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APPENDIX A

Maps

Due to file size, Appendix A Maps must be downloaded separately from

www.westernakaccess.com

APPENDIX B

WAAPS Bibliography

Western Alaska Access Planning Study (WAAPS) Bibliography

Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
Use 1-99	**Resources - Minerals**					
1	Arctic Deposit - Previous Studies	DOWL / Paper Copy	Not indicated	Undated	3	Summary of 1974-1990 studies on Arctic Deposit, detailing reserves, recovery, optimal transportation modes, and costs, among other things. Good quick comparison of how rapidly conditions change for the prospect.
2	State of Alaska Minerals Development Policies	DOWL / PDF file & Web Page http://www.dnr.state.ak.us/mlw/mining/AK_MineralPolicy.pdf	DNR, Division of Mining, Land & Water	Undated	1	Policy statements related to mineral development from Article VIII of the Alaska Constitution & from Alaska Statutes Titles 44 & 27. Statements regarding transportation include: *"The legislature may provide for facilities, improvements, and services to assure greater utilization, development, reclamation, and settlement of lands..." & "...mineral development and the entry into the market place of mineral products be considered in developing a statewide transportation system."*
3 RTA #115 & #117	Transportation Economics of Coal Resources of Northern Slope Coal Fields, Alaska	DOWL / PDF file	Mineral Industry Research Laboratory / Paul R. Clark	May-73	2	Examines northwest coast coal reserves and transportation alternatives to move the resources to market. Of limited value as the resources are far outside the WAAPS study area, but valuable for its evaluation of road-rail-slurry line economics. Would need to be brought up to date in terms of costs. This study was used in the RTA work on the Deadfall Syncline analysis, and most useful information is within that work.
4	Economic Mining Feasibility Studies of Selected Mineral Deposit Types in the Western Brooks Range, Alaska	DOWL / Paper Copy	US Department of the Interior / Uldis Jansons & Robert G. Bottge	1977	3	Major assumption for this study is the availability of a rail system for transporting equipment and concentrates for the base metal mines. Discusses resource estimates and economics of mine only--no transportation costs included.
5 RTA #113	Technical and Economic Feasibility - Surface Mining Coal Deposits, North Slope of Alaska	DOWL / PDF file	US Department of the Interior, Bureau of Mines/ Kaiser Engineers, Inc.	Aug-77	4	The purpose of the report is to study the problems to be encountered in the mining and reclamation of the Alaska North Slope coal deposits; to design surface mining systems to improve coal extraction, overburden handling, and reclamation; and to subject such conceptual mining systems to engineering/economic feasibility and environmental impact analyses. Data gathered on the environment, geology, marketing and transportation, mining equipment and technology, and reclamation. Study area is entirely outside of WAAPS area. Discussion on technical and transportation constraints may be applicable to the WAAPS minerals potential considerations.
6	Summary File Report - Arctic Camp Prospect, Ambler Mining District, Alaska	DOWL / Paper Copy	U.S. Bureau of Mines / Paul A. Metz, Mineral Industry Research Laboratory, UAF	15-Jan-78	3	Transportation assumption is a combination of rail, road, and barge between Arctic and Tacoma, WA. Only a portion of the railroad construction cost is allocated to the mine cost estimates. Very little discussion of transportation. Includes resource estimates & economic tabulations.
7	NANA Region Gravel Study: Site Identification and Policies	DOWL / PDF file	DOT&PF / Maniilaq Association & NANA Regional Corporation	May-84	1	This report provides an overview of gravel extraction and transport challenges in the NANA region. It addresses issues well known to project development agencies regarding 7i (which has been addressed by law) and the challenges of seasonal access to resources.
8 RTA #131 & #132	Western Arctic Coal Development Project Phases II & III	DOWL / PDF file	Alaska Native Foundation & DCCED / Arctic Slope Consulting Engineers	1985 & 1988	4	This report provides an overview of coal transportation from the western coast fields by marine transport to destinations within Alaska to provide a stable energy resource to communities, military installations, and resource developments. There is little value to the discussion of overland routes between the interior and the western coast, except to provide comparative data for moving products by marine transport over a short season versus moving products by road or rail all-season systems.
9 RTA #79	Northwest Area Plan - Minerals Resource Report	ARLIS / Paper Copy	DNR, Division of Land and Water	Feb-89	3	Report attempts to provide minerals resource information to help answer questions concerning the balance of land use for mining versus subsistence and other fish and wildlife resource use. Many state lands in the northwest region were selected primarily for their mineral potential. The report identifies the Ambler Mining District, the DeLong Mountains, and the Seward Peninsula as having great base and precious metal resource potential. Potential coal resources are also identified but development is considered unlikely due to the high development costs as compared to those for liquid fuels. Development of most of these remote prospects was not economically feasible at the time of the report. Maps of potential resources included.

