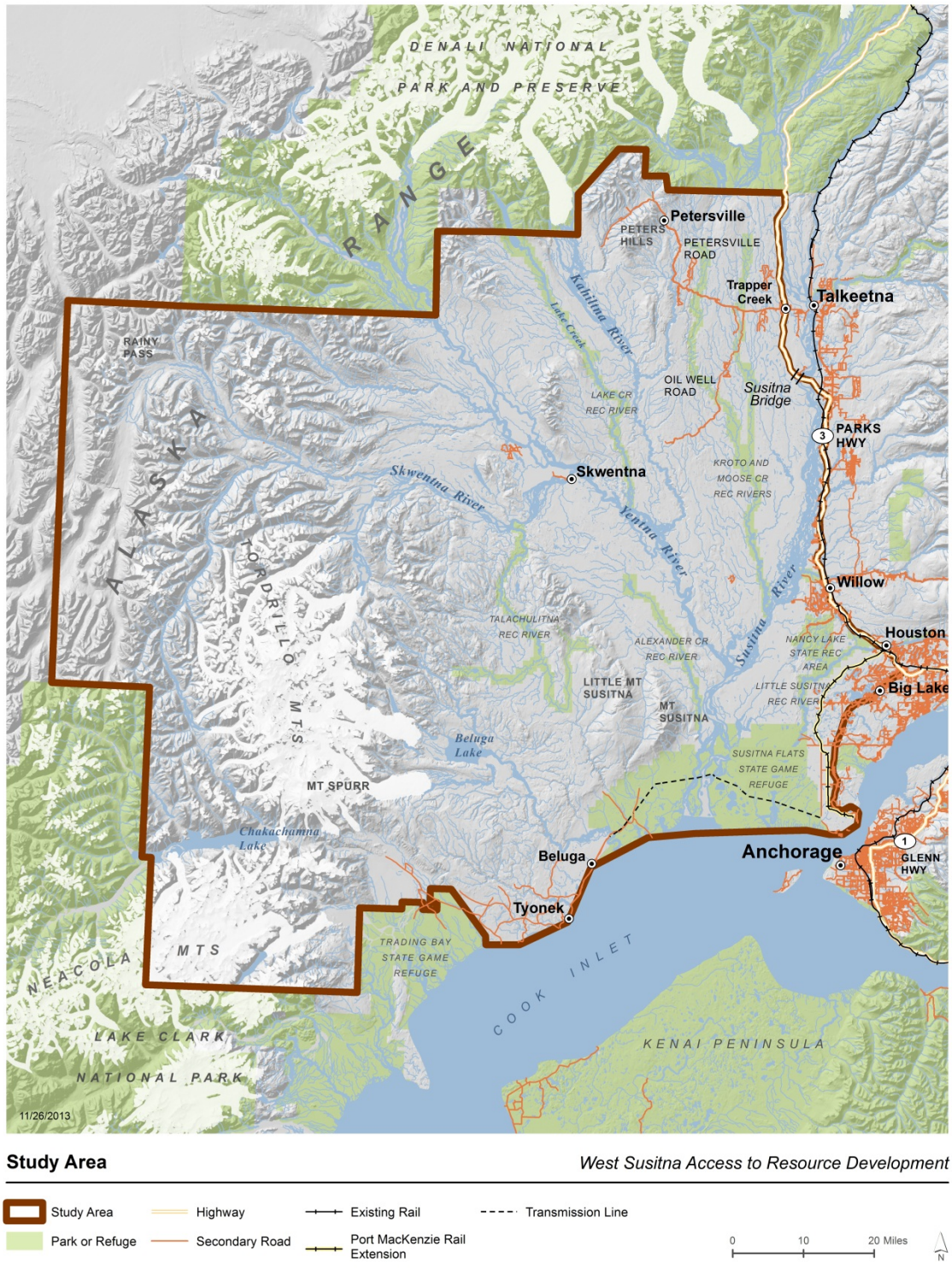
This report is intended to be a reconnaissance-level study based on existing, available information. No field investigations were performed. While agencies and other resource-industry stakeholders were contacted to supplement existing information, a public involvement and stakeholder engagement process was not a part of this reconnaissance-level study at this time. Should this project move forward, a public involvement and stakeholder engagement process would be implemented and subsequent environmental processes and analyses would be pursued.

1.2 Study Setting

The Study Area, depicted in Figure 1-1 and Figure 1-2, is located in Southcentral Alaska, generally west of the Parks Highway, south of Denali National Park and Preserve, east of the Alaska Range, and north of Cook Inlet (including the Beluga/ Tyonek area). At nearly 6.2 million acres, the Study Area is roughly the size of Vermont.

Figure 1-1. Study Area in State Context

Figure 1-2. Study Area



A diverse natural resources base is found in the Study Area, particularly west of the Susitna River. The study team identified the following opportunities for resource exploration, development and access in the Study Area: hardrock minerals, placer gold mining, coal, oil and gas, forestry/timber, agriculture, alternative energy, and recreation. These resources and activities are further discussed in the Resources Inventory, Section 2.

Surface access to most of this area is minimal or non-existent. The majority of the Study Area is not accessible by the existing road network. Access within the Study Area occurs mostly by air, river, or by snowmachine or ice roads during the winter months. Other types of travel modes include skiing and foot travel. Providing surface access to some of these natural resource-dense areas could facilitate further exploration, development, and use of these resources. Natural resource development in Alaska helps to create jobs and stimulate the economy. Creating access to resources also enables residents and visitors to use the land recreationally.

> "Economic growth and stability in Alaska hinges partially, if not primarily, on the availability of a mix of affordable and sustainable energy sources."
>
> *–Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska (DNR- DGGS 2012)*

A number of previous studies have identified corridor alignments into and through the Study Area. These studies and alignments were reviewed as part of this study.

1.3 Background Information

1.3.1 Use of Public Lands

Alaska Statute (AS) 38.04.065 Land Use Planning and Classification and 11 Alaska Administrative Code (AAC) 55.010-.030 requires that the Alaska Department of Natural Resources (DNR) "shall, with local governmental and public involvement under AS 38.05.945, adopt, maintain, and, when appropriate, revise regional land use plans that provide for the use and management of State of Alaska-owned lands." One of DNR's purposes is to identify important land resources and determine how their lands can be used for the "maximum public benefit." Often, multiple uses are allowed on these public lands.

> **Why Plan for the Use of Public Land?**
>
> "Through the management of public lands, the state, borough, and federal governments greatly influence the physical development patterns and the general quality of life in the Susitna Area. Major development projects such as mining, timber harvests, or agriculture influence local job opportunities. Land sold for residential or private recreational use clearly affects the character of community life, as does land retained for hunting, fishing, and other public uses."
>
> *– Susitna Area Plan (DNR 1985)*

DNR has prepared a number of management plans applicable to the Study Area; some of these include: the *Susitna Matanuska Area Plan* (2011), the *Southeast Susitna Area Plan* (2008), the *Susitna Basin Recreation Rivers Management Plan* (1991), the *Susitna Forestry Guidelines* (1991), and the *Susitna Area Plan* (1985). Access is addressed in these plans. For instance, the 1985 *Susitna Area Plan* addresses transportation and access as follows:

"The final major goal of the plan is to open more land in the region to a variety of public and private uses. This is achieved in part by the pattern of land use designations in the plan. This pattern is specifically arranged to combine designated uses in a manner that makes benefits of road construction greater than the cost. For example, in the region south of Petersville Road, forestry

areas are designated to encourage construction of pioneer roads that will open adjacent land to use for public and private recreation and agriculture." (p.11)

In furtherance of its DNR's mission relative to the Susitna Basin a number of detailed resource investigations are ongoing. The DNR-Division of Geological and Geophysical Surveys (DGGS) is currently conducting a mapping project in the Beluga/Tyonek area and another mapping project in the Susitna River basin that will help to determine resource potential.[1] For this effort, baseline geologic data for potential energy systems from surface rock exposures is being collected. The product of this work will be a geologic map and series of technical reports on their field findings. An overview report of the fieldwork in the Susitna basin was published in April 2013, which summarizes the ten reconnaissance field trips that were conducted in the Susitna basin in June 2011.[2] The work has been done in partnership with Alaska DNR-Division of Oil and Gas (DOG), U.S. Geological Survey (USGS), and the University of Alaska Fairbanks. According to the April 2013 report, the information is intended to increase the understanding of the basin's hydrocarbon potential, a "key component of DGGS's multi-year In-State Gas Program." The 2011 summer reconnaissance fieldwork and subsequent analysis is part of a multi-year, multi-agency research effort to investigate the resource potential of the Susitna sedimentary basin. As the data is developed, interpretive technical reports will be produced addressing the stratigraphy, reservoir quality, coal quality and gas potential, hydrocarbon seal integrity, subsurface structure, and uplift history of the basin. The intent is to promote new exploration investment and support responsible resource and land-use management.[3]

Of the nearly 6 million acres of land in the Study Area, a majority of the land is classified as State land and considered an opportunity for access route locations.[4] Land status is addressed in a number of sections in this document: specifically in Section 4.4 in terms of both constraints and opportunities for access route locations and in Section 6.2, as part of the land type located within the proposed access route corridors. Utilizing State lands would be preferable for access route locations because of its lower cost to the state, fewer impacts to private property, and less bureaucratic requirements for using federal property. At this reconnaissance-level of study, the access routes were aligned based on a constraints and opportunities analysis. At this time, access routes were not realigned and re-routed based on a detailed analysis of land ownership. Should this project move forward, a more detailed consideration of land status is warranted.

1.3.2 Roads to Resources Initiative Overview

Alaska has a diverse natural resource base. Some of the natural resource deposits or prospects in Alaska are world-renowned and are considered to be some of the largest in the world. However, surface access to most of these resource development opportunities around the State is minimal or non-existent. Providing access to these natural resources increases the opportunity for job creation and economic growth, which in turn supports funding for essential State programs and boosts the state's treasury.

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[1] DNR-DGGS. March 26, 2013. Personal communication with DNR-DGGS Geologist Robert Gillis.
[2] DNR-DGGS. April 2013. Status of A Reconnaissance Field Study of the Susitna Basin, 2011. By Robert Gillis et al.
[3] DNR-DGGS. January 2012. *Annual Report 2011*.
[4] Land ownership is generalized, based on spatial data from the DNR 2013 General Land Status database, which approximates land status at the section level. Data limitations exist and ownership types are aggregated for planning purposes only. An in-depth analysis of land status and ownership has not been conducted at this reconnaissance-level study. Due to limitations of the data, actual status and ownership of any land should be verified in subsequent project development.

In 2003, to facilitate resource exploration and development of minerals, coal, and oil and gas, the State of Alaska initiated its Industrial Roads Program, also known as the "Roads to Resources" program. This initiative was created to help identify possible partnerships between the State and the resource industry to identify possible surface access needs and opportunities. Encouraging resource development and making exploration, development, and production opportunities more accessible, would in turn increase financial feasibility. This would ultimately benefit Alaska's economic development by providing increased revenue and employment opportunities.

In recent years, the larger Roads to Resources initiatives have generally focused on roads in Alaska's arctic region: the roads to Umiat, Ambler, and Tanana. These projects are much further along in the project development process compared to the *West Susitna Access Reconnaissance Study*, which was initiated in early 2013.

- The proposed road to Umiat, also known as the *Foothills West Transportation Access Project*, would facilitate oil and gas exploration and development in the northern foothills of the Brooks Range and improve access to the National Petroleum Reserve-Alaska (NPR-A) via Umiat. An approximate 75-mile road from the Dalton Highway to the Gubik Gas fields is proposed. Eventually the road would be extended across the Colville River to the State airport in Umiat.
- The road to Ambler, also known as the *Ambler Mining District Access Project*, would consist of a 200 to 370 mile road from the mining district to either a port in western Alaska or to a Dalton Highway connection. The road would provide access primarily to mining resources. A number of corridors were identified several years ago, and subsequent environmental baseline studies are occurring. During its 2013 session, the Alaska State Legislature appropriated $8.5 million for this industrial road to connect with the Dalton Highway. Management of this project shifted from DOT&PF to the Alaska Industrial Development and Export Authority (AIDEA) in 2013.
- A road has been proposed to Tanana from the existing Elliott Highway. The proposed road would extend from the existing road network near Manley Hot Springs and follow along the existing Tofty Road to the Yukon River near the village of Tanana. The road would provide access between remote villages and larger hub communities. The DOT&PF submitted an easement application to DNR in December 2012 for a 300-foot wide approximately 36 mile corridor.[5]

One other non-arctic Roads to Resources initiative proposes to upgrade the existing Klondike Highway near Skagway to accommodate increased industrial uses. It is the only Roads to Resources roadway that was previously already in existence, and its intent is to enhance the pavement and bridge structures to accommodate an anticipated large increase in the transport of ore from Canadian mines to the Port of Skagway.

Other smaller-scale Roads to Resources initiatives[6] include:

- Niblack Mine access – Prince of Wales
- Bokan Mountain Mine access – Prince of Wales
- Granduc Mine – Hyder Salmon Road

[5] State of Alaska. Online Public Notices. http://aws.state.ak.us/OnlinePublicNotices/Notices/View.aspx?id=168193 (accessed July 16, 2013).
[6] http://dnr.alaska.gov/commis/priorities/Slides/Ed_Fogels.pdf

- Katlian Quarry – Baranof Island
- Miscellaneous access roads in southeast Alaska
- Nome and Seward Peninsula – access for several mine prospects

This West Susitna Access Study report will provide a foundation for subsequent work, should funding become available and if the project were to move forward. Other project development activities would include field studies, agency consultation, public involvement, alignment refinement, and an environmental review process.

1.4 General Study Methodology

This study was prepared using the following approach:

- **Review existing literature and relevant** studies to identify resources and access opportunities in the Study Area. Information was obtained based on a cursory literature search of available, existing information and industry knowledge.
- **Conduct interviews** with a variety of industry organizations, land owners and other stakeholders, such as relevant State divisions, to verify and yield additional information and data.
- **Inventory natural resources** in the Study Area.
- **Inventory existing infrastructure** in the Study Area.
- **Identify Susitna River crossing location options and possible transportation corridors** based on identified opportunities and constraints related to the identified resources
- **Identify next steps** for further project development**.**

1.5 Report Contents

This report is generally structured in a way that depicts the methodology used for this study.

- **Section 1** of this report provides background information and explains the general approach methodology used to conduct the study.
- **Section 2** presents an inventory of known natural resources in the Study Area.
- **Section 3** identifies the existing transportation and energy infrastructure in the Study Area.
- **Section 4** describes previously-identified alignments and explains the methodology for developing the access routes through an opportunity and constraints analysis.
- **Section 5** presents the proposed access routes, and **Section 6** evaluates them.
- **Section 7** summarizes the findings of the study and suggests the next steps for further project development.

The following documentation has supported the development of this study:

- Appendix A Preliminary Design Criteria Report
- Appendix B Proposed Access Routes Map Index
- Appendix C Geotechnical Reconnaissance Report
- Appendix D Cost Estimate Details
- Appendix E Annotated Bibliography
- Appendix F Economic Considerations

2 RESOURCE INVENTORY

This section documents the potential natural resource development opportunities, exploration projects, and other resource areas that could benefit from surface access on the west side of the Susitna River. One of the reasons for conducting a resource inventory is to help identify the termini; in other words, if a surface access road is warranted, where would the road begin and end.

2.1 Data Collection and Interviews

Resource information was obtained based on a literature search of available, existing information and industry/area knowledge. Subsequent interviews verified and yielded additional information and data. Projects already occurring in the Study Area are in various stages, between proposed, exploratory, or even further along in project development. It is important to note that leases (number and acreage) are not fixed and are constantly changing.

The resource categories inventoried in this study are:

- Mineral Resources
- Oil and Gas Resources: Exploration and Production Activities
- Forestry/Timber and Agricultural Resources
- Alternative Energy Resources
- Recreation Resources

In addition to data collection through literature research, the study team conducted interviews or attempted outreach with the industry representatives and other stakeholders listed below. Some of the interviews were extensive and provided detailed information, while other entities contacted provided only general information. The following contacts were made:

- Alaska Department of Fish and Game (ADF&G), Marla Carter and staff
- Alaska DNR, Division of Agriculture, Resource specialist Erik Johnson
- Alaska DNR, Division of Forestry (DOF), Palmer Area Forester Rick Jandreau
- Alaska DNR-DGGS, Geologist Robert Gillis, Engineering Geology Section Chief De Anne Stevens, and Mineral Resources Section Geological Scientist and Acting Chief Melanie Werdon
- Alaska DNR, Division of Mining, Land and Water (MLW), Division of Land Planning Unit Manager Ray Burger and Division of Land Natural Resource Specialist Liz Sherwood
- Alaska DNR, DOG, staff
- Alaska DNR, Division of Parks and Outdoor Recreation (DPOR), Matanuska-Susitna (Mat-Su)/Copper Basin area Park Superintendent Wayne Biessel and Susitna Ranger District Chief Ranger John Wilber
- Alaska Energy Authority, Susitna-Watana Hydroelectric Project Engineering Manager Bryan Carey
- Alaska Mental Health Trust (AMHT) Land, Energy & Minerals Senior Manager Rick Fredericksen
- Alaska Oil and Gas Commission, Statistical Technician Jenni Hunt
- Apache Alaska Corporation, Lisa Parker
- Aurora Gas, LLC, George Pollock

- Beluga Coal Company/Barrick Gold Corporation, Senior Advisor Cy Wilsey
- Cook Inlet Energy, LLC, President JR Wilcox
- Cook Inlet Region, Inc. (CIRI), Lands Manager Dara Glass and staff
- Kenai Peninsula Borough (KPB), Land Management Division, Land Agent Dan Conetta
- Kenai Peninsula Economic Development District (KPEDD), Programs Manager Carrie Coeuy
- Kiksa Metals Corporation, CEO Jason Weber
- Linc Energy, Inc., General Manager Corri Feige and Special Projects Manager Marty Rutherford
- Matanuska-Susitna Borough (MSB), Transportation and Environmental Manager Brad Sworts
- Millrock Resources, Inc., CEO Greg Beisher
- On-Line Exploration, President and Vice-President Jim and Devin Adler, respectively
- PacRim Coal, LP, Project Manager Dan Graham

The study team attempted to reach out to other organizations, although some declined to be interviewed; these include Alaska Energy Corporation; Donlin Gold, LLC; Hilcorp Alaska, LLC; and ConocoPhillips Alaska, Inc. The study team also attempted to reach out to the following entities, although no contacts were made or information requests were not returned: Ormat Technologies, Inc., and tourism-related groups including the Anchorage Chamber of Commerce and Mat-Su Convention and Visitors Bureau.

The lengthier interviews consisted of asking approximately 30 questions. Table 2-1 summarizes interviewees' responses to the question regarding the usefulness of an access road from the Parks Highway to their prospective sites or lands interests. Other information is integrated directly into each resource subsection of the report.

The study team did not contact individual claim owners. It is possible that individual claims may also be more attractive economically with increased access.

Table 2-1. Entities Contacted and/or Participated in the Resources Interviews

Entity	Brief description of entity and resource interest. *Response to question regarding usefulness of an access road from the Parks Highway to prospective site?*
HARDROCK MINERALS AND COAL INTERESTS	
Kiska Metals Corporation	Resource interest: Copper, gold, silver. Whistler project and other prospects. 144,000 acres. *"Kiska considers an access road very useful and is strongly supportive."*
Millrock Resources, Inc.	Gold and copper exploration. Estelle, Cristo, Distin prospects. 56,000 acres. An access road would be "*very useful, but recognize that the State should not build roads to exploration projects but to more advanced projects with identified resources." A preferred route would be to Tyonek.*
On-Line Exploration Services, Inc.	Gold, copper, molybdenum, possibly iron. Prospects: Estelle, Molly, Beaver Creek, Kichatna. 14,225 acres. *"…supportive of an all season road as being very helpful to keep exploration costs down"* and "*considers road access to be invaluable*."
PacRim Coal, LP	Coal for export. Chuitna Coal Project. 20,450 acres. "*Considers an access road very useful and is strongly supportive." Has previously considered rail or road links, but is cost prohibitive if self-financed.*
Beluga Coal Company	17,580 acres of coal leases with 8,000 acres of fee-simple leases with CIRI. No current active exploration. *An access road would be "quite useful."*
Linc Energy, Inc.	Underground Coal Gasification exploration. Two licenses covering 98,700 acres. *An access road would be "100% helpful" and "strongly endorsed."*
Cook Inlet Region, Inc. (CIRI)	Multiple projects and land holdings in the Beluga/ Tyonek area. *Prefers development of a deep water port rather than surface road access.*
Donlin Gold, LLC	Advanced gold exploration project. Project mostly outside of Study Area. Declined interview request. *Stated they did not wish "to be included in the roads for resources program."*
OIL AND GAS INTERESTS	
Apache Alaska Corporation	Conducting 3-D seismic exploration operations and exploratory drilling. *"…would be pluses and minuses to a West Susitna access road to the region; the road would make the area more useful and more economically efficient and not restricted by weather (e.g., barging and ice, flying and visibility)."*
Aurora Gas, LLC	Approximately 45,000 acres of leases. In operations and development drilling phases. Just completed drilling two new wells. "Access is a priority" and a *West Susitna access road "would be very useful." "We will take any way we can get stuff there as long as it is timely, cost effective, and consistent delivery all season. We do not care about alignments. It is access, which is the priority. We would work around right of ways."*
Cook Inlet Energy, LLC	Currently in exploration phase. Approximately 680,000 gross acres and five potential targets. *A West Susitna access road "would allow us to execute exploration programs significantly faster and cheaper. It would lower development costs and operating costs. It would shorten development time and lengthen field life, which would in turn have a positive effect on project economics and the size of our recoverable reserves. In short, it would be a powerful stimulus to oil & gas exploration and production in the area."*
ConocoPhillips Alaska, Inc.	Part owner in the Beluga River natural gas field. Declined interview request. *"ConocoPhillips has a neutral position on the importance of accessing the West Susitna region by land. While land access could be useful, it is not considered critical for operation of the BRU or future development."*
Hilcorp Alaska, LLC	Operates a number of units in the Study Area. Declined interview request. *"While Hilcorp would consider land access to the West Susitna Region useful, there are currently no projects that would be directly impacted by road access."*

Entity	Brief description of entity and resource interest. *Response to question regarding usefulness of an access road from the Parks Highway to prospective site?*
OTHER INTERESTS	
Alaska Department of Fish and Game (ADF&G)	*"ADF&G generally supports access to fish and wildlife resources, but also realizes that regulatory changes may need to be considered in the future to adjust to changes in public use and harvests."*
Alaska Department of Natural Resources (DNR), Division of Agriculture	Approximately 50,000 acres classified as potential agricultural opportunities, as adopted in the Susitna Matanuska Area Plan adopted in 2011.
DNR-Division of Forestry (DOF)	Proposed Susitna State Forest includes 33 parcels totaling approximately 763,200 acres. Proposed forests managed for a long-term timber supply for local processors.
DNR- Division of Geologic and Geophysical Surveys (DGGS)	Conducting a mapping project in the Beluga/Tyonek area and is collecting baseline geologic data for potential energy systems from surface rock exposures. Published a brief overview report in April 2013 summarizing recent reconnaissance field data collection in the Susitna Basin. *"All properties would benefit from road access."*
DNR-Division of Mining, Land and Water (MLW)	Prepared the 2011 Susitna Matanuska Area Plan, which addresses land management policies for major resources in the Susitna Basin.
DNR-Division of Oil and Gas (DOG)	Provided information on producing gas units in the Susitna Basin.
DNR-Division of Parks and Outdoor Recreation (DPOR)	*"There would be a great deal of interest for people to go there just to explore as it would provide access to an area that is currently difficult to access."*
Alaska Mental Health Trust Land	AMHT has extensive oil and gas leases and coal leases in the southwest portion of the Study Area. *Supportive of surface access, in light of current logistical challenges of accessing area (e.g., lack of barging in the winter).*
Matanuska-Susitna Borough	Supports agriculture and forestry/timber opportunities on MSB lands. Has previously identified alignments between existing road network to the Little Susitna River.
Kenai Peninsula Borough	KPB lands are located near Tyonek/Beluga. *Is satisfied with existing road network on their lands.*
Kenai Peninsula Economic Development District	Recently prepared a Cook Inlet Infrastructure Study. *"Surface access to the Tyonek region would be very beneficial."*

2.2 Mineral Resources

Alaska's mining industry includes exploration, mine development, and mineral production. This section discusses hardrock mineral exploration activities, placer gold mining activities, and coal exploration and development activities in the Study Area. Figure 2-1 and Figure 2-2 depict mineral resource activities in the Study Area. In the Study Area, most of the mineral resources are held under mining claims; however there are some leases (generally in the Petersville area).

What are the State of Alaska's goals for *Subsurface Resources* in the Susitna Matanuska Area?

Opportunities for Mineral Exploration and Development. Provide opportunities through State land management for the exploration and development of mineral resources.

Economic Opportunities. Provide economic opportunities and stability by managing State lands for the efficient and environmentally sound:

- transfer of minerals from uplands to transport vessels;
- disposal of tailings;
- development of State land and submerged land mining sites; and,
- siting of infrastructure to support development of mineral resources.

Environmental Quality and Cultural Values. When developing subsurface resources, protect the integrity of the environment and affected cultural features to the extent feasible and prudent.

- excerpted from the Susitna Matanuska Area Plan for State Lands
(DNR-DMLW 2011: 2-48)

At the second annual Alaska Strategic and Critical Minerals Summit[7] held on November 30, 2012, DNR Commissioner Daniel Sullivan presented the following values in terms of what mining brings to the State of Alaska:

- In 2011, the gross mineral production value from Alaska totaled $3.8 billion, up 16 percent since 2010.
- Mineral ore production had an export value of $1.8 billion in 2011, nearly 40 percent of Alaska's total exports.
- In 2011, mineral exploration investment in Alaska totaled $365 million - accounting for about one-third of the total spent on exploration in the U.S.
- $2.8 billion has been spent on mineral exploration in Alaska since 1981.

[7] Alaska 2nd Annual Strategic and Critical Minerals Summit. November 30, 2012. Presentation slides: http://dnr.alaska.gov/commis/priorities/2012_minerals_summit_slides.html.

Figure 2-1. Mineral Resources: Hardrock and Gold Placer Mining

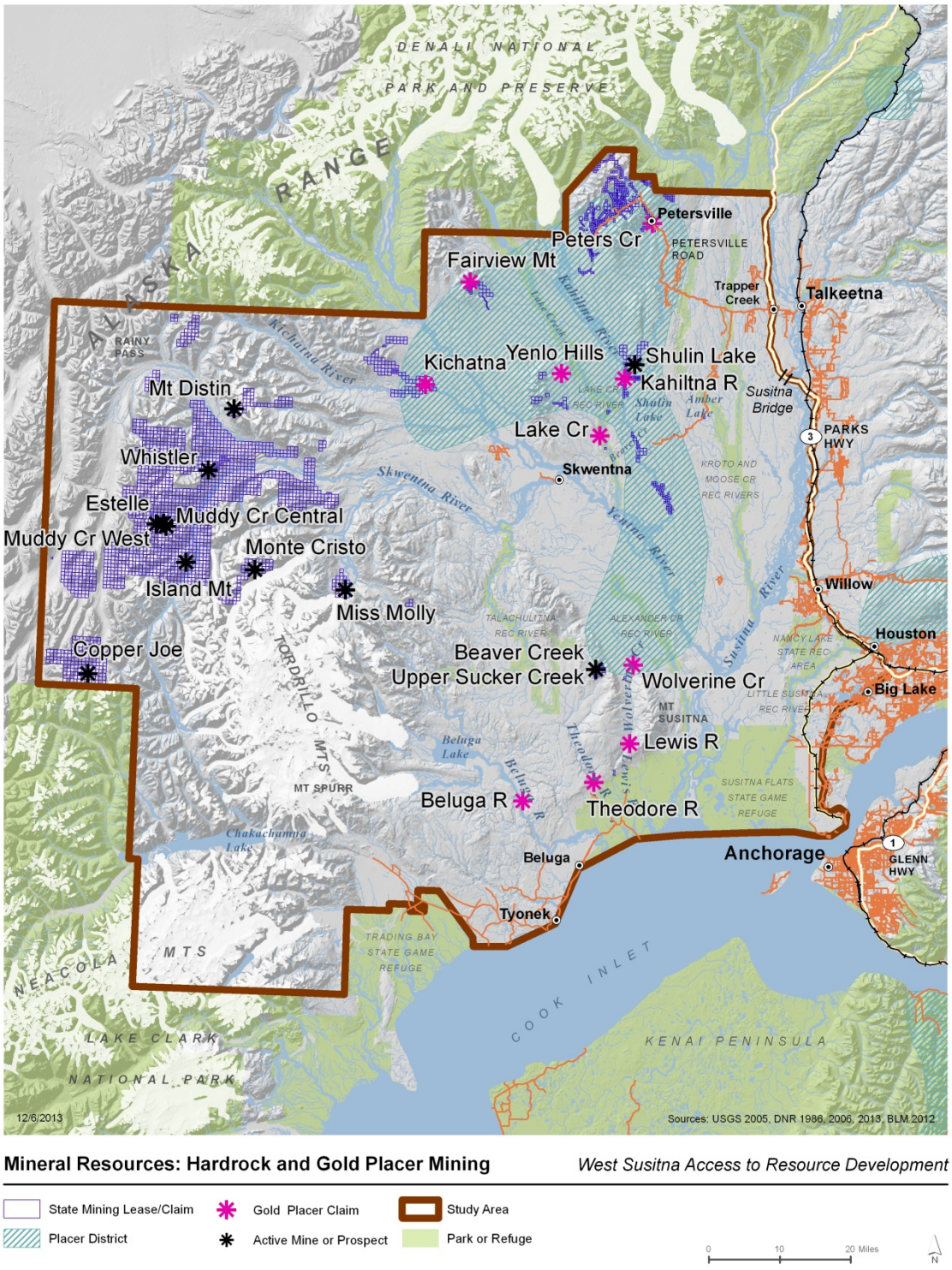
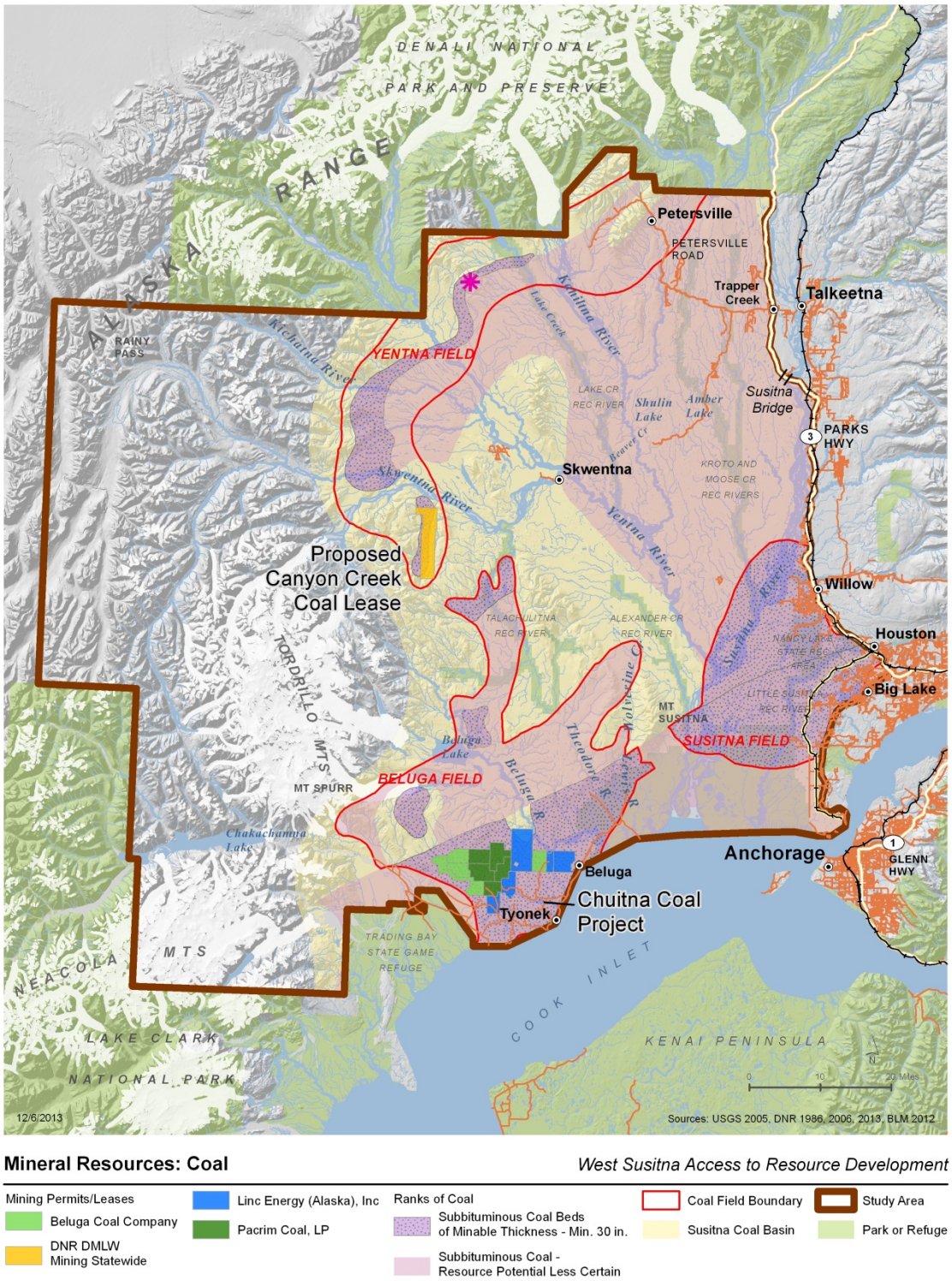


Figure 2-2. Mineral Resources: Coal



2.2.1 Hardrock Mineral Exploration Activities

There are more than 3,000 active mining claims in the Study Area. The highest concentration of claim activity is in the northern portion of the Tordrillo Mountains in the Alaska Range near Rainy Pass area. Commodities include copper, gold, silver, molybdenum, iron, platinum group elements (PGE), and possibly diamonds. The larger hardrock mineral exploration activities are shown in Table 2-2.

Table 2-2. Major Hardrock Mineral Exploration Activities in the Study Area

Company	Project/Prospect Name	Resources/Commodities	Size (acres)
Kiska Metals Corporation*	Whistler mainly, also Island Mountain and Muddy Creek	Copper, gold, silver	144,000
Millrock Resources, Inc.*	Estelle, Cristo, Distin	Copper, gold	119,150
Intercept Alaska, Inc.	A single claim block (JL claims)	Copper, gold	17,760
Kennecott Exploration Company	Copper Joe	Copper, gold, molybdenum	16,000
On-Line Exploration Services, Inc.*	Estelle, Molly, Beaver Creek, Kichatna	Copper, gold, molybdenum, possibly iron	14,225
Alaska Earth Sciences (AES)	Four claim blocks (55 claims)	Primarily copper and gold; silver	8,750
Shulin Lake Mining Company	Moderate-sized claim block (57 claims)	Gold, PGE, possibly diamonds	4,860

Source: DNR-DGGS Alaska Mineral Resources Map: www.dggs.alaska.gov/webpubs/dggs/mp/oversized/mp149_sh001.pdf

* Companies that were interviewed.

The study team conducted interviews with three mineral resource exploration companies that have some of the larger and more active prospects in the Study Area. These are Kiska Metals Corporation, Millrock Resources, Inc., and On-Line Exploration Services, Inc. Interviews have been summarized in this section, particularly with respect to existing activities, identified transportation needs, and site facility/infrastructure needs. Information about other major hardrock mineral exploration activities and claim holders is included in this section as well. Even though the proposed Donlin Gold Mine is located outside of the Study Area, a component of that proposed project extends into the Study Area and is therefore included in this discussion.

Kiska Metals Corporation

Kiska is currently in the exploration stage and their resource interest is copper, gold, and silver. Kiska holds a large number of claims in the Rainy Pass area, having acquired 921 claims from 2003 to 2011, which covers an area of 144,000 acres. Kiska's largest prospect is Whistler, which covers most of the 144,000 acres. Other prospects include Island Mountain and Muddy Creek. Kiska said in a best-case-scenario, they are at least five years from production. Kiska has not formally applied for any mine permits. For the Whistler prospect, economic modeling estimates production at a rate of 11 million tons per year for 13 years, with the possibility of expanded operations based on sufficient and suitable material to mine and process on adjacent properties. While the conceptual mine life is estimated to be 13 years, Kiska said they would like to develop sufficient reserves for a 17- to 20-year mine life.

Table 2-3 contains a summary of the resource estimates for Kiska's Whistler deposit, as directly reported in technical documentation prepared in compliance with National Instrument (NI) 43-101.[8]

Table 2-3. Kiska's Whistler Deposit Resource Estimates, 2011

	Tonnes and Grade					Total Contained Metal			
Resource Category	Tonnes (Mt)	Gold (g/t)	Silver (g/t)	Copper (%)	Gold Eq[2] (g/t)	Gold (Moz)	Silver (Moz)	Copper (Mlbs)	Gold Eq[3] (Moz)
Open Pit Resource									
Indicated[1]	79.2	0.51	1.97	0.17	0.88	1.28	5.03	302	2.25
Inferred[1]	145.8	0.40	1.75	0.15	0.73	1.85	8.21	467	3.35

Source: Moose Mountain Technical Services. March 17, 2011. Kiska Metals Corporation Whistler Resource Estimate, *Table 19-10 Pit Delineated Resource at Base Case Prices and Costs*.
g/t = grams per tonne; M = million; oz = ounces; lbs = pounds.
[1] Reported within a conceptual pit shell (45 degree pit slope angle) and based on a cut-off grade of $7.5/t adjusted for metallurgical recovery and offsite costs.
[2] Gold equivalent grade calculation was based on 75 percent recovery for gold and silver; 85 percent recovery for copper; USD $990 per ounce gold, USD $15.40 per ounce silver and USD $2.91 per pound of copper.
[3] Totals may vary due to rounding.

During an interview on March 19, 2013, Kiska said it would consider an access road very useful and is strongly supportive of it. Kiska emphasized that a road would be of major assistance for activity, citing that its main advantage would be to lower capital expenses for financing. Kiska said current constraints to development are access and capital markets. Kiska said they will need an all-season road for construction material, mining fleet and fuel delivery, and concentrate removal. Four concentrate-removal round trips and three light-service vehicle trips per day are expected.

Current on-site facilities include a 50-person camp facility, fuel storage and a 3,500-foot-long airstrip. An access road, if present today, would reduce the existing costs of transporting in fuel, material and people. In addition, concentrates must be removed from the site to smelting facilities off-site. At this time, Kiska said they are uncertain whether crews would access the site via an access road or as a fly-in operation. Kiska has initially modeled power needs for a 45-megawatt (MW) power line from Tyonek, but access to other power options remains a consideration, including access to any nearby gas pipelines that might be developed.

Millrock Resources, Inc.

Millrock is currently in the exploration stage and their resource interest is primarily gold and copper. Millrock has a number of prospects located in the Yentna Mining District region near the Rainy Pass area, most notably Estelle, Distin, and Cristo (Figure 2-1). The Estelle prospect is for gold, and Cristo is for possibly gold and base metals. Millrock has 763 claims in the Study Area covering 119,150 acres.[9] Teck-Cominco is a partner on the Estelle prospect area, though Millrock owns 100 percent of all their other prospects. Millrock has not applied for any mine leases and no resource estimates have been made public.

[8] NI 43-101 is used within Canada for reporting the "Standards of Disclosure for Minerals Projects."
[9] The Alaska Resource Data Files (ARDF) contains information regarding mining, prospects, and mineral occurrences in Alaska. Available at: http://ardf.wr.usgs.gov/ (accessed March 2013).

Millrock considers the lack of access roads and power in the immediate area as constraints or limiting factors on their development activity. At this exploration stage, all construction, fuel, and mining equipment needs are supplied by air or ice roads. Millrock indicated that while a West Susitna access road would be "very useful, the State should not build roads to exploration projects but to more advanced projects with identified resources." Millrock stated a road access to their prospect would lower the costs of exploration. Millrock said their preferred road route would be to Tyonek and not necessarily to the existing road system (e.g., Parks Highway), though they would strongly be in favor of a road connection regardless of the route.

Millrock has camp facilities at the nearby Whistler project airstrip. If exploration is successful, a range of facilities and buildings would be required, including a camp for onsite worker housing. If exploration is successful power would also be needed and access to any nearby gas pipelines would also be beneficial.

On-Line Exploration Services, Inc.

On-Line has several prospects in the Study Area that are currently in the exploration stage with unknown production start dates. The lode-prospects are gold and copper at Estelle (approximately 875 acres); molybdenum at Molly (4,372 acres); copper and gold with possibly iron at Beaver Creek (1,578 acres); and placer-gold only at K N Resources Kichatna (7,400 acres). Estelle and Molly are 100 percent owned by On-Line; exploration on the other two prospects is managed by On-Line. None of these lode prospects have had any previous mining, with one exception. A record of minor placer production has occurred at the Kichatna placer prospect.

At this exploration stage all exploration equipment, fuel, and camp supplies are transported by air or ice roads, but On-Line was supportive of an all-season road and said it would help keep exploration costs down. On-Line said the constraints or limiting factors on activity include access to roads, power, financing, and support resources such as helicopters during peak season for exploration. On-Line considers road access to be invaluable. A surface road would lower the costs of exploration through reduced costs of fuel equipment and personnel.

On-Line currently has an airstrip located at the Molly and Kichatna prospect locations, and has proposed a runway length expansion from 3,500 feet to 5,000 feet. Other infrastructure needs include power and gas or electric. On-Line also identified the need for access to fiber optic lines for communications.

Kennecott Exploration Company

Kennecott Exploration Company holds the Cooper Joe claim block, which is located about 20 km southwest of the Whistler block. The Copper Joe claim block covers 16,000 acres and the resource interests are copper, gold, and molybdenum. Kiska reports that they have entered into a non-binding letter of intent with Kennecott to acquire a 100 percent interest in the Copper Joe Property.

Intercept Alaska, Inc.

Intercept Alaska, Inc. has a single claim block covering 17,760 acres west of Kiska's Whistler prospect. No drilling has been reported at the claim block. Resource interest is for gold and copper.

Alaska Earth Sciences

Alaska Earth Sciences has four claim blocks (consisting of 55 claims) in the Study Area totaling 8,750 acres. The blocks are located 10 to 20 km northwest of the Whistler block, with one claim

block located east of the Molly claim block. Resource interest is for copper, gold, and silver. Alaska Earth Sciences also provides logistical support for a number of other projects in the Study Area, including CIRI's underground coal gasification (UCG)[10] project at the Beluga Coal Field, the Mt. Spurr geothermal project, and Linc Energy's drilling program in the Beluga Coal Field.

Shulin Lake Mining Company

A moderate-sized claim block (57 claims over an area of 4,860 acres) exists in the Shulin Lake area. The area is reported as having significant concentrations of heavy mineral sands containing some gold and PGE values[11]. Some of the claims appear to be held for placer minerals, but Shulin Lake Mining Company has marketed the property as having diamond potential[12],[13], and at least 22 drill holes were completed on the property. No follow up work has been reported after 2005.

Teryl Resources Corporation

Teryl Resources is a junior precious metals exploration company listed on the TSX Venture Exchange with properties in the Fairbanks area. Teryl maintains a small claim block peripheral to Kiska's claims located approximately 14 miles east of the Whistler prospect. Teryl's claims cover an area of 3,680 acres and partially surround a smaller claim block held by Mark Farrar.

Individual claim holders

Three individuals are listed as claim holders around the Whistler area. Mark Farrar has 14 claims (1,872 acres). The earliest claims were staked in 2004 with additions in 2009 and 2010 before being encircled by Teryl in late 2010. Three more claims were added in 2011 adjacent to two claims held by David Fikill.

Donlin Gold, LLC

The proposed footprint of the actual Donlin gold mine is located outside the Study Area to the west of the Alaska Range. However, components of the Donlin project may pass through the Study Area in the future if the project is constructed as proposed. Donlin Gold, LLC is proposing a number of project elements including an open pit that is 2.2 miles long by 1 mile wide by 1,850 feet deep, a camp, an approximate 300-mile buried natural gas pipeline that would run through the Study Area, and other infrastructure (e.g., airstrip, access road, new barge landing, power plant, conveyor systems, mill, labs, and wastewater treatment plant). The proposed natural gas pipeline would be constructed from Cook Inlet, at the west end of the Beluga Gas Field, to the mine site, which is located approximately 10 miles north of the village of Crooked Creek on the Kuskokwim River west of the Alaska Range. Gold mining operations at the mining site would consist of energy-intensive processes, and past discussions have occurred as to how the 120-140 MW of power would be obtained at the site. Previous ideas to meet the energy needs have included barging the diesel upstream to the mine site, building a coal plant, and purchasing gas from the Cook Inlet area (which is the primary option currently under consideration). The permitting and environmental phase of

[10] UCG is an in-situ gasification process that converts coal into gas without the use of traditional surface or underground mining methods. A mixed gas feedstock is produced through the controlled combustion of underground coal seams.
[11] ARDF, TL048
[12] ARDF, TL078
[13] DNR-DMLW Coal Program. October 8, 2013. Comments provided during a review of a draft of this report indicate the diamond claims have not been confirmed and may be speculative.

this project began in January 2013. Donlin Gold, LLC declined a request for an interview for this study.

2.2.2 Placer Gold Mining Activities

Placer gold was found in the Susitna basin in the early 1900s.[14] Alaska does not distinguish between lode and placer claims, so some speculation is necessary as to the activities conducted on mining claims. The inferred State placer claims in the Study Area cover an area of 45,133 acres and are held by 113 DNR-identified claim holders. The four largest claim holders by acreage are K N Resources, LLC (7,400 acres), Jim D Espinola (7,234 acres), Daniel R. Freitas, (2,862 acres), and Diamond Gold Corporation (2,123 acres). This section includes a general description of the placer gold prospects and claims in the Study Area.

Petersville/ Peters Creek

There are 94 individual claim holders to 499 claims and leaseholds over an area of approximately 20,957 acres and 13 State mining leases over an area of 3,976 acres who likely are involved in placer mining in the Petersville area. A number of claims overlap or are "overstaked," which increases the apparent acreage. In addition, there are 4 federal claims predating statehood, whose claimants have elected to maintain their claims. The Petersville area is already served by public road access from the Parks Highways and by temporary ice roads during the winter for planned seasonal delivery of larger quantities of material.

Kichatna River

Since 2009 a large claim block has developed in the Kichatna River drainage, located approximately 25 miles west northwest of Skwentna between the Yentna and Skwentna River drainages. Two groups (K N Resources, LLC and Jim D Espinola) have almost equally claimed a total of 14,634 acres. The only known prospect within or close to the claim blocks is an historic placer prospect with undetermined production[15]. Assessment work claimed by one of the groups references prospecting, brush clearing, and line cutting in preparation for geophysical surveys, but no drilling. It is thought that these claims are being held for their placer potential.

Kahiltna River

Daniel Frietas holds 72 claims along the Kahiltna River downstream from Shulin Lake, covering an area of 2,862 acres, all of which appear to be placer claims. The claims comprise two blocks separated by approximately 13 miles. Between these two claim blocks is a third, 21-claim block covering 1,600 acres, also targeting heavy mineral deposits along the Kahiltna River centered on the confluence of the Kahiltna River and Beaver Creek. A trend of four small claim blocks extends from the confluence of Beaver Creek northeasterly towards Amber Lake. Small-scale production is reported from placer mines in the vicinity of Daniel Freitas' southern claim block[16].

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[14] Bureau of Public Roads. August 1959. *A Description of Proposed Road Routes in Alaska: Talkeetna-McGrath-Ruby*. Compiled and written by Rose Komatsubara and William DeArmond, under the direction of Elmer Biggs, Acting Planning and Research Engineer. p.15.
[15] ARDF, TL49
[16] ARDF, TL27, 28, and 29

Lake Creek

Four different parties hold eight claims along and adjacent to Lake Creek. There is no evidence for more than minor assessment work on these claims.

Yenlo Hills

Two parties hold 23 claims covering an area of 2,340 acres. Half the claims were added in the past two years. One of the claimants, Diamond Gold Corporation, reports bedrock-hosted Au-bearing veins on their Yenlo claims exposed by trenching[17].

Fairview Mountain

There are 3 placer gold prospects in the Fairview Mountain area, which lies 6 miles southwest of Lake Chelatna. The most northerly is Pass Creek, which has recorded production of gold and PGE back to the turn of the last century (ARDF, TL24). There are three groups that hold 16 claims covering 401 acres. The 2 other prospects in the Fairview Mountain area are Mills and Twin Creeks, both southerly flowing drainages and with historic placer production[18]. Four individuals hold 2,066 acres as State mining claims.

Wolverine Creek

Wolverine Creek is the northerly flowing drainage between Mt. Susitna and Little Mt. Susitna, and is part of the planned route for the Donlin Creek gas pipeline. Two active claims currently remain on Wolverine Creek, a recorded placer prospect location, but in earlier affidavits referenced, up to 11 claims exist till 1990[19]. There is no recorded production.

Lewis Creek, Beluga and Theodore Rivers

Placer gold was reported as actively mined prior to 1918. As recently as the 1980s a significant number of placer claims were held along the Lewis, Beluga, and Theodore River drainages. At present only five remaining claims exist, and annual affidavits indicate no active production is occurring.

2.2.3 Coal Exploration and Development Activities

Alaska possesses a significant amount of the world's remaining coal resources. The majority of Alaska's coal is located on the North Slope, followed by the Cook Inlet region and other areas.[20] The only active coal mine in Alaska, the Usibelli Coal Mine, is located outside the Study Area; it has been active for more than 40 years.

A study prepared by the USGS in 2004 divided the estimated coal resources in Alaska into three major provinces: Northern Alaska-Slope, Central Alaska-Nenana, and Southern Alaska-Cook Inlet[21] (which includes the Study Area). Of the two latter provinces, the report found that only a small fraction of the identified coal resources has been produced (over 40 million short tons or 36 million

[17] ARDF, TL75
[18] ARDF, TL59 and TL26
[19] ARDF, TY006
[20] DNR-DGGS. 2012. *Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska.* Edited by Robert Swenson et al.
[21] USGS. 2004. Alaska Coal Geology, Resources, and Coalbed Methane Potential.

metric tons) of the more than 13.5 billion short tons (12.25 billion metric tons) that are estimated to occur in these two provinces.

DNR-DGGS has requested the recognition that while this study considers the recent exploration and development activities, there is the potential for coal development beyond the currently active prospects. Table 2-4 highlights the estimated coal resources potential in or near the Study Area. See also Figure 2-2.

Table 2-4. Estimated Coal Resources Potential in or near the Study Area

Coal Province and Field	Coal Rank	Identified Resources (Short tons)	*Hypothetical Potential Sale Value ($)*	Hypothetical Resources (Short tons)	*Hypothetical Potential Sale Value ($)*
Cook Inlet-Susitna Province					
Beluga Field	Subbituminous	10 billion	*$153.4 billion*	30 billion	*$460.2 billion*
Yentna Field	Subbituminous	1 billion	*$15.3 billion*	2.5 billion	*$38.3 billion*
Susitna Field	Subbituminous	110 million	*$1.7 billion*	2.3 billion	*$35.3 billion*

Source: DNR-DGGS. October 8, 2013. Comment provided by Jim Clough during a review of a draft of this report. Potential sale revenue was calculated by multiplying the resource quantity by the average sales price of coal nationwide in 2012 (an average state sales price was not available). This was recorded as being $66.04/short ton (Bituminous), $15.34/ short ton (Subbituminous), and $80.21/short ton (Anthracite). For those fields that are thought to have multiple coal ranks, an average was used (per U.S. Energy Information Administration (EIA) 2012 Annual Coal Report; available at: http://www.eia.gov/coal/annual/).

There are a variety of types of proposed coal development projects in the Study Area, which are at varying stages of project development. Due to past and present mining activity, the geology of this region is moderately well understood.[22] Active leases for surface coal reserves exist in the Study Area. The State is considering the decision to hold a coal lease sale in the area of Canyon Creek, which is depicted on Figure 2-3. The Cook Inlet region is also being evaluated for underground coal gasification (UCG) potential. UCG eliminates the need to mine and transport the coal to a power plant, as well as the costs associated with reclaiming the surface-mined coal areas.[23]

Coal projects or areas of interest in the Study Area include:

- Alaska Energy Corporation's proposed Canyon Creek Coal lease
- PacRim Coal, LP's Chuitna Coal mine project in the Beluga coal field – in advanced permitting stage
- Beluga Coal Company– active leases for surface coal reserves in the Beluga coal field
- Linc Energy Alaska, Inc., Cook Inlet Region, Inc. (CIRI)/Stone Horn Ridge, LLC – UCG testing in the Beluga coal field
- Coal-to-liquid plant considerations

Portions of the Study Area hold potential for development of coalbed methane (CBM). In what has more recently become a viable energy resource in the Lower 48, CBM is hindered by many unique challenges and has not yet proven to be economically viable. See Section 2.3.2 on CBM resources within the Study Area.

[22] DNR-DGGS. 2012. *Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska.* Edited by Robert Swenson et al.
[23] Ibid.

For coal resources, the study team conducted interviews with following companies: PacRim Coal, LP; Beluga Coal Company, and Linc Energy, Inc. The study team also discussed the study with Cook Inlet Region Incorporated (CIRI), Knikatnu, Inc., Tyonek Native Corporation, and Chickaloon-Moose Creek Native Association at a meeting held on April 11, 2013. Interviews have been summarized in this section, particularly with respect to existing activities, identified transportation needs, and site facility/infrastructure.

Alaska Energy Corporation (Proposed Canyon Creek Coal Leases)

In 2012 the State of Alaska entered a regulatory best interest finding (BIF)[24] in favor of holding a competitive coal lease in the Canyon Creek area. DMLW issued the BIF based on Alaska Energy Corporation's interest in exploring coal resources in the Canyon Creek area. The proposed lease area covers approximately 13,175 acres and is located 30 km southwest of Skwentna, within the center of the Study Area. DNR estimated the total of the Measured, Indicated, and Inferred Resources within the proposed Canyon Creek coal lease area as approximately 257.9 million short tons of sub-bituminous coal. In July 2013, DNR issued a "Final Finding and Decision" to offer the coal lease.[25]

The proposed Canyon Creek Coal leases are located about 40 miles north of the proposed Chuitna Coal Project, and about 15 miles east of the Whistler prospect. The DNR-DMLW's *2012 Preliminary Decision Competitive Coal Lease Sale in the Canyon Creek Area, Alaska*[26] includes a chapter (Chapter 7) devoted to potential routes for the transport of coal. Figure 2-3 depicts the location of the Canyon Creek proposed lease area and potential transportation routes relative to Kiska's Whistler project as depicted in that report.

[24] DNR-DMLW. 2012. *Preliminary Decision: Competitive Coal Lease Sale in the Canyon Creek Area, Alaska.* http://dnr.alaska.gov/mlw/mining/CanyonCreekPBIF.pdf (accessed March 2013).
[25] DNR-DMLW. 2013. *Final Finding and Decision.* http://dnr.alaska.gov/mlw/mining/coal/canyon_creek/Notice_of_Final_Decision_for_Canyon_Creek_Coal_Lease_Sale.pdf (accessed July 2013).
[26] DNR-DMLW. 2012. *Preliminary Decision: Competitive Coal Lease Sale in the Canyon Creek Area, Alaska.* http://dnr.alaska.gov/mlw/mining/CanyonCreekPBIF.pdf

Figure 2-3. Previously Identified Transportation Routes Relative to the Proposed Canyon Creek Coal Lease Area and Kiska's Whistler Project

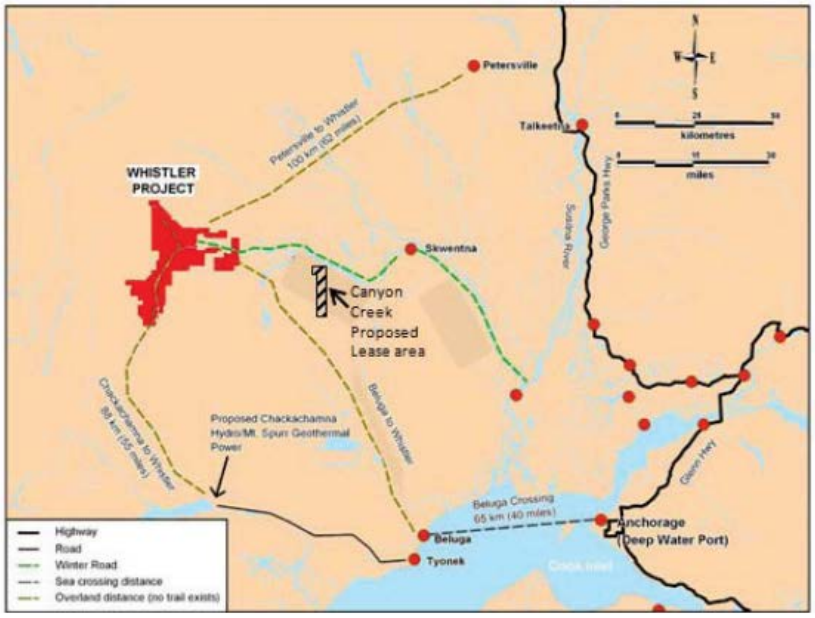

Figure 6.2- Location of the Whistler Project Area and potential transportation routes relative to the Canyon Creek Proposed Lease area (Kiska Metals 2012).

Source: DNR-DMLW. 2012. Preliminary Decision: Competitive Coal Lease Sale in the Canyon Creek Area, Alaska.

A limited amount of drilling has occurred in the past, though additional drilling would be required to prove the coal reserves.[27]

PacRim Coal, LP (Chuitna Coal Project)

PacRim holds a coal lease to 20,450 acres located 12 miles northwest of Tyonek on the north side of Cook Inlet. Within their coal lease, PacRim has identified 300 million tons of minable resource referred to as the Chuitna Coal Project. This deposit has a long history of development activities: exploration in 1968, leases in 1972, and drilling and permitting in the 1980s. The permitting process was reinitiated in 2005; however, a permit application for the mine has not been submitted for the project as of the end of 2013. At present the project is in the supplemental environmental impact statement (EIS) phase, with permitting plans for an open pit mine with an estimated annual production of 12 million tons.[28] Historical proposed start dates for production are as early as late 2014 to 2016. Approximately 5,000 acres would be used for mining operations, with 1,000 acres of support facilities. After an initial 2-year construction phase, the proposed life of the mine is 25 years, followed by reclamation. PacRim anticipates the project will employ up to 500 people during construction, with 250 people onsite and 350 people total during operations.

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[27] Alaska Coal Association. December 2012. *State of the State's Coal Industry*. Presented to the Resource Development Council. www.akrdc.org/membership/events/breakfast/1213/graham.pdf (accessed March 2013).
[28] DNR-DMLW. Chuitna Coal Project Description. Large Mine Permitting webpage. http://dnr.alaska.gov/mlw/mining/largemine/chuitna/ (accessed July 2013).

PacRim said they have significant transportation needs. At present, all supplies for construction and operation are planned to be barged in. During operation, in excess of 10 million gallons (Mgal) of fuel will be needed, which is also anticipated to be barged in. PacRim considered rail and road links, but those were determined to be uneconomical if self-financed. An access road would significantly reduce barge traffic and allow crew changes by bus or private vehicles. Air transport can be limited during bad weather, which makes planning difficult. Barges are very expensive as well.

In its present planned configuration, the site is designed to operate as an independent operation without road connectivity. Operations consist of transporting the coal from the mine site by an 8-mile conveyor to Ladd Landing and then a 2-mile conveyor offshore to a ship load out platform.[29]. Limited mine and transportation facilities currently exist at the site. PacRim uses a camp at the Beluga airstrip and accesses their site via helicopter. Proposed facilities include an onsite camp, deepwater port/loading facility, vehicle workshop area, coal and fuel storage, warehouse, road access from tidewater, conveyor system, crusher, and wash facilities. For power, PacRim plans to build a six-mile tie-in to the Beluga power plant and access the gas pipeline for heating needs.

Beluga Coal Company

The Beluga Coal Company is owned by Barrick Gold Corporation[30] and CIRI. The Beluga Coal Company holds a total of 17,580 acres of coal leases either adjacent to or in close proximity to PacRim's leases. Development activity on the Beluga Coal Company holdings is not as advanced as its PacRim's. Most recently, in 2008, they applied for exploration permits on their Beluga coal leases. No published resource estimates are available, but the geologic continuity suggests similar development opportunities exist as on the PacRim leases. There is no active exploration or development. The project is currently on "care and maintenance" status and is anticipated to remain in this status for the foreseeable future.

Beluga Coal has transportation needs for all levels of exploration and currently uses barges into Tyonek to access the project. Barging is the only current viable transportation mode.

Quantities and schedule of production are unknown at this time. Coal would likely be sent directly to ships from near the mine site area and not be transported on the road system for export. Other infrastructure needs include power and camp facilities.

Linc Energy, Inc.

Linc Energy, Inc. is exploring UCG projects near Tyonek and Beluga that consist of an in-situ method of producing a mixed gas feedstock through the controlled combustion of underground coal seams. Linc has two coal exploration licenses[31] on Alaska Mental Health Trust (AMHT) Authority lands adjacent to and east of PacRim's Chuitna Coal Project. These two licensed areas are called the Kenai and Tyonek, as depicted on Figure 2-4. Presently, these two exploration licenses constitute a total of 98,700 acres under the lease. The Tyonek exploration license will be converted partially or entirely into a three-year coal lease area starting in 2014. Linc has until 2017 to decide its selection in the Kenai bloc, where the terms are for a seven-year lease interval. Exploration is

[29] DNR-DMLW Coal Program. October 8, 2013. Comments provided during a review of a draft of this report.
[30] Barrick Gold Corp. also owns 50% of the Donlin Creek project.
[31] Linc Energy, Inc.'s 2011 exploration permit application describes exploration methods/activities and existing environmental conditions. Available at: http://dnr.alaska.gov/mlw/mining/coal/linc-tyonek/LincEnergy-Tyonek-Area-Exploration-Application-10192011a.pdf (accessed March 2013).

currently ongoing, with additional coal core drilling planned for the summer of 2013. Linc said they anticipate commencement of production in 2016 to 2017. However, according to the DNR-DMLW, the anticipated 2016 production schedule is unlikely since Linc has not started baseline studies or completed sufficient geotechnical work to meet the Alaska Surface Coal Mining Control and Reclamation Act (ASCMCRA) requirements. UCG synthesis gas (syngas) production is anticipated in 2016. Linc said there are sufficient coal resources for more than 70 years of production. All estimates to date are economic modeling constrained and set at 35 years. Access logistics and cost are the limiting factors on activity.

All fuel equipment and supplies currently have to be either flown in or barged. This material could all feasibly be brought to the project by road if one were available. For workforce access, Linc said they would prefer site access by road.

Three products will be produced and are expected to be transported off-site by pipeline. During peak construction, Linc said they could potentially have 1,000 people onsite, but even during operations they would expect 200 people onsite. Linc said they will need electric power for the start-up phases of gas-to-liquids or synthetic natural gas facilities, or syngas-cleanup facilities. An operating liquids facility will generate excess electricity and steam. The site is expected to be in operation for 30 to 50 years.

Cook Inlet Region, Inc. (CIRI)

CIRI is a major landholder in the Beluga/Tyonek area. Stone Horn Ridge, a joint venture of CIRI and Laurus Energy, Inc., is seeking to develop UCG on CIRI-owned land north of Beluga. Stone Horn Ridge is moving to develop a UCG project (to access coal energy without mining) and to initiate commercial operations and production as soon as 2015. However, according to the DNR-DMLW, the anticipated 2015 production schedule is also unlikely due to a lack of baseline studies and sufficient geotechnical work necessary to meet the ACMCRA requirements.

Other Identified Coal-to-Liquid Plans

- A Beluga Coal Gasification Feasibility Study was prepared in 2006 for the National Energy Technology Laboratory, which was to determine the economic feasibility of developing and siting a coal-based integrated gasification combined-cycle plant in the Cook Inlet region of Alaska for the co-production of electric power and marketable by-products.[32]
- In late 2010, Tyonek Native Corporation signed an agreement with Accelergy to develop a coal-to-liquids plant on Tyonek land on the west side of Cook Inlet. The facility would produce aviation fuel, gasoline, and diesel.
- The Alaska Natural Resources to Liquids LLC has previously partnered with the AIDEA to promote plans for an 80,000-barrels-per-day (bpd) coal-to-liquid plant near the Beluga Coal fields near the communities of Tyonek and Beluga.

[32] Research & Development Solutions, LLC (RDS)/Science Applications International Corp. (SAIC). 2006. *Beluga Coal Gasification Feasibility Study*. Prepared for National Energy Technology Laboratory. Available at: www.netl.doe.gov/technologies/coalpower/gasification/pubs/pdf/Beluga%20Coal%20Gasif%20Feasibility%20Study9_15_06.pdf (accessed March 2013).

2.3 Oil and Gas Resources

2.3.1 Current Exploration and Production Activities Snapshot

Active oil and gas exploration continues to occur in Northern Cook Inlet. According to DNR, recent drilling has proven new reserves in existing fields. Cook Inlet oil production peaked at 230,000 bpd in 1970, dropping to about 10,800 bpd in FY 2012.[33] As of early December 2013, there are 398 leases in Cook Inlet totaling 1.12 million acres, of which about one-third are on-shore and two-thirds are off-shore.[34] Figure 2-4 depicts the on-shore oil and gas leases and activities in the Study Area.

There are nine producing oil and gas units and fields in the Study Area (in Northern Cook Inlet and the Susitna Basin), as detailed in Table 2-5.[35] Table 2-5 shows the cumulative production since the inception for each of the units found in the Study Area. The Beluga River Unit is a major supplier for local electric utilities and home gas usage in the Anchorage area.

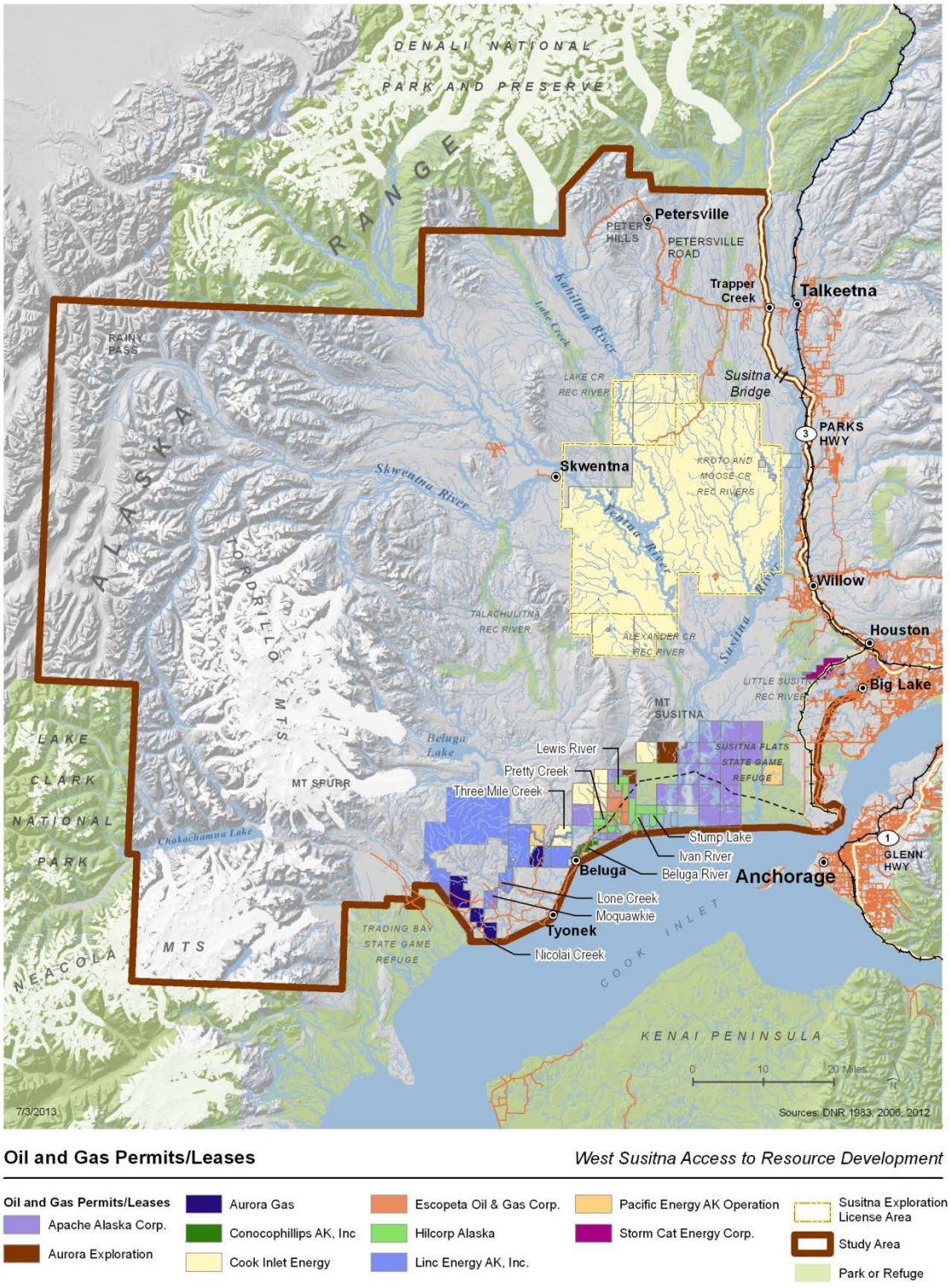
Table 2-5. Oil and Gas Units/Fields in the Study Area, as of November 2013

Unit/ Field	Current Ownership (%)	Inception	Size (acres)	Number of Wells*	Cumulative Production		
					Condensate (barrels [bbl])	Water (bbl)	Gas (millions of cubic feet [MCF])
Ivan River **	Hilcorp: 99.8 uncommitted: 0.2	1990	2,295	6	0	33,872	84,283,767
Stump Lake	Hilcorp: 100	1990	4,880	1	0	505	6,647,923
Beluga River ***	ConocoPhillips: 50 MOA: 33.33 Hilcorp 16.67	1963	8,227	26	0	1,966,167	1,269,300,564
Lewis River	Hilcorp: 100	1984	620	3	0	13,113	14,313,420
Pretty Creek **	Hilcorp: 100	1986	4,600	2	0	17,252	9,540,022
Three Mile Creek	Aurora Gas: 50 Cook Inlet Energy: 50	2005	3,320	2	0	28,719	2,381,336
Lone Creek (CIRI)	Aurora Gas: 100	2003	n/a	3	0	33,467	9,933,627
Moquawkie (CIRI)	Aurora Gas: 100	1967	n/a	5	0	7,582	4,914,788
Nicolai Creek	Aurora Gas: 100	1968	470	6	1	56,764	8,034,348

Source: Personal communication with Alaska Oil and Gas Conservation Commission (AOGCC).
Note: AOGCC maintains production data. Production numbers are as of October 31, 2013.
* Number of completed wells that have been completed and not been plugged and abandoned, as of December 11, 2013.
** There are two gas storage leases in the Study Area: Ivan River and Pretty Creek.
***Cumulative production for Beluga River is approximately 1.3 trillion cubic feet.

[33] Resource Development Council Webpage. *Alaska's Oil & Gas Industry Background.* Available at: www.akrdc.org/issues/oilgas/overview.html (accessed March 2013).
[34] DNR-DOG. December 2013. *Active Oil and Gas Lease Inventory* Webpage. Available at: http://dog.dnr.alaska.gov/Publications/OGInventory.htm (accessed December 2013).
[35] DNR-DOG. 2012. *Cook Inlet Land and Lease Working Interest Ownership* Map. Available at: http://dog.dnr.alaska.gov/Publications/Documents/CookInlet/Maps/Working_Interest_Ownership_Cook_Inlet_2012Dec.pdf (accessed March 2013).

Figure 2-4. Oil and Gas Resources



Apache Alaska Corporation

As of early 2013, Apache is conducting on- and off-shore programs in the Northern Cook Inlet region. Apache's programs consist of conducting extensive 3-D seismic operations in large areas using nodal technology for offshore, onshore, and transition zone acquisition. The land-based seismic analysis has been conducted on land owned by Tyonek Native Corporation and subsurface land owned by CIRI, as well as on State-owned lands. On-shore, Apache is drilling their first Cook Inlet well (Kalachabuna #2, or K2) on CIRI acreage located northeast of Nicolai Creek on the southern end of the Study Area.[36] Apache said these efforts will help identify potential locations for drilling in the future. Another well, Kalachabuna 1, was drilled in 1980 by a different company at the time.

Apache said they need product before a pipeline, and they do not currently have alignments for roads or infrastructure identified. Apache said they have a good working relationship with the Native Village of Eklutna and Tyonek Native Corporation. According to Apache, the Native Village of Eklutna advocates that Apache use existing infrastructure and not build a road, citing their concern that opening this area with a road would ruin the value and the subsistence lifestyle for residents.

The current workforce accesses the area by air, unless traveling by land directly from Tyonek. Apache recognizes there would be pluses and minuses to a West Susitna access road to the region. The road would make the area more useful and economically efficient, and access would not be restricted by weather (e.g., barging and ice, flying and visibility).

Apache currently has temporary camp facilities and a drill waste disposal pit near Tyonek. Apache said they have approximately 60 workers onsite. There is a potential for an 80-person camp in the future, should multiple locations for additional exploratory drilling be identified. When possible and feasible, Apache uses existing facilities. Apache said the area is pretty good for its power needs.

Based on results from testing, the existing drilling will be wrapped up in summer 2013. At this time, Apache is not sure where this project will go next. They have no concentrate or finished product, but would hope to transport gas and oil by pipeline. There are no estimated volumes at this time. Operations would be years away.

Aurora Gas, LLC

Aurora Gas, LLC is in the operations and development drilling phases. Aurora stated they have four units in the southern portion of the Study Area and recently drilled two new wells. The units are Three Mile Creek Field, Lone Creek, Moquawkie Unit, and Nicolai Creek Unit. Aurora is targeting shallow gas in these units and Apache bought the deep rights. The size of Aurora's lease area is approximately 45,000 acres. Aurora said they are in partnership with Cook Inlet Energy, Inc. on the Three Mile Creek wells. Aurora said production could vary annually, but they plan to be in production for 10-15 years. Aurora said there are more leases to drill after obtaining the seismic data from Apache.

Aurora said that access is a priority and a West Susitna access road would be very useful. Fuel comes in by barge or is flown in at a greater expense. There are no roads. Aurora said they need all forms

[36] DNR-DOG. December 2012. *Cook Inlet Oil and Gas Activity Map.* Available at: http://dog.dnr.alaska.gov/GIS/Data/ActivityMaps/CookInlet/Cook_Inlet_Oil_and_Gas_Activity_Map_20121206.pdf (accessed March 2013).

of transport. Like Apache, Aurora experienced transportation infrastructure difficulties when the Chuit bridge was washed out in 2012. This impacted their activities at Lone Creek and the Three Mile Creek locations. The implications of the bridge washout meant employees who are residents of Tyonek had to be flown into the project sites, which resulted in additional costs of lodging, rental vehicles, etc.

Aurora has a few existing production facilities, including a well house, with additional new well facilities on the way. Long-term infrastructure needs include a 40-person camp. Aurora said they are self-contained for power.

Cook Inlet Energy, LLC

Cook Inlet Energy, LLC (CIE)[37] provides oil and gas extraction services and currently has two active exploration operations north of Beluga called Olson Creek and Otter. CIE also has a large land position in the Susitna basin. CIE has approximately 680,000 gross acres and five potential targets at this time. According to DNR records, CIE has a 30 percent stake in the Three Mile Creek lease (gas production facilities). Natural gas production and/or oil could begin as early as 2014, although CIE is still in the exploration phase and planned annual production is not yet determined. The projects would be developed only if economically viable, which presupposes certain minimum production rates. An economically viable project would typically have a life of at least 20-30 years.

In early 2013, CIE constructed a trail from Willow to the Yentna River with a snow road and ice bridge over the river. CIE said property owners and visitors in the Skwentna/Yentna/Deshka area appreciated and made extensive use of the snow road because it provides a route to points west that is safer and shorter than running over the Susitna and Yentna rivers. CIE said the new trail saved travelers to Skwentna 34 miles round trip from Willow.

CIE said they fly or barge in most of their fuel and supplies to the Beluga area. Drill rigs and other equipment get barged in at Tyonek. In the Susitna area, access has been overland by way of ice bridges and snow roads. CIE currently has no air support capabilities in the Susitna area, but said they would develop landing areas prior to drilling. CIE said they will need to bring in supplies for pipelines and surface facilities. Crews would be brought in by fixed-wing aircraft. CIE plans to barge out large volumes of drilling mud and cuttings. Building roads and pads requires heavy equipment.

Currently, crews are either local or coming in via air. If a road were available, crews might drive in from Tyonek or the Mat-Su Valley. CIE has been actively improving and expanding a gravel road and pad system in the Olson Creek/Otter area, including a gravel pit and a new bridge across Olson Creek.

CIE has partnered with other companies, such as CIRI, to help improve infrastructure on the west side of Cook Inlet. CIRI's affiliate, Stone Horn Ridge, is using the Coffee Creek pad for their UCG exploration and is in the same area as Olson Creek and Otter. CIE has two pads and a drill rig in the Olson Creek/Otter area.

CIE may construct facilities, pipelines, and/or camp(s) at Olson Creek, Otter, and/or their prospects in the Susitna Basin. CIE said they would benefit from the expansion of utilities, such as

[37] The company was incorporated in 2009 and operates as a subsidiary of Miller Energy Resources, Inc., according to Bloomsberg Businessweek, available at: http://investing.businessweek.com/research/stocks/private/snapshot.asp?privcapId=108801500 (accessed March 2013).

power and telecommunications, and would need to make major investments in local transportation infrastructure and pipelines. A gas pipeline connecting the Susitna Basin area to the existing natural gas grid is a significant hurdle.

ConocoPhillips Alaska, Inc.

In Southcentral Alaska, ConocoPhillips owns 100 percent interest in the Kenai Liquefied Natural Gas (LNG) facility and operates the Tyonek Platform in the North Cook Inlet field and the Beluga River natural gas field. The Beluga River natural gas field falls within the Study Area, whereas the North Cook Inlet field does not.

The Beluga River natural gas field serves major customers in Southcentral Alaska, including local utilities and industrial consumers. Net natural gas production averaged nearly 20 million cubic feet per day in 2011. ConocoPhillips Alaska, Inc. has a 50 percent stake in the Beluga River Unit, and co-ventures Municipality of Anchorage (MOA)-Municipal Light and Power (ML&P) and Hilcorp have 33.3 percent and 16.67 percent, respectively.

ConocoPhillips declined the request for an interview. However, they said they have a neutral position on the importance of accessing the West Susitna region by land. They said "while land access could be useful, it is not considered critical for operation of the Beluga River Unit or future development."

Hilcorp Alaska, LLC

Hilcorp has interest in multiple on-shore units in the Study Area in northern Cook Inlet, including Lewis River; Ivan River (with a gas storage lease); Pretty Creek (with a gas storage lease); Stump Lake; and Beluga River Unit, in part with ConocoPhillips Alaska, Inc., and the MOA. Hilcorp's stake in the Beluga River Unit is 16.67 percent.

Hilcorp only recently entered the Cook Inlet market when they acquired all of Chevron, Union Oil Co. of California's assets in 2012. The recent acquisition of Marathon's assets further expanded Hilcorp's holdings to 70 percent of the gas production in Cook Inlet.

Hilcorp declined the request for an interview. However, Hilcorp said while they consider land access to the West Susitna region useful, they currently have no projects that would be directly impacted by road access.

- Oil funds more than half the State budget – 56 percent in fiscal year 2012 – and about 90 percent of State general funds
- "The balance sheet of Alaska history is simple: One Prudhoe Bay is worth more in real dollars than everything that has been dug out, cut down, caught, or killed in Alaska since the beginning of time." – Terrence Cole, Alaska Historian

- Alaska Economic Trends June 2013

(Alaska Department of Labor and Workforce Development; http://labor.alaska.gov/trends/jun13.pdf)

2.3.2 Other Oil and Gas Resources Potential

Oil and gas exploration within Alaska's Railbelt Energy Region, which encompasses most of Alaska's major population centers, has received significant focus in recent years as a means to bring more affordable energy to the region. The DNR-DGGS has recently published a summary of findings on exploitable fossil fuel (e.g., coal [as discussed in Section 2.2.3] and conventional and unconventional oil and gas) and geothermal energy resources in the Railbelt region.[38] This section briefly summarizes available information regarding oil and gas resource potential as it relates to the Study Area (geothermal energy is addressed in Section 2.6).

Conventional Oil and Gas. The Railbelt region contains several important basins that hold oil and gas potential. Within the Study Area, the Cook Inlet and Susitna basins contain resource potential. The Cook Inlet basin, which encompasses the very southern part of the Study Area, has been producing oil and gas since the late 1950s, though production from existing fields has been declining.[39] Ongoing exploration and active leases, however, suggest the potential for additional discoveries, and significant focus in recent years has been on identifying recoverable gas reservoirs to supply future energy to southcentral Alaska. The USGS has estimated that the Cook Inlet Region has 599 million barrels of oil (*est. value $63.3 billion*[40]) and 13.7 trillion cubic feet of natural gas (*est. value $76 billion*[41]) to be discovered.[42] The State of Alaska is attempting to incentivize new exploration by offering major tax credits to private industry.

By comparison, the Susitna basin to the north has experienced relatively little exploration and has no proven economic oil and gas resources. To date, only two wells have been established west of the Susitna River, in 1964 and 1980.[43] Portions of the Susitna basin are eligible for new drilling due to two adjacent exploration licenses issued on State lands in 2003.

Coalbed Methane (CBM). The potential for CBM gas recovery within the Study Area is strong. The USGS recently estimated more than 4.5 trillion cubic feet of coalbed gas (*est. value $25 billion*[44]) remains undiscovered in the greater Cook Inlet area.[45] However, the recoverable amount of coalbed

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[38] DNR-DGGS. 2012. Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska. Edited by Robert Swenson et al. p. 94-112.
[39] DNR-DGGS. 2012. Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska. Edited by Robert Swenson et al.
[40] The estimate of $63.3 billion is based on the forecasted price for fiscal year 2014 for North Slope Oil of $105.68 per barrel.
[41] Potential sale revenue was determined by applying the September 2013 natural gas citygate price (citygate is a point or measuring station at which a distributing gas utility receives gas from a natural gas pipeline company or transmission system). According to the EIA, this value was $5.55/thousand cubic feet. The estimate of $76 billion is based on $5.55/thousand cubic feet for citygate value, per U.S. EIA natural gas prices. Available at: http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SAK_m.htm (as accessed December 2013).
[42] Stanley, Richard G. et al. 2011. Assessment of Undiscovered Oil and Gas Resources of the Cook Inlet Region, South-Central Alaska, 2011. Prepared by the Cook Inlet USGS Assessment Team. Available at: http://pubs.usgs.gov/fs/2011/3068/ (Accessed December 2013)
[43] DNR-DGGS. 2012. Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska. Edited by Robert Swenson et al.
[44] Coalbed gas is considered a component of natural gas. For purposes of deriving an estimated value, the $5.55/thousand cubic feet natural gas price was applied, per U.S. EIA pricing. Available at: http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SAK_m.htm (as accessed December 2013)
[45] Stanley, Richard G. et al. 2011. Assessment of Undiscovered Oil and Gas Resources of the Cook Inlet Region, South-Central Alaska, 2011. Prepared by the Cook Inlet USGS Assessment Team. Available at: http://pubs.usgs.gov/fs/2011/3068/ (Accessed December 2013)

gas, especially within the Study Area, is likely much less due to large regions located offshore that are unlikely to be economically developed.[46] The resource potential is greatest in regions with higher rank coals (bituminous and semi-anthracite coals located outside the Study Area). Regardless, subbituminous coal rank areas (see Figure 2-2) located within the Study Area represent regions with CBM potential. While these areas are vast in size, CBM production in the Study Area is non-existent. A 3-year, collaborative study between DGGS, DOG, and USGS is currently underway to learn more about the Susitna Basin's hydrocarbon potential.[47] Field investigations seek to determine from the coal sampled in the region its potential as a primary fuel source and the capacity of the coalbeds to produce and store methane gas. This study is an important component of the DGGS' multiyear In-State Gas Program. The Tyonek area may hold the greatest potential for CBM resource production within the Study Area due to existing infrastructure of petroleum development.

Other (Unconventional) Natural Gases. Other natural gases potentially present within the Study Area include tight gas sands, shale gas, and gas hydrates. These unconventional gases appear to have greater geologic potential of occurring in the lower Cook Inlet region to the south of the Study Area, and do not hold strong economic potential at present.[48]

[46] DNR-DGGS. 2012. Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska. Edited by Robert Swenson et al. p. 105.
[47] DNR-DGGS. April 2013. Status of A Reconnaissance Field Study of the Susitna Basin, 2011. By Robert Gillis et al.
[48] DNR-DGGS. 2012. Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska. Edited by Robert Swenson et al.

2.4 Forestry/Timber Resources

The State of Alaska owns nearly 2 million acres of identified timberlands in the Mat-Su valley, some of which are located within the Study Area.[49] The 2011 Susitna Matanuska Area Plan, which covers a portion of the Study Area, addresses forest resources in the Susitna Matanuska area as follows:

> Extensive forest resources exist within the planning area. These are scattered throughout the eastern, central, and western portions of the planning area, and total approximately 683,000 acres. The plan identifies these areas and specifies the areas considered appropriate for inclusion in the sustained yield calculations that are made by the Division of Forestry. Those areas with forest resource potential that are designated Forestry in the area plan are considered appropriate for inclusion in a state forest, should the legislature consider the creation of a state forest within the planning area. (p. 1-9)

A large amount of land in the Study Area is currently under consideration for legislative designation as a State Forest. House Bill 79/Senate Bill 28 was introduced to the State Legislature in 2013 and was delayed for review until the next session Figure 2-5. The bill would create a new State Forest in the Susitna Valley and expand DNR authority to offer negotiated timber sales statewide.[50] The proposed 763,000-acre Susitna State Forest, if adopted, would become Alaska's fourth State forest, joining the Tanana Valley, Haines, and Southeast State Forests.

The DNR-Division of Forestry plans to construct an ice road in early 2014 to provide access to proposed timber harvest units along Fish Creek, in the southeastern portion of the Study Area. This approximate 7-mile-long ice road would be extended from the existing West Susitna Parkway, as depicted on Figure 2-6. The proposed road would be located primarily on MSB-owned land but would follow section line easements to the greatest extent possible. An approximate 150-foot-long ice bridge would be constructed over the Little Susitna River. The project is being developed consistent with the 2007 Alaska Forest Resources and Practices Regulations. Depending on funding and need for forest management and timber sale production, the DNR-Division of Forestry may

What are the State of Alaska's goals for *Forest Resources* in the Susitna Matanuska Area?

Personal Use Timber. Provide timber to meet the needs of Alaskans. Subject to limits of funding, staffing, and sustained yield, this program will be provided on a demand basis when the operational costs of administering this program are satisfactory.

Economic Opportunities. Provide for economic opportunities and stability in the forest products industry by allowing the use of State uplands in areas designated Forestry. Also, to benefit the state's and borough's economies by providing royalties to the State from stumpage receipts, and adding to the state's economy through wages, purchases, jobs, and business.

Support Timber Industry. Continue to perform reviews of private timber harvests for adherence to the Alaska Forest Resources and Practices Act and provide the timber industry with information, technical expertise, and management guidance for utilizing forest resources.

- excerpted from the Susitna Matanuska Area Plan for State Lands (DNR-DMLW 2011: 2-21)

[49] Mat-Su Resource Conservation & Development Council and MSB. December 2008 Update. *Mat-Su Comprehensive Economic Development Strategy.*

[50] DNR-DOF. January 22, 2013. *Briefing Paper: HB 79/SB 28: Susitna State Forest and Negotiated Timber Sales.* Available at: http://forestry.alaska.gov/pdfs/whats_new/HB79-SB28_Briefing_paper_1-22-13_v2.doc.

build a single-lane all-season road to the timber areas. (Note: the Fish Creek Management area, also shown on this figure, is further discussed in Section 2.5, Agricultural Resources).

A number of other commercial timber opportunities have been identified. Areas designated for timber sales have been identified in the *MSB Five-Year Timber Harvest Schedule*. According to the *2008 Mat-Su Comprehensive Economic Development Strategy*, the primary use of the timber currently produced in the MSB is for woodchips exported to markets in Asia. It is also possible that once the land for the Chuitna Coal Mine is reclaimed, then there is a vision for commercial timber opportunities.[51]

The DNR forest lands with commercial potential in the Susitna basin are fairly remote. In earlier years, the DNR determined that, based on soil and existing vegetation, remote lands with the highest capability for forestry are located between the Yentna and Susitna Rivers south of Petersville Road; in the Lewis, Theodore, and Beluga River drainages southwest of Mt. Susitna; and between Lake Creek and Donkey Slough.[52]

The DNR 1991 Susitna Forestry Guidelines[53] proposes a three-phase approach to introducing additional timber activity into the Susitna Valley. Phase 1, which is currently underway, includes utilizing the area on the east side of the Susitna River and the Chijuk Creek area, and lands surrounding Mt. Susitna. Phase 2 involves lands east of the Kahiltna River. Phase 3 includes all other State-owned lands.

DNR area planning documents for the Susitna Matanuska area delineates the area into a number of sub-regions. Sub-regions relative to the West Susitna Study Area include the following sub-regions: Petersville Region, Sunflower Basin Region, Susitna Lowlands Region, Mt. Susitna Region, Beluga Region[54], and the Alaska Range Region. Each of these sub-regions is delineated on Figure 2-5 and summarized in Table 2-6 and the paragraphs that follow.

According to the MSB's 2007 Market Analysis and Timber Appraisal Report, the average timber value per acre was $85.23 (for year 2007). As the value of a dollar in 2007 is equal to $1.09 in 2013, the anticipated value per acre in 2013 dollars is $92.90. This assigned dollar value per acre represents an aggregate of high and lower quality timber. With a total of approximately 701,000 acres of potential forest for harvest identified in the Study Area, the expected monetary value in 2013 dollars would be approximately $65 million. This amount only represents the direct value of the timber in 2013 dollars and does not incorporate indirect value such as birch lumber used in cabinetry, spruce used for log home construction, wood chips or personal use firewood. Additionally, these areas would have limitations on the amount of harvestable timber per year to ensure appropriate management practices are adhered. As both the MSB and the State have harvest limits on their identified timber areas to ensure proper management of this resource, resources have been quantified collectively. It is possible with increased access harvest limits could be re-evaluated, but at this time the State has a limit of 3,000 acres per year and the MSB identifying roughly 1,000 acres to be harvest over a 5-year period of time. DNR-Division of Forestry suggests that approximately 3,000 acres of forest land per year would be available for harvest in the total acreage proposed for the Susitna State Forest, which includes but is not limited to the Study Area. According to DNR-

[51] Alaska Mental Health Trust, Trust Land Office. March 15, 2013. Personal communication with AMHT Energy and Minerals Senior Manager Rick Fredericksen.
[52] DNR, ADF&G, and MSB in cooperation with U.S. Department of Agriculture (USDA). June 1985. *Susitna Area Plan.* http://dnr.alaska.gov/mlw/planning/areaplans/susitna/
[53] DNR, Division of Land, Land & Resources Section. December 1991. *Susitna Forestry Guidelines.*
[54] The Beluga Region is unique to the 1985 Susitna Area Plan.