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10 RTA #14	Aluaq Mine Study	DOWL / PDF file	Arctic Slope Regional Corporation / Arctic Slope Consulting Group	Nov-89	2	This report provides detailed mine development and transportation costs for the Aluaq Mine. It indicates that the mining operation cannot sustain the full costs of road development, and road maintenance associated with the project is in the range of 40-50% of total operational costs. While the project is outside the study area, the report does provide useful transportation economic data that may be applicable to road construction in other arctic and sub-arctic areas.
11 RTA #15 (& #19?)	Analysis of Bethel, Kivalina (Red Dog), and Omalik Lagoon as Port Sites for Use by the Mineral Industry	DOWL / PDF file & Paper Copy	US Department of the Interior / Gary E. Sherman, Mark P. Meyer, & James R. Coldwell	1990	3	This report is an analysis of various port sites in western and arctic Alaska from a mineral development standpoint for the US Army Corps of Engineers Resource Development Navigation Study. It identifies Bethel and Omalik Lagoon as impractical port sites for mines in those areas and identifies Kivalina (Red Dog) as a practical site. This report formalizes a principal, referred to in earlier studies, of 100 miles being a general boundary for transporting minerals by road out of and products into mining districts from a port facility. All three port sites documented herein lie outside of the WAAPS study area.
12 RTA #16	Analysis of Iliamna Bay, Kotzebue, and Nome as Port Sites for Use by the Mineral Industry	ARLIS / Paper Copy	US Department of the Interior / Gary E. Sherman, Denise A. Herzog, James R. Coldwell & Mark P. Meyer	1990	3	This report is an analysis of various port sites in western and arctic Alaska from a mineral development standpoint for the US Army Corps of Engineers Resource Development Navigation Study. Of the three sites studies in this report, Nome is identified as the site with the most potential for use by the mineral industry. This report formalizes a principal, referred to in earlier studies, of 100 miles being a general boundary for transporting minerals by road out of and products into mining districts from a port facility.
13 RTA #106	Selected Coal Deposits in Alaska	DOWL / PDF file	US Bureau of Mines / Mark P. Meyer	1990	1	This report examines coal deposits thoughout Alaska, providing data for location and general characteristics of the deposits. There is no discussion of transportation infrastructure needed for mine development.
14	Coal Resources of Northwest Alaska: Final Report	DOWL / PDF file	DGGS / James G. Clough & John T. Roe	Jun-90	1	This report provides good base data for the location and general characteristics of coal desposits in Northwest Alaska, including a sizeable area of the WAAPS area. There is little to no transportation data; it was prepared for data entry into the national coal resources data base.
15	Estimated Mineral Potential of Lands Available for State Selection 1991 - 1993	DOWL & AGI / PDF file & Web Page http://www.dggs.dnr.state.ak.us/webpubs/dggs/pdf/text/pdf1993_000.PDF	Land Selection Steering Committee / DGGS	Jun-93	1	DGGS was assigned the task of evaluating the eligible federal lands for mineral and energy potential and providing State Pipeline Coordinator's Office with geotechnical information for potential transportation corridors. Mineral potential for the following units within the WAAPS study area detailed: Units 8, 15-22, & 32-34 (Index Map on p. 2). Geotechnical information for corridors does not appear to be included in this report.
16	Arctic NSR Formula	DOWL / PDF file & Paper Copy	Kennecott / David C. Brown, Arrow Transportation Systems, Inc.	15-Dec-95	3	"Ball park" transportation cost calculations for a possible future mining development in the Ambler District.
17	Arctic Project - Ambler District, Alaska, Mining Potential	DOWL / Paper Copy	Kennecott Minerals	21-Nov-97	2	Evaluates potential synergy between mining the Arctic Deposit in combination with other known deposits in the Ambler District. Ruby Creek, Sunshine Creek, Smucker, Sun, and various other deposits are presented. Includes resource estimates & economic tabulations.
18	Arctic Project Preliminary Scoping Study - Draft	DOWL / Paper Copy	Kennecott Minerals / Steffen Robertson & Kirsten (Canada) Inc.	Nov-98	3	Mining costs and production rates estimates only. Assessment of original economics using an underground mining scenario, as opposed to an open-pit operation.
19	Mineral Investigations in the Koyukuk Mining District, Northern Alaska: Volumes I and II	DOWL / PDF file	BLM / J.M. Kurtak, R.F. Klieforth, J.M. Clark, & E.A. Maclean	Jul-02	2	This report provides good data on mineral resources in the eastern portion of the WAAPS study area and provides useful land status and mineral value data. Volume I - Introductory text and summaries of mines, prospects, and mineral occurrences in the Bettles, Chandalar, Chandler Lake, and Hughes quadrangles. Volume II - Summaries of mines, prospects, and mineral occurrences in the Melozitna, Survey Pass, Tanana, and Wiseman quadrangles.
20	Report of the 2008 Alaska Minerals Commission	DOWL / PDF file & Web Page http://www.library.state.ak.us/asp/edocs/annual/ocm29879200/2008.pdf	Alaska Minerals Commission	2008	1	Presents recommendations for the governor and legislature. Key recommendations relevant to the WAAPS study include (1) Support the need for developing more power generation capacity and distribution in the state; (2) Support the needs to develop a policy and procedure with BLM for application and conveyance of Rights-of-Way over federal lands; (3) Continue to support the Roads to Resources program within DOT&PF.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
Use 100-199	**Resources - Oil & Gas**					
100	Nenana Basin, Alaska	DOWL / PDF file	Doyon, Limited / Petrotechnical Resources Alaska	Undated	3	One-page informational brochure outlining basin potential, economic viability, geology, estimated reserves, and basin location.
101	Coal resource potential	Petrotech	DGGS / Goff, K.M., Clough, J.G., Lueck, L.L., and Belowich, M.A.	1986		Alaska Division of Geological & Geophysical Surveys Public Data File 85-42D, 80 p., 18 sheets, scale 1:250,000.
102	Map of Alaska's coal resources	Petrotech	DGGS / Merritt, R.D., and Hawley, C.C.	1986		Alaska Division of Geological & Geophysical Surveys Special Report 37, 1 sheet, scale 1:2,500,000.
103	Geology and petroleum potential of Hope and Selawik Basins	Petrotech	DGGS / Decker, J.E., Robinson, M.S., Clough, J.G., and Lyle, W.M.	1987		Alaska Division of Geological & Geophysical Surveys Public Data File 88-1, 33 p.
104	Map showing sedimentary basins of onshore and Continental Shelf areas, Alaska	Petrotech	USGS / Kirschner, C.E.	1988		U.S. Geological Survey Map I-1873.
105	Project report of the aeromagnetic survey for the Holitna Basin area, western Alaska	Petrotech	DGGS / SIAL Geosciences Inc., and On-line Exploration Services Inc.	1998		Alaska Division of Geological & Geophysical Surveys Public Data File 98-29, 82 p., 2 sheets, scale 1:125,000.
106 RTA #92	Prospects for Development of Alaska Natural Gas: A Review	DOWL / PDF file	U.S. Department of the Interior, Minerals Management Service / Kirk W. Sherwood & James D. Craig	Jan-01	4	Gas reserves in northern Alaska are stranded by the lack of a means of transportation to market. Three concepts are presented for commercializing the stranded gas resources in northern Alaska and Mackenzie delta: 1) New gas pipelines that link to existing pipelines in Canada; 2) Liquefied natural gas (LNG) to Asian Pacific Rim or U.S. West Coast-gas pipeline from Prudhoe to Southern Alaska; and 3) Gas to liquids (GTL) and tankers to U.S. West Coast-use oil pipeline to move gas from Prudhoe to Valdez. The most likely scenario for exports of northern Alaska gas is a gas pipeline down existing highways from Prudhoe Bay to Alberta, Canada. One proposed tanker route from Nome to Asian markets (p. 98), but no proposed land infrastructure to get gas from Prudhoe to Nome.
107	Map and digital database of sedimentary basins and indications of petroleum in the Central Alaska Province	Petrotech	USGS / Troutman, S.M., and Stanley, R.G.	2002		U.S. Geological Survey Open-File Report 02-483.
108	Alaska's conventional and coalbed methane gas potential	Petrotech	Myers, M.D.	2003		Presentation to Coalbed Methane Symposium 2001, DGGS Misc. Pubs. 127.
109	Geologic and isostatic map of the Nenana basin area, central Alaska	Petrotech	USGS / Frost, G.M., Barnes, D.F., and Stanley, R.G.	2003		U.S. Geological Survey Geological Investigations Series I-2543.
110	Alaska's oil and gas future: New frontiers, expanding opportunities	Web Page http://www.dog.dnr.state.ak.us/oil/products/slideshows/new_frontiers.pdf	Myers, M.D.	2004		Presentation to 2004 Pac-Com Expo and Conference
111	Oil and gas potential in interior Alaska	Web Page http://www.akrepublicans.org/houres/24/pdfs/houres_20050822011_04.pdf	Swenson, R.F.	2005		DNR presentation
Use 200-299	**Resources - Fisheries**					
200	Research and Restoration Plan for Norton Sound Salmon	DOWL / PDF file	Norton Sound Steering Committee / Scientific Technical Committee	18-Feb-03		Plan designed to provide as much specific advice as possible on how to select projects needed to advise managers and residents of the region on short-term and long-term research and restoration actions needed to secure sustainable salmon resources.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
201	Analysis of Southeast Alaska Commercial Salmon Fishing Infrastructure, Final Report	DOWL / PDF file	ADFG, Division of Administration / McDowell Group	Aug-03		The purpose of the study is to provide a strategic planning framework for regional infrastructure funding through the Southeast Sustainable Salmon Fund. The study included: Inventory of salmon fishing infrastructure and infrastructure needs in Southeast Alaska; Assessment of major salmon market trends and their implications for infrastructure development; Research on the role of government in support of industry infrastructure; Development of criteria to guide infrastructure priorities and to identify projects that may not be appropriate for SSSF funding; Recommendations for promising infrastructure projects around the region
202	Western Alaska Salmon Set Net & Upper Yukon River Salmon Fish Wheel Improvement Program	DOWL / PDF file	DCCED, Office of Economic Development	4-Feb-05		The Targeted Fisheries Assistance Program (TFAP), administered by Commerce, is intended to supplement prior grant programs by providing grant assistance toward solving key development problems facing distressed salmon fisheries. Western Alaska and Yukon salmon fisheries fall under this program.
203	Yukon Fisheries News	DOWL / PDF file	Yukon River Drainage Fisheries Association	Fall 2005		2005 Newsletter
204	Alaska Subsistence Fisheries 2003 Annual Report	DOWL / PDF file	ADFG, Division of Subsistence	Sep-05		Report summarizes Alaska's 2003 subsistence fishing season based upon subsistence permit data and harvest assessment surveys from across the state.
205	The Great Salmon Run: Competition Between Wild and Farmed Salmon	DOWL / PDF file	TRAFFIC North America / Gunnar Knapp, Cathy A. Roheim, & James L. Anderson	Jan-07		This report examines economic and policy issues related to wild and farmed salmon in North America. The primary purpose of this report is to inform people who care about these issues—particularly policymakers, the environmental community, and the fishing industry—about the wild and farmed salmon industries and the economic relationships between them, to provide a sound basis for achieving environmental and economic goals.
206	2005 Annual Management Report Norton Sound, Port Clarence, and Kotzebue, Fishery Management Report No. 07-32	DOWL / PDF file	ADFG, Divisions of Sport Fish and Commercial Fisheries / Allegra Banducci, Tom Kohler, Joyce Soong, and Jim Menard	Apr-07		Report summarizes the 2005 season and historical information concerning management of the commercial and subsistence fisheries of Norton Sound, Port Clarence, and Kotzebue Sound Districts.
207	Alaska Subsistence Salmon Fisheries 2005 Annual Report, Review Draft Annual Report, Technical Paper No. 318	DOWL / PDF file	ADFG, Division of Subsistence / J.A. Fall et. al.	Apr-07		Report summarizes Alaska's 2005 subsistence fishing season based upon subsistence permit data and harvest assessment surveys from across the state.
208	Kobuk River Test Fishing Project, 2006, Fishery Data Series No. 07-27	DOWL / PDF file	ADFG, Division of Sport Fish and Commercial Fisheries / Jim Menard and Scott Kent	May-07		Catch statistics and age, sex, and length data for chum salmon from the 2006 Kobuk River drift gillnet test fish project were summarized.
209	Subsistence Harvests of Pacific Halibut in Alaska, 2006	DOWL / PDF file	ADFG, Division of Subsistence / James A. Fall, David Koster, & Michael Turek	Dec-07		This report describes the results of the fourth annual study to estimate the subsistence halibut harvest in Alaska since the National Marine Fisheries Service adopted rules governing subsistence halibut fishing in 2003. Data were collected through a voluntary mail-out survey of all holders of subsistence halibut registration certificates.
210	2008 Norton Sound Summer King Crab Fishery Management Strategies	DOWL / PDF file	ADFG, Division of Commercial Fisheries	2008		An informational letter to the commercial king crab fishers of the Norton Sound Section. Includes status of stock, outlook for 2008, changes in regulations for 2008, and management strategy.
211	Retention of Sublegal Halibut in the Area 4D/4E CDQ Fishery: 2007 Harvests, from Report of Assessment and Research Activities 2007, p. 79-81	DOWL / PDF file	International Pacific Halibut Commission / Gregg H. Williams	2008		The 2007 harvest of retained sublegal halibut for Areas 4D & 4E Commercial Development Quota fishery reported in this paper should be added to the subsistence harvest reported by the Alaska Department of Fish and Game for a full accounting of annual subsistence removals in Alaska.
212	Delicious Success	DOWL / PDF file & Web Page http://www.adn.com/new/alaska/story/325350.html	Anchorage Daily News / Margaret Bauman	25-Feb-08		Creator of Yummy Chummies aims to expand dog treats business