DOF, this acreage is likely to be advertised for private bid in several hundred acre tracts and would likely be on a multi-year contract.[55]

Table 2-6. Forest Resources in the Study Area per DNR Planning Regions

DNR Planning Region	Size (acres)	Specifically-Identified Areas for Potential Forest Harvest	*Hypothetical Applied Direct Economic Value ($)***
Petersville	71,000	Peters Creek, Moose Creek and Kroto Creek areas	*$6.6 million*
Sunflower Basin	15,000	Near Kahiltna River and Lake Creek Corridor	*$1.4 million*
Susitna Lowlands	319,000	Far western edge of Susitna Lowlands; Skwentna River, Alexander Creek, Trail Ridge, west of Lake Creek	*$29.6 million*
Mt. Susitna	219,000	Alexander Creek, Skwentna River, Mount Susitna	*$20 million*
Beluga*	32,000	n/a	*$3.0 million*
Alaska Range	45,000	Limited. Eastern areas of the Region at lower elevations	*$4.2 million*
All planning regions in Study Area	*701,000*	*Assumed total harvest, if acreage is fully realized*	*$65 million*

Source: DNR 1985 Susitna Area Plan, 2011 Susitna Matanuska Area Plan.

*Planning regions were redrawn between the 1985 and 2011 DNR plans. The Beluga planning region is specific to the 1985 Susitna Area Plan. The study team recognizes that the 1985 Susitna Area Plan was superseded by the 2011 Susitna Matanuska Area Plan. However, some information from the 1985 study, such as existing inventories, was considered relevant background to retain and be cited in the West Susitna Access Reconnaissance study, particularly since part of the scope is to identify known resources in the Study Area.

** An assumed value per acre in 2013 dollars is $92.90. This applied economic direct value was based on a market analysis conducted in 2007 in which an average value for timber per acre was available in addition to incorporating inflation. This value does not include indirect or spinoff economic benefits.

[55] DNR-DOF. December 12, 2013. Personal communication with DNR-DOF Mat-Su Area Forester Richard Jandreau.

Figure 2-5. Timber and Agricultural Resources

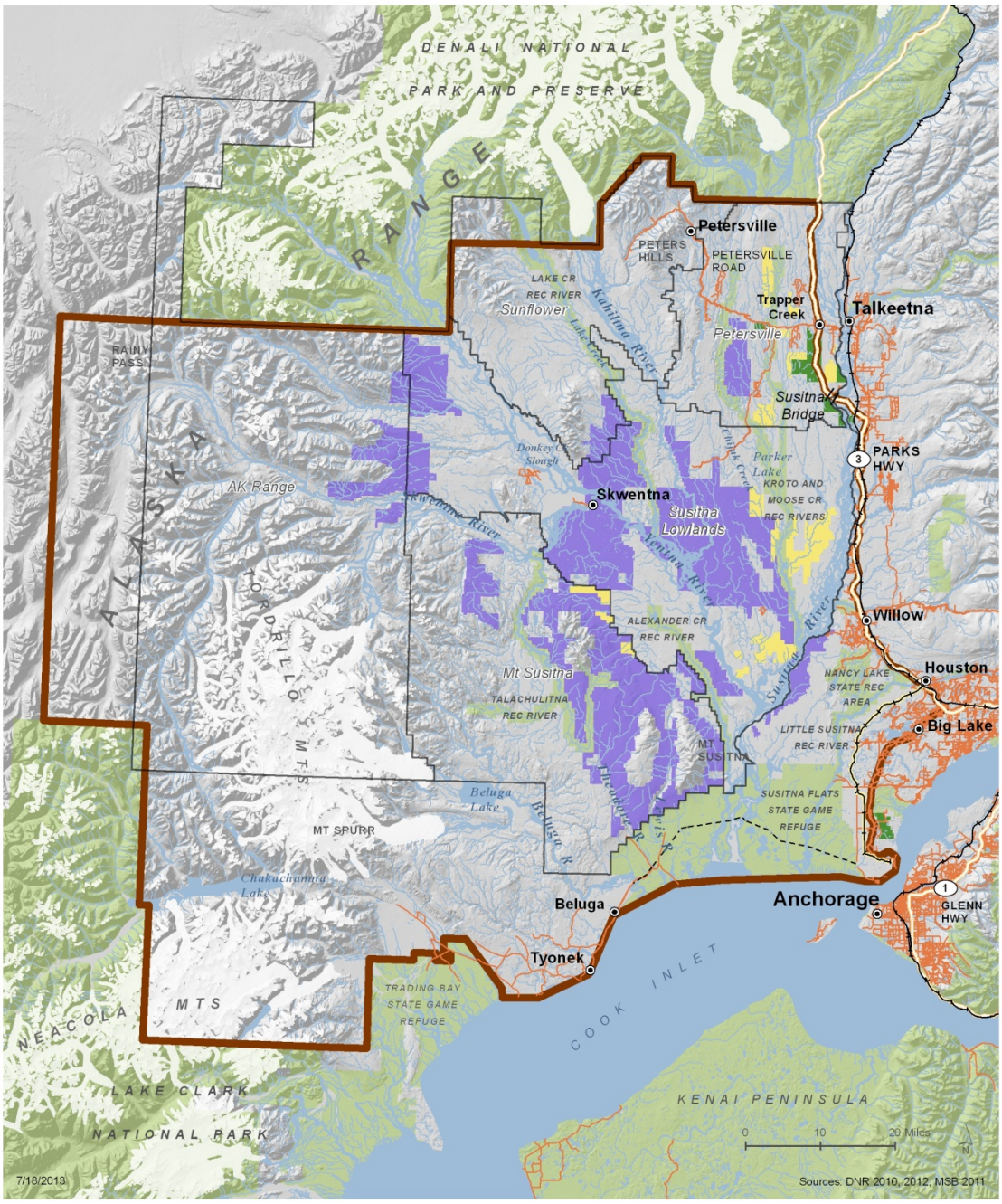
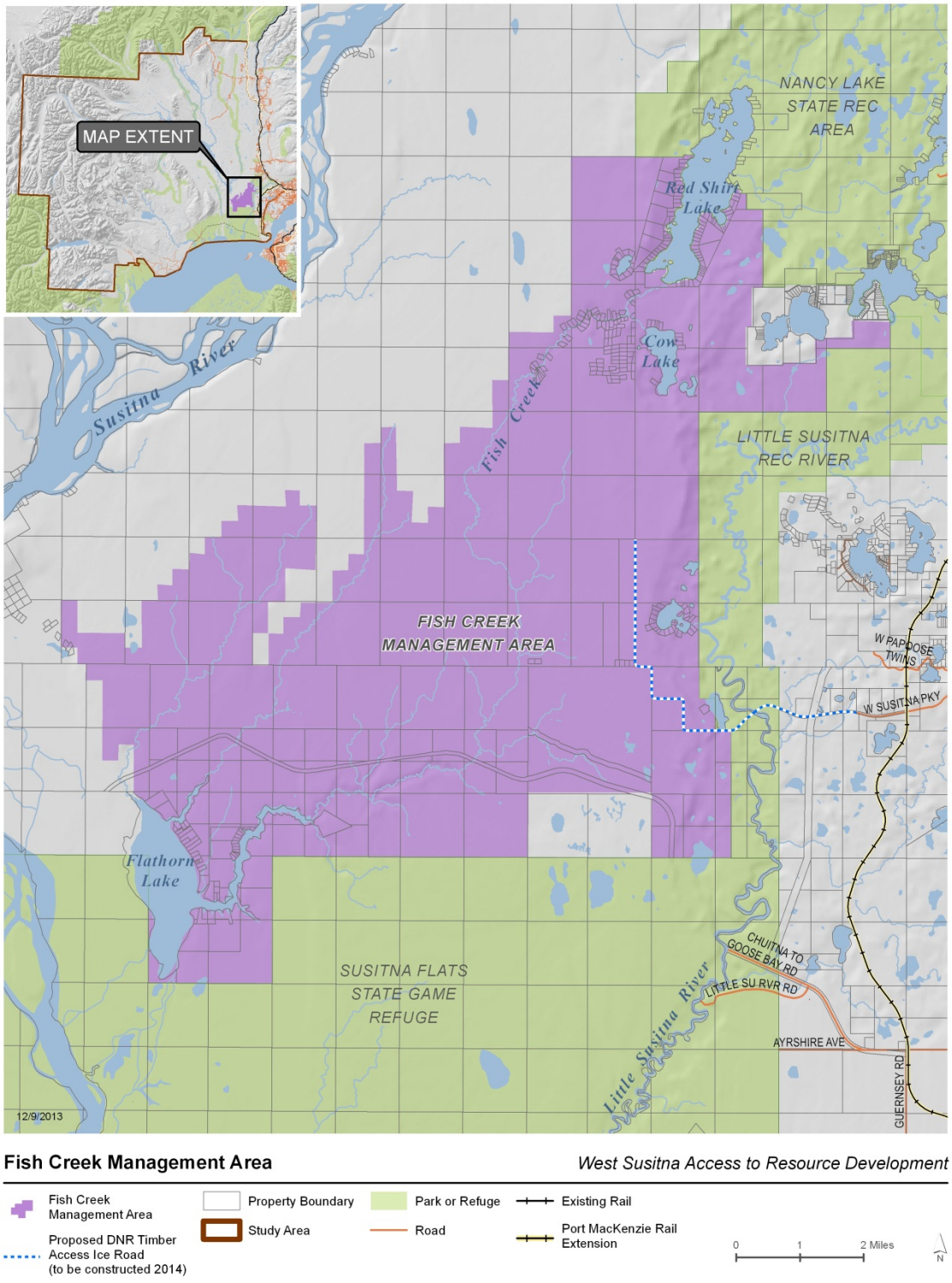


Figure 2-6. Fish Creek Management Area with Proposed DNR 2014 Ice Road



- **Petersville Region.** Approximately 71,000 acres of State land in this area has been identified for forest resource management.[56] This land has been designated as Forestry, with specific locations being considered for timber harvest. Primarily located in the southwestern portion of the subarea (Peters Creek-Kroto Creek area), secondary use forestry tends to be designated along Kroto Creek and Moose Creek.[57]
- **Sunflower Basin Region**. In this subarea, timber use historically was limited to personal use activities (house logs and fuelwood).[58] However, there is a small potential for commercial forestry near the major rivers. Specific areas along the Kahiltna River maintain forest resources and are part of the DNR-DOF's Priority 1 areas.[59] Forestry is also designated as a secondary use area in locations such as the Lake Creek Corridor.[60]
- **Susitna Lowlands Region.** Inaccessibility makes most forest development in this sub-region difficult. However, through improved access, 319,000 acres of State and borough land has the potential for timber management; half of that land has a high or moderate potential to be commercial timber. Historically, designated potential timber lands were located primarily between the Yentna and Susitna Rivers south and west of Parker Lake, along Trail Ridge, and between Lake Creek and the Yenlo Hills.[61] Of this land, 141,400 acres were proposed for legislative or administrative designation to provide for long-term timber management. An additional 465,000 acres of land were retained in public ownership, including 125,000 acres of timberland along the Yentna and Susitna Rivers and Alexander, Kroto, and Moose Creeks, where public recreation and fish and wildlife habitat are the primary uses and forestry could provide a secondary use. In the 2011 Susitna Matanuska Area Plan, upland spruce-hardwood forest was identified near the Kahiltna River, with lowland spruce-hardwood occupying most other areas in the region. Timber resources of "merchantable value" are determined to be primarily located at the far western edge of the Susitna Lowlands Region and between the Skwentna River and Alexander Creek.[62]
- **Mt. Susitna Region.** Forestry resources occur throughout the region, totaling approximately 219,000 acres.[63] Comprised of deciduous forest, evergreen forest, and mixed forest (depending on soils and hydrology), forested lands within the area are located primarily in the central lowlands, west of Alexander Creek and south of the Skwentna River.[64] The Mt. Susitna area encompasses 150,000 acres of potential commercial forestry.[65] The potential for commercial forestry is located primarily within the southeastern portion of the subarea in the lowlands along the Talachulitna River, as well as on the lower slopes of Mt. Susitna and the Little Susitna and Beluga rivers. Areas designated in 1985 as having a high priority for personal use timber harvesting include past and proposed settlement areas such as: High Mt. Lakes; Trinity-Movie Lakes; Hiline Lake; Sunday Lake Remote; Quartz Creek; Lands south of the Skwentna River; and lands south of Mt. Susitna. Presently, it is

[56] 2011 *Susitna Matanuska Area Plan*
[57] 1985 *Susitna Area Plan*
[58] Ibid.
[59] 2011 *Susitna Matanuska Area Plan*
[60] 1985 *Susitna Area Plan*
[61] 1985 Ibid.
[62] 2011 *Susitna Matanuska Area Plan*
[63] 2011 Ibid.
[64] 2011 Ibid.
[65] 1985 *Susitna Area Plan*

not anticipated that forest resources within the area will be harvested for large-scale commercial purposes.[66] The 2011 Susitna Matanuska Area Plan attributes this lack of commercial harvesting to absence of road and bridge access.

- **Beluga Region.** The 1985 plan designated forestry as a primary land use on approximately 32,000 acres. However, this land is also valuable wildlife habitat and maintains coal reserves. The land will be used only for timber harvest until the area is utilized for coal development.
- **Alaska Range Region**. Although some of the eastern areas of the Alaska Range Region contain merchantable timber (spruce and poplar) at lower elevations[67], forestry opportunities in this subarea are limited by slow growth rates and uncertainty associated with timber regeneration.[68]

[66] 2011 *Susitna Matanuska Area Plan*
[67] 2011 *Susitna Matanuska Area Plan*
[68] 1985 *Susitna Area Plan*

2.5 Agricultural Resources

Agriculture has long had a presence in the Mat-Su Valley and was one of the area's first economic drivers. However, agriculture's role in the Mat-Su economy has lessened over the years, with a total value of agricultural production in 2007 at $11.8 million.[69] According to the *2008 Mat-Su Comprehensive Economic Development Strategy*, four dairies operate in the Mat-Su Valley and a variety of other agricultural products are produced, such as:

- Agricultural products: vegetables, beef, dairy, potatoes, oats, hay, and greenhouse plants
- Agricultural-based products: honey, vodka, birch syrup, and candy

A number of factors have had a negative impact on agricultural production, including a limited climate, development completion, and the rising cost of fertilizer. However the Mat-Su Valley residents still value and support agriculture in the area. Some suggest that a major hindrance in the expansion of agriculture is the lack of access to potential agricultural lands in the region. This area encompasses the last large area of State-owned agricultural land in Southcentral Alaska.[70] DNR-identified agricultural areas are depicted on Figure 2-5.

As stated earlier, DNR area planning documents for the Susitna Matanuska area delineates the area into a number of sub-regions and addresses resources within these areas, as summarized on the following page and in Table 2-7.

Table 2-7. Agricultural Resources in the Study Area per DNR Planning Regions

DNR Planning Region	Size (acres)	Specifically-Identified Areas for Potential Agricultural Uses	*Hypothetical Applied Direct Economic Value ($)***
Petersville	20,000	Near existing roadways; near Moose Creek	*$16.1 million*
Sunflower Basin	n/a	Lake Creek area; Kahiltna River	*n/a*
Susitna Lowlands	38,000	Kashwitna Knobs area, west of the Susitna River	*$30.6 million*
Mt. Susitna	7,000	Scattered tracts in lowlands west of Alexander Creek	*$5.6 million*
Beluga*	n/a	Scattered tracts	*n/a*
Alaska Range	n/a	None. Limited potential due to soils, topography and climate	*n/a*
All planning regions in Study Area	*65,000*	*Assumed total harvest, if acreage is fully realized*	*$52.4 million*

Source: DNR 1985 Susitna Area Plan, 2011 Susitna Matanuska Area Plan.

*Planning regions were redrawn between the 1985 and 2011 DNR plans. The Beluga planning region is specific to the 1985 Susitna Area Plan.

** An assumed value per acre is $806.45. This applied economic direct value was based on the 2012 USDA State Agricultural Census, given approximately $25 million of income was produced from crops on nearly 31,000 acres.

[69] 2008 *Mat-Su Comprehensive Economic Development Strategy Update*
[70] 2011 *Susitna Matanuska Area Plan*

According to the U.S. Department of Agriculture (USDA), more than 80% of the 680 farms in Alaska are family owned and operated.[71] Based upon information collected by the USDA as part of an agricultural census in 2012, the final gross earnings for the approximately 680 farms including crops, animals and services and forestry was approximately $41 million, with approximately $25 million of this income produced from crops on nearly 31,000 acres.[72]

Potential Agricultural Uses in the DNR Planning Regions:

- **Petersville Road Vicinity**. The 2011 Susitna Matanuska Area Plan set aside 20,000 acres of State land for agriculture. In the 2011 plan, five of the seven agricultural parcels are located within one mile of existing roadways, while the remaining two flank the west side of Moose Creek. The primary location of the State agricultural lands for this subarea is within the Moose and Rabidux Creek areas.[73] Historical documentation indicates that while some of the areas within the sub-region are deemed suitable for agriculture, some areas are characterized by poor soil conditions and little potential for grazing, making agricultural opportunities in this area sparse.[74]
- **Sunflower Basin Region**. Historical planning documents indicate there is very little opportunity for agriculture in this area, citing lack of road access and remoteness as limiting factors.[75] However, soils suitable for agriculture are scattered throughout the region. Concentrated areas with viable soil are the Lake Creek State Recreation River (SRR) and the floodplain of the Kahiltna River.[76] However, because agriculture use is not permitted within the SRR, only areas adjacent to the Kahiltna River are suitable and available for agricultural use.[77]
- **Susitna Lowlands Region.** Within the Susitna Lowlands region, 38,000 acres of State-owned land is set aside for agriculture, which is almost half of the entire amount set aside for all of the Mat-Su Valley.[78] Most of the State-designated agricultural land within the Susitna Lowlands is concentrated where soils are suitable for agriculture, which results in one large area west of the Susitna River.[79] It is the inaccessibility of this subarea that limits its agricultural production. The 1985 area plan indicated there were approximately 18,000 acres of land designated as having commercial agricultural potential in the Kashwitna Knobs area. In addition, 10,640 acres were also identified as potential agricultural homesteads west of Kroto Creek and southeast of Lockwood Lake.[80]
- **Mt. Susitna Region.** Historical planning documents cite the lack of road access to the sub-region as the reason for large-scale agricultural development being infeasible.[81] Despite the fact that there are few areas with cultivable soils in this area, some areas have been identified

[71] USDA. 2013. USDA Economic Research Service webpage State Fact Sheets, updated as of November 6, 2013. Available at: http://www.ers.usda.gov/data-products/state-fact-sheets/state-data.aspx?StateFIPS=02&StateName=Alaska#P62b07c1d25cc4018a91953cb08af3466_2_39iT0 (accessed 12/13/2013)
[72] 2013 Ibid.
[73] 2011 Ibid.
[74] 1985 *Susitna Area Plan*
[75] 1985 *Susitna Area Plan*
[76] 2011 *Susitna Matanuska Area Plan*
[77] 2011 Ibid.
[78] 2011 Ibid.
[79] 2011 Ibid.
[80] 1985 *Susitna Area Plan*
[81] 1985 Ibid.

along the northern and eastern periphery of the subarea and scattered throughout the western portion of the Mt. Susitna area.[82] Most of the areas suitable for agriculture occur within the SRR area, where agriculture is a prohibited use.[83] Small, scattered areas of land suitable for agriculture lie outside of the SRR area.[84] With a total footprint of approximately 7,000 acres, these small tracts are located predominately in the lowlands west of Alexander Creek.[85] In the 2011 Susitna Matanuska Area Plan, it was determined that agricultural development in the Mt. Susitna region is unlikely due to the relatively scattered distribution of the tracts, their remote location, and the lack of road access.

- **Beluga Region**. There are several pockets of publicly owned cultivable soils in this sub-region, as well as several large blocks of cultivable soils on native lands. However, aspirations for the land are associated more with coal use.
- **Alaska Range Region**. There is little potential for agriculture in this subarea due to its soils, topography, and climate.[86]

Access to the west side of the Susitna River would open access to several areas determined to have agricultural soils and agricultural potential. Specifically, the DNR-Division of Agriculture cites potential access being opened to a larger area known as the Fish Creek Management Area. This area designated a 7,000 acre unit (Lower Fish Creek) as Agriculture and another 11,000 acres were previously designated as Agriculture before the 2009 update (the lands are now designated as "Resource Management"). [87] Figure 2-6 depicts the Fish Creek Management Area boundary. A 337-acre unit was also identified unit adjacent to the Fish Creek Management Area as being designated for future agricultural use.[88]

[82] 1985 Ibid.
[83] 2011 *Susitna Matanuska Area Plan*
[84] 2011 Ibid.
[85] 2011 Ibid.
[86] 1985 *Susitna Area Plan*
[87] DNR-Division of Agriculture. October 8, 2013. Comments provided during a review of a draft of this report.
[88] 2008 *Southeast Susitna Area Plan for State Lands*

2.6 Alternative Energy Resources

Some of the main alternative energy resource opportunities in Alaska include hydroelectric power, geothermal energy, wind power, solar power, and tidal power. Within the Study Area, two types of alternative energy resource projects have been historically studied. These are the Mount Spurr Geothermal and the Chakachamna Hydroelectric projects. See Figure 2-7.

2.6.1 Geothermal Resources: Mount Spurr Geothermal Leases

Geothermal exploration is increasing in the state.[89] For several decades, the State has held geothermal lease sales near the Mount Spurr volcano, which is located about 80 miles west of Anchorage on the west side of Cook Inlet. The Alaska DNR held geothermal lease sales in the 1980s and 1990s, though there was little interest at that time. In 2008, the Alaska DNR held geothermal lease sales for Mount Spurr's southern flank. The leases covered more than 36,000 acres spread over 16 leases. Ormat Technologies, Inc., a geothermal power company, purchased 15 of the 16 leases offered.[90] Ormat initially estimated a 50-megawatt baselode of power from a geothermal power plant could be developed at Mount Spurr.

Since 2008, Ormat has been conducting exploration in the area and assessing the resource. Ormat drilled several test wells in 2010 and 2011, though the results found the formation temperature was half of what was needed for a viable geothermal project. In early 2013, Ormat indicated they will shift their targets to drill sites farther west near the volcano's crater, where subsurface temperatures may be appropriate. As of spring 2013, the project entered a hiatus as Ormat looked into options for a future power plant. Ormat plans to resume drilling in 2014.[91]

In recent years, additional State funds have been contributed to the project, through the Alaska Energy Authority (AEA), for instance. The State approved $18 million for the project in FY2012.[92]

2.6.2 Hydropower Resources: Chakachamna Hydroelectric Project

Over the years, the State of Alaska has considered a number of potential sites for hydropower projects for serving the needs of Southcentral Alaska's communities. The two most notable hydropower projects in Southcentral Alaska are the Susitna-Watana Hydroelectric project and Chakachamna Hydroelectric project. The Susitna-Watana Hydroelectric project site is located on the Susitna River 184 river miles upstream from Cook Inlet and the Chakachamna Hydroelectric project is located approximately 85 miles west of Anchorage on Chakachamna Lake. Both of these projects have been under consideration for a long time. The Susitna-Watana Hydroelectric project location is outside of the Study Area, whereas the Chakachmna hydroelectric project is located within the Study Area.

A proposed hydropower project at Chakachamna Lake has been under consideration for more than 70 years, with a variety of agencies leading the effort, including the Department of Interior, U.S. Army Corps of Engineers (USACE), and the Alaska Power Authority. In 2006, the Federal Energy Regulatory Commission (FERC) granted TDX Power, Inc. a 3-year preliminary permit under

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[89] Alaska Energy Authority and Renewable Energy Alaska Project (REAP). August 2011. *Renewable Energy Atlas of Alaska.* ftp://ftp.aidea.org/AEApublications/2011_RenewableEnergyAtlasofAlaska.pdf (accessed March 2013).
[90] Chat Attermann purchased the other lease. All leases expire October 31, 2018.
[91] Baily, Alan. Anchorage Daily News. May 10, 2013. *Ormat says Spurr geothermal project still in the works.* Available at: www.adn.com/2013/05/10/2898490/ormat-says-spurr-geothermal-project.html
[92] http://omb.alaska.gov/ombfiles/12_budget/CapBackup/proj56386.pdf (accessed March 2013).

Section 4(f) of the Federal Power Act to study the potential for a 300- MW project. The project would have entailed the inter-basin transfer of water from a lake-tap near the outlet of Chakachamna Lake through an approximate 11-mile-long hard-rock tunnel to an underground powerhouse that would discharge to the McArthur River.

The AEA prepared a report in 2010 that considered the two possible project site locations. The report included a risk analysis comparison of the two projects and recommended that the Susitna-Watana project be the primary project for the State to pursue. As such, the State is moving forward on the project and several dozen studies have occurred or are currently underway as part of the FERC process. The AEA plans to file a license application to FERC in 2015 for the Susitna-Watana project.[93] The State is no longer pursuing a hydroelectric project at Chakachamna Lake.

2.6.3 Woody Biomass Resources: Susitna Valley High School Project and the MSB

AEA has increasingly considered the use of woody biomass as an alternative energy resource. This is especially true for small Alaskan communities who, unconnected to the power grid or road system, are forced to have fuel barged or flown in. Use of woody biomass resources has the potential to reduce energy prices substantially in these communities. However, the increase in biomass projects creates an increase in demand for wood resources because biomass generators and wood pellet manufacturers create demand for low-grade timber, which makes previously uneconomical timber tracts profitable for loggers.[94]

As of the summer of 2013, 19 biomass heating projects are operated in that state, with 50 communities expressing interest in starting biomass programs.[95] Within the Study area, one community has received grant money to implement a biomass project (Talkeetna) and the other is undergoing the application process (Tyonek). In 2011, the Susitna Valley High School, located in Talkeetna, was awarded the Woody Biomass Utilization Grant by AEA. The school had been destroyed by a fire in 2007 and reconstruction efforts aimed to provide heating the school with locally available firewood. The primary purpose of the project was to reduce the heating costs that have been rising over time as a result of increases in heating oil prices.[96] However, the community returned the grant money after learning that a renewable core wood system would not meet the design requirements of the new school.[97] In 2008, the Native Village of Tyonek submitted a *Preliminary Feasibility Assessment for High Efficiency, Low Emission Wood Heating in Tyonek*. This study assed the feasibility of implementing biomass systems at the tribal center, snack bar, Boys and Girls Club, Justin Time General Store, and as part of the district heating system. The study found the most practical solution for the community of Tyonek would be to install a centralized heating plant that would then distribute heat to nearby buildings via hot water and insulated underground plastic

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[93] AEA. Susitna-Watana Hydro. Project Description. Available at www.susitna-watanahydro.org/project/project-description/ (accessed March 2013).
[94] Alaska Economic Trends. October 2010. Alaska's Mining Industry *Alaska's Timber Industry*.
[95] Petersen, Karen. June, July, and August 2013. *An Overview of Biomass in the State of Alaska*. Western Forester. Vol. 58 No. 3. Pages 14-15. http://www.forestry.org/media/docs/westernforester/2013/WF_June_July_Aug2013.pdf
[96] MSB. 2010. Susitna_Valley_High School_Biomass Final. Available at ftp://ftp.aidea.org/ReFund_RoundIV_Recommendations/REFundRound4/2_Project_Specific_Docs/economic_analysis_summaries/WordReports/623%20Susitna%20Valley%20HS%20Biomass_final_110310.docx. (accessed November 2013).
[97] Alaska Energy Authority. November 27, 2013. Personal communication with Devany Plentovich, Program Manager - Biomass/CHP, Alaska Energy Authority.

tubing.[98] The community of Tyonek is still working with AEA to acquire a grant and implement the project.

In addition to the projects mentioned above, there is the potential for an increased demand for wood resources as new core wood systems from Europe (a pellet system with a bulk silo) make biomass use in residential homes more economical.[99]

Timber inventories are an important element in determining the viability and sustainability of biomass energy projects. A biomass supply and cost profile was conducted for MSB-owned lands, as detailed in the National Association of Conservation Districts' Woody Biomass Desk Guide & Toolkit document.[100] The profile concluded that a supply of biomass resources was available locally. The MSB owns forest managements units (FMUs) within the Study Area, as listed in Table 2-8 and shown on Figure 2-7. The following FMUs are located within the Study Area and were analyzed in the Biomass Supply and Cost Profile: Matanuska-Susitna Borough-owned Lands, Alaska: Rabideux Creek, Moose Creek, and Susitna River Corridor. Table 2-8 summarizes these specific FMUs.[101]

Table 2-8. MSB-Owned Forest Management Units in the Study Area with Measurable Woody Biomass Yields

MSB- Owned Forest Management Units	Operable Forest Land Acres	Assumed Fuelwood Yield (dry ton/acre/year)	Total Yield (dry ton/acre/year)
Rabideux Creek	1,568	1.0	1,568
Moose Creek	0	1.0	0
Susitna River Corridor	2,330	1.0	2,330

Source: National Association of Conservation Districts n.d. Woody Biomass Desk Guide & Toolkit. Appendix D: Biomass Supply and Cost Profile: Matanuska-Susitna Borough-owned Lands, Alaska.

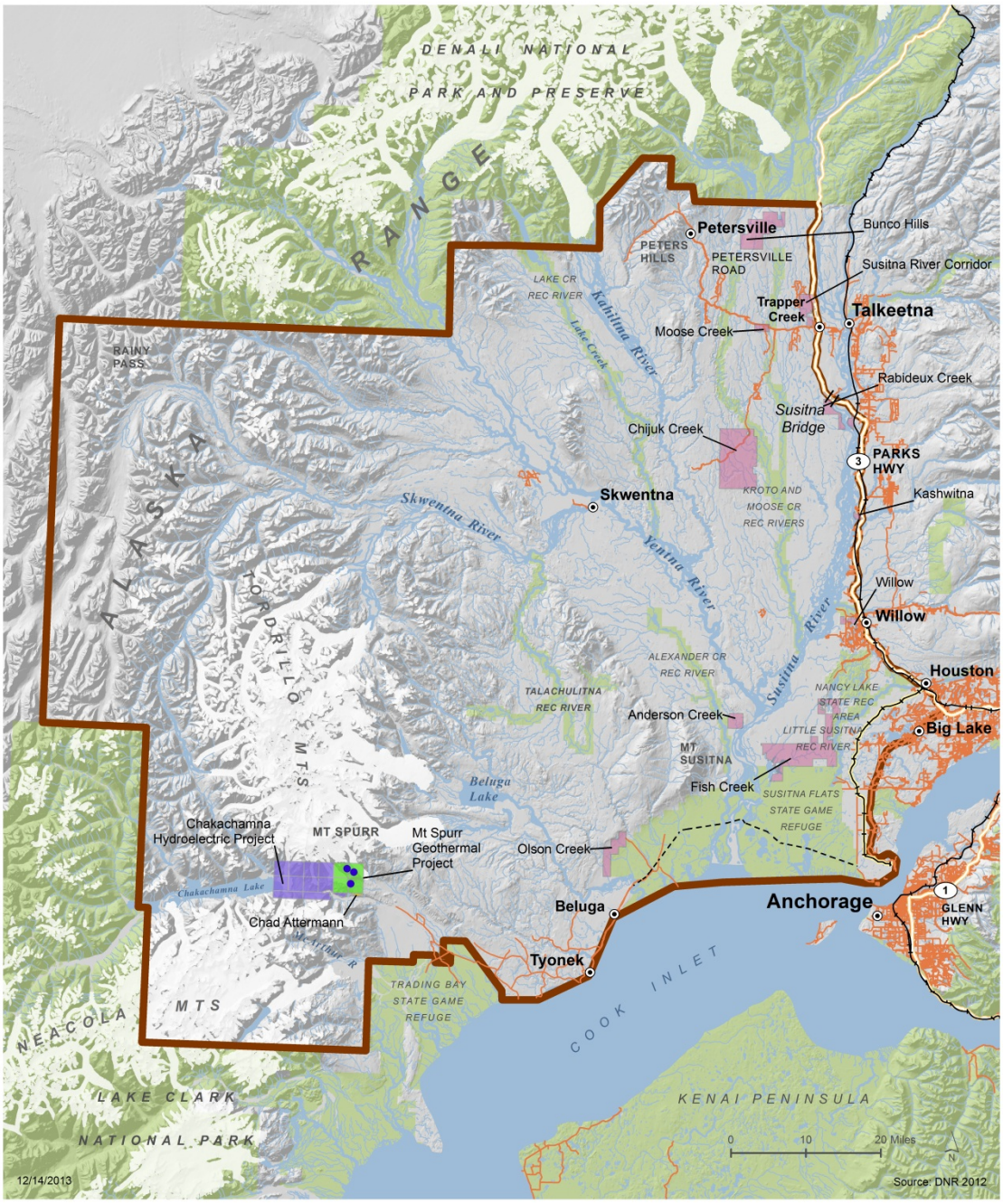
* According to the Woody Biomass Desk Guide & Toolkit (p. 15), pulp wood and commercial-grade timber can be used as an energy or bioproducts feedstock. When used this way, the fiber is called fuelwood.

* Other MSB FMUs are located in the Study Area, but have not been analyzed for quantities of fuelwood (e.g. Chijuk, Montana Creek, Fish Creek).

Unless a project requires 5,000 gallons of fuel or more, all that is needed is a wood stove or a pellet stove; otherwise it would not be economical. However, there are new core wood systems from Europe that will be cheaper and it is hoped that this pellet system with a bulk silo would be used in more residential homes. Early trials in Juneau have found that residential woody biomass systems provide a 40 percent savings on the price of fuel.

[98] Parrent, Daniel. 2008. Juneau Economic Development Council. *Preliminary Feasibility Assessment for High Efficiency, Low Emission Wood Heating in Tyonek.*
[99] Plentovich, 2013
[100] National Association of Conservation Districts n.d. Woody Biomass Desk Guide & Toolkit. Appendix D: Biomass Supply and Cost Profile: Matanuska-Susitna Borough-owned Lands, Alaska. Available at: http://www.nacdnet.org/resources/guides/biomass/pdfs/AppendixD.pdf (accessed November 2013).
[101] National Association of Conservation Districts n.d. Woody Biomass Desk Guide & Toolkit. Appendix D: Biomass Supply and Cost Profile: Matanuska-Susitna Borough-owned Lands, Alaska.

Figure 2-7. Alternative Energy Resources



2.7 Recreational Resources

Recreation is a popular use of State lands in Alaska. A majority of the land within the more than 6 million acres that make up the Study Area is State land, and much of that is considered remote (see Table 4-2). Within the Study Area, the large acreages of undeveloped lands contribute to vast recreational opportunities. The Study Area is well endowed with recreational resources opportunities, from its low-lying areas consisting of fish-filled lakes and rivers to the foothills and mountains of the Alaska Mountain Range. The Study Area is bounded by federally managed recreational lands to the north and southwest: Denali National Park and Preserve and Lake Clark National Park and Preserve, respectively. See Figure 2-8.

A sampling of recreational resource opportunities and experiences in the Study Area includes:

- Recreational characteristics of wilderness and remote lands
- State-designated recreational areas and rivers
- Private lands and remote cabins
- Consumptive uses, such as sportfishing, hunting, and firewood harvesting
- Wildlife viewing
- Winter recreation
- Tourism, such as wilderness lodges and sportfishing

When it comes to recreation, there is a balancing act between providing access for the visitor and preserving the resource. A publicly accessible access road into the Study Area would provide new recreational opportunities to the public. This could be perceived as having either a positive or negative impact or both. Currently remote and largely undisturbed areas would see increased human use and associated noise, activity, and development. Some people have remote recreational properties and private cabins in the Study Area because of its isolated nature.

Initial correspondence with ADF&G specifically for this study indicates that the ADF&G generally supports access to fish and wildlife resources, but also realizes that regulatory changes may need to be considered in the future to adjust to changes in public use and harvests and the increased pressure on such resources.[102]

What are the State of Alaska's goals for *Recreation and Scenic Resources* in the Susitna Matanuska Area?

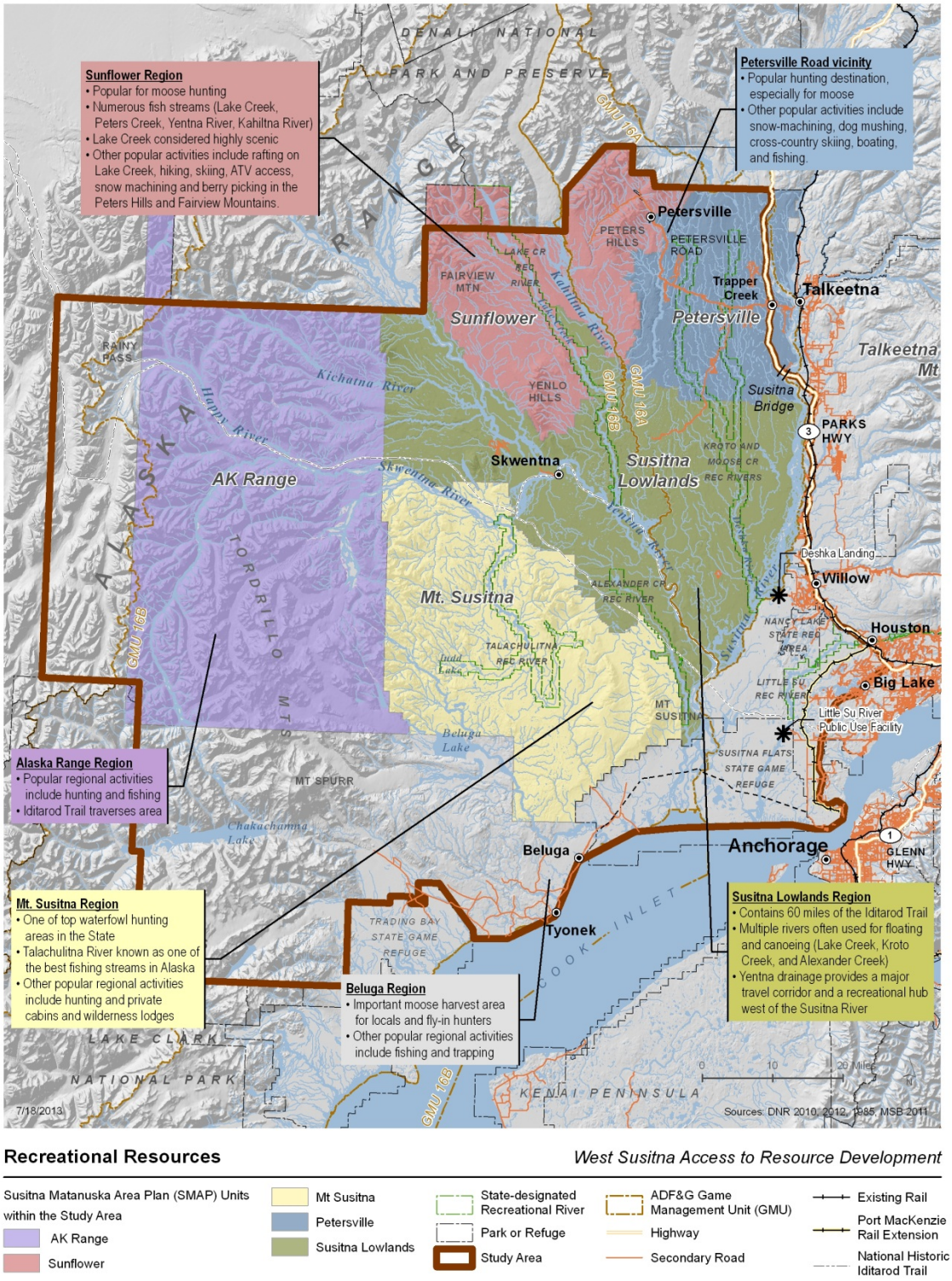
Recreation Opportunities. Lands will be provided for accessible outdoor recreational opportunities with well-designed and conveniently located recreational facilities. In addition, undeveloped lands should be provided for recreation pursuits that do not require developed facilities. These opportunities shall be realized by:

- Providing recreation opportunities on State land and water that serves multiple purposes such as habitat protection, timber management, and mineral resource extraction;
- Protection of recreation resources including public access, visual resources, fish and wildlife important for recreation, and, where appropriate, the isolation and unique wilderness characteristics of the planning area;
- Management of recreation to avoid or minimize user conflict, provide for a quality experience for all user groups, and protect the natural values and attributes of the area within which the recreation occurs; and,
- Protection of ecosystems and habitat from damage caused by inappropriate recreation use.

- excerpted from the *Susitna Matanuska Area Plan for State Lands* (DNR-DMLW 2011: 2-30)

[102] ADF&G. April 29, 2013. Letter from ADF&G Habitat Biologist Marla Carter.

Figure 2-8. Recreational Resources by DNR Planning Regions



Access for recreation. A majority of the Study Area, particularly west of the Susitna River, is considered remote. A wide variety of recreational opportunities occur despite limited access. The Study Area's eastern boundary is the only portion accessible by the existing road system network. Presently, most recreational users access the area by flying in; using all-terrain vehicles (ATVs) or snowmachines; using a variety of boating options such as kayaking, canoeing, or floating some of the rivers; or by simply hiking or skiing to their desired destination. Despite the scarcity of groomed trails, the area becomes more accessible during the winter as rivers, lakes, and wetlands freeze over, forming provisional trail corridors. The area also encompasses mining routes and abandoned seismic trails that are heavily used, especially by snowmachines during the winter months. Given the remoteness of the area, amenities for recreational users are sparse, and the number of designated trails is limited. As a result, access to formal trails consists primarily of roadside parking areas, boat landings, and frozen lakes.[103]

Private cabins, many accessible only by air, are also found in the Study Area. Fly-in wilderness lodges offer guiding and recreational opportunities. Lakes provide float plane access, in addition to providing for sockeye salmon production and general public recreation.

Settlement lands and recreation. Another consideration for providing access into the Susitna basin is settlement lands. The DNR, under the direction of the Alaska Constitution, State laws and the Alaska Legislature, has the authority to sell State land for settlement and private ownership.[104] The DNR makes land available for private ownership through a sealed-bid auction program (primarily for sale of subdivision and other surveyed parcels) and by granting remote recreational cabin sites, whereby an applicant may stake a parcel of land in an area designated for remote staking for recreational use. State settlement lands identified for development typically adjoin current or projected residential areas and are relatively close to access and necessary infrastructure. In areas where State settlement lands abut borough lands, land disposal programs are coordinated between the two entities to ensure that economies of scale are achieved and infrastructure costs are reduced. In accordance with AS 38.04.010, year-round settlement areas are focused where services exist or can be provided with reasonable efficiency.

As part of the 2011 Susitna Matanuska Area Plan, settlement areas are identified for seasonal residences for recreation, year-round residences for community expansion, and as potential commercial or industrial development.[105] According to the 2011 plan, there are 32 units designated for settlement within the Study Area, consisting of nearly 435,000 acres. Presently within the Study Area, settlement lands sell for approximately $837 per acre on average.[106] Under this assumption, the approximate value of the settlement lands would be approximately $364 million. Settlement designation for these lands resulted from consideration as to whether the unit: had reasonable access by road, water, or air; consisted of topography that would be suitable for development; and posed

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[103] MSB. Community Development, Trails webpage. Available at ww1.matsugov.us/communitydevelopment/index.php?option=com_content&view=article&id=195&Itemid=255 (accessed March 2013)

[104] DNR-ML&W. Alaska State Land Offerings. Current Land Offerings webpage. Available at: http://dnr.alaska.gov/mlw/landsale/ (accessed on December 11, 2013

[105] 2011 *Susitna Matanuska Area Plan*

[106] This estimate is very approximate due to the fact that price will vary depending on the exact location of the property (e.g. lakefront). Alaska DNR Division of ML&W. Land Sales. Southcentral Region Subdivision. (Webpage viewed 12/11/13)
< http://dnr.alaska.gov/mlw/landsale/otc/regions_subdiv.cfm?region=SOUTHCENTRAL/>.

minimal conflict with recreation, scenic values, important fish and wildlife resources, or resource development. Compatibility with adjacent land uses and the plan designations were also considered.

An area currently being considered for concentrated development is the Fish Creek/Point MacKenzie area. Under the current Fish Creek Management Plan (see Figure 2-6 for geographic location), several areas (in the Moraine Ridge and Flat Horn Lakes Management Units) are designated for residential settlement. The development plan for this management unit is to allow minimal land sales that promote the current remote residential use of the area.[107]

Within the Study Area, the MSB is also in the conceptual stage of pursuing two future settlement projects: Point MacKenzie and Fish Creek town sites. The proposed location of the Point MacKenzie site would be on Borough-owned property. The proposed Fish Creek town site would require a joint effort between the MSB and DNR due to the different land ownership status. Presently, the area considered for the Fish Creek town site would extend from near Red Shirt Lake to slightly north of West Little Susitna River Road and from west of the Little Susitna Area to east of the Big Susitna River. The Point MacKenzie town site under consideration would be located east of Point Mackenzie Road, northwest of Cook Inlet, south of the Goose Bay State Game Refuge, and north of the northern Port District Boundary.[108]

Organized recreational activities. A number of organized recreational activities occur in the Study Area as well. The Iditarod trail, which traverses the Study Area, hosts several recreational activities, such as: the Iditarod race; the Irondog off-road snowmobile race (running from Big Lake to Nome); and the Iditasport (a race that includes skiing, biking, walking/running, and/or snowshoeing). Other multi-sport races include the Susitna 100 or the Little Su 50k, a winter race that also includes skiing, biking, or running/walking/snowshoeing.

Iditarod Trail. There are several trails and historic sites within the MSB that are identified as part of the Iditarod National Historic Trail System (INHTS). The Iditarod Race Trail is a part of the INHTS. The Iditarod Race Trail is split into a northern route (used during even years) and a southern route (used during odd years). It was determined that both the northern and the southern route should be used in order to allow more communities to participate in the event and to relieve neighboring communities of the presence of mushers, press, and volunteers every other year.[109] Within the Study Area, the race trail remains the same: beginning in Willow and passing through Yentna, Skwentna, and Finger Lake before exiting through the Study Area over Rainy Pass.

The Iditarod Race Trail and the INHTS have different management prescriptions in the 2011 Susitna Matanuska Area Plan. According to the plan, the race trail is protected by a 200-foot publicly-owned corridor. Re-routing the trail to reduce its impacts on adjacent land uses, or to preserve it for its continued use, is permitted via consultation with the State Office of History and Archaeology and the Iditarod Trail Committee.[110] The INHTS is composed of several trails (some well defined and some not) and historic sites. Permits and leases along the INHTS also require consultation with the State Office of History and Archaeology. The State of Alaska and the U.S.

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[107] MSB. 2009. *Fish Creek Management Plan*
[108] MSB. Point Mackenzie Town Site Location Map. Projects in Process. Available at: www.matsugov.us/planning/plans/projects (accessed on December 12, 2013)
[109] The Iditarod Trail. *The Most Common Question Asked About the Trail* Webpage. Available at: http://iditarod.com/about/the-iditarod-trail/ (accessed December 2, 2013)
[110] 2011 *Susitna Matanuska Area Plan*

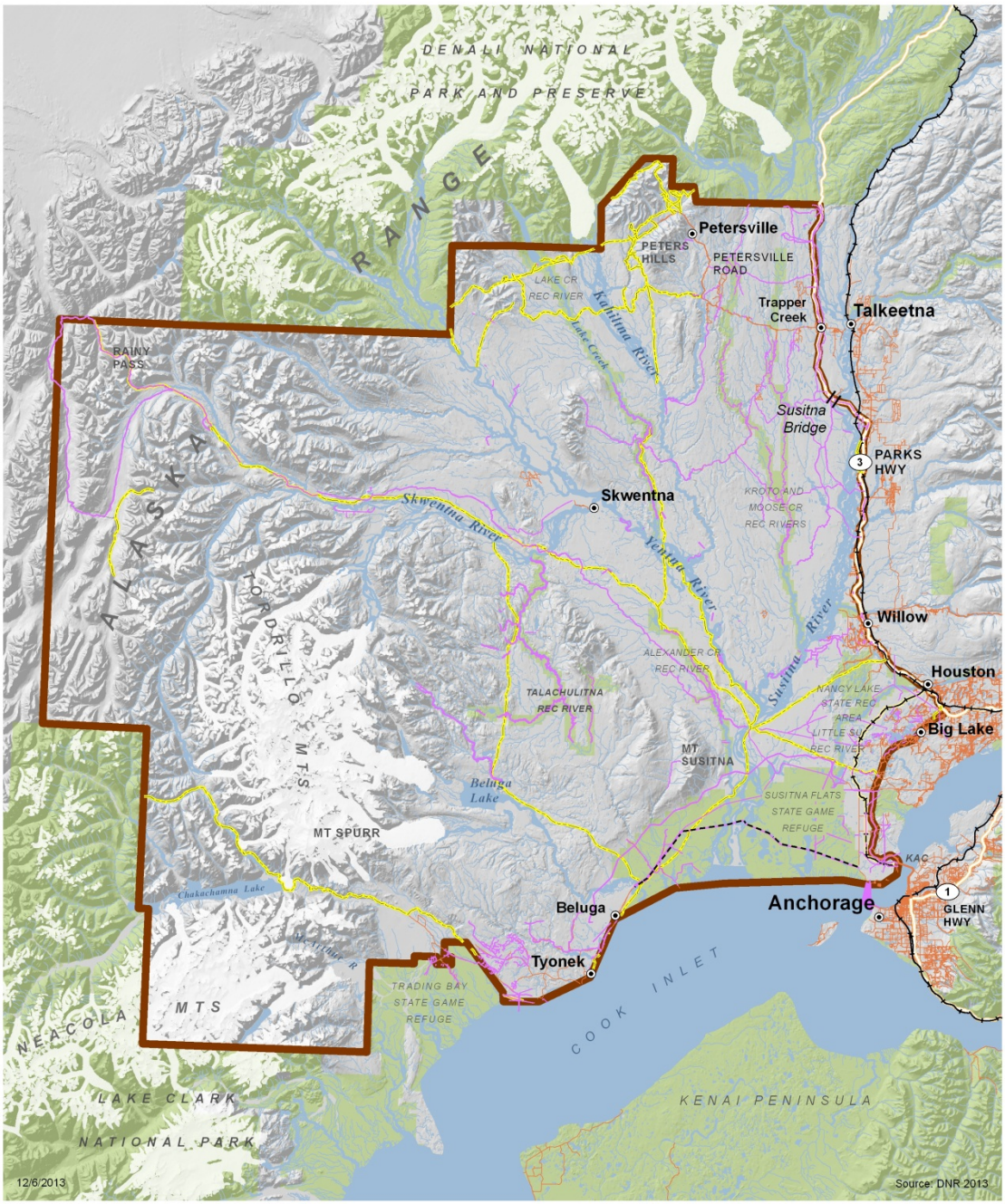
Department of the Interior have signed a memorandum of agreement covering management of the INHTS under terms of the Comprehensive Management Plan for the trail system.

Trails. There is an active trail community (e.g., dog mushing, snow machining, skiing, etc.) in and/or near the Study Area vicinity, especially in the eastern portion of the Study Area. Although the Study Area lacks a formally-developed trail network (excluding winter trails), there are many trails formed under Revised Statute (RS) 2477 located within the Matanuska-Susitna area. Figure 2-9 depicts RS 2477s and other DNR easements in the Study Area. Under RS 2477, U.S. states and territories were allowed unrestricted rights-of-way (ROW) over federal lands absent of existing reservations or private entries. The law remained in effect until Congress repealed it in 1972. Although the authority to establish new RS 2477 ROW in Alaska ended in 1968, under Public Land Order 4582, pre-existing rights were maintained. [111] Many of these RS 2477 ROWs are currently utilized for public recreation, be it cross-country skiing, snow machining, dogsledding, or driving four-wheel ATVs.RS 2477s are also used by a variety of people, including oil and gas and mining companies and everyday access, primarily in the winter, for local residents and recreation users of the area.

The MSB prepared an *Asset Management Plan* in 2001 that proposes a number of recreation enhancements in the Study Area. One of the types of improvements identified was to develop a linked trail system that utilizes stream corridors or other "natural undevelopable lands." Two such proposed areas located within the Study Area are (1) a 75-mile loop system and (2) a 150-mile regional outer loop corridor system. The 75-mile loop trail would be located in the southeastern portion of the Study Area and would incorporate portions of the Little Susitna River Corridor, the Iron Dog Trail/ Big Lake Recreational Corridor, and the Knik Arm/ Palmer Hay Flats area. The 150-mile loop trail would be located in the southern portion of the Study Area and would incorporate portions of the Susitna River Recreational Center, the Petersville Road Scenic Byway, the Lake Creek Recreational Corridor, the Lower Susitna – Yentna public use area, and the Susitna Flats State Game Refuge.

[111] DNR-DMLW. *RS 2477* webpage: Available at: http://dnr.alaska.gov/mlw/trails/rs2477/index.cfm (accessed November 2013)

Figure 2-9. Existing Easements of R.S. 2477 Rights-of-Way



Existing Easements and R.S. 2477 Rights-of-Way *West Susitna Access to Resource Development*

R.S. 2477 Rights-of-Way
AK DNR Easement*
Study Area
Park or Refuge
Transmission Line
Highway
Secondary Road
Existing Rail
Port MacKenzie Rail Extension
0 10 20 Miles
N

** Alaska DNR Easements includes private and public easements and rights-of-way granted by the State of Alaska.*

Public Use Facilities. Deshka Landing is the only boat launch open to the public on the lower Susitna River. The facility is State-owned but is run by a concessionaire. In the eastern portion of the Study Area is the road-accessible Little Susitna River. The Little Susitna River Public Use Facility is also located east of the Susitna River, at "River Mile 28.5." The public use facility offers boat access, with a boat launch and trailer parking, camping facilities, and a dump station for recreational vehicles. A new State law also designated two areas of public land within the Study Area near the Petersville Road for recreational mining and other general public recreation.[112]

Patented mining claims. As of May 8, 2013, more than 100 nine to ten-acre lots have become available for private ownership in the Cache Creek mining district area, located approximately 35 miles west into the Old Petersville and Cache Creek Area. Part of the historical gold mining area, these lots are federally patented land and allow for recreational gold mining.[113]

State-designated recreational areas and rivers. The Susitna River and its tributaries support the second largest salmon-producing system within Cook Inlet. In addition to the Susitna River, the Study Area encompasses a number of State recreational areas and rivers. The following State Recreational Sites (SRSs) are located east of the Susitna River: Big Lake North SRS, Big Lake South SRS, Nancy Lake SRS, Montana Creek SRS, and Willow Creek SRS.

The Study Area includes five State-designated Recreational Rivers, as detailed in the *Susitna Basin Recreation Rivers Management Plan*:

- Alexander Creek
- Talachulitna River
- Deshka River (Kroto Creek and Moose Creek)
- Lake Creek
- Little Susitna River

These rivers are State-designated for their recreational importance, high public use values, and a need for active management to protect resources from degradation and overuse. These rivers and their tributaries support the five species of Pacific salmon and numerous resident fish species, most importantly rainbow trout, grayling, and Dolly Varden.

Sport fishing and hunting. Even though the west side of the Susitna basin is not road accessible, a significant amount of effort is directed at the fisheries, which are accessed by boat and air. About 70,000 angler days are expended annually west of the Susitna River, compared to 95,000 angler days annually on the road-accessible rivers east of the Susitna River.[114] Much of this effort is incorporated in remote lodge operations, but also includes a large number of private cabin owners. Chinook and coho salmon and rainbow trout fishing are the largest sport fisheries with the heaviest activity occurring on Deshka River, Lake Creek, and Talachulitna River. About 5,000 Chinook are harvested on the Deshka River annually and about 3,000 each year at Lake Creek. ADF&G's Division of Sport Fish suspects in-river exploitation of Chinook salmon to be greatest at Lake Creek. Currently the Lake Creek area supports close to 60 guides, which is more than any other area within this unit. About 14,000 coho salmon are harvested annually among all west-side tributaries. Area rainbow trout regulations are already fairly conservative with minimal harvest allowed. Many areas are catch-

[112] DNR-DMLW. 2012. *Petersville Recreation Mining Area* factsheet. http://dnr.alaska.gov/mlw/factsht/mine_fs/petersvi.pdf (accessed May 2013).
[113] http://www.detectorprospector.com/mining-claims-for-sale/alaska-mining-claims-for-sale-or-lease.htm
[114] ADF&G. April 29, 2013. Letter from ADF&G Habitat Biologist Marla Carter.

and-release only. For example, most of Lake Creek and Deshka River are already catch-and-release only. The Talachulitna River has been catch-and-release only for rainbow trout since 1977. About 30,000 rainbow trout are caught annually, mainly among these 3 systems, about 14,000 coming from Lake Creek alone, due in part to the large amount of guiding on this system.

The major tributaries draining into west Cook Inlet that support king salmon production are presently closed to Chinook salmon fishing due to low Chinook salmon returns over the past 7 years to the Chuit, Theodore, and Lewis Rivers.[115] There is limited coho and rainbow trout fishing opportunity on these three rivers as well as several streams within the Beluga River drainage. Coho and sockeye sport fishing harvests and opportunity increases dramatically to the south of Tyonek. The fish resources on the west side of the Susitna River are highly sought after for both recreation and subsistence.

Overall, road access would provide more opportunity for sport fishing. Access would also accelerate future regulatory change needed to ensure fisheries remain sustainable under conditions of increased use. Fisheries currently exploited at a moderate rate now, would likely become more restrictive with regulations similar to those presently governing the east Susitna River/Talkeetna areas.

The southeastern portion of the Study Area encompasses the Susitna Flats State Game Refuge (SGR), which was established by the Alaska Legislature in 1976 to protect fish and wildlife habitat and populations, particularly waterfowl nesting, feeding, and migration areas; moose calving areas; spring and fall bear feeding areas; and salmon spawning and rearing habitats. The SGR also provides public uses of fish and wildlife, such as waterfowl, bear, and moose hunting; wildlife viewing and photography; and general outdoor recreation. By early May, as many as 100,000 waterfowl use the SGR as a feeding and resting area before heading on to their breeding and nesting grounds. Approximately 10 percent of the annual waterfowl harvest in the state occurs on the SGR with about 15,000 ducks and 500 geese taken. Rivers within the SGR are also popular for sportfishing, with the Theodore and Lewis rivers supporting more than 7,000 user-days a year. Overland access into the SGR is limited, with most access by float plane or boat during open water months and by snowmachine in winter. A portion of the "Beluga Highway," which supports oil and gas production, extends approximately 10 miles into the SGR from the community of Beluga.

The entire Study Area is located within ADF&G's Game Management Units (GMUs) 16A and 16B, which provide habitat for many wildlife species including moose, black and brown bears, wolves, and several species of furbearers. All species are managed on a sustained yield basis. Access into GMU 16 for hunting is mainly by aircraft, boats, and snowmachines. According to ADF&G, current moose populations are estimated at around 2,600 for Unit 16A and 6,700 for Unit 16B, and are approaching the desired management objectives. Populations of predators, such as black and brown bear, appear steady. The moose harvest from 2007-2011 averaged 110 moose in Unit 16A (harvest goal 190-360) and 162 moose from Unit 16B (harvest goal of 310-600).[116] ADF&G implements management programs in the Study Area intended to increase moose population size and harvest by reducing predation by wolves and black and brown bears. According

> "A road through the Susitna basin would open up a vast sportsman's paradise to the public, for this region contains some of the finest big game country in Alaska."
>
> –A Description of Road Routes in Alaska (Bureau of Public Roads 1959: p.12)

[115] ADF&G. Division of Sport Fish. October 2, 2013. Comments provided during a review of a draft of this report.
[116] ADF&G. April 29, 2013. Letter from ADF&G Habitat Biologist Marla Carter.

to ADF&G, human effort is expected to increase in Unit 16 due to liberalized seasons and bag limits and increasing moose abundance. Moose hunting pressures in other nearby units (e.g., GMU 20A) may likely lead to increased hunting in the Study Area. As a result, ADF&G is in the process of mapping access areas into the Susitna basin as part of relieving hunting pressures in other areas.[117]

ADF&G's Division of Wildlife Conservation continues to believe that winter access to the Study Area for wildlife, recreation, and other use is generally good using snowmachines.[118] Currently, during hunting season, those seeking moose, bear, and other species use boats and aircraft. Surface roads in the less accessible, higher elevation areas would tend to improve access for moose, bear, and ptarmigan hunters. Roadways in the lower, generally more accessible areas would increase access opportunities for some users while at the same time increase competition for those currently accessing the area using other means. ADF&G suggested locating roads in the areas with little current access to wildlife resources. During autumn hunting seasons, the most inaccessible areas are those farther from the major rivers and lakes.[119]

Subsistence plays a key role for several communities within the Study Area. Specifically, subsistence use and harvest of fish, birds, mammals, wood, berries, and other wild plants is widely practiced in the communities of Tyonek and Beluga. Between 2005 and 2006, 217 pounds of 9 different subsistence resources were acquired per person by residents of Tyonek and 204 pounds of 15 different subsistence resources were acquired per person in Beluga. Ninety-six percent of Tyonek households used wild resources during that time period and 100 percent of Beluga residents attempted subsistence harvest.

The primary subsistence resource for both communities is salmon, which is acquired during the summer months. Secondary resources include large land mammals such as moose, and non-salmon fish such as rainbow trout, eulachon, and Dolly Varden. Migratory birds are also hunted by both communities. Both communities also harvest small game animals such as beavers, porcupines, and snowshoe hares.

Residents of both communities have previously expressed concern about the potential impacts associated with an increased population of the area and the resulting competition for subsistence resources. Increasing access has the potential to strain these resources.

–Harvest and uses of wild resources in Tyonek and Beluga, Alaska, 2005-2006, Technical Paper No. 321 (ADF&G-Division of Subsistence, Juneau: 2007)

Recreation opportunities by geographic location. Several locations within the Study Area draw a concentrated number of recreational users, including the Petersville Road vicinity, as well as other regions delineated and described in DNR's 1985 *Susitna Area Plan* and August 2011 *Susitna Matanuska Area Plan*. These include: Sunflower region, Susitna Lowlands region, Mt. Susitna region, Beluga region, and the Alaska Range region. Each of these sub-regions addresses recreation opportunities as described in the following paragraphs.

- **Petersville Road vicinity.** Petersville Road is located in the northeastern portion of the Study Area. A popular hunting destination, this area is also used for snowmachining, dog mushing, cross-country skiing, boating, and fishing. Hunting and fishing opportunities

[117] DNR. June 17, 2013. Personal communication with Ed Fogels, DNR Deputy Commissioner.
[118] ADF&G-Division of Wildlife Conservation. October 2, 2013. Comments provided during a review of a draft of this report.
[119] ADF&G-Division of Wildlife Conservation. October 2, 2013. Comments provided during a review of a draft of this report.

abound, with the Petersville Road area being one of the most heavily used moose hunting locations in the Susitna Basin.

- **Sunflower Region**. The Sunflower Region is located in the northern portion of the Study Area. The area is popular for moose hunting. Improved public access and habitat enhancement have been encouraged in this area to promote big-game (moose, black bear, and brown bear) hunting and salmon fishing. Mining areas provide the most-populated hunting locations due to their provision of airstrips and roads. The Sunflower Region also encompasses the headwaters of numerous major anadromous streams, such as Lake Creek, Peters Creek, Yentna River, and Kahiltna River. Lake Creek has been designated as a State Recreation River. According to the 1991 *Susitna Basin Recreational Rivers Management Plan*, the scenic qualities of Lake Creek are perhaps the highest of all the Recreation Rivers. Other recreational opportunities, in addition to hunting and fishing, include rafting on Lake Creek; and hiking, skiing, snow machining, and berry picking in the Peters Hills and Fairview Mountains. There are two major trail systems in the sub-area, both of which are heavily used by ATVs accessing hunting grounds: one originating 5 miles north of Petersville, and the other at the junction of Petersville Road and Petersville Creek.
- **Susitna Lowlands Region.** The Susitna Lowlands Region is located in the southeastern portion of the Study Area. Most of the lowlands are not easily accessible. The sub-area, primarily reached by air or trail, contains no year-round roads. Primary trails include: 60 miles of the Iditarod Trail; a winter trail that runs south from Oilwell Road and connects with the Iditarod Trail; and a 30-mile winter tractor trail originating from the Parks Highway near Trapper Creek and heading south to the Delta Island area. Despite their inaccessibility, the Lake Creek, Kroto Creek, and Alexander Creek corridors are often utilized for floating and canoeing. Alexander Lake is known for its pike fishing.
- **Mt. Susitna Region.** The Mt. Susitna Region is located in the southwestern portion of the Study Area. This region contains one of the best-known waterfowl hunting areas in the State, located near the western half of the Susitna Game Flats. The Talachulitna River, designated as a State Recreation River, is considered one of the best fishing streams in Alaska. Peaks in recreation and fishing activity correspond with the king and coho salmon runs on the Talachulitna River. The more popular fishing areas are the mouth, tributary junctions, the confluence with Talachulitna Creek, and the outlet of Judd Lake. The northern portion of the area is also a popular hunting spot. Public recreation tends to be focused around Mt. Susitna, on the Alexander and Susitna rivers, and within the Talachulitna River and Creek corridors. There are a number of lodges on the Talachulitna River and some private cabins around Judd Lake.[120]
- **Beluga Region**. The Beluga Region, located at the southernmost portion of the Study Area, is considered an important moose harvest area for local residents and fly-in hunters. Past discussions indicate there may be an interest in improving public access to promote additional hunting and control the local moose population. Fishing and trapping are also popular in the area. Important salmon streams in the area include the Chuitna, Nicolai, and Beluga rivers.
- **Alaska Range Region**. The Alaska Range Region is located in the western portion of the Study Area. Hunting and fishing are the two primary forms of recreation in the Alaska

[120] 2011 *Susitna Matanuska Area Plan*

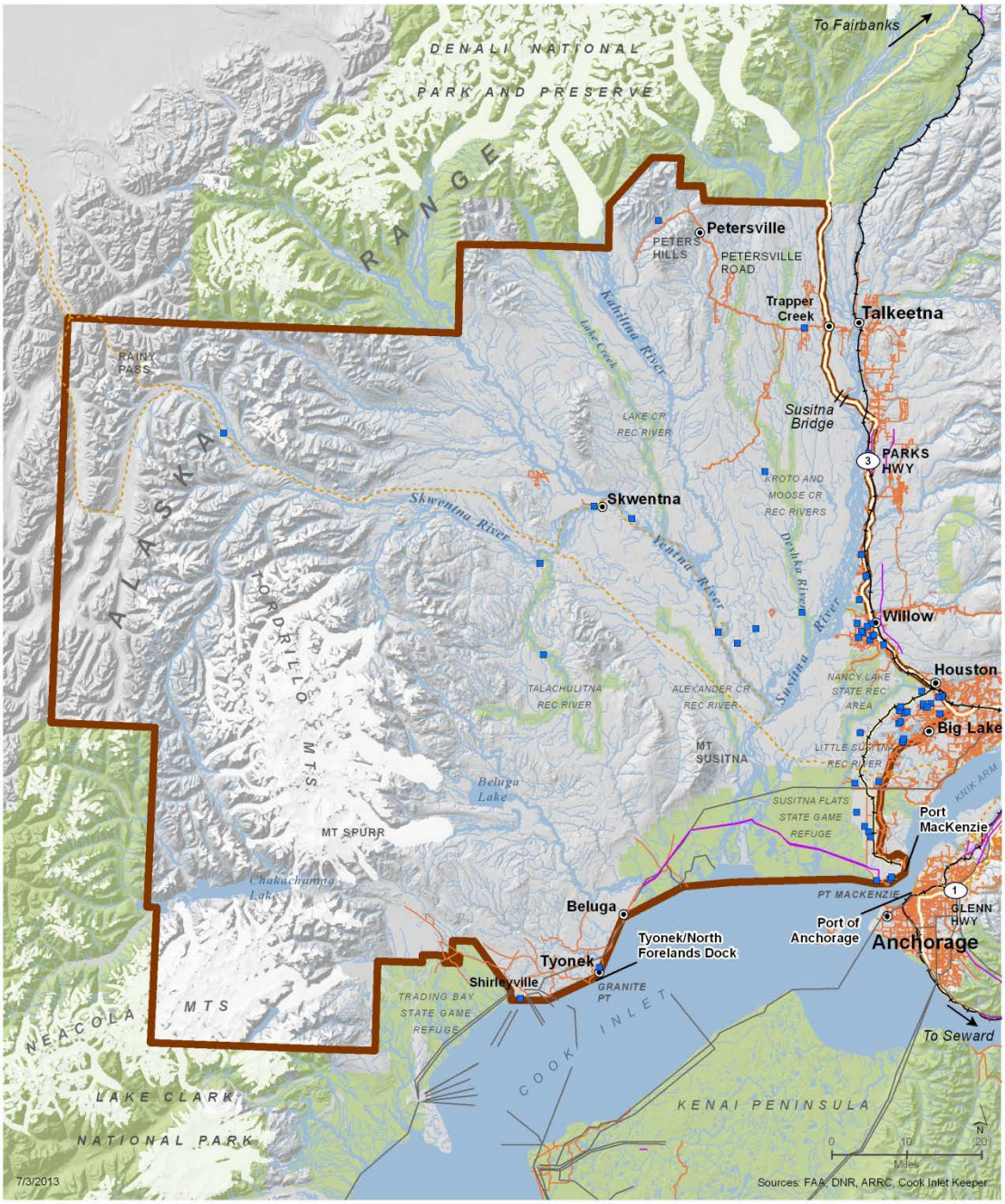
Range sub-area. Moose, sheep, caribou, and black and brown bear are all hunted in the area. Anadromous fish streams, such as the Kichatna River, the Skwentna River, the Happy River, and their tributaries, produce salmon for the Cook Inlet fisheries. In addition to fishing and hunting, the Iditarod Trail traverses the sub-area, and flight trips are often taken to view the Alaska Range.

3 INFRASTRUCTURE INVENTORY

Largely remote, the Study Area is relatively absent of developed transportation and energy infrastructure as shown on Figure 3-1. While the Parks Highway traverses the eastern border of the Study Area, there are no formal road systems that provide year-round access to the areas west of the Susitna River. Year-round access to the area is provided primarily via air. There is a fairly extensive network of winter routes that provide access into the Study Area by snowmachines. Rivers provide both a source of recreation as well as a transportation corridor.

The lack of transportation infrastructure also extends to energy transmission within the Study Area. Although the State's largest power generation facility, Beluga Power Plant, is located in the southern portion of the Study Area, most of the energy is transmitted out of the Study Area. As a result, there are few pipelines and transmission networks present north of the Cook Inlet shore within the Study Area. Despite lacking a highly developed infrastructure network, the Study Area does provide the necessary baseline infrastructure to support extension and expansion of these networks. An inventory of the existing infrastructure is detailed in this section.

Figure 3-1. Existing Infrastructure



Existing Infrastructure *West Susitna Access to Resource Development*

- Airport, Heliport, or Seaplane Base
- Transmission Line
- Pipeline
- Iditarod NHT
- Highway
- Secondary Road
- Existing Rail
- Port MacKenzie Rail Extension
- Study Area
- Park or Refuge

3.1 Transportation Infrastructure

This section presents the existing transportation infrastructure, briefly describing the roadways, airports, railroads, and ports that service the Study Area.

3.1.1 Roadways

The existing transportation infrastructure within the Study Area is primarily concentrated in the eastern boundary connecting to the Parks Highway infrastructure and related community development of Big Lake, Knik-Goose Bay, and Willow, or in the Petersville region in the northeastern portion of the Study Area.

Considering the size of the Study Area, very few roads exist. Existing road networks tend to be concentrated in areas already more-heavily populated or that support power generation and transmission. A query of the MSB roads Geographic Information System (GIS) database shows there are approximately 400 miles of roads within the Study Area. The MSB roads GIS database contains a classification of each road type. Based on this classification, a summary of approximate length of roads by road type are as follows: 44 miles of highway (Parks Highway), 45 miles of major roads, 30 miles of medium roads, 268 miles of minor roads, and 20 miles of primitive roads. Excluded from this summary, but present within the GIS database, are the approximately 70 miles of private and unconstructed roads. Additional spatial data for roads obtained from the DNR shows a network of secondary roads within the Beluga/Tyonek area in the southern portion of the Study Area, as well as in the Skwentna vicinity.

Parks Highway. The Parks Highway is part of the National Highway System and Interstate Highway system and is the most heavily-used roadway within the Study Area. Running in a north-south direction along the Study Area's eastern boundary, it parallels much of the Alaska Railroad. The Parks Highway provides access to the nearby communities of Talkeetna, Willow, and Houston, and Wasilla with Anchorage and Fairbanks. It is the main thoroughfare in the Mat-Su Valley. As a result, the Parks Highway serves as the primary road from which other smaller roads propagate into the Study Area.

West of Big Lake/Point MacKenzie. Approximately 40 percent[121] of the roads within the Study Area lie in the region south of Houston, west of Big Lake, and north of Cook Inlet. This includes the following two major roads within the Study Area: Point MacKenzie Road and Big Lake Road. Much of the existing road infrastructure in this area spills over from the communities of Big Lake and Houston, or was constructed to provide access to Point MacKenzie.

West side of Cook Inlet: Beluga/Tyonek. Road infrastructure in Beluga and Tyonek is fairly limited. There are approximately 132 miles of roads in the vicinity, which are generally primitive or unpaved. These roads do not connect to any other road system in the state, and many of them were constructed to access oil and gas exploration areas. The Tyonek road system, comprised of only gravel roads, does tie into the Beluga/Lewis River road system; however, this connects to the limited road network associated with the Granite Point area.[122] In the area abutting the northern shore of Cook Inlet, almost all of the bridges are owned and maintained by the State.[123] The bridge across the Chuit River washed away in a flood as recently as 2012, and a temporary bridge was required.

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[121] Excludes the Parks Highway and also the approximate 70 miles of private and unconstructed roads.
[122] CH2MHILL. 2013. *Cook Inlet Facility Assessment*. Prepared for Kenai Peninsula Economic Development District.
[123] CH2MHILL. 2013. *Cook Inlet Facility Assessment*. Prepared for Kenai Peninsula Economic Development District.

Petersville vicinity. Approximately 28 percent[124] of the roadways are located within the Petersville/Trapper Creek area, including the 37-mile-long Petersville Road. The presence of roads in this area can be directly attributed to gold mining operations in the early 20th century.[125] With a decline of the gold mining industry, portions of the roads deteriorated and may now be impassable. The Petersville Road is such an example. The majority of the roads in this location are categorized as minor, primitive, or not constructed. However, the State recently set aside an area for recreational gold mining called the Petersville State Recreation Mining Areas. Improvements to the road network may be considered or implemented as part of the Petersville Recreation Mining Area planning process (per AS 41.23.630).[126]

3.1.2 Aviation Access

Within the Study Area, there are a wide variety of landing strip types and sizes, ranging from small, privately-owned, dirt airstrips to large waterbodies designated for floatplane landings for the public.

There are 61 Federal Aviation Administration (FAA)-identified landing locations within the Study Area. Of these locations, the majority are on land, with 23 percent being located on a waterbody. While waterbody landing locations are typically publicly accessible, private landing strips are more prevalent, comprising 75 percent of the total landing sites in the Study Area (see Table 3-1).

In terms of public access on waterbodies, aircraft use of a lake or river deems it navigable. However, shorelines of the waterbody can be controlled by a private entity. This means that while any aircraft can use the water, they cannot touch the shore without the landowner's permission. Some shore owners have filed with the FAA that they own the water landing area because they own a dock. This is why some of the water landing areas identified in Table 3-1 are actually shown as private.

In addition to the FAA-identified landing locations, there is an abundance of unregistered airstrips located within the Study Area. For instance, a quick glance of aerial images of the Study Area revealed 11 airstrips that were not documented on the FAA Master List: 7 near the Kahiltna River west of the Petersville area, 3 along the Yenta River, and 1 near the Deshka River. These likely represent just a few of many undocumented airstrips that exist in the Study Area and are likely used by private parties for recreational access or to access private property or cabins.

Table 3-1. FAA-Identified Airstrips and Helicopter Landing Locations in the Study Area

Name	Private/Public[1]	Dimensions (in feet)	Surface (and condition when applicable)
Beluga	Private	5,002 X 100	Gravel–good
Beluga	Private	40 X 40	Gravel
Nikolai Creek	Private	4,100 X 75	Gravel
Tyonek	Private	3,000 x 90	Gravel
Rainy Pass	Public	2,100 x 25	Dirt-poor

[124] Excludes the Parks Highway and also the approximate 70 miles of private and unconstructed roads.
[125] Bureau of Public Roads. August 1959. *A Description of Proposed Road Routes in Alaska: Talkeetna-McGrath-Ruby*. Compiled and written by Rose Komatsubara and William DeArmond, under the direction of Elmer Biggs, Acting Planning and Research Engineer. Page 21.
[126] DNR-Office of Project Management and Permitting (OPMP). October 8, 2013. Comments provided during a review of a draft of this report.

Name	Private/Public[1]	Dimensions (in feet)	Surface (and condition when applicable)
Carpentiers Strip	Private	1,200 x 30	Gravel
Falcon Lake Strip	Private	2,000 x 30	Gravel
MacKenzie Country Airpark	Private	1,650 x 85	Turf
Point Mac	Private	3,000 x 30	Gravel
Point MacKenzie	Public	30 x 30	Turf
Robin's Landing	Private	2,500 x 40	Gravel
Sleepers Strip	Private	1,600 x 60	Gravel
Turinsky Airstrip	Private	2,000 x 120	Gravel
Nancy Lake	Public	6,000 x 60	Water
Beaver Lake	Public	5,000 X 400	Water
Big Lake	Public	2,435 x 70	Gravel-good
Brocker Lake	Public	1,200 x 100	Water
Brown's Homestead	Private	1,100 x 58	Turf
Cowell's	Private	20 x 20	Wood
Cubdivision	Private	1,200 x 100	Gravel
Fisher	Private	1,200 x 80	Gravel
H&H Field	Private	675 x 30	Gravel
Hoppe's	Private	1,150 x 200	Water
Horseshoe Lake	Private	5,500 x 200	Water
Jones Landing	Public	1,267 x 75	Water
Kramer	Private	850 x 70	Turf-Gravel
Kucera	Private	5,000 x 200	Water
Kucera Residence	Private	1,200 x 25	Gravel
Marion	Private	3,400 x 200	Water
Owen Field	Private	1,300 x 75	Turf
Saddleback Island	Private	50 x 50	Mats
Team Levine	Private	50 x 50	Concrete
Twin Lake	Private	1,000 x 80	Turf
West Beaver	Private	1,300 x 60	Turf
West Beaver	Private	3,800 x 500	Water
Farewell	Public	4,600 x 30	Gravel -Dirt-poor
Farewell Lake	Public	5,000 x 500	Water
Tin Creek	Public	2,000 x 12	Gravel-Poor
Goose Bay	Public	3,000 x 75	Gravel-Good
River John	Private	1,850 x 50	Dirt
Skwentna	Public	3,400 x 75	Gravel-Good
Talachulitna River	Private	1,800 x 50	Gravel
Talaheim	Private	950 x 35	Dirt
Little Susitna	Private	2,600 x 50	Dirt
C.T.S.	Private	1,300 x 200	Turf
Ernies Airstrip	Private	1,875 x 70	Turf-Gravel
HoneyBee Lake Aero Park	Private	2,000 x 30	Gravel
Jewell	Private	1,950 x 150	Turf
Kashwitna Lake	Private	4,000 x 500	Water

Name	Private/Public[1]	Dimensions (in feet)	Surface (and condition when applicable)
Laub	Private	1,080 x 100	Turf
Long Lake	Private	5,000 x 600	Water
Long Lake	Private	1,800 x 40	Gravel
Minuteman Lake	Public	1,500 x 50	Water
Minuteman Strip	Private	1,200 x 40	Gravel
Rustic Wilderness	Private	2,200 x 45	Gravel
Shirley Lake	Private	1,800 x 30	Turf
Skid Marks	Private	1,400 x 100	Dirt
Thomas Strip	Private	1,650 x 30	Gravel
Willow	Public	4,400 x 75	Gravel-Good
Willow SPB	Public	3,600 x 400	Water
Yentna Bend Strip	Private	1,000 x 150	Turf-Dirt

[1] Lakes are public and managed by DNR; however, docks are private and connected to private properties along the lakes. This applies to all private lake listings.

Source: Airport IQ 5010: Airport Master Records and Reports. FAA Aeronautical Information Services. Accessed May 2, 2013.

Airships.[127] While not a part of the existing transportation infrastructure, , it bears mentioning that in recent years the DOT&PF and resource-development industry stakeholders have expressed interest in the potential use of airships for transporting large and heavy supplies, fuel, equipment, and other materials in and out of remote areas. Airships, large lighter-than-air aircraft, are currently under development in a half dozen countries and are expected to be on the market within five years. They are capable of carrying heavy cargo (tens of tons).Though it canceled its trip, the Florida-based Skyship Services Inc. was planning to bring its 200-foot Skyship 600 blimp to Alaska during summer 2013 to demonstrate its capabilities. The use of airships is a possible consideration for moving heavy loads to mining sites and moving concentrates from the mines.

3.1.3 Railroads

The Alaska Railroad travels along the eastern boundary of the Study Area. Heading north out of Seward towards Fairbanks, the railroad parallels the Parks Highway until it diverges slightly to the east of the highway 12 miles south of Talkeetna. Three depots are located near the Study Area, in Anchorage, Wasilla, and Talkeetna. Construction is currently underway for the Port MacKenzie rail extension, which includes approximately 32 miles of new rail line that will connect Port MacKenzie the Alaska Railroad System and the interior rail corridor to Port MacKenzie on Cook Inlet. The rail line would travel north from the port facility at Port MacKenzie and connect to the existing rail system just south of Houston, providing additional rail infrastructure within the Study Area. Construction began in 2012, and three segments are currently under construction. Depending on funding, the new rail extension is expected to be completed by 2016 or 2017. This may help support the goal of the 2010 Point MacKenzie Comprehensive Plan to promote development of a rail siding at the end of Holstein Road in order to support local agriculture.

[127] Cargo Airships for Northern Operations website. Available at http://event.arc.nasa.gov/airships/ (accessed May 2013)

3.1.4 Port Facilities

The Cook Inlet basin contains many on- and off-shore oil and gas deposits, as well as coal deposits. The development, production, and/or exploration of such resources have necessitated marine infrastructure and facilities. Two notable existing docks in the Study Area are Port MacKenzie and Tyonek/North Forelands Dock. Other barge landing areas exist near Beluga/Tyonek.

Port MacKenzie. Port Mackenzie is located at the head of Cook Inlet along Knik Arm across from Anchorage and is considered a deep draft port.[128] The facility includes a 14.7-acre barge dock, a 1,200-foot-long deep-draft dock, and 14 square miles of adjacent lands available for lease. The deep-draft dock is equipped with a conveyor system capable of loading bulk commodities such as wood chips or coal. Rail infrastructure improvements in the area include the Port MacKenzie rail extension project, which is currently under construction and will bring rail service to these dock facilities. The *Port MacKenzie Master Plan Update*[129], as adopted in February 2011, states the goal for future port operations is to include bulk natural resources and other cargo movement of coal, petroleum products, oil and gas field modules, natural gas pipeline construction materials, forest products, limestone products, and other minerals. The 2013 KPED report cites this facility as having limited use to oil and gas exploration and production activities in Cook Inlet because there is no road connecting the facility to the lease areas on the west side of Cook Inlet.

North Foreland Facility Dock at Tyonek. The North Foreland Facility is located on the west side of Cook Inlet near Tyonek and is considered a light draft port.[130] The facility consists of a T-shaped dock that extends 1,500 feet from shore.[131]

Barge facilities near Beluga/Tyonek. A 2013 Cook Inlet Infrastructure Report prepared for the KPED states that most of the bulk cargo and heavy equipment used by residents and industry on the west side of Cook Inlet is shuttled by barge and offloaded at one of four barge-landing areas in the Beluga/Tyonek vicinity. The report cites the following four barge landing locations, three of which are located within the Study Area:

- The Ladd Landing site is located north of the mouth of the Chuitna River, between Beluga and Tyonek. This landing has been used extensively by Chugach Electric Association (CEA) to supply the Beluga power plant; by operators of the natural gas fields, coal, and other mineral exploration efforts; and by residents of Beluga.
- The City of Tyonek also has a barge landing site, which is used for unloading bulk cargo, equipment, and fuel.
- A third barge landing site, located 1 mile west of Granite Point, between Shirleyville and the Granite Point Pump Station, is a privately owned facility that supports the oil and gas industry, fishing, mining, and recreational use.
- A fourth barge landing site is located south and outside of the Study Area at the mouth of the Drift River and directly west of the City of Kenai. It is used primarily to support oil tanker operations at the Drift River Terminal.

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[128] Cape International, Inc. and Nuka Research and Planning Group, LLC. January 2012. *Cook Inlet Vessel Traffic Study*.
[129] MSB. Adopted 2011. *Port MacKenzie Master Plan Update*. http://matsugov.us/docman/doc_view/3226-port-mackenzie-master-plan-updatefinal?tmpl=component&format=raw.
[130] Cape International, Inc. and Nuka Research and Planning Group, LLC. January 2012. *Cook Inlet Vessel Traffic Study*.
[131] CH2MHILL. 2013. *Cook Inlet Facility Assessment*. Prepared for Kenai Peninsula Economic Development District.

3.1.5 Other Proposed Transportation Infrastructure

The Knik Arm Bridge and Toll Authority (KABATA) is proposing the Knik Arm Crossing project, which consists of a proposed 1.74-mile toll bridge across Cook Inlet's Knik Arm to provide another surface transportation link between Anchorage and the MSB. In addition to the new bridge, the project would require 18 miles of supporting roads be constructed to integrate into the existing transportation infrastructure. Supporting roads located within the MSB would include a "Mat-Su approach" called the "Northern Access route." This route begins at MP 9.5 of the Point MacKenzie Road, where an intersection would be developed at the northwestern entrance to the Port MacKenzie District.[132] From this intersection, a new controlled access, two-lane, 3.5-mile long alignment would be constructed. The new alignment would head north of Lake Lorraine and continue east toward the Knik Arm bluff. The route would terminate on the eastern side of the Port MacKenzie District at a location approximately 7,200 feet north of Port MacKenzie Dock and 1,500 feet south of Anderson Dock. At this location, a toll plaza and multiuse facility for road maintenance equipment would be constructed and controlled access would be provided to and from Port MacKenzie and Anderson Dock. During Phase 2 of construction, this route would be upgraded to a four-lane divided highway (with two travel lanes in each direction) and would include frontage roads and a pedestrian pathway.

The Final FEIS[133] for the project was published in the Federal Register in January 2008. A Record of Decision (ROD) was then signed by FHWA in December 2010. Since the ROD was signed, KABATA has submitted a number of permit applications to move the project forward.

3.2 Energy Infrastructure

The Study Area has very little energy infrastructure, particularly in areas not connected to the road system. However, the State's largest power generation facility, the Beluga power plant, is located on the west side of Cook Inlet within the Study Area and provides significant transmission infrastructure to the rest of the power transmission grid in Southcentral Alaska. This section includes existing and proposed energy infrastructure, related to natural gas facilities and pipelines servicing the nearby populated areas of Southcentral Alaska.

3.2.1 Pipelines

ENSTAR is the primary natural gas service provider to the MOA and MSB region. ENSTAR transports natural gas from the Beluga gas fields east to these regions with a 20-inch pipeline. Numerous gas fields near Beluga are connected by pipeline as well, including Nicolai Creek, Lone Creek, Pretty Creek, Lewis River, and Stump Lake.

3.2.2 Fuel Storage Facilities

The Granite Point Tank Farm near Tyonek consists of four storage facilities.[134] The capacities of these four storage facilities are 3,000 barrels (bbls), 10,000 bbls, 30,000 bbls, and 55,200 bbls. A 5-million-gallon bulk fuel storage plant is planned for construction at Port MacKenzie as part of their

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[132] KABATA website. Available at: http://knikarmbridge.com/ (accessed December 2013)
[133] Final EIS summary document. Available at: http://www.knikarmbridge.com/FEIS%20CD%202/FEIS/FEIS%20Summary/FEIS%20Summary-ALL.pdf (accessed December 2013)
[134] ADEC Spill Prevention and Response webpage. www.dec.alaska.gov/spar/perp/cookinletpor/documents/070210cipporrisklayers.pdf.

upgrades and improvement projects.[135] The Port of Anchorage, located outside the Study Area, has the largest capacity in Southcentral Alaska and is able to store up to 23 million gallons.[136]

3.2.3 Power Generation Facilities and Electrical Distribution

Chugach Electric Association (CEA) is an electric utility that generates, transmits, and distributes electricity to retail and wholesale customers in Southcentral Alaska. Of its five power plants, the Beluga Power Plant, which generates 385 megawatts,[137] is the only one located within the Study Area. Seven of the units at the Beluga Power Plant are powered by natural gas, and one by a steam turbine. In its system, the majority of the kilowatt-hours that CEA generates come from natural gas units (92 percent), with 8 percent from hydroelectric resources.

Power generation continues to grow in Southcentral Alaska, with the most recent expansion coming online in early 2013. In conjunction with the MOA-ML&P, CEA brought online a new 183-MW natural gas-fired plant located in Anchorage as part of the Southcentral Power Project.[138] This facility has three gas turbine-generators and one steam turbine-generator.

The Matanuska Electric Association (MEA) is currently in the planning, design, and procurement stage for a new 171-MW natural gas-/diesel-fired plant at Eklutna (located outside of the Study Area). This is scheduled to begin operation as early as 2015.[139] New facilities may also be added to the Cook Inlet infrastructure, depending on the locations of new gas discoveries and the potential routing of a North Slope gas pipeline.[140] According to the 2013 *Cook Inlet Facility Assessment* report, such infrastructure would include a facility that would convert gas to LNG for export and associated terminal and docking facilities.

A major transmission line originates at the Beluga Power Plant near Tyonek and reaches a bulk substation near Port MacKenzie. CEA sells some of the energy from these lines to the MEA, which is the primary electric service provider in the Mat-Su area. CEA is partnered with four other electric associations in Southcentral Alaska that makes up the Alaska Railbelt Transmission and Electric Company (ARTEC). [141]

3.2.4 Other Proposed Energy Infrastructure Sources or Needs

Most of the following energy infrastructure projects have been proposed but have not been implemented in the Study Area. Although it is unlikely that all of these projects will be adopted and acted on, they are worth noting in terms of interest and previous studies. These proposals are still in the preliminary review stage, so locations and design specifications are subject to change.

Other Proposed Energy Infrastructure Sources affecting the Study Area

Natural gas has been the Cook Inlet region's primary energy source, though its availability has steadily declined in recent years. A number of alternative energy resources have been considered over the years as possible means to meet the region's existing power needs and to support other

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[135] Cape International, Inc. and Nuka Research and Planning Group, LLC. January 2012. *Cook Inlet Vessel Traffic Study*.
[136] Northern Economics Inc. April 2008. *Port of Anchorage Transportation Cost Comparison Study*. http://www.muni.org/Departments/port/TIGERIIBCA/2%20Cost%20Comparison%20Study.pdf
[137] CEA Facilities webpage. www.chugachelectric.com/inside-chugach/the-company/facilities.
[138] CEA Projects webpage: www.chugachelectric.com/inside-chugach/projects/southcentral-power-project
[139] CH2MHILL. 2013. *Cook Inlet Facility Assessment*. Prepared for Kenai Peninsula Economic Development District.
[140] Ibid.
[141] Five utilities who from the Kenai Peninsula to Fairbanks collectively deal with Railbelt energy needs and challenges.

proposed projects that would require power. Some of the proposed alternative energy sources or projects are located within or near the Study Area; the ones briefly mentioned below include geothermal, hydropower, wind power or other natural gas resources.