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
213	Yukon River Salmon 2007 Season Summary and 2008 Season Outlook, Regional Information Report No.3A08-01	DOWL / PDF file	ADFG, Division of Commercial Fisheries / The United States and Canada Yukon River Joint Technical Committee	Mar-08		Report summarizes the status of 2007 salmon stocks with reference to historical data, presents an outlook for the 2008 season, and provides data on the utilization of salmon species by commercial and subsistence harvests, personal use, and sport fishery.
214	2008 Kotzebue Sound Salmon Fisheries Management Plan, Regional Information Report No. 3A08-02	DOWL / PDF file	ADFG, Division of Commercial Fisheries / Jim Menard	May-08		Plan provides the expected run outlooks and harvest strategies for Kotzebue Sound salmon fisheries in 2008.
215	2008 Norton Sound Salmon Fisheries Management Plan, Regional Information Report No. 3A08-04	DOWL / PDF file	ADFG, Division of Commercial Fisheries / Jim Menard	May-08		Plan provides the expected run outlooks, management issues, and harvest strategies for Norton Sound salmon fisheries in 2008.
216	2008 Yukon Area Subsistence, Personal Use, and Commercial Salmon Fisheries Outlook and Management Strategies, Regional Information Report No. 3A08-03	DOWL / PDF file	ADFG, Division of Commercial Fisheries / Fred J. Bue & Steve J. Hayes	May-08		Plan provides an overview of the expected salmon outlooks, management issues, and harvest strategies for the Yukon River summer and fall salmon fisheries in 2008.
217	2007 Annual Management Report Norton Sound, Port Clarence, and Kotzebue, Fishery Management Report No. 07-32	DOWL / PDF file	ADFG, Divisions of Sport Fish and Commercial Fisheries / Joyce Soong, Allegra Banducci, Scott Kent,and Jim Menard	Jun-08		Report summarizes the 2007 season and historical information concerning management of the commercial and subsistence fisheries of Norton Sound, Port Clarence, and Kotzebue Sound Districts.
218	Annual Management Report Yukon and Northern Areas 2002-2004, Fishery Management Report No. 08-39	DOWL / PDF file	ADFG, Divisions of Sport Fish and Commercial Fisheries / S. J. Hayes, F. J. Bue, B. M. Borba, K. R. Boeck, E. J. Newland, Ke. J. Clark, and W. H. Busher	Jun-08		Report summarizes the 2002-2004 seasons and historical information concerning management of the commercial, subsistence, and personal use fisheries in the Yukon Area.
219	Alaska Chum Eggs are Liquid Gold	DOWL / PDF file & Web Page http://www.newsminer.com/news/2008/sep/10/alaska-chum-eggs-are-liquid-gold/	Fairbanks Daily News Miner / Kate Golden	10-Sep-08		Chum salmon caviar
Use 300-399	**Resources - Tourism & Recreation**					
300	Alaska Community Tourism Handbook: How to Develop Tourism in Your Community	Northern Economics / Electronic Copy	DCCED	Undated	4	Describes the costs and benefits of rural tourism in Alaska.
301	Far North: Western Arctic	Web page http://www.travelalaska.com/Regions/RegionSubArea.aspx?aID=2	TravelAlaska.com	Undated	4	Describes tourist resources in Western Arctic region of Alaska.
302	Far North Community: Kotzebue	Web page http://travelalaska.com/Regions/CommunityDetail.aspx?LocationID=46	TravelAlaska.com	Undated	4	Describes tourist resources in Kotzebue.
303	Far North Community: Nome	Web page http://travelalaska.com/Regions/CommunityDetail.aspx?LocationID=53	TravelAlaska.com	Undated	4	Describes tourist resources in Nome.

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304	Nome Alaska	Web page http://alaska.org/nome/nome-alaska-airlines-vacations.htm	Alaska.org	Undated	4	Describes tourist resources in Nome.
305	Rural Alaska Tourism Infrastructure Needs Assessment: Northwest Arctic Borough	Northern Economics / Electronic Copy	Northwest Arctic Borough Economic Development Commission & DCCED	Undated	3	Describes tourist resources in Northwest Arctic Borough and constraints and opportunities for development.
306	The Noatak River: Fall Caribou Hunting and Airplane Use	Northern Economics / Electronic Copy	ADFG / Georgette, Susan and Hannah Loon	1988	4	Provides a detailed discussion of subsistence/sport hunting conflicts along the Noatak River.
307	Eskimo Tourism: Micro-Models and Marginal Men.	Web page http://www.questia.com/read/43089170?title=Hosts%20and%20Guests%3a%20The%20Anthropology%20of%20Tourism%20(Chap.%203%20%22Eskimo%20Tourism%3a%20Micro-Models%20and%20Marginal%20Men%22)	Smith, Valene	1989	4	Presents a history of tourism in Nome and Kotzebue
308	Subsistence and Sport Fishing of Sheefish on the Upper Kobuk River	Northern Economics / Electronic Copy	ADFG / Georgette, Susan and Hannah Loon	1990	4	Provides a detailed discussion of subsistence/sport fishing conflicts in the Upper Kobuk River Sheefish fishery.
309	Gates of the Arctic, Kobuk River Sport Hunter Study	Northern Economics / Electronic Copy	Aldo Leopold Wilderness Research Institute and U.S. Departments of the Interior and Agriculture / Christensen, Neal and Alan Watson	Mar-02	2	Presents the results of a survey of sport hunters who had hunted in the Gates of the Arctic National Park and Preserve.
310	Nome Area Tourism Demand, Potential, and Infrastructure Study	Northern Economics / Electronic Copy	DOT&PF / Land Design North	Oct-03	3	Disusses strengths and deficienies of Nome's transportation infrastruture in terms of tourism.
311	Northwest Alaska Transportation Plan: Community Transportation Analysis	Northern Economics / Electronic Copy	DOT&PF	Feb-04	1	Describes tourism demand, potential and infrastructure in the Nome area.
312	Northwest Arctic Borough Comprehensive Economic Development Strategy	Northern Economics / Electronic Copy	Stoops, Lee	Sep-04	4	Describes tourist resources in Northwest Arctic Borough and constraints and opportunities for development.
313	Bering Land Bridge National Preserve: Directions	Web page http://www.nps.gov/bela/planyourvisit/directions.htm	National Park Service	2006	4	Describes National Park Service facilities for Bering Land Bridge National Preserve.
314	2006 Profile of Visitors to Rural Alaska and the Bering Strait Region	DOWL / PDF file & Web page http://commerce.state.ak.us/oed/toubus/pub/Bering_Strait.pdf	DCCED / McDowell Group	Mar-06	2	Provides an estimate of visitor volume for the Bering Strait region.
315	A Crisis in the Making in Northwest Alaska; Caribou, Hunting Pressure and Conflicting Values	DOWL / PDF file & Web page http://www.wildlifenews.alaska.gov/index.cfm?adfg=wildlife_news.view_article&articles_id=236	Steinacher, Sue	Sep-06	3	Describes escalating resource user conflicts in Game Management Unit 23.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
316	Kotzebue Airport Relocation Feasibility Study	Web page http://www.kotzebueairport.info/reports.htm	DOT&PF / PDC Inc. Engineers	Jan-07	4	Provides an overview of the tourism industry in Kotzebue.
317	Alaska Rural Visitor Industry Product Development Project: Final Report	Northern Economics / Electronic Copy	DCCED	Jun-07	2	Presents Nome/Bering Strait Regional case study describing constraints and opportunities for rural tourism.
318	Participation, Catch, and Harvest in Alaska Sport Fisheries During 2004	Northern Economics / Electronic Copy	ADFG / Jennings, Gretchen, Kathrin Sundet and Allen Bingham	Jun-07	1	Presents time series data on sport fishing catch and effort in Alaska by region.
319	Kobuk-Seward Peninsula Proposed Resource Management Plan and Final Environmental Impact Statement	Web page http://www.blm.gov/ak/st/en/prog/planning/ksp/ksp_documents/ksp_draft_rmp_eis.html	U.S. Department of the Interior, Bureau of Land Management	Sep-07	3	Describes recreational resources and user issues on Bureau of Land Managements lands on the Kobuk-Seward Peninsula.
320	Cape Krusenstern National Monument: Plan Your Visit	Web page http://www.nps.gov/cakr/planyourvisit/index.htm	National Park Service	2008	4	Describes visitor facilities at Cape Krusenstern National Monument.
321	Kanuti National Wildlife Refuge: Kanuti Controlled Use Area	Web page http://kanuti.fws.gov/controlled.htm	U.S. Fish and Wildlife Service	2008	4	Provides a brief overview of the Kanuti Controlled Use Area.
322	LaVonne's Fish Camp	Web page http://www.fishcamp.org/	LaVonne's Fish Camp	2008	4	Describes facilities and services offerred to guests.
323	Northwest Arctic Heritage Center, Kotzebue, Alaska	Web page http://www.nps.gov/cakr/parknews/nwahc.htm	National Park Service	2008	4	Describes in detail the planned Northwest Arctic Heritage Center in Kotzebue.
324	Northwest Management Area Description	Web page http://www.sf.adfg.state.ak.us/Management/areas.cfm/FA/northwestoverview.overview	ADFG	2008	2	Provides an overview of sport fisheries in the Northwestern Management Area.