Geothermal. Geothermal potential occurs within the Study Area near Mt. Spurr. In early 2013, geothermal leases on Mt. Spurr were renewed. The extent of project development is only exploration at this time.

Hydropower. No major, existing hydropower operations are located within the Study Area. However, the potential Susitna-Watana Hydro Project, if developed, would be partially situated in the Study Area. Presently, plans include construction of a dam on the Susitna River (upstream and outside of the Study Area), reservoir, and related facilities on the Susitna River. As part of the project, transmission lines would also be constructed that would connect the dam to the existing Railbelt transmission system. The project is expected to have an installed capacity of 600 MW, an annual energy production of 2,800,000 MWh, and a project life of more than 100 years.[142] It is anticipated that a license application will be filed for the project by the end of 2015.

The Chakachamna hydroelectric project was a previously-considered project within the Study Area. However, this project is no longer under consideration as the State's preferred hydroelectric project. Focus has shifted to the Susitna-Watana Hydro Project.

Wind Power. Located near the Study Area in Cook Inlet, the Fire Island Wind project began operation in September 2012. It is expected to generate up to 17.6 MW of electricity for CEA in Anchorage. Within the Study Area, residents near Tyonek previously considered installing a wind turbine. According to AMHT, the Village of Tyonek is pursuing grant funding for possible wind energy projects.[143] These projects demonstrate the potential for wind power generation within the Cook Inlet area.

Other Natural Gas Resources. A number of proposed infrastructure projects intended to provide energy to Southcentral Alaska would, to some degree, potentially influence the infrastructure or power needs within the Study Area. The following projects are not directly located within the Study Area, but are worth mentioning as they may affect the demand for infrastructure within the Study Area:

- **Alaska Pipeline Project.** TransCanada and ExxonMobil began working together in 2009 to develop the Alaska Pipeline Project. The proposed pipeline project would connect Alaska's North Slope natural gas resources to new markets. The Alaska Gasline Inducement Act (AGIA) was enacted into law by the State of Alaska in May 2007, with the purpose of helping expedite the development of a natural gas pipeline. A competitive bid and review process occurred, and TransCanada was selected by the State in August 2008 as the exclusive recipient of the AGIA license.
- **Alaska Stand Alone Gas Pipeline.** The Alaska Stand Alone Gas Pipeline project, being proposed by the State of Alaska, would construct a 24-inch diameter, high-pressure natural gas pipeline from Alaska's North Slope to Cook Inlet. The proposed project would construct a 737-mile pipeline that would tie into the existing ENSTAR pipeline

[142] AEA. Susitna-Watana Hydro. Project Description. Available at www.susitna-watanahydro.org/project/project-description/ (accessed March 2013).
[143] Alaska Mental Health Trust, Trust Land Office. March 15, 2013. Personal communication with Rick Fredericksen, AMHT Energy and Minerals Senior Manager.

infrastructure and include a Cook Inlet Natural Gas Liquid Extraction Plant. North Slope natural gas would be transported to in-state Alaska markets and be accessed from off-take points for the Fairbanks Area and other locations along the route. The USACE was the lead federal agency. The Final EIS was made available for public review at the end of 2012.

- **Gas to Liquids.** Alaska Natural Resources to Liquids, LLC was one of several "gas-to-liquids" proposals that would convert North Slope natural gas to liquid hydrocarbon fuels (e.g., diesel and gasoline) and then transport them via a new pipeline or through the existing Trans Alaska Pipeline System to Valdez.

Other Proposed Energy Infrastructure Needs affecting the Study Area

Other private entities have proposed to construct additional pipeline infrastructure and connect to the energy network within the Study Area. Proposed projects include:

- The Donlin Gold Project, as currently proposed, would require a 14-inch pipeline to be constructed to transport natural gas from the existing 20-inch natural gas pipeline near Beluga, through the Study Area, to the proposed mine site located approximately 313 miles away, west of the Alaska Range. The proposed Donlin pipeline would cross the Alaska Range north of Rainy Pass and westward beyond the Study Area to terminate at the mine site.
- Another project is proposed by Aurora Gas as part of their 2013 drilling program. As proposed, a new 4-inch pipeline would be constructed approximately 10 miles south of Tyonek and one mile from Shirleyville Camp to connect the newly-drilled Nicolai Creek #13 well to the existing Nicolai Creek #1, 2, and 9 production facilities. In addition to the pipeline, a new access road, pad, and pad facilities would also be constructed, providing additional infrastructure to the area.

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4 ALTERNATIVES DEVELOPMENT

The objective of this study is to identify possible routes to connect to areas of resources (mineral, timber, oil, gas, etc.) identified in the Alaska Range and its southeast foothills, as presented earlier in this document. This section discusses the methodology used to develop the corridor segments, alignments, and proposed access routes.

The scope of this study addressed only a hard surface road access option. Rail access could be another option but was not considered or evaluated as part of this study at this time.

4.1 Corridor Development Methodology

Alternatives development for this study occurred in a six-step process:

1. Inventory resource opportunities for access in the Study Area
2. Consider previously identified alignments or corridors
3. Identify Susitna River crossing location(s)
4. Identify environmental constraints and opportunities
5. Identify broad preliminary corridor opportunities and refine alignment centerlines
6. Evaluate proposed access routes for strengths and weaknesses

- Step 1. Inventory resource opportunities in the Study Area

The project team reviewed existing literature and conducted interviews to determine the location of resource opportunities (and constraints) for a potential access road into the Susitna Basin. The result of this process is the identification of possible logical termini – the origin and destination for the proposed corridors. At the outset of the study, the beginning point was the Parks Highway system; however, as the study progressed, other possible origin locations were identified, which included the Beluga/Tyonek region, the Alaska railroad, or Port MacKenzie. The other possible termini for surface transportation access were the identified resource opportunities, most specifically the mineral deposits generally located either southeast of Rainy Pass or in the Beluga/Tyonek region. The subsequent corridors between these termini provide access to additional resource opportunities (e.g., timber, agriculture, recreation, etc.). The objective of providing access is not to connect to any one particular resource deposit, but to provide access to an area where multiple resources could be accessed by a transportation system. Resource opportunities are described in the resource inventory, Section 2.

- Step 2. Consider previously identified alignments or corridors

Several access corridors into or through the Susitna Basin have been previously identified by a number of agencies over the past 50 years. Information was gleaned from these reports, and the previously identified routes were considered in determining the location for access corridors as part of this current study.

- Step 3. Identify Susitna River crossing location(s)

There are very few locations where the Susitna River can be reasonably crossed, based on a number of factors including river stability, required crossing length, and approach topography. Once the crossing location(s) of the Susitna River were identified, the corridors were routed to connect to these crossing locations.

- Step 4. Identify environmental constraints and opportunities

The team identified environmental opportunities and constraints for the location of an access road. Whereas opportunity identification helps to determine where the road could feasibly and reasonably be located, constraints identification helped to determine where placement of the road should be avoided from an engineering or permitting perspective. Constraints included natural barriers or factors such as topography, rivers, wetlands, and other features such as non-State lands (e.g., private lands).

- Step 5. Identify broad preliminary corridors and refine alignment centerlines

Broad preliminary corridors were identified based on the location of natural resources, constraints, and opportunities. Based on these broad corridors, alignment centerlines were refined and combined to create potential access routes for evaluation.

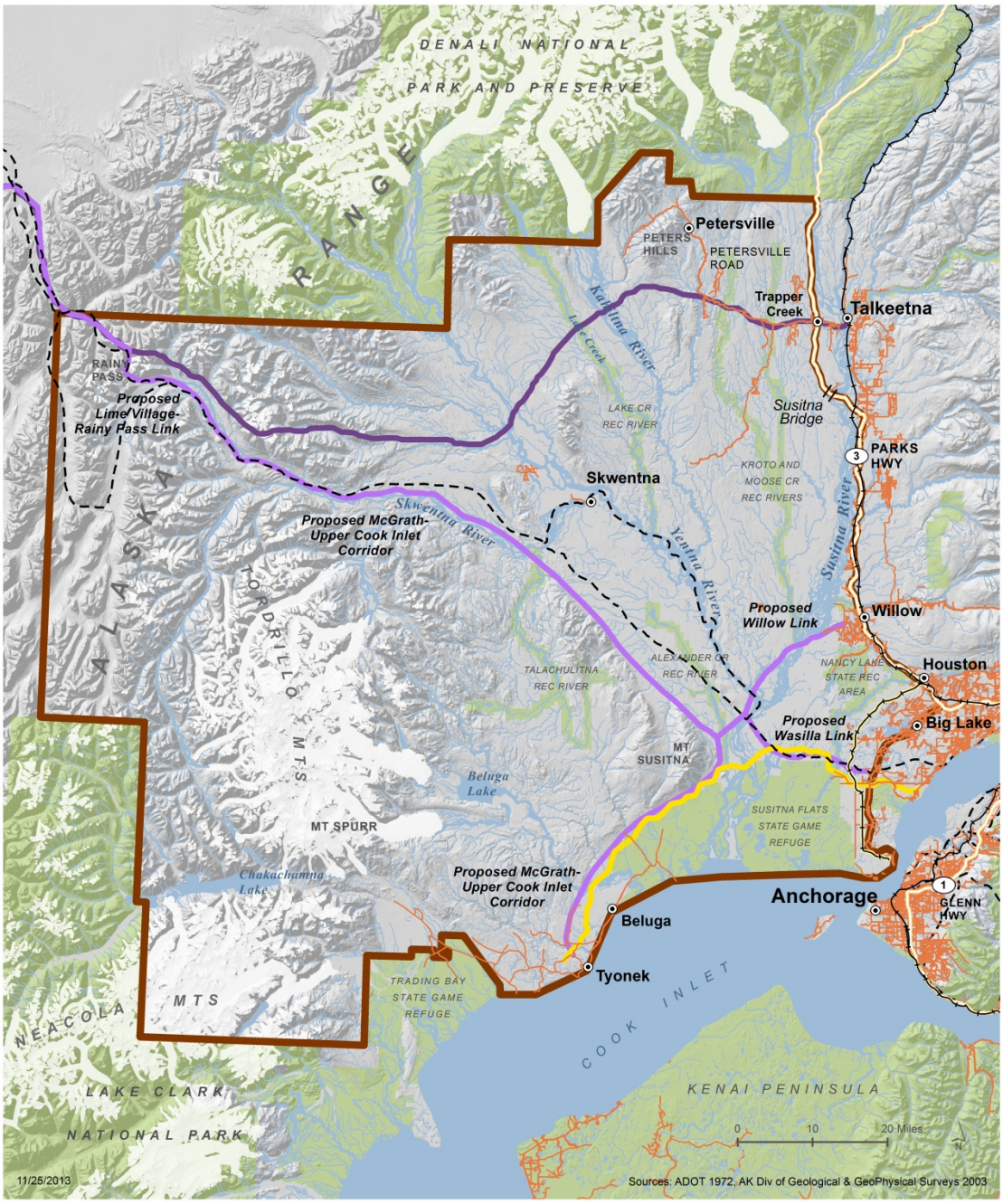
- Step 6. Evaluate proposed access routes for strengths and weaknesses

The project team evaluated the strengths (opportunities) and weaknesses (constraints) of the identified alignments.

4.2 Previously Identified Alignments in the Study Area

As data was collected and literature was reviewed during the resource inventory task, three previously identified alignments into the Study Area were discovered. These previously identified alignments are described briefly in this section and shown on Figure 4-1.

Figure 4-1. Previously Identified Alignments



4.2.1 McGrath-Upper Cook Inlet Corridor, DNR-DGGS 1992

In 1992, the DNR-DGGS compiled a series of digital maps for the State depicting transportation corridors to areas with high resource potential and areas that required land links between critical locations. The corridors were identified by the State Pipeline Coordinators Office via a Corridor Selection Steering Committee. Many of the centerlines had been a part of their long-range planning documents for many years while some routes were identified at the time of the State's Land Selection project. These DGGS maps were compiled based on previously published and unpublished reports, and interpretations of aerial photographs and satellite imagery. Nearly 200 sources of technical information were used and nearly 400 geologic maps were produced through this corridor evaluation project. These maps were published and made available in 2003.[144]

> "Access to Alaska's mineral lands is a strategic issue for the mineral industry and the state and federal governments. During previous campaigns undertaken by the state of Alaska to choose stateland entitlement lands, many potential access corridors were identified and linked in a conceptual long-range transportation grid. This grid is the basis for much of the state's current transportation planning and is consulted when considering access to new mineral discoveries."
>
> - Survey of Geology, Geologic Materials, and Geologic Hazards in Proposed Access Corridors, Alaska. (DNR-DGGS 2003)
>
> http://137.229.113.112/webpubs/dggs/mp/text/mp129.pdf

The DGGS maps depict 10-mile-wide corridors that straddle the centerlines of the proposed access routes. These routes were identified to connect strategically important centers of population, ports, pinch points, and resource-rich lands. The routes were identified based on favorable terrain and avoiding natural hazards so that available geologic-materials resources could also be selected.

Two geologic maps (in the Tyonek and Talkeetna quadrangles) depict DNR-DGGS corridors in the Study Area. These two corridors are:

- A proposed McGrath-Upper Cook Inlet Corridor that begins in the Beluga/Tyonek region and travels east of Mount Susitna before turning northwest and traveling through Rainy Pass to McGrath.
- A proposed Willow or Wasilla Link that connects to the McGrath-Upper Cook Inlet Corridor as an alternative to the Beluga/Tyonek termini.

4.2.2 Chuitna River to Goose Bay Corridor, Department of Highways 1972

The State of Alaska Department of Highways (the precursor to the Alaska DOT&PF) prepared a series of ROW maps dated May 1972 showing an alignment that goes west from Goose Bay across the Susitna River to the Beluga area. The DNR Alaska Division of Land (ADL) 575888 record indicates the Department of Highways had submitted an application in 1972 requesting a ROW corridor of 400 feet and 65 miles in length for the Chuitna River to Goose Bay project. The ADL record indicates that a number of land disposal activities have been recorded over the years for the subject lands, including land conveyances to Native corporations and several sections deleted from this ROW corridor as land was transferred. The case file was closed in 2008 and then reopened shortly thereafter. The application for the ROW corridor was never formally acted upon.

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[144] DNR-DGGS. May 17, 2013. Personal communication with De Anne Stevens, DNR-DGGS Engineering Geology Section Chief.

As drawn on the 1972 maps, the alignment crosses approximately 61 sections. As of March 2013, 9 of those sections contain Mental Health Trust land, 16 contain Municipal Entitlement land, and one section had been conveyed per Alaska Native Claims Settlement Act (ANCSA). Based on communications with DNR in March 2013, approximately 43 percent of the corridor is not on state-patented or state-selected land.

4.2.3 Talkeetna-McGrath-Ruby Proposed Road Route, Bureau of Public Roads 1959

The Bureau of Public Roads prepared a report in 1959 depicting a proposed road route from Talkeetna to McGrath and Ruby. The alignment starts near Talkeetna and Petersville and travels through the Study Area and on through Rainy Pass. The document describes the existing conditions in 1959, the proposed transportation routes, and how construction of the proposed routes may aid in the development of the area's natural resources. At the time of the report, only the Alaska Railroad tracks were in place (as the Parks Highway had not yet been constructed).

4.3 Susitna River Crossing Location

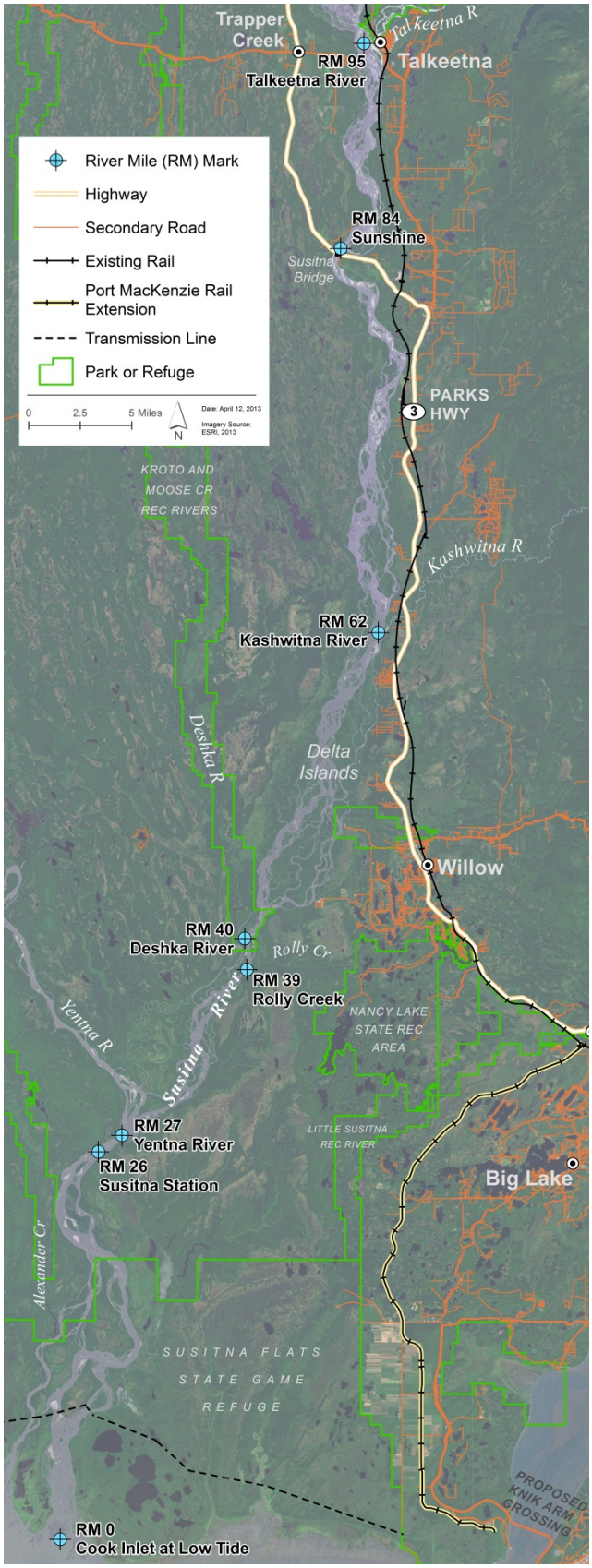
4.3.1 Introduction

The Susitna River originates in glaciers of the Alaska and Talkeetna Mountain ranges and flows about 320 miles in a southerly direction before entering northern Cook Inlet. The river is generally differentiated into the lower river and the upper river at the confluence of the Susitna River, Talkeetna River, and Chulitna River at Talkeetna. The only existing road crossing of the Lower Susitna River is the Parks Highway crossing at Sunshine, approximately 12 river miles downstream of Talkeetna.

A literature and aerial photograph review was completed to evaluate potential crossing locations of the lower Susitna River. The results of the review are described in this section. The river miles (RMs) referenced are based on river mapping, with RM 0 approximately at the confluence of the Susitna River and Cook Inlet at low tide and RM 95 in Talkeetna. For reference only, other notable RMs include the Kashwitna River (RM 62); Deshka River (RM 40); Rolly Creek (RM 39); Yentna River (RM 27); and Susitna Landing (RM 26) (also known as Susitna Station). Figure 4-2 depicts these locations. The project team assessed the entire lower Susitna River (RM 0 to RM 95) for potential crossings, as described in the following sections.

Numerous clear water tributaries enter the east side of the Lower Susitna River, and generally enter perpendicular to the river. In contrast, tributaries on the west side flow roughly parallel to the river and enter the main stem below Willow Creek. West side tributaries include the Deshka River, Lake and Alexander Creeks, and the Yentna River and its tributaries. Much of this west side drainage north of the Yentna River flows north to south.

Figure 4-2. Lower Susitna River Vicinity



4.3.2 Crossing Location Options and Analysis

Identifying where to cross the Susitna River is a key element in establishing the location and practicality of potential access corridors in the Study Area. Crossing width, approach topography, geotechnical aspects, stream hydrology, and bank stability are considerations to factor into determination of a crossing location.

The study team identified potential crossing locations and rated them as suitable, marginal, or unsuitable. A suitable location is defined as a location where the river is stable, the banks are high enough for abutments, and the crossing length is relatively short. Alternatively, an unsuitable location is anticipated to be unstable with low banks and a relatively long crossing length. A marginal location is rated somewhere in between. Only "suitable" locations were recommended for crossing locations at this preliminary level of evaluation.

Three possible locations were identified for crossing the Susitna River between Talkeetna and tidewater. Of the three locations, only two locations were determined to be suitable: (1) Sunshine at RM 84 and (2) Susitna Landing at RM 26. There is also a marginally suitable third location at the Deshka River (RM 40). These three locations are summarized in Table 4-1 and further described in the following section.

Table 4-1. Potential Susitna River Crossing Locations

Susitna River Mile (RM)	Crossing Name	Crossing Width (feet)	Comments
84	Sunshine	1,000	High stable banks, single channel. Good crossing location with the existing bridge.
40	Deshka River	3,000 to 5,000	Low unstable banks, primarily single channel, ongoing channel migration. Will require extensive bank stabilization. Marginal crossing location.
26	Susitna Landing*	2,000	Stable banks, bedrock control, single channel. Good crossing location.

*Also called Susitna Station.

RM 95 (Talkeetna) to RM 62 (Kashwitna River). Downstream of the Three River Confluence at Talkeetna, the Susitna River is braided with multiple channels interlaced through a sparsely vegetated floodplain. The floodplain consists of river-deposited alluvial sediments that are easily moved by the river. The area is subject to major channel and floodplain changes during flood events. The main channel is intermittently controlled laterally where it flows against terraces. Since the active floodplain is very wide, the presence of terraces has little significance except for determining the general orientation of the river system. An exception is where the terraces constrict the river to a single channel at the Parks Highway Bridge at Sunshine at RM 84. See Figure 4-3.

The existing crossing at Sunshine is the only suitable crossing location in this reach.

Figure 4-3. Susitna River: Talkeetna (RM 95) to Kashwitna River (RM 62)

RM 62 (Kashwitna River) to RM 40 (Deshka River). Downstream of the Kashwitna River confluence the Susitna River branches out into multiple channels separated by islands with established vegetation. This reach of the river has been named Delta Islands because it resembles the distributary channel network common with large river deltas. The Delta Islands section has a very broad floodplain, approximately 1 mile wide, with little lateral control. The floodplain consists of river-deposited alluvial sediments that are easily moved by the river. The area is subject to major changes during flood events. See Figure 4-4.

There are no suitable crossing locations in this reach.

Figure 4-4. Susitna River: Kashwitna River (RM 62) to Deshka River (RM 40)

RM 40 (Deshka River). Terraces constrict the Susitna River for a short distance between the downstream end of the Deshka River and the upstream end of Kroto Slough. Despite the constriction, there is significant channel movement in this reach. A crossing would be possible at this location but significant bank stabilization will be required.

This is a marginal site for a road crossing.

RM 39 (Rolly Creek) to RM 27 (Yentna River). This reach of the Susitna River is composed of multiple split channels. This reach is actively migrating within a broad floodplain. For much of this reach, the river is paralleled by Kroto Slough on the west side, and the Yentna River enters at RM 27. See Figure 4-5.

There are no suitable crossing locations in this reach.

Figure 4-5. Susitna River: Rolly Creek (RM 39) to Yentna River (RM 27)

RM 26 (Susitna Landing). Susitna Landing is the historic landing area on the river and has been in use since the early 1900s. It is located at a straight reach of river with one of the few bedrock controls on the entire lower river. The river banks are stable. Water velocity is low due to the low gradient of the river. The location is just downstream of the Yentna River (RM 27).

This is a suitable site for a road crossing.

RM 26 (Susitna Landing) to RM 0 (Cook Inlet). This reach of the river is composed of multiple split channels. Downstream of RM 20 the river is tidally influenced and branches out into delta distributary channels. See Figure 4-6.

There are no suitable crossing locations in this reach.

Figure 4-6. Susitna River: Susitna Landing (RM 26) to Cook Inlet (RM 0)

4.4 Environmental Constraints

4.4.1 Constraints Analysis

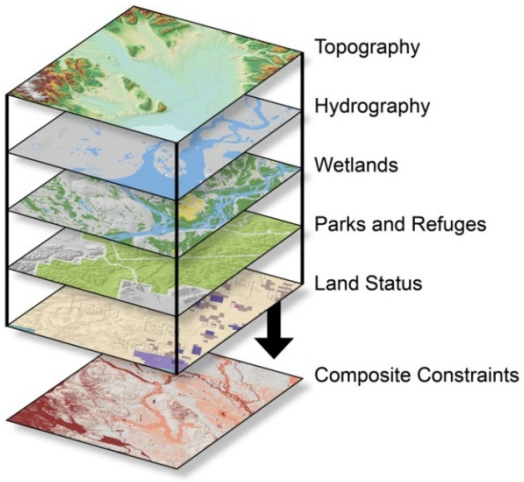
To identify and evaluate corridor opportunities for an access road into the Susitna basin to reach resources, the project team developed a composite environmental constraints map. The purpose of this mapping process is to identify potential corridors based on constraints considered to be less suitable for locating an access road (and conversely identifying areas more conducive to an access road). This method allows the identification of broad preliminary corridors and then more specific alignments that avoid or minimize the potential environmental impacts or engineering constraints of a proposed access road. The constraints analysis process is depicted in Figure 4-7. Baseline environmental features are displayed on Figure 4-8 through Figure 4-11.

Using available data, each environmental constraint was considered separately and then all were considered collectively to determine if there were opportunities to avoid or minimize the potential impacts of the project. The composite constraints map revealed areas more conducive to potential corridors.

To develop this overall understanding of the Study Area's constraints, the project team used a modern version of an overlay process introduced in the 1960s by landscape architect Ian McHarg. McHarg developed this process so that a project's environmental impacts could be considered in the early stages of project development. The process entails mapping environmental resources separately and then combining them in a layering process to develop a map that reveals the overall environmental constraints of an area.

The evaluation process starts with the identification of the factors or resources to be considered. For each factor, a GIS layer was created, with dark gradations representing areas with the most constraints (least suitable for roadway access) and the lightest gradations representing the areas with the fewest constraints (more suitable for roadway access). The layers were digitally superimposed on each other to form a composite constraints map. The darkest areas were those with the most overall constraints, and the lightest were those with the fewest constraints. The layering process enabled the project team to identify broad preliminary corridors while attempting to avoid environmental constraints.

Figure 4-7. Composite Constraints Development Process



4.4.2 Constraints

The project team identified the following environmental factors that had readily available information for environmental evaluation in a GIS format. The factors used to develop the composite constraints map are: topography, hydrography (waterbodies, anadromous fish streams, wetlands), parks and refuges, and land status.

Individual constraints are displayed on Figure 4-12 through Figure 4-16. Steep slopes and major waterbodies and streams were carried forward in all the constraints figures as these areas were deemed as extremely prohibitive for an access road.

Composite constraints are depicted on Figure 4-17. The previously identified alignments were overlaid on the composite constraints map, as depicted on Figure 4-18. The previously studied alignments did a pretty good job of missing major constraints.

Topography/slope. The elevation in the Study Area greatly varies from sea level at Cook Inlet, to several hundred feet near the Parks Highway to the slopes and mountains of the Alaska Range, as shown on Figure 4-12. Slopes were derived in GIS using a 30-meter digital elevation model (DEM) of the Study Area. The slope function calculates the rate of change of elevation for each DEM cell. Slopes for the Study Area are classified by slope value and graphically depicted in a light gray (flat terrain) to dark red (steep terrain) color scheme.

Hydrography/waterbodies and anadromous fish streams. A large number of the streams in the Study Area originate from glaciers. Large glaciers, such as the Kahiltna, flow down into the Susitna Basin. The Study Area is characterized by major river valleys and countless smaller streams. See Figure 4-13.

Waterbodies such as lakes and rivers are generally environmentally sensitive areas. Within the Study Area, they can be considered an opportunity for access as well as a constraint for the development of an access road. Water crossings were considered important to avoid when possible due to permitting requirements and the expense of culverts or bridges. The information on waterbodies in the Study Area came from the USGS National Hydrography Dataset. The resulting map is depicted in Figure 4-13.

Fish, particularly salmon, are an important resource in Alaska for economic, subsistence, and recreational purposes as part of the ecosystem. As a result, the State has developed regulations designed to protect fish habitat, particularly those streams that support anadromous fish. Activities that can impact anadromous fish streams, such as culvert and bridge construction or stream bank disturbances, require an ADF&G Title 16 Permit. The project team mapped anadromous fish streams as identified by the ADF&G Anadromous Fish Stream Catalog[145].

Wetlands. Under most circumstances, wetlands and other "waters of the U.S." are regulated by the USACE under authority of Section 404 of the Clean Water Act (CWA) or under authority of Section 10 of the Rivers and Harbors Act of 1899. By federal law (CWA) and associated policy, it is necessary to avoid project impacts to wetlands wherever practicable, minimize impact where impact is not avoidable, and in some cases compensate for the impact. Construction in Waters of the U.S., including wetlands, requires a permit process whereby any work proposed in wetlands must comply with the CWA. Before a permit to work in a wetland is granted by the USACE, the project

[145] Alaska Department of Fish and Game. 2013. *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes—Southcentral Region.* http://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=main.home

proponent must demonstrate that no practicable alternatives exist that would avoid impacts to wetlands altogether and still meet the overall project purpose. Alternatives are typically evaluated to determine whether wetlands have been avoided where possible.

The USFWS National Wetlands Inventory (NWI) mapped wetlands in the general project area in 1984 (see Figure 4-14). NWI mapping is an effective tool for large-scale planning and wetland analysis but is generally not suitable for a Section 404 permit application. NWI mapping is based primarily on aerial photographic interpretation with limited ground verification, and therefore wetland boundaries tend to be overly simplistic, with many smaller wetlands not included in the mapping. A significant area of the Study Area does not have NWI mapping, as indicated on Figure 4-14. As a result, due to coarse data resolution and missing data, the wetlands in the Study Area are likely greatly underestimated.

Parks, refuges, and recreation areas. State parks and wildlife refuges represent important public recreation and wildlife resources. These public lands were designated for primary purposes ranging from protecting fish and wildlife habitat to providing public recreation opportunities. Recreational resources are discussed further in Section 2.7. The project team used information from the DNR Administrative Large Parcel dataset to identify State parks and refuges in the Study Area. Parks and refuges are shown in Figure 4-15.

The Iditarod National Historic Trail traverses the Study Area and might also be considered a constraint. In addition to this trail, due to historic uses in the Susitna basin, there are likely a number of historic and archaeological resources that may also be considered constraints. A historic and archaeological survey of the Study Area was conducted at this reconnaissance-level analysis.

Land status. Land status can be viewed as both an opportunity and a constraint because the motivation for owning land can vary. Some entities own land with the intent to make a profit from the development or sale of that land. For example, the State's Mental Health Trust Land Office, which manages trust lands, manages their lands to derive income to support mental health organizations. In addition, government-owned land tends to consist of large parcels. Buying land from a few owners is preferable to buying small amounts of land from multiple land owners because it simplifies the ROW acquisition process. Institutions that have lands for the primary purpose of generating income tend to be more willing sellers than private owners. Fore these reasons, land owned the Trust or a government agency (excluding land designated as a State park, recreation area, or game refuge) was considered an opportunity.

Spatial data depicting general land status for the State of Alaska, available from the DNR Information Resource Management Division, Alaska General Land Status database, January 2013, was used to assess land status within the Study Area. The dataset combines land ownership and status records from both the U.S. Bureau of Land Management (BLM) and DNR to produce a section level indicator of general land ownership. Land status classification is summarized at the section level; therefore limitations exist with using this information. The general land ownership categories as defined within the dataset are summarized in Table 4-2 for the Study Area. The study team recognizes that additional land status analysis is important as access routes are further refined.

Table 4-2. General Land Ownership Status within the Study Area

Owner Category	Data Code	Size (acres)	% of Study Area	Viewed as Constraint or Opportunity
BLM	1500	441,509	7.2	Opportunity
Native Patented	2101	27,603	0.5	Constraint
Native Interim Conveyed (IC)	2102	11,440	0.2	Constraint
CIRI Patented	2111	1,909	0.0	Constraint
CIRI Interim Conveyed (IC)	2112	323,384	5.3	Constraint
State Patented	3101	4,333,123	70.8	Opportunity
State Tentatively Approved (TA)	3102	180,690	3.0	Opportunity
State and Native Owned	4100	8,829	0.1	Constraint
Privately Owned - BLM	5101	53,620	0.9	Constraint
State Land Disposals - Other than Municipal	5102	436,642	7.1	Constraint
State Land Disposals - Municipal Entitlements, Municipal Land Exchanges, Public & Charitable Use	5103	302,173	4.9	Opportunity
Total		6,120,922	100	

Source: GIS data from DNR 2013.

When possible, additional information and interpretation of each owner type is provided below in an attempt to better define the individual categories. Due to limitations of the data, actual ownership of any land should be verified using legal documents such as contracts, leases, etc., and/or Master Title Plats (federal land), Status Plats (state land), or municipal/borough plats in subsequent project development.

- **BLM:** This ownership type represents federally-owned land under management of BLM for various purposes such as national conservation areas, wilderness areas, national scenic and historic trails, grazing, and abandoned mines. Within the Study Area, there is only one National Historic Trail: the Iditarod. There are no National Conservation Areas, BLM Wilderness Areas, or National Scenic Trails.[146] There are various levels of interest possible (e.g., subsurface mineral estate underlying federal, State or private lands, or surface estate, etc.).
- **Native patented:** This ownership type generally consists of land for which a Native corporation or village received a patent. Additionally, interpretation may include land patented as a Native allotment to an individual or group of individuals by means of a "Certificate of Native Allotment."
- **Native Interim Conveyance:** Land designated as an entitlement to a Native corporation or village under ANCSA. Interests in the land are binding but subject to pending plat of survey and issuance of final patent.

[146] DNR-Office of Project Management and Permitting (OPMP). October 8, 2013. Comments provided during a review of a draft of this report. In subsequent project development, DNR-OPMP requested additional information be considered in terms of whether the BLM land has been designated for a particular purpose or if it is managed for multiple uses.

- **CIRI patented**: Cook Inlet Region, Inc. land for which the Native corporation CIRI holds a patent. Interests are typically subsurface but occasionally include surface rights as well.
- **CIRI Interim Conveyance**: Land designated as an entitlement to the corporation under ANCSA. Interests in the land are binding but subject to pending plat of survey and issuance of final patent.
- **State tentatively approved**: Lands that have been approved for conveyance to the State but for which the State has not yet received final patent. These lands could have been offered and even conditionally sold via quitclaim deed to private individuals (the sale cancelled/refunded if the State is not granted patent). The State of Alaska DNR typically manages these lands.
- **State patented**: Lands that have been conveyed to the State of Alaska for various purposes (e.g., Mental Health Grants, Community Grants, School Land Settlements, University Grant, General Grant, Mineral Estate, Railroad Transfer, etc.) and at varying levels of interest (e.g., surface, subsurface, or both). Interpretation may also include land patented by the State to an individual or group of individuals.
- **State- and Native-owned**: Interpreted as land owned by both the State of Alaska and a native corporation or village; individually defined above. More research is required.
- **Privately owned - BLM**: More research is required to determine specifics on this ownership type. It is assumed these lands are under private ownership.
- **State Land Disposals - other than municipal**: There are several types of land sales programs whereby State land is disposed of by DNR to private individuals under programs such as the sealed-bid auction program for the sale of subdivision and other surveyed parcels, over-the-counter sales, and remote recreational cabin site sales. Alaska Mental Health Trust Land office (by lease) and the University of Alaska Land Management office (by sale and/or lease) are also involved in disposal of State land.
- **State Land Disposals - Municipal Entitlements, Municipal Land Exchanges, Public and Charitable Use**: Under the General Grant Land law (AS29.65) local government acquires, at no cost, large undeveloped tracts of land from the state. Restrictions apply to disposal of this land by the municipality (i.e., it cannot be transferred except for a public purpose).

The above ownership types were aggregated to provide a more concise description of land ownership. Within the Study Area, the State of Alaska owns or has selected approximately 74 percent of the land (Codes 3101 and 3102). Of the remaining land, 7 percent is federally owned (Code 1500), 5 percent is Borough-owned land (MSB and KPB, Code 5103), 6 percent is owned by Native village and regional corporations (Codes 2101, 2102, 2111, and 2112), and 8 percent is in private ownership (Codes 5101 and 5102). Land status constraints are depicted on Figure 4-16**.**

Figure 4-8. Anadromous Streams

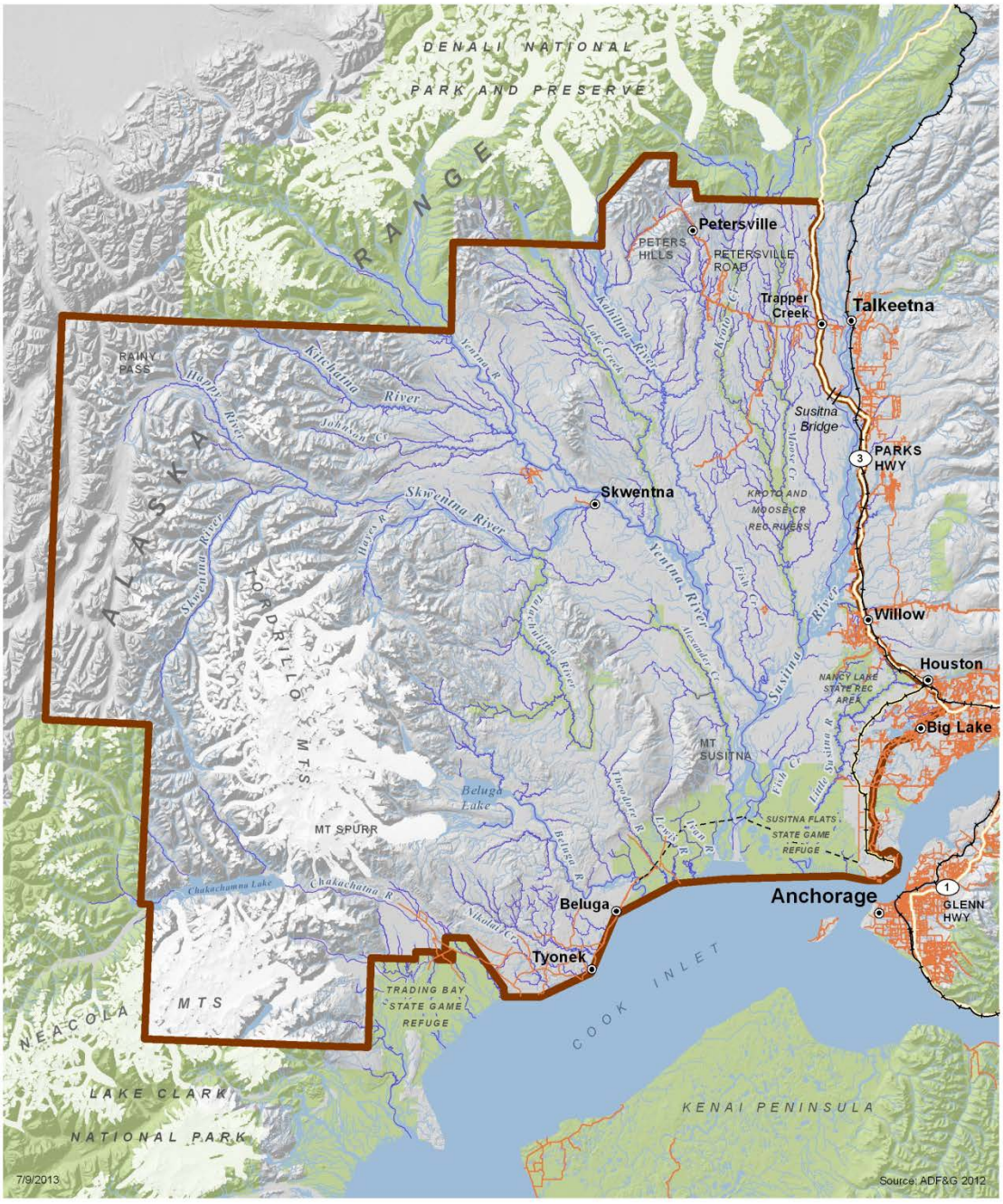
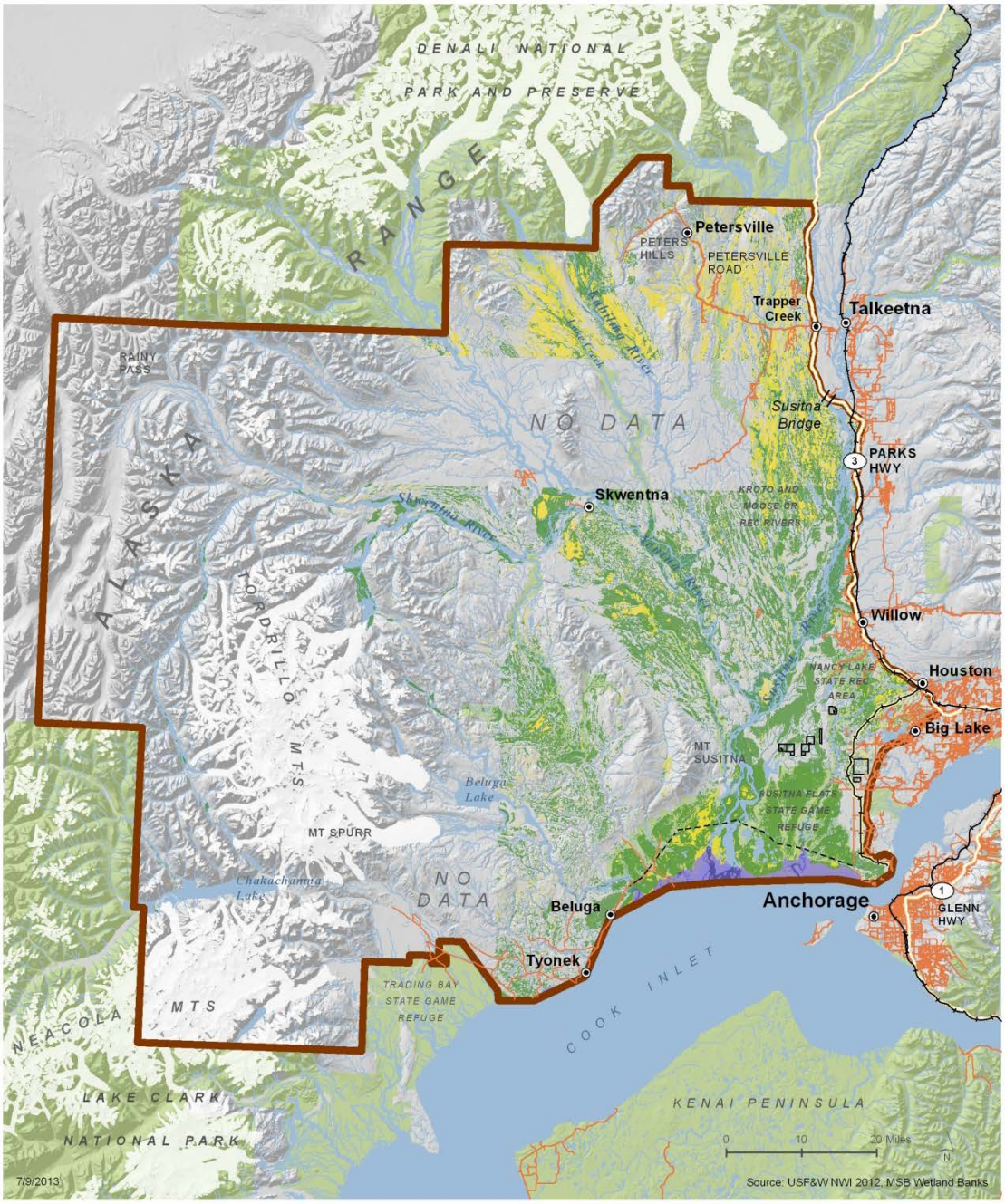


Figure 4-9. Wetlands



Wetlands *West Susitna Access to Resource Development*

National Wetlands Inventory
- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater and Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond, Lake, Riverine
- Stream
- Mat-Su Borough Wetland Bank
- Study Area
- Park or Refuge
- Highway
- Secondary Road
- Transmission Line

Figure 4-10. Parks and Refuges

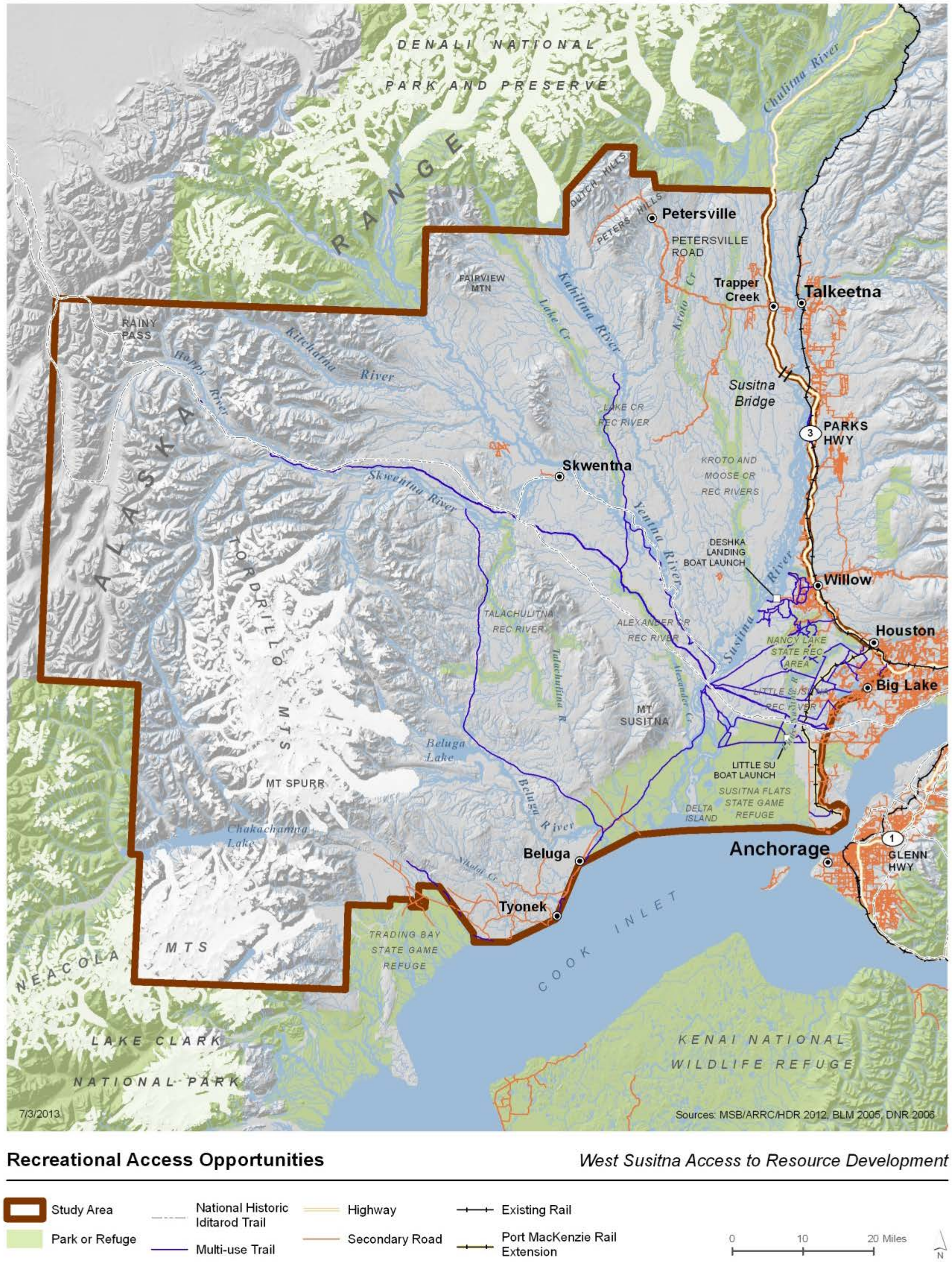
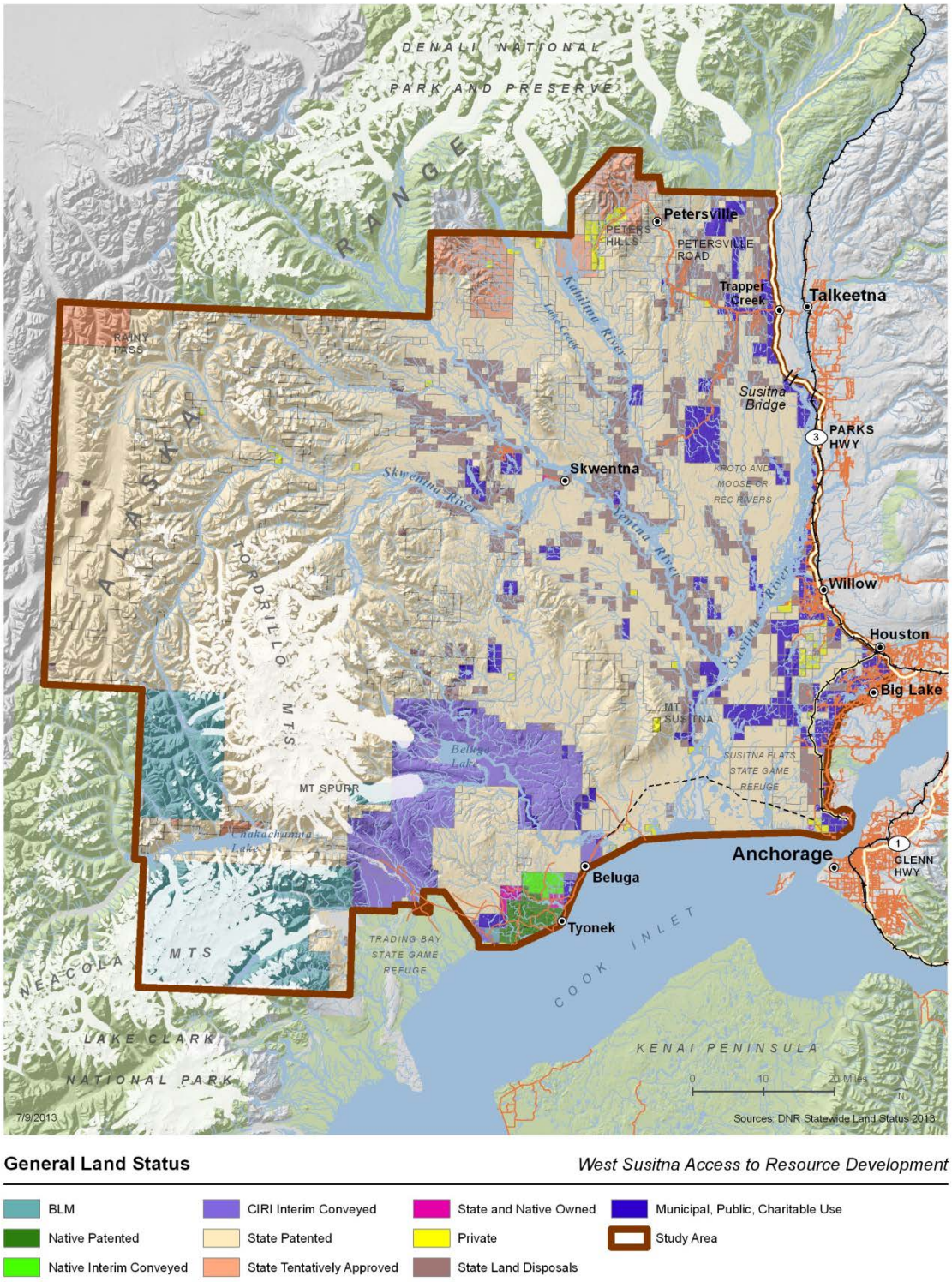


Figure 4-11. Land Status



General Land Status *West Susitna Access to Resource Development*

BLM	CIRI Interim Conveyed	State and Native Owned	Municipal, Public, Charitable Use
Native Patented	State Patented	Private	Study Area
Native Interim Conveyed	State Tentatively Approved	State Land Disposals	

Figure 4-12. Constraints: Slope

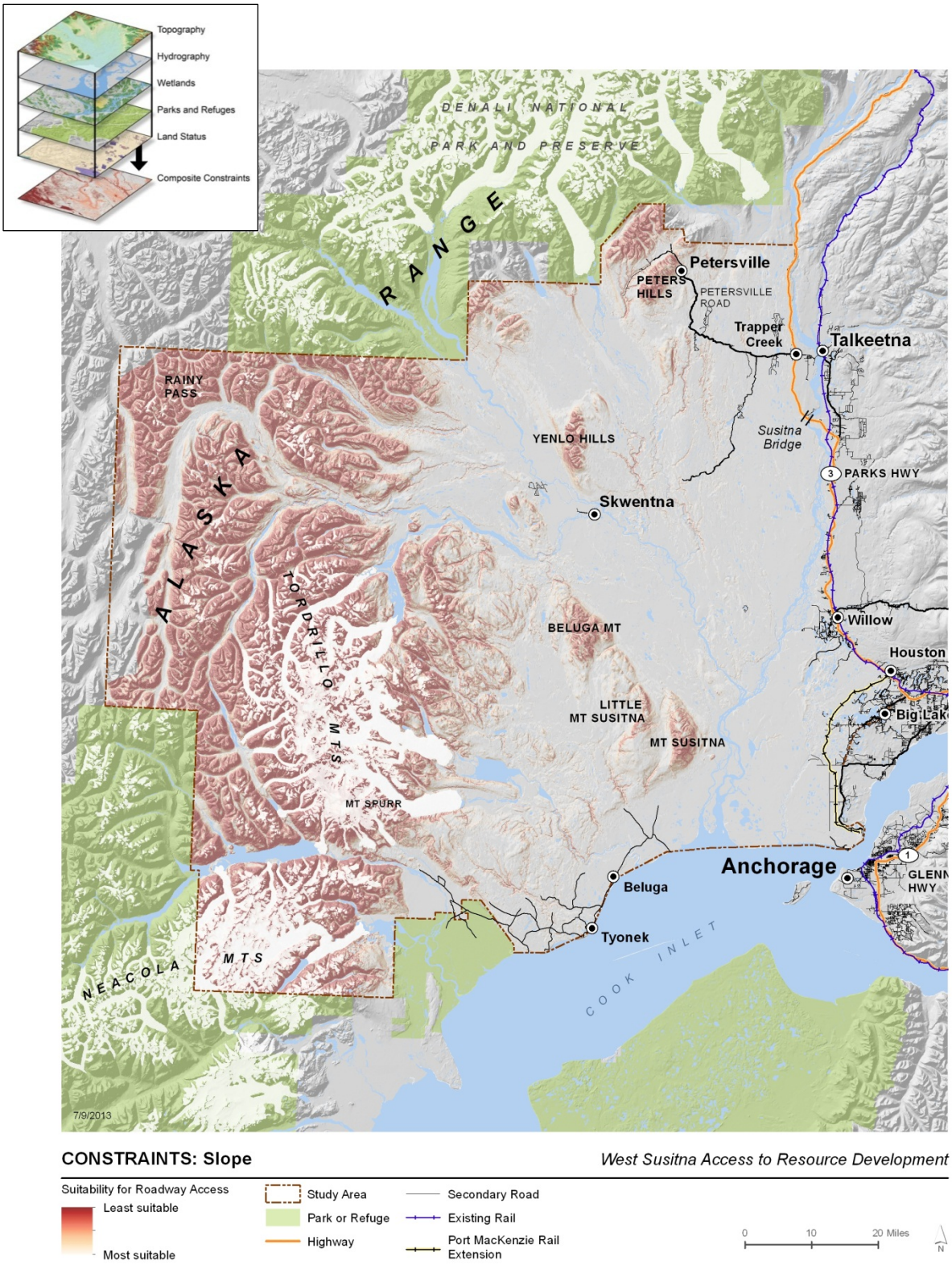


Figure 4-13. Constraints: Slope + Waterbodies and Streams

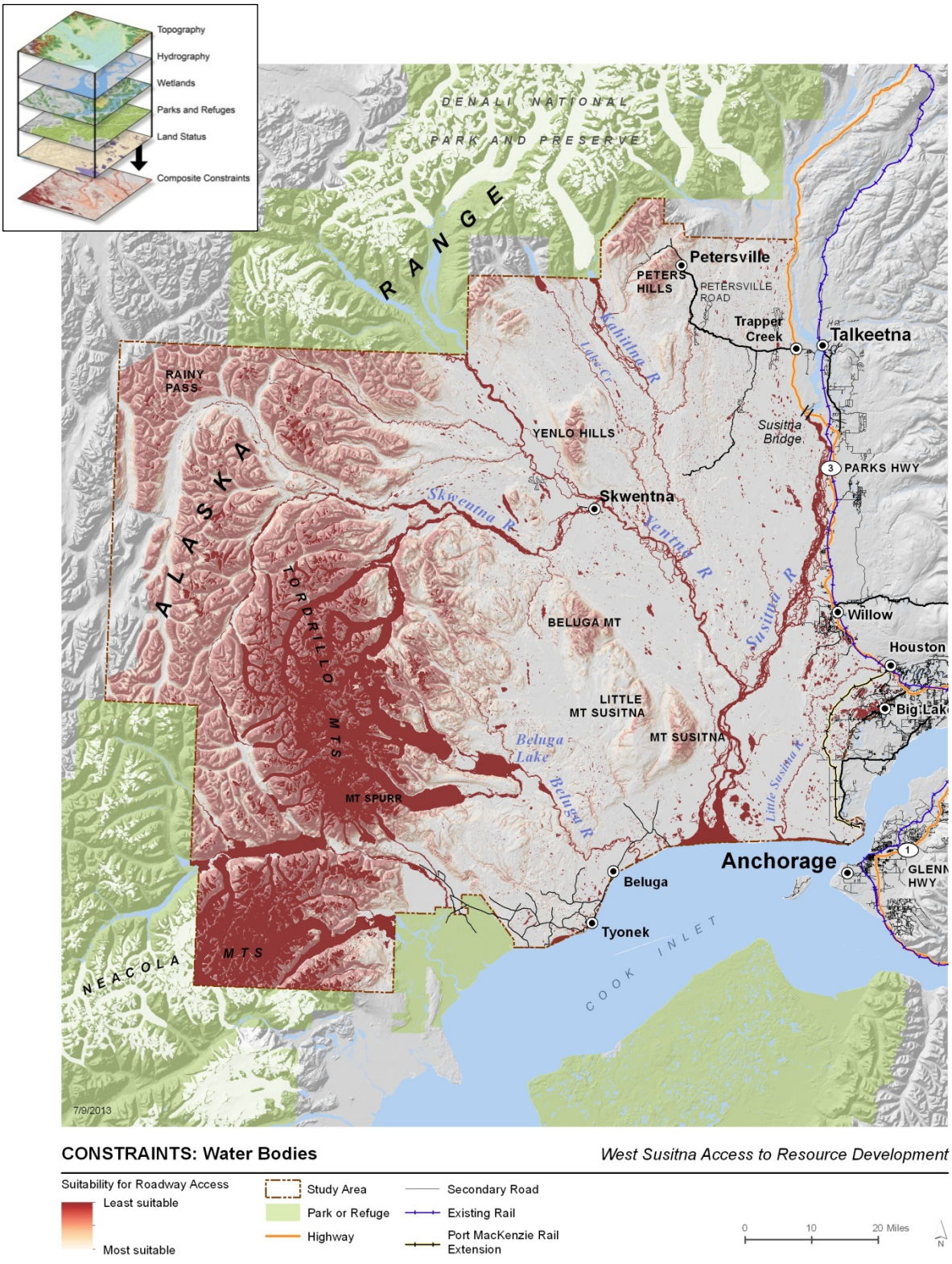


Figure 4-14. Constraints: Slope, Waterbodies, and Streams + Wetlands

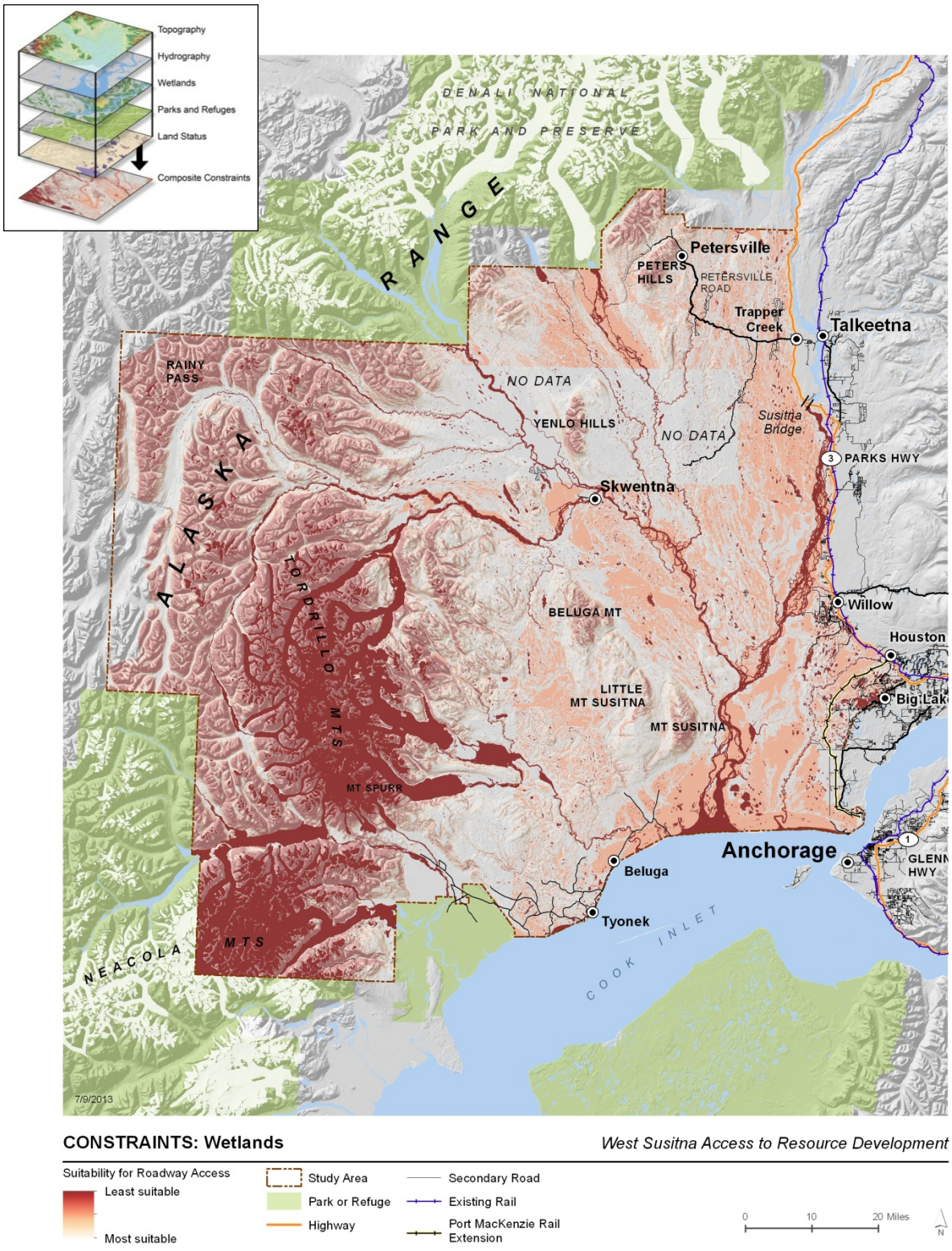


Figure 4-15. Constraints: Slope, Waterbodies, and Streams + Parks and Refuges

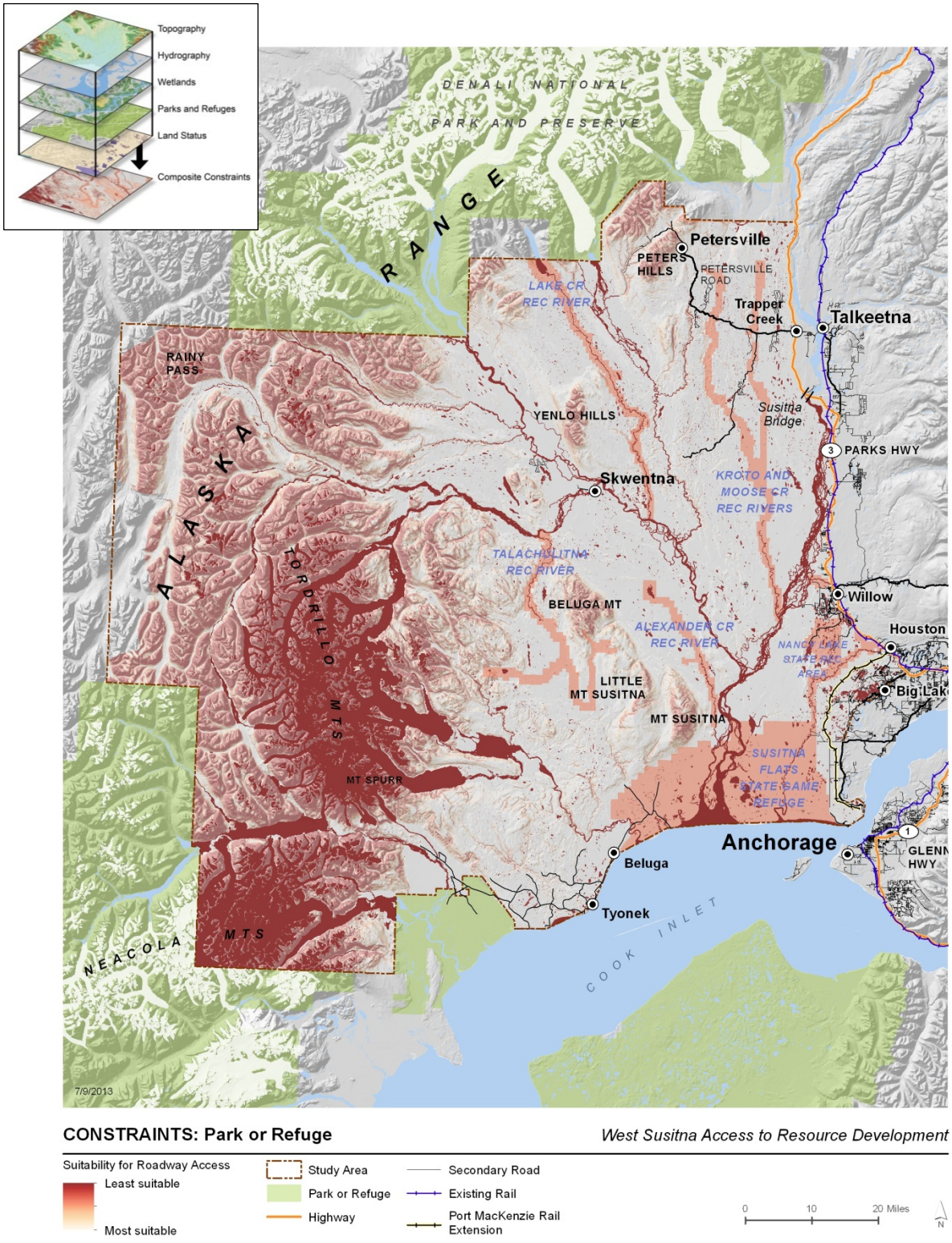


Figure 4-16. Constraints: Slope, Waterbodies, and Streams + Land Status

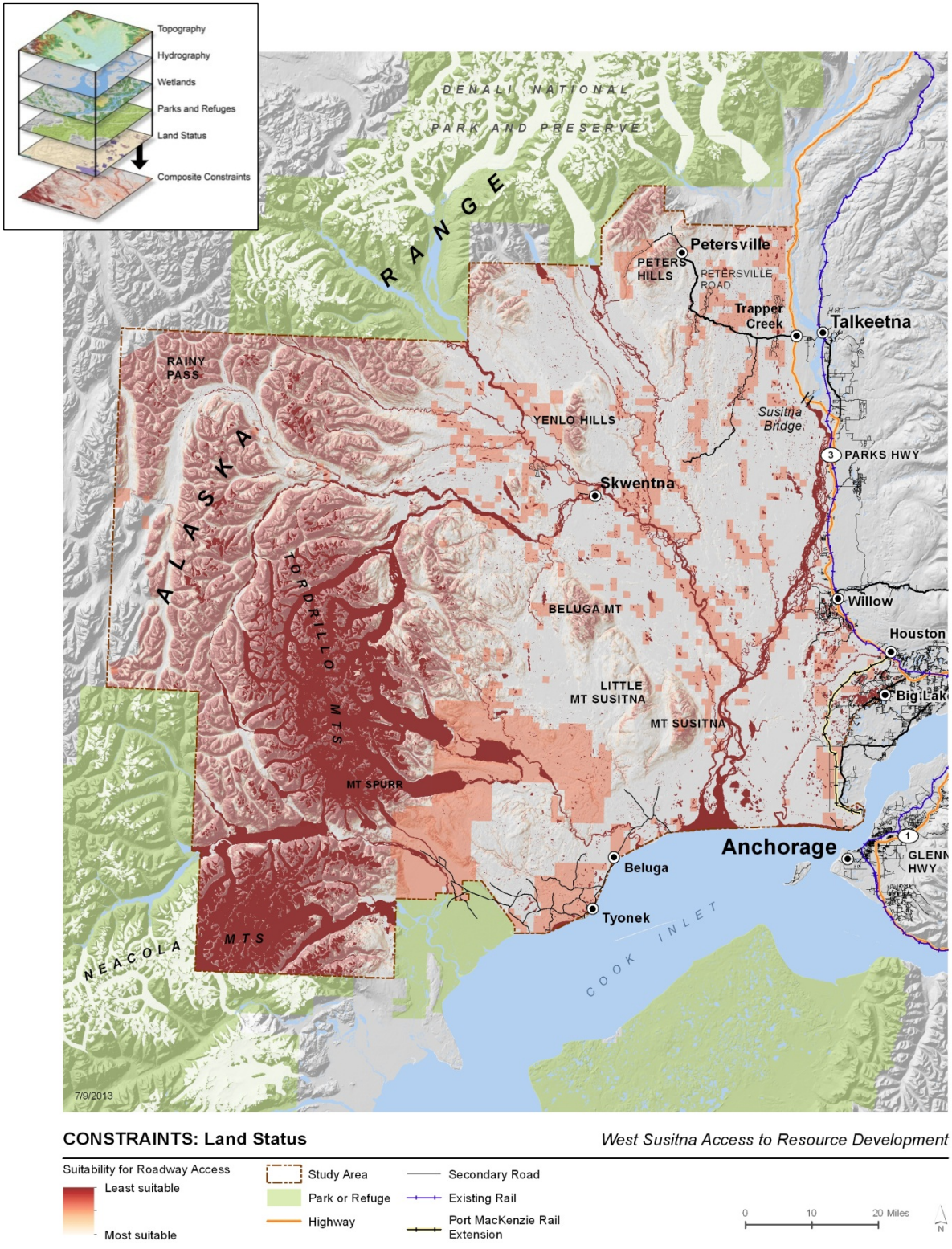


Figure 4-17. Composite Constraints

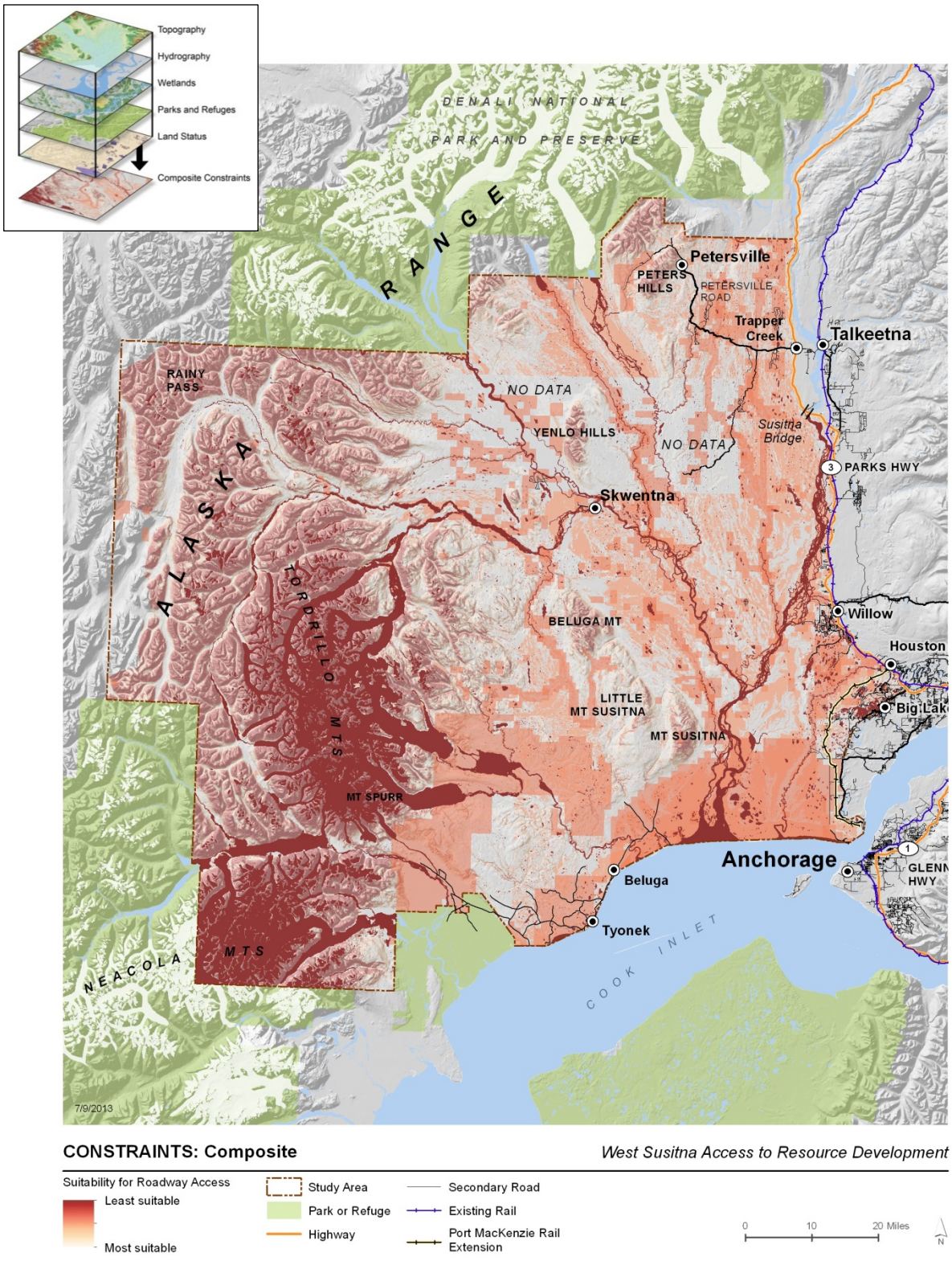
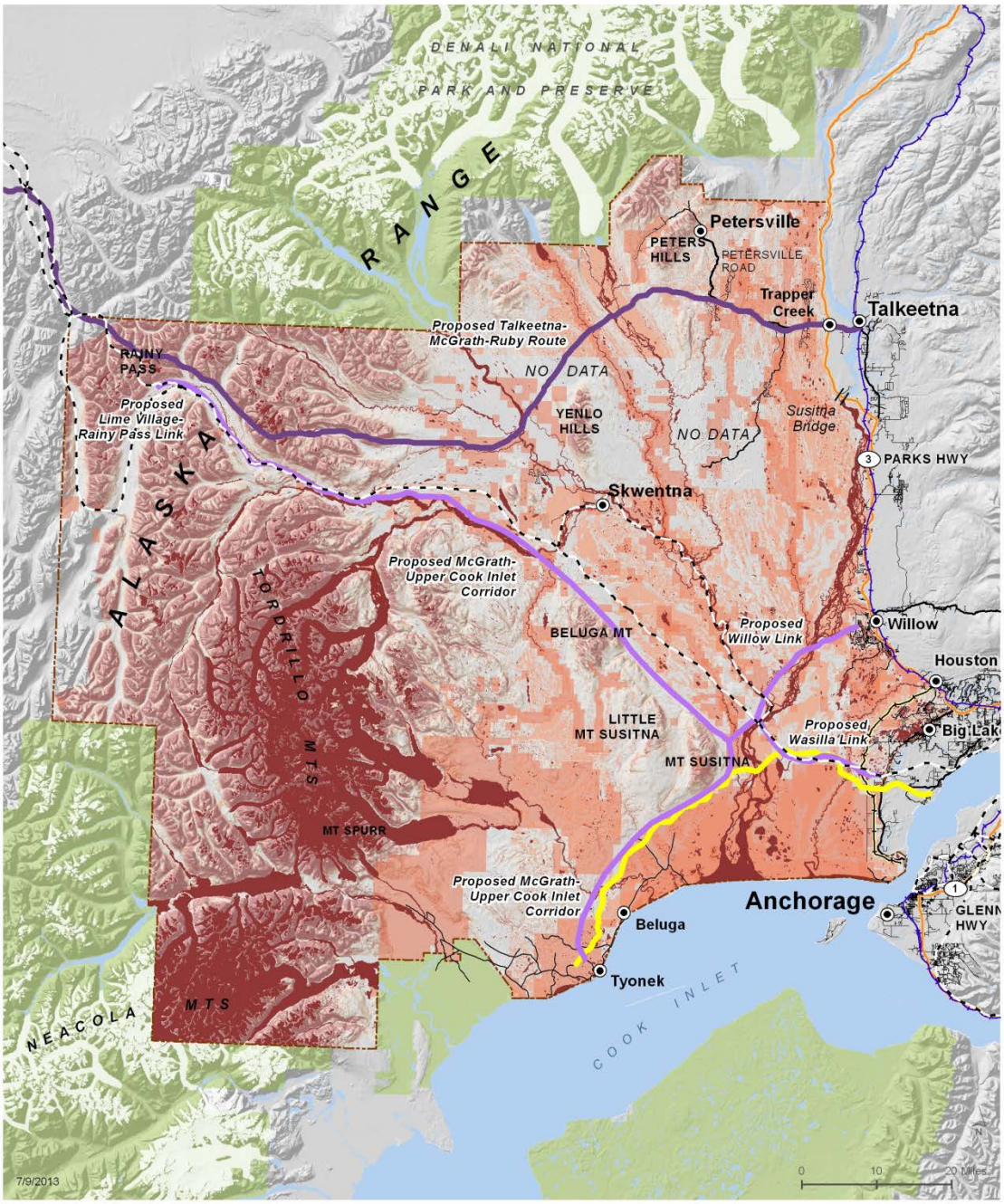


Figure 4-18. Composite Constraints and Previously Identified Alignments



Previously Identified Alignments and Constraints Composite *West Susitna Access to Resource Development*

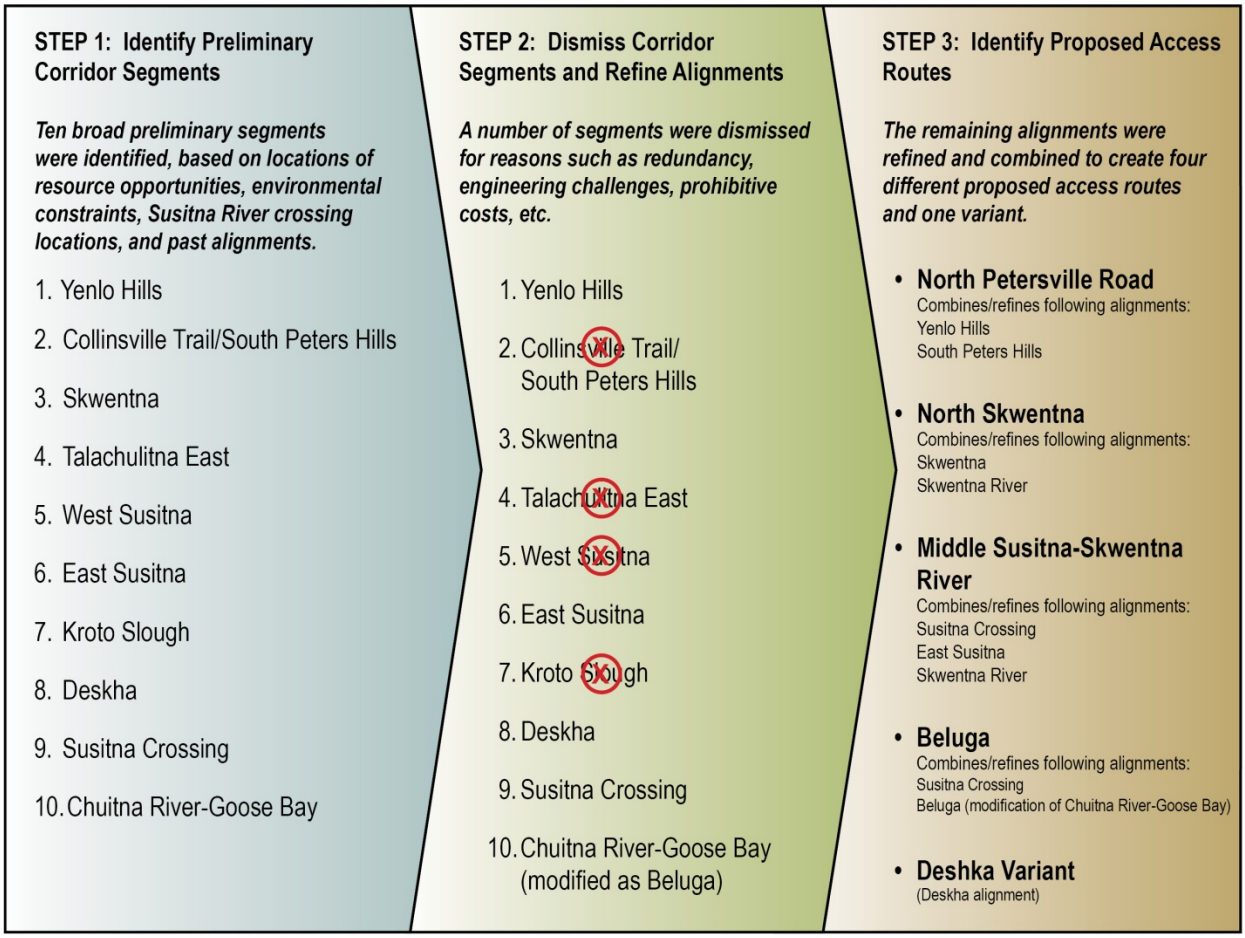
Suitability for Roadway Access
Least suitable
Most suitable

- National Historic Itidarod Trail
- Possible road routes (ADNR DGGS 1992)
- Chuitna River to Goose Bay (ADOT 1972)
- Talkeetna-McGrath-Ruby Route (Bureau of Public Roads 1959)
- Study Area
- Park or Refuge
- Highway
- Secondary Road
- Existing Rail
- Port MacKenzie Rail Extension

4.5 Preliminary Corridors

Developing preliminary corridor segments and centerline alignments was a multi-step process, as shown in Figure 4-19. As part of refining the initial 10 corridor segments (see Figure 4-20), preliminary conceptual engineering was conducted. Initial centerline alignments were laid out within the initial corridor segments in AutoCAD using USGS 15-minute, 1:63,360-scale quadrangle base maps to provide contour mapping for the Study Area. Standard roadway design criteria were used as specified in the Preliminary Design Criteria Technical Report. Additionally, the effort was assisted by use of aerial imagery available from Google Earth™. The goal was to provide a geographic range of corridor options that could access identified resources.

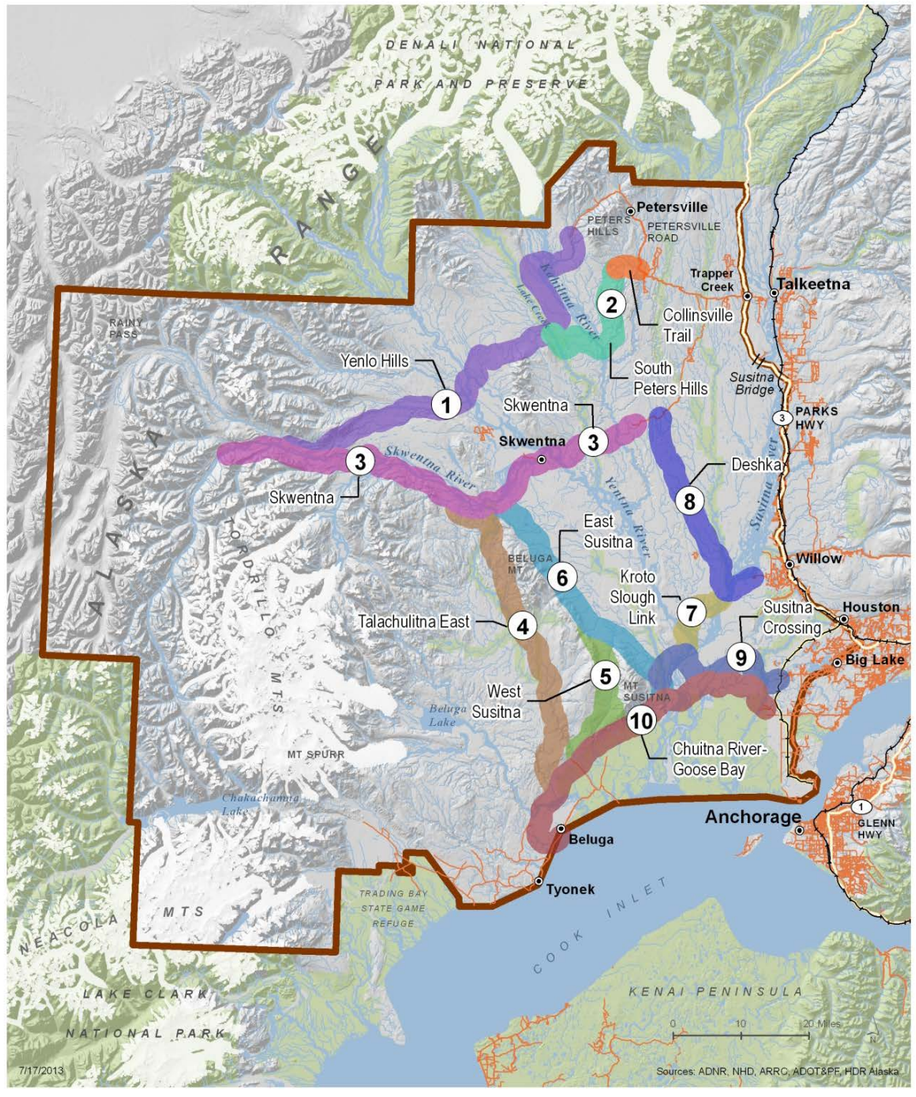
Figure 4-19. Access Route Development Process



4.5.1 Step 1: Preliminary Corridor Segments

Once the locations of the resource opportunities, environmental constraints, suitable Susitna River crossing locations, and past alignments were identified, 10 broad preliminary corridor segments were identified, as depicted on Figure 4-20. The broad preliminary corridor segments were based primarily on avoiding environmental constraints such as topographic features (mountains, steep slopes, and hills), waterbodies or wetlands, and river or stream crossings. Preliminary corridor segments were identified based on sound engineering judgment using available data.

Figure 4-20. Preliminary Corridor Segments



(1) Yenlo Hills Corridor Segment. This segment connects the Upper Skwentna mineralized area (the mineral deposits generally located southeast of Rainy Pass) with the road network at the Cache Creek mining district located near Petersville. This route crosses the Skwentna River, Johnson Creek, Yentna River, Lake Creek, and Kahiltna River. The route crosses wetlands in the Kahiltna and Yentna River valleys. It ascends and descends the northern flank of the Yenlo Hills. Near the western end the route passes near a couple of wilderness lodges located near Red and Finger Lakes. The road along Cache Creek would need to be upgraded.

(2) Collinsville Trail/South Peters Hills Corridor Segment. This segment is an attempt to shorten the distance of the Yenlo Hills segment. Instead of looping north along Cache Creek, it crosses south of the Peters Hills. It makes use of an old mining track called the Collinsville Trail, then passes down the west side of Little Peters Hills. This route crosses the Kahiltna River at a better location than the Yenlo Hills segment. It still has issues of crossing lumpy bedrock terrain and some wetlands.

(3) Skwentna Corridor Segment. This segment leaves the Upper Skwentna mineralized area and travels along the south side of the Skwentna River to connect with an extension from Oil Well Road. It crosses the Hayes River, Talachulitna River, Yentna River, Lake Creek and Kahiltna River. Portions of this route cross wetlands and pass through terrain consisting of lumpy bedrock and scattered kettle lakes.

(4) Talachulitna East Corridor Segment. This segment skirts the lower slopes of Mount Susitna and Beluga Mountain to avoid the wetlands prevalent in the Talachulitna River drainage. The north portion of the route between the Talachulitna River crossing and Skwentna River will be more difficult to construct due to lumpy bedrock terrain interspersed with many kettle lakes.

(5) West Susitna Corridor Segment. This segment was created in case the route around the east side of Mount Susitna ran into too many construction issues. The alignment crosses the saddle separating Mt. Susitna and Little Mt. Susitna; it is anticipated that this saddle experiences heavy snow drifting and avalanche potential.

(6) East Susitna Corridor Segment. This segment skirts the lower slopes of the east side of Mt. Susitna and Beluga Mountain and maintains a lower elevation than the other segments (Talchulitna East and West Susitna) going north from Beluga. This segment crosses fewer wetlands and avoids more of the lumpy terrain the Talachulitna East Alignment crosses.

(7) Kroto Slough Link Segment. This segment is used to link the Parks Highway access through Deshka Landing to Beluga. It travels along the north side of Kroto Slough and crosses the Yentna River 3 miles upstream from its confluence with the Susitna River. The portion of the alignment east of the Yentna River crosses wet soils. This link would connect the Deshka segment with the Susitna Crossing segment.

(8) Deshka Corridor Segment. This segment leaves the road network at Deshka Landing, west of Willow, to cross the Susitna River just downstream of the mouth of the Deshka River. It then turns north to roughly parallel the Deshka River to connect with the southern end of Oil Well Road. The north end of Oil Well Road connects to Petersville Road. The whole length of the Deshka segment on the west side of the Susitna River crosses soils with a high water table, if not true wetlands.

(9) Susitna Crossing Corridor Segment. This segment crosses the Susitna River at one of the most stable river bank locations along the southern portion of the river. It crosses just north of Flat Horn Lake to connect to Goldsteak Drive, west of Big Lake.

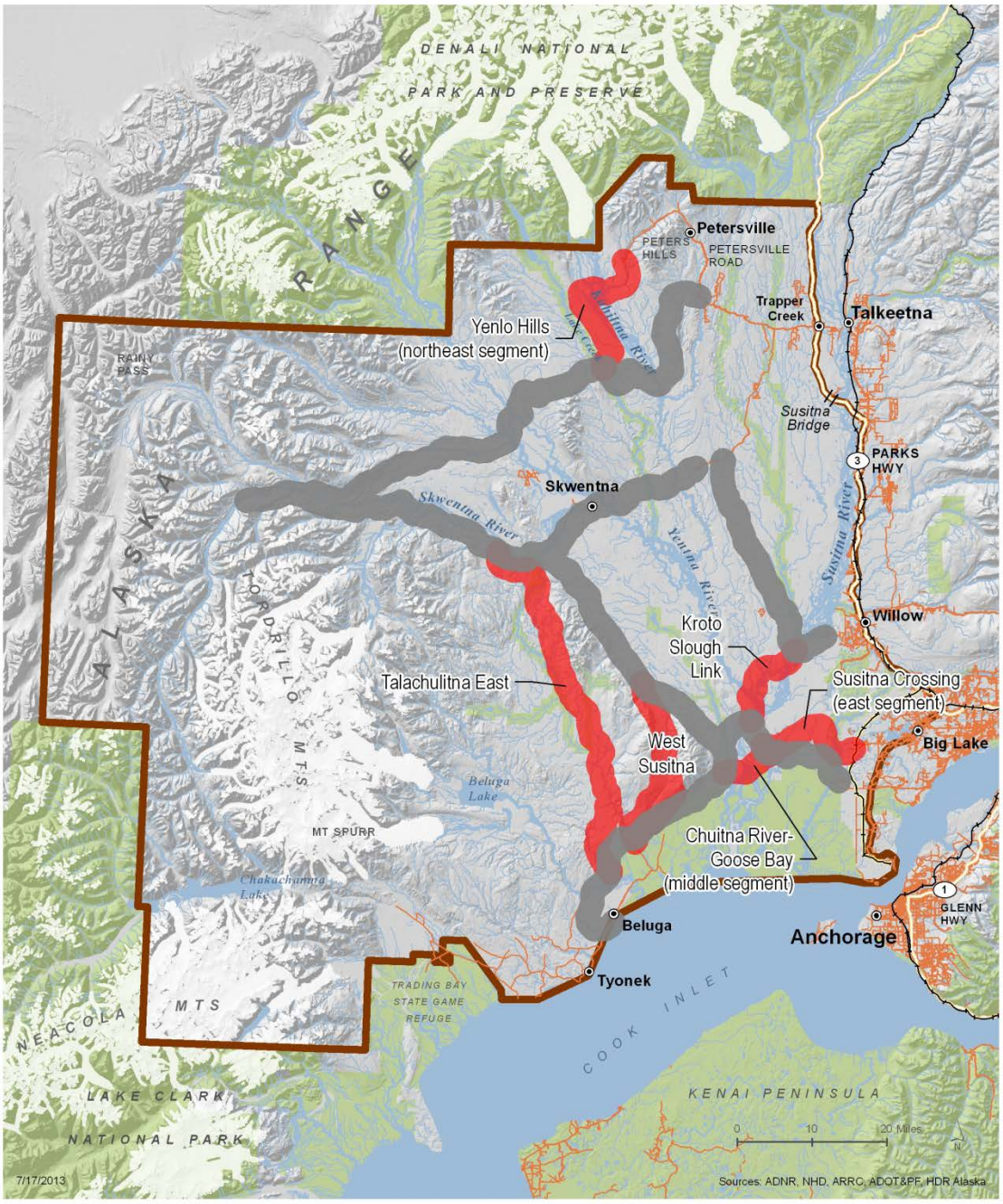
(10) Chuitna River-Goose Bay Corridor Segment. This is the corridor alignment previously identified by DOT in 1972. The main issue with this route is that it crosses the Susitna River in a braided area with many moving gravel bars. A better crossing of the Susitna River is located 8 miles upstream at the Susitna Crossing (as described earlier in Section 4.3). This alignment originally extended to the road network at Goose Bay, but since then the road network has been extended to the Little Susitna River where the project team shows it ending.

4.5.2 Step 2: Preliminary Corridor Segment Screening - Dismissed Segments

For the level of effort for this reconnaissance-level study, and as part of the preliminary corridor refinement process, several of the initial 10 preliminary corridor segments were dismissed for a variety of reasons. These reasons include redundancy compared with other similar alignments, engineering challenges, wetlands, and additional bridge requirements and associated costs with structures. See Figure 4-21 for the dismissed corridor segments. The corridor segments considered but dismissed are as follows:

- Only one of the two options departing the region near the end of the Petersville Road was retained for further analysis as part of the Yenlo Hills corridor segment. This region is characterized by lots of wetlands.
- Only one of the three options connecting from the Beluga area northwestward towards the Upper Skwentna mineralized area near Rainy Pass will be retained for further analysis. The Talachulitna East corridor segment and West Susitna corridor segment were dropped in this area and the East Susitna corridor segment was retained. The two dismissed segments were dropped because both options added extra, unnecessary miles from the crossing of the Susitna River compared with the West Susitna segment.
- The Kroto Slough link segment was eliminated from further analysis; the corridor crosses very wet terrain.
- The Chuitna River-Goose Bay route, the route previously identified by DOT in 1972, crosses the Susitna River in a location this study did not identify as a reasonable river crossing. Therefore, this specific route will not be carried forward. Instead, the corridor route will be modified to cross the Susitna River in a more reasonable location, as identified as part of this study. The alignment carried forward in this portion of the Study Area will be a combination of the Susitna Crossing segment and the Chuitna River-Goose Bay segment. In the next section and subsequent analysis in this report, this alignment will be known as the Beluga alignment west of the Susitna River crossing.

Figure 4-21. Preliminary Corridor Segments Considered but Dismissed



The seven remaining corridor alignments provide a geographical span of potential roadway access opportunities (see Table 4-3 and Figure 4-22). These seven corridor alignments are also depicted on USGS quad sheets (see Appendix B). These remaining corridor alignments have been combined in several ways to make several potential resource access route options, as described in this section. It should be noted that there are alternate ways to connect the segments together to create alternatives.

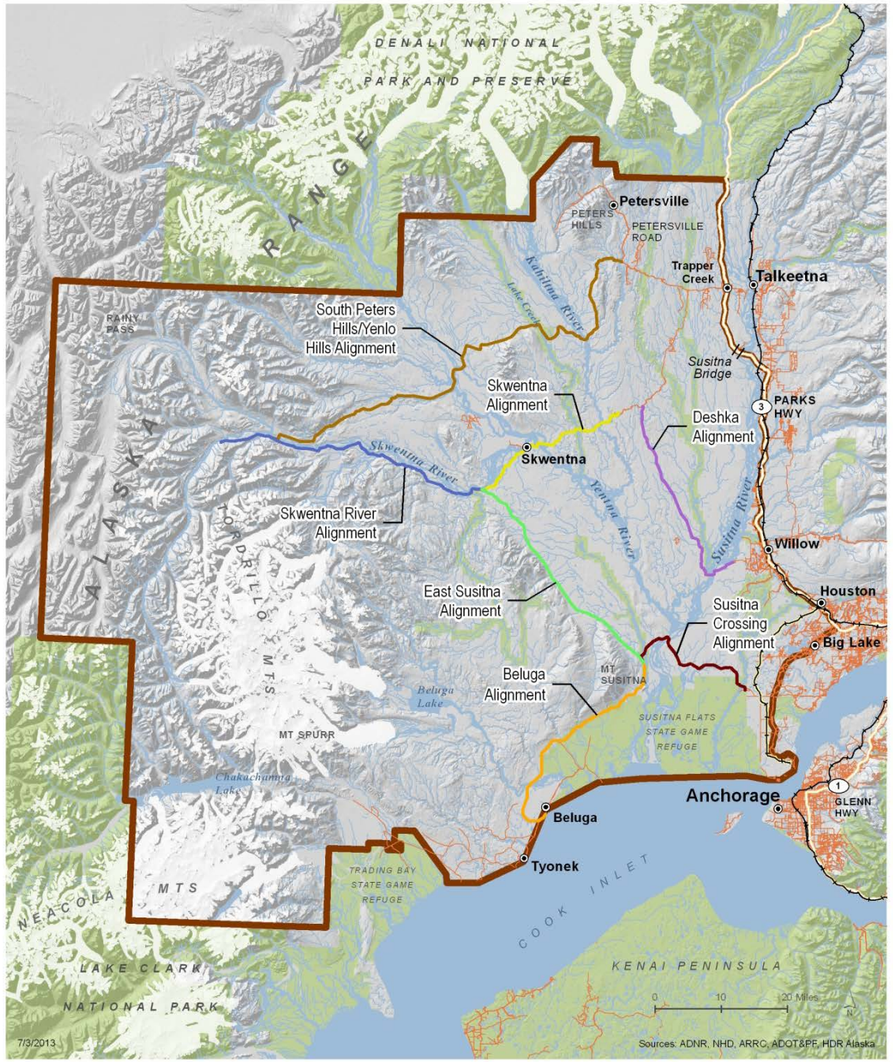
The benefit of having a range of alternatives is the option to do multi-phased construction, whereby multiple termini and resources may be accessed throughout the Study Area and alternative segments sequentially built based on priority, availability of funding, and timing of access needs. For instance, should accessing the Upper Skwentna mineralized area southeast of the Rainy Pass area be paramount, the South Peters Hills/Yenlo Hills Alignment could be the first phase of road access into the West Susitna region. Subsequent phases could then be built to the south, providing connection to the Beluga/Tyonek region. Alternatively, West Susitna access could be implemented in the reverse order, beginning with the Beluga/Tyonek region and subsequent development to the north later.

Table 4-3. Refined Corridor Alignments

Corridor Alignment Name	Approximate Length (miles)
South Peters Hills/Yenlo Hills	79
Skwentna River	44
Skwentna	27
East Susitna	37
Deshka	34
Susitna Crossing	26
Beluga[1]	38

[1] The Beluga alignment is a slightly altered version of the initial Chuitna River-Goose Bay corridor segment.

Figure 4-22. Refined Corridor Alignments



Refined Corridor Alignments *West Susitna Access to Resource Development*

Alignments
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment
- Study Area
- Park or Refuge
- Highway
- Secondary Road
- Existing Rail
- Port MacKenzie Rail Extension

South Peters Hills/Yenlo Hills Alignment. The South Peters Hill/Yenlo Hills Alignment begins at Petersville Road, roughly at the location where it nears Peters Creek and veers north. This alignment would cross Peters Creek and trend west for about 3.5 miles, then travel southward on the western side of the Little Peters Hills to a crossing of the Kahiltna River. From the Kahiltna River crossing, this alignment trends generally westward, crossing Lake Creek and the Lake Creek Recreation River area, passing north of the Yenlo Hills, to a crossing of the Yetna River. From the Yetna River crossing, the alignment generally trends in a southwesterly direction to the Skwentna River. This alignment is roughly 79 miles in length and reaches a maximum elevation of approximately 1,800 feet.

Skwentna River Alignment. The Skwentna River Alignment begins at the theoretical junction of the Skwentna Alignment and the East Susitna Alignment. It provides access from the Skwentna River valley to the Upper Skwentna mineralized area, traveling in an east to west direction on the south side of the Skwentna River. From its beginning, this alignment travels about 2 miles to a crossing with the Talachuitna River. The alignment then climbs gradually along the south side of the Skwentna for nearly 15 miles to a crossing of the Hayes River. The alignment continues westward across a braided floodplain for another approximately 17.5 miles to the theoretical junction with the South Peters Hills/Yenlo Hills Alignment, then crosses the Chickak River and continues for another 7 miles to the terminus of the alignment. This alignment is roughly 44 miles in length.

Skwentna Alignment. The Skwentna Alignment begins at its highest elevation of about 800 feet at the southern end of Oilwell Road and travels west for approximately 4 miles before reaching a crossing of the Kahiltna River. It then traverses another 4 miles to a crossing of Lake Creek. From this crossing, the alignment continues westward to a crossing of the Yetna River, passing near the community of Skwentna. It then travels in a southwesterly direction, staying on the south side of the Skwentna River to the approximate confluence of the Talachuitna River and Skwentna River. This alignment is roughly 27 miles long and reaches a maximum elevation of about 1,500 feet.

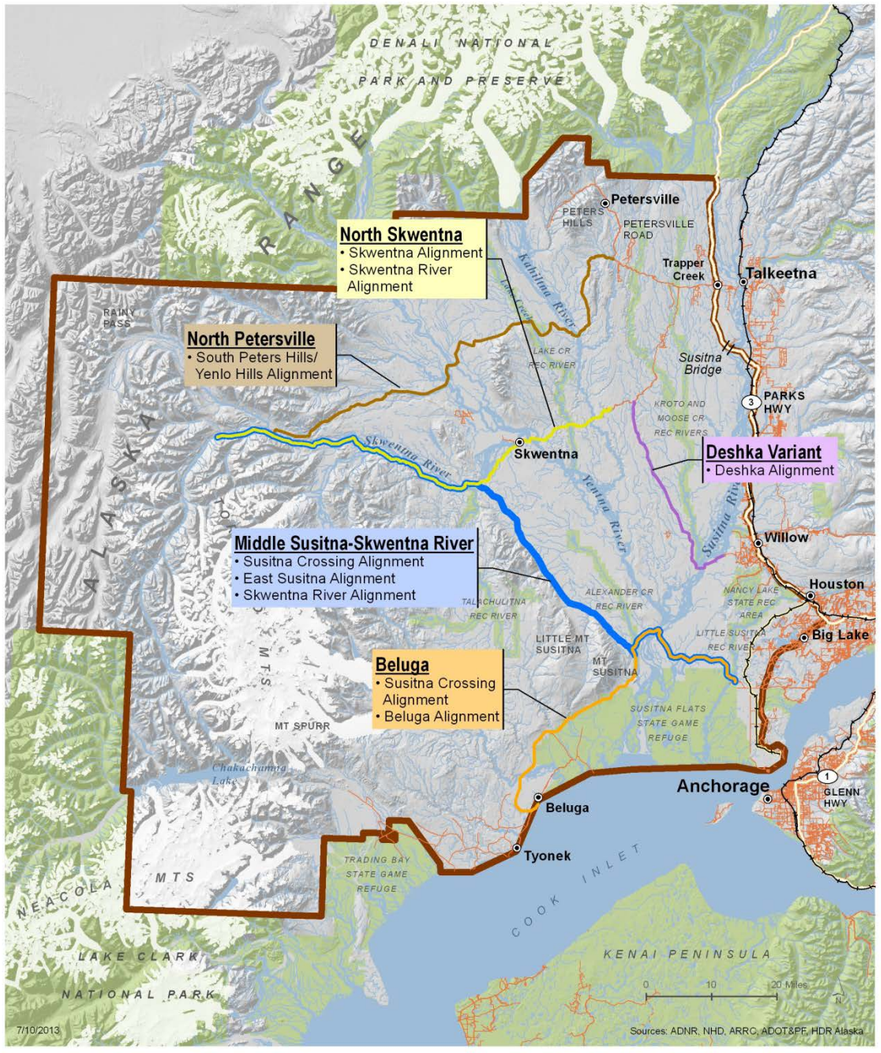
East Susitna Alignment. The East Susitna Alignment begins at the theoretical junction of the Susitna Crossing Alignment and the Beluga Alignment. It provides access from the eastern side of Mt. Susitna and the lower Susitna Valley to the Skwentna River. This alignment begins on the eastern side of Mt. Susitna and travels in a northwesterly direction and crosses many smaller creeks flowing from the eastern slopes of Mt. Susitna, Little Mt. Susitna, and Beluga Mountain. The alignment descends from the slopes of Beluga Mountain to lower-lying terrain and ends at the Skwentna River. The alignment is approximately 37.5 miles in length and reaches a maximum elevation of 560 feet.

Deshka Alignment. The Deshka Alignment provides access from the MSB road system across the Susitna River and up the valley between the Yentna and Kahiltna rivers and Kroto Creek to a point located on Oilwell Road. This alignment begins at Deshka Landing Road and travels about 3.5 miles to the southwest to a crossing of the Susitna River. The alignment then travels north-northwest for roughly 30 miles until it reaches Oilwell Road. This alignment is approximately 33.5 miles in length and reaches a maximum elevation of 600 feet.

Susitna Crossing Alignment. The Susitna Crossing Alignment provides access from the MSB road system to a location on the western side of the Susitna River. It begins from the Little Susitna River Road and crosses the Little Susitna River, then travels in a northwesterly direction, crossing several smaller streams, for roughly 16 miles to a crossing of the Susitna River. From this crossing, the alignment then turns to the southwest and travels another 6.5 miles and ends at the theoretical junction of the Beluga and East Susitna alignments. This alignment is approximately 26 miles in length and reaches a maximum elevation of about 150 feet.

Beluga Alignment. The Beluga Alignment provides access from the coastal community of Beluga and the Cook Inlet up to the eastern slopes of Mt. Susitna. This alignment begins at the southern end of the Beluga Airport and then wraps to the south around the large wetland complex before veering to the north and crossing the Beluga River. From the Beluga River the alignment trends generally to the north and northeast for roughly 9.5 miles to a crossing of the Theodore River. The alignment continues traveling in a northeast direction, remaining on more level terrain and crossing several smaller streams as it traverses the base of Little Susitna and Mt. Susitna and zigzags across the northwest boundary of the Susitna Flats State Game Refuge. The alignment then wraps around the southeastern side of Mt. Susitna before ending at the theoretical junction of the Susitna Crossing and East Susitna alignments. This alignment is approximately 38 miles long and reaches a maximum elevation of about 430 feet.

Figure 4-23. Proposed Access Routes



4.5.3 Step 3: Proposed Access Routes

The remaining alignments were refined and combined to create four different proposed access routes and one variant, as depicted on Figure 4-23. Appendix B contains a mapbook series of these remaining alignments drawn on USGS quad maps.

North Petersville Road

The North Petersville Road access route would be 78.8 miles long. This route originates from the existing Petersville Road and provides access to the western section of the Study Area, particularly the mining area west of the Upper Skwentna River (the Upper Skwentna mineralized area). A major bridge crossing of the Yentna River would be required. This route would require 13 bridge structures.

North Skwentna

The North Skwentna access route would be 71.6 miles long. It originates from Oil Well Road and also provides access to the Upper Skwentna mineralized area. This option would require two major bridge structures over the Yentna and Hayes rivers, in addition to 16 other bridges.

Middle Susitna-Skwentna River

The Middle Susitna-Skwentna River access route would be 107.9 miles long and is the longest route. It originates from the Little Susitna River Road and provides access to the mining area north of the Tordrillo Mountains. This route requires the highest number of bridges (24) of all the route options, including a 1,640-foot-long bridge over the Susitna River.

Beluga

The Beluga access route would be 63.8 miles long and is the shortest route. It originates from the Little Susitna River Road and provides access to the resources in the Beluga/Tyonek area. This route requires 13 bridge structures, including a 1,640-foot-long bridge over the Susitna River.

Deshka Variant

The Deshka variant option would be 33.5 miles long. It was included in this study to evaluate the possibility of providing access to nearby existing infrastructure, as well as providing road access particularly to lands with agricultural and timber/forestry potential.

5 ENGINEERING OF RESOURCE ACCESS ROUTES

Ten preliminary corridor segments were developed based on previously identified alignments, the constraints analysis, and engineering and environmental considerations, as detailed in Section 4. Further refinement of the preliminary corridor segments resulted in seven individual corridor alignments. For purposes of this study and determining access routes to identified termini, these alignments have been combined and refined, resulting in four access routes and one variant option, as presented in Section 4.5.3. Depending on the priority, funding, and timing of access needs, multiple routes could be chosen and combined or added to other routes in subsequent phases.

5.1 Preliminary Design Criteria

The road design criteria for the West Susitna access study were generated from the following published guidelines (in addition to professional engineering judgment):

- American Association of State Highway and Transportation Officials (AASHTO) 2004 *A Policy on Geometric Design of Highways and Streets* (PGDHS), as supplemented by the current edition of the Alaska DOT&PF's *Highway Preconstruction Manual* (PCM)
- AASHTO's 2001 Guidelines for Geometric Design of Very Low-Volume Local Roads
- U.S. Forest Service's Roadway Preconstruction Handbook

Table 5-1 summarizes the design criteria assumed at this time for a West Susitna access road. Anticipating the myriad of uses and vehicles that this new access road could see (e.g., public access for recreation, resource recovery, etc.), a 24-foot-wide, two-lane gravel access road (2'-10'-10'-2') was considered the facility, with the idea that the ultimate facility may be significantly wider based on further investigations or interest in the Study Area. See Appendix A for more details, as included in the Preliminary Design Criteria report. The dimension guidelines in Table 5-1 include the needs for both resource recovery and providing public access.

Table 5-1. West Susitna Access Design Criteria Summary

Functional classification	Rural Resource Recovery Road
Purpose:	Provide resource transport
Traffic volume	< 400 AADT
Number of Lanes	Two lanes
Design Vehicle	Tractors with double (belly-dump) trailers (WB-120 Trucks)
Design Speed	20-40 MPH depending on terrain
Surface	Unpaved
Traveled way width	10 feet (for two lanes)
Shoulder width	2 feet
Bridge width	Two lanes
Maximum Grade	7-16% (depending on terrain)
Curve Radius	380-feet @ 40 MPH
Stopping Sight Distance	250-feet @ 40 MPH
Vertical curves	Crest K = 29 @ 40 MPH Sag K = 35 @ 40 MPH
Clear Zone	0 to 6 feet or more up to 10 feet
Sideslopes	Foreslopes 4:1 Backslopes 2:1
Turnouts	n/a

AADT = Annual average daily traffic; MPH = miles per hour

5.1.1 Functional Classification

The suggested functional classification of an access road into the West Susitna basin would be a two-lane gravel **Rural Resource Recovery Road**.[147] The corridor would initially be considered a very low-volume local road. The PGDHS defines a very low-volume local road as one with an average annual daily traffic volume of 400 PVD or less.

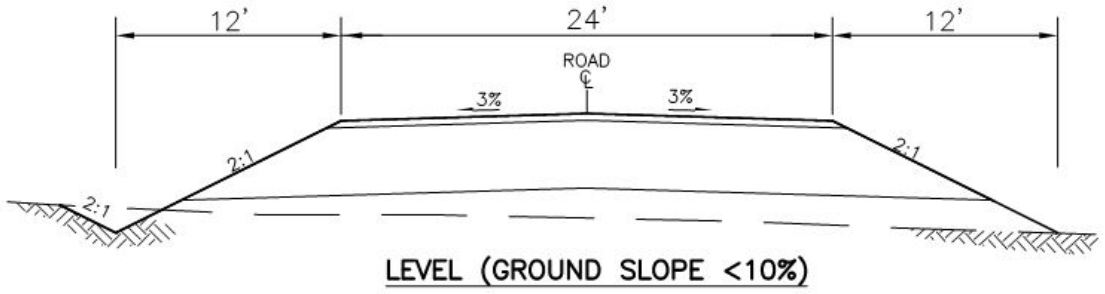
The dimensions of a Rural Resource Recovery Road would more than meet the roadway dimensions and needs required for a **Rural Local Road**[148] or **Rural Minor Access Road**[149]. The Rural Local Road classification is included here to highlight that this type of roadway could serve as pioneer access for initial exploratory investigations for natural resources. With minimal traffic, such an initial phase access would be classified as a Rural Local Road with the understanding that it will eventually function as and become a Rural Resource Recovery Road. However, Rural Local Road dimensions do not satisfy the design criteria needs (e.g., total roadway width) required for providing public access, per the Rural Minor Access Road classification. Therefore, the Rural Resource Recovery Road is the most reasonable functional classification for the West Sustina access route corridors at this time. Also, design criteria appropriate for a Rural Resource Recovery Road in many areas are

[147] AASHTO. 2004. A Policy on Geometric Design of Highways and Streets (PGDHS), page 414
[148] PGHDS, page 416
[149] AASHTO. 2001. Guidelines for Geometric Design of Very Low-Volume Local Roads, page 6

not significantly different from those for recreational roads.[150] Oftentimes, resource development roads are ultimately used for other (e.g., recreational) purposes, assuming the volumes are still below 400 VPD. The Rural Resource Recovery Road classification for West Susitna access takes into account these varying usages.

The recommended road typical cross-section is a 24-foot-wide embankment (gravel, two lanes [2'-10'-10'-2']), as depicted in Figure 5-1. It is possible a wider road would ultimately be needed, depending on the type of vehicles used to transport the resource and access needs. At this time, it is not known which resources or equipment may be transported on this road, so we have assumed the road profile would suffice based on this reconnaissance-level effort.

Figure 5-1. West Susitna Access Typical Cross Section for a Rural Resource Recovery Road



The study team assumes the West Susitna access road could initially be classified as a very low-volume roadway (less than an average of 400 vehicles per day) to serve as a pioneer access route for exploratory investigations for natural resources. It is assumed that the roadway would be open to the public. In terms of public access, the road could also provide access to communities and recreational or hunting sites along the road. At this time and phase in the study, traffic volumes are assumed to still be below 400 vehicles per day and the road could meet the needs of a **Rural Resource Recovery Road**[151] classification. Depending on resource development needs and public interest in accessing the lands found within the Study Area, traffic volumes could be more than 400 vehicles per day. With the uncertainty of resource development needs and public interest, it is difficult at this time to know with certainty traffic volumes. It is also possible a toll road could be a feature of the road, though there would not be limitations on the type of people who use it.

5.1.2 Other Design Considerations based on Interview-Identified Needs

While the data collection and resource industry interviews provided additional information, at this reconnaissance-level study, it is too early to project traffic generation and demand because not enough information exists about resource extraction quantities and transport needs. At this present time the amount, type, and schedule of concentrate removal and transport needs is not known. However, during the interviews conducted in early 2013 as part of the resource inventory task described in Section 2, the interviewees were asked the six transportation-specific questions listed below. Some of the answers provided, as they pertain to design criteria requirements, have been excerpted and included.

[150] PDGHS, page 414

Selected Questions:

- What transportation needs to do you have for construction, fuel and mining equipment?
- Have access plans been explored? What kinds of modes have been considered or ruled out (rail, barge, air, pipeline, etc.)?
- What logistical challenges that you have experienced would be resolved by road access from the existing road system?
- What are typical vehicle types and/or sizes? Are there large, non-divisible loads that are overweight or over-sized?
- What type of concentrate or finished product will be taken from the site (estimated quantities and likely schedule)?
- What is the anticipated traffic (vehicle trips per day)? Will the workforce access the site by road or air?

Selected Answers:

- **Kiska** indicated they will need an all-season road for construction material, mining fleet and fuel delivery, and concentrate removal. Four concentrate-removal round trips and three light-service vehicle trips per day are expected. Kiska said pick-up trucks and standard tractor-trailers would be used to carry commercial loads. During production, vehicle traffic would include concentrate haul trucks. Kiska said their initial modeling suggests a single lane could be feasible, but a two-lane road is preferable. Kiska said their engineers suggest that occasional large, non-divisible loads are possible during construction, but during operation such loads would be less likely. Kiska said the Whistler mine would produce a gold-bearing copper sulphide concentrate. Daily concentrate production is estimated at 200 tonnes, requiring four daily round-trips using 52-tonne capacity concentrate haul trucks. For their workforce, Kiska estimates three light service trips daily. Crew changes would be either by road or by air.
- According to **On-Line**, the road would need to accommodate truck traffic, fuel haulage, and tractor-trailer rigs (standard commercial loads). If On-Line's project reached production, vehicle traffic would increase and include crew transportation vehicles and possibly larger concentrate haul trucks. On-Line said at present, during exploration, no product is produced from the site. If the project goes into production, concentrate removal down the access road will likely be required, depending on the commodities present. It is not possible at the present time to know the amount, type, and schedule of concentrate removal. For their workforce, On-Line anticipates remote sites, requiring on-site accommodations with fly-in crew changes. Possibly their Beaver Creek site could be a daily commute by crew bus.
- **PacRim** is planning to use air and barge for the Chuitna coal project. Rail and road links were considered, but are uneconomical if self-financed. Due to the project location, PacRim would use a barge option for large equipment. PacRim said coal would not be transported on the road system for export; all coal would be exported directly to ships from the mine site. PacRim said they anticipated 4 to 5 trucks per day for operations purposes. Workforce would be brought in by road and would require 150 round trips per week if private vehicles were allowed, far fewer if crew buses were used.
- **Apache** suggested giving the road an industrial classification. Apache said they have no concentrate or finished product, but they would hope to transport gas and oil by pipeline. There are no estimated volumes at this time. Operations would be years away.

- **Millrock** said during the exploration phase, typical vehicles on a roadway would be pick-up trucks and standard commercial loads. If the project reached production, vehicle traffic would increase and include crew transportation vehicles and possibly larger concentrate haul trucks. Millrock said at present, during exploration, no product is produced from the site. If the project goes into production, concentrate removal down the access road will likely be required, depending on the commodities present. For workforce access, Millrock anticipates an operation like Red Dog, with fly-in crew changes.
- **Linc Energy** said standard vehicles would be used for the bulk of their operations. Linc Energy said during construction of their plant facilities, there would be an expected need for large, non-divisible overweight loads; however, many of these would be brought by ocean-going ships and off-loaded close to the project area, minimizing distance traveled over the road system. Linc Energy said three products will be produced and all are expected to be transported off site by pipeline. The first product is UCG syngas transported to processing facilities on site or put into existing pipelines. Approximately 50 bcf/yr production is anticipated. The second product will be a synthetic fuel produced from the syngas, with estimated production ranging from 5,000 to 20,000 bbl/day. Final product would be CO2 gas for enhanced oil recovery on the order of 7,000 or more tonnes per day. Linc Energy said they would prefer site access by road. During the peak construction phase, they said they could potentially have 1,000 people on site, but even during operations they would expect 200 persons on site. Access likely would be by crew cabs, rather than individual vehicles, but they said nothing is definite at present. Anticipated traffic is a function of number of persons on site and means of access.
- **Aurora** said the rig they move requires permit loads with a safety index of at least 200,000 load capacity for a single load.
- **Cook Inlet Energy** said typical vehicle types include tank trucks, drill rigs, cat machinery, and pick up trucks. Cook Inlet Energy said their drill rigs are at 95,000 pounds load weight. Cook Inlet Energy said their natural gas and/or oil would be transported by pipeline. Drilling waste would leave in sacks or bags. Cook Inlet Energy said the drilling and construction phases will have more traffic than the operations phase. Crews will either be local or arrive via air. But, if a road were available, they may drive in from Tyonek or the Matanuska-Susitna Valley. Cook Inlet Energy has been actively improving and expanding a gravel road and pad system in the Olson Creek / Otter area, including a gravel pit and a new bridge across Olsen Creek.

5.2 Additional Engineering Considerations

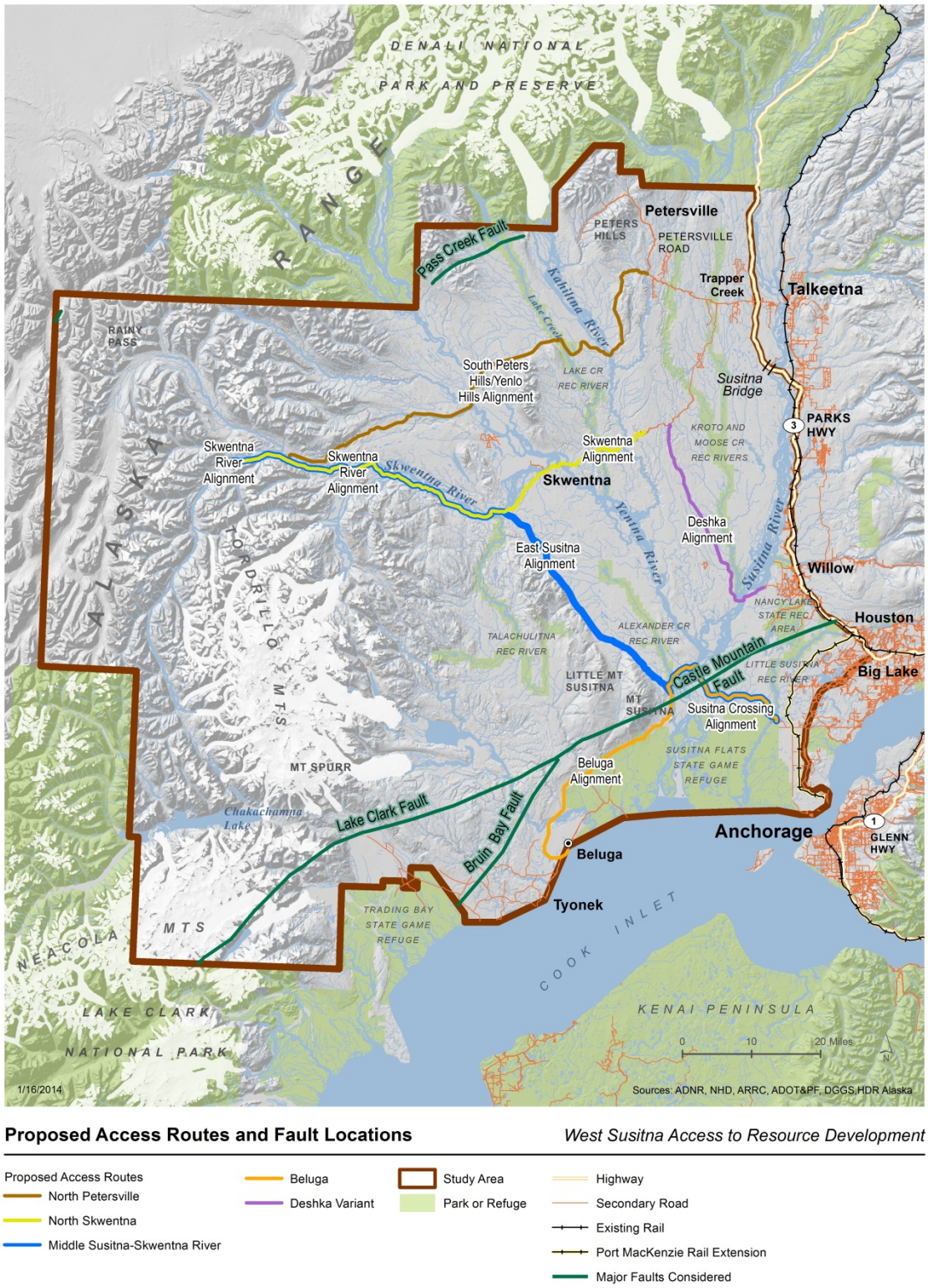
5.2.1 Seismicity

The Study Area is located in one of the most seismically active areas in the U.S. and is historically subject to relatively large earthquakes. Figure 5-2 depicts the fault locations in the Study Area. Within the Study Area, the Castle Mountain fault is located on the southern end of the Susitna lowlands. The Bruin Bay fault is also found in the Study Area; however, it is not considered an active fault system. The Bruin Bay fault is located along the base of Mount Susitna and trending northwest toward Beluga Mountain along the mountain front. The Lake Clark fault runs along the southeastern portion of the Study Area; it is not considered to be active. The relatively recent Pass Creek fault is centrally located in the Susitna lowlands with northeast to southwest trending surface expressions mapped west of Mt. Yenlo and the Kahiltna River.

If faulting is present and becomes active, seismicity could cause displacement along the roadway or associated structures. The potential for strong ground motions or associated liquefaction and slope failure should be a consideration in road location because some of these faults are considered to be Quaternary and active and are relevant to development and hazards mitigation. Additional explorations and evaluation should be conducted to more accurately locate or identify a fault in this location so that the alignment and associated features can be positioned so as not to straddle both sides of the fault's surface expression. Additionally, DNR-DGGS recommends that a neotectonic study may be required to map active surface traces of faults and to evaluate the local ground motions that may be generated by significant events. DGGS also recommends the scope of such a study should cover liquefaction, tectonic folding or warping of the ground surface, as well as secondary tectonic ground deformation (i.e., slope stability, lateral spread, and rock fall).[152]

[152] DNR-DGGS. October 8, 2013. Comments provided during a review of a draft of this report.

Figure 5-2. Proposed Access Routes and Fault Locations



5.2.2 Hydrologic Considerations

Hydrology data are limited for the Study Area (other than near the Susitna River), likely a result of the relatively undeveloped and remote nature of the area. The Susitna River aside, creek crossings were identified from USGS mapping and Google Earth™. Bridge lengths were measured off Google Earth™, and quite often the imagery was fuzzy, so the bank-to-bank widths are estimates. Also, many of the small rivers or creeks are in a braided channel; the actual river or creek may only occupy a small fraction of the width of the channel. Bank-to-bank width was measured for the braided channels. Each proposed access route crosses major rivers and numerous drainages, requiring multiple bridge structures and culverts.

The hydrology of the Susitna River is fairly well documented. The location of the crossing over the Susitna River considered a number of hydrological factors, as discussed earlier in Section 4.3. The crossing of the Susitna River considered the floodplain extent. However, due to the hydrologically active nature of the region, the DNR-DGGS recommends obtaining current imagery and LIDAR to conduct a cursory flood hazard evaluation. Though beyond the scope of this reconnaissance-level study, additional hydrologic considerations that should be further considered include potential basin responses to intense storms, glacio-fluvial controls, sediment mobilization, and landslide and debris flows, particularly in regard to how these might affect road infrastructure.[153]

Construction, and likely maintenance, of the road will require nearby water sources. During construction of the access road, water will be necessary for both dust control and aggregate compaction. The construction contractor will request a permit to pump water from a waterbody (such as a nearby creek or lake) that can sustain the draw-off of the water. After the road is constructed, the need for water will no longer exist unless a large repair area forms and the maintenance crew does not have its own source of water needed to compact the aggregate. If the road design requires seeding the sideslopes of the road, water would be required to keep the grass growing until it is accepted as self-sustaining. In the event that ice roads are used, sprayers would be required to build up the ice thickness until there is enough to support the anticipated loads. Maintenance would only be required after the ice road is damaged through melting.

5.2.3 Geological and Geotechnical Considerations

Numerous glaciers are found in the Alaska Range and extend down valleys to near the edges of the lowlands. Glacially carved bedrock, moraines, drumlins, and kettle lakes are some of the landforms in the Study Area that are constantly being reshaped by continuous erosional processes.

Regional geologic processes will have a substantive impact on the design and performance of transportation infrastructure in the Study Area. Such processes include stream icing, slope instability, flooding (through precipitation, liquefaction, lateral spreading, etc.). Many of these processes are complementary and should be evaluated separately as well as in relation to each other. The Study Area is likely subject to most, if not all, of these regional processes; however, some areas may be more prone than others. In general, the flooding, icing, and seismic influences will be more prevalent in low-lying areas and in areas near streams and floodways. Glacial outburst flooding will be difficult to predict, but can influence areas well outside of natural river floodways for relatively large distances below existing glaciers. Seismic influences will also more significantly impact areas adjacent to or on sloping ground, with greater severity on steeper gradients.

[153] DNR-DGGS. October 8, 2013. Comments provided during a review of a draft of this report.

Rock Borrow Availability

Rock material source availability addresses the proximity of rock materials to the corridors studied for this project. Rock materials will be an important resource for the construction of the proposed access road and associated facilities and structures. Material produced from quarries can be used in a wide variety of applications, including embankment development, concrete and/or asphalt aggregate, revetment, and surfacing material. The proximity of the rock materials is important because the distance that the material will need to be hauled during construction will have a direct impact on the cost of construction. If rock material is not available adjacent to the roadway, additional access roads may be needed to reach potential sources, which would also have an impact on the cost of the improvements and increase the footprint of the project. For successful completion of this project, it will be essential that the final corridor selected have multiple sources of rock material along its full length. These sources will ideally be located adjacent to the final road alignment and require minimal development of branch roads to access them.

Rock Borrow Quality

Borrow rock quality addresses the rock material types available along each corridor for construction of the road and associated facilities. Rock material quality is important to the project because some of the uses for the material will require it to be durable (i.e., resistant to mechanical degradation). In general, rock material used in the construction of this project will need to meet the various durability requirements set forth in DOT&PF standards, depending on its application (aggregate, rip-rap, etc.). The highest quality, most durable materials should be used in the production of aggregates and rip-rap, while lower quality materials can be used in embankment construction as shot-rock fill. Typically, intrusive igneous rocks such as granite and diorite yield very high durability values. Extrusive igneous rocks (such as basalt) and lightly metamorphosed rocks (such as phylite) typically have somewhat lower durability characteristics. Highly metamorphosed rocks such as schist, as well as sedimentary rocks, usually have the lowest durability values. The selected corridor should have rock sources that produce high-durability materials that can be developed into rock materials of a wide variety of sizes. High-quality sources will reduce the construction costs by reducing the need to import higher durability materials from long distances.

Soil Borrow Availability

Soil borrow source availability addresses the proximity of soil materials to the corridors studied for this project. Soil borrow materials will be an important resource for the construction of the proposed access road and associated facilities and structures. Soil borrow materials will likely be most widely used to provide embankment fill materials and as structural fill for the roadway. It could also likely be used in producing fine aggregates and as structural fill around drainage structures, culverts, bridges, and in utility trenches. As with rock material sources, the proximity of the soil borrow sources to the proposed roadway will have a direct impact on construction costs. Sources that are farther from the proposed roadway will have longer haul times and will increase the footprint of the project. To complete the construction of this project, the final corridor selected will need multiple sources of soil borrow along its full length. As with the rock material sources, the soil borrow sources should be located adjacent to the final road alignment so that additional branch roads are not needed for access.

Soil Borrow Quality

Borrow soil quality addresses the soil material types available in the soil borrow sources along each corridor. While soil availability is important, the quality of the available material will also impact the cost of the project. Ideally, soil borrow used for this project will consist of clean (low fines content), well-graded sand and gravel. Such material will most likely be found in outwash and/or alluvial deposits as well as some moraine deposits. This material would lend itself well to development of structural sections for the road as well as structural fill around bridge and culvert foundations. Poorly graded soils or soils with higher fines content (such as those found in glacial till or moraine deposits) may also be utilized, but their applications will be limited to deep embankment development. Regardless of the gradation of the soil fill used, it should not contain free ice, organic detritus, or a significant amount of plastic fines. Higher quality soil borrow resources along the project corridor will help reduce construction cost. The high quality materials will require less processing (washing, screening, etc.), and if they are located at regular intervals along the alignment, they will not need to be imported from long distances. Ideally, the final selected corridor will have multiple, high-quality soil borrow sources along its full length.

Foundation Support

Foundation support addresses the overall likely subgrade support for structure foundations along the various corridors. From a foundation support standpoint, the most ideal condition is a foundation supported on shallow, competent bedrock. Less ideal conditions range from soft bedrock and/or dense soil support to thick deposits of soft and/or compressible mineral and organic soils that require deep foundations. Other less ideal conditions include thaw unstable permafrost and liquefiable soils. In general, the poorer the foundation support conditions, the deeper the foundation systems must be to transmit structural loads to the subsurface. The cost advantages to selecting a corridor with ideal foundation support conditions is obvious in that shallower foundations require significantly fewer materials and less effort to construct. Ideally, the corridor that is selected will traverse ground that lends itself to development of relatively shallow foundations on bedrock and/or dense, stable, mineral soils.

Permafrost Conditions

Permafrost conditions address the state and nature of frozen ground under the various corridors studied for this project. The proposed improvements will have an impact on the thermal regime along each corridor that will likely result in warming of the ground under and around the new road. Based on the location of this project, it is likely that the majority of the ground beneath each alignment is not frozen continuously throughout the year. If permafrost conditions exist in a given area, it is more favorable if the soil consists of materials that do not lose a significant amount of strength when thawed. Such conditions will likely include shallow bedrock and dense soils that have low fines content. Unfavorable conditions include poorly drained soils, fine-grained soils, and permafrost conditions with large amounts of segregated ice. Such soils are subject to long-term creep under foundation and/or slope loading and typically lose a significant amount of strength when thawed. Having favorable permafrost conditions along the selected corridor will have a cost benefit, as no measures (such as insulation and refrigeration) will need to be taken to maintain the thermal balance under the roadway and associated structures.

Subgrade Support

Subgrade support addresses the general support capabilities of the subsurface materials along each corridor considered for this project. In general, favorable subgrade support conditions consist of shallow bedrock and/or firm, well-drained mineral soils. Poor conditions include thaw unstable permafrost and thick deposits of soft and compressible (mineral or organic) soils. Favorable subgrade support conditions will have a positive impact on construction costs in several ways. Firm subgrade support typically provides more ideal construction conditions and presents fewer constructability challenges since conventional equipment can be used. Furthermore, firm subgrade support circumvents the need for costly subgrade improvement such as excavation and replacement of unsuitable soils, and typically results in thinner embankments and structural sections. Additionally, ideal subgrade support conditions allow for steeper embankment slopes that require less material to construct and result in a smaller project footprint.

Drainage

Drainage addresses the general surface and near-surface drainage characteristics of each corridor considered for this project. Well-drained conditions are usually found in free-draining soils and in topography that is sloped to allow for the conveyance of surface water. Poor drainage is typically encountered in flat terrain with soils that do not allow for infiltration of surface water (such as in peat bogs or in permafrost terrain). In general, well-drained ground conditions typically result in favorable support conditions for new roads and structures. Development of roadways in poorly drained areas results in higher costs associated with designing and constructing additional drainage provisions in the form of culverts and/or porous embankments. Additional costs may also be associated with development of embankments and structures with poor subgrade support in these areas.

5.3 Proposed Access Routes

The proposed access routes are described in this section and engineering considerations are summarized in Table 5-2. Depending on the priority, availability and timing of access needs, multiple routes could be chosen and combined or added to other routes in subsequent phasing. For example, the destination for the Middle Susitna-Skwentna River route is the mining area in the Tordrillo Mountains. If this route was selected and then later access to Beluga was desired, an approximate 38-mile alignment branching from the Middle Susitna-Skwentna River route could be added for an additional approximate $103 million.

Table 5-2. Proposed Access Routes Engineering Considerations Summary

	North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
Alignment combination	South Peters Hills/ Yenlo Hills	Skwentna Skwentna River	Susitna Crossing East Susitna Skwentna River	Susitna Crossing Beluga	Deshka
General origin	Petersville Rd	Oil Well Rd	Little Su River Rd	Little Su River Rd	Willow area
General destination	Upper Skwentna mineralized area	Upper Skwentna mineralized area	Upper Skwentna mineralized area	Beluga/ Tyonek	Area south of Oil Well Rd
Length (miles)	78.8	71.6	107.9	63.8	33.5
Bridges (#)					
Conventional [1]	9	12	20	11	1
Long Span[2]	4	6	4	2	2
Total	13	18	24	13	3
Bridges (>1,000 feet)	1,150 (Yentna)	1,200 (Yentna) 1,200 (Hayes)	1,200 (Hayes) 1,640 (Susitna)	1,640 (Susitna)	1,200 (Susitna)
Culverts (#)					
Large [3]	12	12	14	6	2
Small [4]	37	26	40	12	11
Minor Drainage [5]	316	292	440	260	136
Cost Estimate (millions)					
Subtotal[6]	$147.6	$188.3	$187.4	$106.9	$72.2
Total [7]	$376.4	$504.3	$453.2	$257.8	$216.9
Total per mile [8]	$4.6	$6.3	$4.2	$4.0	$5.2

Assumptions:

[1] Conventional bridges are considered less than 300 feet in length.

[2] Long span bridges are 300 feet or longer.

[3] A culvert approximately 96 feet or longer.

[4] Small culverts and minor drainage culverts have an assumed length of approximately 50 feet.

[5] An additional four culverts per mile to accommodate minor drainage patterns.

[6]Subtotal cost estimate for new proposed roadways includes clearing, earthwork, structures, stream and river crossings (including culverts), guardrail and retaining walls, and miscellaneous items such as topsoil, seeding, geotextile and signing.

[7] Total cost estimate includes drainage measures, erosion and pollution, surveying, environmental studies and permits, existing road upgrades, construction, mobilization, ROW acquisition, contingency, design, and utilities.

[8] Total per mile cost includes only the proposed access routes and does not include existing roadways or cost to upgrade them.

5.3.1 North Petersville Access Route

The 78.8-mile North Petersville access route would originate from the existing Petersville Road and end in the mining area north of the Tordrillo Mountains. See Figure 5-3. This route consists of the South Peters Hills/Yenlo Hills alignment, as described in Section 1.1.1. From Petersville Road, the route would cross a number of major rivers and travel through the Lake Creek and Kroto and Moose Creek Recreation Rivers.

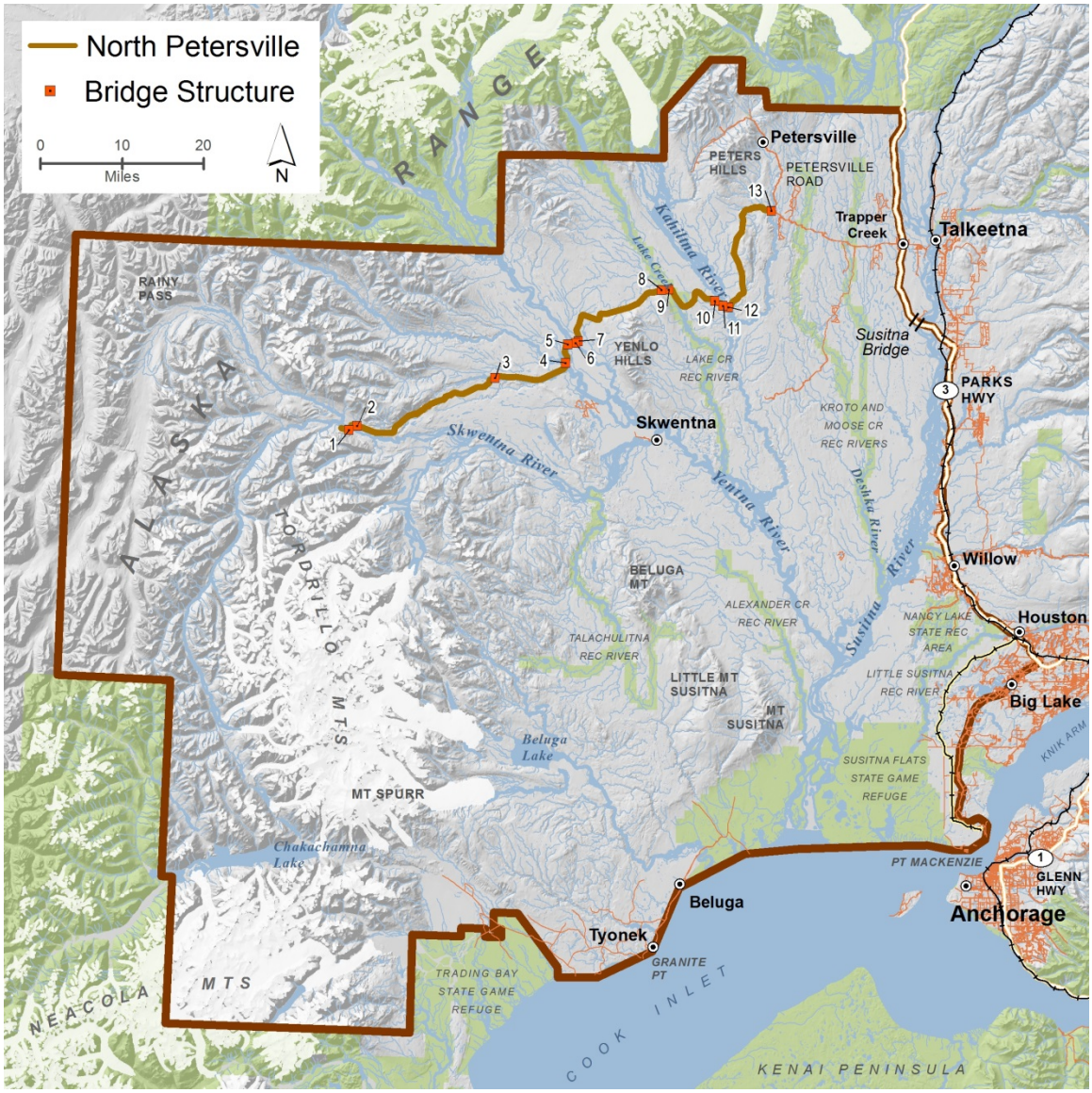
The North Petersville access route generally trends east to west and typically follows topographic highs where possible. Much of the eastern two-thirds of the route is characterized by low (less than 100 feet tall) topographical highs, separated by low, poorly drained, boggy areas. Given the variable terrain, it is anticipated that drainage along the route is generally good except for the interspersed wetland areas that will be crossed. The potential for permafrost along this route is likely the greatest in comparison to other routes in this study. Permafrost soils can be expected in higher elevations and on the north side of topographic high areas. Some of the low, poorly drained, boggy areas may also be underlain by permafrost soils.

The route would require the following 13 bridge structures, as numbered on the associated figure:

1. 500-ft over Skwentna River
2. 30-ft over an unnamed creek
3. 220-ft over Johnson Creek
4. 400-ft over Kitchatna River
5. 1,150-ft over Yentna River
6. 120-ft over Donkey Creek Slough
7. 80-ft over Donkey Creek
8. 40-ft over an unnamed slough
9. 280-ft over Lake Creek
10. 50-ft over Shovel Creek
11. 50-ft over an unnamed creek
12. 420-ft over Kahiltna River
13. 170-ft over Peters Creek

Compared to other route options, this route provides access to an average amount of resources, as shown in Table 6-1.

Figure 5-3. North Petersville Proposed Access Route



5.3.2 North Skwentna Access Route

The 71.6-mile North Skwentna access route would originate from the existing Oil Well Road and end in the mining area north of the Tordrillo Mountains. See Figure 5-4. This route combines the Skwentna and Skwentna River alignments, as detailed in Section 1.1.1. This route goes through the Lake Creek and Talachulitna Recreation Rivers.

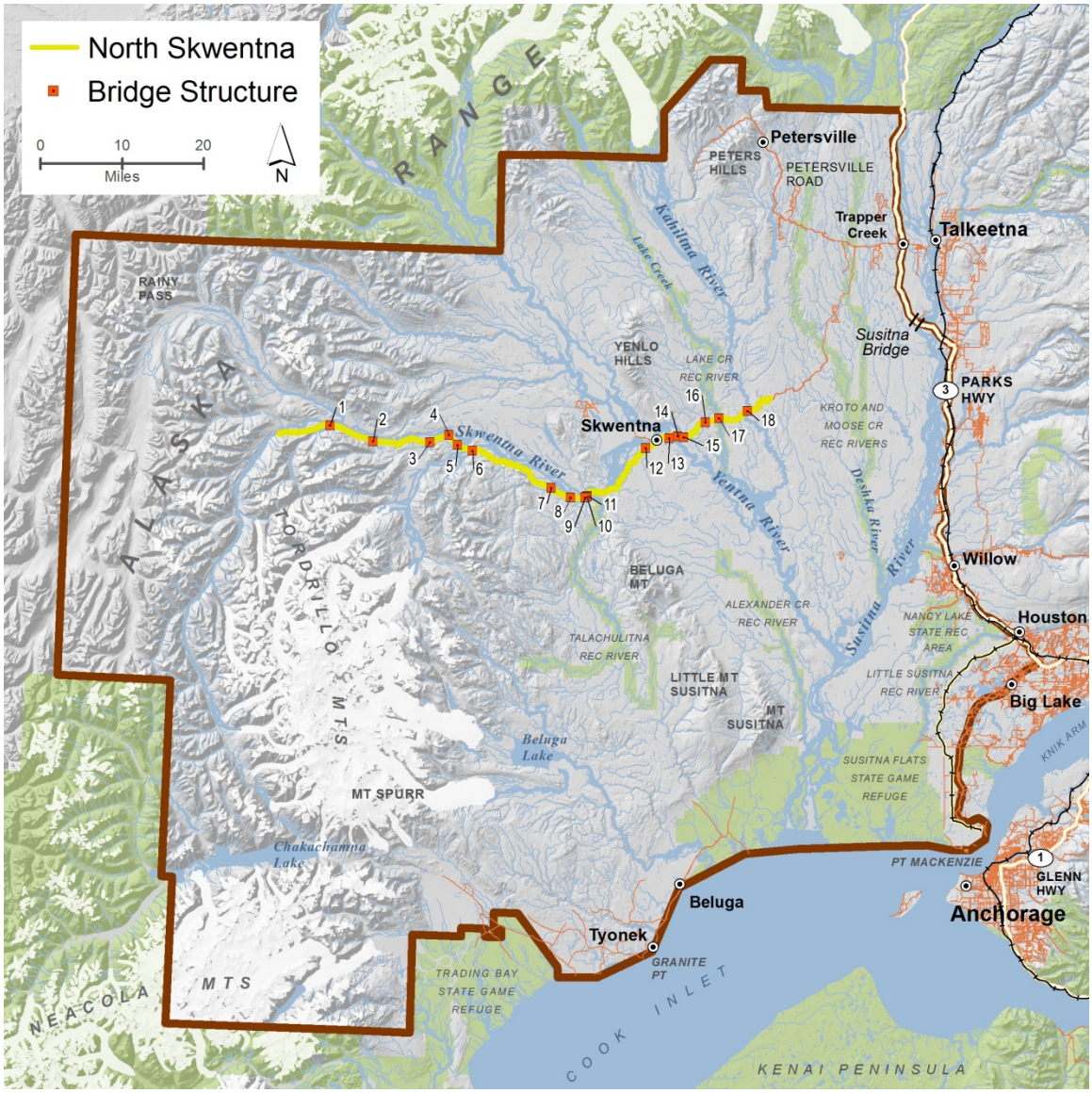
The eastern portion of this route (Skwentna alignment) generally runs east-west along lowlands around the Yentna and Skwentna Rivers. Low-lying, boggy areas are very prevalent along this portion. Subgrade support is anticipated to be highly variable, and drainage in the boggy areas may be a challenge in design and construction. The route crosses the Skwentna River and traverses well-drained, alluvial terraces between the Skwentna River and the mountainous terrain. Permafrost soils are not anticipated to be encountered along the eastern portion of the route, whereas they might be encountered as the route comes within close proximity to the mountainous terrain.

The route would require the following 18 bridge structures, as numbered on the associated figure:

1. 300-ft over Chickak River
2. 440-ft over Old Man Creek
3. 90-ft over Red Salmon Creek
4. 200-ft over an unnamed slough
5. 250-ft over an unnamed slough
6. 1,200-ft over Hayes River
7. 250-ft over Canyon Creek
8. 50-ft over an unnamed slough
9. 90-ft over an unnamed slough
10. 60-ft over an unnamed slough
11. 250-ft over Talachulitna River
12. 80-ft over Eightmile Creek
13. 1,200-ft over Yentna River
14. 80-ft over an unnamed creek
15. 320-ft over an unnamed slough
16. 160-ft over an unnamed slough
17. 270-ft over Lake Creek
18. 450-ft over Kahiltna River

Compared to other routes, this route provides access to the greatest number of acres of hardrock mineral resources. This route also provides access to a great number of forestry/timber resources.

Figure 5-4. North Skwentna Proposed Access Route



5.3.3 Middle Susitna-Skwentna River Access Route

The Middle Susitna-Skwentna River access route would originate from the existing Little Susitna River Road and end in the mining area north of the Tordrillo Mountains. See Figure 5-5. Nearly 108 miles long, this is the longest access route proposed in this study. This route combines three alignments (Susitna Crossing, East Susitna, and Skwentna River), as detailed in Section 1.1.1. This route goes near the Susitna Flats State Game Refuge and the Alexander Creek, Talachulitna, and Little Susitna Recreation Rivers.

The western portion of this route (the Susitna Crossing alignment) travels east-west, with existing mapping showing the route crossing almost exclusively glacial moraine and kame deposits except for alluvial terrace deposits adjacent to Alexander Creek and the Susitna River. Based on USGS mapping, the land between the Little Susitna and Susitna Rivers contains many scattered, low-lying, poorly drained, boggy areas. To the west of the Susitna River crossing, mapping indicates the route (East Susitna alignment) goes through soil deposits that are variable ranging from glacial tills, outwash, and isolated alluvial deposits, which should yield a variety of soil materials with variable quality. The route then traverses well-drained, alluvial terraces between the Skwentna River and the mountainous terrain (Skwentna River alignment). Permafrost is not anticipated in the eastern portion of this route, but may be encountered in the mountainous terrain to the west of the Susitna River.

The route would require the following 24 bridge structures, as numbered on the associated figure:

1. 300-ft over Chickak River
2. 440-ft over Old Man Creek
3. 90-ft over Red Salmon Creek
4. 200-ft over an unnamed slough
5. 250-ft over an unnamed slough
6. 1,200-ft over Hayes River
7. 250-ft over Canyon Creek
8. 50-ft over an unnamed slough
9. 90-ft over an unnamed slough
10. 60-ft over an unnamed slough
11. 250-ft over Talachulitna River
12. 20-ft over an unnamed creek
13. 50-ft over Deep Creek
14. 50-ft over Clear Creek
15. 40-ft over Bear Creek
16. 50-ft over Upper Sucker Creek
17. 80-ft over Wolverine Creek
18. 200-ft over Alexander Creek
19. 150-ft over Anderson Creek
20. 1,640-ft over Susitna River
21. 30-ft over an unnamed slough
22. 30-ft over an unnamed slough
23. 30-ft over Fish Creek
24. 170-ft over Little Susitna River

Due to the length of this route, this route provides access to the greatest number of claims and acreages of a number of resources, including hardrock minerals, placer gold mining claims, and forestry/timber resources. See Table 6-1.

Figure 5-5. Middle Susitna-Skwentna River Proposed Access Route

5.3.4 Beluga Access Route

The Beluga access route would originate from the existing Little Susitna River Road and end near Beluga. Approximately 64 miles in length, this is the shortest access route proposed in this study (other than the Deshka variant, which is only 33.5 miles long). See Figure 5-6. This route combines the Susitna Crossing and Beluga alignments, as further described in Section 1.1.1. This route runs through the Susitna Flats State Game Refuge and the Alexander Creek and Little Susitna Recreation Rivers.

The western portion of this route (the Susitna Crossing alignment) travels east-west, with existing mapping showing the route crossing almost exclusively glacial moraine and kame deposits except for alluvial terrace deposits adjacent to Alexander Creek and the Susitna River. Based on USGS mapping, the land between the Little Susitna and Susitna Rivers contains many scattered, low-lying, poorly drained, boggy areas. Once west of the Susitna River, the ground traversed by the route appears to be relatively well-drained, except for the far southwest end of the alignment near the Beluga River. The Castle Mountain fault is mapped in this area and appears to follow a significant portion of the route west of the Susitna River. Permafrost soils are not anticipated along this route.

The route would require the following 13 bridge structures, as numbered on the associated figure:

1. 650-ft over Beluga River
2. 50-ft over Olson Creek
3. 150-ft over Theodore River
4. 210-ft over Lewis River
5. 40-ft over Granite Creek
6. 40-ft over Pierce Creek
7. 200-ft over Alexander Creek
8. 150-ft over Anderson Creek
9. 1,640-ft over Susitna River
10. 30-ft over an unnamed slough
11. 30-ft over an unnamed slough
12. 30-ft over Fish Creek
13. 170-ft over Little Susitna River

Compared to other routes, this route provides access to the highest number of acres of coal resources and second highest acreage of oil and gas resources.

Figure 5-6. Beluga Proposed Access Route

5.3.5 Deshka Variant Access Route

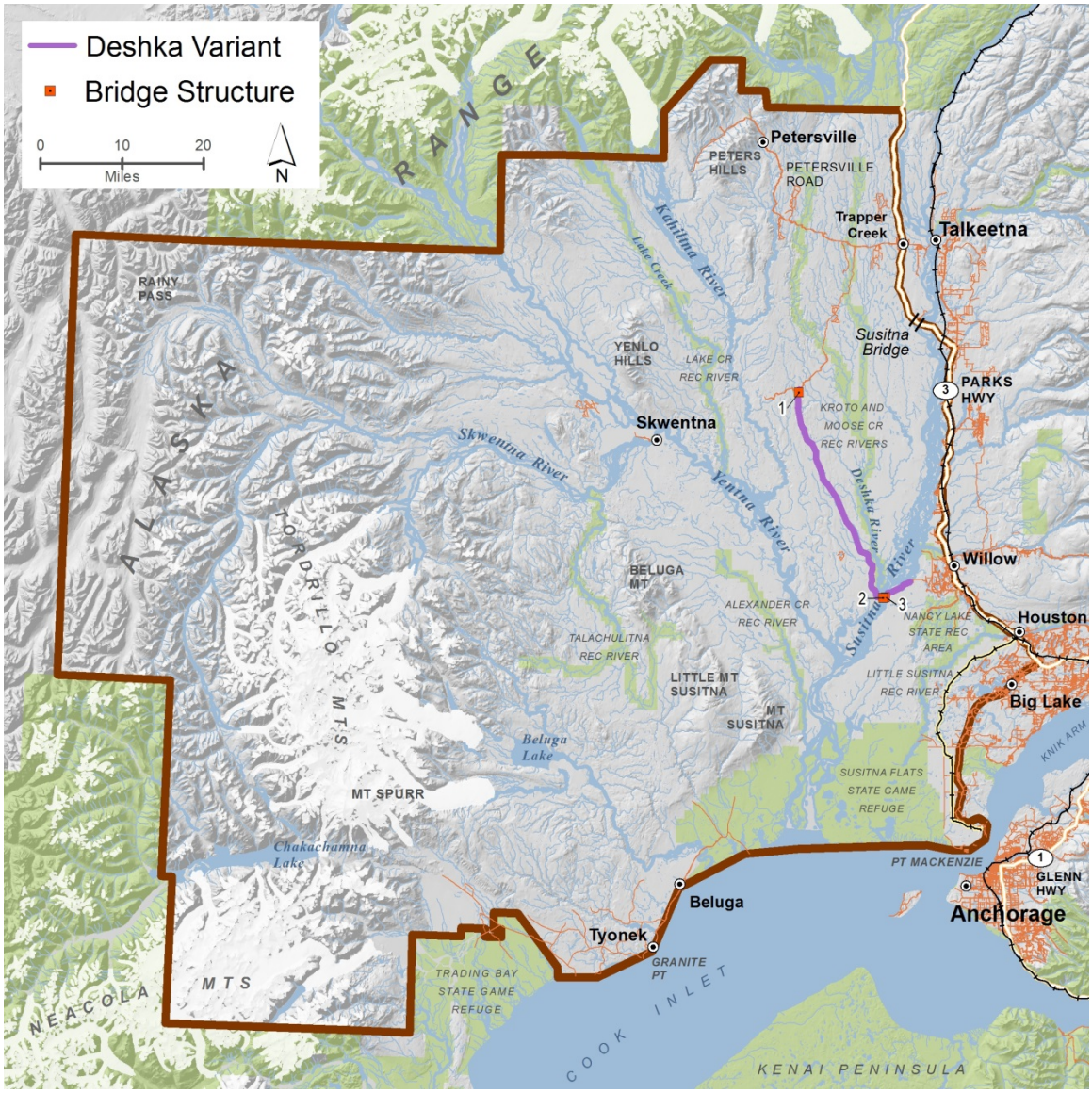
The 33.5-mile Deshka variant access route was included to provide access near existing infrastructure and specifically to potential agricultural and timber lands. See Figure 5-7. This variant originates near Deshka Landing, west of Willow, and traverses north to the existing Oil Well Road. Section 1.1.1 details this further. This route runs near the Kroto and Moose Creek Recreation Rivers as well as the Nancy Lake and Willow Creek State Recreation Area.

In general, this route follows relatively low relief ridges (less than 50 to 100 foot tall) that parallel the Deshka River. The variant would require two bridge structures over the Susitna River and one additional structure over an unnamed creek, as depicted on the associated figure.

1. 20-ft over an unnamed creek
2. 1,200-ft over Susitna River (Susitna River Bridge #2)
3. 900-ft over Susitna River (Susitna River Bridge #1)

Compared to other routes, this variant provides access to the most amounts of acres of oil and gas permit/leases and potential agricultural areas. It provides access to the least amount of hardrock minerals and coal acres.

Figure 5-7. Deshka Variant Access Route



5.4 Preliminary Cost Estimates

Preliminary cost estimates were prepared using the reconnaissance-level engineering and DOT&PF bid tabs for the Northern Region. Where data for a particular item was not available, similar information from the DOT&PF Central Region was used. Using the National Highway Construction Cost Index (NHCC) published by the Federal Highway Administration (FHWA), the average unit prices were adjusted from their date of bidding to 2013 dollars. Once all of the average unit prices had been normalized to 2013 dollars, they were plotted to determine whether a trend existed within the data set. For many of the items, a distinct trend emerged and made it possible to estimate the unit price as a function of the item quantity. Due to the scale of the project, quantities for some items exceeded the quantities for any of the available historic bid tab data. In these cases, the unit price for the highest quantity on record was substituted as a conservative estimate. Unit prices were rounded to the nearest cent. Figure 5-8 and Table 5-3 presents the preliminary cost estimates with assumptions following the table. See Appendix D for additional cost estimate details.

Figure 5-8. Reconnaissance-Level Total Cost Estimate Comparison

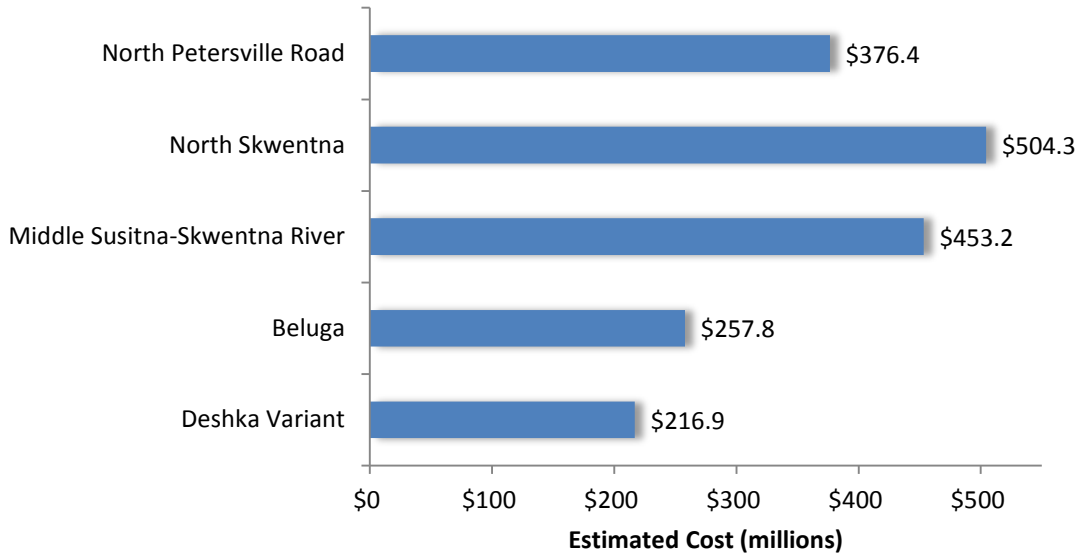


Table 5-3. Preliminary Cost Estimates (in millions)

	North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
Clearing	$2.2	$2.0	$2.7	$1.5	$0.73
Earthwork	$29.4	$29.3	$26.4	$9.9	$3.7
Structural Section	$15.9	$14.5	$21.9	$12.9	$6.8
Stream/River Crossings (includes bridges and culverts)	$83.7	$125.9	$119.4	$74.9	$57.3
Miscellaneous	$16.3	$16.6	$17.0	$7.6	$3.7
Subtotal	*$147.6*	*$188.3*	*$187.4*	*$106.9*	*$72.2*
Drainage Measures	$14.8	$18.9	$18.8	$10.7	$7.3
Erosion and Pollution	$4.5	$5.7	$5.7	$3.3	$2.2
Surveying	$4.5	$5.7	$5.7	$3.3	$2.2
Construction Traffic Control	$7.4	$9.5	$9.4	$5.4	$3.7
Contractor Furnished	$1.5	$1.9	$1.9	$1.1	$0.8
Mobilization (10%)	$14.8	$18.9	$18.8	$10.7	$7.3
Subtotal	*$195.1*	*$248.9*	*$247.7*	*$141.4*	*$95.7*
Contingency (30%)	$58.5	$74.7	$74.3	$42.4	$28.7
Construction Subtotal	*$253.6*	*$323.6*	*$322.1*	*$183.9*	*$124.5*
Environmental study/ permitting (3%)	$7.6	$9.7	$9.6	$5.5	$3.7
Construction Administration (15%)	$38.1	$48.6	$48.4	$27.6	$18.7
Project Camp (2%)	$5.1	$6.5	$6.5	$3.7	$2.5
Subtotal	*$304.4*	*$388.4*	*$386.7*	*$220.7*	*$149.4*
Design (10%)	$30.5	$38.9	$38.7	$22.1	$15.0
Utilities (0.5%)	$1.6	$2.0	$2.0	$1.2	$0.8
ROW	$5.7	$1.4	$4.2	$1.5	$0.05
Subtotal	*$342.2*	*$430.7*	*$431.6*	*$245.5*	*$165.3*
ICAP	$17.1	$21.5	$21.6	$12.3	$8.3
TOTAL for new access routes	**$359.4**	**$452.3**	**$453.2**	**$257.8**	**$173.6**
Existing road upgrades	$17.0	$52.0	$0	$0	$43.3
TOTAL	**$376.4**	**$504.3**	**$453.2**	**$257.8**	**$216.9**
*Total per mile for new roadway **	*$4.6*	*$6.3*	*$4.2*	*$4.0*	*$5.2*

* Total per mile includes only the proposed access routes and does not include existing roadways or cost to upgrade them.

5.4.1 Assumptions for Cost Estimate Development

Once the unit price-quantity relationships were established, they were applied to planning level quantities to calculate and estimate the cost for each item. Additional assumptions were made in applying engineering judgment to many items that will not be directly measured at this stage of the project. The assumptions for each item are as follows.

Clearing

Assuming an average embankment width of 40 feet plus an additional 10 feet on either side, the clearing quantity is estimated at 7.3 acres per mile for all three terrain classifications.

Unclassified Excavation

Due to the coarseness of the available terrain data, modeling earthwork over representative sections gives a rough estimate at best. Instead, representative cross sections were drawn for each terrain type. In each typical section the roadway template remains constant but the terrain cross slope is varied as follows; 10% for level, 25% for rolling, 40% for mountainous. The resulting excavation and embankment cross section areas were then used as the basis for the per mile quantity. The portions of the alignment crossing each terrain type were added together then were multiplied by the respective quantity in that terrain type to arrive at the total quantity.

Embankment Borrow C

The quantities for embankment were estimated for each terrain type as described above. The large embankment quantity is an example of an item where quantity relevant cost information was unavailable from the bid tab data. In this instance the unit price for the largest quantity on record was used as a conservative estimate. This item also varies per mile cost based on terrain.

Borrow A and Aggregate Surface Course

These items have a constant quantity per mile across all terrain types using a roadway top width of 24 feet. The depth of Borrow A is 48 inches and aggregate surface course was estimated at a thickness of 4 inches.

Bridges

A width of 26 feet was assumed for all roadway bridges to accommodate the 24-foot top and bridge railing. Bridges were subdivided into two categories; conventional and long span. Both unit prices were based on engineering construction experience with recent projects in Alaska and the Lower 48. Lengths for each structure were estimated from USGS topographic maps and aerial photography and the proposed crossing geometry. Conventional bridges assume deck bulb-T construction which is very common throughout Alaska at a cost of $350 per square foot. Bridges 300 feet or more are considered long span bridges. Recent national projects indicate that building such structures in fairly rugged conditions and remote areas warrants a cost of $1000 per square foot.

Culverts

Following a preliminary assessment of visible stream crossings using USGS topographic maps and aerial photography, culvert types were subdivided into three categories: large culverts, small culverts and minor drainage culverts. An assumed culvert length of approximately 50 feet to daylight on either side of a four foot embankment with 2:1 side slopes was used for both the minor drainage culverts and small culvert classification. To account for the deeper embankments associated with

large culverts, a culvert length of approximately 96 feet was used to daylight on either side of a 20 foot embankment with 2:1 side slopes. The unit prices for the two categories of culvert are based on project experience in Southcentral Alaska.

ADF&G, Division of Habitat, provided the following initial input regarding culverts and bridges affecting anadromous fish streams. Pursuant to AS 16.05.841 and AS 16.05.871, (1) the preferred route should be sited to minimize the number of stream crossing(s) to the extent practical; (2) bridge construction is preferred over culvert installation for stream crossings greater than 20 feet in width; and (3) any culvert installation in fish-bearing waters should use a stream simulation design criteria to ensure the upstream and downstream movement of fish is maintained.

Retaining Walls

To reduce earthwork quantities in mountainous terrain gabion retaining walls were assumed. It is assumed that 0.25 of each mile in mountainous terrain will require walls on one side of the roadway. The average height of these walls is assumed to be 10 feet.

Guardrail

It is assumed that guardrail will only be needed along half of each mile of mountainous terrain. The number of end sections required is calculated on the assumption that the average length of each guardrail segment is 250 feet.

Topsoil and Seeding

Topsoil and seeding were estimated at 4.84 acres/mile. This represents an average of 20 feet of topsoil and seeding on either side of the edge of gravel.

Geotextile Fabric

Geotextile fabric will be required in areas with permafrost or soft soils. It has been assumed that permafrost and soft soils will be encountered in 25 percent of level terrain and 15 percent of rolling terrain areas.

Signing

Signing for this project is assumed to minimal due to its backcountry nature. $1000/lane-mile has been assumed to cover these costs.

ROW

An average cost per acre to acquire ROW was developed for each route based on comparable State sales closest to the proposed access routes. For each route, the road length was multiplied by a presumed 200 foot wide ROW to calculate the total number of acres needing to be acquired. (The 200-foot ROW width is a preliminary placeholder, and depending upon the route, access and staging needs, may require more or less than the 200 feet width). An average cost per acre based on comparative sales in the vicinity of the access route was multiplied by the total number of acres to get a ROW acquisition cost estimate for each route.

Table 5-4. Preliminary ROW Acquisition Cost Estimates

	North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
Acres to be acquired [1]	1910.3	1735.8	2615.8	1551.5	812.1
State sale comparable close to access route per acre	$3,100 $3,100 $1,943	$481 $960 $702	$1,943 $1,493 $962	 $962 $815	$1,143 $1,298 $1,159
Subtotal average cost per acre	$2,714	$715	$1,466	$889	$1,200
Total average cost per acre [2]	$3,000	$790	$1,600	$980	$1,320
Total ROW acquisition cost	$5.7 million	$1.4 million	$4.2 million	$1.5 million	$45,000

[1]Route length multiplied by a 200 foot ROW

[2]Total average cost per acre is rounded and includes 10% inflation.

A more detailed title search should be conducted in a subsequent phase should this project move forward. The acquisition cost does not take into account the cost (in time) to acquire the ROW.

Environmental/Permitting

A 3% line item was included to incorporate the costs to conduct some environmental baseline studies and coordinate permit acquisition.

Existing Road Upgrades

Two proposed West Susitna access routes would likely necessitate the need to upgrade two existing roadways: Petersville Road and Oilwell Road. The North Petersville Road access route branches off from milepost (MP) 18 of Petersville Road.[154] For the North Skwentna access route and Deshka Variant, Oilwell Road would need to be upgraded. Oilwell Road branches off from MP 6 of Petersville Road and continues for approximately 17 miles before becoming more of a trail than a road. Roadway conditions along these two roads vary greatly and are not fully known without field-verifying the conditions. Assumptions are inferred regarding these two roadways and required upgrades.

Petersville Road is classified as a minor collector road that is approximately 37 miles long. The DOT&PF maintains a portion of Petersville Road. Based on conversations with DOT&PF staff and professional judgment, we have assumed the first approximate 9.5 miles are paved and would require little to no upgrade. This paved portion is assumed to be 24-feet wide with gravel shoulders. No culvert information for this roadway segment is available at this time.

Between MP 9.5 and 18 of Petersville Road, the roadway is dirt and the road top ranges between 18-feet to 24-feet wide. For cost estimate purposes, we have assumed the existing roadway top averages 21-feet wide and would need to be widened to the proposed width of 24 feet. Along this 8.5-mile stretch, one 105-foot bridge would need to be replaced and we assumed six minor drainage culverts

[154] MP locations are approximate

would be needed per mile. Other assumptions include: no clearing; one-third of the existing embankment should be replaced with Borrow C and one-third of Borrow A would be replaced.

Oilwell Road conditions vary significantly and much of the existing conditions are unknown. The MSB maintains the first 12.5 miles of this roadway, with additional minor maintenance of the "trail" between MP 12.5 and MP 15, the site of the Kroto Creek bridge. According to MSB maintenance personnel, beyond MP 15 is a mere trail and how far it extends is unclear.[155]

To prepare cost estimates for upgrading this road, Oilwell Road was broken down into four segments: (1) MP 0-12.6, (2) 12.6-16.76, (3) a 5.1-mile extension, and (4) a second extension by 4.7 miles. The North Skwentna access route would require all four Oilwell Road segment upgrades, while the Deshka Variant branches off slightly early and would only require the three segment upgrades. Assumptions for upgrading the four Oilwell Road segments are as follows:

- **MP 0-12.6:**
  - The total cost estimate for upgrading this segment is approximately $20.7 million, or about $1.6 million per mile.
  - 25% of the length requires clearing
  - Includes rebuilding road, new embankment and all new structural section
  - Replaces three bridges that are the following length: one that is 65 feet and two that are 35 feet
  - Assumes six minor drainage culverts per mile
- **MP 12.6-16.76:**
  - The total cost estimate for upgrading this segment is approximately $11.3 million, or about $2.7 million per mile.
  - 50% of length requires clearing
  - Includes rebuilding road, new embankment and all new structural section
  - Replaces two bridges: one 75-feet long and one 45-feet long
  - Assumes six minor drainage culverts per mile
- **5.1-mile road extension**
  - The total cost estimate for upgrading this segment is approximately $11.3 million, or about $2.2 million per mile.
  - 50% of length requires clearing
  - Includes rebuilding road, new embankment and all new structural section
  - No bridges are needed along this segment
  - Assumes six minor drainage culverts per mile
- **4.7-mile road extension** *(required only for the North Skwentna access route)*
  - The total cost estimate for upgrading this segment is approximately $8.7 million, or about $1.8 million per mile.
  - 50% of length requires clearing
  - Includes rebuilding road, new embankment and all new structural section
  - No bridges are needed along this segment
  - Assumes six minor drainage culverts per mile

[155] MSB. December 2013. Personal communication with MSB roads maintenance staff Mike Lachelt

6 EVALUATION OF PROPOSED ACCESS ROUTES

This section presents a comparison of the proposed routes developed for providing access to resources in the Susitna River basin. Because this is a reconnaissance-level study, the comparative analysis is based on existing available information. Numbers provided in this quantitative analysis present a broad picture of potential impacts and large swaths of resources to which access is provided.

One purpose of this report is to evaluate and compare the strengths (opportunities) and weaknesses (impacts) of the proposed access routes. This section explores some of the strengths and weaknesses of each route by utilizing a disaggregate method to describe opportunities and impacts for each route based in "natural" units. These measurements include physical units, monetary terms, or other quantifiable engineering and environmental terms. At this point, these access routes have been developed only to a reconnaissance level and could shift significantly in the future based on further study and refinement when more data become available, and therefore could result in different impacts.

6.1 Resource Accessibility

One of the key considerations of the proposed routes is opening up access to the identified resources. To determine how many acres of resources would be made accessible, a 5-mile-wide buffer on either side of the centerline (10 miles total) was applied to each of the proposed access routes. The assumption was that if an access route were provided into these areas, an interested party (claim/lease holder or land owner) would add their own infrastructure up to within 5 miles from the proposed route centerline. The study team recognizes the 5-mile-wide buffer on either side as a reasonable distance from which interested landowners could connect their own infrastructure. It is also true that access connections to the main spine road could also be made. This may be especially true in the northwest portion of the Study Area where there are numerous mineral deposits and mining claim clusters that extend outside of the 10 mile corridor. However, to quantify resources that are made accessible using the data available in GIS, a specific distance needed to be chosen and 5 miles (10 mile buffer) was deemed reasonable.

Table 6-1 summarizes resources accessed within the 10-mile buffer by each access route. Figure 6-1 through Figure 6-3 depict this graphically for mining, oil and gas, forestry/timber, and agricultural resources. To quantify the amount of recreational resources made accessible, (State Recreation Rivers, State Recreation Areas and State Refuges within the Study Area were evaluated in GIS to calculate acreages accessed using the same buffer width.[156]

[156] The study team recognizes the limitations in using this methodology to assess the amount of recreational resources made accessible. This approach discounts the importance of lands other than State Recreation Rivers, State Recreation Areas, and State Refuges in providing areas of hunting, fishing, wildlife viewing, and other types of outdoor recreation such as camping or access to recreational cabins. The study team recognizes the southern portion of the Study Area is more readily accessible by existing means, whereas the lands made accessible by the access routes in the middle of the Study Area would create new access opportunities for moose and ptarmigan hunting, for example. While not the most ideal methodology, there is not a readily comparable way to measure recreational access quantitatively using GIS.

Table 6-1. Summary of Amount of Resources Made Accessible within a 10-mile Buffer of Proposed Routes ("Route Strengths")

Resources Accessed	North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
Hardrock minerals					
Claims/Leases (#)	404	676	688	8	68
Acres of claims/leases accessed	39,104	79,306	78,788	16,668	2,353
Placer gold mining					
Claims (#)	3	4	5	0	0
Coal					
Acres of leases accessed	119,655	103,438	264,258	288,278	81,624
Oil and gas					
Permits/Leases (#)	2	10	28	158	10
Acres of permits/leases accessed	7,245	70,599	87,760	109,919	183,392
Forestry/Timber Resources					
Acres Accessed	56,618	150,290	179,049	43,674	97,718
Agriculture					
Acres Accessed	0	0	7,262	0	21,132
Recreation [1]					
Acres Accessed	19,439	15,899	61,643	116,025	21,968

Analysis based on a 10-mile-wide corridor, 5 miles on either side of the proposed route centerline.

As further detailed in the footnote of Table ES-1, colored shading was used to comparatively indicate the more or less favorable metrics.

Green = Proposed access route(s) with the greatest number of claims, leases, or acres of resources accessed.

Red = Proposed access route(s) with the fewest number of claims, leases, or acres of resources accessed.

[1] Recreation resources accessed, as listed in the table, represents State-identified parks, refuges and recreation areas, as stated earlier. One could argue most of the land in the Study Area provides recreational opportunities.

Compared to other routes, the North Skwentna route provides access to the greatest number of acres of hardrock mineral resources. Due to the length of this route, the Middle Susitna-Skwentna River route provides access to the greatest number of claims and acreages of a number of resources, including hardrock minerals, placer gold mining claims, and the potential for forestry/timber resources. Compared to other routes, the Beluga Access route provides access to the greatest number of acres of coal resources and second greatest acreage of oil and gas resources.