325	Draft Environmental Impact Statement for the Yukon Flats National Wildlife Refuge Proposed Land Exchange	Web page http://yukonflatseis.ensr.com/yukon_flats/documents.htm	U.S. Fish and Wildlife Service	Jan-08	4	This draft environmental impact statement includes a detailed description of the potential impacts of road construction on subsistence resource users in the Yukon Flats.
326	Fall Hunting in Game Management Unit 23: Assessment of Issues and Proposal for a Planning Process	Northern Economics / Electronic Copy	ADFG / Jacobson, Cynthia	Feb-08	4	Describes resource user conflicts in Game Management Unit 23, including interviews with key stakeholders, and presents the outcome of a planning group meeting to consider ideas to address issues.
Use 400-449	**Resources - Agriculture**					
400	American Perceptions of the Agricultural Potential of Alaska: 1867-1958	Book	Shortridge, J.R.	1972	2	Explores Alaska's agriculture from Russian purchase to statehood. Explains why Alaska has its own model of agricultural development.
401	The Russian Population in Alaska and California: Late 18th Century-1867	Book	Pierce, R.A., ed. and Donnelly, A.S., trans.	1973	3	Historical context of agriculture and forestry uses.
402	Resources Inventory Arctic Region: Agriculture and Range Resources	Report	Joint Federal-State Land Use Planning Commission / Snodgrass, R.	1974	1	Excellent overview of land and soils potential.
403	Resources Inventory Northwest Region: Agriculture and Range Resources	Report	Joint Federal-State Land Use Planning Commission / Snodgrass, R.	1974	1	Excellent overview of land and soils potential.
404	Resources Inventory Yukon Region: Agriculture and Range Resources	Report	Joint Federal-State Land Use Planning Commission / Snodgrass, R.	1974	1	Excellent overview of land and soils potential.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
405	The Frontier in Alaska and the Matanuska Colony	Book	Miller, Orlando	1975	2	Good discussion on why Alaska's agriculture developed differently than the western US.
406	The Russian Orthodox Religious Mission in America, 1794-1837	Book	Pierce, R.A., ed. and Bearne, C., trans.	1978	4	Historical context of agriculture and forestry uses.
407	Early Russian Contact	Book	Black, L.T. and Desson, D.	1986	2	Identified early agricultural needs, challenges; identified forest use.
408	Russia in North America: Proceedings of the 2nd International Conference on Russian America	Book	Pierce, R.A., ed.	1990	1	Provides historical context; agricultural problems are much the same as first contact.
409	Yuungnaqpiallerput/The Way We Genuinely Live: Masterworks of Yup'ik Science and Survival	Book	Fienup-Riordan, A.	2007	4	Current context of food and perceptions towards food and fish, southwest Alaska.
Use 450-499	**Resources - Forestry**					
450	Flag Over the North		Kitchener, L.D.	1954	2	Excellent history of NC Company: firewood, steamers, early Fairbanks wood use for electrical generation.
451	Alaska's Forest Resource	Paper Copy	U.S. Forest Service / Hutchinson, O.	1967	2	U.S. Forest Service Resource Bulletin No. 19
452	A Preliminary Classification System for Vegetation of Alaska	Paper Copy	U.S. Forest Service / Viereck, L.A. and Dyrness, C.T.	1980	3	U.S. Forest Service General Technical Report No. 106
453	Forest Resource & Allowable Cut: Fairbanks Working Circle	Paper Copy	Department of Forest, Land, and Water Management, DNR / Wieczorek, D.	1980	2	Provides annual allowable harvest level calculations for Tanana State Forest.
454	Potential Economic Development of Forest Resources in Interior Alaska	Paper Copy	Pacific Northwest Forest and Range Experiment Station / Smith, R.C.	1980	1	Defines potential products from forest resource in interior Alaska.
455	Forest Resource Development for Interior Alaska	Paper Copy	Alaska Renewable Resources Corporation (Anchorage) / Marshall, H.	1981	1	First overall forest potential for interior Alaska - based on soils, products, species, markets.
456	Timber Resource Management Plan for Five Villages in the Nana Region	The Mauneluk Corporation (Kotzebue) / Paper Copy	Reid, Collins, Inc. / Hogan, K.M.	1981	1	Field and aerial photo analysis of forest potential in five villages.
457	Use of Wood Energy in Remote Interior Alaskan Communities	Paper Copy	Division of Energy and Power Development / Marshall, H.	1981	1	Addresses early use of forest resource in project area; river steamers at end of 19th century.
458	Potential for Economical Recovery of Fuel from Land Clearing Residue in Interior Alaska	Paper Copy	U.S. Forest Service / Sampson, G.R. and Ruppert, F.A.	1983	2	U.S. Forest Service Research Paper No. 308
459	Potential for Forest Products in Interior Alaska	Paper Copy	U.S. Forest Service / Sampson, G.R., van Hees, W., Setzer, T. and Smith, R.	1988	3	U.S. Forest Service Resource Bulletin No. RB-153
460	Kantishna Timber Cruise	Paper Copy	State of Alaska / Kerr, C.L and Sanders, R.C.	1989	1	Detailed, export-level field sampling, including fall, buck, and scale defect analysis on white spruce.
461	Tanana State Forestry Lands - Periodic Sustained Yield Analysis	DOWL / PDF file	DNR / Parsons & Associates	2001	1	Parsons & Associates, Inc. contracted by the State of Alaska DNR, Division of Forestry to calculate the potential PSY of timber available from the Tanana State Forestry Lands.
Use 500-599	**Transportation**					
500	Notes and Institute News - The Fairbanks Economic Community	DOWL / PDF file	unknown	undated	4	This article is a general history of development in the Fairbanks and interior areas and is of little value to the WAAPS project.