Figure 6-1. Mining Resources within a 10-mile Buffer of Proposed Routes

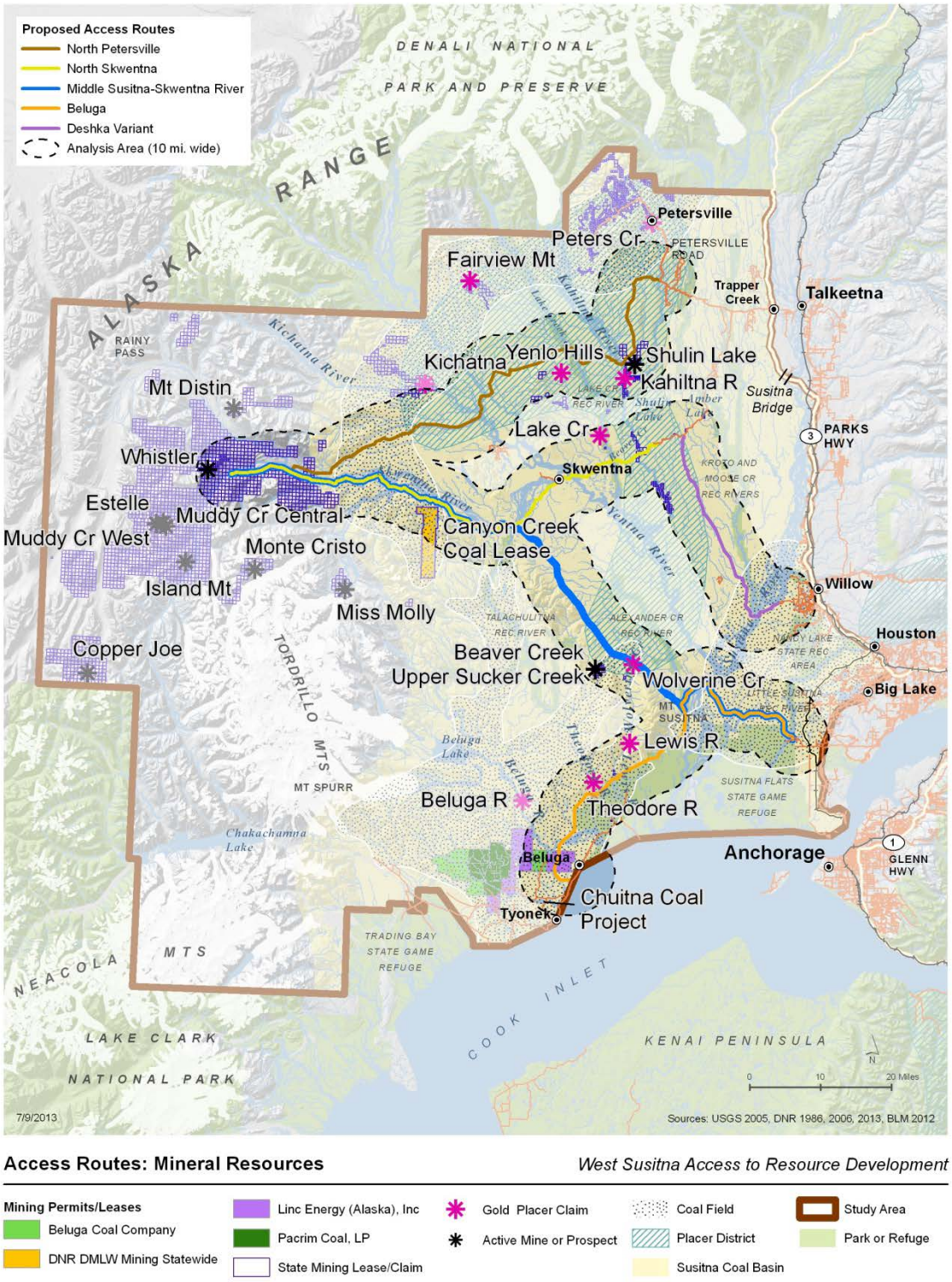
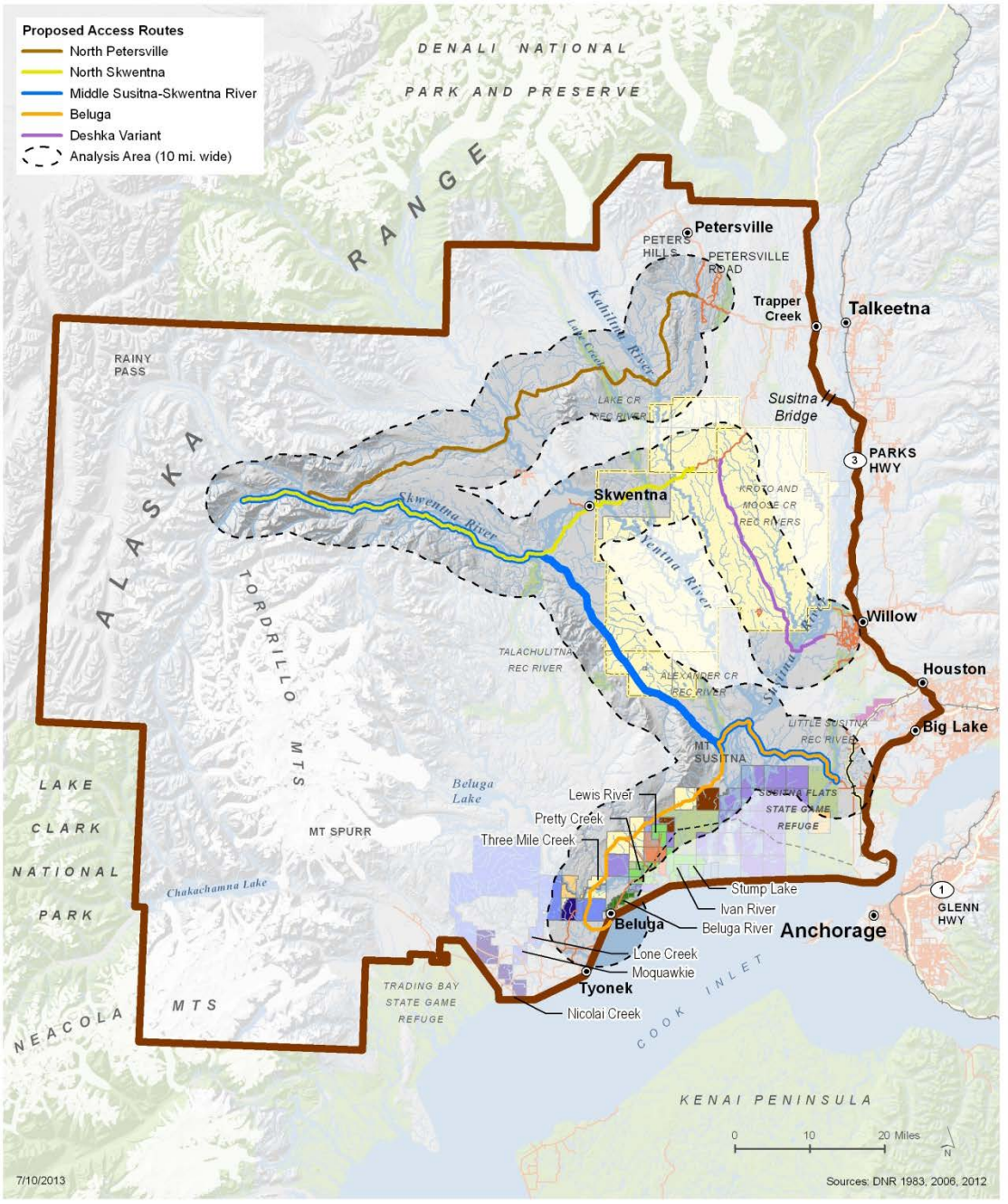


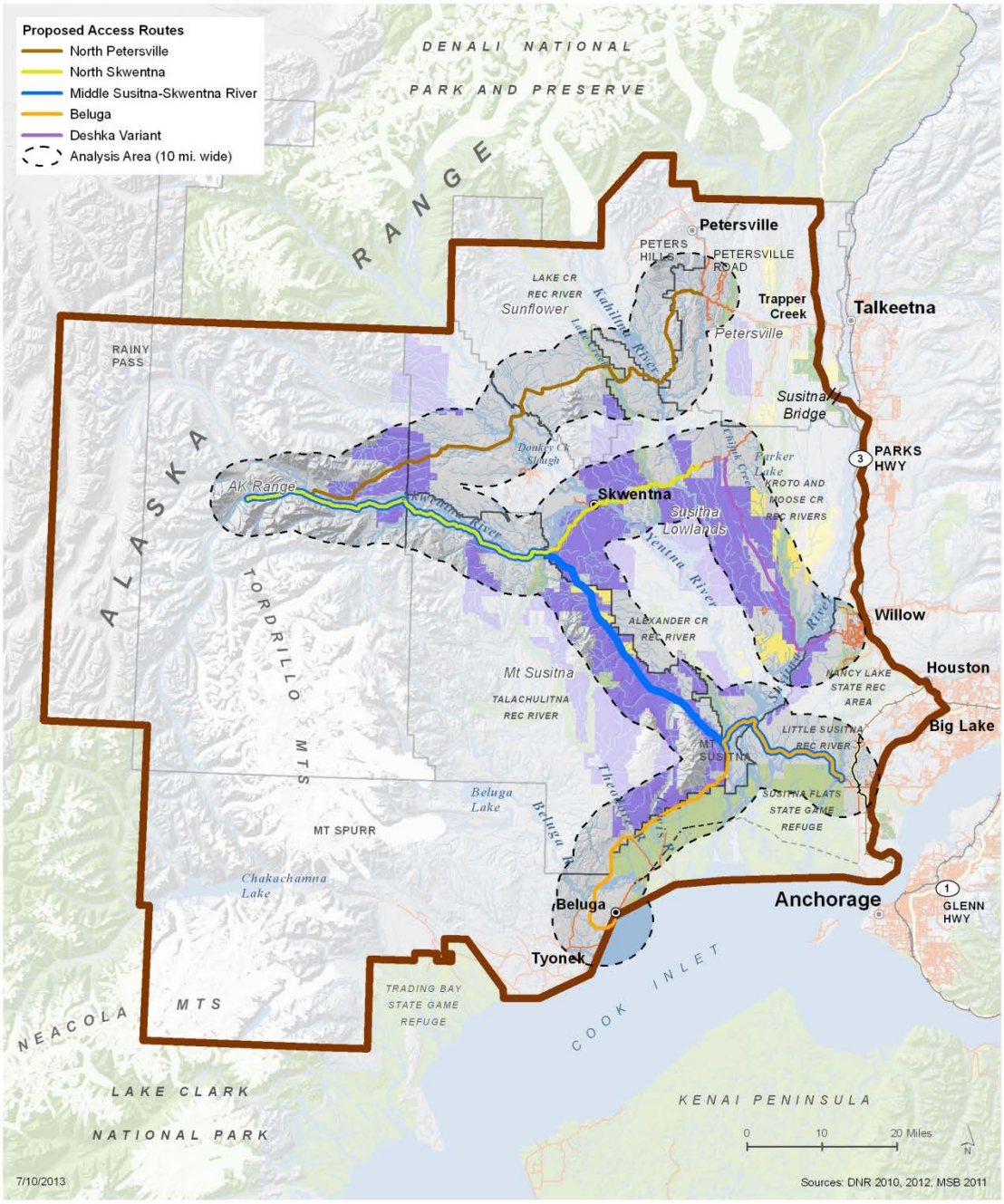
Figure 6-2. Oil and Gas Resources within a 10-mile Buffer of Proposed Routes



Access Routes to Oil and Gas Permits/Leases *West Susitna Access to Resource Development*

Oil and Gas Permits/Leases
- Apache Alaska Corp.
- Aurora Exploration
- Aurora Gas
- Conocophillips AK, Inc
- Cook Inlet Energy
- Escopeta Oil & Gas Corp.
- Hilcorp Alaska
- Linc Energy AK, Inc.
- Pacific Energy AK Operation
- Storm Cat Energy Corp.
- Susitna Exploration License Area
- Study Area
- Park or Refuge

Figure 6-3. Forestry/Timber and Agricultural Resources within a 10-mile Buffer of Proposed Routes



6.2 Land Status

The status of general land ownership was presented in Section 4.4 and Table 4-2. To determine a preliminary quantity of land that would be impacted by land owner, a 200-foot-wide ROW buffer (100 feet on both sides of the centerline) was applied within GIS. Land ownership is generalized, based upon the DNR 2013 General Land Status database, which approximates land status at the section level. Data limitations exist and ownership types are aggregated for planning purposes only. The acreage of land by land owner type for each access route is shown in Table 6-2.

Compared to other routes, the North Petersville Road and North Skwentna route options utilize the most State land within 100 feet on either side of their centerlines. As previously presented, utilizing state lands is viewed as a strength or opportunity.

Table 6-2. Land Status within a 200-foot-wide ROW of Proposed Access Routes

Land Type (by acres)	North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
Federal	-	-	-	-	-
State	1,510	1,275	1,717	640	484
Borough	17	-	461	704	113
Native	-	-	-	31	-
Private	383	462	388	97	216

Analysis based on a 200-foot-wide buffer, 100 feet on either side of the proposed route centerlines.

As further detailed in the footnote of Table ES-1, colored shading was used to comparatively indicate the more or less favorable metrics.

Green = Proposed access route(s) utilizing greatest amount of land identified as an opportunity.

Red = Proposed access route(s) utilizing greatest amount of land identified as a constraint.

6.3 Wetlands

Information on wetlands in the Study Area and available wetlands data was presented in Section 4.4. A significant portion of the Study Area has no NWI wetlands mapping. Routes going through the Study Area that are located in areas that have no available wetlands mapping include North Petersville Road, North Skwentna, and Deshka. Acres of wetlands impacted for each access route, based on available data, is shown in Table 6-3.

Table 6-3. Wetlands Potentially Impacted within a 200-foot-wide ROW of Proposed Access Routes

	North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
Wetlands impacted [1] (acres)	42.1	215	217.5	123.7	137.2

Analysis based on a 200-foot-wide buffer, 100 feet on either side of the proposed route centerline.

Wetland impacts determined through GIS intersection analysis of NWI database and a 200-foot-wide corridor.

[1] Acreages are greatly underreported for the North Petersville access route, and to a lesser extent for the eastern portion of the North Skwentna access route and Deshka variant, due to a large area of no wetlands data within the NWI database.

6.4 Terrain Types and Road Grades

The terrain in the Study Area is characterized by relatively flat and rolling terrain to the east, which gains relief as it becomes more rolling and mountainous terrain farther west towards the foothills of the Alaska Range. Terrain and ground profiles along the access routes were classified as level, rolling, or mountainous, according to the values listed in Table 6-4 and shown in Figure 6-4. Profiles of the existing ground line were created along the centerline of the access route using GIS. A 200-foot buffer (100 feet on either side of the centerline) was created to give a representation of the terrain in proximity to the routes. Length and percent of the route for each terrain type classification is summarized in Table 6-5. Terrain type is considered for cost estimating and constructability purposes.

Table 6-4. Terrain Types

Terrain Type	Ground Profile Along the Access Route (% grade)
Level	< 10
Rolling	10-25
Mountainous	> 25

The North Skwentna access route runs through the greatest percentage of mountainous terrain compared to the other access routes. The Beluga access route and Deshka variant are mostly located in level terrain (67 percent and 84 percent of their routes, respectively) with only 5 percent and 3 percent, respectively, of their alignments going through mountainous terrain. The amount of mountainous terrain will likely affect the roadway construction cost and its operational efficiency. Should these routes be furthered for evaluation, the alignments should be refined to make better use of the level/flat terrain.

Table 6-5. Terrain Type by Proposed Access Route

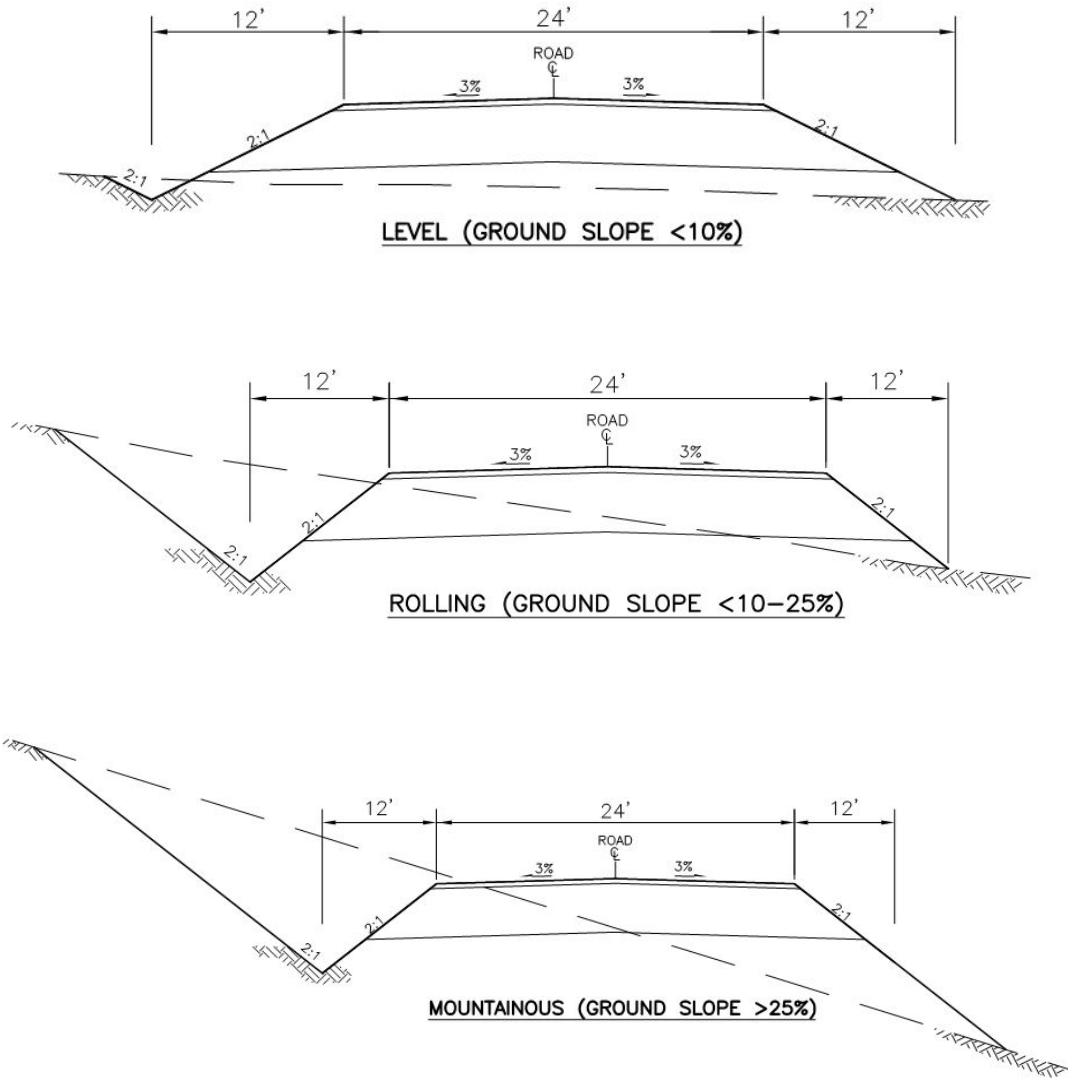
		North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
Length (miles)		78.8	71.6	107.9	63.8	33.5
Terrain type						
Level	Miles	31.3	31.4	48.1	42.9	28.2
	% of route	*40*	*44*	*45*	*67*	*84*
Rolling	Miles	25.7	16.3	29.14	18.33	4.63
	% of route	*33*	*23*	*27*	*29*	*14*
Mountainous	Miles	21.92	24.1	31.15	2.91	0.85
	% of route	*28*	*34*	*29*	*5*	*3*

As further detailed in the footnote of Table ES-1, colored shading was used to comparatively indicate the more or less favorable metrics.

Green = Proposed access route(s) through the most amount of level terrain.

Red = Proposed access route(s) through the most amount of mountainous terrain.

Figure 6-4. Typical Road Cross Section by Terrain Type



6.5 Seismicity

The Study Area is located in one of the most seismically active areas in the country. In particular, the Beluga access route appears to follow a significant portion of the Castle Mountain fault in the southern end of the Susitna lowlands. Seismicity should be a consideration for any access route moved forward. A neotectonic study may be warranted to map active surface traces of faults and to evaluate the local ground motions that may be generated by significant events. Such a study would also cover liquefaction, tectonic folding or warping of the ground surface, as well as secondary tectonic ground deformation (i.e., slope stability, lateral spread, and rock fall).

6.6 Hydrologic Considerations

All the proposed access routes cross major rivers and numerous drainages, requiring multiple bridge structures and culverts, as highlighted in Table 6-6.

Table 6-6. Hydrologic Considerations by Proposed Access Route

	North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
Length (miles)	78.8	71.6	107.9	63.8	33.5
Bridges (#)					
Conventional [1]	9	12	20	11	1
Long span [2]	4	6	4	2	2
Total	13	18	24	13	3
Bridges (>1,000 feet)	1,150 (Yentna)	1,200 (Yentna) 1,200 (Hayes)	1,200 (Hayes) 1,640 (Susitna)	1,640 (Susitna)	1,200 (Susitna)
Culverts (#)					
Large [3]	12	12	14	6	2
Small [4]	37	26	40	12	11
Minor drainage [5]	316	292	440	260	136

As further detailed in the footnote of Table ES-1, colored shading was used to comparatively indicate the more or less favorable metrics.
Green = Proposed access route(s) with the least number of bridges and culverts required.
Red = Proposed access route(s) with the greatest number of bridges and culverts required.

Assumptions:

[1] Conventional bridges are considered less than 300 feet in length.

[2] Long span bridges are 300 feet or longer.

[3] Culverts are approximately 96 feet or longer.

[4] Small culverts and minor drainage culverts have an assumed length of approximately 50 feet.

[5] An additional four culverts per mile to accommodate minor drainage patterns.

6.7 Geological and Geotechnical Considerations

Numerous glaciers are found in the Alaska Range and extend down valleys to near the edges of the lowlands. Glacially carved bedrock, moraines, drumlins, and kettle lakes are some of the landforms in the Study Area that are constantly being reshaped by continuous erosional processes. A reconnaissance-level geotechnical evaluation of the proposed access routes was performed for this study, as included in Appendix C and summarized briefly in this section.

A limited amount of quantifiable data is available to evaluate the geologic and geotechnical conditions, and therefore was evaluated on a qualitative basis. Table 6-7 represents the suitability for a road corridor based on a number of geologic and geotechnical considerations.

It is possible geotechnical challenges may arise for the following access routes:

- North Petersville Road access route: potential constraints due to Pass Creek fault
- Middle Susitna-Skwentna River access route: potential constraints due to Castle Mountain fault
- Beluga access route: Potential constraints due to Castle Mountain fault

Table 6-7. Geologic and Geotechnical Considerations by Proposed Access Route

	North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
Rock borrow availability	Medium	Eastern half poor Western half good	Eastern half poor Western half good	Poor	Poor
Rock borrow quality	Poor	Eastern half poor Western half good	Good	Good	Poor
Soil borrow availability	Good	Good	Eastern half medium Western half good	Eastern half medium Western half good	Good
Soil borrow quality	Medium	Good	Eastern half medium Western half good	Eastern half medium Western half good	Good
Foundation support	Medium	Eastern half poor Medium	Medium	Medium	Poor
Permafrost conditions	Medium	Good	Eastern half good Western half medium	Good	Good
Subgrade support	Medium	Eastern half poor Western half good	Eastern half poor Western half good	Eastern half poor Western half good	Poor
Drainage	Good	Eastern half poor Western half good	Eastern half poor Western half good	Eastern half poor Western half good	Poor

As further detailed in the footnote of Table ES-1, colored shading was used to comparatively indicate the more or less favorable metrics.

Green = Proposed access route(s) with the greatest (optimum) availability/quality of rock borrow and soil borrow, in addition to most suitable drainage, subgrade support, foundation support, and permafrost conditions.

Red = Proposed access route(s) with the least (poorest) availability/quality of rock borrow and soil borrow, in addition to most suitable drainage, subgrade support, foundation support, and permafrost conditions.

See the Table on page 9 in the Geotechnical Reconnaissance Report in Appendix C for greater detail for how the geotechnical considerations were ranked and evaluated.

Rock Borrow Availability

In general, rock borrow sources are readily available along the access routes as they go further westward. Routes toward the eastern portion of the Study Area have no significant sources of rock borrow material. The North Petersville Road route has readily available rock materials scattered relatively widely along the alignment, with more available in the west. The Beluga route and Deshka Variant have no significant sources of rock borrow material.

Rock Borrow Quality

There is a potential for relatively high quality soil materials to be available, especially in glacial outwash and frequent alluvial/terrace formations, as found in the eastern portion of the North Skwentna route. For the Beluga route, the only rock source available appears to be intrusive igneous rocks (granodiorite) on the northeast end at the foot of Mount Susitna, which should yield relatively durable, high quality materials.

Soil Borrow Availability

In general, soil borrow materials area readily available along all the proposed routes.

Soil Borrow Quality

As with the relative availability of soil borrow materials, the quality of soil borrow materials along the proposed routes seems potentially high.

Foundation Support

Overall, foundation support conditions are anticipated to be relatively favorable, though pile foundations will likely be needed to varying depths.

Permafrost Conditions

The potential for permafrost along the North Petersville route is likely the greatest in comparison to the other routes in this study. Permafrost soils can be expected in higher elevations and on the north side of topographic high areas. Some of the low, poorly drained, boggy areas may also be underlain by permafrost soils.

Subgrade Support

In general, subgrade support is anticipated to be highly variable along the routes, and drainage in the boggy areas may be a challenge in design and construction. Routes in the western portion of the Study Area are likely to encounter more optimum subgrade support conditions than the eastern portion of the Study Area.

Drainage

All proposed routes will require frequent crossings of wetland/boggy areas.

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7 SUMMARY AND NEXT STEPS

The product of this reconnaissance-level study was the identification of the locations of four possible access routes and one variant road option for providing access to resources within the Susitna basin. These proposed route locations were based on a review of existing literature, interviews with industry stakeholders, an inventory of natural resources and existing infrastructure, identifying reasonable crossing locations of major rivers (e.g., Susitna River), and a constraints and opportunities analysis. Table 7-1 presents a comparative summary of the proposed access routes' strengths/advantages and weaknesses/challenges as previously detailed in Section 6.

Table 7-1. Proposed Access Routes Strengths and Weaknesses Comparison

	North Petersville Road	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
Length (miles)	78.8	71.6	107.9	63.8	33.5
Ranking for amount of resources accessed [1]					
Hardrock minerals	Medium	High	Highest	Lowest	Low
Placer gold mining	Medium	High	Highest	Lowest	Lowest
Coal	Medium	Medium	High	Highest	Lowest
Oil and gas	Lowest	Medium	Medium	High	Highest
Forestry/timber	Low	High	Highest	Low	Medium
Agriculture	Lowest	Lowest	Medium	Lowest	Highest
Recreation	Low	Lowest	Medium	Highest	Low
Ranking for utilizing "opportunistic" land [2]	High	Medium	Highest	Medium	Medium
Ranking for optimum geologic considerations [3]	Medium	Good	Good	Good	Poor
Ranking for required bridge/culvert structures [4]	Low	Medium	Requires most bridges/culverts	Low	Lowest
Ranking for terrain type [5]	Medium	Most mountainous	Medium	Most Level	Most Level
Planning-level Cost Estimate (millions)					
Subtotal [6]	$147.6	$188.3	$187.4	$106.9	$72.2
Total [7]	$376.4	$504.3	$453.2	$257.8	$216.9
Total per mile [8]	$4.6	$6.3	$4.2	$4.0	$5.2

As further detailed in the footnote of Table ES-1, colored shading was used to comparatively indicate the more or less favorable metrics.

Green = Proposed access route(s) with the fewest number of roadway miles, bridges, culverts, and/or costs. Also, indicates highest amount of resources made accessible. Route(s) goes through the most amount of level terrain, utilizing most optimum geologic conditions, and/or traversing most "opportunistic" land based on status.

Red = Proposed access route(s) with the greatest number of roadway miles, bridges, culverts, and/or costs. Also, indicates least amount of resources made accessible. Route(s) goes through the most amount of mountainous terrain, utilizing least optimum geologic conditions, and/or traversing least "opportunistic" land based on status.

Assumptions:

[1] Resources made accessible within a 10-mile buffer of the proposed centerline. See Table 6-1.

[2] Land status within 200-foot ROW that is ranked as either opportunistic (e.g., State lands) or a constraint (e.g., private). See Table 4-2and Table 6-2.

[3] Geological considerations include 8 features, as detailed in Table 6-7.

[4] Hydrologic considerations include number of bridges and culverts required. See Table 6-6.

[5] Percentage of route traversing terrain type, with level terrain viewed as an opportunity and mountainous as a constraint. See Table 6-5.

[6] Subtotal cost estimate for new proposed roadways includes clearing, earthwork, structures, stream and river crossings (including culverts), guardrail and retaining walls, and miscellaneous items such as topsoil, seeding, geotextile and signing.

[7] Total cost estimate includes drainage measures, erosion and pollution, surveying, environmental studies and permits, existing road upgrades, construction, mobilization, ROW acquisition, contingency, design, and utilities.

[8] Total per mile includes only the proposed access routes and does not include existing roadways or cost to upgrade them.

7.1 Identified Data Gaps and Next Steps

This reconnaissance study provides a foundation for additional project development should the project be moved forward. Future tasks to further advance the possibility of an access road into the Susitna Basin west of the Susitna River include further engineering refinement, environmental field studies, origin/destination assessment, economic analysis, acquiring aerial photography or LIDAR, cost estimate refinement, and public involvement and stakeholder engagement. Many of the data sets used in this report contained incomplete information. In other cases, data was sparse.

Engineering refinement. Preliminary conceptual engineering alignments were identified based on engineering judgment using available data. Additional environmental, geotechnical, hydrologic, and topographic data would need to be obtained to further refine the alignments. For the access routes that would connect to and utilize exiting roadways (e.g., Oil Well Road, Petersville Road, Little Susitna River Road, etc.), the preliminary cost estimates included an initial examination of the cost to upgrade these roads. However, further field reconnaissance would need to occur to determine actual road width and condition and number of culverts and/or bridges that may need to be upgraded or replaced to accommodate the dimensions of the proposed West Susitna access road. Additional coordination should occur with other interested parties who are already conducting and collecting existing baseline conditions in the area. For instance, recent efforts over the summer of 2013 by Donlin Gold, LLC included conducting fieldwork, such as delineating wetlands along their proposed pipeline corridor.

Affected land management agencies, such as divisions of the State of Alaska and local governments such as the Mat-Su Borough, should also be consulted and coordinated with as routes get further refined and a preferred route is chosen. This is particularly important as route locations would have a fundamental effect on the development of State lands throughout the Study Area. Several State of Alaska departments and divisions have suggested that it would benefit future planning efforts to have identified routes surveyed and reserved to the state for future access needs.

Environmental studies. To supplement the limited available data, a number of field studies and office-based studies are recommended to help further refine the proposed access routes and preferred stream crossing and drainage locations. At a minimum, additional studies should include:

- Soils and Geology
- Hydrology
- Vegetation
- Wetlands and waterbodies
- Fish streams and essential fish habitat
- Wildlife
- Land ownership
- Historic and archaeological resources
- Recreation

Refined origin/destination assessment and travel forecast. Additional analysis should be conducted to determine the most viable project termini based on a project purpose and need, additional details on the types of vehicles and level of traffic demand.

Economic analysis. An economic analysis should be conducted to determine the costs/benefits of constructing an access road into the Susitna basin. This examination would provide supporting information for the purpose and need for the project and would be a foundation for refining the

travel forecast. This would also include further refined analysis of the existing resources in the Study Area. This analysis would assess the value of resource extraction potential being lost due to lack of transportation access.

Aerial photography or LIDAR. Existing mapping is limited to USGS mapping, which is at best, suitable for high-level planning. More detailed aerial photography or LIDAR would be necessary for refining the proposed access routes, preliminary engineering (including cost estimates), and would support environmental studies.

Cost estimate refinement. As the alignments are further engineered, the cost estimates need to be refined.

Public involvement and stakeholder engagement. This reconnaissance-level report was prepared to determine possible locations for an access road into the Susitna basin to support potentially significant resource development opportunities. Should this project be furthered, seeking public input and comment from relevant stakeholders is a critical next step.

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West Susitna Access Reconnaissance Study
West Susitna Access to Resource Development

Transportation Analysis Report

Appendix A:
Preliminary Design Criteria Report

WEST SUSITNA ACCESS RECONNAISSANCE STUDY

PRELIMINARY DESIGN CRITERIA TECHNICAL MEMORANDUM

December 2013

Alaska Department of Transportation and Public Facilities

Prepared by

HDR Alaska
Anchorage, Alaska

Submitted by:

_____ ____
Michael R Tooley Date
Senior Transportation Engineer

Approved by:

_____ ____
Date
Department of Transportation and Public Facilities

The State of Alaska, Department of Transportation and Public Facilities, Division of Program Development (Roads to Resources Initiative), is evaluating one or more potential transportation corridors and river crossing(s) to provide surface access to resource development opportunities west of the Susitna River in Southcentral Alaska.

The West Susitna Access objective is to identify feasible access route options to connect resources (mineral, timber, coal, recreation opportunities, oil, and gas) identified in the Alaska Range and its southeast foothills to the road or marine transportation system. This *Preliminary Design Criteria* presents the standards proposed to be used as the basis for evaluation of the road transportation access prepared during the reconnaissance phase for the West Susitna Access. These criteria will be revised as more information is discovered during the preliminary reconnaissance and design stages.

The *Preliminary Design Criteria* will be applicable to all access routes analyzed. The project Study Area includes areas west of the Parks Highway between Knik Arm and Petersville, south of Denali National Park and Preserve, and north of Cook Inlet (see Figure 1, Study Area, below).

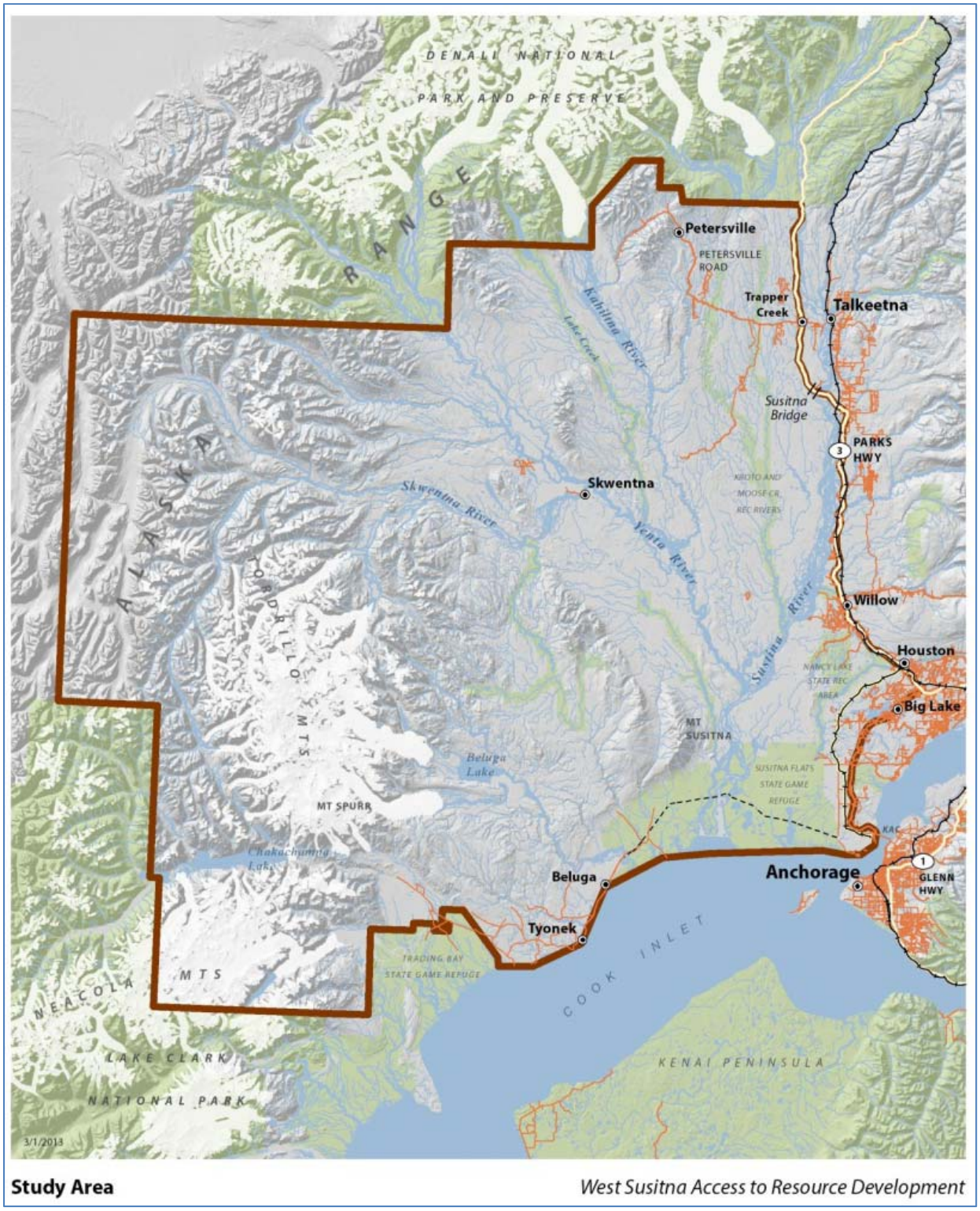


Figure 1. Study Area

Assumptions

Over the course of the development of this reconnaissance study, it was determined that the West Susitna access road would be utilized by both the resource development industry for resource exploration/transport as well as open to the public. This *Preliminary Design Criteria Technical Memorandum* reflects the design criteria associated with those dual functions. It is also possible a toll road or fee might be associated with the road, but that is not a part of the analysis in this memorandum.

Development for resource recovery typically advances in three stages: the investigation and discovery, the site development, and then extraction and processing of the finished product. Depending on the resource, it generally progresses as follows:

1. *Initial Phase*. For initial site investigation access, a pioneer road concept is proposed – a low-volume, two-way single-lane gravel access road. Vehicles will be four-wheel drive (4WD) crew cab pickups and single unit support trucks for exploratory purposes only. Such traffic can use single lane roads with intervisible turnouts.
2. *Construction Phase*. During resource site construction, the road may continue to be a two-way single-lane road if minimal heavy equipment is needed for site development. It may also need to expand to a two-lane facility between the material source and resource site.
3. *Production Phase*. If all the resource development work is on-site with a pipe or line transmission facility, or the finish product is being hauled out, a two-way single-lane facility may be sufficient. It is anticipated transporting raw product or concentrate to a production facility or to tidewater will be required; thus, a two-lane facility will need to eventually be provided.

Initially, the preliminary design criteria considered for the West Susitna access road was based on an initial phased concept of a single-lane gravel road. Upon proof of product and start of production, this initial work could then be expanded into the production phase. Additional initial assumptions included:

- Initial traffic volumes for resource exploration efforts would be under 100 vehicles per day (VPD). This traffic volume is the maximum suggested for two-way single-lane gravel roads driven by professionals who are often in contact with each other by radio. It is an appropriate assumption during initial roadway construction and resource exploration efforts.
- Resource development traffic volumes would remain under 400 VPD. This would result in a minimal two-way two-lane gravel road for planning and estimating purposes.
- Vehicle traffic would enter and exit the route using the George A. Parks Highway (or other roadways such as the Point MacKenzie Road, Petersville Road, and/or Oil Well Road, depending on the corridors chosen), and therefore must conform to State legal size, length, and weight restrictions (17 AAC 25).
- Preliminary discussions considered that initial access would be limited to construction and industry traffic, and would not be conditionally opened to the public until a later date. However, as this study has progressed, design considerations are for the road to be open to the public from the beginning, with traffic volumes still below 400 VPD. Depending on

resource development needs and public interest in accessing Study Area lands, traffic volumes could be more than 400 VPD. With the uncertainty of resource development needs and level of public interest, it is difficult at this time to know with certainty traffic volumes.

- Material is readily available and is easily obtained along the corridor for use.

Reference Design Standards

The preliminary design criteria for the West Susitna Access were based on the American Association of State Highway and Transportation Officials (AASHTO) Geometric Design of Highways and Streets, 2004 (PGDHS), as supplemented by the current edition of the Department's Highway Preconstruction Manual (PCM). Additional guidance was provided from the applicable sections of the AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads, 2001 (GDVLVLR), the U.S. Forest Service Roadway Preconstruction Handbook, 2011 (FS-RPH); and engineering judgment. References and sources are noted within the text.

Functional Classification

Anticipating the myriad of uses and vehicles that the West Susitna access road could see (e.g., resource recovery, public access for recreation, etc.), a 24-foot-wide, two-lane gravel access road (2'-10'-10'-2') was considered for the facility, with the idea that the ultimate facility may be significantly wider based on further investigations or interest in the Study Area. The suggested functional classification of an access road into the West Susitna basin would be a two-lane gravel **Rural Resource Recovery Road**.[1] At this time, the corridor would be considered a very low-volume local road. The PGDHS defines a very low-volume local road as one with an average annual daily traffic volume of 400 VPD or less.

The dimensions of a Rural Resource Recovery Road would more than meet the roadway dimensions and needs required for a **Rural Local Road**[2] or **Rural Minor Access Road**.[3] Table 3 highlights the design criteria for all three road classifications, indicating that the Rural Resource Recovery Road would more than satisfy the need for the other roadway uses. The Rural Local Road classification is included here to highlight that this type of roadway could serve as pioneer access for initial exploratory investigations for natural resources.[4] With minimal traffic, such an initial phase access would be classified as a **Rural Local Road** with the understanding that it will eventually function as and become a **Rural Resource Recovery Road**. However, Rural Local Road dimensions do not satisfy the design criteria needs (e.g., total roadway width) required for public access, per the Rural Minor Access Road classification. Therefore, the Rural Resource Recovery Road is the most reasonable functional classification for the West Susitna access route corridors. Also, design criteria appropriate for a Rural Resource Recovery Road in many areas are not significantly different from those for

[1] PGDHS, page 414
[2] PGDHS, page 416
[3] GDVLVLR, page 6
[4] In terms of initial "pioneer access", the PGDHS goes on to recommend the GDVLVLR guidelines (page 52) in lieu of the PGDHS for geometric design, which goes even further stating that two-way single-lane gravel roads serve less than 50 VPD (100 VPD if radio connected). The GDVLVLR also suggests using the FS-RPH as an additional resource for single-lane roads.

recreational roads.[5] Oftentimes, resource development roads are ultimately used for other (e.g., recreational) purposes, assuming the volumes are still below 400 VPD. The Rural Resource Recovery Road classification for West Susitna access takes into account these varying usages.

Design Vehicle

In terms of resources exploration, development, and extraction, as would be expected, the design vehicle evolves through each anticipated project phase.

1. *Initial Phase*. Vehicles such as 4WD crew cab pickups and single unit (SU) flatbed trucks, drill rigs, fuel tankers, etc., would make up the majority of the expected traffic in the investigative period.
2. *Construction Phase*. Trucks for hauling gravels and building materials would probably be tractors with double (bellydump) trailers (WB-120).
3. *Production Phase*. The majority of the anticipated traffic would be heavy haul vehicles. This would cover a wide range of transportation needs, including moving heavy mining equipment and hauling large amounts of extract or product from product origin to process plants, or to tidewater for shipping Outside. These vehicles may or may not be street-legal.

Photo 1: Klondike Highway Truck

Photo 2: Red Dog Truck

If the access corridor connects to the existing highway network, vehicles using the new corridor will need to be consistent with the State requirements governing the existing highways (17 AAC 25).

However, given other similar developments around the State, it is not unreasonable to expect that a more robust type of design vehicle could be utilized – like the 10-axle, 200,000-pound double trailer similar to the trucks proposed for use over the Klondike Highway in Southeast, or the 13-axle, 260,000-pound double haul trailers used at the Red Dog mine in Western Alaska.

[5] PGDHS, page 414

For public access, it is anticipated that the primary vehicle will be a 4WD pickup or suburban class vehicle, possibly towing an ATV, boat, or camping trailer.

Design Speed

A two-way single-lane gravel road is designed to operate at low speeds, typically no more and usually less than 30 MPH. The lower speeds also allow for smaller radius curves that will permit the initial phase road to better conform to the terrain and reduce the amount of earthwork.

Users of the two-lane gravel roadway can function at higher operating speeds, subject to the control of the terrain features[6].

Table 1. Proposed Design Speeds

TERRAIN	DESIGN SPEED (MPH)
Level	40
Rolling	30
Mountainous	20

The proposed design speed for the production phase should be increased to match the speed at which the majority of the professional drivers are comfortable traveling, while adapting to visual and physical cues such as sight distance, lane width, and road alignment. This may entail a design speed in level terrain of up to 50 MPH wherever possible.

Typical Section

Because the size of equipment that travels on haul roads varies significantly, vehicle size rather than vehicle type or gross vehicle weight are best used to define road width requirements. In the past, it was recommended that each lane of travel should provide clearance on each side of the vehicle equal to one-half of the width of the widest vehicle in use (AASHO 1965).

During the initial phase, the typical section of the 30 MPH two-way single-lane access roadway for 4WD pickups and service vehicles would consist of one 12-foot travel lane, with 2-foot shoulders on each side for a total width of 16 feet[7].

In the production phase, the ultimate build-out of the higher speed two-lane resource recovery road typical section width would be a function of the intended design vehicle. This could vary from the 16-foot-wide single-lane for an oil or gas pipeline or aerial poleline service road, to 32 feet for the two-way Klondike Highway or 30 feet for the one-way Red Dog mine road. The GDVLVLR recommends a 22.5-foot-wide resource recovery roadway.

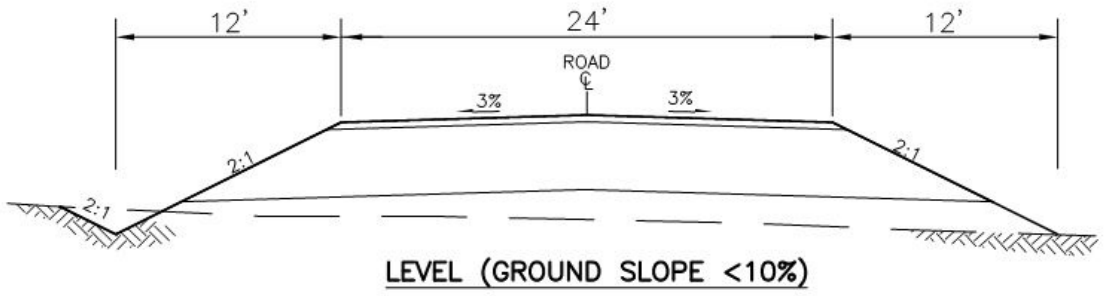
The GDVLVLR also suggests that a public minor access road be 18 feet wide.

Anticipating the varying uses and vehicles that this new access road could see, it is proposed that the production phase width should be at least 22.5 feet wide.

[6] PGDHS, page 415
[7] FS-RPH, page 20

For purposes of this Study, as shown on Figure 2, a 24-foot-wide two-lane gravel access road (2'-10'-10'-2') will be the considered facility, with the idea that the ultimate facility may be significantly wider.

Figure 2. West Susitna Access Typical Cross Section



Bridges

Bridges will be estimated initially as two-lane structures. For long bridges in excess of 200 feet, the width may be reduced for economy. Once a design vehicle and any special restricted usage is identified, design criteria will be per the current edition of the AASHTO Load and Resistance Factor Design Bridge Design Specifications (LRFD).

Grades

The maximum grade for a pioneer road is 18 percent for 4WD and high clearance vehicles[8].

The grade for a resource recovery road varies with design speed and surrounding terrain. From the PGDHS, the following is interpolated[9]:

Table 2. Terrain Grades

TERRAIN	DESIGN SPEED	GRADE
Level	40	7
Rolling	30	10
Mountainous	20	16

For 50 MPH, the maximum grade decreases to 6 percent on the flat topography[10]. Further reductions may be required to address the use of even heavier haul vehicles. AASHTO cautions that "sections of adverse grades should not be so long that they slow a loaded truck to crawl

[8] FS-RPH, page 56
[9] PGDHS, page 409
[10] PGDHS, page 382

speed… In many instances, failure to use flatter grades may result in additional expenses for transportation during the life of the road far in excess of any savings in construction cost."[11]

Curve Radius

The minimum curve radius matches the design speed and friction factor of the road surface with superelevation to the design vehicle to comfortably negotiate the curve. The PGDHS recommends a curve radius of 485 feet for a design speed of 40 MPH, and 833 feet for 50 MPH for a high type facility, but the GDVLVLR calculates a minimum curve radius of 185 feet for 30 MPH, and 380 feet for 40 MPH for lower volume roadways with a high percentage of truck traffic[12]. In climates that commonly receive snow and ice, 6 percent superelevation is considered the maximum[13].

Sight Distance

The GDVLVLR recommends doubling the two-lane stopping sight distance for single-lane roads[14]. At 40 MPH, the stopping sight distance for the two-way two-lane roadway is 250 feet[15].

K value is the rate of change of grade on a vertical curve (the distance in feet required to achieve a 1% change in grade); it is used to make sure the crest vertical curve is shallow enough to allow drivers to see what is on the other side in time to stop their vehicle, or that a sag vertical curve is flat enough for their headlights to illuminate a possible obstruction ahead of them. K values are based on the stopping sight distance; for a 40 MPH design speed, the crest K value is 29[16]. The GDVLVLR does not provide specific guidance on sag vertical curves, but the FS-RPH formula recommends a computed sag K value of 35 at 40 MPH[17].

Sideslopes

According to AASHTO, sideslopes are "designed to ensure roadway stability and to provide a reasonable opportunity for recovery for an out-of-control vehicle"[18]. Slopes are divided into "recoverable" (≥4H:1V), "traversable" (>3:1 and <4:1), and "non-traversable" (≤3:1). The initial phase pioneer road would incorporate 2:1 slopes.

The production phase road design would analyze 4:1 sideslopes, where practical, to provide a reasonable recovery area prior to a more cost-effective 2:1 slope[19]. On more significant fills, a 2:1 fill slope protected by guardrail (subject to geotechnical investigation), would be incorporated into the design to reduce earthwork quantities, as well as to reduce impacts to area resources.

[11] PGDHS, page 415
[12] GDVLVLR, page 28
[13] FS-RPH, page 40
[14] GDVLVLR, page 52
[15] GDVLVLR, page 39
[16] GDVLVLR, page 39
[17] FS-RPH, page 43 ($k = v^2 / 46.5$)
[18] PGDHS, page 330
[19] PGDHS, pages 413 and 387

Clear Zones

The clear zone is the portion of the roadside that is free of obstructions and sufficiently flat to enable an errant vehicle to encroach without overturning. Shoulders are part of the roadside clear zone. Providing roadside clear zones, flatter slopes, or traffic barriers is generally inconsistent with the economic decision to build and maintain an unpaved surface[20]. However, the GDVLVLR design guidelines for new construction states that a clear recovery area of 6 feet or more should be considered if cost, terrain, right-of-way, and social/environmental impacts are not an issue[21]. If the impacts are considered large, clear zones from 0 to 6 feet may be used.

Turnouts

The U.S. Forest Service operates many unpaved two-way single-lane roads, and their design criteria recommends turnouts be provided at regular intervals to allow opposing vehicles to pass one another safely. The location of the turnouts should consider topography and horizontal and vertical alignment. Turnouts should be intervisible, with a maximum spacing of 1,000 feet[22]. In some cases where sight distances are impractical, roadways should be widened at crests. The recommended turnout width is 120 feet long by 10 feet in width with 50 foot transitions at each end (based on a 120-foot design vehicle length)[23].

Access

The purpose of this road is to encourage development of and provide new access to State lands. At this time, controlled-access restrictions may not be warranted; though it is recommended that all access to the new roadways be in accordance with the Department's current edition of the Driveway Regulations. On a corridor planning level, controlled-access may make sense, especially closer to the already-developed areas where the proposed access routes would connect to existing roadways.

Summary

The West Susitna Access reconnaissance study proposes to look at the development of possibly several resource recovery road corridors to the west of the Parks Highway. The proposed access route(s) would provide the opportunity for both resource exploration/recovery and public access to lands. In terms of resource exploration, the intent is to initially provide access for investigative services. Once a site has been identified to advance, then the production phase would be initiated and work on the resource could begin.

Table 3 highlights the design criteria based on the functional uses of the proposed access road. At this time, it is assumed the **Rural Resource Recovery Road** classification would more than meet the needs of the varying proposed uses and development phases of resource development.

[20] GDVLVLR, page 50
[21] GDVLVLR, page 48
[22] FS-RPH, page 22
[23] FS-RPH, page 24

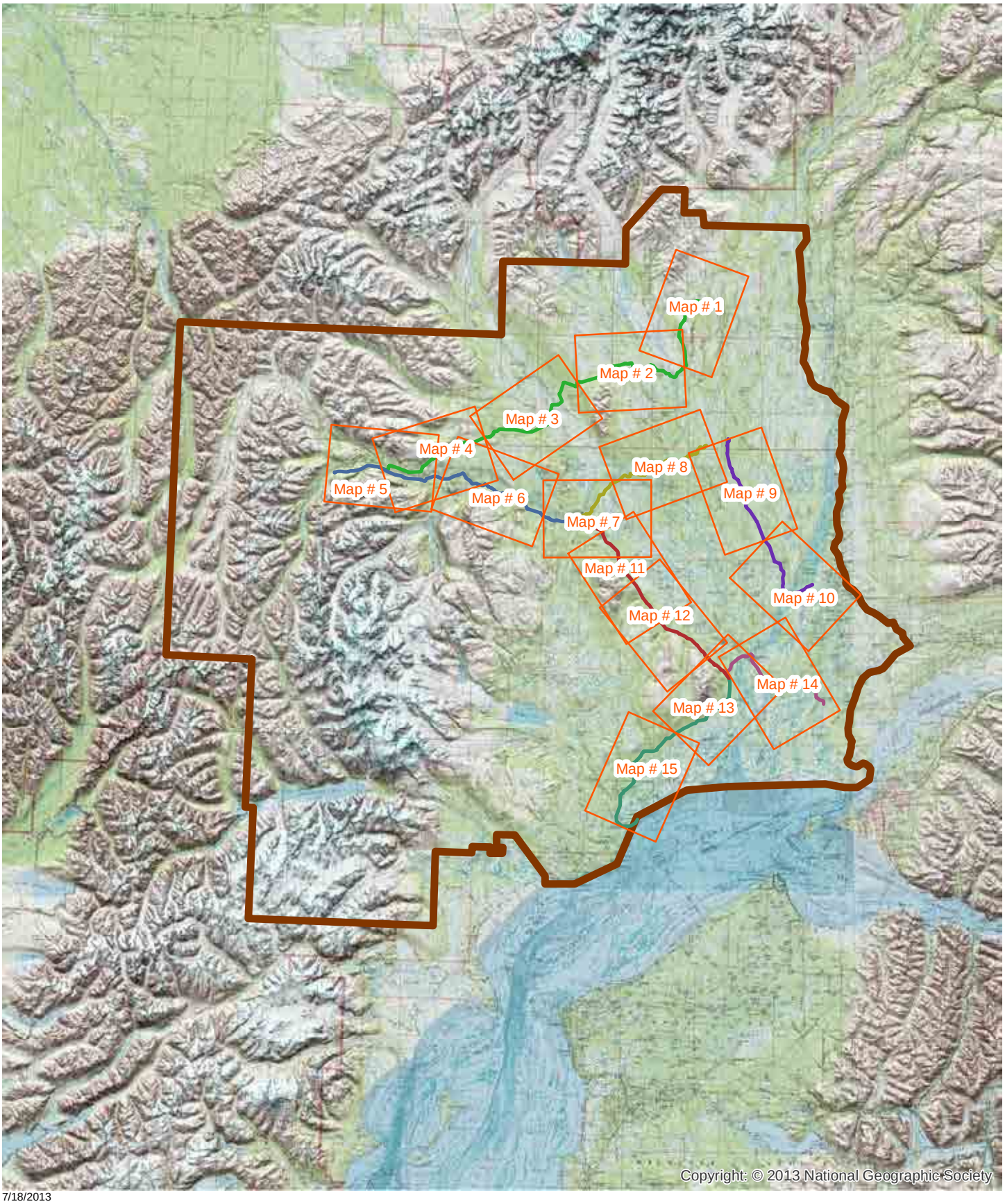
Table 3. Preliminary Design Criteria

ELEMENT	INITIAL PHASE	PRODUCTION PHASE	PUBLIC ACCESS CONSIDERATION
Functional Classification	Rural Local Road	**Rural Resource Recovery Road**	Rural Minor Access Roads
Traffic Volume	< 100 AADT	**< 400 AADT**	< 400 AADT
Number of Lanes	One lane with turnouts	**Two lanes**	Two lanes
Design Vehicle	Single Unit Vehicle	**WB-120 Trucks**	Single Unit Vehicle with Trailer
Design Speed	30 MPH	**20 – 40 MPH depending on terrain**	20 – 40 MPH depending on terrain
Surfacing	Unpaved	**Unpaved**	Unpaved
Traveled Way Width	12 feet (one lane)	**10 feet (two lanes)**	18 feet
Shoulder Width	2 feet	**2 feet**	—
Bridge Width	Two lanes	**Two lanes**	Two lanes
Maximum Grade	18%	**7-16% depending on terrain**	7-16% depending on terrain
Curve Radius	185 feet @ 30 MPH	**380 feet @ 40 MPH**	380 feet @ 40 MPH
Stopping Sight Distance	270 feet @ 30 MPH	**250 feet @ 40 MPH**	250 feet @ 40 MPH
Vertical Curves	Crest K = 9 @ 30 MPH Sag K = 19 @ 30 MPH	**Crest K = 29 @ 40 MPH** **Sag K = 35 @ 40 MPH**	Crest K = 29 @ 40 MPH Sag K = 35 @ 40 MPH
Clear Zone	0 to 6 feet	**0 to 6 feet or more up to 10 feet**	0 to 6 feet
Sideslopes	Foreslopes – 2:1 Backslopes – 2:1	**Foreslopes – 4:1** **Backslopes – 2:1**	Foreslopes – 2:1 Backslopes – 2:1
Turnouts	Intervisible, with 1,000-foot spacing	**Not applicable**	Not applicable

West Susitna Access Reconnaissance Study
West Susitna Access to Resource Development

Transportation Analysis Report

Appendix B:
Proposed Access Routes Map Index



7/18/2013

Proposed Corridor Alignments

West Susitna Access to Resource Development

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

USGS Quad Index Map

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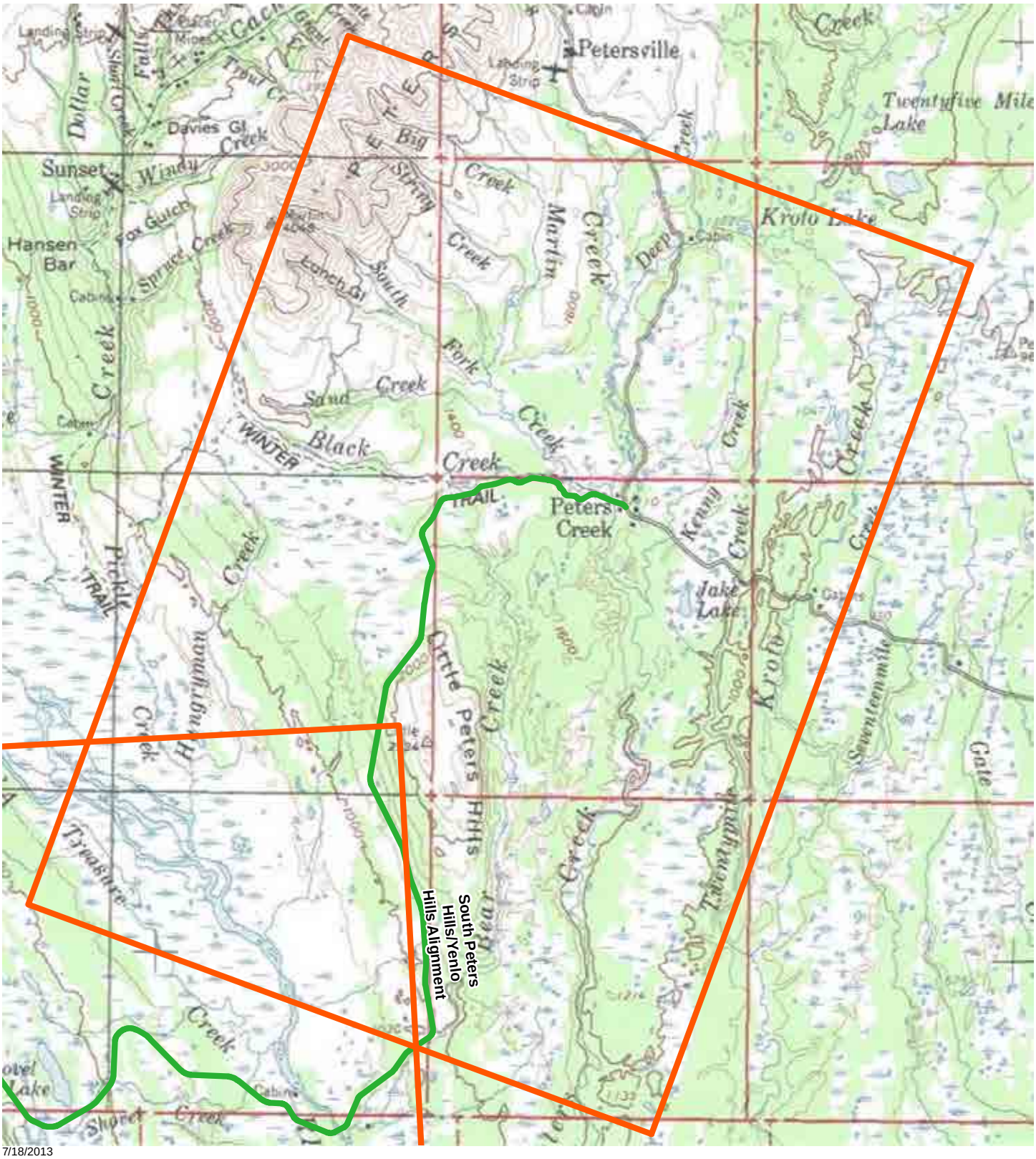

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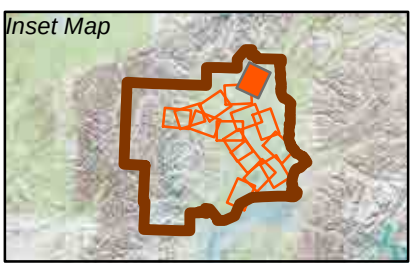
Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TALKEETNA A-2 and B-2 *Map #: 1*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment



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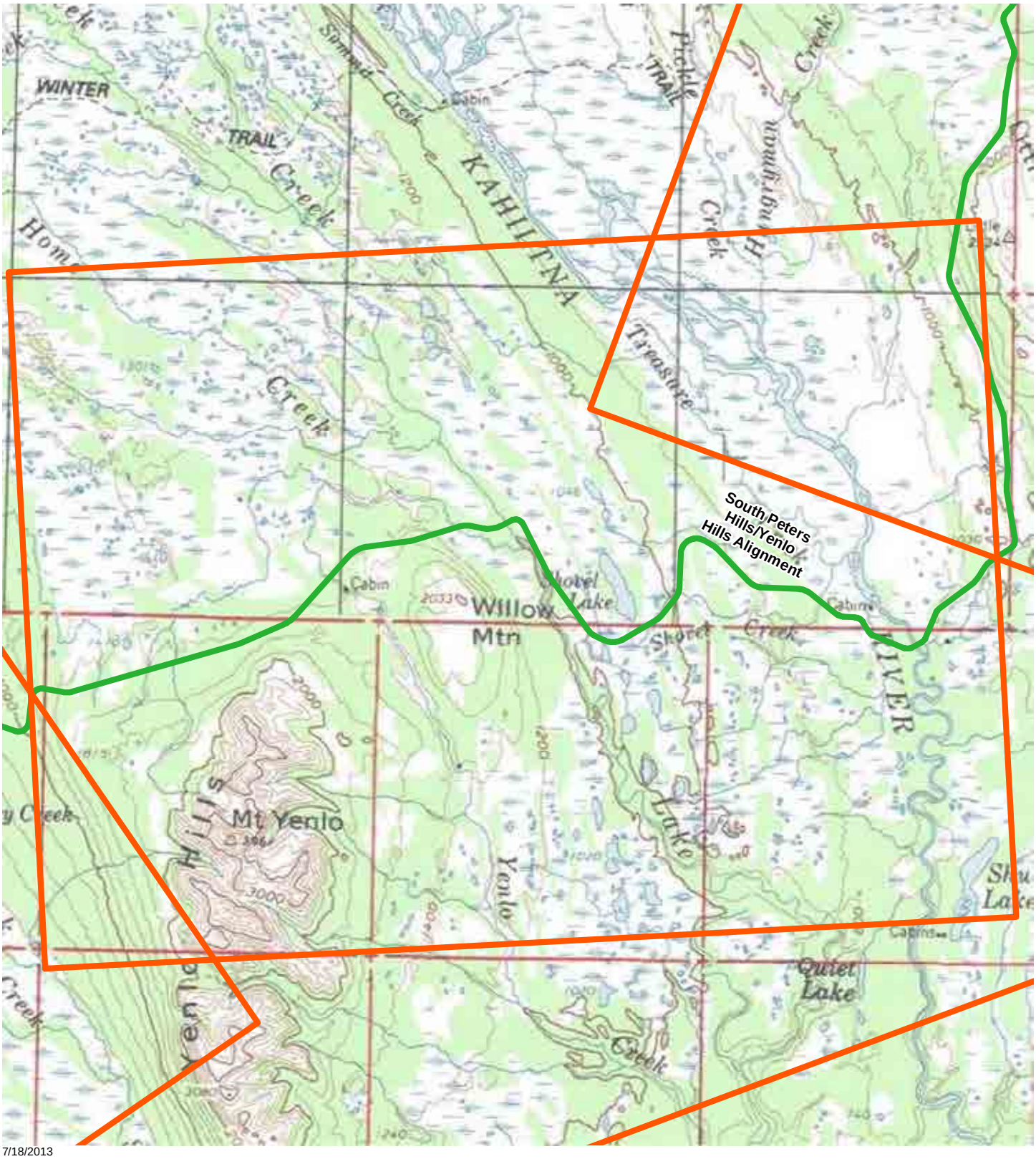

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Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TALKEETNA A-2, A-3, and B-2 *Map #: 2*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

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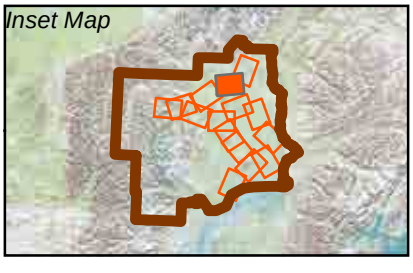

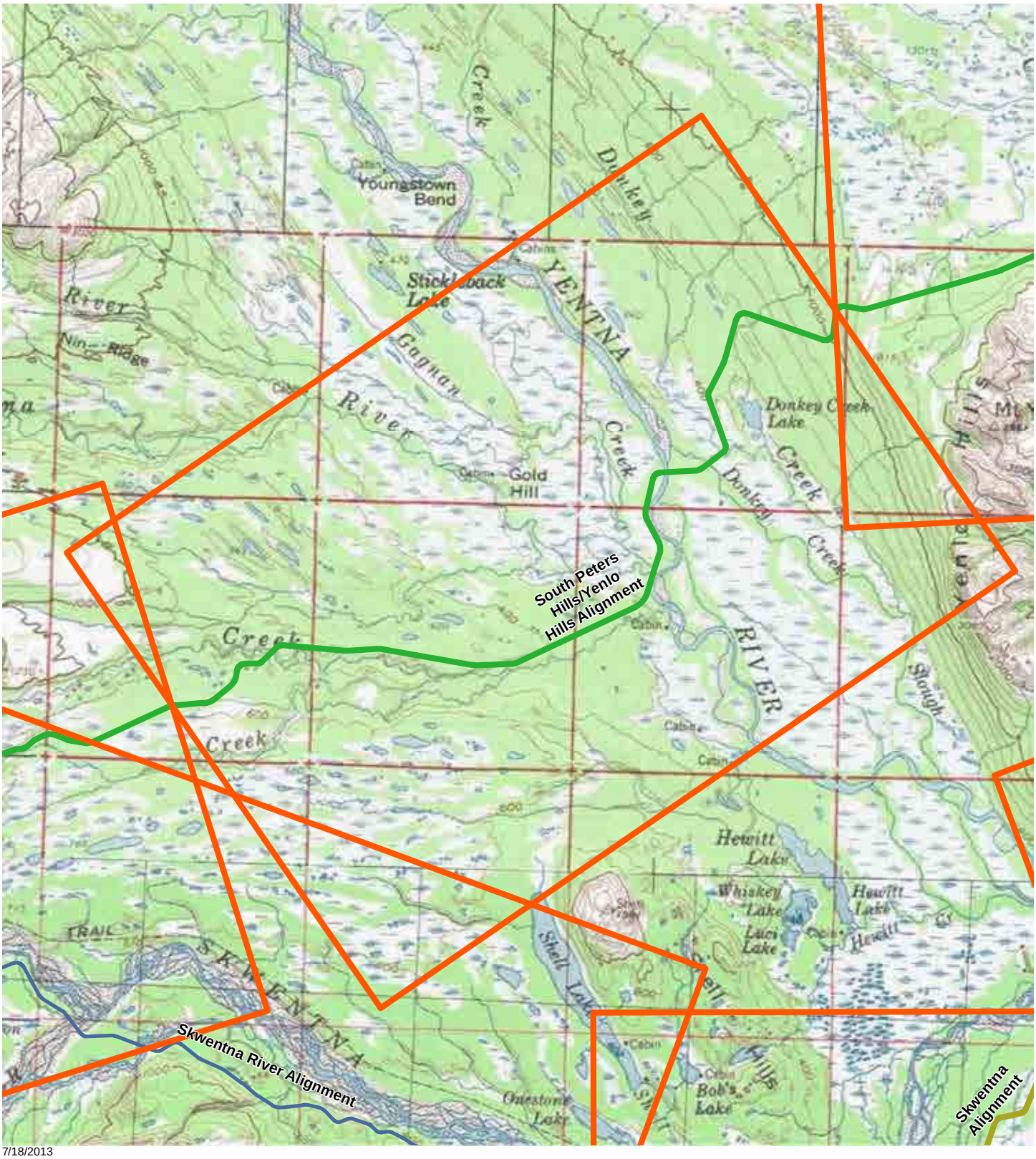

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Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TALKEETNA A-3, A-4, and TYONEK D-5 Map #: 3

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

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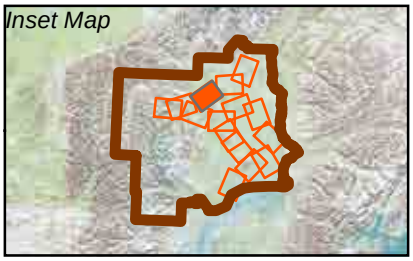

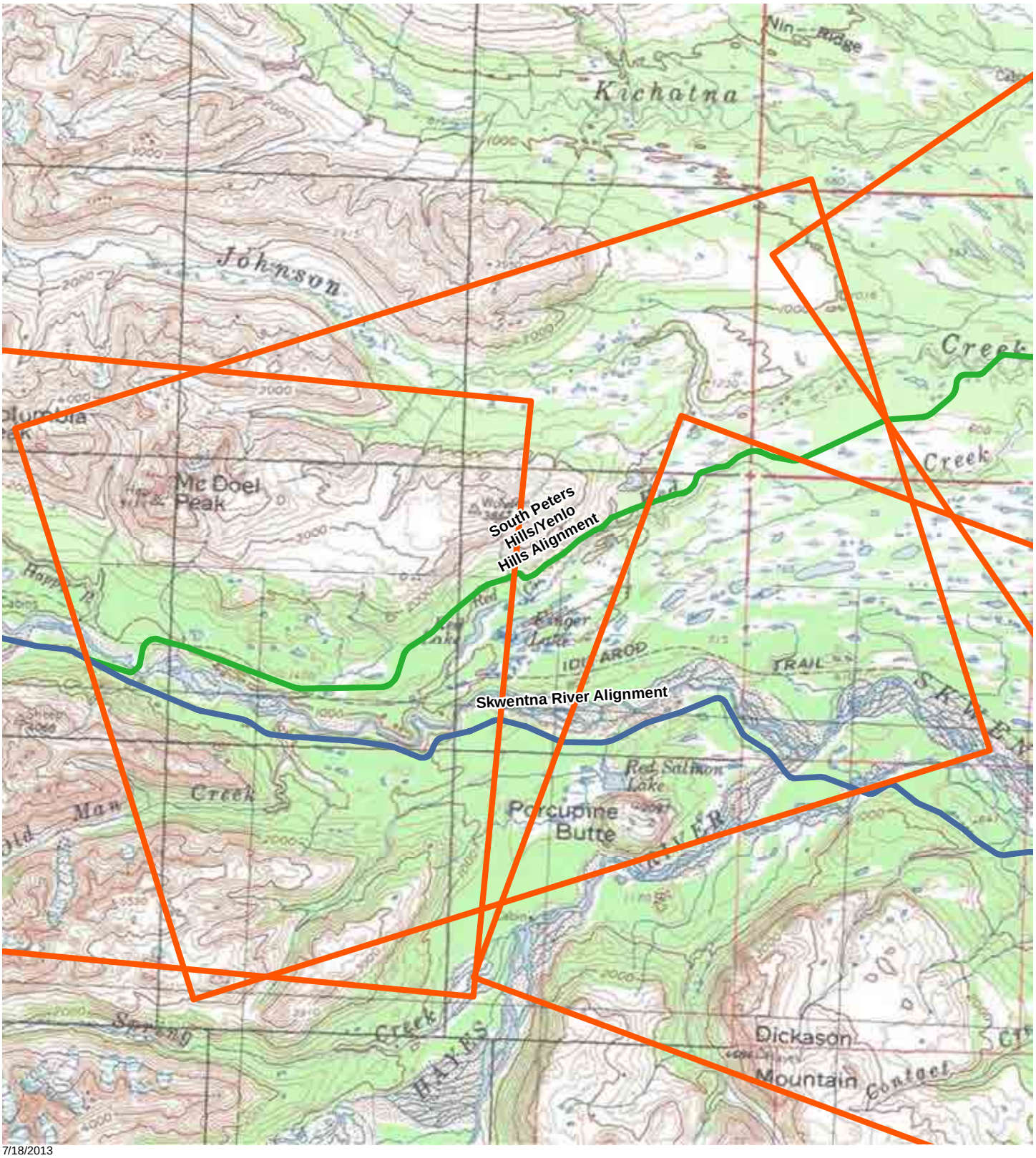

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Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TALKEETNA A-4, A-5 and TYONEK D-5, D-6, D-7 *Map #: 4*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

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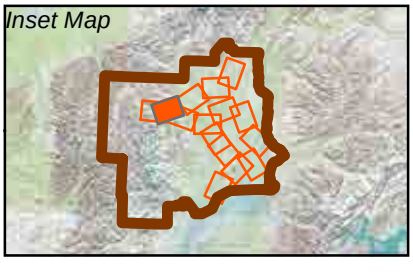

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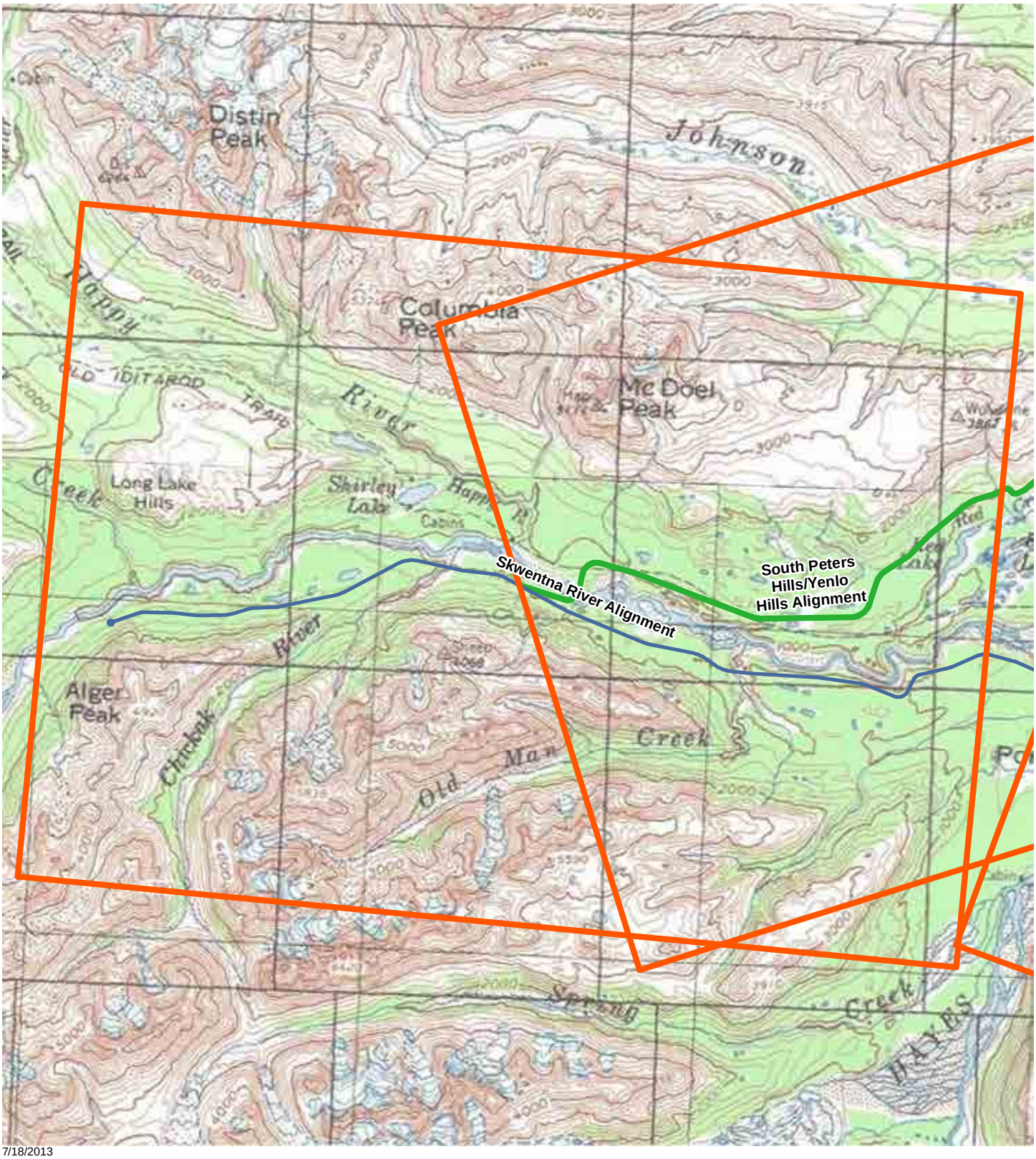

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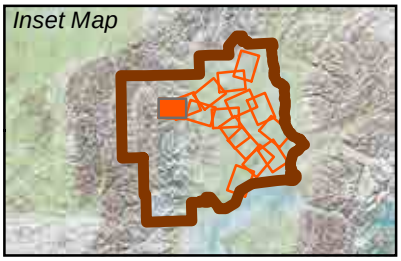
Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TALKEETNA A-5 and TYONEK D-6, D-7 *Map #: 5*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment



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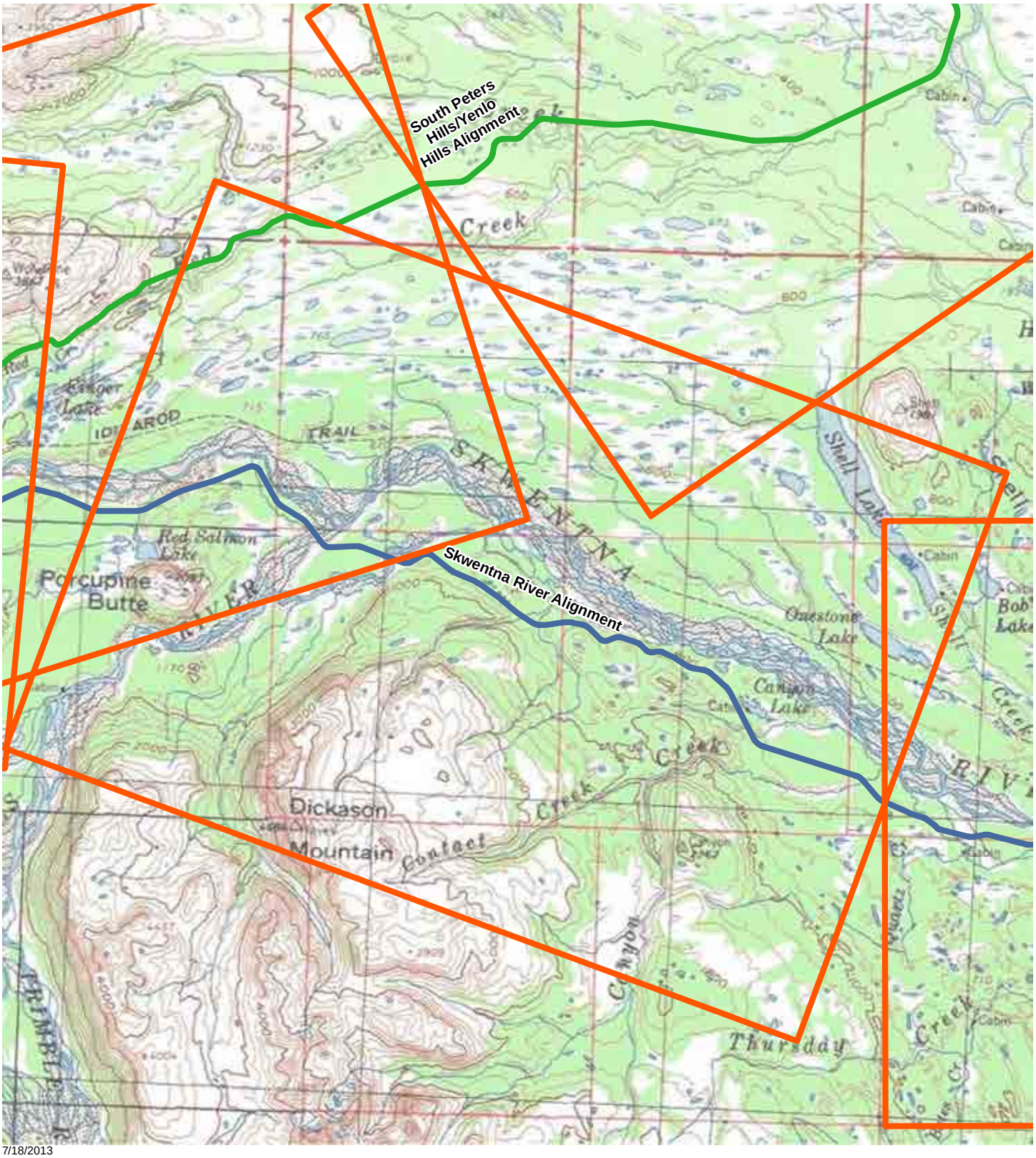

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Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TALKEETNA A-4 and TYONEK D-5, D-6 *Map #: 6*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

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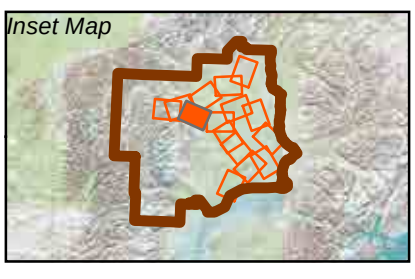

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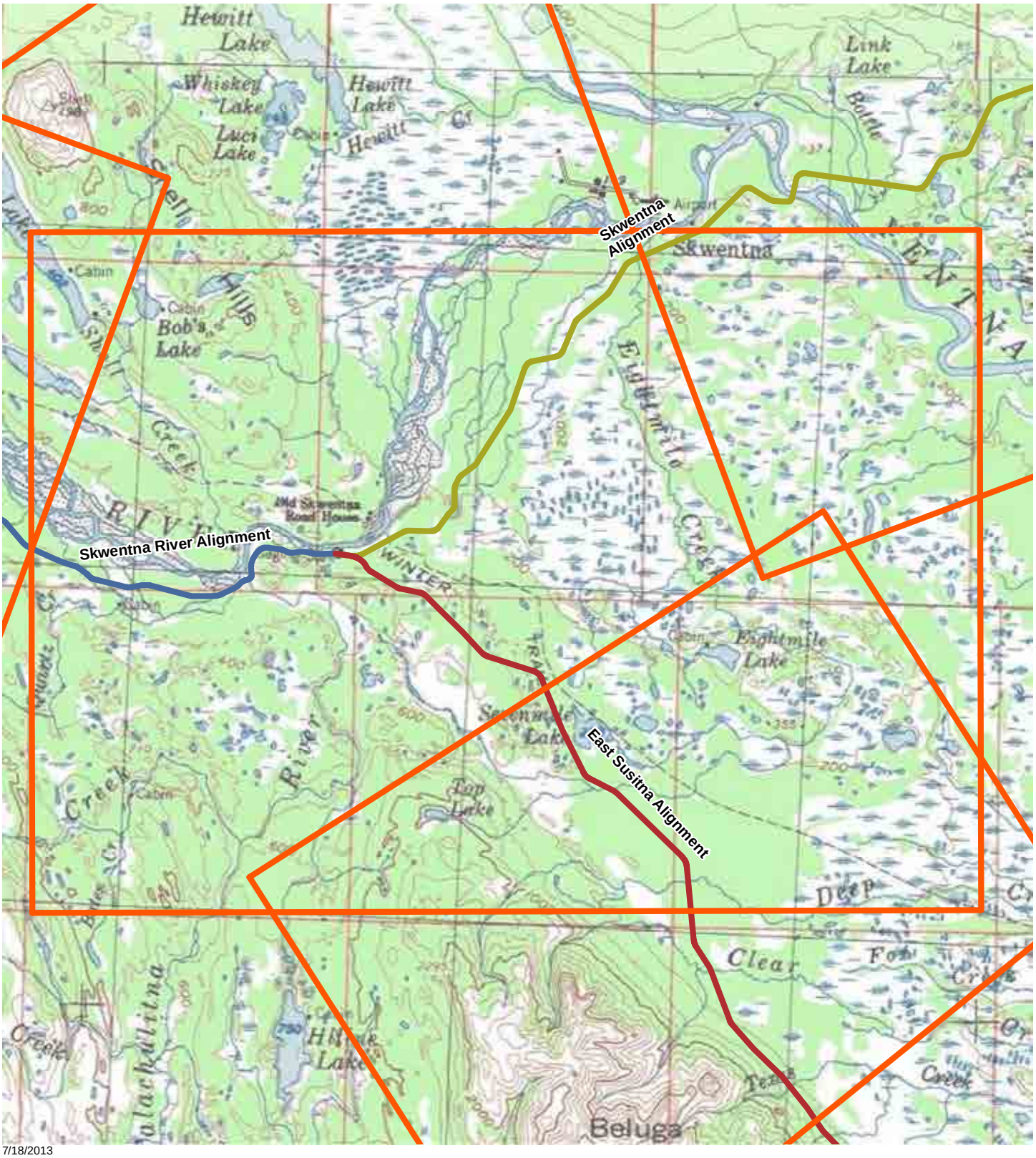

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Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TYONEK D-3, D-4, and D-5 *Map #: 7*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

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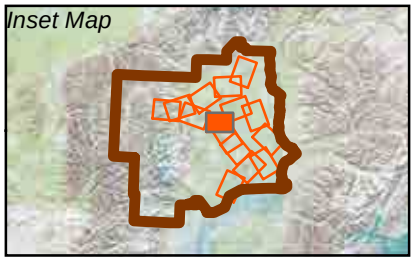

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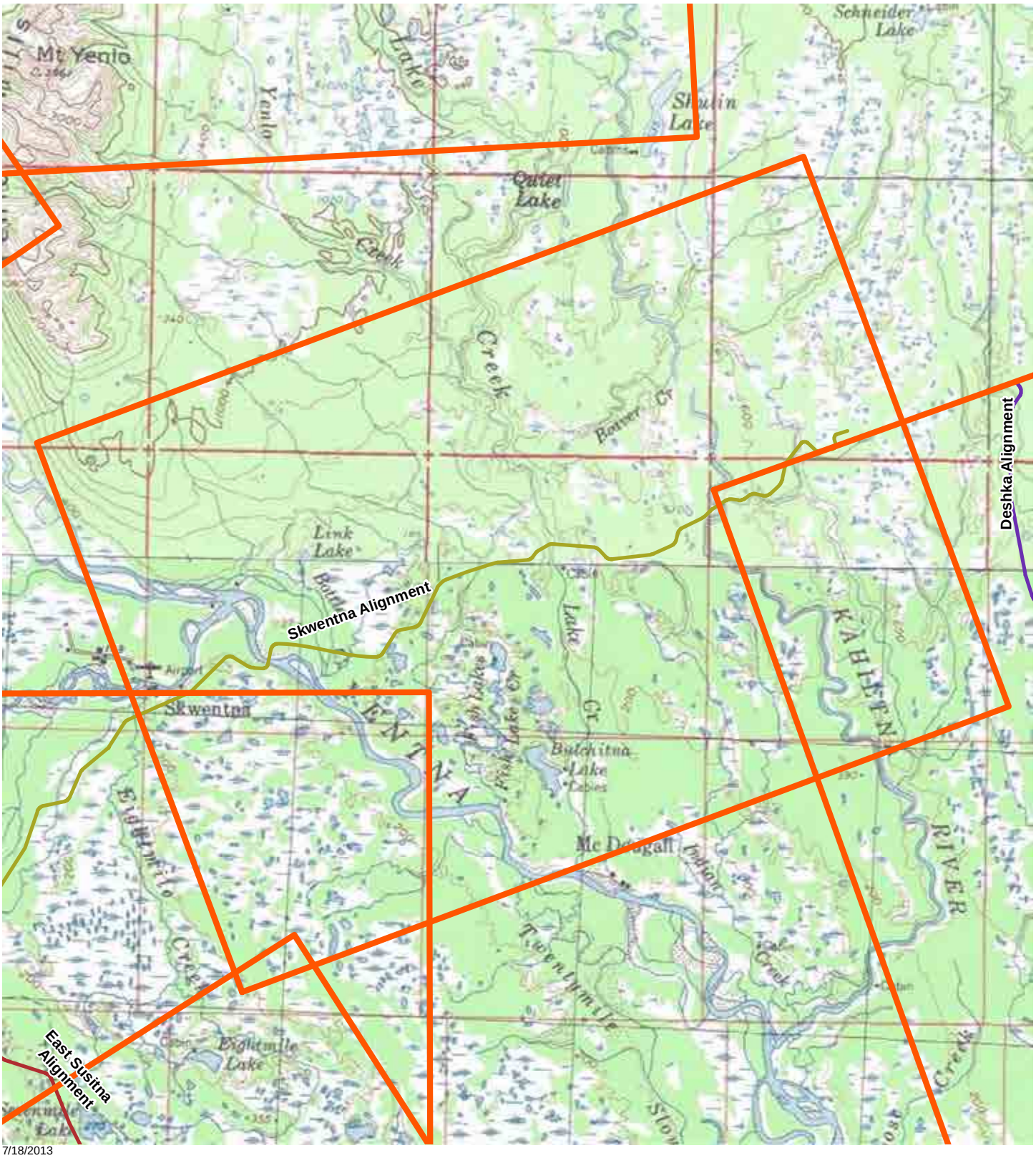

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Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TALKEETNA A-2, A-3 and TYONEK D-2, D-3, D-4 *Map #: 8*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

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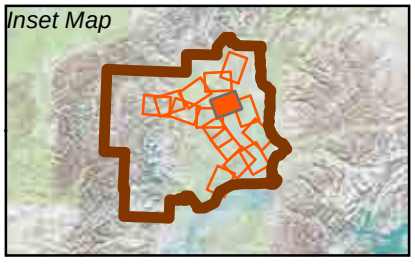

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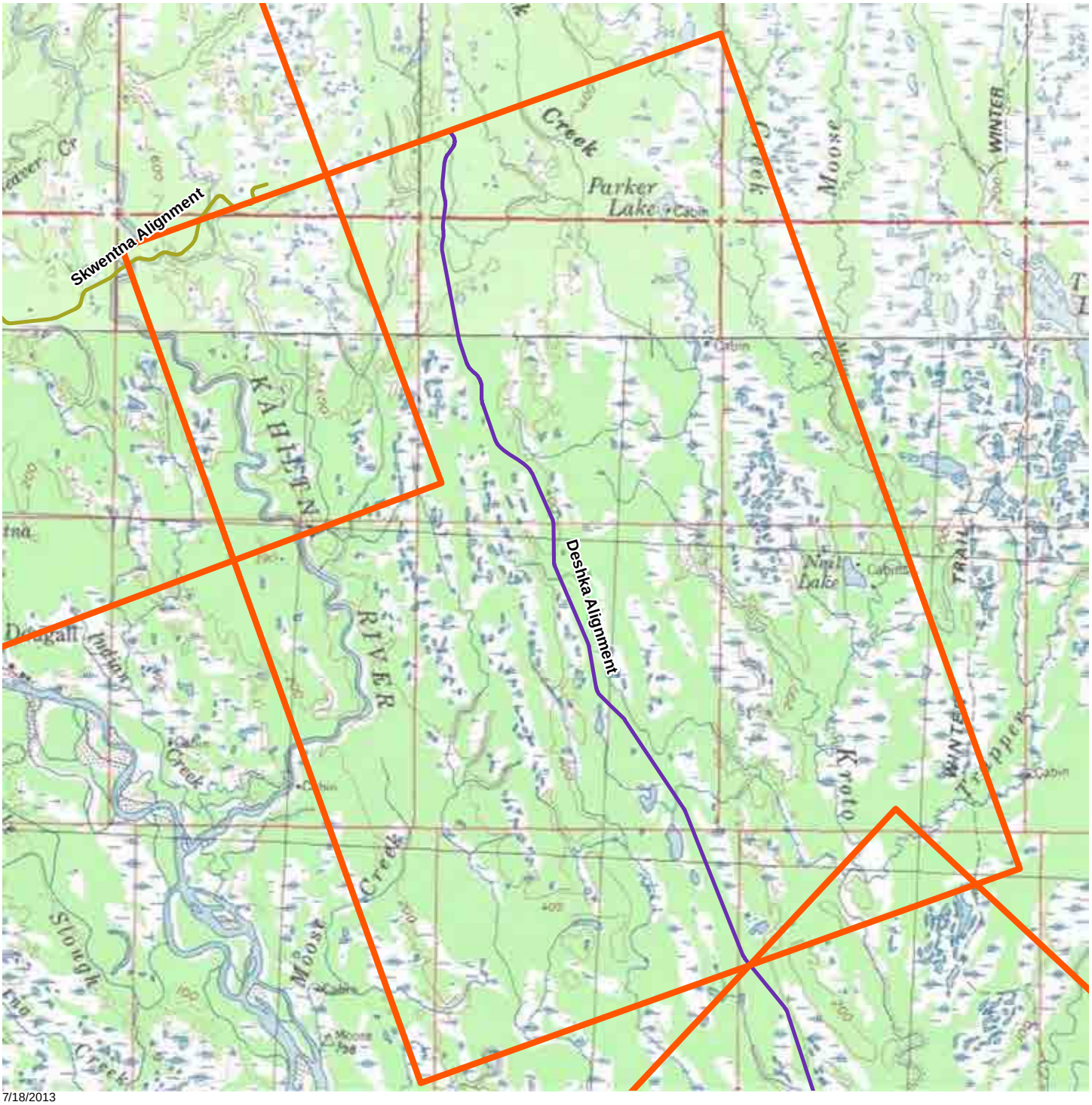

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Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TALKEETNA A-2 and TYONEK D-1,D-2,D-3 *Map #: 9*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

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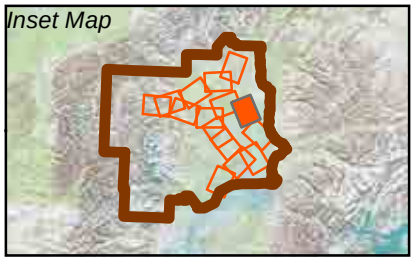

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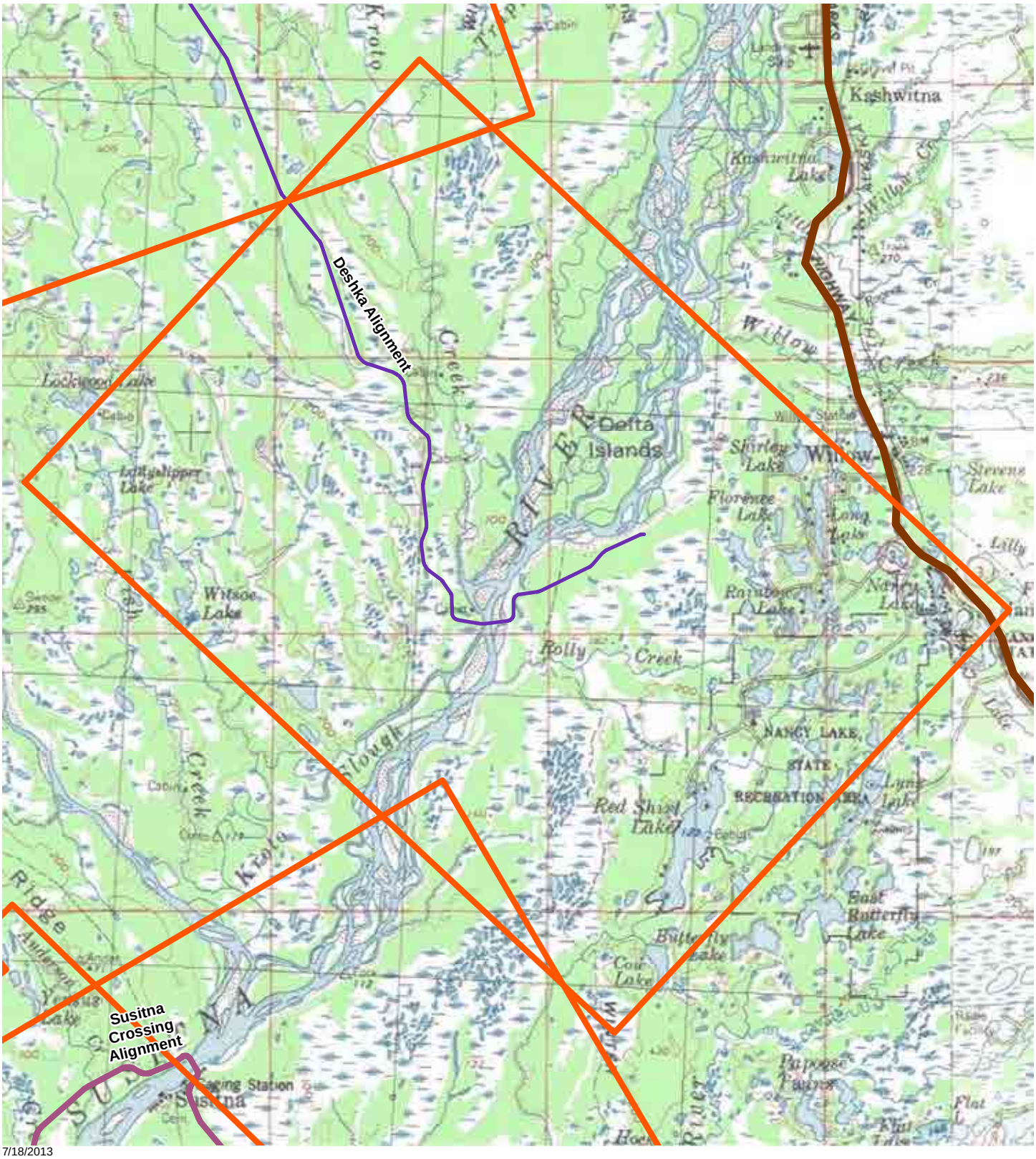

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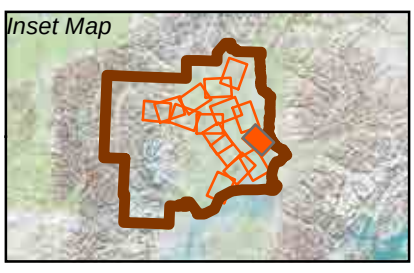
Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TYONEK C-1, C-2, D-1, and D-2 *Map #: 10*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment



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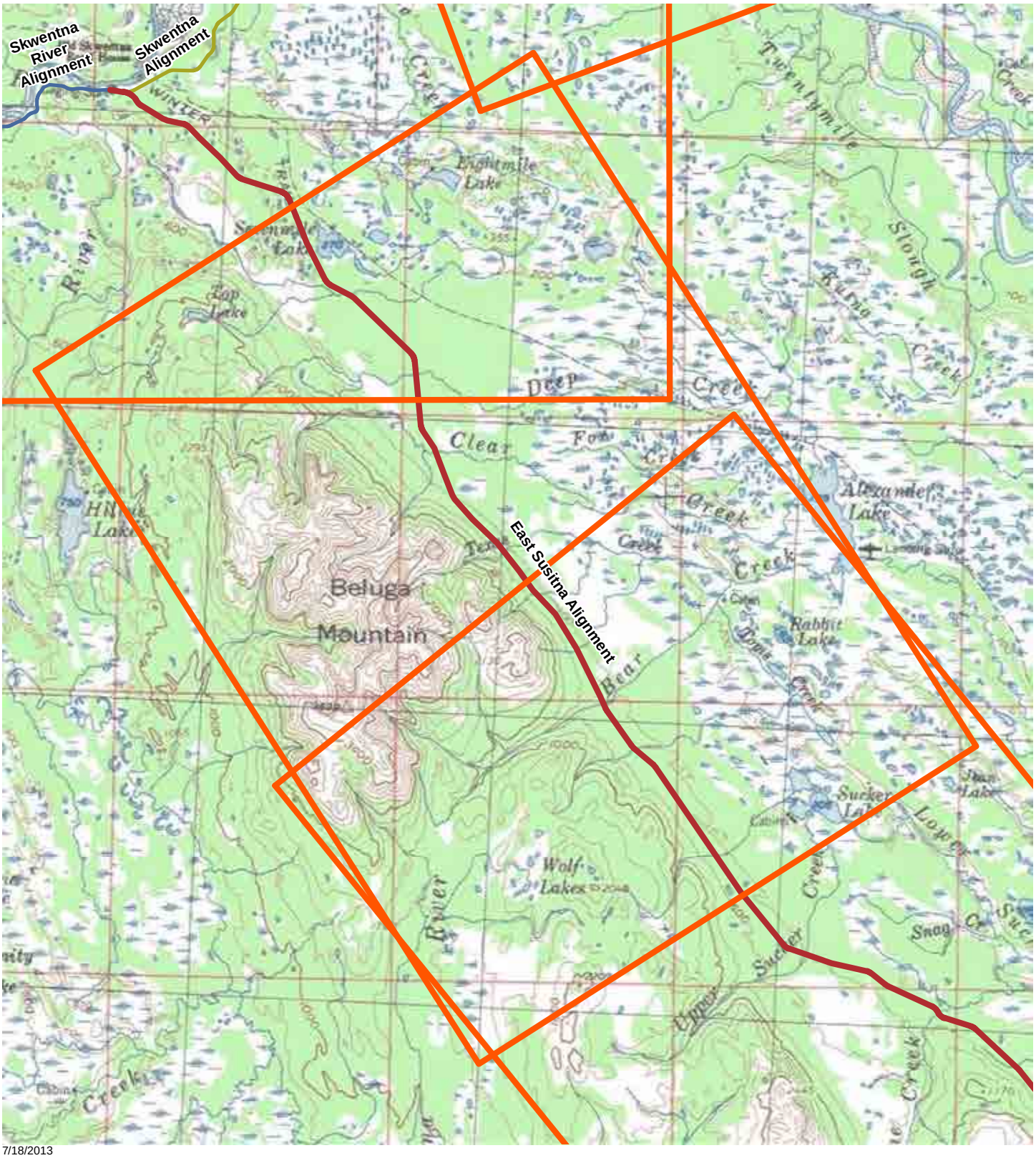


7/18/2013

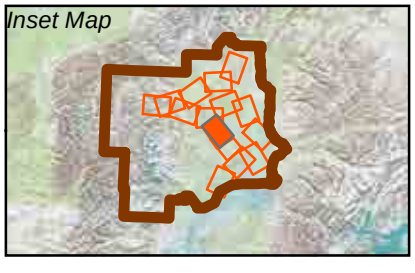
Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TYONEK C-3, C-4, D-3, and D-4 *Map #: 11*

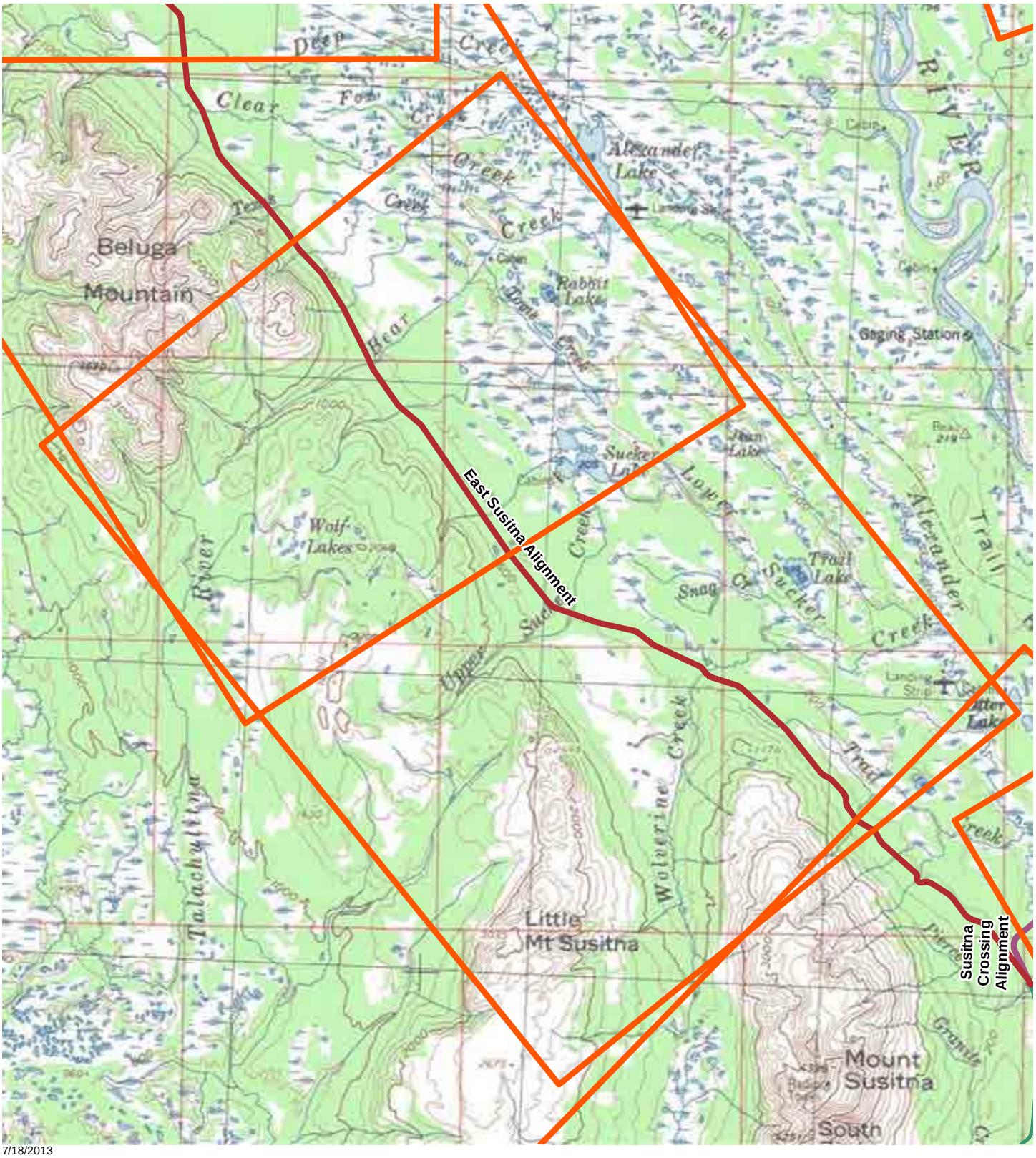
- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

Inset Map



N

0 1.5 3 Miles



7/18/2013

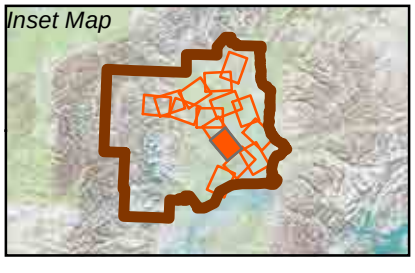
Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TYONEK B-2, C-2, C-3, and D-3 *Map #: 12*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

Inset Map



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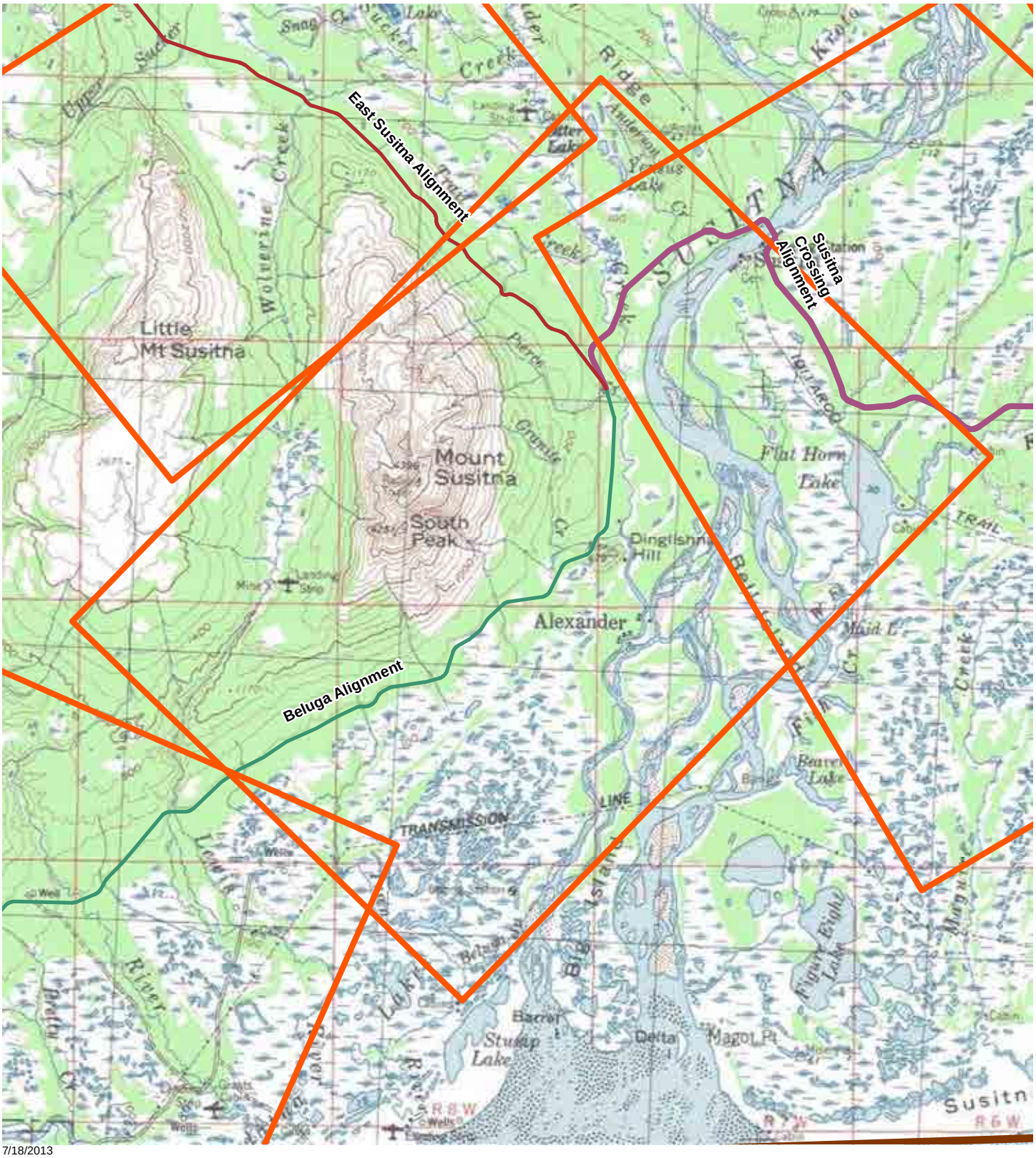


7/18/2013

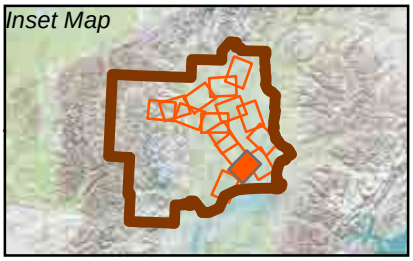
Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TYONEK B-2, B-3, C-2, and C-3 *Map #: 13*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

Inset Map



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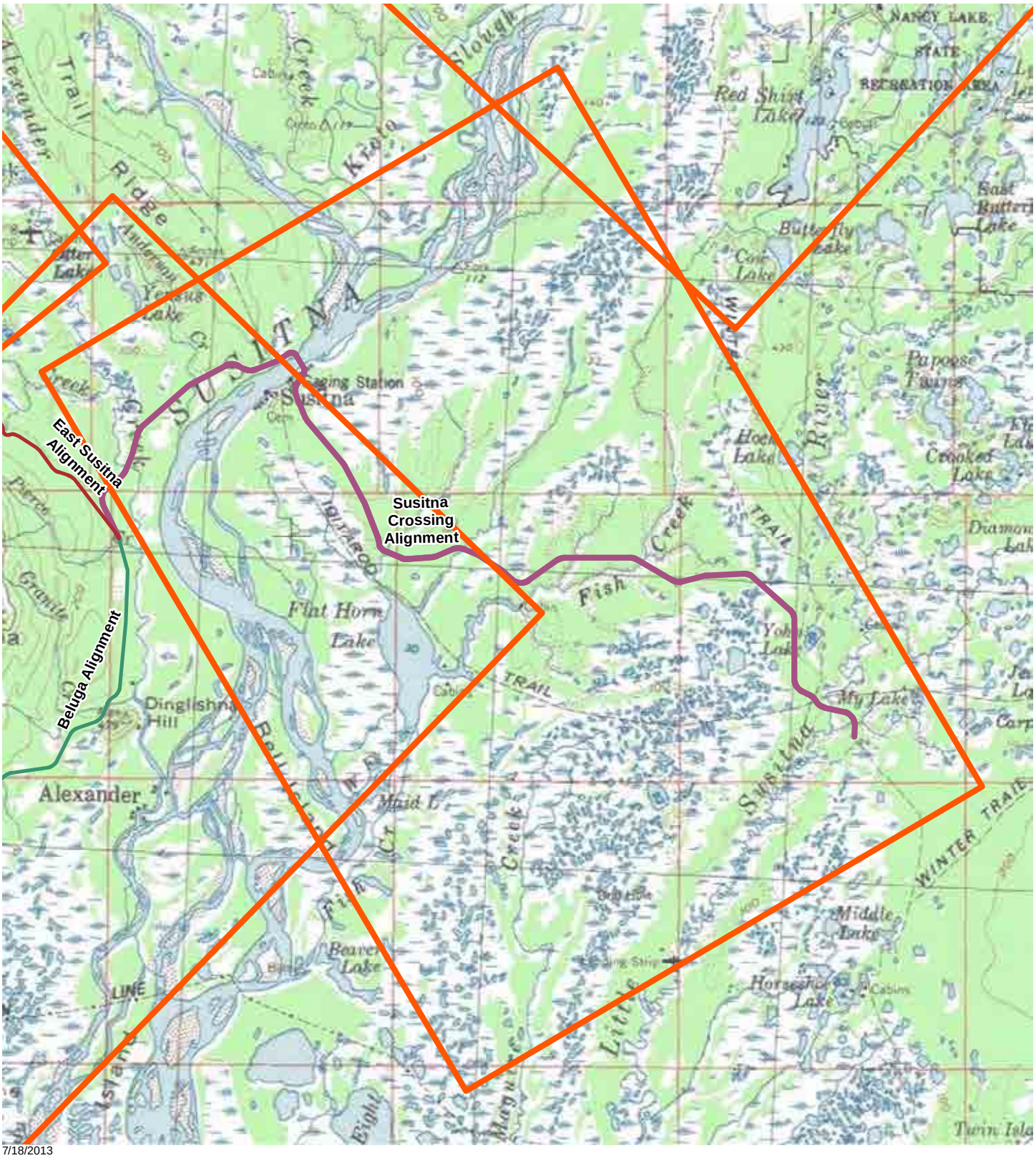


7/18/2013

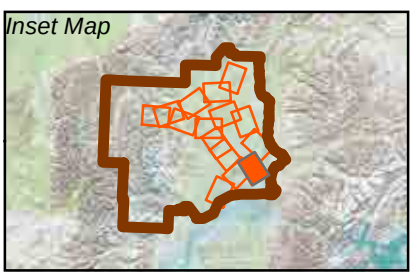
Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TYONEK B-1, B-2, C-1, and C-2 *Map #: 14*

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment

Inset Map



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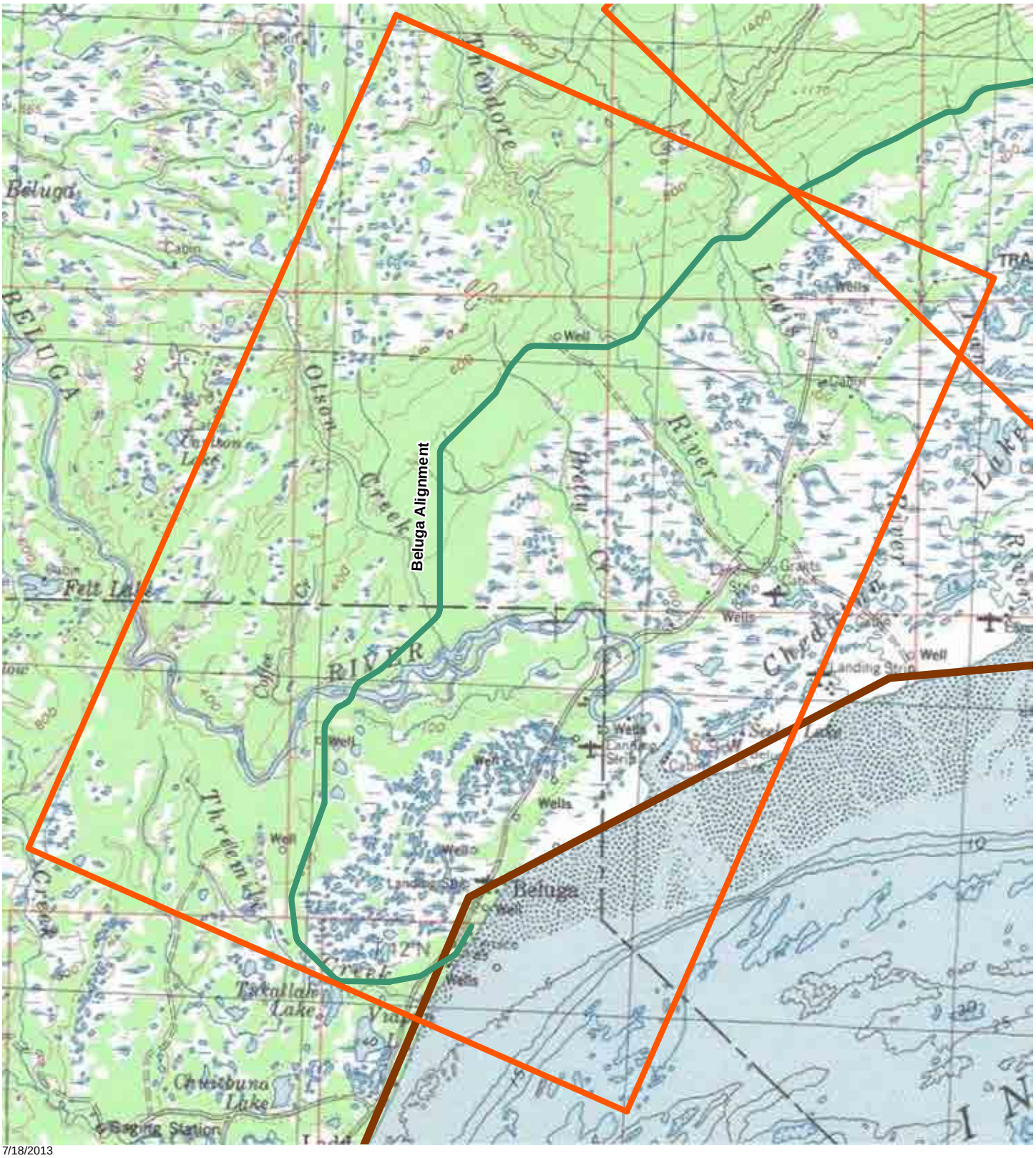


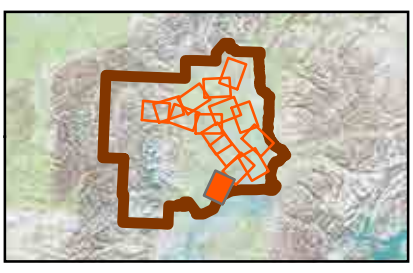
7/18/2013

Proposed Corridor Alignments

West Susitna Access to Resource Development

USGS Quad: TYONEK A-3, A-4, and B-3 Map #: 15

- Study Area
- Alignment Sections
- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment



N

0 1 2 Miles

West Susitna Access Reconnaissance Study
West Susitna Access to Resource Development

Transportation Analysis Report






Appendix C:
Geotechnical Reconnaissance Report

Geotechnical Reconnaissance Report
West Susitna Access
Mat-Su Borough, Alaska

December 2013

Submitted To:

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32-1-02301

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WEST SUSITNA ACCESS
MAT-SU BOROUGH, ALASKA

1.0 INTRODUCTION

This report presents the results of our literature research and geotechnical engineering evaluation for the West Susitna Access project in the Matanuska-Susitna (Mat-Su) Borough, Alaska. The purpose of this study was to perform a geotechnical evaluation of several transportation corridors for the area between the Parks Highway and the Alaska Range. To develop the criteria for use in our evaluation, we reviewed existing geological and geotechnical information from the area. Included in this report are descriptions of the site and project, results of our literature research, and our evaluation of the corridors reviewed during our study. The results of our evaluation will be used to supplement other evaluation criteria, such as construction cost and environmental impacts, in an attempt to evaluate the viability of each corridor for development.

Authorization to proceed with this work was received in the form of a Subconsultant Agreement signed by Duane Hippe of HDR Alaska, Inc. on February 12, 2013. The work was performed in general accordance with the scope of services included in the Subconsultant Agreement.

2.0 PROJECT DESCRIPTION

The West Susitna Access Project is focused on evaluating alternatives for developing transportation corridors to connect road inaccessible lands west of the Parks Highway between Wasilla and Petersville. The overall goal of the project is to evaluate the viability of developing road access into the region to support what the State of Alaska (State) anticipates as potentially significant resource development in the form of timber, mining, oil and gas, and recreation. Given the wide variety of potential developments, there is no single target point for access corridors, but rather many smaller, focus areas within the region. As such, several corridors are being considered, each having different start and end points. It is envisioned that the new roadway or roadways could see a variety of traffic types depending on what is being accessed and whether or not it is a roadway dedicated for industrial use or open to the public.

Our studies included seven unique alignments as shown on the vicinity map on Figure 1. The seven alignments included in our review include the:

- South Peters Hills/Yenlo Hills Alignment,
- Skwentna Alignment,
- Deshka Alignment,
- Skwentna River Alignment,
- East Susitna Alignment,
- Susitna Crossing Alignment, and
- Beluga Alignment

Several of these alignments are combined to provide four alternatives and one variant as shown in the following table.

Alternatives	Corridor Segments
North Petersville	South Peters Hills/Yenlo Hills Alignment
North Skwentna	Skwentna Alignment Skwentna River Alignment
Middle Susitna-Skwentna River	Susitna Crossing Alignment East Susitna Alignment Skwentna River Alignment
Beluga	Susitna Crossing Alignment Beluga Alignment
Deshka Variant	Deshka Alignment

These alignments were generally selected to provide access for potential and existing mining, oil and gas, and forest resources within the region. To accommodate the preliminary nature of this study the project alignments were based on existing land feature mapping provided by the United Stated Geological and Geophysical Survey (USGS) and available topographic data. More detailed plan view maps of each alignment are included on the site plans in Figures 2 through 8 along with narrative descriptions in the sections below.

2.1 South Peters Hills/Yenlo Hills Alignment

The North Petersville Alignment (Figures 2a and 2b) consists solely of the South Peters Hills/Yenlo Hills Alignment and begins at Petersville Road which connects Trapper Creek with Petersville to the northwest. The South Peters Hills/Yenlo Hills Alignment heads west and south and crosses the Kahiltna River, Lake Creek, and the Yentna River to the northwest of the town of

Skwentna. The potential alignment continues west near the foothills of the Alaska Range and terminates after crossing the Skwentna River on the north side of the Tordrillo Mountains. This alignment crosses four major rivers or tributaries and several small drainages and low lying marshlands.

2.2 Skwentna Alignment

The Skwentna Alignment (Figures 3a and 3b) is one of two segments (along with the Skwentna River Alignment) that make up the North Skwentna Alternative. The Skwentna Alignment begins from Oil Well Road which heads south from the Petersville Road approximately six miles from the junction of the Glenn Highway and Petersville Road. The alignment trends to the west/southwest toward the town of Skwentna. The Kahiltna River, Lake Creek, and the Yentna River are the major river crossings for this alignment and several smaller drainages and/or low lying marshy crossings should be expected. The alignment passes through the town of Skwentna and then follows the south side of the Skwentna River until it terminates at the junction of the East Susitna Alignment and the Skwentna River Alignment.

2.3 Deshka Alignment

The Deshka Alignment (Figures 4a and 4b) is the sole alignment in the Deshka Variant and begins from Oil Well Road and heads south parallel to and east of the Yentna and Kahiltna Rivers. The Deshka Alignment crosses the Susitna River (east of Willow) and makes a sharp turn to the east to its junction with the road system near Willow. This alignment parallels the general northwest/southeast trend of the drainages and marshy low lying areas with its only major river crossing being the Susitna River.

2.4 Skwentna River Alignment

The Skwentna River Alignment (Figures 5a and 5b) is part of the North Skwentna Alternative (along with the Skwentna Alignment) and part of the Middle Susitna-Skwentna River Alternative (along with the Susitna Crossing Alignment, the East Susitna Alignment, and the Skwentna River Alignment). The Skwentna River Alignment begins at its junction with the Skwentna Alignment and East Susitna Alignment and follows the south side of the Skwentna River to its termination within the Skwentna River Valley in the Alaska Mountain Range. This alignment is generally at the base of the north side of the Tordrillo Mountains and is contained within the

Skwentna River valley. One major river crossing would be necessary at Hayes River which drains the Hayes Glacier within the Tordrillo Mountains.

2.5 East Susitna Alignment

The East Susitna Alignment (Figures 6a and 6b) is part of the Middle Susitna-Skwentna River Alternative along with the Susitna Crossing Alignment and the Skwentna River Alignment. The East Susitna Alignment begins at its junction with the Susitna Crossing Alignment and the Beluga Alignment and trends in a northwest direction to its junction with the Skwentna Alignment and the Skwentna River Alignment. The East Susitna Alignment is located on the western margin of the Yentna River valley along the base of Mount Susitna, Little Mount Susitna, and Beluga Mountain. To the east of this alignment lies the Yentna River valley and to the west lies the above mentioned mountains. This distinct change in topography is likely due to the Beluga Mountain Thrust fault upon which this alignment lies.

2.6 Susitna Crossing Alignment

The Susitna Crossing Alignment (Figures 7a and 7b) is part of the Middle Susitna-Skwentna River Alternative (along with the East Susitna Alignment and the Skwentna River Alignment) and part of the Beluga Alternative (along with the Beluga Alignment). The Susitna Crossing Alignment begins from West Little Susitna River Road in Big Lake, Alaska and trends to the northwest crossing the Little Susitna River, several marshy low-lying bogs, and the Susitna River (below its junction with the Yentna River). This alignment terminates at the junction with the East Susitna Alignment and the Beluga Alignment on the western flanks of Mount Susitna.

2.7 Beluga Alignment

The Beluga Alignment (Figures 8a and 8b), along with the Susitna Crossing Alignment is part of the Beluga Alternative which provides road access to Beluga, Alaska. The Beluga Alignment begins at the junction of the Susitna Crossing Alignment and the East Susitna Alignment and trends southwest following the western edge of the Susitna Flats State Game Refuge at the base of Mount Susitna. The alignment generally stays in the upland areas and skirts the marshy lowlands of the state game refuge. There would be several potential minor stream crossings and one major crossing at Beluga River. After the alignment crosses Beluga River, it curves to the east and then north to terminate in Beluga, Alaska.

3.0 LITERATURE RESEARCH

Literature research was conducted to find and evaluate the existing subsurface information available for the project area. The primary existing data sources reviewed for this work were existing geologic maps of the area by the USGS. This information, along with large scale landform and terrain evaluation supported by aerial photography provided by HDR was the basis for our evaluations of the access corridors. In general, coverage for the project area is sporadic, likely a result of the relative remoteness of the area. A bibliography of literature that is available for the project area is included in Section 9.0.

4.0 REGIONAL GEOLOGY

The Susitna Lowlands are bound on the north and west by the Alaska Range and bound on the east by the Talkeetna Mountains. The topography is generally flat to rolling hills and gains relief near the foothills of the Alaska Range. Numerous glaciers populate the mountains and extend down valleys to near the edges of the lowlands. Evidence indicates that at least five glaciations played a part in the landscape and deposits that form the lowlands. Glacially carved bedrock, moraines, drumlins, and kettle lakes are a few of the landforms found and continuous erosional processes are constantly reshaping the land. The following sections discuss the regional bedrock geology, soil stratigraphy, tectonics, seismicity, and permafrost conditions. Surficial geology along each of the alignments is shown in Figures 2 through 8. A brief legend to the mapped units is provided on Figure 9.

4.1 Bedrock Geology

Beneath the Quaternary surficial deposits, the bedrock geology consists primarily of Tertiary deposits of the Kenai Group overlying a pre-Tertiary basement complex. The Kenai group represents clastic forearc basin deposits of early and late Cenozoic tectonic cycles and the rocks are characteristic of a fluvial system. The Kenai Group consists of five major formations; the Sterling formation, the Beluga formation, the Tyonek formation, the Hemlock Conglomerate, and the West Foreland formation (from top to bottom). These five formations contain packages of sedimentary rocks including sandstone, claystone, siltstone, conglomerate, and coal beds; with the thickest coal beds in the Beluga and Tyonek formations. Parent rock for the sediments found within the Susitna lowlands include plutonic and metamorphic sources from the Alaska Range to the north and west and from the Talkeetna Mountains to the east.

In addition to the Tertiary sedimentary rocks, the project area also includes Tertiary granites and intermediate to mafic volcanic rocks. Cretaceous sedimentary, igneous, and metamorphic rocks are also found including turbidites, granodiorite, granite, and intermediate to felsic volcanics.

4.2 Quaternary Deposits

Potentially thick sequences of Quaternary sediments derived from glacial and erosional processes are likely present predominantly in the lowlands. Glacially derived soil (glacial drift) materials may consist of till, outwash, and glaciolacustrine sediments. Glacial till is typically randomly sorted and consists of relatively equal fractions of silt, sand, and gravel, along with some cobble- and boulder-sized particles. Outwash materials generally consist of cleaner sand and gravels that may be well or poorly graded. Glaciolacustrine deposits of fine sand, silt, or clay may also be present in localized areas that were once occupied by moraine or glacially dammed lakes.

More recent deposits of sand and gravel are likely present in localized areas throughout stream and river valleys or near alluvial fans as coarse sediments are carried from the nearby mountains. Steep slopes may be covered or skirted by talus as frost wedging pries the bedrock apart. In addition, ash layers have been observed up to 3 feet thick in some places and vegetation suggests that it may have fallen more than 100 to 200 years ago.

4.3 Tectonics and Seismicity

The project region is one of the most seismically active areas in the U.S. and historically subjected to relatively large earthquakes. According to the Alaska Earthquake Information Center, two large (greater than magnitude 7) earthquakes have occurred within or near the project area in 1933 and 1943. Several hundred smaller earthquakes have also been recorded since 1899. Regional seismicity is shown on Figure 10 and much of the information presented in this section is based on Alaska Division of Geology & Geophysical Surveys (DGGS) Miscellaneous Publication 141 (Koehler et.al. 2012).

On a large scale, the tectonics and active seismicity of the region are the result of ongoing north-northwest movement of the Pacific Plate relative to the North American Plate. The relative movement results in a region of right lateral strike-slip faulting along the eastern margin of the Gulf of Alaska and subduction along the central and western margins of the gulf. Along the

eastern margin of the Gulf of Alaska (+ 250 miles southeast of the project area), the relative right-lateral movement between the plates is accommodated primarily by northwest-striking high-angle strike-slip faults (i.e., Fairweather and Queen Charlotte Faults). The right-lateral movement is translated northwest of the gulf into the interior of Alaska along the right lateral Denali Fault system (DFS), which extends through the southern Alaska Range to the north of the project area.

In terms of engineering significance, three broad seismic sources may present hazards in the project area. Nearest the project area, the DFS was responsible for the 2002, magnitude 7.9 Denali Fault earthquake. Associated surface rupture was documented for hundreds of kilometers along the fault trace. The Alaska-Aleutian Subduction Zone, a mega-thrust source at the interface between the North American and Pacific Plates was the source of the 1964, magnitude 9.2 Great Alaska Earthquake.

Other shallow crustal sources such as the Castle Mountain fault on the south end of the Susitna lowlands may also impact the project area. It is postulated that the Castle Mountain fault is capable of producing earthquake magnitudes up to 7.5. Displacement along the Castle Mountain fault is visible in the landforms across the Susitna flats. The relatively recent Pass Creek fault is centrally located in the Susitna lowlands with northeast to southwest trending surface expressions mapped west of Mt. Yenlo and the Kahiltna River. The fault has been identified as a northward dipping reverse fault with displacement of less than 0.2mm per year and most likely will be a source of earthquakes with magnitudes between 4.0 and 6.0. In addition, the Bruin Bay fault has been mapped along the base of Mount Susitna trending northwest toward Beluga Mountain along the mountain front. This fault is a high angle reverse fault with several hundred meters of displacement, but is not considered to be an active fault system.

Given the various sources of ground motions that are associated with this part of Alaska, the types of shaking during seismic events can vary significantly. In addition to the magnitude of the events, the peak ground accelerations as well as duration of shaking can have a significant impact on design of transportation features in this area. Seismic events along the Benioff zone of the Alaska-Aleutian Subduction Zone that lie directly beneath the project area are generated from very deep sources (typically greater than 120 miles below the ground surface). This shaking is caused by large scale rupture along the subducting and overriding plates and is typically characterized by relatively low peak ground acceleration, low frequency, and long

duration seismic events. Such long duration shaking typically effect very large regions and can have significant impacts on soils sensitive to strength loss and liquefiable soils. Shallow-source earthquakes such as the Pass Creek Fault and other faults associated with the DFS tend to create high frequency, high acceleration, and relatively short duration shaking events. Such events can impart very high stresses of structures, can result in significant displacements along the surface expression of the fault, and can also result in localized soil strength loss and liquefaction. Lateral extent of shaking from these sources is typically limited to areas relatively close to the portion of the fault that ruptures.

4.4 Permafrost

Permafrost is defined as soil or rock beneath the ground surface where a temperature below 32 degrees Fahrenheit has existed for two or more years. Permafrost within the project area has been mapped as isolated masses of permafrost, discontinuous permafrost, or be generally free from permafrost. Most of the area along the Susitna River is likely generally free from permafrost. The isolated masses and discontinuous permafrost will likely be found in fine grained soils, whereas course grained soils may be free from permafrost. Thick surface layers of organic soils may also provide insulation for permafrost soils. Permafrost in the project area is likely to be relatively warm and will begin to degrade if the thermal regime is adversely impacted by modifications to the ground surface. Depths of permafrost are variable, especially in areas of discontinuous permafrost, and depend upon exposure, ground cover, soil characteristics, and other factors. The thickness of the active layer (the near-surface ground that undergoes an annual freeze-thaw cycle) is largely dependent on soil type, ground cover, and snow depth. In general, the active layer across the project is likely within the upper 10 to 20 feet below the ground surface.

4.5 Regional Geologic Processes

Regional geologic processes will also have a significant impact on the design and performance of transportation improvements in the project area. Such processes include stream icing, slope instability, flooding (through precipitation, snow melt, and glacial lake outbursts, etc.), and seismic influences (e.g. ground motions, liquefaction, lateral spreading, etc.). Many of these processes are complementary and should be evaluated separately as well as in relation to each other. For example, seismic influences such as liquefaction can cause damaging settlement, but

can also contribute to slope instability and flooding. Similarly, flooding can produce damaging erosion and deposition of material, but can also instigate slope instabilities (in previously stable areas) through erosion. It is our opinion that the entire study area is subject to most, if not all, of these regional processes, however, some areas may be more prone than others. In general, the flooding, icing, and seismic influences will be more prevalent in low-lying areas and in areas near streams and floodways. Glacial outburst flooding will be difficult to predict, but can influence areas well outside of natural river floodways for relatively large distances below existing glaciers. Seismic influences will also more significantly impact areas adjacent to or on sloping ground, with greater severity on steeper gradients.

5.0 GEOTECHNICAL ENGINEERING CONSIDERATIONS

We developed a system of geotechnical criteria in order to evaluate the geotechnical conditions along each of the potential alignments. These criteria range from the availability and quality of borrow materials along the alignment, subgrade and foundation support, drainage, permafrost and other conditions. In essence, the geotechnical criteria included in our evaluation were selected because it is our opinion that they are the geotechnical criteria that will have the most significant impact on the design, construction, and cost of the project. We performed a broad-based evaluation of each proposed alignment using these criteria based on the subjective point value system described in the following table.

Criteria	Optimum Condition (1 point)	Poorest Condition (5 points)
Rock Borrow Availability	Majority of potential sources are likely less than 2.5 miles from alignment or spaced less than 2.5 miles along alignment	Majority of potential sources are likely greater than 5 miles from alignment or spaced greater than 5 miles along alignment
Rock Borrow Quality	Majority of potential sources likely to yield massive, durable rock	Majority of potential sources likely to yield poor quality, low durability rock
Soil Borrow Availability	Majority of potential sources are likely less than 2.5 miles from alignment or spaced less than 2.5 miles along alignment	Majority of potential sources are likely greater than 5 miles from alignment or spaced greater than 5 miles along alignment
Soil Borrow Quality	Majority of potential sources of available borrow likely to consist of Selected Material Type A or B	Majority of potential sources of available borrow likely to consist of Selected Material Type C
Foundation Support	Majority of structural foundations likely to be on non-erodible, competent bedrock	Majority of structures will likely to require deep foundations accommodating soft or liquefiable soils
Permafrost Conditions	No expected permafrost or majority of frozen soils are expected to be thaw stable	Significant extents of thaw-unstable permafrost conditions expected
Subgrade Support	Average subcut expected to be less than 2 feet below existing ground surface	Average subcut expected to be greater than 5 feet below existing ground surface or extensive subgrade improvement anticipated
Drainage	Average groundwater conditions expected to be deeper than excavation limits in cuts and greater than 10 feet below the ground surface in fills	Average groundwater conditions expected to be above excavation limits in cuts and near the ground surface in fills

Detailed descriptions of each criterion are provided in the sections below. These criteria were used to frame the engineering discussions for each potential alignment provided in Section 6.0. The point values assigned to each criterion for the proposed alignments are also provided in Section 6.0.

5.1 Rock Borrow Availability

Rock material source availability addresses the proximity of rock materials to the corridors studied for this project. Rock materials will be an important resource for the construction of the proposed access road and associated facilities and structures. Material produced from quarries can be used in a wide variety of applications from embankment development, concrete and/or asphalt aggregate, revetment, and surfacing material. The proximity of the rock materials is important because the distance that the material will need to be hauled during construction will have a direct impact on the cost of construction. If rock material is not available adjacent to the roadway, additional access roads may be needed to access potential sources which would also have an impact on the cost of the improvements and will increase the footprint of the project. For successful completion of this project, it will be essential that the final corridor selected will have multiple sources of rock material along its full length. These sources will ideally be located adjacent to the final road alignment and will require minimal development of access branch roads to access them.

5.2 Rock Borrow Quality

Borrow rock quality addresses the rock material types that will be available along each corridor for construction of the road and associated facilities. Rock material quality is important to the project because some of the uses for the rock will require the material to be durable (i.e. resistant to mechanical degradation). In general, rock material that is used in the construction of this project will need to meet the various durability requirements set forth in ADOT&PF standards depending on its application (aggregate, rip-rap, etc.). The highest quality, most durable materials should be used in the production of aggregates and rip-rap, while lower quality materials can be used in embankment construction as shot-rock fill. Typically, intrusive igneous rocks such as granite and diorite yield very high durability values. Extrusive igneous rocks (such as basalt) and lightly metamorphosed rocks (such as phylite) typically have somewhat lower durability characteristics. Highly metamorphosed rocks such as schist as well as sedimentary rocks usually have the lowest durability values. The selected corridor should have rock sources that produce high durability materials that can be developed into rock materials of a wide variety of sizes. High quality sources will reduce the construction costs by reducing the need to import higher durability materials from long distances.

5.3 Soil Borrow Availability

Soil borrow source availability addresses the proximity of soil materials to the corridors studied for this project. Soil borrow materials will be an important resource for the construction of the proposed access road and associated facilities and structures. Soil borrow materials will likely be most widely used to provide embankment fill materials and as structural fill for the roadway. It could also likely be used in producing fine aggregates and as structural fill around drainage structures, culverts, bridges, and in utility trenches. As with rock materials sources, the proximity of the soil borrow sources with respect to the proposed roadway will have a direct impact on construction costs. Sources that are farther from the proposed roadway will have longer haul times and will increase the footprint of the project. To complete the construction of this project, the final corridor selected will need multiple sources of soil borrow along its full length. As with the rock material sources, the soil borrow sources should be located adjacent to the final road alignment so that additional branch roads are not needed for access.

5.4 Soil Borrow Quality

Borrow soil quality addresses the soil material types that are available in the soil borrow sources along each corridor. While soil availability is important, the quality of the material that is available will also impact the cost of the project. Ideally, soil borrow used for this project will consist of clean (low fines content), well graded sand and gravel. Such material will most likely be found in outwash and/or alluvial deposits as well as some moraine deposits. This material would lend itself well to development of structural sections for the road as well as structural fill around bridge and culvert foundations. Poorly graded soils or soils with higher fines content (such as those found in glacial till or moraine deposits) may also be utilized, but their applications will be limited to deep embankment development. Regardless of the gradation of the soil fill used, it should not contain free ice, organic detritus, or a significant amount of plastic fines. Higher quality soil borrow resources along the project corridor will have a positive impact on the construction cost. The high quality materials will require less processing (washing, screening, etc…), and if they are located at regular intervals along the alignment, they will not need to be imported from long distances. Ideally, the final selected corridor will have multiple, high quality soil borrow sources along its full length.

5.5 Foundation Support

Foundation support addresses the overall likely subgrade support for structure foundations along the various corridors. From a foundation support standpoint, the most ideal condition is a foundation supported on shallow, competent bedrock. Less ideal conditions range from soft bedrock and/or dense soil support to thick deposits of soft and/or compressible mineral and organic soils that require deep foundations. Other less ideal conditions include thaw unstable permafrost and liquefiable soils. In general, the poorer the foundation support conditions are, the deeper the foundation systems will need to be to transmit structural loads to the subsurface. The cost advantages to selecting a corridor with ideal foundation support conditions is obvious in that shallower foundations require significantly less materials and effort to construct. Ideally, the corridor that is selected will traverse ground that lends itself to development of relatively shallow foundations on bedrock and/or dense, stable, mineral soils.

5.6 Permafrost Conditions

Permafrost conditions addresses the state and nature of frozen ground under the various corridors studied for this project. The proposed improvements will have an impact on the thermal regime that exists along each corridor that will likely result in warming of the ground under and around the new road. Based on the location of this project, it is likely that the majority of the ground beneath each alignment is not frozen continuously throughout the year. If permafrost conditions exist in a given area, it is more favorable if the soil consists of materials that do not lose a significant amount of strength when they are thawed. Such conditions will likely include shallow bedrock and dense soils that have low fines content. Unfavorable conditions include poorly drained soils, fine grained soils, and permafrost conditions with large amounts of segregated ice. Such soils are subject to long term creep under foundation and/or slope loading and typically lose a significant amount of strength when thawed. Having favorable permafrost conditions along the selected corridor will have a cost benefit as measures (such as insulation and refrigeration) will not need to be taken to maintain the thermal balance under the roadway and associated structures.

5.7 Subgrade Support

Subgrade support addresses the general support capabilities of the subsurface materials along each corridor considered for this project. In general, favorable subgrade support conditions

consist of shallow bedrock and/or firm, well drained mineral soils. Poor conditions include thaw unstable permafrost and thick deposits of soft and compressible (mineral or organic) soils. Favorable subgrade support conditions will have a positive impact on construction costs in several ways. Firm subgrade support typically provides more ideal construction conditions and presents fewer constructability challenges since conventional equipment can be used. Furthermore, firm subgrade support circumvents the need for costly subgrade improvement such as excavation and replacement of unsuitable soils, and typically results in thinner embankments and structural sections. Additionally, ideal subgrade support conditions allow for steeper embankment slopes that require less material to construct, and result in a smaller project footprint.

5.8 Drainage

Drainage addresses the general surface and near-surface drainage characteristics of each corridor considered for this project. Well drained conditions are usually found in free-draining soils and in topography that is sloped to allow for the conveyance of surface water. Poor drainage is typically encountered in flat terrain with soils that do not allow for infiltration of surface water (such as in peat bogs or in permafrost terrain). In general, well drained ground conditions typically result in favorable support conditions for new roads and structures. Development of roadways in poorly drained areas result in higher costs associated with designing and constructing additional drainage provisions in the form of culverts and/or porous embankments. Additional costs may also be associated with development of embankments and structures with poor subgrade support in these areas.

6.0 ALIGNMENT-SPECIFIC ENGINEERING CONSIDERATIONS

In order to select the favored alignment, a general understanding of the geotechnical framework of each considered alignment (except for the South Alignment alternatives) is needed. The table below presents the results of our subjective evaluation of each alignment based on the geotechnical criteria discussed in Section 5.0.

Criterion	South Peters Hills/Yenlo Hills	Skwentna	Deshka	Skwentna River	East Susitna	Susitna Crossing	Beluga
Rock Borrow Availability	3	5	5	2	1	4	4
Rock Borrow Quality	4	5	5	2	2	2	2
Soil Borrow Availability	1	2	1	1	2	3	2
Soil Borrow Quality	3	2	2	1	2	3	2
Foundation Support	3	4	3	3	2	3	3
Permafrost Conditions	3	2	1	2	3	1	1
Subgrade Support	3	4	2	2	2	4	2
Drainage	2	4	2	1	2	4	2
Point Tally:	22	28	21	15	16	24	18

Each alignment has unique characteristics and crosses a wide variety of terrain and geological conditions. The discussions below highlight aspects of each alignment that are favorable for development, as well as those that may present a design and/or construction challenge. Because of the scale of this project and the fact that very limited subsurface information exists for this area, the information contained in the following sections should be considered preliminary and used for general planning purposes and route evaluation only. Further reconnaissance, explorations, and engineering analysis will be needed to identify specific borrow sources, identify an alignment route, and develop engineering recommendations for the project.

Regardless of the route or routes selected, a significant amount of design level explorations will be needed to provide the parameters for a final design. Geotechnical explorations should consist of standard soils and rock investigations and should also include an effort to map existing fault traces on the ground surface. In addition, a probabilistic seismic hazard analysis (PSHA) will need to be conducted to evaluate ground motion parameters that will be needed in the design of the project. Given the potential route lengths and seismic variability of the project area, it is likely that several PSHAs will be needed depending on the route or routes selected and the structural features to be constructed. The PSHA results will be used to provide ground motion design parameters and in evaluation of seismic effects such as liquefaction, soil strength loss, and slope stability evaluations.

6.1 South Peters Hills/Yenlo Hills Alignment

This alignment generally trends east to west and typically follows topographic highs where possible, particularly in the eastern half of the alignment. The long axes of landforms (ridges,

hills, valleys, etc.) over which the alignment traverses largely trend northwest to southeast, reflecting the general flow of past glaciation in the region. Much of the eastern two thirds of the alignment is characterized by low (less than 100 feet tall) topographical highs separated by low, poorly drained, boggy areas. Because the eastern two thirds of the alignment's orientation does not follow the overall topographical orientation, there are many areas where the alignment must cross the topographic highs and lows which presents a challenge for developing stable roadways over variable support soils. This is especially true around the crossings of the Kahiltna and Yentna Rivers which flow in the bottoms of wide, glacially incised valleys. Given the variable terrain, it is anticipated that drainage along the alignment is generally good except for the interspersed wetland areas that will be crossed.

Soil availability along the alignment is anticipated to be relatively abundant along the alignment given terrain features. The alignment should be able to take advantage of numerous short cut sections that are likely adjacent to short fill sections over boggy areas. However, given the glacial origin of the soils, it is likely that the soil quality will be variable and could have elevated fines contents. However, glacial outwash and alluvial deposits (of which there are several mapped along the alignment) could yield potentially high quality, low fines content, well graded sands and gravels that could be used as structural fill for road sections. Rock materials are anticipated to be scattered relatively widely along the alignment, with more availability along the west end of the alignment. Much of the bedrock material along the alignment is mapped as metamorphosed sedimentary materials which tend to be somewhat lower quality on average. These materials may be reliably used for embankment/fill development and potentially aggregate for higher durability materials.

Foundation conditions at major river crossings along this alignment are not anticipated to be on bedrock, but are likely good given that much of the soils along the alignment have been glacially overridden. It is likely that major bridge structures will need to be supported by pile foundations, but piles will likely not need to be driven to great depths (more than about 60 to 80) feet to reach competent support soils. Unconsolidated alluvial or organic soils that are susceptible to liquefaction or consolidation are likely relatively thin at major bridge crossing locations.

The potential for permafrost along this alignment is likely the greatest in comparison to other alignments in this study. Permafrost soils can be expected in higher elevations and on the north side of topographic high areas. Some of the low, poorly drained, boggy areas may also be

underlain by permafrost soils. In general, permafrost is likely relatively warm and deteriorating in this area which will result in ongoing settlements of roadways constructed over these soils. Other geologic hazards along the alignment consist of isolated areas of potentially liquefiable soils that may be susceptible to lateral spreading or seismically induced settlement near river features. In addition, although the surrounding terrain is generally relatively subdued along the alignment, there may be isolated areas of slope instability in soil slopes near deeply incised river channels (or river terraces near major rivers) that will need to be addressed in design.

6.2 Skwentna Alignment

The Skwentna Alignment generally runs east-west along lowlands around the Yentna and Skwentna Rivers. The topographic trend in this area is also mostly northwest to southeast and low-lying, boggy areas (though relatively small individually) are very prevalent along the alignment. Subgrade support is anticipated to be highly variable, and drainage in the boggy areas may be a challenge in design and construction. Soil borrow materials are anticipated to be relatively abundant over most of the alignment, and there is the potential for relatively high quality soil materials to be available, especially in glacial outwash and frequent alluvial/terrace formations that are mapped along the alignment. Rock sources are not anticipated to be readily available along this alignment.

Foundation conditions at major stream crossings at Indian Creek and the Yentna River are anticipated to be relatively good. Pile foundations will likely be needed at these crossings to support structures and the potential exists for significant thicknesses of alluvial material in these areas. While alluvial materials are generally good foundation soils, if they have low fines content and are not of sufficient density, they may be susceptible to liquefaction. Pile foundations are suitable to support structure in these conditions; however, they may need to be relatively deep (greater than approximately 80 to 100 feet) if potentially liquefiable soils are encountered.

Permafrost soils are not anticipated to be encountered along this alignment. The most likely geologic hazard anticipated along this alignment is likely associated with seismically induced ground failure. Sandy soils with low fines content (like those likely to be encountered in outwash and alluvial deposits) that are of insufficient density could liquefy under seismic shaking. Liquefaction will result in rapid soil strength loss which could cause differential

settlement and lateral spreading. Most of these hazards will be able to be addressed by route selection and embankment design, but risk of damage to bridge foundations at stream crossings will be a more significant factor that will need to be addressed in design.

6.3 Deshka Alignment

The Deshka Alignment generally runs southeast to northwest from Willow to the existing Oil Well Road. In general, the alignment follows the dominant topographic orientation and, though it crosses ground that is similar to the Skwentna Alignment, it is oriented in such a way as to follow relatively low relief (less than 50 to 100 foot tall) ridges that parallel the Deshka River. Because of this orientation, we believe that the support conditions under new embankments will be relatively good consisting of mineral soils with relatively few and isolated areas where bog crossings are needed. We believe that soil borrow sources along the alignment are likely abundant, but most of the soils along the alignment are mapped as various glacial-type deposits that may not provide a reliable source of high quality (low fines content, well graded sands and gravels) soil borrow materials. We do not believe that rock borrow sources are available along this alignment.

Because of the alignment's orientation, few stream crossings will be needed; however, this alignment does include a Susitna River crossing just south of the mouth of the Deshka River. Based on existing geologic mapping, it is likely that the bridge crossing over the Susitna River will require pile foundations that may need to extend relatively deeply (greater than 100 feet) if the alluvial soils in this area are susceptible to liquefaction. Furthermore, scour depths in the Susitna River are likely relatively deep and the channel may migrate with time, which could also require piles to be driven deeply.

Permafrost soils are not anticipated on this alignment and geologic hazards are likely to be limited to potential liquefaction near the Susitna River.

6.4 Skwentna River Alignment

The Skwentna River Alignment generally runs east-west along the south side of Skwentna River. Based on geologic mapping, the alignment generally traverses well drained, alluvial terraces between the river and mountainous terrain to the south. It is likely that soil borrow materials along most of the alignment are abundant and of relatively high quality. In addition, rock

materials in the highlands south of the alignment are also readily available and (based on mapping) appear to consist of a mixture of igneous and metamorphosed sedimentary rocks. In general, it is likely that the igneous materials will likely yield higher quality, more durable rock than the metamorphic rocks. High quality rocks will likely be suitable for aggregates while lower quality materials will be more suitable for embankment fill development.

The alignment contains one major stream crossing (Hayes River) and several smaller drainages flowing south to north into the Skwentna River cross the alignment. The foundation support conditions for these crossings will likely be relatively favorable and will likely consist of pile foundations in alluvial soils with the potential for shallow foundations on rock along the western end of the alignment. The major crossing at Hayes River approximately midway along the alignment may be able to be positioned in such a way as to take advantage of potentially shallow bedrock for foundation support on both sides of the river. Though it does not appear that bedrock is exposed at the ground surface, relatively shallow pile foundations may be able to be socketed into bedrock if it is shallower than 50 feet.

Permafrost soils may be encountered along the western half of this alignment where it comes within close proximity to mountain slopes to the south. However, given the anticipated relatively high-energy environment, alluvial soils that likely exist in this area, if permafrost soils are present, are likely thaw stable and should not be difficult to account for in the design. Other geologic hazards along this alignment consist of liquefaction potential of alluvial soils adjacent to the stream crossings.

6.5 East Susitna Alignment

The East Susitna Alignment travels southeast to northwest along the bases of Mount Susitna, Little Mount Susitna, and Beluga Mountain. Based on mapping, the alignment generally traverses the boundary between exposed or shallow bedrock in uplands to the southwest and various glacial deposits in the lowlands to the northeast. Mapping and landforms suggest that the soil deposits are variable ranging from glacial tills, outwash, and isolated alluvial deposits which should yield a variety of soil materials with variable quality. Given that most of the alignment traverses sloping terrain, it is anticipated that the ground is relatively well drained, except for a few isolated low-lying boggy areas near the middle and north end of the alignment. Mapping shows that most of the rock materials that comprise the hills to the southwest consist of

metamorphosed volcanic and sedimentary rocks. Rock quality and durability from these types of rock can be highly variable, but at a minimum should provide materials suitable for embankment development.

Several minor stream crossings exist along the alignment. It is likely that many of these stream crossings will be able to be supported by shallow foundations on bedrock based on topography and existing mapping.

Given the alignment traverses a northeast facing slope, permafrost conditions could potentially be encountered within the corridor. In areas of shallow bedrock, permafrost will not likely impact design of the roadway, however, in glacial soils, permafrost conditions may require designs to address down slope creep of frozen soils. Thaw settlement may also occur if the permafrost soils are ice rich and/or thaw unstable. Additional geologic hazards may exist along the alignment, given its close proximity to relatively steep slopes. Colluvium deposits at the toes of natural rock slopes may be unstable if exposed during construction, or may introduce periodic instability during seismic or high rainfall events. Additional hazard along this alignment may be associated with potential faulting that may parallel the alignment. Based on topography, it appears that a fault may have formed the mountainous terrain west of this alignment, though no active faults are mapped in this area. If faulting is present and becomes active, seismicity could cause displacement along the roadway or associated structures. Additional explorations and evaluation should be conducted to more accurately locate or identify a fault in this location so that the alignment and associated features can be positioned so as not to straddle both sides of the fault's surface expression.

6.6 Susitna Crossing Alignment

The Susitna Crossing Alignment travels east-west between Burma Landing on the Little Susitna River and Alexander Creek west of the Susitna River. Existing mapping shows the alignment crossing is almost exclusively glacial moraine and kame deposits except for alluvial terrace deposits adjacent to Alexander Creek and the Susitna River. It is also evident from USGS mapping that the land between the Little Susitna and Susitna Rivers contains many scattered, low-lying, poorly drained, boggy areas. Though sources of soil or borrow along this alignment are anticipated to be readily available, the quality of the material yielded from sources (other than those in alluvium near the Susitna River) may be relatively low with elevated fines contents.

The only potential source for rock that is evident along the alignment is mapped as a granodioritic pluton on the west side of the Susitna River crossing.

Given the presence of interspersed boggy areas along this alignment, we anticipate relatively variable subgrade support conditions and frequent transitions between soft and firm subgrades. Foundation conditions for the crossing at the Susitna River appear to be relatively favorable with the potential for shallow bedrock on the west side of the crossing and alluvial soils on the east side. The crossing of Alexander Creek appears as though it will be supported by alluvial soils on both sides. As mentioned above, alluvial materials may be susceptible to liquefaction if they are not of sufficient density, but pile foundations should be readily developable at both crossings. Pile foundation depth will be dictated by anticipated loads, soil density, scour depth, and liquefaction potential, but will likely need to be at least 100 feet deep. It is possible that foundations on the west side of the Susitna River could be cast directly on shallow bedrock if soil overburden is thin at the chosen abutment location. It should be noted that significantly different foundation rigidity and seismic ground motions on either side of the Susitna River crossing may present complex loading during seismic events.

Permafrost soils are not anticipated along this alignment. Other geologic hazards along this alignment appear to be limited to potentially liquefiable soils near the river crossings as described above.

6.7 Beluga Alignment

The Beluga Alignment generally runs northeast to southwest between Alexander Creek and Beluga on the gentle slopes north of the Susitna Flats Game Refuge. Based on the topography of the area, it appears that the ground traversed by the alignment appears to be relatively well drained, except for the far southwest end of the alignment near Beluga River. Geologic mapping along the alignment suggests that the soils are predominantly of glacial origin including tills, moraines, and outwash deposits. There are also several alluvial and terrace deposits associated with stream crossings. Soil materials are expected to be highly variable with potential for high quality sand and gravel deposits scattered along the alignment. The only rock sources available along this alignment appear to be intrusive igneous rocks (granodiorite) on the northeast end of the alignment at the foot of Mount Susitna which should yield relatively durable, high quality materials.

Foundation support conditions at the several minor stream crossings and at Beluga River are anticipated to be relatively favorable. Piles will likely be used to support bridge structures, bearing on alluvial and/or glacial materials. As with other alignments, alluvial soils may be susceptible to liquefaction depending on density. The actual depth of pile foundations will depend on structural loads, scour, actual soil conditions, and liquefaction potential. However, we anticipate that pile foundations along this alignment will likely need to be on the order of 80 to 120 feet in depth.

The Castle Mountain Fault is mapped in this area and appears to follow a significant portion of the alignment. Examination of aerial imagery suggests a significant surface expression for the fault and care should be taken to provide offset from the fault in selecting a final alignment. Embankments and/or bridges that straddle the fault line could experience significant distress and lateral/vertical displacement in a seismic event along the liniment.

Permafrost soils are not anticipated along this alignment. Other geologic hazards along this alignment appear to be limited to potentially liquefiable soils near the river crossings as described above.

7.0 CONCLUSIONS

Based on our review of the existing data, it is our opinion that from a geotechnical standpoint, each corridor likely provides a viable option for accessing various areas within the project study region. However, the corridors are not equal in their feasibility and each corridor has some significant design and construction challenges that will need to be addressed. The following table summarizes specific geotechnical design considerations that may present challenges in developing the potential alignments.

Alignment	Favorable Conditions	Geotechnical Challenges
South Peters Hills/Yenlo Hills	• Readily available soil borrow materials • Rock borrow sources spread along length of alignment • Favorable foundation support conditions for river crossings	• Frequent wetland/boggy area crossings • Potential permafrost soils • Sloping river approaches • Potential constraints due to Pass Creek fault
Skwentna	• Readily available soil borrow materials • Potentially high quality soil borrow materials	• Frequent wetland/boggy area crossings • Potentially liquefiable soils adjacent to river crossings • No significant source of rock borrow material
Deshka	• Alignment follows orientation of terrain to avoid boggy lowlands • Readily available soil borrow materials • Potentially high quality soil borrow materials	• Potentially liquefiable soils adjacent to river crossings • Potentially unstable river channel at Susitna River crossing • No significant source of rock borrow material
Skwentna River	• Readily available soil borrow materials • Potentially high quality soil borrow materials • Readily available rock borrow sources • Favorable conditions for river crossings	• Potential permafrost soils
East Susitna	• Readily available soil borrow materials • Readily available rock borrow sources	• Potential permafrost soils • Potential colluvial deposits • Potential constraints due to Castle Mountain fault
Susitna Crossing	• Favorable foundation conditions for Susitna River crossing	• Frequent wetland/boggy area crossings • No significant source of rock borrow material • Potential structural implications for Susitna River bridge related to variable support conditions on either side of river • Potential constraints due to Castle Mountain fault
Beluga	• Readily available soil borrow materials • Potentially high quality soil borrow materials	• No significant source of rock borrow material • Potential constraints due to Castle Mountain fault

Note that the table above only considers geotechnical issues for development of the corridors and should be considered applicable only to general corridor selection. Additionally, the information included above is not intended to be a complete list of design challenges as new information may present challenges that are not apparent from conducting a desktop study such as this. Further studies are needed to further evaluate the proposed corridors, identify borrow sources, and define the geotechnical engineering parameters for each corridor.

8.0 CLOSURE AND LIMITATIONS

This report was prepared for the exclusive use of our client and their representatives for evaluating the site as it relates to the geotechnical aspects discussed herein. The conclusions contained in this report are based on information provided from the observed site conditions and other conditions described herein. The analyses and conclusions contained in this report are based on site conditions as they presently exist.

The evaluations and conclusions in this report are based on literature research. As such, the information contained in this report should be considered preliminary and not used for final design of the access corridors. A significant degree of additional explorations and engineering analyses is required to develop design-level engineering recommendations for this project. The information included in this report is intended to be used only for preliminary route evaluation purposes.

Unanticipated soil conditions are commonly encountered and cannot fully be determined by merely taking soil samples or advancing borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs. Shannon & Wilson has prepared the attachments in Appendix A *Important Information About Your Geotechnical/Environmental Report* to assist you and others in understanding the use and limitations of the reports.

Copies of documents that may be relied upon by our client are limited to the printed copies (also known as hard copies) that are signed or sealed by Shannon & Wilson with a wet, blue ink signature. Files provided in electronic media format are furnished solely for the convenience of the client. Any conclusion or information obtained or derived from such electronic files shall be

at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, or you question the authenticity of the report please contact the undersigned.

We appreciate this opportunity to be of service. Please contact the undersigned at (907) 561-2120 with questions or comments concerning the contents of this report.

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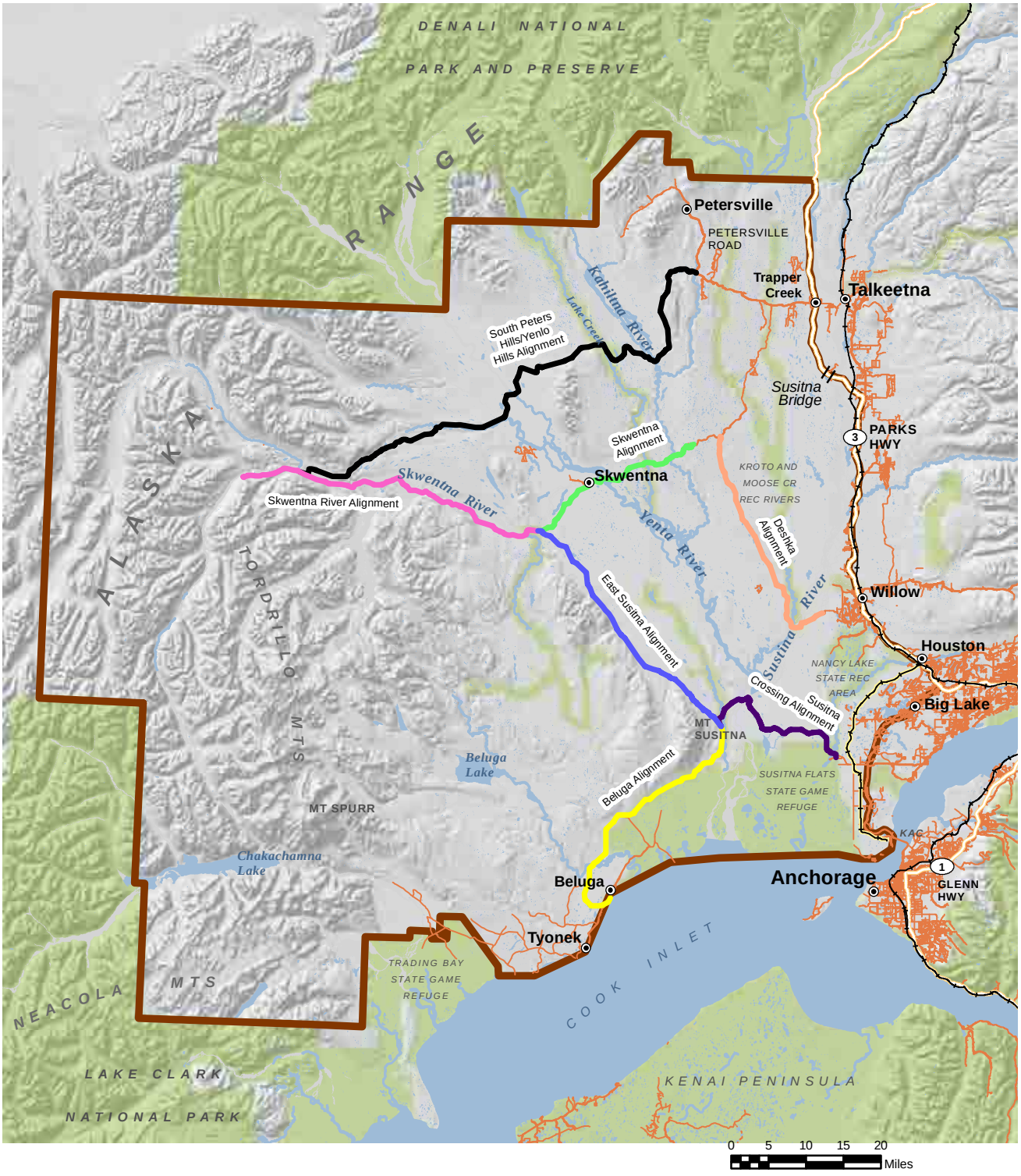

LEGEND

Alignment

- Beluga Alignment
- Deshka Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- South Peters Hills/Yenlo Hills Alignment
- Susitna Crossing Alignment
- Study Area
- Park or Refuge

N

West Susitna Access
Mat-Su Borough, Alaska

VICINITY MAP

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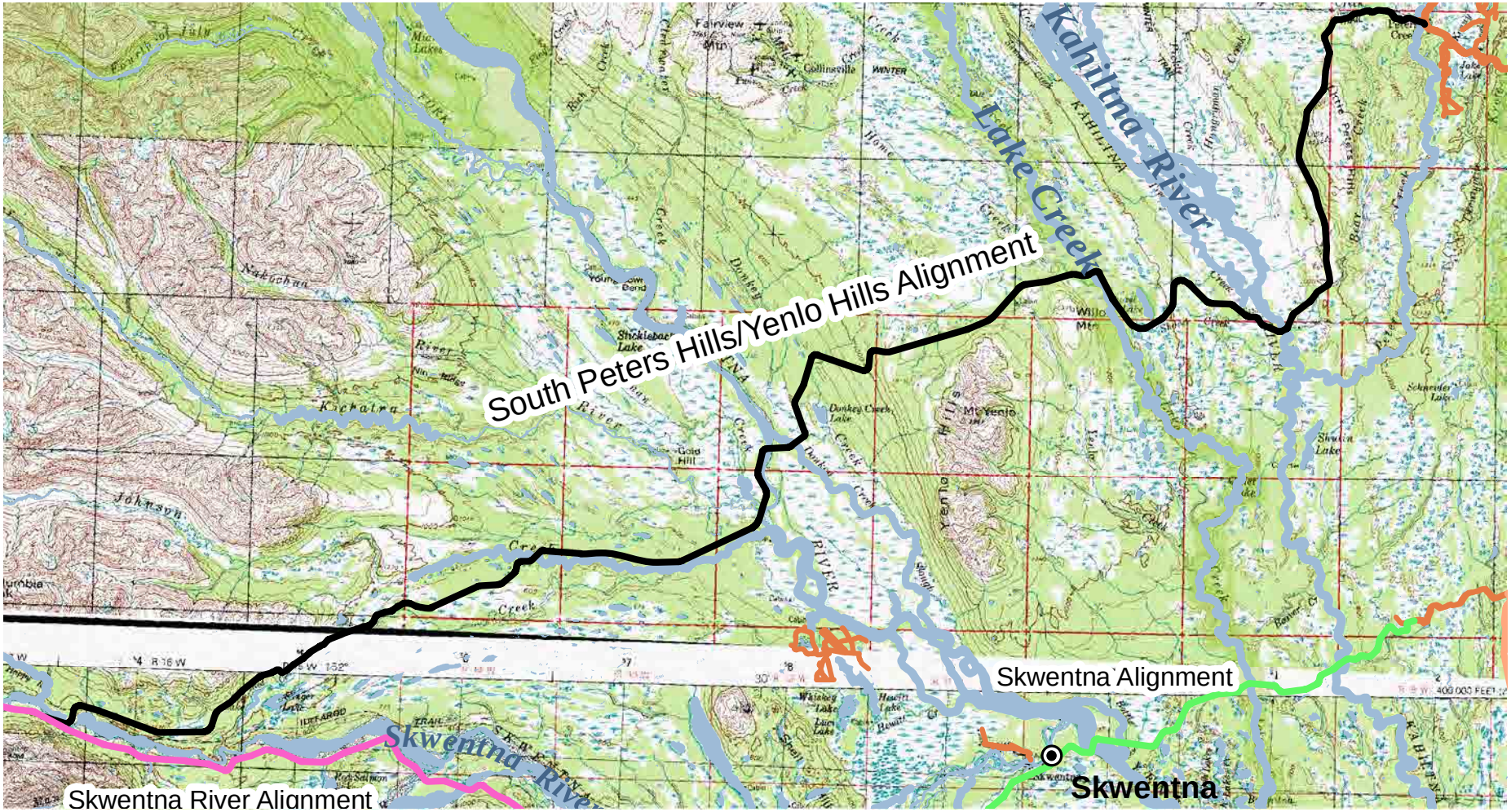
FIG. 1



LEGEND

Alignment

- South Peters Hills/Yenlo Hills Alignment
- Skwentna River Alignment
- Skwentna Alignment
- Secondary Road

N

0 2 4 6 Miles

West Susitna Access
Mat-Su Borough, Alaska

SOUTH PETERS HILLS/YENLO HILLS ALIGNMENT TOPOGRAPHY

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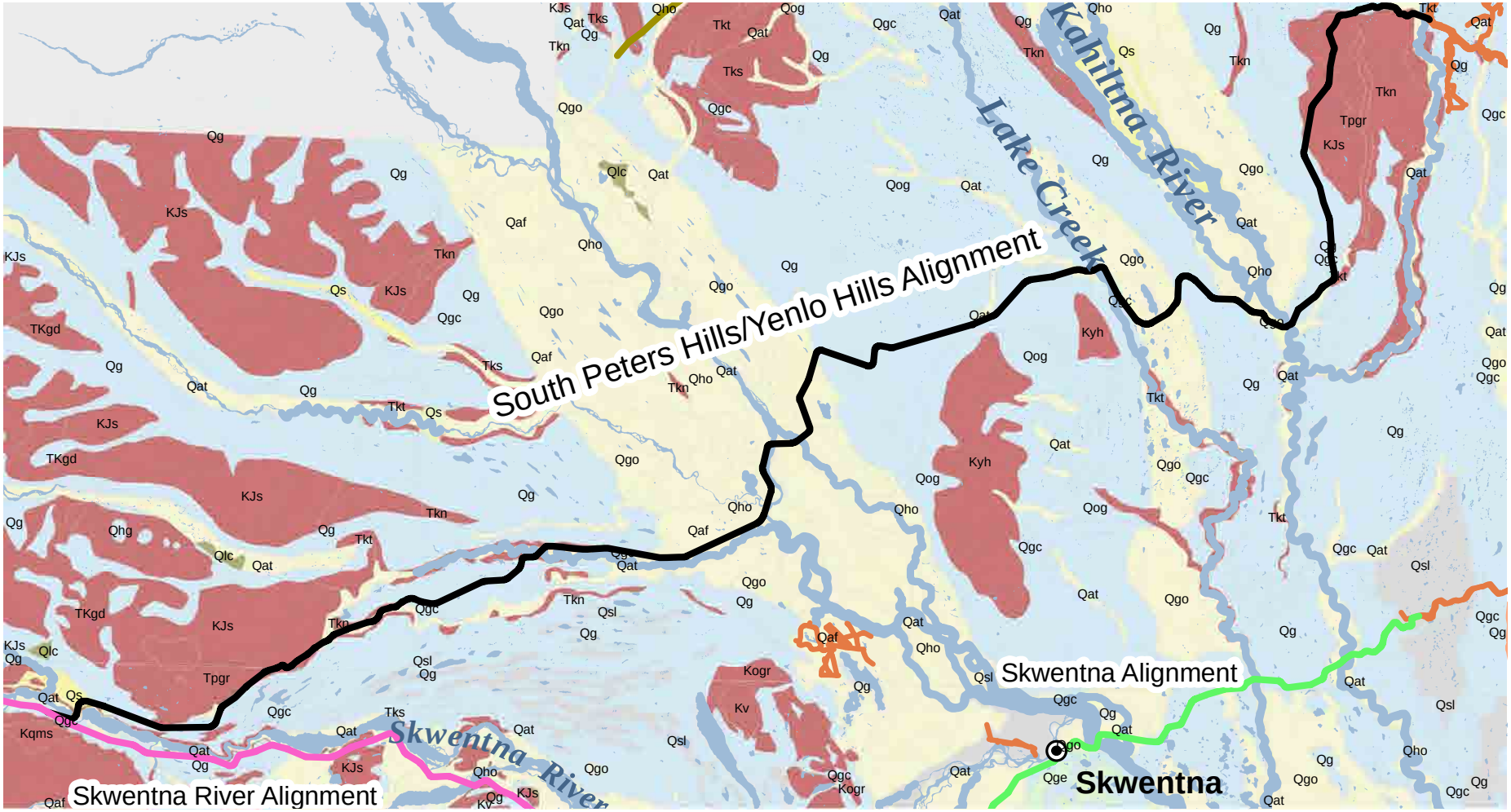
FIG. 2a



Note: See Figure 9 for geologic unit descriptions

LEGEND

Alignment

- South Peters Hills/Yenlo Hills Alignment
- Skwentna River Alignment
- Skwentna Alignment
- Secondary Road

N

0 2 4 6 Miles

West Susitna Access
Mat-Su Borough, Alaska

SOUTH PETERS HILLS/YENLO HILLS ALIGNMENT GEOLOGY

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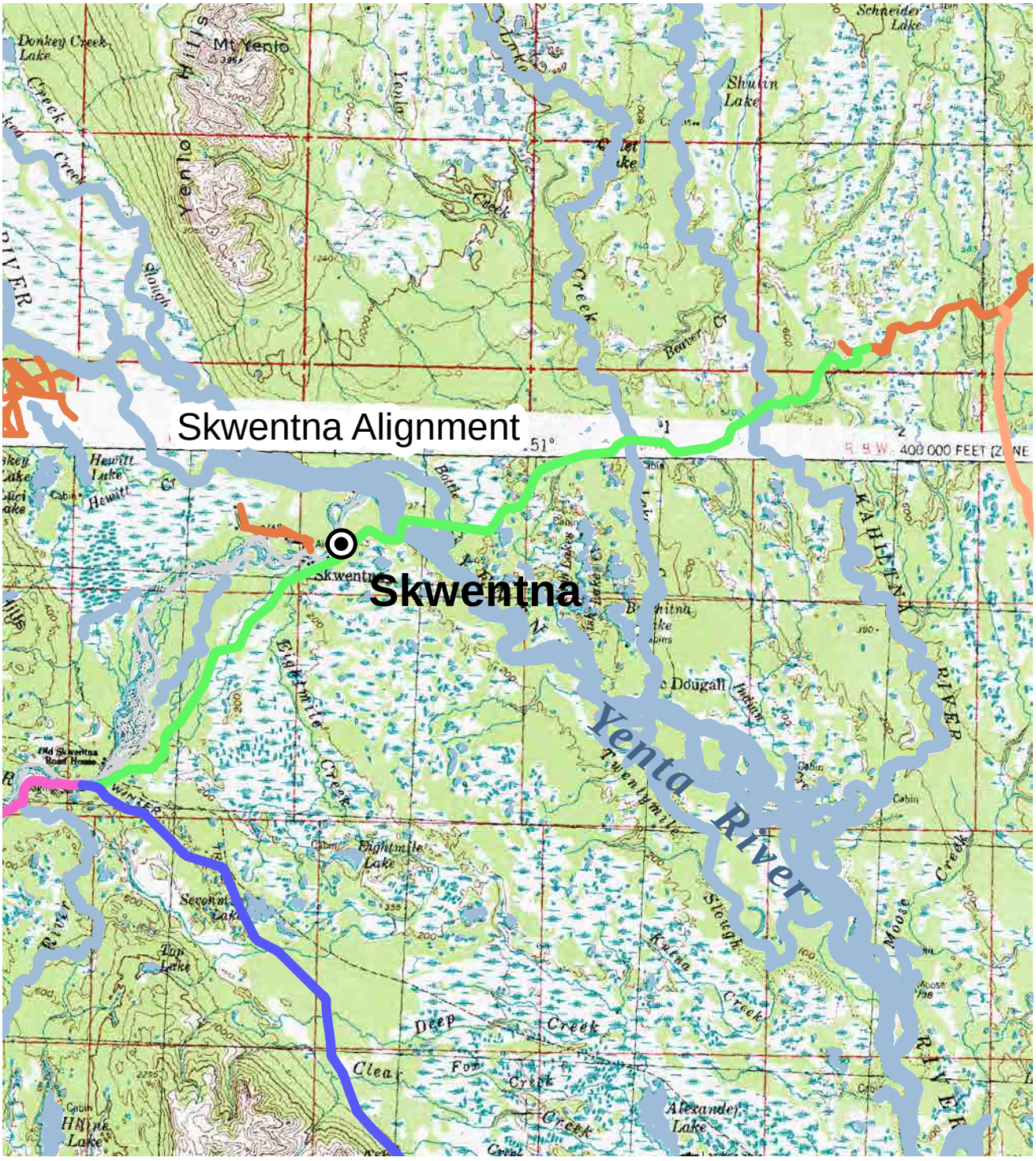
FIG. 2b



LEGEND

Alignment

- Skwentna Alignment
- East Susitna Alignment
- Skwentna River Alignment
- Deshka Alignment
- Secondary Road

N

West Susitna Access
Mat-Su Borough, Alaska

SKWENTNA ALIGNMENT TOPOGRAPHY

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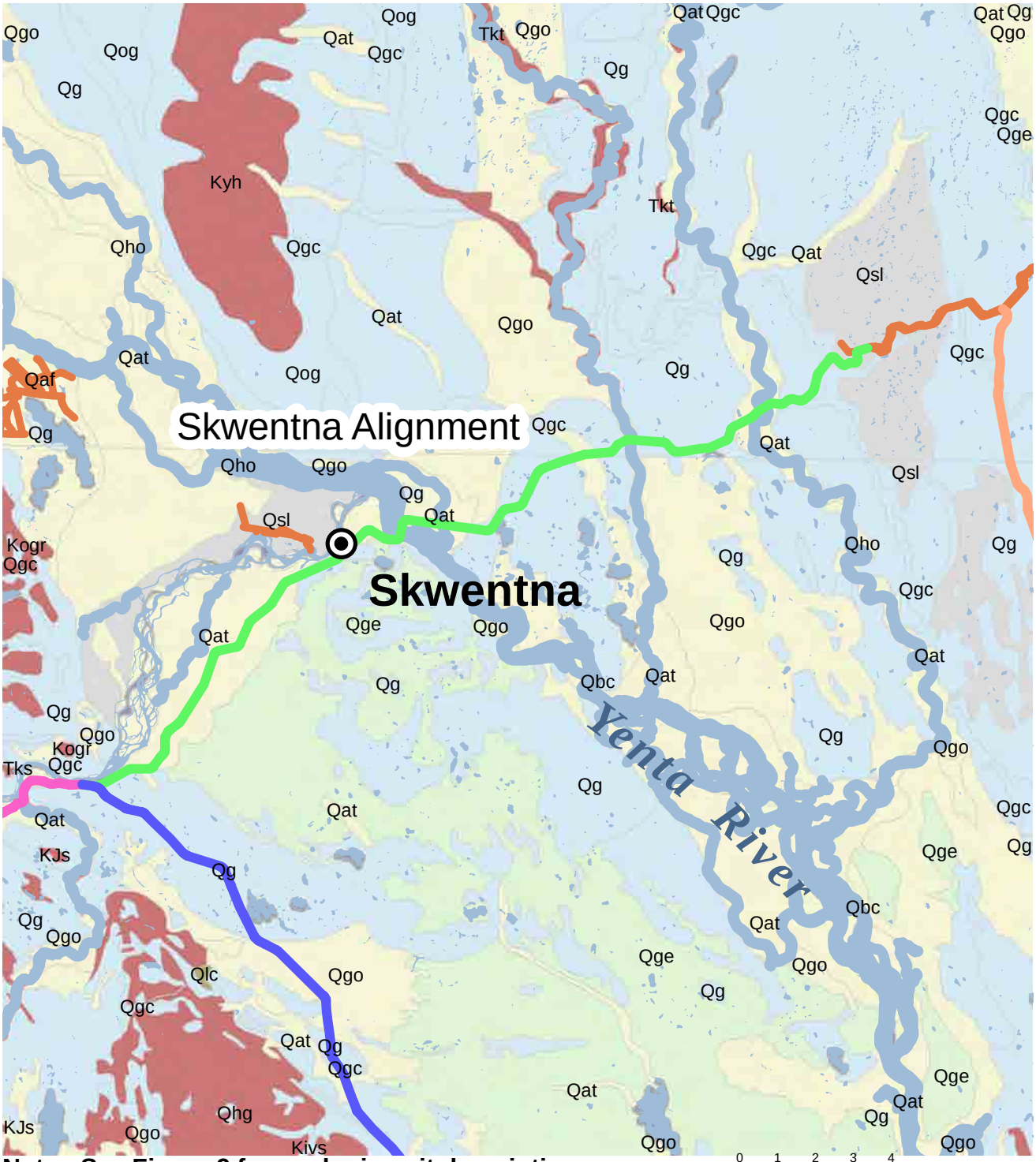
FIG. 3a



Note: See Figure 9 for geologic unit descriptions

LEGEND

Alignment

- Skwentna Alignment
- East Susitna Alignment
- Skwentna River Alignment
- Deshka Alignment
- Secondary Road

N

West Susitna Access
Mat-Su Borough, Alaska

SKWENTNA ALIGNMENT GEOLOGY

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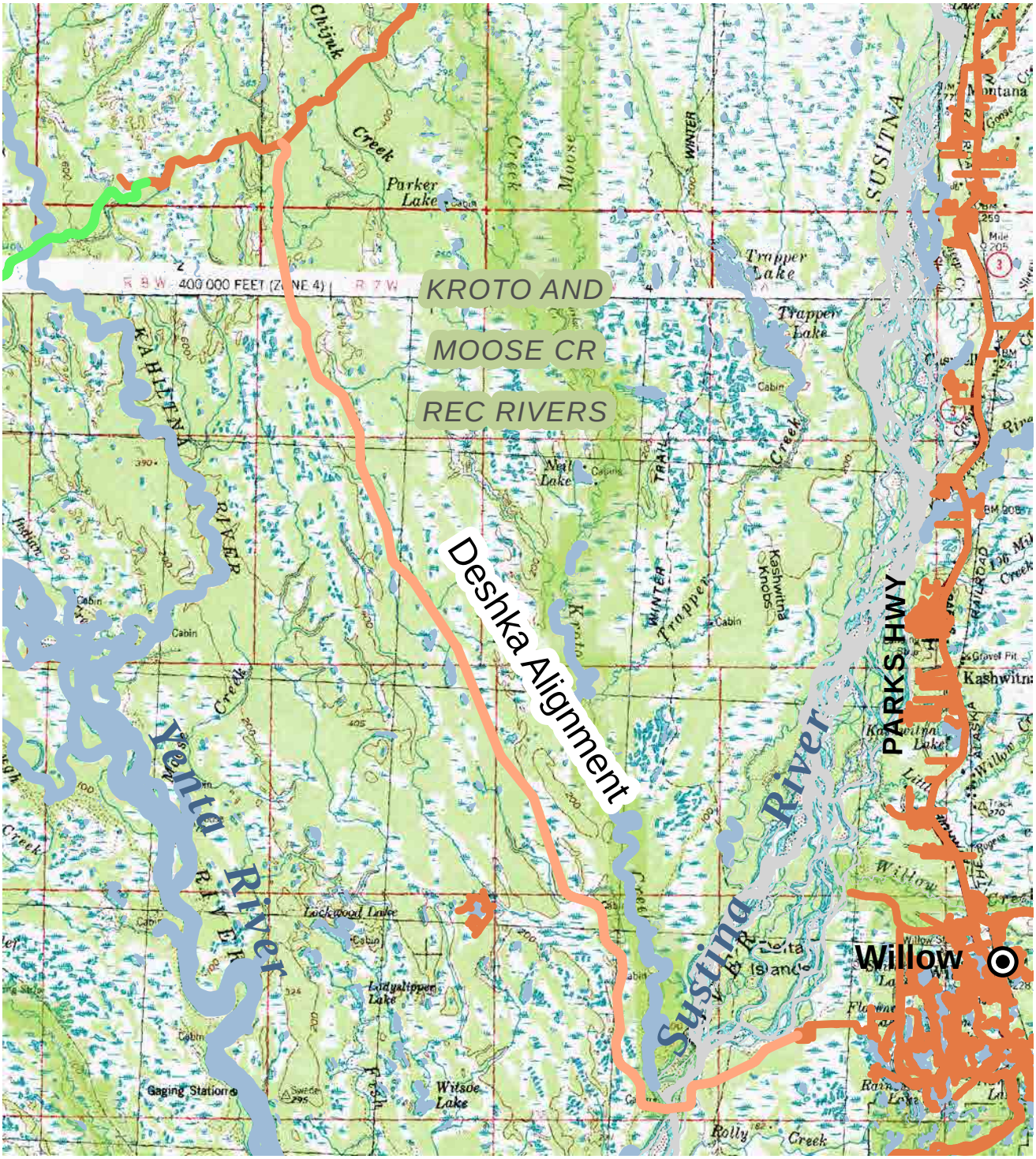
FIG. 3b