NOTE: Additional references and resource documents can be found in the *References* sections in each of the Working Papers produced for Phase I of WAAPS.

Western Alaska Access Planning Study (WAAPS) Bibliography

Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
501	Port of Nome, Alaska - Economic Development Analysis	DOWL / PDF file	TAMS Engineers	Undated	4	Report assesses the impact that a new major port facility at Nome will have on the long-term development of Northwest Alaska. Anticipated new economic activities include offshore oil and gas development, mineral extraction, and commercial fishing. A new facility would also be anticipated to lower transportation costs for the Region. The report concludes that the total economic benefits of the proposed port to the State and to the Nome Region justify construction.
502	Railroad Drawings in the Americas	DOWL / PDF file	unknown	undated	4	2-page document provided by the Interhemispheric Bering Strait Tunnel & Railroad Group. Pages have been extracted from a larger document. Figures are: *Proposed Conceptual Arrangement of the Railroad-Utility-Roadway Transportation Corridor as the Basis for Economic Development Between Cities Incorporating the Land Bridge Idea* & *Route Location of the Alaska Canada Northern Tier Railroad Utility Connector*.
503	Tunnel and Railroad Wales Brevig Marys Igloo Nome Routes	DOWL / PDF file	unknown	undated	4	2-page document provided by the Interhemispheric Bering Strait Tunnel & Railroad Group. Pages have been extracted from a larger document. Figures are: *Horizontal and Vertical Profiles of the Proposed Bering Strait Railroad Tunnel from Wales, Alaska to Uelen, Chukotka to Connect the United States and Russia with North America Asia* & *Specific Geographic Zones for Construction and Operation of the Intercontinental Railroad*.
504	A Description of Proposed Road Routes in Alaska: Talkeetna - McGrath - Ruby	DOWL / PDF file	Bureau of Public Roads Region 10 / Rose S. Komatsubara & William D. DeArmond	Aug-59	3	Provides overview of topography, climate, vegetation, fish and game, settlements, transportation, and resources between Talkeetna and Ruby. Provides fairly detailed route description, map, and general engineering and maintenance considerations for the route. The section detailed in this study is part of the larger Anchorage - McGrath - Ruby route.
505	Transport Requirements for the Growth of Northwest North America, Volumes 1-3	ARLIS / Paper Copy	Alaska International Rail and Highway Commission	1961	4	Study is concerned primarily with connecting Alaska to the Lower 48 and developing transportation improvements in the eastern and southeastern portions of the state (linking to Canadian systems). The Rex-McGrath-Ophir-Poorman-Ruby-Tanana-Eureka loop out of Fairbanks and two routes between Eureka and Nome are briefly discussed in Volume 3, with some cost estimates provided, but no maps or detailed descriptions.
506	Alaska Transportation Corridor Study	ARLIS & Alaska Railroad Corporation / Paper Copy	US DOT & FHWA / Tudor-Kelly-Shannon	Apr-72	2	Summary report.--Interim reports 1: Corridor recommendation, Nenana to Alatna.--Interim report 2: Corridor recommendation, Bettles to Alatna and Alatna to Kobuk.--Interim report 3: Corridor recommendation, Bettles to Prudhoe Bay.--Interim report 4: Criteria for preliminary design.--Interim report 5: Design criteria, cost estimates, oil transportation study. Key to WAAPS: DOT&PF requested a feasibility study for a rail line and a highway running from Bettles to Kobuk. Study concluded that it is feasible, from an engineering standpoint, to construct and maintain both railroad and highway facilities through corridors developed in the course of the study. The best corridor for an east-west railroad would begin at Alatna and folllow the Alatna and Kobuk Rivers westward, terminating at Dahl Creek Airstrip near Kobuk (139 miles). The best corridor for an east-west highway would begin at Prospect Creek, move overland via Bettles to the Alatna River, and thereafter follow the same corridor as the railroad to the Dahl Creek Airstrip (187 miles). Contains exerpts from previous studies. Construction cost and materials estimates are provided for each segment of the corridors.
507	Reconnaissance Report for a Cargo Unloading Facility at Tanana, Alaska	DOWL / PDF file	State of Alaska Department of Public Works / George S. Silides & Harold H. Galliett, Jr.	Apr-72	4	A response to the lack of river barge cargo handling facility at Tanana. Report concludes that any facilities improvements would decrease shipping costs for consumers and that any improvements made should be compatible with downstream river communities.
508 RTA #83	Optimum Transportation Systems to Serve the Mineral Industry North of the Yukon Basin in Alaska	DOWL / Paper Copy	U.S. Bureau of Mines / Mineral Industry Research Laboratory, UAF	Sep-73	1	Considers highway, rail, cargo aircraft, river barge, winter haul road, and air cushion vehicles (A.C.V.) as transport modes to get minerals from mine sites to ports for shipping. Estimates benefits and costs for each of the transportation alternatives. The optimum system is determined to be linkage of existing transportation systems with aircraft or A.C.V. to ship high-value product. A slurry pipeline is determined to be the most viable transport mode for coal. Report identifies need to investigate power alternatives for Northwestern Alaska. Figures 2-1, 2-2, and 2-3 show known mineral reserves. Figure IV-2 shows proposed transportation network. Includes resource estimates & economic tabulations.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
509	Yukon River Ferry System	DOWL / PDF file	Alaska Department of Public Works / Lyon Associates, Inc.	Oct-73	4	Useful only for its discussion of demand. Reinforces the value of road segments by virtue of showing that a seasonal operation like a ferry system does not address overall transport needs that are not already addressed by barge operations and personal travel. There does not appear to be a population base, nor the expected tourist traffic to warrant the vessel and shoreside infrastructure.
510	Ambler District Evaluation - Interoffice Memorandum	DOWL / Paper Copy	Kennecott Copper Corporation / John L. Halls	19-Jul-74	2	Evaluation of Arctic Deposit based on use of Boeing 747 transport of ore concentrates to Anchorage, then rail to port of Seward, then ship to smelter. Grade of the ore body and metal prices at the time made air transportation feasible for this evaluation. Assumptions and cost estimates provided, including estimates for rail and sea legs of transportation chain. Construction of road and rail routes determined to be too expensive at the time. Includes resource estimates & economic tabulations.
511	Arctic Deposit - Order of Magnitude Evaluation - Open Pit Operation	DOWL / Paper Copy	Kennecott Copper Corporation / John L. Halls	03-Jul-76	2	Updated evaluation of the Arctic Deposit, accounting for a reduction in ore reserve grade and inflation in Alaska since the 19 July 1974 evaluation. Air transport by Boeing 747 still determined to be viable. Includes resource estimates & economic tabulations.
512 RTA #116	Transportation and Development of Alaska Natural Resources	ARLIS / Paper Copy	Federal-State Land Use Planning Commission for Alaska / Paul Engelmen, Bradford Tuck, Jerry D. Kreitner, & Dennis M. Dooley	Mar-78	1	VERY good report addressing the transportation and resource development issues and considerations specific to Alaska. Principal concerns addressed by the report: 1) future demand for transportation, considering future resource development and the role of transportation in determining feasibility of development; 2) the relationship between (d)(2) lands and future transportation development. The transportation system should facilitate economic and social well-being in the State. *"Transportation should not be used as a subsidy to resource development." "Transportation is a necessary but not sufficient condition for development of most resources." "It is a commonly stated proposition that transportation costs are <u>the</u> barrier to successful hardrock mineral development." Alternatively, "the <u>total costs</u> of mining in Alaska preclude most economic development of hardrock mineral resources, and even with an in-place transportation infrastructure, such development would not take place under present national and world market conditions."* Agriculture, Forestry, Fisheries, Hardrock Minerals, and Energy Resources are discussed in relation to transportation. One key conclusion of the report is, *"The costs of moving concentrates via the west coast of Alaska, even making a generous allowance for port site costs, might prove to be significantly less than moving the same amount of material east and south."*
513	Arctic Deposit - Order of Magnitude Evaluation	DOWL / Paper Copy	Kennecott Copper Corporation / John L. Halls	04-Aug-78	2	Updated evaluation of the Arctic Deposit, accounting for a decrease in forecasted metal prices and an increase in air freight costs. With State provision of a road from Arctic to Golovin Bay and a State-provided port, the Arctic Deposit still remains viable for development. *"Arctic...needs a road to the coast and a port before any further development will take place. We can forget about aircraft."* Seven access route alternatives considered in this latest evaluation (map included), and issues/benefits of each are discussed (p. 8-13). Includes resource estimates & economic tabulations.
514 RTA #118	Transportation Systems Planning for Alaska	ARLIS / Paper Copy	Institute of Social and Economic Research, UAF / John T. Gray	30-Nov-79	4	The principal objective of the study was to develop economic and transportation system models which could be used to evaluate the impacts of alternative transportation policies and decisions on the operation of the transport system and on the pattern of state and regional economic development. Characteristics of the existing transportation system carrying important implications: 1) Sparseness of the network; 2) Flow imbalance, resulting in low back haul rates; 3) Excess capacity of existing network. Western Alaska and major mineral developments other than oil were largely left out of the considerations and modeling.
515	Western and Arctic Alaska Transportation Study - Nome-Kotzebue Road Preliminary Feasibility Study	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates	Jan-80	2	Part of 1981 Western and Arctic Alaska Transportation Study. Four proposed road alignments studied. "Local service road" used for design criteria. Design, construction, and maintenance costs estimated. Transportation costs for people and goods using existing systems were found to be generally less than those using proposed new roads. Estimated economic benefits of the road do not justify construction/maintenance. Conclusion: proposed new road would not be economically viable. The only possible occurrence identified that could substantially change the results of the analysis would be a major mineral development. A high priority is given to studying the possibility of developing coal deposits at Chicago Creek and other mineral deposits on the Seward Peninsula.