LEGEND

Alignment

- Deshka Alignment
- Skwentna Alignment
- Secondary Road

N

West Susitna Access
Mat-Su Borough, Alaska

DESHKA ALIGNMENT TOPOGRAPHY

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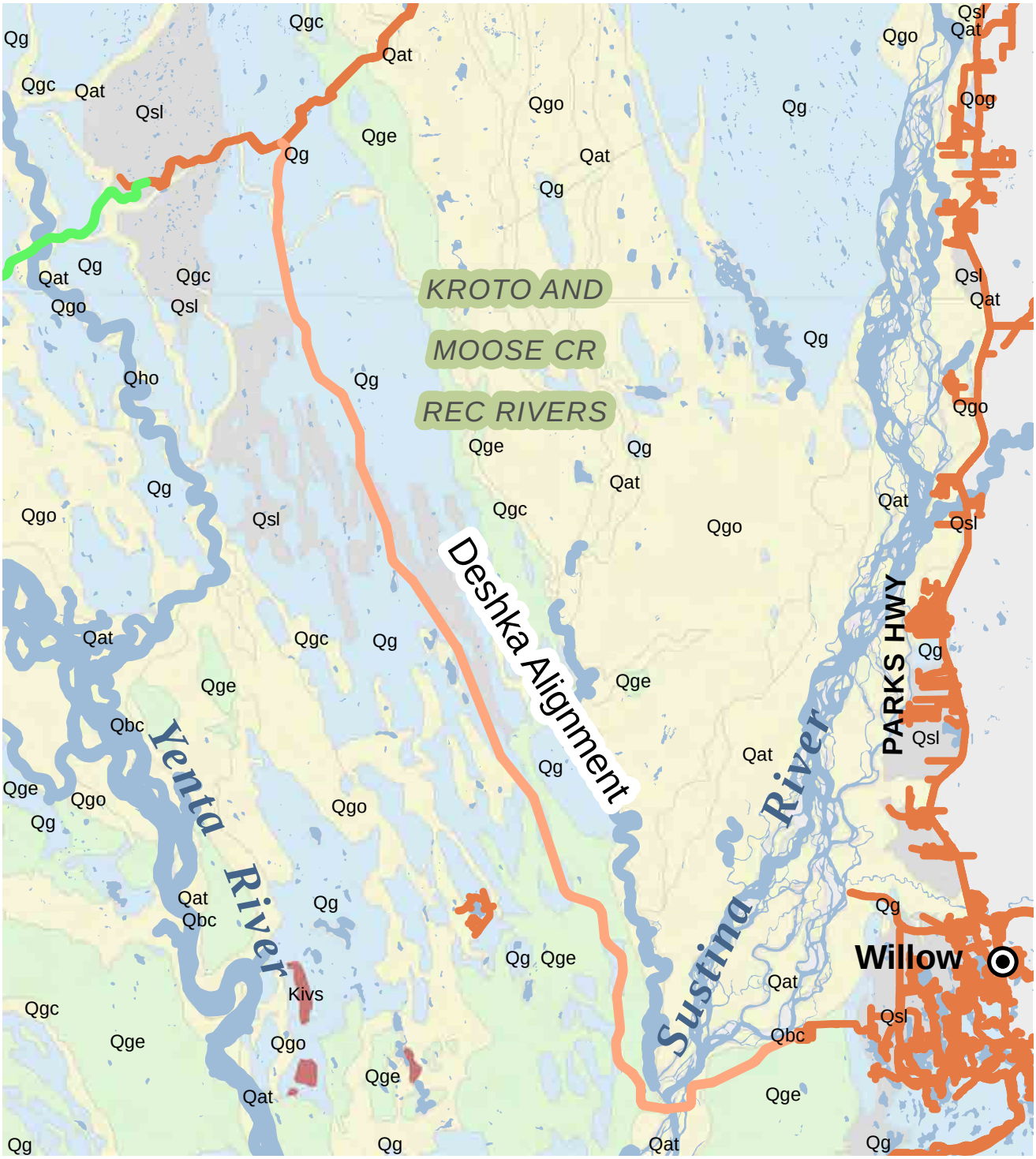
FIG. 4a



Note: See Figure 9 for geologic unit descriptions

0 1 2 3 4 Miles

LEGEND

Alignment

- Deshka Alignment
- Skwentna Alignment
- Secondary Road

N

West Susitna Access
Mat-Su Borough, Alaska

DESHKA ALIGNMENT GEOLOGY

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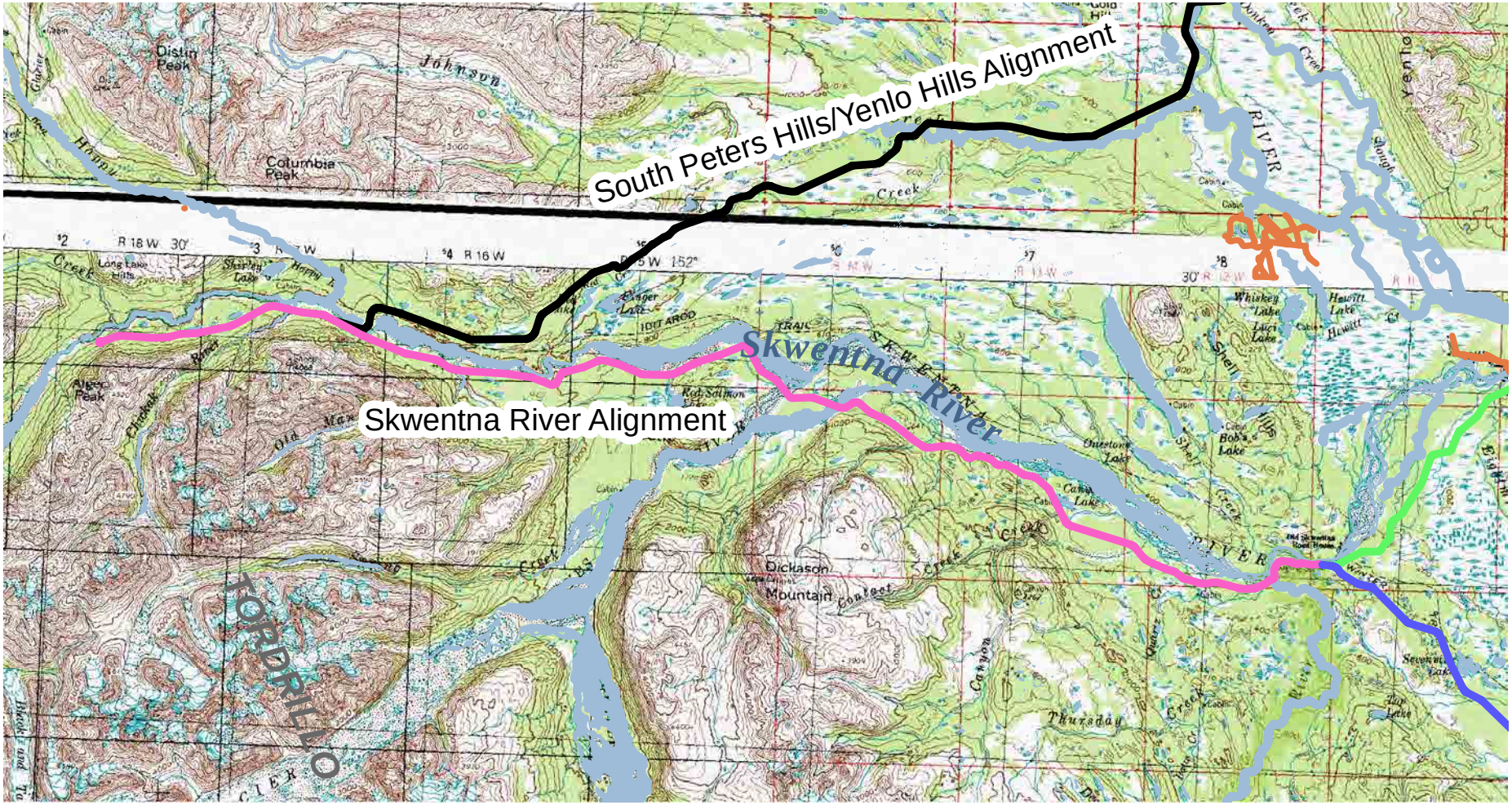
FIG. 4b



LEGEND

Alignment

- South Peters Hills/Yenlo Hills Alignment
- Skwentna River Alignment
- Skwentna Alignment
- Secondary Road
- East Susitna Alignment

N

0 1 2 3 4 Miles

West Susitna Access
Mat-Su Borough, Alaska

SKWENTNA RIVER ALIGNMENT TOPOGRAPHY

December 2013 32-1-02301

SHANNON & WILSON, INC.
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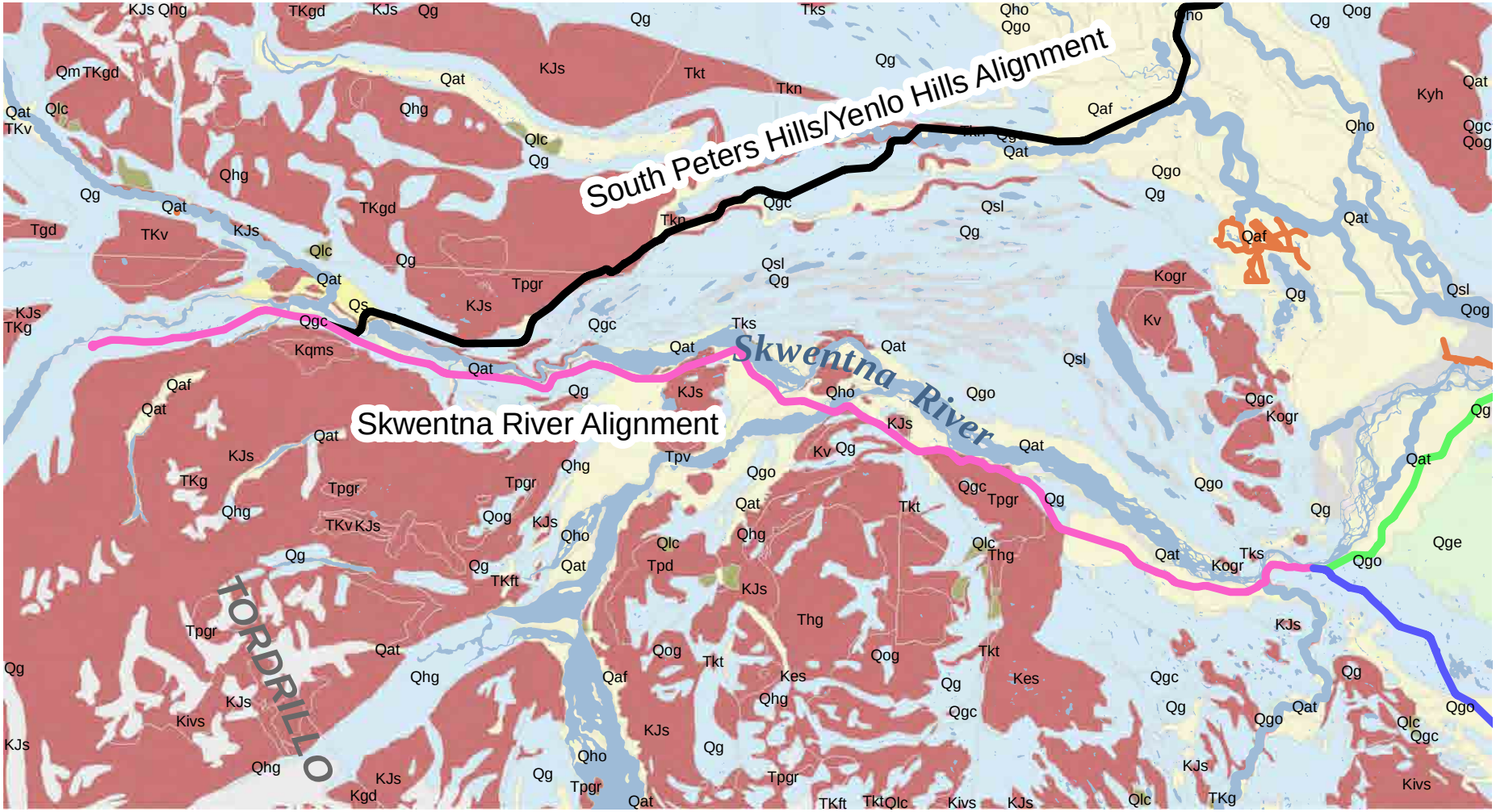
FIG. 5a



Note: See Figure 9 for geologic unit descriptions

LEGEND

Alignment

- South Peters Hills/Yenlo Hills Alignment
- Skwentna River Alignment
- Skwentna Alignment
- Secondary Road
- East Susitna Alignment

N

0 1 2 3 4 Miles

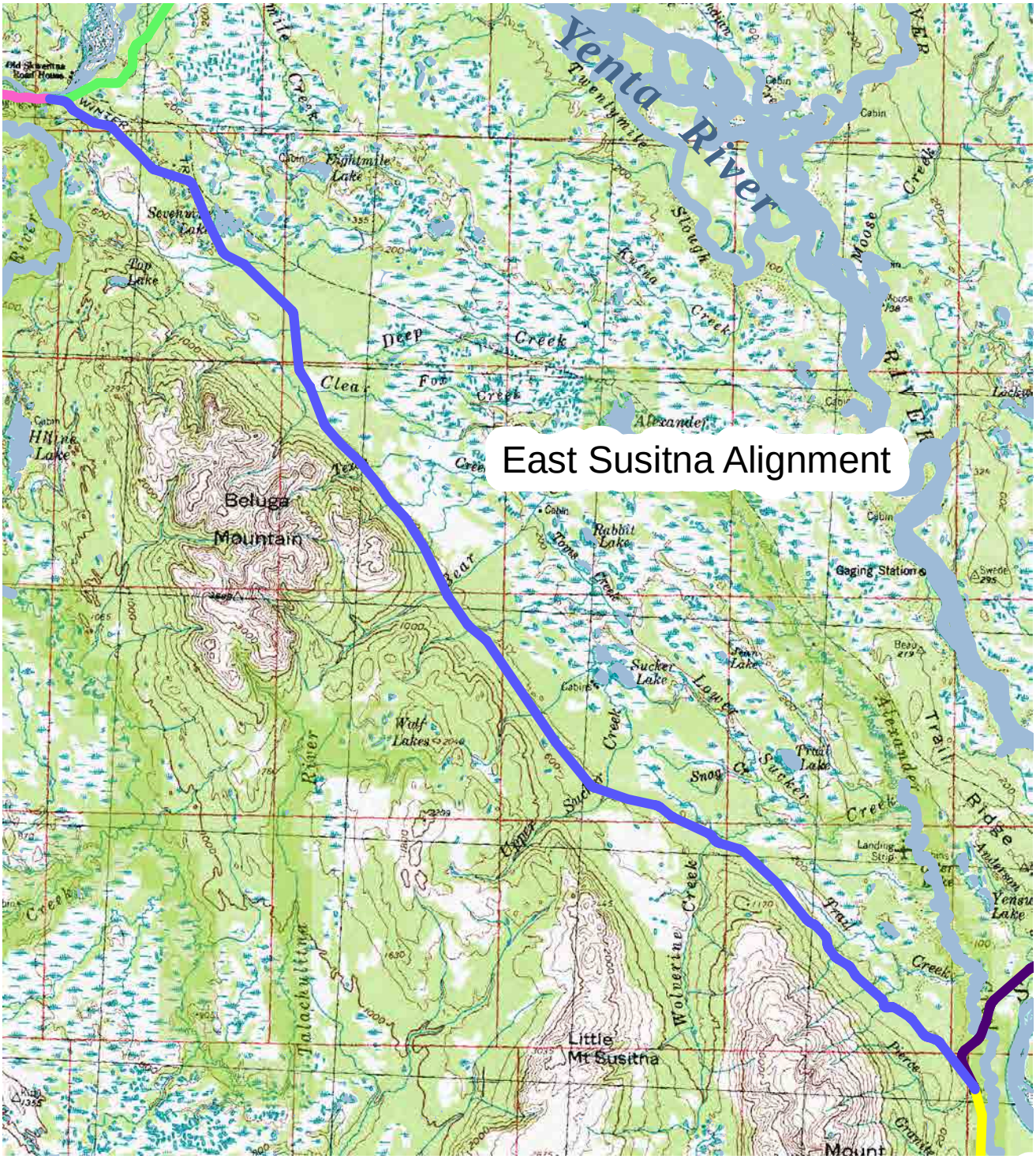
West Susitna Access
Mat-Su Borough, Alaska

SKWENTNA RIVER ALIGNMENT GEOLOGY

December 2013 32-1-02301

SHANNON & WILSON, INC. GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 5b



LEGEND

Alignment

- Beluga Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- Susitna Crossing Alignment

N

West Susitna Access
Mat-Su Borough, Alaska

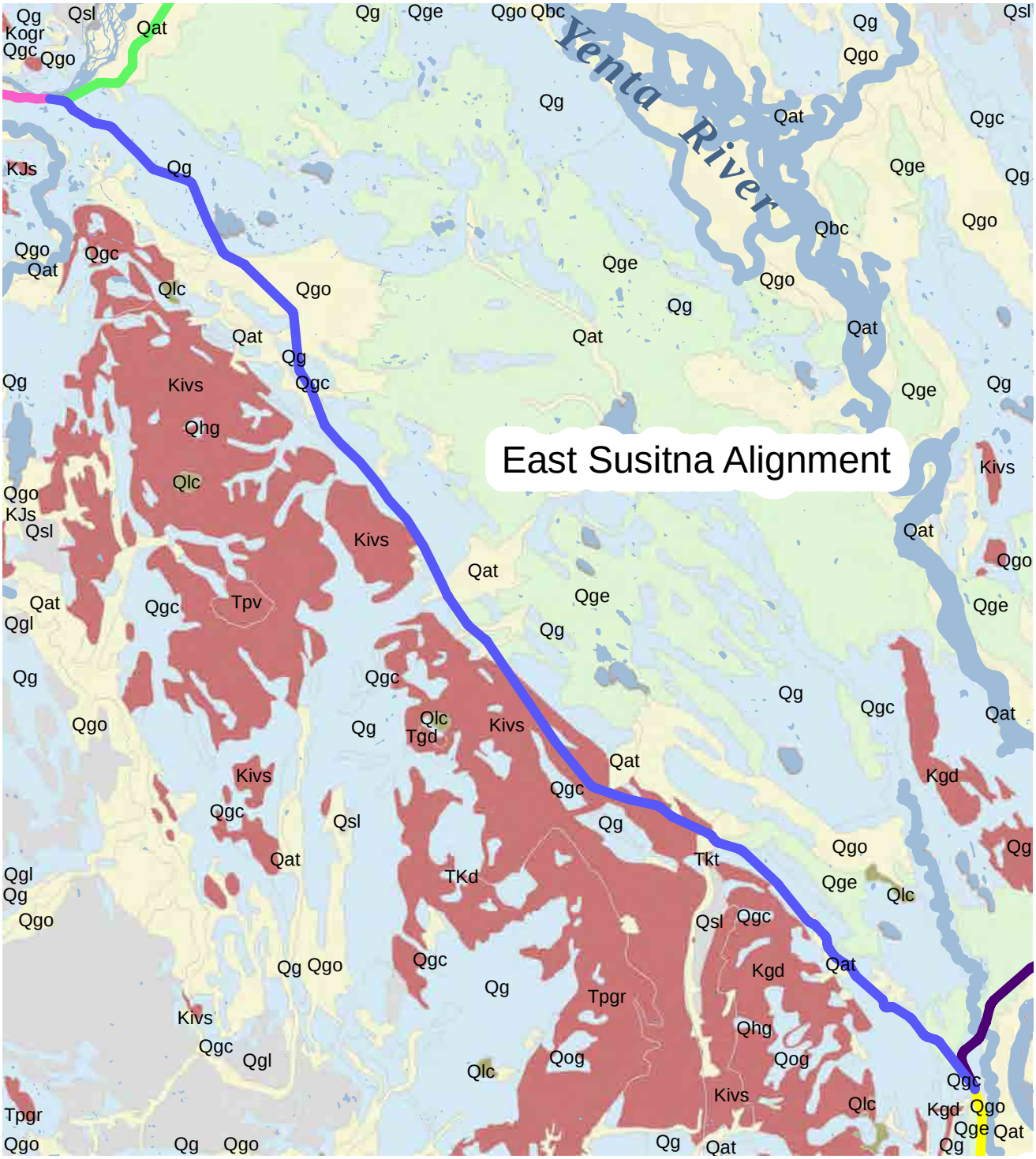
EAST SUSITNA CROSSING ALIGNMENT TOPOGRAPHY

December 2013

32-1-02301

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 6a



Note: See Figure 9 for geologic unit descriptions

LEGEND

Alignment

- Beluga Alignment
- East Susitna Alignment
- Skwentna Alignment
- Skwentna River Alignment
- Susitna Crossing Alignment

N

West Susitna Access
Mat-Su Borough, Alaska

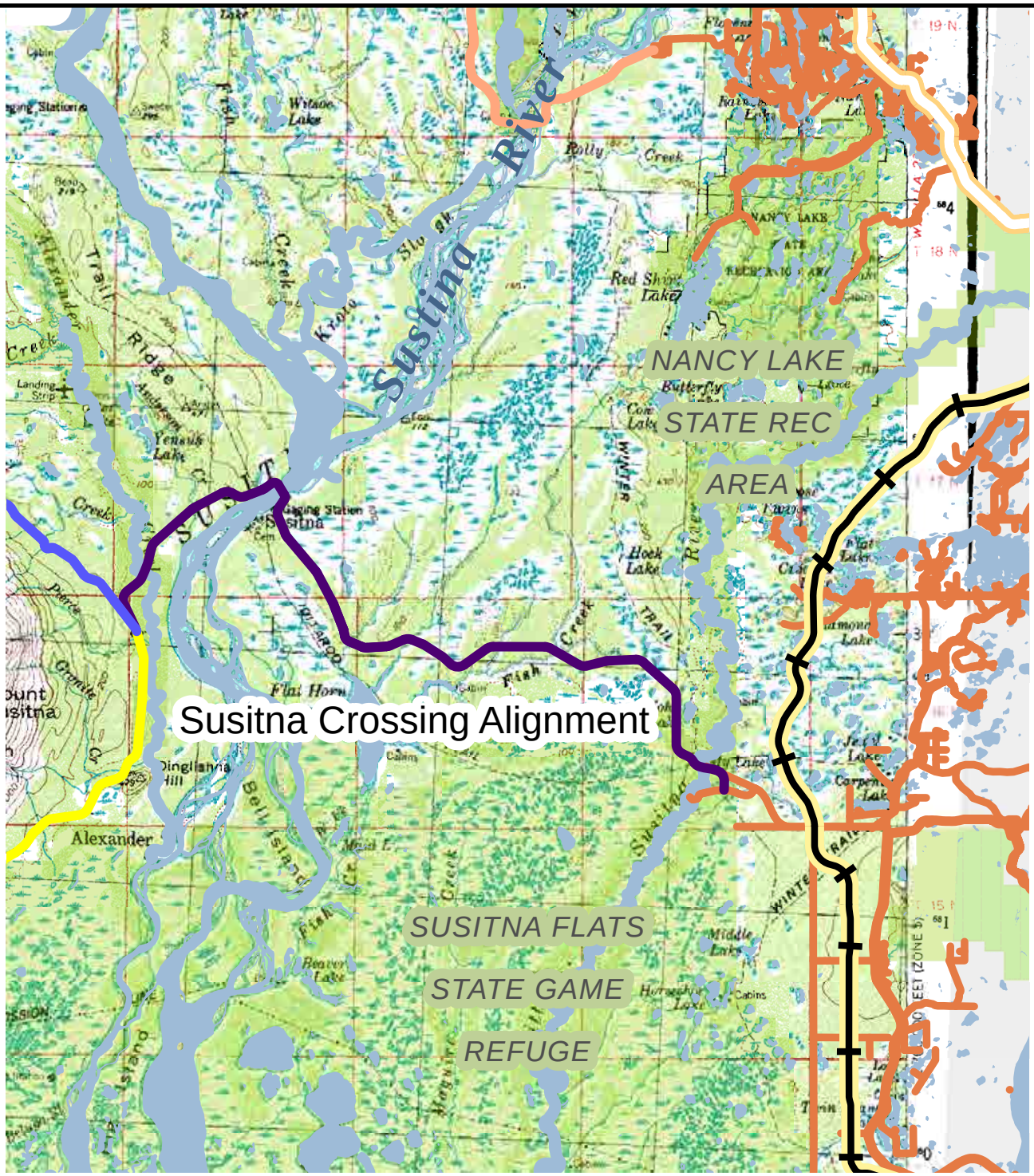
EAST SUSITNA CROSSING ALIGNMENT GEOLOGY

December 2013

32-1-02301

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 6b



0 1 2 3 4 Miles

LEGEND

Alignment

- Beluga Alignment
- East Susitna Alignment
- Susitna Crossing Alignment
- Secondary Road
- Port MacKenzie Rail Extension
- Highway

N

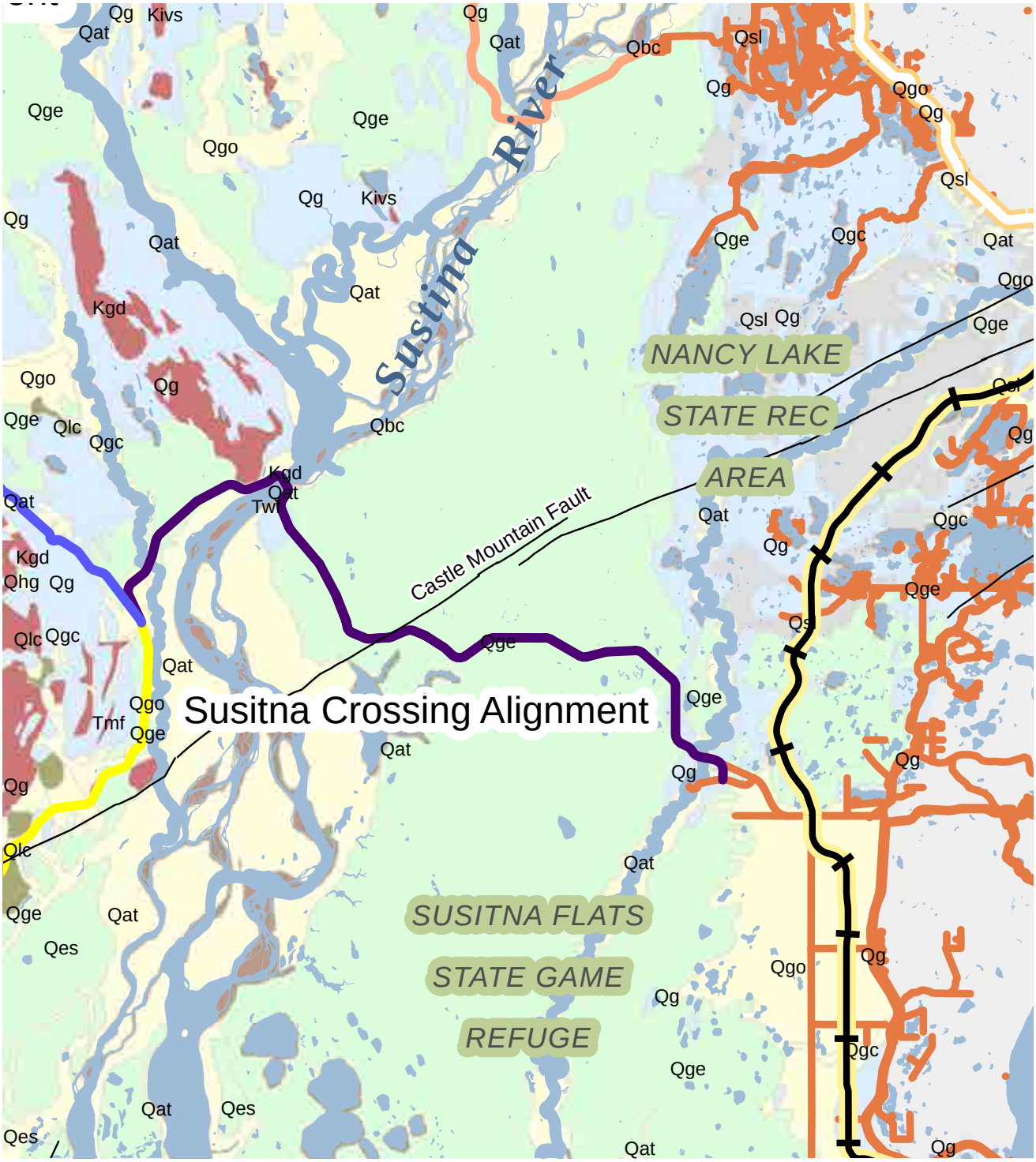
West Susitna Access
Mat-Su Borough, Alaska

SUSITNA CROSSING ALIGNMENT TOPOGRAPHY

December 2013 32-1-02301

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 7a



Note: See Figure 9 for geologic unit descriptions

LEGEND

Alignment

- Beluga Alignment
- East Susitna Alignment
- Susitna Crossing Alignment
- Secondary Road
- Port MacKenzie Rail Extension
- Highway
- Quaternary Faults

N

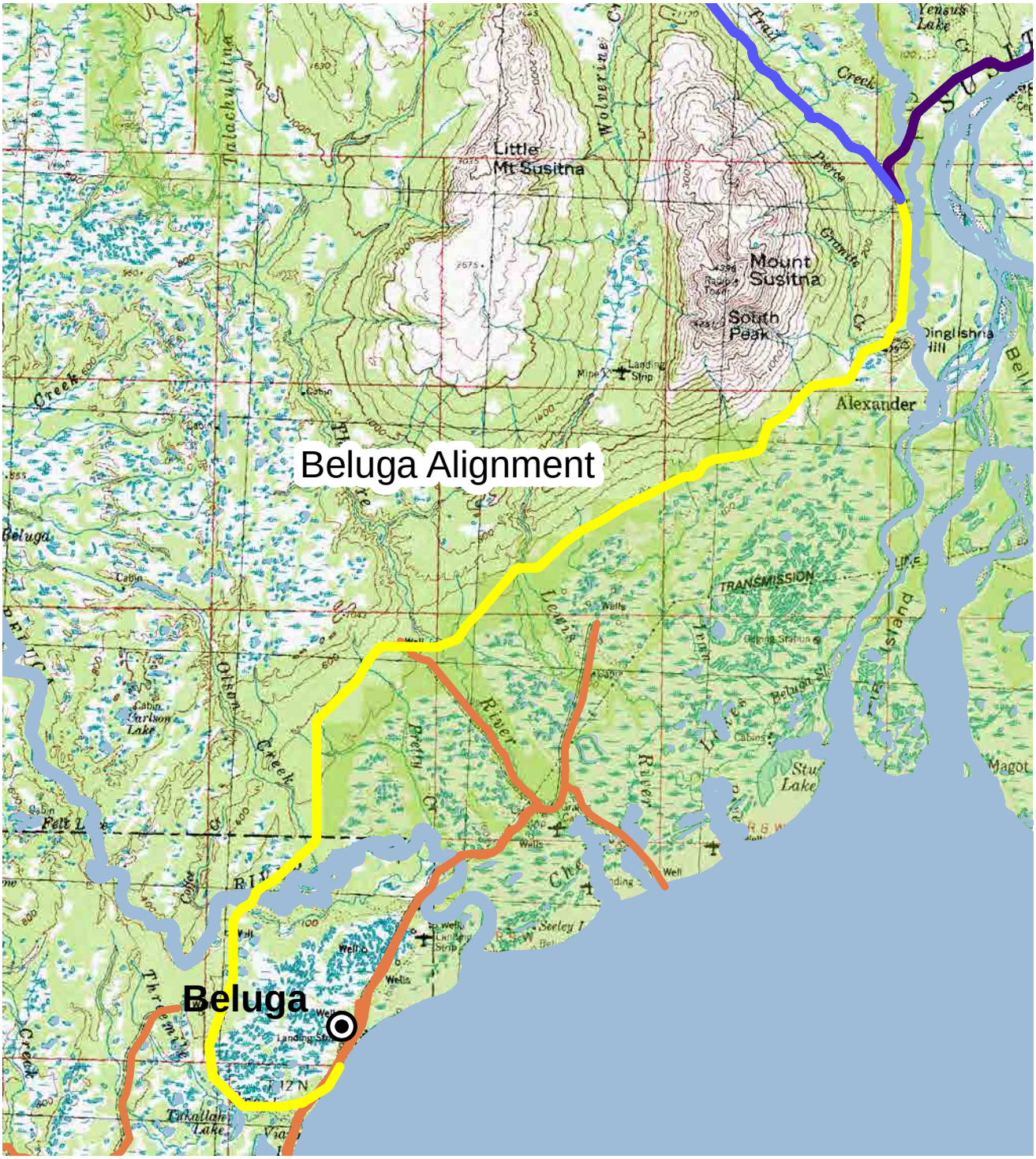
West Susitna Access
Mat-Su Borough, Alaska

SUSITNA CROSSING ALIGNMENT GEOLOGY

December 2013 32-1-02301

SHANNON & WILSON, INC. GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 7b



LEGEND

Alignment

- Beluga Alignment
- East Susitna Alignment
- Susitna Crossing Alignment
- Secondary Road

N

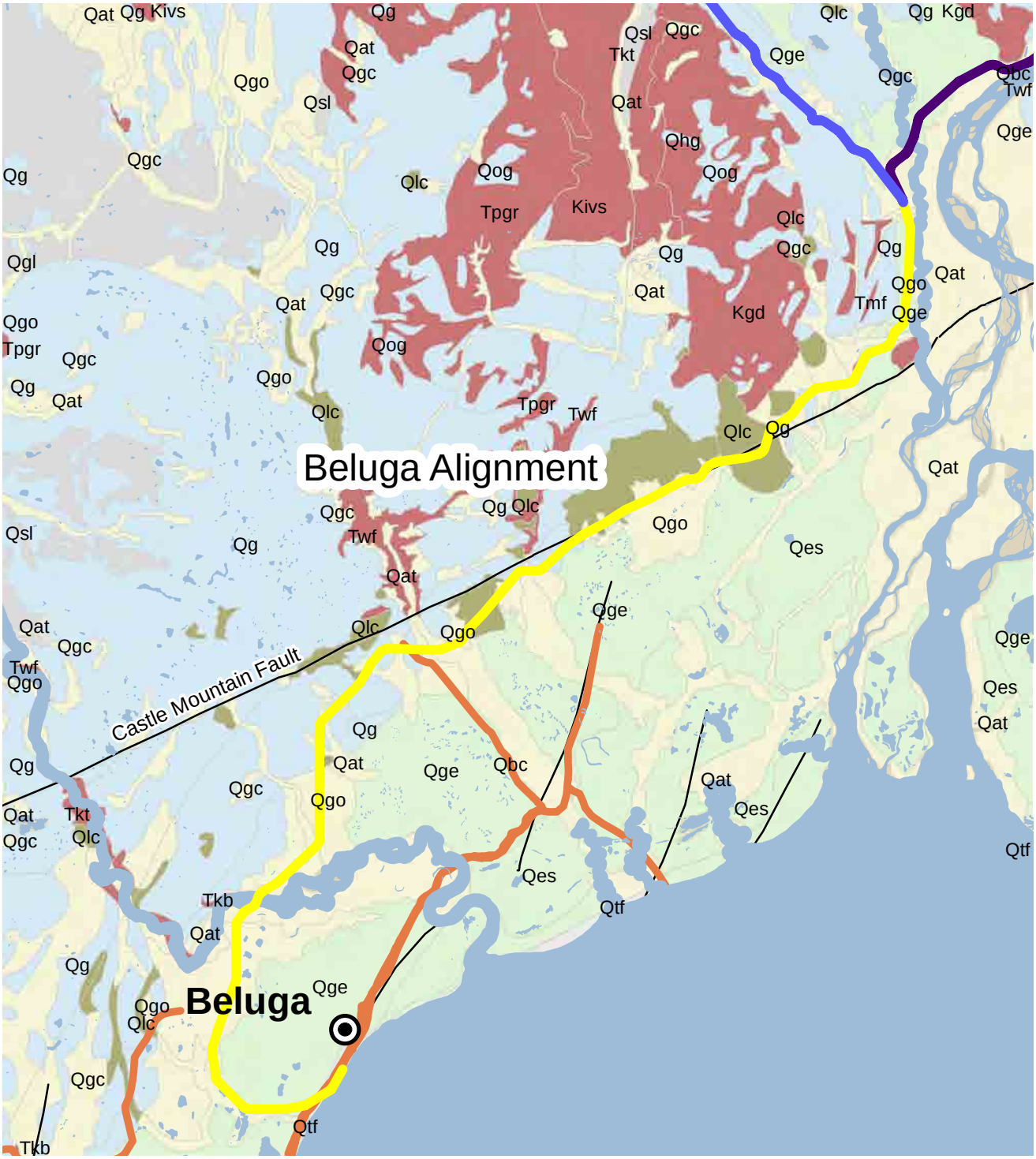
West Susitna Access
Mat-Su Borough, Alaska

BELUGA ALIGNMENT TOPOGRAPHY

December 2013 32-1-02301

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 8a



Note: See Figure 9 for geologic unit descriptions

LEGEND

Alignment

- Beluga Alignment
- East Susitna Alignment
- Susitna Crossing Alignment
- Secondary Road
- Quaternary Faults

N

West Susitna Access
Mat-Su Borough, Alaska

BELUGA ALIGNMENT GEOLOGY

December 2013 32-1-02301

SHANNON & WILSON, INC. GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 8b

Legend

All Rock Units

Jqd, KJq, Kivs, Kogr, Kqms, KJs, Kes, Kyh, Ksf, Kgd, Kqd, TKg, TKgb, TKgd, Tgd, Tpd, Kv, Tkb, Tkn, Tks, Tkt, Tvs, TKft, TKv, Tgn, Thg, Tmf, Tpgr, Tpv, Twf, TFd, Qhv, Qv

Alluvial Deposits (including glaciofluvial)

Qaf, Qdl, Qat, Qho, Qgc, Qgo

Estuarine and Marine Deposits

Qge, Qes, Qtf, Qbc

Lacustrine and Silt Deposits

Qsl, Qgl

Flow, Slide, and Colluvial Deposits

Qdf, Qlc

Glacial Deposits (excluding glaciofluvial)

Qhg, Qm, Qg, Qog

Surficial Deposits

Qs

Note:

The geologic units included in this report have been grouped for presentation purposes. Due to the variability of the various subtypes in each unit delineated in this report, please refer to the the source publication for more detailed descriptions of individual units.

Legend based on Preliminary Geologic Map of the Cook Inlet Region, Alaska: United States Geological Survey, Open-File Report 2009-1108, Version 1.0, Sheet 1 of 2, Scale 1:250,000 by Wilson, F.H., Hults, C.P., Schmoll, H.R., Haeussler, P.J., Schmidt, J.M., Yehle, L.A., Labay, K.A., 2009.

West Susitna Access
Mat-Su Borough, Alaska

GEOLOGY LEGEND

December 2013 32-1-02301

SHANNON & WILSON, INC.
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FIG. 9

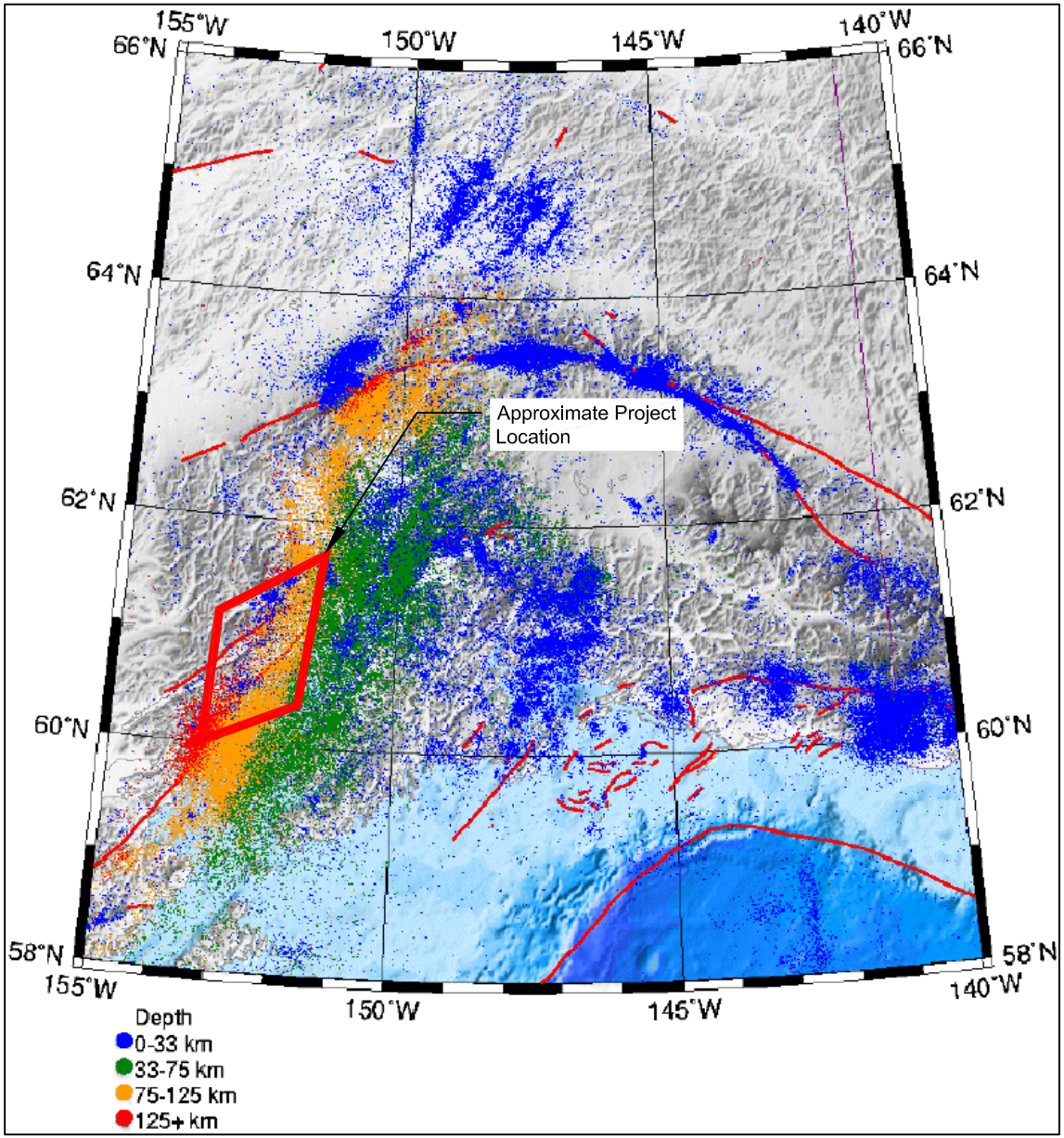

Image provided by Alaska Earthquake Information Center. www.aeic.alaska.edu

West Susitna Access
Mat-Su Borough, Alaska

REGIONAL SEISMICITY

December 2013

32-1-02301

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 10

APPENDIX A

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Attachment to 32-1-02301

Date: December 2013
To: HDR Alaska, Inc.
Re: West Susitna Access, Mat-Su Borough, Alaska

Important Information About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors, which were considered in the development of the report, have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland

3/2004

West Susitna Access Reconnaissance Study
West Susitna Access to Resource Development

Transportation Analysis Report






Appendix D:
Preliminary Cost Estimate

WEST SUSITNA ACCESS TO RESOURCE DEVELOPMENT

COST ESTIMATE for NEW ROADS

Alternatives	Length, mi	Terrain Summary Level, mi	Rolling, mi	Mountainous, mi
North Petersville	**78.8**	**31.3**	**25.7**	**21.8**
South Peters Hills	27.5			
Yenlo Hills	51.3			
North Skwentna	**71.6**	**31.3**	**16.2**	**24.1**
Skwentna	27.3	17.6	6.4	3.3
Skwentna River	44.4	13.7	9.9	20.8
Middle Susitna-Skwentna Riv	**108.0**	**62.8**	**29.3**	**15.8**
Susitna Crossing	26.1	22.0	2.9	1.3
East Susitna	37.5	12.3	16.1	9.1
Skwentna River	44.4	28.6	10.3	5.4
Beluga	**63.8**	**42.6**	**18.3**	**2.9**
Susitna Crossing	26.1	22.0	2.9	1.3
Beluga Alignment	37.6	20.6	15.3	1.7
Deshka Variant	**33.5**	**28.1**	**4.6**	**0.9**
Deshka	33.5	28.1	4.6	0.9

TYPICAL SECTION	
Roadway Width, ft =	24
STRUCTURAL SECTION, in	
Gravel Wearing Surface =	4
Borrow "A" =	48

DESCRIPTION	ASSUMPTIONS	ASSUMPTION FACTORS		ITEM No	Pay Unit	Unit Price	Quantity Per Mile: Level	Rolling	Mountainous	Total Route Quantities: North Petersville	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant	COST: North Petersville	North Skwentna	Middle Susitna-Skwentna River	Beluga	Deshka Variant
CLEARING				201 (1A)	ACRE	$3,092.40	6.4	9.7	12.1	714	650	879	486	235	$2,208,993	$2,011,601	$2,719,736	$1,502,907	$726,669
EARTHWORK																			
UNCLASSIFIED EXCAVATION				203 (3)	CY	$9.13	4,994	17,211	66,076	2,040,557	2,028,279	1,862,453	720,319	275,858	$18,623,944	$18,511,884	$16,998,410	$6,574,279	$2,517,729
EMBANKMENT BORROW C				203 (6C)	TON	$3.83	4,505	22,664	95,294	2,803,159	2,805,767	2,453,258	884,627	312,296	$10,736,097	$10,746,087	$9,395,979	$3,388,121	$1,196,095
STRUCTURAL SECTION																			
BORROW A				203 (6A)	TON	$3.25	51,954	51,954	51,954	4,091,867	3,720,398	5,608,393	3,312,043	1,739,927	$13,298,567	$12,091,295	$18,227,277	$10,764,140	$5,654,761
AGGREGATE SURFACE COURSE				301 (3)	TON	$10.43	3,218	3,218	3,218	253,435	230,428	347,363	205,136	107,765	$2,643,491	$2,403,509	$3,623,220	$2,139,697	$1,124,054
STREAM AND RIVER CROSSINGS																			
CONVENTIONAL BRIDGES	Length of bridge multiplied by 26' width.	26			SF	$350.00				27,040	42,900	38,740	28,600	520	$9,464,000	$15,015,000	$13,559,000	$10,010,000	$182,000
LONG SPAN BRIDGES	Length of bridge multiplied by 26' width.	26			SF	$1,000.00				64,220	101,660	93,860	59,540	54,600	$64,220,000	$101,660,000	$93,860,000	$59,540,000	$54,600,000
MINOR DRAINAGE CULVERT	Culvert length approximately 50' to daylight on eit	50		603()	LF	$150.00				15,800	14,600	22,000	13,000	6,800	$2,370,000	$2,190,000	$3,300,000	$1,950,000	$1,020,000
SMALL CULVERT	Culvert length approximately 50' to daylight on eit	50		603()	LF	$1,000.00				1,850	1,300	2,000	600	550	$1,850,000	$1,300,000	$2,000,000	$600,000	$550,000
LARGE CULVERT	Culvert length approximately 96' to daylight on eit	96		603()	LF	$5,000.00				1,152	1,152	1,344	576	192	$5,760,000	$5,760,000	$6,720,000	$2,880,000	$960,000
GUARDRAIL																			
GABION RETAINING WALLS	Walls are only used in mountainous terrain.	0.25	30	636(1)	CY	$166.28			1,467	32,027	35,351	23,171	4,293	1,272	$5,325,418	$5,878,151	$3,852,854	$713,782	$211,587
W-BEAM GUARDRAIL	Guardrail are only used in mountainous terrain.	0.5		606(1)	FT	$25.94			2,640	57,648	63,632	41,708	7,727	2,290	$1,495,521	$1,650,744	$1,081,985	$200,449	$59,419
END-SECTIONS (ET-2000)	Average length of guardrail installation at 250', terminals at either end.			606(11)	EACH	$3,239.47				231	255	167	31	9	$746,999	$824,531	$540,442	$100,123	$29,679
MISCELLANEOUS																			
TOPSOIL				620(1)	SY	$1.38	16,808	33,751	101,522	3,608,282	3,520,604	3,649,699	1,628,930	713,505	$4,979,430	$4,858,434	$5,036,584	$2,247,923	$984,637
SEEDING				618(1)	ACRE	$69.66	3.47	6.97	20.98	746	727	754	337	147	$51,934	$50,672	$52,530	$23,445	$10,270
GEOTEXTILE TEXTILE	Level terrain = 25%, Rolling terrain = 15%			685()	SY	$5.30	14,667	8,800		684,383	601,505	1,179,487	784,912	451,762	$3,627,233	$3,187,976	$6,251,284	$4,160,033	$2,394,338
SIGNING					LANE-MILE	$1,000.00				158	143	216	128	56	$157,520	$143,220	$215,900	$127,500	$28,071
														SUBTOTAL	**$147,559,146**	**$188,283,104**	**$187,435,201**	**$106,922,399**	**$72,249,309**
														DRAINAGE MEASURES (10%)	$14,800,000	$18,900,000	$18,800,000	$10,700,000	$7,300,000
														EROSION and POLLUTION (3%)	$4,500,000	$5,700,000	$5,700,000	$3,300,000	$2,200,000
														SURVEYING (3%)	$4,500,000	$5,700,000	$5,700,000	$3,300,000	$2,200,000
														CONSTRUCTION TRAFFIC CONTROL (5%)	$7,400,000	$9,500,000	$9,400,000	$5,400,000	$3,700,000
														CONTRACTOR FURNISHED (1%)	$1,500,000	$1,900,000	$1,900,000	$1,100,000	$800,000
														MOBILIZATION (10%)	$14,800,000	$18,900,000	$18,800,000	$10,700,000	$7,300,000
														SUBTOTAL	**$195,059,146**	**$248,883,104**	**$247,735,201**	**$141,422,399**	**$95,749,309**
														CONTINGENCY (30%)	$58,517,744	$74,664,931	$74,320,560	$42,426,720	$28,724,793
														CONSTRUCTION SUBTOTAL	**$253,600,000**	**$323,600,000**	**$322,100,000**	**$183,900,000**	**$124,500,000**
														ENVIRONMENTAL STUDY & PERMITTING (3%)	$7,608,000	$9,708,000	$9,663,000	$5,517,000	$3,735,000
														CONSTRUCTION ADMINISTRATION (15%)	$38,100,000	$48,600,000	$48,400,000	$27,600,000	$18,700,000
														PROJECT CAMP (2%)	$5,100,000	$6,500,000	$6,500,000	$3,700,000	$2,500,000
														SUBTOTAL	**$304,408,000**	**$388,408,000**	**$386,663,000**	**$220,717,000**	**$149,435,000**
														DESIGN (10%)	$30,500,000	$38,900,000	$38,700,000	$22,100,000	$15,000,000
														UTILITIES (0.5%)	$1,600,000	$2,000,000	$2,000,000	$1,200,000	$800,000
														RIGHT-of-WAY	$5,700,000	$1,400,000	$4,200,000	$1,500,000	$45,000
														SUBTOTAL	**$342,208,000**	**$430,708,000**	**$431,563,000**	**$245,517,000**	**$165,280,000**
														ICAP(5%)	$17,110,400	$21,535,400	$21,578,150	$12,275,850	$8,264,000
														TOTAL	**$359,400,000**	**$452,300,000**	**$453,200,000**	**$257,800,000**	**$173,600,000**
														Cost Per Mile	*$4,600,000*	*$6,300,000*	*$4,200,000*	*$4,000,000*	*$5,200,000*

Subtotal for Guardrail and Miscellaneous	**$16,384,054**	**$16,593,728**	**$17,031,580**	**$7,573,255**	**$3,718,001**
Subtotal for Earthwork	**$29,360,041**	**$29,257,971**	**$26,394,389**	**$9,962,400**	**$3,713,824**
Subtotal for road Structural Section	**$15,942,058**	**$14,494,804**	**$21,850,497**	**$12,903,837**	**$6,778,816**
Subtotal for Stream and River Crossings	**$83,664,000**	**$125,925,000**	**$119,439,000**	**$74,980,000**	**$57,312,000**

WEST SUSITNA ACCESS TO RESOURCE DEVELOPMENT
COST ESTIMATE for UPGRADING EXISTING ROADS

Alternatives	Length, mi	Terrain Summary		
		Level, mi	Rolling, mi	Mountainous, mi
Petersville Road	8.5	6.4	2.1	0.0
Oilwell Road 0-12.6	12.6	9.5	3.2	0.0
Oilwell Road 12.6-16.76	4.2	3.1	1.0	0.0
Oilwell Road Extension I	5.1	3.8	1.3	0.0
Oilwell Road Extension II	4.7	3.5	1.2	0.0

TYPICAL SECTION	
Roadway Width, ft =	24
STRUCTURAL SECTION, in	
Gravel Wearing Surface =	4
Borrow "A" =	48

DESCRIPTION	ASSUMPTIONS	ASSUMPTION FACTORS		ITEM No	Pay Unit	Unit Price	Quantity Per Mile			Total Route Quantities					COST				
							Level	Rolling	Mountainous	Petersville Road	Oilwell Road MP0 to 12.6	Oilwell Road MP12.6 to 16.76	Oilwell Rd Extension I 5.1miles	Oilwell Rd Extension II 4.7miles	Petersville Road	Oilwell Road MP0 to 12.6	Oilwell Road MP12.6 to16.76	Oilwell Road Extension I 5.1 miles	Oilwell Road Extension II 4.7 miles
CLEARING				201 (1A)	ACRE	$3,092.40	6.4	9.7	0.0	0	23	15	18	17	$0	$70,549	$46,585	$57,111	$52,296
EARTHWORK																			
UNCLASSIFIED EXCAVATION				203 (3)	CY	$8.06	4,994	17,211	0	22,804	101,412	33,482	41,048	37,587	$183,865	$817,667	$269,960	$330,961	$303,056
EMBANKMENT BORROW C				203 (6C)	TON	$3.83	4,505	22,664	0	25,627	113,967	37,627	46,130	42,240	$98,153	$436,495	$144,113	$176,677	$161,780
STRUCTURAL SECTION																			
BORROW A				203 (6A)	TON	$3.25	51,954	51,954	0	147,187	654,616	216,127	264,963	242,623	$478,358	$2,127,501	$702,413	$861,131	$788,526
AGGREGATE SURFACE COURSE				301 (3)	TON	$23.73	3,218	3,218	0	27,351	40,544	13,386	16,411	15,027	$649,069	$962,149	$317,662	$389,441	$356,606
STREAM AND RIVER CROSSINGS																			
CONVENTIONAL BRIDGES	Length of bridge multiplied by 26' width.	26			SF	$350.00				2,730	1,010	1,245	0	0	$955,500	$353,500	$435,750	$0	$0
LONG SPAN BRIDGES	Length of bridge multiplied by 26' width.	26			SF	$1,000.00				0	0	0	0	0	$0	$0	$0	$0	$0
MINOR DRAINAGE CULVERT	Culvert length approximately 50' to daylight on eit	50		603()	LF	$150.00				2,550	3,800	1,250	1,530	1,401	$382,500	$570,000	$187,500	$229,500	$210,150
SMALL CULVERT	Culvert length approximately 50' to daylight on eit	50		603()	LF	$1,000.00				500	250	0	100	0	$500,000	$250,000	$0	$100,000	$0
LARGE CULVERT	Culvert length approximately 96' to daylight on eit	96		603()	LF	$5,000.00				0	192	0	192	192	$0	$960,000	$0	$960,000	$960,000
GUARDRAIL																			
GABION RETAINING WALLS	Walls are only used in mountainous terrain.	0.25	30	636(1)	CY	$0.00			0	0	0	0	0	0	$0	$0	$0	$0	$0
W-BEAM GUARDRAIL	Guardrail are only used in mountainous terrain.	0.5		606(1)	FT	$0.00			0	0	0	0	0	0	$0	$0	$0	$0	$0
END-SECTIONS (ET-2000)	Average length of guardrail installation at 250', terminals at either end.			606(11)	EACH	$0.00				0	0	0	0	0	$0	$0	$0	$0	$0
MISCELLANEOUS																			
TOPSOIL				620(1)	SY	$1.38	16,808	33,751	0	178,871	265,150	87,542	107,323	98,274	$246,842	$365,907	$120,807	$148,105	$135,618
SEEDING				618(1)	ACRE	$99.63	3.47	6.97	0.00	37	55	18	22	20	$3,682	$5,458	$1,802	$2,209	$2,023
GEOTEXTILE TEXTILE	Level terrain = 25%, Rolling terrain = 15%			685()	SY	$5.30	14,667	8,800		112,200	166,320	54,912	67,320	61,644	$594,660	$881,496	$291,034	$356,796	$326,713
SIGNING					LANE-MILE	$1,000.00				17	25	8	10	7	$17,000	$25,200	$8,320	$10,200	$3,503
														SUBTOTAL	$4,109,629	$7,825,922	$2,525,945	$3,622,131	$3,300,271
														DRAINAGE MEASURES (10%)	$500,000	$800,000	$300,000	$400,000	$400,000
														EROSION and POLLUTION (3%)	$200,000	$300,000	$100,000	$200,000	$100,000
														SURVEYING (3%)	$200,000	$300,000	$100,000	$200,000	$100,000
														CONSTRUCTION TRAFFIC CONTROL (5%)	$300,000	$400,000	$200,000	$200,000	$200,000
														CONTRACTOR FURNISHED (1%)	$100,000	$100,000	$100,000	$100,000	$100,000
														MOBILIZATION (10%)	$500,000	$800,000	$300,000	$400,000	$400,000
														SUBTOTAL	$5,909,629	$10,525,922	$3,625,945	$5,122,131	$4,600,271
														CONTINGENCY (30%)	$1,772,889	$3,157,777	$1,087,784	$1,536,639	$1,380,081
														CONSTRUCTION SUBTOTAL	$7,700,000	$13,700,000	$4,800,000	$6,700,000	$6,000,000
														ENVIRONMENTAL STUDY & PERMITTING (3%)	$231,000	$411,000	$144,000	$201,000	$180,000
														CONSTRUCTION ADMINISTRATION (15%)	$1,200,000	$2,100,000	$800,000	$1,100,000	$900,000
														PROJECT CAMP (2%)	$200,000	$300,000	$100,000	$200,000	$200,000
														SUBTOTAL	$9,331,000	$16,511,000	$5,844,000	$8,201,000	$7,280,000
														DESIGN (10%)	$1,000,000	$1,700,000	$600,000	$900,000	$800,000
														UTILITIES (0.5%)	$100,000	$100,000	$100,000	$100,000	$100,000
														RIGHT-of-WAY	$5,700,000	$1,400,000	$4,200,000	$1,500,000	$45,000
														SUBTOTAL	$16,131,000	$19,711,000	$10,744,000	$10,701,000	$8,225,000
														ICAP(5%)	$806,550	$985,550	$537,200	$535,050	$411,250
														TOTAL	$17,000,000	$20,700,000	$11,300,000	$11,300,000	$8,700,000
														Cost Per Mile	*$2,000,000*	*$1,600,000*	*$2,700,000*	*$2,200,000*	*$1,800,000*

Subtotal for Miscellaneous	**$862,184**	**$1,278,061**	**$421,963**	**$517,311**	**$467,857**
Subtotal for Earthwork	**$282,018**	**$1,254,163**	**$414,073**	**$507,637**	**$464,837**
Subtotal for road Structural Section	**$1,127,427**	**$3,089,649**	**$1,020,075**	**$1,250,572**	**$1,145,132**
Subtotal for Stream and River Crossings	**$1,838,000**	**$2,133,500**	**$623,250**	**$1,289,500**	**$1,170,150**

West Susitna Access Reconnaissance Study
West Susitna Access to Resource Development

Transportation Analysis Report

Appendix E: Annotated Bibliography

PDF Name/ Link to Electronic Copy	Document Title	Author	Publication Date	Publisher/Sponsor	Document Type (e.g., map, journal, report, etc.)	Category/ Resource Type (e.g., coal, oil and gas, forestry, etc.)	Document Summary
ADF&G Division of Subsistence_1987_ Report_Fish and Game Harvest and Use Middle Susitna Basin.pdf	Fish and Game Harvest and Use in the Middle Susitna Basin: The Results of a Survey of Residents of the Road-Connected Areas of Game Management Units 14B and 16A, 1987	James A. Fall and Dan J. Foster	April 1987	Alaska Department of Fish and Game Division of Subsistence	Report	Recreation in Middle Susitna Basin	This report presents 1986 patterns of wild resource use by residents of the portion MatSu Borough in Game Management Units 14B and 16A.
ADF&G_2007_Technical Report_Harvest and Uses of Wild Resources in Tyonek and Belgua 2005-2006.pdf	Harvest and Uses of Wild Resources in Tyonek and Belgua 2005-2006	Stanek,Holen, and Wassillie	November 2007	Alaska Dept. of Fish and Game, Division of Subsistence	Technical Report	Subsistence	The report describes patterns in the harvest and use of fish, land and marine mammals, birds, and wild plants by the residents of Tyonke and Beluga. It updates baseline information first documented in the 1980s.
ADF&G_1994_Management Plan_Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan.pdf	Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan	Alaska Department of Fish and Game (ADF&G)-Divisions of Habitat Restoration and Wildlife Conservation	July 1994	Alaska Department of Fish and Game (ADF&G)-Divisions of Habitat Restoration and Wildlife Conservation	Management Plan	Land and habitat management plan	This management plan includes goals, policies, and statutes for the management of the Trading Bay State Game Refuge.
ADNR DGGS_2003_Map_Geologic Map of Proposed Transportation Corridors (Talkeetna).pdf	Geologic Map of Proposed Transportation Corridors in the Talkeetna Quadrangle, Alaska	D.S.P Stevens and R.L. Smith	2003	Alaska Geological & Geophysical Surveys	Map	Previous identified alignment	This geologic map depicts several proposed transportation corridors in the Study Area. The identified corridors on this map are called McGrath-Upper Cook Inlet Corridor and "Lime Village-Rainy Pass Link."
ADNR DGGS_2003_Map_Geologic Map of Proposed Transportation Corridors (Tyonek).pdf	Geologic Map of Proposed Transportation Corridors in the Tyonek Quadrangle, Alaska	R.D. Reger, G.R. Cruse, D.S.P. Stevens, and R.L. Smith	2003	Alaska Geological & Geophysical Surveys	Map	Previous identified alignment	This geologic map depicts several proposed transportation corridors in the Study Area. The identified corridors are called "McGrath-Upper Cook Inlet," "Wasilla Link," "Willow Link," and "McGrath-Upper Cook Inlet."
ADNR DGGS_2003_Report_Survey of Geology, Geologic Materials and Geologic Hazards in Proposed Access Corridors.pdf	Survey of Geology, Geologic Materials, and Geologic Hazards in Proposed Access Corridors, Alaska	Division of Geological & Geophysical Surveys	2003	Alaska Department of Natural Resources: Division of Geological & Geophysical Surveys	Report	Geology and Geologic Hazards	This report presents the results of 1992 1:250,000-scale maps of the geology, geologic materials, and geologic hazards for 10-mile-wide corridors containing proposed access routes, as well as a summary overview to accompany the re-drafted, single-quadrangle digital map suites.
ADNR DGGS_2011_Report_Alaskas Mineral Industry 2011 Exploration Activity.pdf	Alaska's Mineral Industry 2011- Exploration Activity, Special Report 67	D.J. Szumigala	2011	Alaska Department of Natural Resources: Division of Geological & Geophysical Surveys	Report	Mineral Industry	This report provides a summary of Alaska's mineral industry exploration activity for 2011 based on press releases, company annual and financial reports, phone interviews, other research, and replies to questionnaires.
ADNR DGGS_2012_Report_Fossil Fuel and Geothermal Energy Sources For Local Use in Alaska.pdf	Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska: Summary of Available Information, Special Report 66	Alaska DNR-Division of Geological & Geophysical Surveys	2012	Alaska DNR-Division of Geological & Geophysical Surveys	Report	Coal, oil and gas, geothermal	This report includes a summary of fossil fuel and geothermal resource potential in the Railbelt Energy Region and other regions in the State. Potential resources included are mineable coal, conventional and unconventional oil and gas resource, and geothermal.
ADNR DGGS_2012_Report_Alaska Geological & Geophysical Survey Annual Report 2011.pdf	Alaska Division of Geological & Geophysical Surveys Annual Report 2012	ADNR-Division of Geological & Geophysical Surveys	January 2013	ADNR-Division of Geological & Geophysical Surveys	Report	Energy resources, mineral resources	This annual report summarizes the Alaska Geological & Geophysical Surveys' recent efforts, in particular, as it relates to energy and mineral resources.
ADNR DGGS_2012_Report_Alaska Geological & Geophysical Survey Annual Report 2011.pdf	Alaska Geological & Geophysical Survey Annual Report 2011	ADNR-Division of Geological & Geophysical Surveys	Jan. 2012	Alaska Geological & Geophysical Surveys	Report	Energy resources, mineral resources	This annual report summarizes the Alaska Geological & Geophysical Surveys' recent efforts, in particular, as it relates to energy and mineral resources.
ADNR DGGS_2013_Map_Alaskas Mineral Resources 2012.pdf	Alaska's Mineral Resources-2012	Werdon and Freeman	2013	Alaska Department of Natural Resources: Division of Geological & Geophysical Surveys	Map	Mineral Resources	This map shows mineral the location of mineral prospects, such as gold, coal, iron, mercury, etc., throughout the State.
ADNR DGGS_2013_Report_Status of a Reconnaissance Field Study of the Susitna Basin.pdf	Status of a Reconnaissance Field Study of the Susitna Basin, 2011	Robert J. Gillis, et al.	Apr. 2013	Alaska Department of Natural Resources: Division of Geological & Geophysical Surveys	Report	Susitna Basin	The Alaska Division of Geological & Geophysical Surveys (DGGS) and Alaska Division of Oil and Gas (DOG), in collaboration with the U.S. Geological Survey (USGS) performed reconnaissance field studies in the Susitna basin, directly north of Cook Inlet, to reconnoiter outcrops in the basin and along its periphery. This overview report summarizes new information found regarding the basin's formation history and stratigraphy.
ADNR Division of Forestry_2007_Regulations_Forest Resources and Practices Regulations.pdf	Alaska Forest Resources and Practices Regulations	Alaska Department of Natural Resources - Division of Forestry	2007	Alaska Department of Natural Resources - Division of Forestry	Regulations	Forestry	Alaska Forest Resources and Practices Regulations
ADNR Division of Forestry_2010_Report_Forest Resources on State Forest Lands in Susitna Valley.pdf	Forest Resources on State Forest Lands in the Susitna Valley Interim Report 2010	Douglas Hanson	Nov. 2010	Alaska Department of Natural Resources: Division of Forestry Northern Region	Report	Forestry Resources	This report provides a comprehensive stand-based inventory of the Susitna Valley. It was conducted by the Division of Forestry (DOF) to obtain biomass resource information and identify suitable biomass resources for timber production.
ADNR Division of Forestry_2012_Public Brief_Proposed Susitna State Forest.pdf	Public Brief Proposed Susitna State Forest		December 10, 2012	Alaska DNR-Division of Forestry	Public Brief	Forestry	This two page document briefly describes DNR's proposed Susitna State Forest Lands.
ADNR Division of Gas_2011_Report_Annual Report.pdf	Alaska Department of Natural Resources Division of Oil & Gas Annual Report 2011	Alaska Department of Natural Resources Division of Oil & Gas	2011	Alaska Department of Natural Resources Division of Oil & Gas	Report	Oil and Gas	This report provides an overview of the Department of Oil and Gas' operations in 2011. It discusses its oil and gas royalty, and provides data regarding north slope production, cook inlet production, exploration wells, and development wells. The report also provides a summary table of statewide undiscovered, technically recoverable conventional oil and gas.
ADNR Division of Gas_2011_Report_Cook Inlet Natural Gas Production Cost Study.pdf	Cook Inlet Natural Gas Production Cost Study	Alaska DNR-Division of Oil and Gas et al.	June 2011	Alaska DNR-Division of Oil and Gas	Report	Gas	This study, primarily conducted by DNR-Division of Oil and Gas staff, attempts to quantify remaining gas reserves in the Cook Inlet Basin.
ADNR Division of Oil and Gas_2012_Map_Cook Inlet Oil and Gas Activity.pdf	Cook Inlet Unit Land and Lease Working Interest Ownership	Alaska DNR-Division of Oil and Gas	December 2012	Alaska DNR-Division of Oil and Gas	Map	Oil and gas	This Land and Lease Working Interest Ownership map depicts producing units and fields, non-producing fields, platforms and gas storage lease areas in Cook Inlet, as of December 2012.

PDF Name/ Link to Electronic Copy	Document Title	Author	Publication Date	Publisher/Sponsor	Document Type (e.g., map, journal, report, etc.)	Category/ Resource Type (e.g., coal, oil and gas, forestry, etc.)	Document Summary
ADNR ML&W 2012 FactSheet Petersville Recreation Mining Area.pdf	Petersville Recreation Mining Area	Alaska Department of Natural Resources Division of Mining, Land & Water	Jun. 2012	Alaska Department of Natural Resources Division of Mining, Land & Water	Fact Sheet	Mining	This fact sheet provides answers to general questions about the two designated recreational mining areas near the Petersville Road. A map of the area is also provided.
ADNR ML&W 2012 Preliminary Decision Proposed Land Offering in the Matanuska-Susitna Borough Tundra Isles Subdivision.pdf	Proposed Land Offering in the Matanuska-Susitna Borough Tundra Isles Subdivision – ADL 230819 AS 38.05.035(e), AS 38.05.045	Alaska Department of Natural Resources - Division of Mining, Land, and Water (DML&W)	December 2013	Alaska Department of Natural Resources - Division of Mining, Land, and Water (DML&W)	Preliminary Decision	Settlement Lands	Describes proposal to offer State-owned land for sale for private ownership. Project area consists of approximately 14,620 acres and is within the Susitna Matanuska Area Plan (SMAP), Petersville Road Region, Management Unit P-04
ADNR ML&W 2013 FactSheet TitleR.S.2477 Rights of Way.pdf	Fact Sheet: Title R.S. 2477 Rights-of-Way	Alaska Department of Natural Resources - Division of Mining, Land, and Water (DML&W)	2013	Alaska Department of Natural Resources - Division of Mining, Land, and Water (DML&W)	Fact Sheet	Recreation	This fact sheet explains the origin of a century-old mining law that has broad implications for Alaska's future. It is intended to illustrate the potential this law has in helping preserve Alaska's public access options for the future
ADNR 1985 Area Plan Susitna Area Plan.pdf	Susitna Area Plan	Alaska Department of Natural Resources (DNR), ADF&G, and Matanuska Susitna Borough (MSB) with U.S. Department of Agriculture (USDA)	June 1985	Alaska Department of Natural Resources (DNR), ADF&G, and Matanuska Susitna Borough (MSB) with U.S. Department of Agriculture (USDA)	Area Plan	General land management	The plan includes areawide land management policies, including for forestry, recreation, and transportation, and other topics in the Susitna area.
ADNR 1991 Guidelines Report Susitna Forestry Guidelines.pdf	Susitna Forestry Guidelines	Alaska DNR-Division of Land, Land & Resources Section	December 1991	Alaska DNR-Division of Land, Land & Resources Section	Guidelines Report	Forestry	The document directs management of forest resources, sets standards for timber management and access, identifies areas available for timber harvesting, summarizes current timber volumes, and establishes the annual allowable cut for the Susitna valley area
ADNR 1991 Management Plan Susitna Basin Recreation Rivers Management Plan.pdf	Susitna Basin Recreation Rivers Management Plan	Alaska DNR-Division of Land, Land & Resources Section	August 1991	Alaska DNR-Division of Land, Land & Resources Section	Management Plan	Recreation	The contents of this Susitna Basin Recreation Rivers management plan include areawide land and water management policies, land and water management policies for each unit, and implementation recommendations
ADNR 2008 Area Plan Southeast Susitna Area Plan.pdf	Southeast Susitna Area Plan for State Lands	Alaska Department of Natural Resources-Division of Mining, Land and Water (DNR-MLW), Resource Assessment and	April 2008	Alaska Department of Natural Resources-Division of Mining, Land and Water (DNR-MLW), Resource	Area Plan	General land management	The plan for the southeast Susitna area includes areawide land management policies, including for forestry, material sites, recreation, public access, and other topics.
ADNR 2011 Area Plan Susitna Matanuska Area Plan for State Lands.pdf	Susitna Matanuska Area Plan for State Lands	Alaska DNR-MLW, Resource Assessment and Development Section	August 2011	Alaska DNR-MLW, Resource Assessment and Development Section	Area Plan	General land management	The plan for the Susitna Matanuska Area includes areawide land management policies, including for forestry, material sites, recreation, public access, and other topics.
ADNR 2012 Map Cook Inlet Oil and Gas Activity.pdf	Cook Inlet Oil and Gas Activity 2012	Alaska DNR-Division of Oil and Gas	December 2012	Alaska DNR-Division of Oil and Gas	Map	Oil and gas	This map depicts oil and gas activity in Cook Inlet as of December 2012.
ADNR 2012 PowerPoint Strategic&CriticalMineralsSummit.pdf	2012 Strategic and Critical Minerals Summit: Access to our Land and Resources	Deputy Commissioner Ed Fogels	2012	Alaska Department of Natural Resources	PowerPoint Presentation	Natural Resources	This PowerPoint presentation discusses current land ownership statewide, roads to resources projects, and permitting reform efforts
ADNR 2012 Preliminary Decision Canyon Creek Area Coal Preliminary Decision.pdf	Preliminary Decision: Competitive Coal Lease Sale in the Canyon Creek Area, Alaska (ADL 553937)	Alaska Department of Natural Resources - Division of Mining, Land, and Water (DML&W)	2012	Alaska Department of Natural Resources - Division of Mining, Land, and Water (DML&W)	Preliminary Decision	Coal	The DNR issued a regulatory best interest finding (BIF) in favor of holding a competitive coal lease in the Canyon Creek area. This document describes the existing coal resources, project area, environmental conditions, and potential transportation routes
ADOLWD 2013 Report Economic Trends Mining Industry.pdf	Alaska Economic Trends May 2013: Alaska's Mining Industry	Alaska Department of Labor & Workforce Development	May. 2013	Alaska Department of Labor & Workforce Development	Report	Mining	This report provides a summary of Alaska's mining industry, a profile of new resident workers, and an assessment of unemployment in Alaska.
AgnewBeck and Jade North 2007 Management Plan Fish Creek Management Plan Draft Alternatives.pdf	Fish Creek Management Plan Draft Alternatives	Agnew::Beck Consulting, LLC, JadeNorth Consulting	May 2, 2007	Matanuska-Susitna Borough	Management Plan	Fish Creek Development	This document presents and evaluates a set of three general alternatives for the future of the Fish Creek area. Considerations in developing these alternatives included: physical characteristics of the site, market demands for different uses, costs for extending access into the area, and applicable government land use policies, including the policies of the previous plan
AgnewBeck and Jade North 2009 Management Plan Fish Creek Management Plan.pdf	Fish Creek Management Plan	Agnew::Beck Consulting, LLC and Jade North Consulting	October 2009	MSB	Management Plan	General land management	This plan guides the use of 43,330 acres of land managed by the Matanuska Susitna Borough and by the Alaska Department of Natural Resources. Specifically, the plan considers agriculture, local food sources, recreation and forest products. Map 1.3 identifies a number of potential access routes into the area
AK Department of Highways 1972 Map Chuitna River to Goose Bay ROW map Sheet 1 of 6.pdf	Chuitna River to Goose Bay Right of Way Map (Sheet 1 of 6)		May 1972	Alaska Department of Highways	Map	Previous identified alignment	This Right of Way sheet (dated 1972) identifies a road corridor between Chuitna River and Goose Bay. Stream crossings are denoted.
AK Department of Highways 1972 Map Chuitna River to Goose Bay ROW map Sheet 2 of 6.pdf	Chuitna River to Goose Bay Right of Way Map (Sheet 2 of 6)		May 1972	Alaska Department of Highways	Map	Previous identified alignment	This Right of Way sheet (dated 1972) identifies a road corridor between Chuitna River and Goose Bay. Stream crossings are denoted.
AK Department of Highways 1972 Map Chuitna River to Goose Bay ROW map Sheet 4 of 6.pdf	Chuitna River to Goose Bay Right of Way Map (Sheet 4 of 6)		May 1972	Alaska Department of Highways	Map	Previous identified alignment	This Right of Way sheet (dated 1972) identifies a road corridor between Chuitna River and Goose Bay. Stream crossings are denoted.
AK Department of Highways 1972 Map Chuitna River to Goose Bay ROW map Sheet 5 of 6.pdf	Chuitna River to Goose Bay Right of Way Map (Sheet 5 of 6)		May 1972	Alaska Department of Highways	Map	Previous identified alignment	This Right of Way sheet (dated 1972) identifies a road corridor between Chuitna River and Goose Bay. Stream crossings are denoted.
AK Department of Highways 1972 Map Chuitna River to Goose Bay ROW map Sheet 6 of 6.pdf	Chuitna River to Goose Bay Right of Way Map (Sheet 6 of 6)		May 1972	Alaska Department of Highways	Map	Previous identified alignment	This Right of Way sheet (dated 1972) identifies a road corridor between Chuitna River and Goose Bay. Stream crossings are denoted.

PDF Name/ Link to Electronic Copy	Document Title	Author	Publication Date	Publisher/Sponsor	Document Type (e.g., map, journal, report, etc.)	Category/ Resource Type (e.g., coal, oil and gas, forestry, etc.)	Document Summary
AK Department of Highways_1972_Map_Chuitna River to Goose Bay ROW map Sheet 3 of 6.pdf	Chuitna River to Goose Bay Right of Way Map (Sheet 3 of 6)		May 1972	Alaska Department of Highways	Map	Previous identified alignment	This Right of Way sheet (dated 1972) identifies a road corridor between Chuitna River and Goose Bay. Stream crossings are denoted.
AKDOT&PF Northern Region_Technical Report_Highway Rights of Way in Alaska.pdf	Highway Rights of Way in Alaska		November 1993	Alaska Department of Transportation and Public Facilities (AKDOT&PF)	Technical Report	Transportation	This technical report is a compilation of notes relating to highway rights of way in Alaska. The discussion in this paper is primarily limited to those highway rights of way established by State or Federal legislation and under the jurisdiction of the predecessors of the Department of Transportation and Public Facilities. The primary intent of this presentation is to provide the land professional with an understanding of the process by which many of the highway rights of way in Alaska were established as well as some guidelines and sources of information which can be used to determine whether a particular property is impacted by these
AKDOT&PF_2010_Report_Little Susitna River Access Road and Bridge_57048.pdf	Little Susitna River Access Road and Bridge 57048 Alternatives Analysis		November 2010	Alaska Department of Transportation and Public Facilities (AKDOT&PF)	Report	Transportation	The report decribes alternatives considered for the the Little Susitna River Access Road and Bridge project.
Alaska Energy Authority_2010_Report_Railbelt Large Hydroelectric Evaluation Preliminary Decision Document.pdf	Railbelt Large Hydro Evaluation Preliminary Decision Document		November 23, 2010	Alaska Energy Authority	Report	Hydroelectric	This document provides a risk analysis comparison of two proposed hydroelectric projects (Susitna Watana and Chakachamna). Engineering issues such as access and transmission are included in the analysis.
Alaska Energy Authority_2011_Presentation_Mt. Spurr Geothermal Presentation Slides.pdf	The Mount Spurr Geothermal Project Presentation to House and Senate Resource Committees	Ormat	January 24, 2011		Presentation slides	Geothermal	These presentation slides include an estimated timeline, proposed infrastructure needs, expected amount of power, and legislative needs for the proposed Mount Spurr Geothermal project.
Alaska Energy Authority_2012_Report_Mt. Spurr Geothermal Final Year-End 2011.pdf	Mount Spurr Geothermal Project - Final Report for Year End 2011	Orni 46, LLC	February 6, 2012	Alaska Energy Authority	Report	Geothermal	This report includes basic project information, a summary of 2010 exploration, 2011 permitting efforts, and recommendations for the Mount Spurr Geothermal project.
Alaska Journal Of Commerce_2013_Article_State Forecasts Major Drop in Revenues Oil Production.pdf	State forecasts major drop in revenues, oil production		December 2013	Alaska Journal of Commerce	Article	Oil and gas	The newspaper article provides a revenue forecast based on an Alaska North Slope oil price of $105.68 per barrel for fiscal year 2014 and $105.06 per barrel for fiscal year 2015.
Alaska Mental Health Trust_2010_License Prospectus_Underground Coal Gasification Exploration License Prospectus.pdf	Underground Coal Gasification Exploration License Prospectus		June 2010	The Alaska Mental Health Trust, Trust Land Office	Prospectus	Underground coal gasification	This exploration license prospectus discusses and summarizes some of the possibilities for deep coal deposits amenable to underground coal gasification resource extraction, describes the Tracts being offered, and the application process.
Alaska Resource Data Files_2013_Resource Data Files_Study Area Prospect Files.pdf	Alaska Resource Data Files			U.S. Geological Survey (USGS)	Resource data files	Hardrock mineral	This pdf is a compilation of the USGS' Alaska Resource Data Files (ARDF) for prospects in the Study Area. The files contain descriptions of mines, prospects, and mineral occurrences.
AOGCC_2013_Webpage_Aurora Gas Lone Creek Pool Statistics.pdf	Alaska Oil and Gas Conservation Commission (AOGCC) Pool Statistics Lone Creek Field, Undefined Gas Pool		n.d. accessed 2/2013	Aurora Gas, LLC	Webpage	Natural gas	The AOGCC webpage includes a summary of statistics and production for Aurora Gas LLC's Lone Creek Field.
AOGCC_2013_Webpage_Aurora Gas Moquawkie Field Pool Statistics.pdf	AOGCC Pool Statistics Moquawkie Field, Undefined Gas Pool		n.d. accessed 2/2013	Aurora Gas, LLC	Webpage	Natural gas	The AOGCC webpage includes a summary of statistics and production for Aurora Gas LLC's Moquawkie Field.
AOGCC_2013_Webpage_Aurora Gas Nicolai Creek Unit Pool Statistics.pdf	AOGCC Pool Statistics Nicolai Creek Unit, Undefined Gas Pool		n.d. accessed 2/2013	Aurora Gas, LLC	Webpage	Natural gas	The AOGCC webpage includes a summary of statistics and production for Aurora Gas LLC's Nicolai Creek Unit.
AOGCC_2013_Webpage_ConocoPhillips Beluga River Coal.pdf	AOGCC Pool Statistics Beluga River Field, Undefined Gas Pool		n.d. accessed 2/2013	AOGCC	Webpage	Gas	The AOGCC webpage includes statistics regarding the status, geology and production of ConocoPhillips Alaska Inc.'s Beluga River Unit No. 1.
APA_1982_Report_Surveys & Site Facilities Access Roads.pdf	Susitna Hydroelectric Project: Task 2- Surveys and Site Facilities	Acres	Mar.1982	Alaska Power Authority	Report	Hydroelectric Power	This report defines alternative access routes required for construction and operation of the power developments at the Watana and Devil Canyon damsites of the Susitna Hydroelectric Project. It evaluates the related economical, environmental and engineering factors involved with each alternative and selects a preferred route.
Bureau of Public Roads_1959_Report_Description of Public Road Routes in Alaska.pdf	A Description of Proposed Routes in Alaska: Talkeetna-McGrath-Ruby	Rose s. Komatsubara and William D. DeArmond	Aug. 1959	Bureau of Public Roads Region 10	Report	Transportation	This report describes the existing conditions in 1959, the proposed transportation routes in Talkeetna-McGrath-Ruby area, and how construction of proposed routes may aid in the development of the area's natural resources.
CIRI_Factsheet_Stone Horn Ridge.pdf			n.d. accessed 2/2013	Cook Inlet Region, Inc. (CIRI)	Factsheet	Underground coal gasification	This factsheet includes a brief description of CIRI's Stone Horn Ridge project and a proposed project site figure depicting stratigraphic core holes.
CIRI_Map_Beluga_Stone Horn Ridge.jpg	CIRI Land Rights Map - Cook Inlet Region		Jan. 2001	Cook Inlet Region, Inc. (CIRI)	Map	Mining	Map of CIRI surface and subsurface rights in the Cook Inlet Region.
CIRI_Webpage_Stone Horn Ridge.pdf			n.d. accessed 2/2013	Cook Inlet Region, Inc. (CIRI)	Stone Horn Ridge project webpage	Underground coal gasification	This webpage includes a brief description of CIRI's Stone Horn Ridge project.
ConocoPhillipsAlaska_2012_Fact Sheet_North Cook Inlet Gas Field.pdf	Kenai Liquefied Natural Gas Plant and North Cook Inlet Gas Field, Alaska		August 2012	ConocoPhillips Alaska	Factsheet	Natural gas	This factsheet describes the facility, technology, and history of the Kenai Liquefied Natural Gas Plant and North Cook Inlet Gas Field.
CookInletEnergy_2013_Permit Application_Plan of Operations Permit Application.pdf	Alaska DNR-Division of Oil and Gas: Lease/Unit Plan of Operations Application for Kroto Creek Site Development		February 7, 2013	Cook Inlet Energy, LLC	Lease/Unit Plan of Operations Application	Natural gas	This is Cook Inlet Energy's application for creating a groomed winter trail and drilling pad in preparation for exploratory drilling activities on the Kroto Creek Prospect, which is located in Susitna Basil Oil & Gas Exploration License #2.

PDF Name/ Link to Electronic Copy	Document Title	Author	Publication Date	Publisher/Sponsor	Document Type (e.g., map, journal, report, etc.)	Category/ Resource Type (e.g., coal, oil and gas, forestry, etc.)	Document Summary
CookInletEnergy_2013_Exploration License Plan of Operations_Kroto Creek Access Trail and Pad Susitna Exploration License #2.pdf	Exploration License Plan of Operations for Kroto Creek Access Trail and Pad, Susitna Exploration License #2 Cook Inlet Area Exploration Program		February 11, 2013	Cook Inlet Energy, LLC	Exploration License Plan of Operations	Natural gas	This Plan of Operations describes the project, location and site development, general operations, including access construction and other topics for the Kroto Creek Access Trail and Pad in the Susitna Exploration License #2 area.
Freeman_2013_PowerPoint_Alaska Mineral Industry Overview.pdf	Alaska Mineral Industry Overview: AMEbc Mineral Exploration Roundup 2013	Curt Freeman and Melanie Werdon	1/28/2013	Alaska Division of Geological & Geophysical Surveys, Department of Natural Resources	PowerPoint Presentation	Mining	This powerpoint presentation describes recent mining activity, exploration, investments and commitments, 2012 production, and potential future prospects/endeavors.
Hanson et a.l_2009_Technical Report_Donlin Creek Gold Project.pdf	Nova Gold Resources Inc. Donlin Creek Gold Project NI 43-101 Technical Report	Hanson et al.	April 2009	Nova Gold Resources, Inc.	Report	Gold	The contents of this report includes a description of the Nova Gold's Donlin Creek Gold project property location, including proposed mining operations area, accessibility, local resources and infrastructure, history, geologic setting, mineralization, exploration, and mineral resource estimates.
Hard copy only	Lower Susitna Boating Access Study: Willow Creek Site	HDR Alaska, Inc.	Nov. 2000	Alaska Department of Fish and Game	Final Report	Lower Susitna River	This report identifies a site selection for developing a new boat launch (small or large scale) and evaluates physical qualities of sites at Willow Creek RM 49.0. The report includes total life-cycle costs.
Hard copy only	Lower Susitna River	R&M Consultants for Harza-Ebasco Susitna Joint Venture	2/7/1984	Alaska Power Authority	28 11x17 B&W photography sheets	Susitna River	28 11x17 B&W photography sheets
Hard copy only	Lower Susitna River Boating Access Study	HDR Alaska, Inc.	Dec. 1997	Alaska Department of Fish and Game	Final Report	Lower Susitna River	This report identifies a site selection for developing a new boat launch and evaluates physical qualities of sites at RM 39.5, and at Willow Creek (RM 49 to RM 50) and Deshka Landing (RM 45.5). The report also includes permitting prospects and total life-cycle cost for each site.
Hard copy only	River Morphology	R&M Consultants for ACRES AMERICAN INC.	Jan. 1982	Alaska Power Authority	Final Report	Susitna River	The following topics related to the Susitna River are discussed in this report: basin overview, flow regime, sediment regime, regime analysis, side channels and sloughs, and ice processes.
Hard copy only	Susitna Hydroelectric Project Effects on Navigation	R&M Consultants, Stephen Bredthauer and Bob Butera for Harza-Ebasco Susitna Joint Venture	1985	Alaska Power Authority	Final Report	Susitna River	This report includes a description of the following: Susitna River morphology, watercraft, access, destinations, river use, navigation restrictions and Susitna Hydroelectric Project effects on flow regimen, river morphology, thermal and ice rgime, and navigation.
Hard copy only	West Cook Inlet Ethnographic Overview and Assessment for Lake Clark National Park & Preserve	Stanek, R.T., Fall, J.A., and D.L. Holen	2006	U.S. Dept. of the Interior, National Park Service	Report	Subsistence	Describes the culture and history of the people and communities of western Cook Inlet, southcentral Alaska. A primary goal is to identify the traditional and contemporary associations between the people and comunities of western Cook Inlet and the Lake Clark National Park and Preserve.
Holen and Fall_ 2011_Technical Report_Overview of Subsistence Salmon Fisheries in the Tyonek Subdistrict and Yetna River Cook Inlet.pdf	Overiview of Subsistence Salmon Fisheries in the Tyonek Subdistric and Yentna River, Cook Inlet, Alaska	Davin Holen and James A. Fall	2011	Alaska Dept. of Fish and Game, Division of Subsistence	Technical Report	Subsistence	This report provides background on the subsistence harvest and uses of salmon in the Tyonek Subdistrict and Yentna River, in Upper Cook Inlet.
Juneau Economic Development Council_2008_Report_Preliminary Feasibility Assessment for High Efficiency, Low Emission Wood Heating inTyonek.pdf	Juneau Economic Development Council	Juneau Economic Development Council	2008	Native Village of Tyonek	Report	Alternative Energy	This reports discusses the condiitions of four facilities in Tyonek and attempts to demonstrate, by use of a realistic, though hypothetical, example, the feasibility of installing a high efficiency, low emission cordowood boiler to heat the tribal center, snack bar, boys and girls club, and the Justin Time General Store.
KABATA_2011_Permit Application Appendix_404 Permit Attachment A_Project Description.pdf	Knik Arm Crossing 404 Permit Attachment A - Project Description		2011	KABATA	Permit Application Appendix	Transportation	Permit appendix provides a general project description and purpose, project overview, and a description of the selected alternative.
Kiska_2013_Presentation_Whistler project.pdf	The Whistler Project: An Emerging Gold-Copper Porphyry District	Jason Weber, President & CEO	February 2013	Kiska Metals Corporation	Whistler Project Presentation	Hardrock mineral	These presentation slides show the status of the Whistler Project and give a description of the resources.
Kiska_2013_Webpage_Whistler project.pdf	Whistler Project Webpage	Kiska Metals Corporation	n.d. accessed 2/2013	Kiska Metals Corporation	Whistler Project Webpage	Hardrock mineral	This webpage includes a description of the site property, 2012 program, and resource amount (2008 and 2011) for the Whistler project.
Kiska_Webpage_Copper Joe Project.pdf	Copper Joe Project Webpage	Copper Joe Project Webpage	n.d. accessed 2/2013	Kiska Metals Corporation	Copper Joe Project Webpage	Hardrock mineral	This webpage includes a description of the property status and overview of the Copper Joe project.
Koontz and Wall_2013_Technical Report_Chickaloon Biomass Pre-Feasibility Study.pdf	Chickaloon Biomass Pre-feasibility Study	Greg Koontz, ME and Bill Wall, PhD	July 2013	Chickaloon Tribal Administration Office	Technical Report	Alternative Energy	The report documents the results of a pre-feasibility study performed for the Village of Chickaloon. The subject of the study is the feasibility of converting two buildings to utilize an automated wood-fired heat boiler as the primary source.
Land Design North_2001_Plan_MSB Parks and Recreation Open Space Plan.pdf	Matanuska-Susitna Borough Asset Management Plan: Parks, Recreation & Open Space Plan	Land Design North	June 2001	Matanuska-Susitna Borough	Plan	Recreation	This MSB plan is intended to provide management guidance and direction for all Borough-owned land and natural resources. Two proposed trail loops are located in the West Susitna Reconnaissance Study Area.
LincEnergy_2011_Application Package_Tyonek Area Exploration.pdf	Alaska DNR-Division of Mining, Land and Water Coal Exploration: Notice of Intent to Explore and Exploration Application package and response to DNR comments		August 29, 2011	Linc Energy Operations, Inc.	Permit application package	Underground coal gasification	This permit package contains Linc's applications for permits to drill and responses to DNR's comments for their underground coal gasification efforts near Tyonek.
Mcdowell_2008_Report_MSBTourismInfrastructureNeedsStudy.pdf	Matanuska-Susitna Borough Tourism Infrastructure Needs Study	McDowell Group	Jun-08	Matanuska-Susitna Borough	Report	Recreation/Transportation Infrastructure	This report summarizes findings of a tourism infrastructure needs study, which looked at: existing tourism infrastructure, visitor markets, the value of tourism to the borough, and tourism infrastructure needs. Included in the report is discussion of recreation and fishing opportunities, wilderness lodges in the MatSu Borough (MSB), and MSB public airports.

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McDowell_2011_The_Role_of_Oil_and_Gas_Industry_in_Alaska's_Economy.pdf	The Role of the Oil and Gas Industry in Alaska's Economy	McDowell Group	October 2011	Alaska Oil and Gas Association (AOGA)	Report	Oil and gas	The report assesses the role of the oil and gas industry in Alaska's economy and in the economies of the Municipality of Anchorage, the Kenai Peninsula Borough, the Matanuska-Susitna Borough, the Fairbanks North Star Borough, the City of Valdez, and the North Slope Borough.
McDowell_2012_AK_Mining_Industry_Economic_Impacts.pdf	The Economic Impacts of Alaska's Mining Industry	McDowell Group	January 2012	Alaska Miners Association	Report	Mining	This report measures the economic impact of Alaska's mining industry (exploration activity, mine development and mineral production). Direct, indirect, and induced economic impacts of the mining industry in 2010 are examined.
Millrock_Cristo_project_webpage.pdf	Cristo Project Webpage		n.d. accessed 2/2013	Millrock Resources Inc.	Cristo Project Webpage	Hardrock mineral	This webpage includes a project and resource description and site photos for the Cristo project.
Millrock_Distin_project_webpage.pdf	Distin Project Webpage		n.d. accessed 2/2013	Millrock Resources Inc.	Distin Project Webpage	Hardrock mineral	This webpage includes a project and resource description and site photos for the Distin project.
Millrock_Estelle_2012_project_presentation.pdf	Estelle Project Presentation slides		2012	Millrock Resources Inc.	Estelle Project Presentation slides	Hardrock mineral	These presentation slides are from a 2012 presentation for the Estelle project.
Millrock_Estelle_2012_project_presentation.pdf	Estelle Project Webpage		n.d. accessed 2/2013	Millrock Resources Inc.	Estelle Project Webpage	Hardrock mineral	This webpage includes a project and resource description and site photos for the Estelle project.
Millrock_Renegade_project_webpage.pdf	Renegade Project Webpage		n.d. accessed 2/2013	Millrock Resources Inc.	Renegade Project Webpage	Hardrock mineral	This webpage includes a project and resource description and site photos for the Renegade project.
Morris_2011_Resource_Estimate_Update_ForWhistler_Gold_Copper_Deposit.pdf	Resource Estimate Update for the Whistler Gold Copper Deposit and Results of Property Wide Exploration (Yentna Mining District, Alaska)	R.J. Morris, Moose Mountain Technical Services	March 17, 2011	Kiska Metals Corporation	Report	Hardrock mineral	This report documents the updated resource estimates for Kiska's Whistler Gold Copper Deposit. The report includes information on mineralization, exploration, and drilling conducted by Kiska and others, such as Cominco Alaska Inc., Kennecott, and Geoinformatics.
MSB and Mat-Su Resource Conservation & Development Council_2008_Plan_MSB Mat-Su Comprehensive Economic Development Strategy Plan.pdf	Mat-Su Comprehensive Economic Development Strategy December 2008 Update	Marty Metiva, Mat-Su Resource Conservation & Development Council	December 2008	Matanuska-Susitna Borough	Plan	Economic development	This MSB document is a comprehensive economic development strategy plan for a particular resource conservation and development area. The plan discusses mining, oil & gas, timber, agriculture and other potential resources to develop.
MSB_2008_Map_Recreational Trails Plan Map 12.pdf	MSB Recreational Trails Plan Map #12		2008	Matanuska-Susitna Borough	Map	Recreation	This map shows current and proposed recreational trails in the Trapper Creek/Petersville area in 2008.
MSB_2008_Map_Recreational Trails Plan Map 8.pdf	MSB Recreational Trails Plan Map #8		2008	Matanuska-Susitna Borough	Map	Recreation	This map shows current and proposed recreational trails in the Skwentna area in 2008.
MSB_2008_Map_Recreational Trails Plan Map Index.pdf	MSB Recreational Trails Plan Map Index		2008	Matanuska-Susitna Borough	Map	Recreation	This map is an index map for the 2008 MSB Recreational Trails Plan.
MSB_2010_Application_Susitna Valley High School Biomass.pdf	Susitna Valley High School Biomass		2010	Matanuska-Susitna Borough	Application	Alternative Energy	This application was completed by the Matanuska-Susitna Borough to the Alaska Energy Authority for a proposed project to design and build a wood fired heating plant to supplement space heating for the Susitna Valley High School.
MSB_2011_Document_Five Year Timber Schedule.pdf	Matanuska-Susitna Borough Five-Year Timber Harvest Schedule DRAFT, September 1, 2011-December 31, 2015		July 26, 2011	MSB, Community Development Department, Land and Resource Management Division	Document	Forestry	This document, published every two years, identifies areas where the MSB is planning timber harvests.
MSB_2013_Map_Pt. MacTown Site Location.pdf	Point MacKenzie Town Site Location Map		2013	Matanuska-Susitna Borough	Map	Settlement Lands	Map of proposed Point MacKenzie town site.
N/A	The Harvest and Use of Wild Resources in Cantwell, Chase, Talkeetna, Trapper Creek, Susitna Station/ Alexander Creek, and Skwentna Alaska, 2012	Holen,Hazell, Van Lanen,Ream,Jones, and Zimpelman	Forthcoming Report per ADF&G-Div. of Sub	Alaska Dept. of Fish and Game, Division of Subsistence	Technical Report	Subsistence	Forthcoming Report
National Association of Conservation Districts_Report_Woody Biomass Toolkit.pdf	Woody Biomass Desk Guide and Toolkit	National Association of Conservation Districts		National Association of Conservation Districts through funding from a joint cooperative agreement with the U.S. Department of Interior and the USDA Forest Service	Report	Alternative Energy	This report provides an overview of woody biomass production and utilization in the U.S., tips of how to provide effective outreach for clientele, and educational handouts The purpose of this guide is to equip natural resource professionals and outreach specialists with the information and tools needed to increase awareness of the use of woody biomass for energy in the U.S. Appendix D provides a Biomass Supply and Cost Profile for Matanuska-Susitna Borough-owned lands.
Northern Economics_2007_Report_Final Market Analysis and Timber Appraisal.pdf	Matanuska-Susitna Borough Market Analysis and Timber Appraisal Report	Northern Economics Inc.	2007	Matanuska-Susitna Borough	Report	Forestry	The report provides a forest inventory and an operational analysis, market analysis and timber appraisal for designated MSB Commercial Forest Lands.
Oasis_2007_Report_Chuitna Coal Project 2006 Land Use Baseline Report.pdf	Chuitna Coal Project - 2006 Land Use Baseline Report	OASIS Environmental Inc.	April 3, 2007	Drven Corporation	Report	Coal	Report contents include land use classifications and historical and present land uses in the project area.
PacRimCoal_2012_Project Description_Chuitna Coal Project Applicants Proposed Project.pdf	Applicant's Proposed Project (September 2012)			PacRim Coal, LP	Project description	Coal	This 5 page document includes a description of the applicant's proposed project (dated September 2012), which includes proposed infrastructure needs.
Petersen_2013_Article_An Overview of Biomass in Alaska.pdf	An Overview of Biomass in the State of Alaska	Karen Petersen	2013	Western Forester	Article	Alternative Energy	Article provides an overview of biomass use and projects in the State of Alaska to date (2013).
Petersville Road Corridor Management Plan_1998_Report.pdf	Petersville Road Corridor Management Plan		1998		Report	Transportation	The report provides management goals and priorities of a road corridor, identifies existing and potential problemes within the corridor and offers solutions to these problems.
PetroleumNewsletter_Week of November 27 2011.pdf	Vol. 16, No.48		11/272011	Petroleum News	Newspaper	Oil and Gas	This newsletter provides the weekly oil and gas information for the end of November 2011. It discusses current exploration and production endeavors, financial viability of current operations, and news concerning associated legal and environmental issues.
Petrotechnical Resources of Alaska_2010_Report_Cook Inlet Gas Study.pdf	Cook Inlet Gas Study - An Analysis for Meeting the Natural Gas Needs of Cook Inlet Utility Customers	Petrotechnical Resources of Alaska	March 2010	ENSTAR Natural Gas Company, Chugach Electric Association and Municipal Lighting and Power	Study report	Cook Inlet Utilities	This study looked at the natural gas reserves in Cook Inlet, forecasted annual natural gas production, and estimated the cost of the development necessary to meet the immediate needs of Cook Inlet utility customers from 2010 to 2020.

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Petrotechnical Resources of Alaska 2012 Report Cook Inlet Gas Study.pdf	Cook Inlet Gas Study - 2012 Update	Peter J. Stokes	Oct. 2012	Petrotechnical Resources of Alaska	Report	Oil and Gas	Prepared for Enstar, Chugach, and ML&P, this report updates gas supply and demand forecasts.
RDS-SAIC 2006 Report Beluga Coal Gasification Feasibility Study.pdf	Beluga Coal Gasification Feasibility Study, Phase I Final Report for Subtask 41817.333.01.01	Research & Development Solutions, LLC (RDS)/ Science Applications International Corp. (SAIC)	July 2006	National Energy Technology Laboratory	Study report	Underground coal gasification	This study was prepared to determine the economic feasibility of developing and siting a coal-based integrated gasification combined-cycle plant in the Cook Inlet region of Alaska for the co-production of electric power and marketable by-products. The study includes a discussion of coal supply options, including those in the West Susitna Reconnaissance Study Area.
RWS Consulting 2010 Plan Asset Management Plan Natural Resource Management Units.pdf	Asset Management Plan: Natural Resource Management Units	RWS Consulting	2010	Matanuska-Susitna Borough	Plan	Forestry	This plan provides the goals, management intent, land use designations, classifications, guidelines, and implementation actions for the new Natural Resource Management Units that will replace the old Forest Management Units.
Sanders Forestry Consulting 2006 Technical Report Forest Inventory Report.pdf	Matanuska-Susitna Borough:Forest Inventory Report	Sanders Forestry Consulting	2006	Matanuska-Susitna Borough	Technical Report	Forestry	This report provides: background, methodology, cruise results and analysis of the timber inventoried during 2006.
Sanders Forestry Consulting 2007 Technical Report Operable Forest Land Analysis Report.pdf	Operable Forest Land Analysis Report	Sanders Forestry Consulting	2007	Matanuska-Susitna Borough	Technical Report	Forestry	This Operational Analysis Report summarizes operable forest lands identified within the Commercial Forest Lands (CFL) boundaries and presented on individual management unit operational analysis. In addition, this report contains Annual Allowable Cut calculations based on CFL and operable CFL timber volumes, acreages, and estimated average site productivity. Also included is a section on Silvicultural Considerations (regeneration).
SRKConsulting 2008 Report Mineral Resource Estimation Whistler Copper-Gold Project.pdf	Mineral Resource Estimation Whistler Copper-Gold Project, Alaska Range, Alaska	SRK Consulting	February 15, 2008	Geoinformatics Exploration Inc.	Report	Hardrock mineral	This report includes a description of the Whistler project, accessibility, mineral deposits, drilling and exploration activities.
TDXPower 2009 Document Chakachamna FERC Pre-Application.pdf	FERC Notice of Intent of TDX Power to File and Application for an Original License for the Chakachamna Hydroelectric Project (FERC No. 12660) and Chakachamna Hydroelectric Project Pre-Application Document	TDX Power	July 2009		Pre-application document	Hydroelectric	This document includes a description of the project location, facilities, operations, and existing environmental resources and impacts for the proposed Chakachamna hydroelectric project.
Tyonek Native Corporation 2008 Presentation West Cook Inlet 2008-2020.pdf	West Cook Inlet: 2008 to 2020	Tyonek Native Corporation	December 2008		Presentation slides	Coal, coal-to-liquid, geothermal, hydropower	This presentation includes 31 slides that describe opportunities in West Cook Inlet, including the Chuitna coal project, Beluga coal-to-liquid plant, oil and gas facilities in Cook Inlet, Chakachamna hydropower project, Mt. Spurr Geothermal power project, ferry and road access to Tyonek, and others.
Tyonek Native Corporation 2009 Power Point West Cook Inlet 2009 & Beyond.pdf	West Cook Inlet: 2009 & Beyond		Nov. 2009	Tyonek Native Corporation	PowerPoint Presentation	All	This powerpoint presentation provides an overview of: Chuitna Coal Project, Cook Inlet Oil & Gas Facilities, Petrochemical Plants, Chakachamna Hydropower, Mt. Spurr Geothermal, New Ferry Service to Tyonek, West Cook Inlet Population Projections, North Foreland Port & Facilities, Aggregate Export, West Susitna Road Link, 2020 Cook Inlet Power Options, and Tyonek Gold Port & Development.
Tyonek Native Corporation 2010 Presentation Coal to Liquids.pdf	Coal-To-Liquids Plant Tyonek Location: A Solution for Alaska & the USAF		October 13,2010	Tyonek Native Corporation	Presentation slides	Coal-to-liquids	These eight presentation slides briefly describe the coal reserves at the Chuitna location.
U.S. Energy Information Administration 2013 Report Annual Coal Report 2012.pdf	Annual Coal Report 2012		2013	U.S. Energy Information Administration (EIA)	Report	Coal	This report assesses U.S. coal industry in 2012. Production, productive capacity, employment and productivity, and consuption are discussed.
U.S. Energy Information Administration 2013 Webpage Annual Energy Outlook Market Trends Natural Gas.pdf	Annual Energy Outlook 2013		Decemeber 2013	U.S. Energy Information Administration (EIA)	Webpage	Oil and gas	This webpage article describes market trends for natural gas.
U.S. Energy Information Administration 2013 Webpage Natural Gas Prices.pdf	Natural Gas Prices		2013	U.S. Energy Information Administration (EIA)	Webpage	Oil and gas	This webpage provides recent natural gas prices in dollars per thousand cubic feet.
USGS and DOI 2012 Map Geologic Map Cook Inlet Region.pdf	Geologic map of the Cook Inlet region, Alaska, including parts of the Talkeetna, Talkeetna Mountains, Tyonek, Anchorage, Lake Clark, Kenai, Seward, Iliamna, Seldovia, Mount Katmai, and Afognak	Frederic H. Wilson et al.	2012	U.S. Geological Survey and Alaska Department of Natural Resources Division of Oil and Gas	Map	Oil and Gas	This map sheet depicts the geologic composition of the Cook Inlet at a 1:250,000 scale. The map includes parts of the Talkeetna, Talkeetna Mountains, Tyonek, Anchorage, Lake Clark, Kenai, Seward, Iliamna, Seldovia, Mount Katmai, and Afognak.
USGS and DOI 2012 Poster Map and Digital Database Sedimentary Basins & Petroleum Central AK.pdf	Map and Digital Database of Sedimentary Basins and Indications of Petroleum in the Central Alaska Province	Sandra M. Troutman and Richard G. Stanley	2012	U.S. Geological Survey, U.S. Department of the Interior	Scientific Poster	Oil and Gas	This map and the accompanying digital database show sedimentary basins and reported occurrences of petroleum in wells and natural seeps in central Alaska.
USGS and DOI 2012 Report Geologic Map Cook Inlet Region.pdf	Geologic map of the Cook Inlet Region, Alaska: Including parts of the Talkeetna, Talkeetna Mountains, Tyonek, Anchorage, Lake Clark, Kenai, Seward, Iliamna, Seldovia, Mount Katmai, and Afognak	Frederic H. Wilson et al.	2012	Alaska Department of Natural Resources Division of Oil & Gas	Report	Oil and Gas	This pamphlet (report) provides a summary and description of map units for an accompanying, but separate, 2012 geologic map of the Cook Inlet Region

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USGS_1961_Map_Reconnaissance Geologic MapTalkeetna McGrath Route Sheet 1.pdf	Reconnaissance Engineering Geology for Selection of Highway Route from Talkeetna to McGrath, Alaska	Florence R. Weber	1961	U.S. Geological Survey on behalf of U.S. Bureau of Public Roads	Map	Previous identified alignment	This sheet coincides with the map depiction of a possible road route between Talkeetna and McGrath, prepared by the USGS on behalf of the U.S. Bureau of Public Roads. This sheet describes a general basis for determination of road routes and is concerned only with the geological factors as they would affect construction. This sheet describes the following conditions of the route area: geography, climate glaciation and permafrost, terrain, vegetation, drainage, excavation and compaction, and evaluation for road construction and maintenance. Note: This route and map was prepared prior to
USGS_1961_Report_Reconnaissance Geologic MapTalkeetna McGrath Route Sheet 2.pdf	Reconnaissance Engineering Geology for Selection of Highway Route from Talkeetna to McGrath, Alaska	Florence R. Weber	1961	U.S. Bureau of Public Roads	Report	Geology and Geologic Hazards	This provides a write-up and graphs to accompany the reconnaissance map of Talkeetna and McGrath
USGS_2004_Report_Alaska Coal Geology Resources and Coalbed Methane Potential.pdf	Alaska Coal Geology, Resources, and Coalbed Methane Potential	Romeo M. Flores, Gary D. Stricker, and Scott A. Kinney	2004	U.S. Geological Survey, U.S. Department of the Interior	Report	Coal	This report is a synthesis of the largely untapped hypothetical coal resources of Alaska, which are estimated to be as much as 5,526 billion short (or 5.5 trillion) tons (5,012 billion metric tons).This report focuses on an assessment of the coal resources of the three major coal provinces in Alaska: Northern Alaska-Slope, Central Alaska-Nenana, and Southern Alaska-Cook Inlet and makes up 87 percent of the total coal resources of the State. Also, it concentrates on the origin, geologic setting, and depositional environments of the coal, as well as coal rank, quality, and petrology and the amount of the resources. In addition, this report summarizes the coalbed methane potential and prioritize areas for exploration and development in these major coal provinces.
USGS_2011_PowerPoint_Assessment of Undiscovered Oil in Cook Inlet.pdf	U.S. Geological Survey 2011 Assessment of Undiscovered Oil and Gas Resources of the Cook Inlet Region, South-Central Alaska; U.S. Geological Survey Open-File Report 2011–1237	Richard G. Stanley, Brenda S. Pierce, and David W. Houseknecht	2011	U.S. Geological Survey on behalf of U.S. Bureau of Public Roads	PowerPoint Presentation	Oil and Gas	This powerpoint presentation discusses findings from a study done to identify the potential for undiscovered oil and gas resources in the Cook Inlet.
USGS_2011_PowerPoint_Assessment of Undiscovered Oil in Cook Inlet.pdf	U.S. Geological Survey 2011 Assessment of Undiscovered Oil and Gas Resources of the Cook Inlet Region, South-Central Alaska; U.S. Geological Survey Open-File Report 2011–1237	By Richard G. Stanley, Brenda S. Pierce, and David W. Houseknecht	2011	U.S. Geological Survey, U.S. Department of the Interior	PowerPoint Presentation	Oil and Gas	The U.S. Geological Survey (USGS) has completed an assessment of the volumes of undiscovered, technically recoverable oil and gas resources in conventional and continuous accumulations in Cook Inlet. The assessment used a geology-based methodology and results from new scientific research by the USGS and the State of Alaska, Department of Natural Resources, Division of Geological and Geophysical Surveys and Division of Oil and Gas (DOG). In the Cook Inlet region, the USGS estimates mean undiscovered volumes of nearly 600 million barrels of oil, about 19 trillion cubic feet of gas, and about 46 million barrels of natural gas liquids.
VanWyck_2013_Figure_Placer Claims and Prospects in Study Area Figure.pdf	Placer Claims and Prosepects in Study Area	Nicholas Van Wyck	March 2013		Figure	Hardrock mineral	This figure depicts the major placer claims and mineral leases in the Study Area.
VanWyck_2013_Figure_Prospects and Claims Near Rainy Pass.pdf	Prospects and Claims Near Rainy Pass	Nicholas Van Wyck	March 2013		Figure	Hardrock mineral	This figure depicts the location of propsects and claims around the Whistler prospect near Rainy Pass.
			2012	ADF&G	GIS data layer	GIS	GIS Data Layer – Fish Distribution Database Regulatory Update
			1983	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Oil and Gas Basins in Alaska
			2012	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Cook Inlet Areawide Sale Boundaries
			2012	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Cook Inlet Areawide Sale Tracts
			2012	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Alaska Statewide Active Lease Boundaries
			2012	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Statewide Oil & Gas Participating Area Boundaries
			2012	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Statewide Oil & Gas Participating Area Tracts
			2012	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Statewide Oil & Gas Unit Boundaries
			2012	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Statewide Oil & Gas Unit Tracts
			2012	Alaska DNR	GIS data layer	GIS	GIS Data Layer – DNR Proposed State Timber Lands
			1986	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Boundaries of Coal Basins and Prospective Coal Basins
			1986	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Boundaries of Coal Fields in Alaska
			2006	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Placer Districts in Alaska
			2006	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Significant Metaliferous Lode Deposits in Alaska
			2006	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Alaska DNR State Mining Claims
			2006	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Alaska DNR State Mining Lease
			2006	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Alaska DNR State Prospecting Sites
			2006	Alaska DNR	GIS data layer	GIS	GIS Data Layer – Administrative Large Parcel Boundaries
			2012	BLM	GIS data layer	GIS	GIS Data Layer – Alaska Native Allotments
			2012	BLM	GIS data layer	GIS	GIS Data Layer – Generalized Lands Conveyed to Private Entities

PDF Name/ Link to Electronic Copy	Document Title	Author	Publication Date	Publisher/Sponsor	Document Type (e.g., map, journal, report, etc.)	Category/ Resource Type (e.g., coal, oil and gas, forestry, etc.)	Document Summary
			2012	BLM	GIS data layer	GIS	GIS Data Layer – Federal Mining Claims
			2006	BLM	GIS data layer	GIS	GIS Data Layers – Alaska DNR RS2477 Trails
			2012	Bureau of Land Management (BLM)	GIS data layer	GIS	GIS Data Layer – Generalized Land Status of Alaska NAD83
			2011	MSB	GIS data layer	GIS	GIS Data Layer – Parcels
			2011	MSB	GIS data layer	GIS	GIS Data Layer – Five-Year Timber Harvest Schedule
			2011	MSB	GIS data layer	GIS	GIS Data Layer – MSB Wetlands
			2011	MSB	GIS data layer	GIS	GIS Data Layer – Wetland Mitigation Banks
			2012	MSB	GIS data layer	GIS	GIS Data Layers – Trails
			2012	U.S. Fish and Wildlife Service	GIS data layer	GIS	GIS Data Layer – Alaska National Wetlands Inventory, Alaska.
			2000	USDA, Natural Resources Conservation Service (NRCS)	GIS data layer	GIS	GIS Data Layer – Soils
			2012	USGS	GIS data layer	GIS	GIS Data Layer –National Hydrography Dataset 1902
			2005	USGS	GIS data layer	GIS	GIS Data Layer – Alaska Resources Data File
			2009	USGS	GIS data layer	GIS	GIS Data Layer – Surface Geology
			2008	USGS	GIS data layer	GIS	GIS Data Layer – Castle Mountain Fault

West Susitna Access Reconnaissance Study
West Susitna Access to Resource Development

Transportation Analysis Report






Appendix F: Economic Considerations

West Susitna

Reconnaissance Study for Access to Resource Development Opportunities

Roads to Resources

West Susitna Access

Reconnaissance Study for Access to Resource Development Opportunities

Minerals
The study discusses a number of activities, including hardrock mineral exploration, placer gold mining, and coal exploration and development. There are more than 3,000 active mining claims in the Study Area.

Oil & Gas
Active oil and gas exploration continues to occur in Northern Cook Inlet. There are nine producing oil and gas units and fields in the Study Area.

Agriculture
The Alaska Department of Natural Resources has identified about 65,000 acres in the Study Area for potential agricultural uses.

Forest /Timber
The Alaska Department of Natural Resources has identified more than 700,000 acres in the Study Area for potential forest harvest.

Alternative Energy
Examples of alternative energy resource opportunities previously identified in the Study Area include geothermal exploration, hydropower, and woody biomass resources.

Recreational Resources
Recreational resource opportunities in the Study Area are immense. These include sportfishing, hunting, wildlife viewing, firewood harvesting, and remote private cabins and wilderness lodges.

Overview

The Alaska Department of Transportation and Public Facilities' (DOT&PF) Roads to Resources Program initiated the West Susitna Access Reconnaissance Study in January 2013. The purpose of this reconnaissance-level study is to evaluate and consider the need for surface access to resource development opportunities west of the Susitna River in Southcentral Alaska. This study aims to identify locations that may benefit from a proposed surface connection. The study will:

- Identify resource development opportunities west of the Susitna River.
- Identify one or more potential crossings of the Susitna River.
- Identify one or more potential transportation corridors to access identified resources.

Resource Development = Economic Benefit

So what does this mean for Alaska?

Alaska has a diverse natural resource base. Some of the natural resource deposits or prospects in Alaska are world-renowned and considered some of the largest in the world. However, surface access to most of these resource development opportunities around the State is minimal or non-existent, largely due to their remoteness. The transportation infrastructure in these areas is one of the most challenging issues that constrain resource development efforts in the state. Providing access to these natural resources increases the opportunity for job creation and economic growth, which in turn supports funding for essential State programs and boosts the state's treasury. The resource categories inventoried in this study are:

- Mineral Resources
- Oil and Gas Resources
- Forestry/Timber and Agricultural Resources
- Alternative Energy Resources
- Recreational Resources

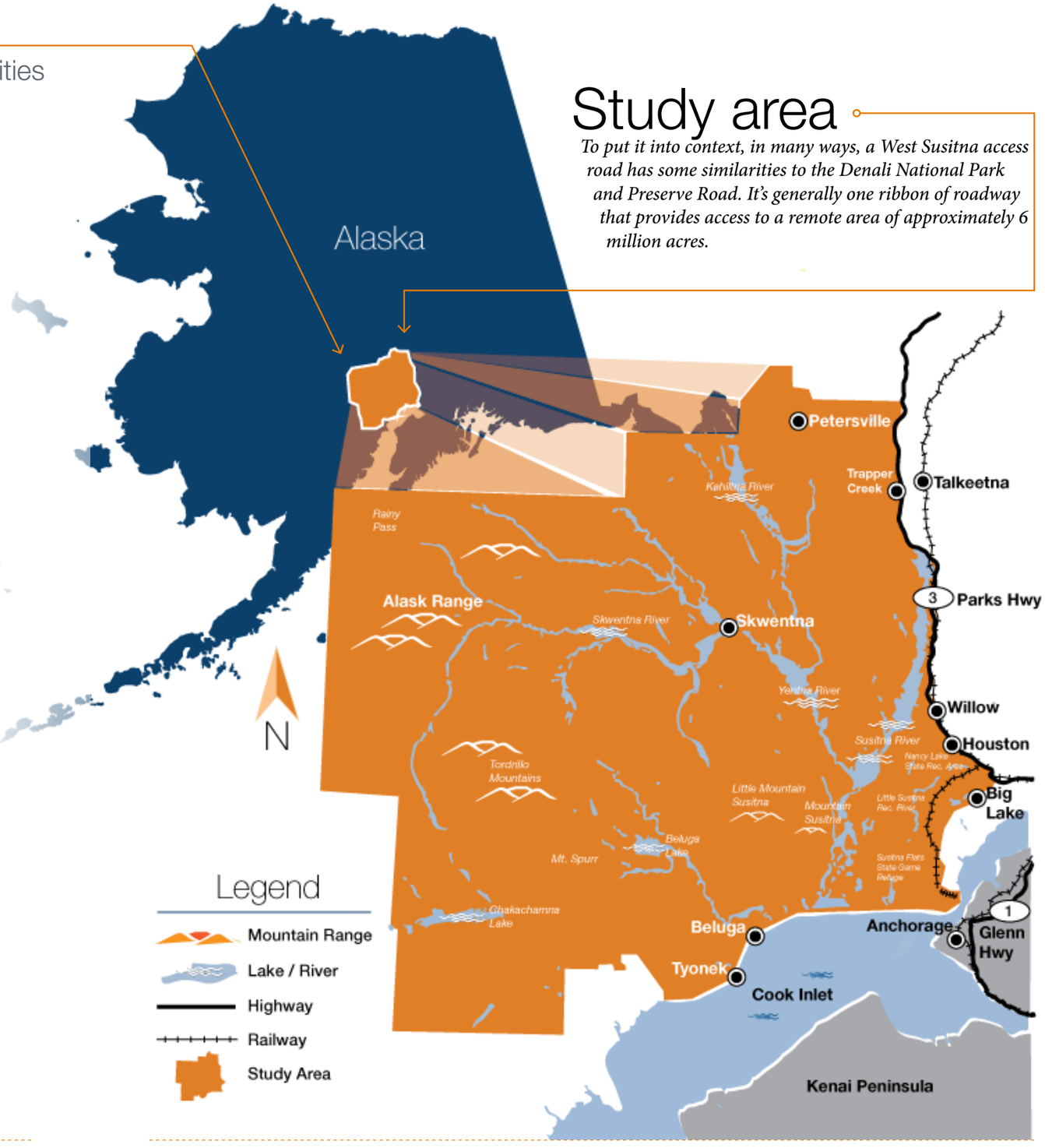
Economic benefits of proposed access

Investment in surface access transportation infrastructure to remote areas in Alaska, such as the area west of the Susitna River, can help reduce costs associated with resource development, such as the mobilization of personnel and construction or extraction equipment. Further cost reductions may be realized in fuel, construction materials, food and other basic necessities. Such investment can improve the production capacity of the state and drive overall economic development. There are concerns, however, that these investments can negatively impact the subsistence and remote lifestyles of people in these areas. While these concerns are valid and warrant a careful assessment of all impacts, the economic opportunities offer a strong basis for investment. What is needed is a long range strategic plan for prioritizing and funding infrastructure investments.

Investing in transportation infrastructure to the remote areas of Alaska will directly impact a number of resource development industries, including oil, gas, and mining, all of which have been plagued by high costs of transportation and operations. Strategic and pro-active investments have the opportunity to address these issues and generate improved production and consequently stimulate economic development.

Study area

To put it into context, in many ways, a West Susitna access road has some similarities to the Denali National Park and Preserve Road. It's generally one ribbon of roadway that provides access to a remote area of approximately 6 million acres.



West Susitna Photo courtesy of HRD Alaska, Inc. - Julie Jessen

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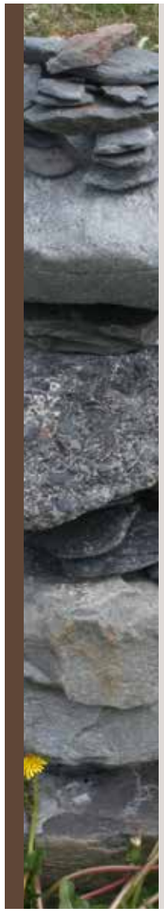
1 Mineral Resources - Hardrock and Coal



There are more than 3,000 active mining claims in the Study Area. The highest concentration of claim activity is in the northern portion of the Tordrillo Mountains in the Alaska Range near Rainy Pass area. Possible commodities include copper, gold, silver, molybdenum, platinum group elements (PGEs), and possibly diamonds. Also, the inferred State placer gold mining claims in the Study Area cover an area of 45,133 acres and are held by 113 Alaska Department of Natural Resources (DNR)-identified customer names.

Based on interviews conducted during the reconnaissance study and estimates of other producing mines in Alaska, there is considerable mining-related job potential in the Study Area. Kiska Metals Corporation, with its 144,000 lease acres, is estimated to generate over 200 direct permanent jobs[1] and upwards of 130 additional indirect jobs[2] when in full production. To put these estimates in context, statewide, approximately 1,000 people were employed in the mining industry[3] . Other leases, such as Millrock's nearly 120,000 acres could generate a commensurate number of jobs.

According to the Alaska Department of Labor, mining jobs are high paying, with earnings higher than any other industry except, oil and gas. In 2009, for instance, the average earning for each mining job was $91,100 per year (almost twice the statewide average)[4] and had reached $98,000 per year by 2011[5] .

1 Based on Kiska's estimates during interviews.
2 Based on indirect: direct at same ratio Pogo Mine report, Alaska Journal of Commerce, September 2013
3 Alaska Department of Labor. Alaska Economic Trends. May 2013.
4 Alaska Department of Labor. Alaska Economic Trends. October 2010.
5 Alaska Department of Labor. Alaska Economic Trends. May 2013.

Table 1.1: Major Hardrock Mineral Exploration Activities in the Study Area

Company	Project/Prospect Name	Resources/ Commodities	Lease Size (acres)
Kiska Metals Corporation	Whistler mainly, also Island Mountain and Muddy Creek	Copper, gold, silver	144,000
Millrock Resources, Inc.	Estelle, Cristo, Distin	Copper, gold	119,150
Intercept Alaska, Inc.	A single claim block (JL claims)	Copper, gold	17,760
Kennecott Exploration Company	Copper Joe	Copper, gold, molybdenum	16,000
On-Line Exploration Services, Inc.	Estelle, Molly, Beaver Creek, Kichatna	Copper, gold, molybdenum, possibly iron	14,225
Alaska Earth Sciences	Four claim blocks (55 claims)	Primarily copper and gold; silver	8,750
Shulin Lake Mining Company	Moderate-sized claim block (57 claims)	Gold, platinum group elements (PGE), possibly diamonds	4,860

Source: Alaska Department of Natural Resources-Division of Geological and Geophysical Surveys (DNR-DGGS) Alaska Mineral Resources Map (www.dggs.alaska.gov/webpubs/dggs/mp/oversized/mp149_sh001.pdf)

Stone Photo Courtesy of HDR Alaska, Inc. - Summer Hudson

ROAD ACCESS SUPPORTS LOCAL HIRE

Road access can greatly influence the location of a mine's workforce. For example the Pogo mine has road access via a private mine road to the public road system. The Pogo mine provides a crew shift bus to the mine site for employees and uses a relatively short four-day work shift. As a result, most of the staff is local hire (Fairbanks, Delta Junction) because the travel burden is workable. If the road did not exist, the likely shift change would be via aircraft and rotations would be once every two weeks similar to the Red Dog mine in northwest Alaska. Quite possibly, there would be more non-local hire able to work this rotation schedule.

The local hire can mean a lot for the local economy. For example, consider the multiplier effects of mine employee property taxes. At the Greens Creek mine in Southeast Alaska, locally hired employees living in Juneau paid approximately $430,000 in property taxes. Likewise, Fort Knox Gold Mine employees were estimated to have paid approximately $1 million in property taxes in 2010 to Fairbanks. Projects like the Chuitna coal or Linc Energy's underground coal gasification are estimated to require hundreds of employees – the economic implications of where these employees live likely would be significant.

Photo courtesy of HDR Alaska, Inc.

COAL

There are a variety of types of proposed coal development projects in the Study Area, which are at varying stages of project development. Coal projects or areas of interest in the Study Area include:

- Alaska Energy Corporation's proposed Canyon Creek Coal lease
- PacRim Coal, LP's Chuitna Coal mine project in the Beluga coal field – in advanced permitting stage
- Beluga Coal Company– active leases for surface coal reserves in the Beluga coal field
- Linc Energy Alaska, Inc., Cook Inlet Region, Inc. (CIRI)/ Stone Horn Ridge, LLC – Underground Coal Gasification (UCG) testing in the Beluga coal field
- Coal-to-liquid plant considerations

A study prepared by the U.S. Geological Survey in 2004 divided the estimated coal resources in Alaska into three major provinces: Northern Alaska-Slope, Central Alaska-Nenana, and Southern Alaska-Cook Inlet[6] (which includes the Study Area). Of the two latter provinces, the report found that only a small fraction of the identified coal resources has been produced (over 40 million short tons or 36 million metric tons) of the more than 13.5 billion short tons (12.25 billion metric tons) that are estimated to occur in these two provinces.

if these prospects were fully developed, estimates of job development associated with these prospects indicate a potential for more than 1,200 direct jobs and an additional 850 indirect jobs could be generated within the study area. That is more than 2,000 jobs total. To put that into context, Usibelli Coal Mine near Healy employs about 130 people and averages about 2 million tons of coal production per year[7] .

6 USGS. 2004. Alaska Coal Geology, Resources, and Coalbed Methane Potential.
7 http://usibelli.com/

Table 1.2 Estimated Coal Resources Potential in or near the Study Area

Coal Province and Field	Coal Rank	Identified Resources (Short tons)	Identified Potential Sale Revenue (Dollars, billions)	Hypothetical Resources (Short tons)	Hypothetical Potential Sale Revenue (Dollars, billions)
Cook Inlet-Susitna Province					
Beluga Field	Subbituminous	10 billion	$153.4	30 billion	$460.2
Yentna Field	Subbituminous	1 billion	$15.3	2.5 billion	$38.3
Susitna Field	Subbituminous	110 million	$1.7	2.3 billion	$35.3

Source: DNR-DGGS. October 8, 2013. Personal communication with Jim Clough.
Potential sale revenue was calculated by multiplying the resource quantity by the average sales price of coal nationwide in 2012 (an average state sales price was not available). This was recorded as being $66.04/short ton (Bituminous), $15.34/ short ton (Subbituminous), and $80.21/short ton (Anthracite). For those fields that are thought to have multiple coal ranks, an average was used (per U.S. Energy Information Administration (EIA) 2012 Annual Coal Report; available at: http://www.eia.gov/coal/annual/).

These tables and figures depict a snapshot of some of the larger and/or more active mineral resource activities occurring in the West Susitna Study Area.

Table 1.3: Hardrock and Gold Placer Mining Opportunities

Estimated Prospects	
1	***Estimated Copper, Gold and Silver*** *Kiska Metals Corporation – Whistler, Island Mountain and Muddy Creek* *Size = 144,000 acres* *Estimated Employment – 200 direct and 130 indirect full time employees*
2	***Estimated Copper, Gold and Silver*** *Alaska Earth Sciences* *Size = 8,750 acres (four claim blocks consisting of 55 claims)*
3	***Estimated Gold (Placer)*** *Petersville/Peters Creek* *94 claim holders* *Size = 20,957 acres (499 claims and leaseholds)*
4	***Estimated Gold and Mining Opportunities (Placer)*** *Lewis Clark – no mining leases, but two leasehold locations* *Beluga River – one mining claim* *Theodore River – a block of 133 state mining claims*
5	***Estimated Copper, Gold, Molybdenum and Iron*** *On-Line Exploration Services, Inc. – Estelle, Molly, Beaver Creek and Kichatna* *Size: 14,225 acres*
6	***Estimated Gold*** *Millrock Resources, Inc. – Estelle, Cristo and Distin* *Size = 119,150 acres*
7	***Estimated Gold (Placer) and Gem*** *Diamond Gold Corporation and one other party – Yenlo Hills* *Size = 2,340 acres (23 claims)*
8	***Estimated Gold (Placer)*** *Individual claim holders* *Size = 1,800+ acres (19 claims)*
9	***Precious Metals*** *Teryl Resources Corporation* *Size = 3,680 acres*

Estimated Prospects	
10	***Estimated Gold (Placer)*** *Daniel Frietas* *Size = 2,862 acres (72 claims)*
11	***Estimated Gold (Placer)*** *Wolverine Creek (2 claims)*
12	***Heavy Mineral (Placer)*** *Size = 1,600 acres (21 claim block)*
13	***Estimated Gold (Placer)*** *Size = 401 acres (16 claims)*
14	***Estimated Gold*** *Mills and Twin Creeks* *Size = 2,066 acres*
15	***Estimated Gold (Placer)*** *Lake Creek (8 claims)*
16	***Estimated Copper, Gold and Molybdenum*** *Kennecott Exploration Company – Copper Joe* *Size = 16,000 acres*
17	***Estimated gold, platinum group elements (PGE) and Diamonds*** *Shulin Lake Mining Company* *Diamond claims are speculative* *Size = 4,860 (claim block consists of 57 claims)*
18	***Estimated Gold (Placer) and Copper*** *Intercept Alaska, Inc.* *Size = 17,760 acres (one claim block)*
19	***Estimated Gold (Placer)*** *K N Resources, LLC and Jim D. Espinola – Kichatna* *Size = 14,634 acres*

**Note: Property values and employment forecasts are best estimates based upon interviews, existing information and comparative analysis of similar mining operations. Information also came from the DNR's mineral estate permits and leases database and/or DNR-Division of Mining, Land and Water staff.*

Table 1.4: Coal Mining Opportunities

Mineral Resources / Coal	
20	***Alaska Energy Corp – Canyon Creek Coal*** *Size = 13,175 acres* *Estimated Land Value: $200 million with expected production of 2 MT/annually* *Estimated Employment: 100 direct and 65 indirect full time employees*
21	***PacRim Coal, LP – Chuitna*** *Size = 20,450 acres* *Estimated Land Value: $600 million with expected production of 12 MT/annually* *Estimated Employment: 350 direct and 220 indirect full time employees*

Mineral Resources / Coal	
22	***Beluga Coal Company*** *Size = 17,580 acres* *Estimated Land Value: $600 million with expected production of 12 MT/annually* *Estimated Employment: 350 direct and 220 indirect full time employees* *Number estimates based on similar sized adjacent Chuitna project*
	CIRI and Laurus Energy, Inc. – Stone Horn Ridge *Estimated Employment: 200 direct and 200 indirect full time employees*
	Linc Energy, Inc. – Kenai and Tyonek Coal Leases *Total area: 98,700 acres* *Estimated Employment: 200 direct and 200 indirect full time employees (up to 1,000 peak season)*

**Note: Property values and employment forecasts are best estimates based upon interviews, existing information and comparative analysis of similar mining operations.*

Figure 1.1: Hardrock and Gold Placer Mining Opportunities

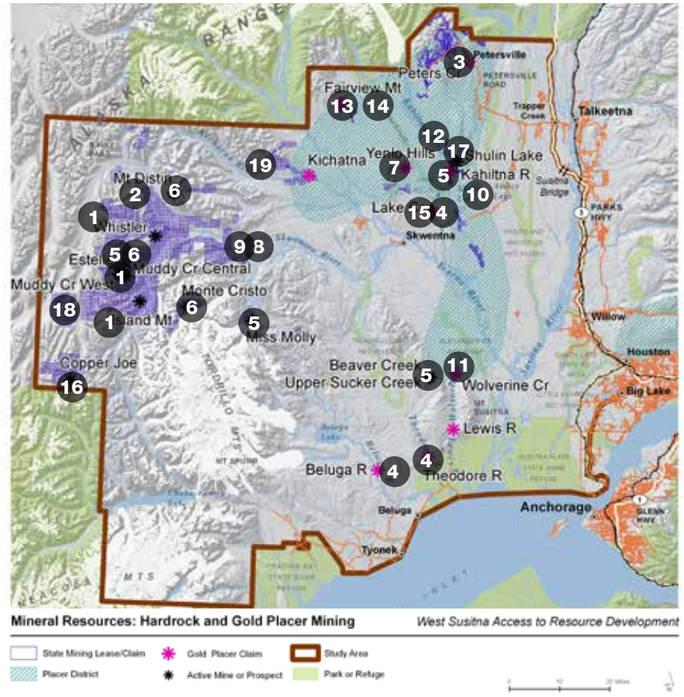
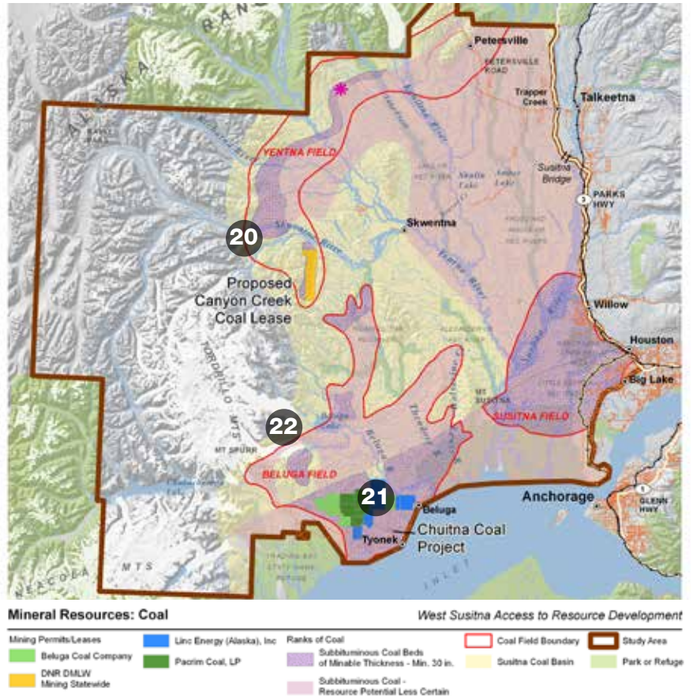


Figure 1.2: Coal Mining Opportunities



2 Oil and Gas Resources

Active oil and gas exploration continues to occur in Northern Cook Inlet. According to the Alaska Department of Natural Resources, recent drilling has proven new reserves in existing fields. Cook Inlet oil production peaked at 230,000 barrels per day (bpd) in 1970, dropping to about 10,800 bpd in FY 2012[8]. As of early December 2013, there are 398 leases in Cook Inlet totaling 1.12 million acres, of which about one-third are on-shore and two-thirds are off-shore[9]. There are nine producing oil and gas units and fields in the Study Area (in Northern Cook Inlet and the Susitna Basin) owned by six different companies; the Beluga River Unit is a major supplier for local electric utilities and home gas usage in the Anchorage area.

8 Resource Development Council Web page. Alaska's Oil & Gas Industry Background. Available at: www.akrdc.org/issues/oilgas/overview.html (accessed March 2013).

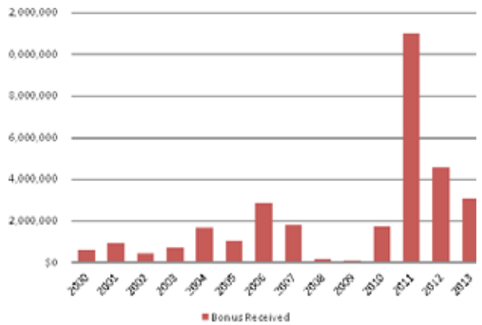
9 DNR-Division of Oil and Gas. December 2013. Active Oil and Gas Lease Inventory Web page. Available at: http://dog.dnr.alaska.gov/Publications/OGInventory.htm (accessed December 2013).

Cook Inlet Region

The majority of the State of Alaska's income is generated from the oil industry (approximately 93.4 percent in Fiscal Year 2012)[10]. According to the Alaska Economic Report Supplement (2013), the Department of Revenue is expecting production of an average of 13,500 barrels of oil/day, a 52 percent increase in Cook Inlet production since 2010 and this trend is likely to continue[11]. The U.S. Geological Survey (USGS) has estimated that the Cook Inlet Region has 599 million barrels of oil and 13.7 trillion cubic feet of natural gas yet to be discovered[12]. The Alaska Department of Revenue forecasts a crude oil price of $105.68 for Fiscal Year 2014[13]. Natural gas prices in September 2013 were $5,550 per million cubic foot[14]. Based on these prices there would be approximately $63.3 billion worth of oil and approximately $76 billion worth of natural gas in Cook Inlet.

Interest in Cook Inlet increased early this decade and has been generating lease revenues to the State. The adjacent graph shows the amount of lease revenue generated from Cook Inlet. Revenue peaked in 2011 with nearly $11 million in lease bonuses received and 545,000 acres leased.

State Competitive Oil and Gas Lease Sales
Cook Inlet
Bonus Received 2000-2013



Source: http://dog.dnr.alaska.gov/Leasing/SaleResults.htm#cinlet2 (Accessed December 2013)

Note: Data depicts Cook Inlet as a whole and not just Northern Cook Inlet.

North Cook Inlet Region

Oil and gas units or fields located specifically in the West Susitna Study Area, in the Northern Cook Inlet region, are depicted in Tables 2.1 and 2.2 and Figure 2.1.

10 Alaska Department of Natural Resources Division of Oil and Gas. State of Alaska Five-Year Program of Proposed Oil and Gas Lease Sales, January 2013

11 Alaska Economic Report Supplement December 4, 2013

12 Stanley, Richard G. et al. 2011. Assessment of Undiscovered Oil and Gas Resources of the Cook Inlet Region, South-Central Alaska, 2011. Prepared by the Cook Inlet USGS Assessment Team. Available at: http://pubs.usgs.gov/fs/2011/3068/ (Accessed December 2013)

13 Revenue Sources Book Fall 2013, Alaska Department of Revenue – Tax Division December 4, 2013

14 http://www.eia.gov/dnav/ng/hist/n3050ak3m.htm

Cook Inlet Aerial Photo Courtesy of HDR Alaska, Inc.

Table 2.1: Oil and Gas Units/Fields in the Study Area, as of November 2013

Unit/Field	Current Ownership (%)	Inception	Size (acres)	Number of Wells*	Cumulative Production		
					Condensate (barrels [bbl])	Water (bbl)	Gas (millions of cubic feet [MCF])
Ivan River **	Hilcorp: 99.8 Uncommitted: 0.2	1990	2,295	6	0	33,872	84,283,767
Stump Lake	Hilcorp: 100	1990	4,880	1	0	505	6,647,923
Beluga River ***	ConocoPhillips: 50 MOA: 33.33 Hilcorp 16.67	1963	8,227	26	0	1,966,167	1,269,300,564
Lewis River	Hilcorp: 100	1984	620	3	0	13,113	14,313,420
Pretty Creek **	Hilcorp: 100	1986	4,600	2	0	17,252	9,540,022
Three Mile Creek	Aurora Gas: 50 Cook Inlet Energy: 50	2005	3,320	2	0	28,719	2,381,336
Lone Creek (CIRI)	Aurora Gas: 100	2003	n/a	3	0	33,467	9,933,627
Moquawkie (CIRI)	Aurora Gas: 100	1967	n/a	5	0	7,582	4,914,788
Nicolai Creek	Aurora Gas: 100	1968	470	6	1	56,764	8,034,348

Source: *Personal communication with Alaska Oil and Gas Conservation Commission (AOGCC).*
Note: AOGCC maintains production data. Production numbers are as of October 31, 2013.

** Number of completed wells that have been completed and not been plugged and abandoned, as of December 11, 2013.*
*** There are two gas storage leases in the Study Area: Ivan River and Pretty Creek.*
****Cumulative production for Beluga River is approximately 1.3 trillion cubic feet.*

Cook Inlet Photo Courtesy of HDR Alaska, Inc.

These oil and gas permits /leases correspond to those depicted on the adjacent figure.

Table 2.2: Oil and Gas Permits/Leases
Natural Gas and/or Oil Potential *Otter – Cook Inlet Energy* *Active Exploration Operations*
Susitna Basin – Cook Inlet Energy *Size = 680,000 acres (5 targets)*
Natural Gas and/or Oil Potential *Olsen Creek – Cook Inlet Energy* *Active Exploration Operations*
Natural Gas Development *Aurora Gas – Apache*
Potential Oil Development - Apache
Natural Gas *Lone Creek (CIRI) – Aurora Gas (100%)* *3 wells; 9.8 MCF gas production since 2003*
Natural Gas *Three Mile Creek – Aurora Gas (50%) and CIRI (50%)* *Size = 3,320 acres* *2 wells; 2.4 MCF gas production since 2005*
Natural Gas *Moquakie Unit (CIRI) – Aurora Gas (100%)* *3 wells; 4.9 MCF gas production since 1967*
Natural Gas *Nicolai Creek – Aurora Gas (100%)* *6 wells; 7.7 MCF gas production since 1968*
Natural Gas *Three Mile Creek Field, Lone Creek, Moquakie Unit and Nicolai Creek* *Aurora Gas (Shallow); Apache (Deep)* *Size = 45,000 acres with exploration expected over 10 to 15 years*

Table 2.2: Oil and Gas Permits/Leases
Natural Gas *Beluga River – ConocoPhillips (50%); MOA (33.3%); Hilcorp (16.7%)* *Size = 8,227 acres* *26 wells; 1,259.9 MCF gas production in 1963*
Natural Gas Potential *Kenai LNG Facility – ConocoPhillips*
Natural Gas *Lewis River, Ivan River (Gas Storage Lease); Petty Creek (Gas Storage Lease); Stump Lake; Beluga River Units* *Hilcorp, Conoco Phillips and MOA*
Natural Gas *Stump Lake – Hilcorp (100%)* *Size = 4,880 acres* *1 well; 6.6 MCF gas production since 1990*
Natural Gas *Ivan River – Hilcorp (99.8%)* *Size = 2,295 acres* *6 wells; 83.9 MCF gas production since 1990*
Natural Gas *Lewis River – Hilcorp (100%)* *Size = 620 acres* *3 wells; 14.1 MCF gas production since 1984*
Natural Gas *Petty Creek – Hilcorp (100%)* *Size = 4,600 acres* *2 wells; 9.5 MCF gas production since 1986*

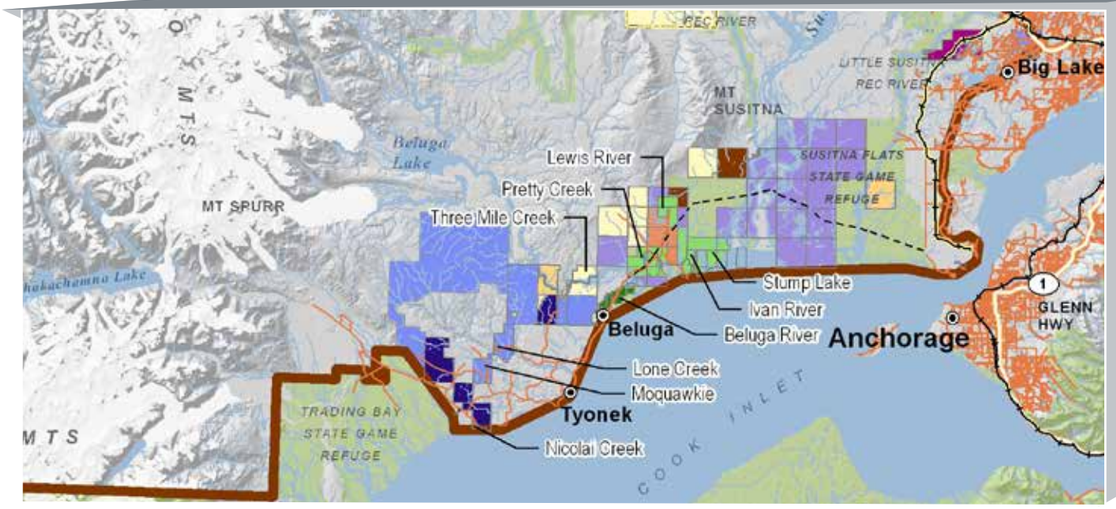
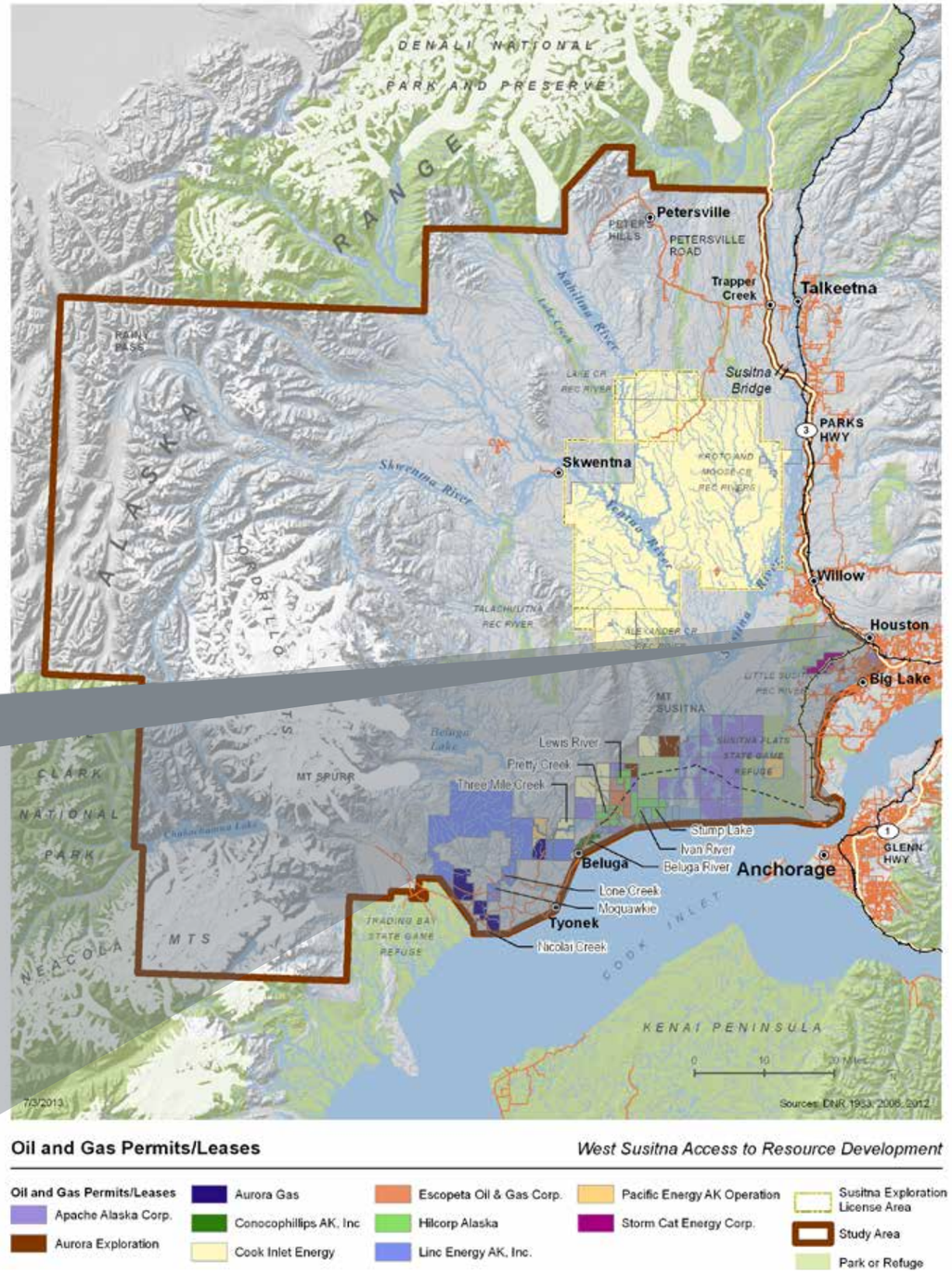
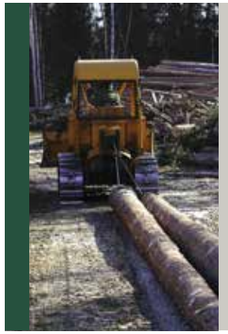


Figure 2.1: Oil and Gas Permits/Leases



3 Forestry/Timber Resources



GROWING THE REGIONS TIMBER INDUSTRY

The Region has a long history and interest in further development of the existing timber industry. Current mills are small and serve niche markets, many of which are high value. Access to the regions forest resources has been a major impediment to fully developing the current industry and evaluating new opportunities. If improved year-round access to lands west of the Little Susitna and Susitna rivers was provided, this would remove a major barrier and access significant acreages of public lands identified for forest management. A new timber supply that is both sustainable and economic to produce would be a tremendous asset to the region.

A number of potential forestry and timber resource areas have been identified in the Study Area that may be available for future development, particularly if a new road made these areas more accessible.

A large amount of land in the Study Area is currently under consideration for legislative designation as a State Forest. House Bill 79/Senate Bill 28 was introduced to the State Legislature in 2013 and was delayed for review until the 2014 session. The bill would create a new State Forest in the Susitna Valley and expand DNR authority to offer negotiated timber sales. The proposed 763,000 acre Susitna State Forest, if adopted, would become the fourth state forest in Alaska, joining the Tanana Valley, Haines, and Southeast State Forests.

DNR area planning documents for the Susitna Matanuska area delineate the area into a number of sub-regions. These sub-regions are summarized in the following table. According to the MSB's 2007 Market Analysis and Timber Appraisal Report, the average timber value per acre was $85.23 (for year 2007). Accounting inflation, the estimated value per acre in 2013 dollars is $92.90. With a total of approximately 701,000 acres of potential forest for harvest identified in the Study Area, the expected monetary value in 2013 dollars would be approximately $65 million.

Table 3.1: Forest Resources in the Study Area by DNR Planning Regions

DNR Planning Region	Size (acres)	Specifically-Identified Areas for Potential Forest Harvest	Hypothetical Applied Direct Economic Value ($) **
Petersville	*71,000*	*Peters Creek, Moose Creek and Kroto Creek areas*	*$6.6 million*
Sunflower Basin	*15,000*	*Near Kahiltna River and Lake Creek Corridor*	*$1.4 million*
Susitna Lowlands	*319,000*	*Far western edge of Susitna Lowlands; Skwentna River, Alexander Creek, Trail Ridge, west of Lake Creek*	*$29.6 million*
Mt. Susitna	*219,000*	*Alexander Creek, Skwentna River, Mount Susitna*	*$20 million*
Beluga	*32,000*	*None specifically identified*	*$3.0 million*
Alaska Range	*45,000*	*Limited. Eastern areas of the Region at lower elevations*	*$4.2 million*
All planning regions in Study Area	*701,000*	*Assumed total harvest, if acreage is fully realized*	*$65 million*

Source: *DNR 1985 Susitna Area Plan, 2011 Susitna Matanuska Area Plan.*

** Planning regions were redrawn between the 1985 and 2011 DNR plans. The Beluga planning region is specific to the 1985 Susitna Area Plan. The study team recognizes that the 1985 Susitna Area Plan was superseded by the 2011 Susitna Matanuska Area Plan. However, some information from the 1985 study, such as existing inventories, was considered relevant background to retain and be cited in the West Susitna Access Reconnaissance study, particularly since part of the scope is to identify known resources in the Study Area.*

*** An assumed value per acre in 2013 dollars is $92.90. This applied economic direct value was based on a market analysis conducted in 2007 in which an average value for timber per acre was available. This value does not include indirect or spin-off economic benefits.*

Skidding Photo Courtesy of DNR

Figure 3.1: Forestry/Timber Resource Potential

LOCAL TIMBER BENEFITS LOCAL ECONOMIES

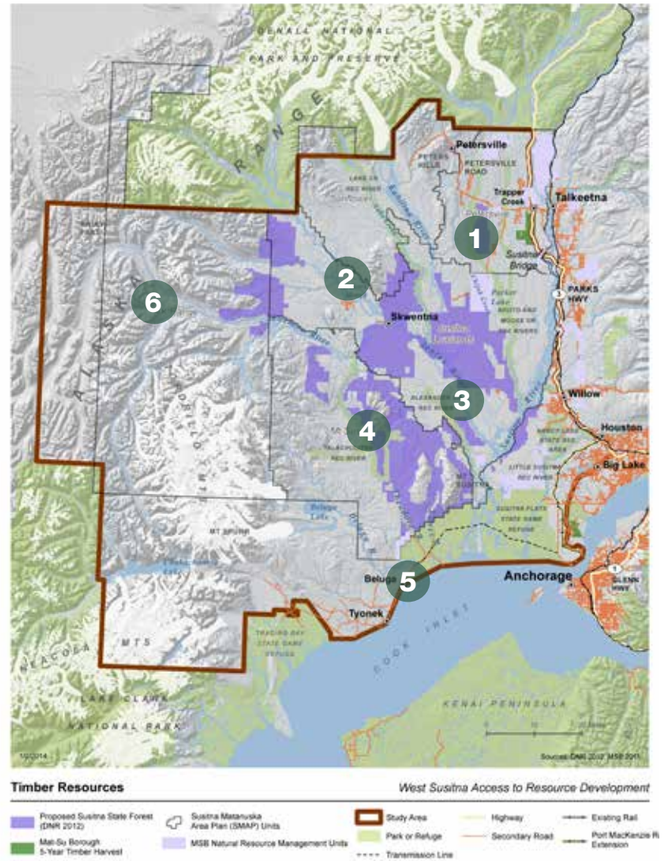
Having enhanced access to areas for forestry strengthens Alaska's economy not just through direct and indirect gains but also through spin-off industries such as building supplies, heating sources, food resources, and products for export or local use. Shipping costs drive up the overall costs of quality products such as custom cabinetry and logs for home construction. Local businesses such as sawmills in the Matanuska Susitna Borough and Anchorage and custom cabinet builders and distributors across the state would benefit from increased local supplies.

Table 3.2: Areas for Potential Forest Harvest

1	***Petersville*** *71,000 acres considered for potential timber harvest* *Note: near existing roadways; some lands designated as forestry, with specific locations considered for timber harvest*
2	***Sunflower Basin*** *15,000 acres considered for potential timber harvest, including personal use activities (house logs and firewood)* *Note: small commercial forestry potential near major rivers (e.g., Kahiltna River and Lake Creek); Kahiltna River area designated by DNR-Division of Forestry as priority area*
3	***Susitna Lowlands*** *319,000 acres for timber management, half of which has high or moderate potential to be commercial timber*
4	***Mt. Susitna*** *219,000 acres, some of which has potential for commercial forestry* *Note: DNR attributes lack of commercial harvest in area to absence of road and bridge access*
5	***Beluga*** *32,000 acres for timber harvest until the area is utilized for coal development*
6	***Alaska Range*** *45,000 acres, though limited potential (due to slow growth rates and uncertainty associated with timber regeneration)*

Specific 2011 DNR-identified areas for Potential Forest Harvest Total: 701,000 acres of forest lands.
Note: overlaps with State of Alaska's Proposed Susitna State forest area

Potential Timber Resources
State of Alaska's Proposed Susitna State Forest: Proposed 763,000-acres Status: Bill under consideration in State Legislature in 2013 and 2014. Note: Would become Alaska's fourth State forest; overlaps with 2011 DNR-identified forest resource areas



Timber Photo Courtesy of HDR Alaska, Inc - Sasha Prewit

4 Agricultural Resources

Agriculture has had a long presence in the Matanuska-Susitna valley and was one of the area's first economic drivers. Agriculture has always played an important role in the Mat-Su economy, with a total value of agricultural production in 2007 valued at $11.8 million[15]. The Susitna Matanuska area encompasses the last large area of State-owned agricultural land in Southcentral Alaska[16].

DNR's 2011 Susitna Matanuska Area Plan identified a number of potential agricultural project areas west of the Susitna River. A major hindrance in the expansion of agriculture is the lack of access.

15 2008 Mat-Su Comprehensive Economic Development Strategy Update
16 2011 Susitna Matanuska Area Plan

POSSIBLE ECONOMIC BENEFITS

Approximately 65,000 acres of agricultural lands have been identified within the project vicinity. Much of this land is not accessible by road and is currently land locked making access a limiting factor for agricultural pursuits.

According to the U.S. Department of Agriculture (USDA), in 2012 approximately 17% of Alaska households were food insecure or very low food secure. What this means is that a large percentage of households in Alaska don't have access to nutritionally adequate or safe foods. If the State were to provide better access to viable agricultural lands and produce more food resources within the state, it may help keep costs down to the end consumer for products such as potatoes, carrots, grain for local use, hay for livestock operations, and other products. In turn this could promote buying local and keeping the end prices more affordable.

SUPPORTING FAMILY FARMS[17]

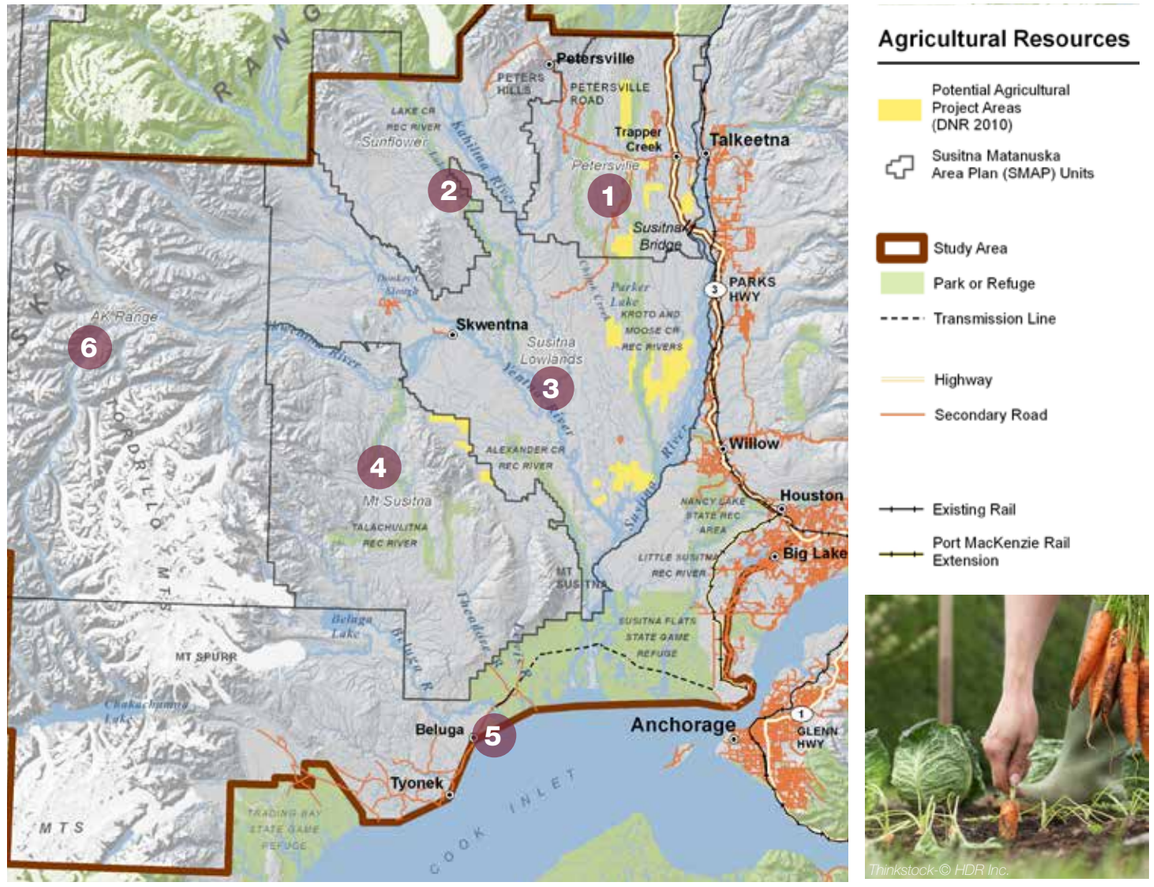
According to the USDA, more than 80% of the farms in Alaska are family owned and operated. Bruce Bush, a small scale vegetable farmer in the Matanuska Valley, provided some insight on employment at his commercial farming operation. He farms 26 acres of vegetables and employs approximately 10 people seasonally and one year-round farm manager. He indicated some of the larger vegetable farmers may have 3 to 4 year-round employees. Bruce estimated that for every $1 created from his farm operation $10 was created elsewhere. This money goes into parts, amenities such as seasonal housing, fuel, fertilizer and equipment costs.

Based upon information collected by the USDA as part of an agricultural census in 2012, the final gross earnings for Alaska's farms including crops, animals and services and forestry was approximately $41 million, with approximately $25 million of this income produced from crops on nearly 31,000 acres. Applying an average per acre harvest value to the identified agricultural acreage in the Study Area (approximately 65,000 acres) indicates a potential annual value of about $52 million from direct farm sales and as mush as 10 times that much in indirect spending.

17 USDA. 2013. USDA Economic Research Service State Fact Sheets, updated as of November 6, 2013. http://1.usa.gov/KlBnKQ (accessed 12/13/2013)

Wetlands Photo Courtesy of HDR Alaska, Inc.
Round bail Photo Shutterstock - © HDR Inc.

Figure 4.1: Agricultural Resources in the Study Area



Thinkstock © HDR Inc.

Table 4.1: Agricultural Resources in the Study Area

DNR Planning Region		Size (acres)	Specifically-Identified Areas for Potential Agricultural Uses	Estimated Direct Annual Economic Value ($) *
1	Petersville	20,000	Near existing roadways; near Moose Creek	$16.1 million
2	Sunflower Basin	n/a	Lake Creek area; Kahiltna River	n/a
3	Susitna Lowlands	38,000	Kashwitna Knobs area, west of the Susitna River	$30.6 million
4	Mt. Susitna	7,000	Scattered tracts in lowlands west of Alexander Creek	$5.6 million
5	Beluga	n/a	Scattered tracts	n/a
6	Alaska Range	n/a	None. Limited potential due to soils, topography and climate	n/a
All planning regions in Study Area		65,000	Assumed total harvest, if acreage is fully realized	$52.4 million

Source: *DNR 1985 Susitna Area Plan, 2011 Susitna Matanuska Area Plan. Note: Planning regions were redrawn between the 1985 and 2011 DNR plans. The Beluga planning region is specific to the 1985 Susitna Area Plan.*

** An assumed value per acre is $806.45. This applied economic direct value was based on the 2012 USDA State Agricultural Census, given approximately $25 million of income was produced from crops on nearly 31,000 acres.*

5 Alternative Energy

Alaska boasts some of the greatest renewable energy resources in the world, which has the potential to help offset some of the state's high energy costs. Some of the main alternative energy resource opportunities in Alaska include hydroelectric power, geothermal energy, woody biomass, wind power, solar power, and ocean and river hydrokinetics. Within the Study Area, two types of alternative energy resource projects have been historically studied. These are the Mount Spurr Geothermal and the Chakachamna Hydroelectric projects. A third alternative energy resource opportunity – woody biomass – is currently being considered.

Geothermal exploration is increasing in the state[18]. For several decades, the State has held geothermal lease sales near the Mount Spurr volcano, which is located about 80 miles west of Anchorage on the west side of Cook Inlet.

Over the years, the State of Alaska has considered a number of potential sites for hydropower projects for serving the needs of Southcentral Alaska's communities. The two most notable hydropower projects in Southcentral Alaska are the Susitna-Watana Hydroelectric project and Chakachamna Hydroelectric project. While the State actually chose and is pursuing the Susitna-Watana site, it's important to note that potential hydroelectric resources exist on Chakachamna Lake, located within the Study Area approximately 85 miles west of Anchorage.

Wood continues to remain an important renewable energy source for Alaskans. The community of Tyonek is currently undergoing the grant application process to implement a biomass project, while the community of Talkeetna, located very close to the Study Area, received grant funds in 2011. The Matanuska-Susitna Borough also has identified forest management units located within the Study Area that have the potential to yield measurable woody biomass. Early trials in Juneau have found that residential woody biomass systems provide a 40% savings on the price of fuel.

OTHER POTENTIAL ALTERNATIVE ENERGY SOURCES

Limited exploration of other potential alternative energy sources within the Study Area has occurred. Elsewhere, the combination of wind and hydroelectric, Kodiak Electric Association shuts off their diesel generators for the majority of the year, while saving their members over $6 million since 2009[19].

18 Alaska Energy Authority and Renewable Energy Alaska Project (REAP). August 2011. Renewable Energy Atlas of Alaska. ftp://ftp.aidea.org/AEApublications/2011_RenewableEnergyAtlasofAlaska.pdf (accessed March 2013).

19 Wind Power in Alaska, Fall 2013

Table 5.1: Potential Alternative Energy Resources

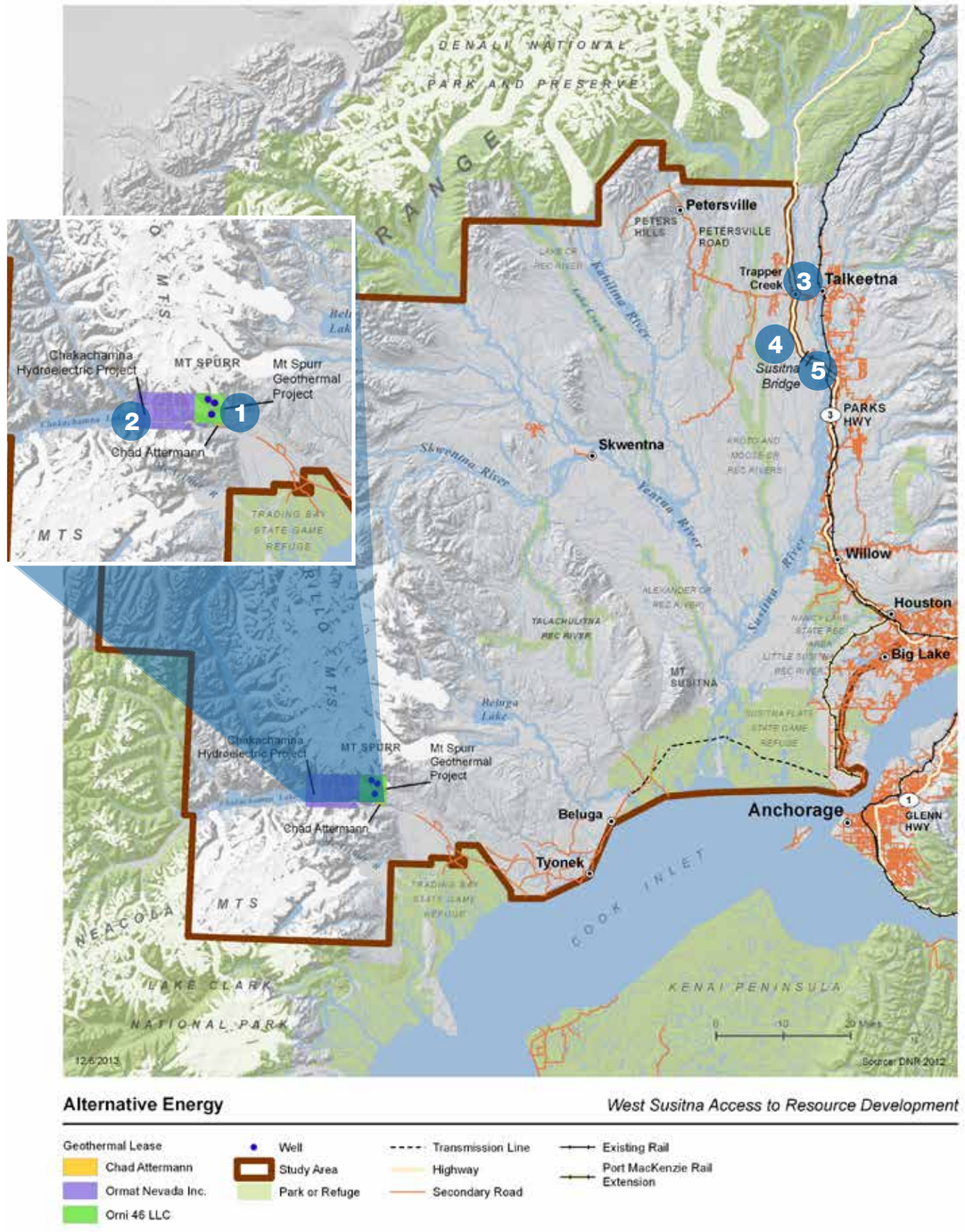
1	*Potential geothermal energy resource* ***Mt. Spurr Geothermal Lease*** ***Ormat Technologies, Inc.*** *Owns 15 leases over approximately 30,000 acres (there are 16 leases total covering 36,000 acres)* ***Status:*** *Initial estimates were for a 50-megawatt base load of power from a geothermal power plant, though it was found to be half of what would be a viable geothermal project. Drilling to resume in 2014 after a hiatus.*
2	*Potential hydropower resource* ***Chakachamna Hydroelectric Project*** *TDX Power, Inc. received a 3-year permit in 2006 to study the potential for a 300-MW project* ***Status:*** *State of Alaska chose a different location to pursue (Susitna-Watana project, located northeast of the West Susitna Study Area)*

Wind Turbine Photo Courtesy of HDR Alaska, Inc.

Table 5.1: Potential Alternative Energy Resources

3	*Potential for Woody biomass resources* ***Talkeetna*** *Talkeetna has received grant money to implement a biomass project. Tyonek is undergoing an application process.* *Note: As of the summer of 2013, 19 biomass heating projects are operated in that state, with 50 communities expressing interest in starting biomass programs.*
4	*MSB-Owned Forest Management Units with Measurable Woody Biomass Yields* ***Rabideux Creek*** *1,568 acres of operable forest land* *With an assumed 1.0 fuel-wood yield ratio of dry ton/acre/year, total yield is 1,568 acres.*
5	*MSB-Owned Forest Management Units with Measurable Woody Biomass Yields* ***Susitna River Corridor*** *2,330 acres of operable forest land* *With an assumed 1.0 fuel-wood yield ratio of dry ton/acre/year, total yield is 2,330 acres.*

Figure 5.1: Potential Alternative Energy Resources



6 Recreational Resources

Recreation is a popular use of State lands in Alaska. A majority of the land within the more than 6 million acres that make up the Study Area is State land, and much of that is considered to have recreational potential. Within the Study Area, the large acreages of undeveloped lands contribute to vast recreational opportunities. The Study Area is well endowed with recreational resources opportunities, from its low-lying areas consisting of fish-filled lakes and rivers to the foothills and mountains of the Alaska Mountain Range.

In 2007, the Cook Inlet Region experienced 761,221 resident angler days and 481,877 non resident angler days. That equated to $989 million of spending in the Southcentral region directly generating $240 million in income to nearly 8,000 full and part time workers. The Cook Inlet subregion contributed $279 million of income and 8,056 jobs to the larger Southcentral economy, including economic multiplier effects.

According to the 2008 Mat-Su Borough Comprehensive Economic Development Strategy Plan, the tourism and visitor industry accounts for over $282 million per year. It also provides approximately 4,000 jobs and $100 million in direct payroll with between 780,000 – 800,000 visitors per year[20].

Sport fisheries are accessed by boat and air. About 70,000 angler days are expended annually west of the Susitna River, compared to 95,000 angler days annually on the road-accessible rivers east of the Susitna River[21]. Much of this effort is incorporated in remote lodge operations, but also includes a large number of private cabin owners. Statewide each angler day was worth $277 dollars on average[22]. Meaning more than $19 million dollars was spent on the 70,000 angler days west of the Susitna and more than $26 million was spent on road accessible areas. If the study area were made more accessible, additional visitation and the economic benefits that come with it would be substantial.

The Susitna Flats State Game Refuge (SGR) provides public uses of fish and wildlife, such as waterfowl, bear, and moose hunting; wildlife viewing and photography; and general outdoor recreation. Approximately 10 percent of the annual waterfowl harvest in the state occurs on the SGR with about 15,000 ducks and 500 geese taken. Rivers within the SGR are also popular for sportfishing, with the Theodore and Lewis rivers supporting more than 7,000 user-days a year.

Table 6.1: Recreational Resource Potential

Recreational Opportunities	
Activities like snowmachining, hiking, dog mushing, cross-country skiing, and boating, to name just a few.	
Patented Mining Claims/ Recreational Mining	
Note: More than 100 nine to ten-acre lots are available for private ownership in the Cache Creek mining district area, near the end west of Petersville Road. The lots are federally-patented land and allow for recreational gold mining.	
Hunting	
» *Moose, sheep, caribou, and black and brown bear are all hunted in the Study Area* » *Waterfowl: Approximately 10% of the State's annual waterfowl harvest occurs on the Susitna Flats Game Refuge.*	
Sportfishing	
» *Within the Susitna Flats Game Refuge, the Theodore and Lewis rivers support more than 7,000 sportfishing user-days a year.* » *Annual angler days:* – *70,000 west of the Susitna River, and 95,000 on the road-accessible rivers east of the Susitna River* » *Annual harvests:* – *5,000 Chinook on the Deshka River, 3,000 Chinook on Lake Creek, 14,000 Coho among all west-side tributaries, and 30,000 rainbow trout, mainly from Lake Creek, Deshka River, and Talachulitna River*	» *Guides:* – *Lake Creek area supports ~60 guides* » *Other anadromous fish streams producing salmon for Cook Inlet fisheries: Kichatna River, Skwentna River, Happy River and their tributaries* » *Other important salmon streams: Chuitna, Nicolai, and Beluga Rivers* » *Alexander Lake is known for its pike fishing*

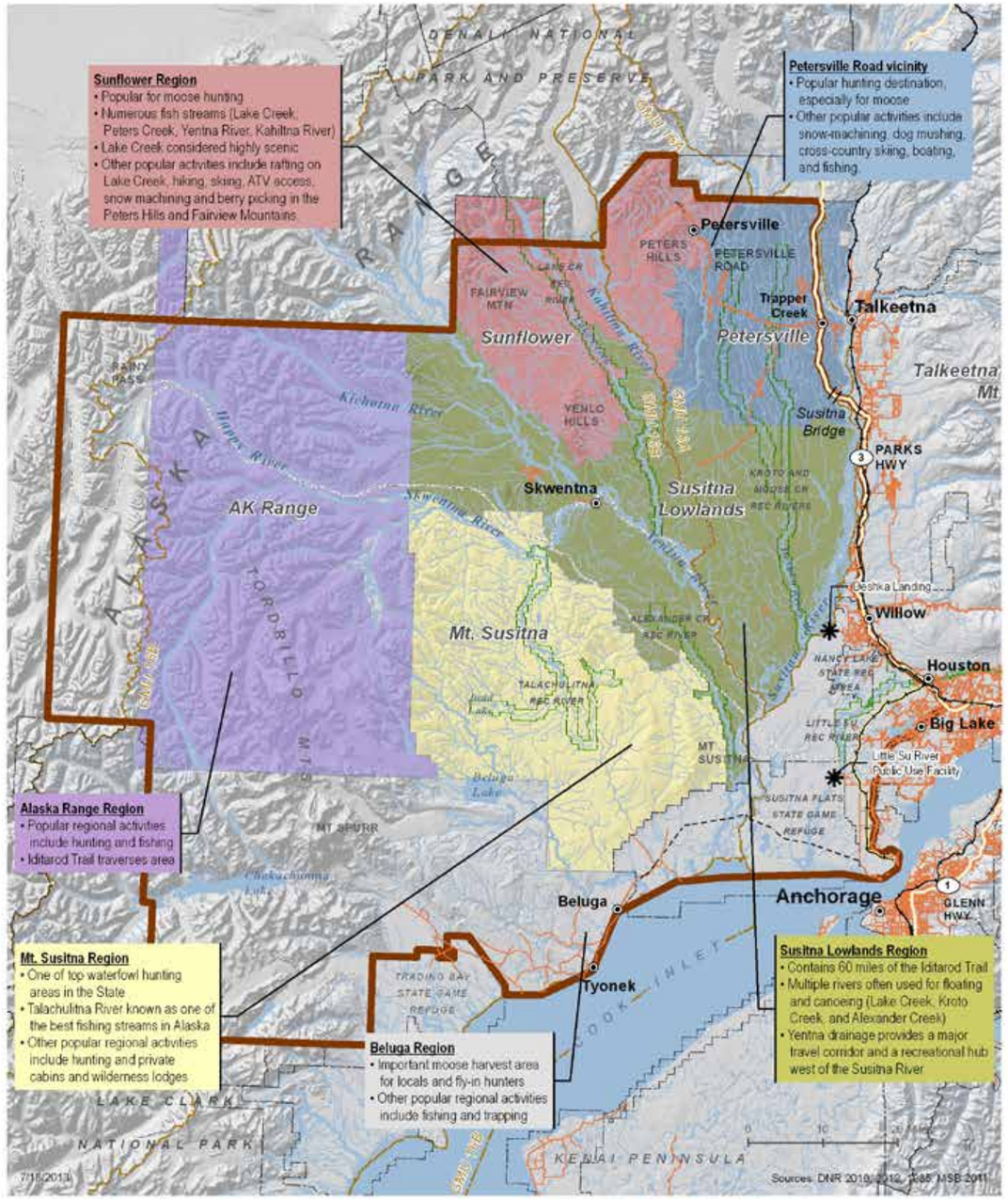
20 Mat-Su Comprehensive Economic Development Strategy December 2008 Update. Mat-Su Resource Conservation and Development Council

21 Alaska Department of Fish and Game (ADF&G). April 29, 2013. Letter from ADF&G Habitat Biologist Marla Carter.

22 ADF&G. 2008. Economic Impacts and Contributions of Sportfishing in Alaska, 2007

Iditarod Photo Courtesy of HDR Alaska, Inc - Sasha Prewitt

Figure 6.1: Recreational Resource Potential



Recreational Resources *West Susitna Access to Resource Development*

Susitna Matanuska Area Plan (SMAP) Units within the Study Area
- AK Range
- Sunflower
- Mt Susitna
- Petersville
- Susitna Lowlands
- State-designated Recreational River
- Park or Refuge
- Study Area
- ADF&G Game Management Unit (GMU)
- Highway
- Secondary Road
- Existing Rail
- Port MacKenzie Rail Extension
- National Historic Iditarod Trail

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