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Western Alaska Access Planning Study (WAAPS) Bibliography

Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
516 RTA #125	Western and Arctic Alaska Transportation Study - Phase I: Data Collection Final Report, Volume I: General	DOWL / PDF file & Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	Feb-80	3	Phase I primarily involves data collection and the beginning of the public involvement program. Volume I includes a description of the study area, its transportation system and socio-economic structure, transportation policy, planning, and institution, the environment, and the public involvement program. Also includes overviews of resources in the area - agricultural, mineral, fisheries, tourism. Pages 4-2 to 4-4 and 4-9 to 4-11 include a list of the primary laws and pending legislation pertinent to land ownership and use in the study area. Chapter 5 includes general environmental impacts--these are addressed more specifically in Volume V. *WAATS study area only partially overlaps with WAAPS study area & WAATS report/data is largely outdated.*
517	Western and Arctic Alaska Transportation Study - Phase I: Data Collection Final Report, Volume II: Aviation	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	Feb-80	4	Volume II includes a description of the aviation transport system in the study area including its infrastructure organization, operations and fleet, the traffic, costs, tariffs and charges, the technology used, and environmental data.
518	Western and Arctic Alaska Transportation Study - Phase I: Data Collection Final Report, Volume III: Marine Transportation	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	Feb-80	4	Volume III includes a description of the water transportation system including marine infrastructure, navigational aids, organization, operation and fleet, waterborn traffic data, costs, tariffs, and charges, the technology used, and the environmental data.
519	Western and Arctic Alaska Transportation Study - Phase I: Data Collection Final Report, Volume IV: Other Modes of Transportation	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	Feb-80	2	Volume IV includes a description of the highway and railway transportation, of pipelines and off-road transportation and storage, a review of the infrastructure of each, as well as the organization, operations and fleet, where appropriate, the costs, tariffs, and charges, the technology used, and the environmental data. The construction and maintenance costs sections, while outdated, may be useful models for data collection and presentation. Section 1.6 *Technology* includes some important considerations for arctic construction. Section 1.7 *Highways and the Environment* lists and describes potential environmental impacts specific to highways.
520 RTA #126	Western and Arctic Alaska Transportation Study - Phase II: Forecasting and Analysis Final Report, Volume I: Chapters 1-3	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	Aug-80	3	Phase II involves the forecasting and analysis segment of the study, primarily an analysis of specific projects and programs. Phase II involves the determination of future transportation demand, comparisons of demand and capacity of facilities and fleets, and analysis aimed at identifying present and future transportation problem areas. The Phase II report identifies alternatives to be studied in the final phase of the study and determines that there is generally adequate capacity in most transportation infrastructure, that the commodity flows are virtually all one-way flows resulting in an uneven utilization of the transportation system, that factors such as land use policies and future development of oil, gas, and mineral resources will have the greatest impact on the future transportation system in the study area. Volume I is a description of the methodology; the socioeconomic and transportation costs; and the analysis of institution and policies which influence transportation in the study area. *WAATS report/data is largely outdated, and this phase of the study may simply serve as a helpful model.*
521	Western and Arctic Alaska Transportation Study - Phase II: Forecasting and Analysis Final Report, Volume II: Chapters 4-10	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	Aug-80	3	Volume II includes the analysis and identification of project alternatives for aviation, marine transportation, highways, railways, and off-road transportation; analysis of storage capacity; review of environmental impacts, planning procedures, the public involvement program, and community profiles. Sections 6.1 and 6.2 address highways and railways. Highway alternatives relevant to the WAAPS study primarily involve small road extensions and improvements to the local/regional road system around Nome. Three railway alternatives within the WAAPS area are discussed, with only one showing potential viability. The rail-road map illustrates the logical routing between Fairbanks and the Dalton Highway termini with the exception that only wilderness areas and not conservation units in general are deemed unavailable for rail-road construction.

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522 RTA #127	Western and Arctic Alaska Transportation Study - Phase II: Forecasting and Analysis Final Report, Volume III: Appendices	DOWL / PDF file & Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	Aug-80	3	Volume III includes appendices for Chapter 2: Transportation Analysis from Phase II, Volume I. Appendices include forecasts, fuel data, minerals resources data, and costs.
523	Western and Arctic Alaska Transportation Study - Phase II: Forecasting and Analysis Final Report, Volume IV: Appendices	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	Aug-80	3	Volume III includes appendices for Chapters 3, 5, 6, 7, and 9.
524	Historic Profile of the Alaska Railroad	DOWL & AGI / PDF file	DOT&PF / Bivens & Associates, Inc.	Sep-80	4	Provides history of Alaska Railroad and History of the White Pass and Yukon Railway.
525	Nenana Agricultural Transportation Systems (select pages from)	DOWL / PDF file (Full Report available at UAA/APU Consortium Library)	HDR & Alaska Transportation Consultants, Inc.	Feb-81	3	Report states that "efficient and competitive routing of goods to and from a rural center is the key in providing social and economic benefits to that area." Cost estimates and map of proposed road provided in limited pages acquired.
526	Yukon River Oil Delivery Study - An Analysis of a Yukon Crossing Fuels Refinery and Delivery of Bulk Petroleum in Rural Alaska	DOT&PF / Paper Copy	Alaska Legislative Budget and Audit Committee / Alaska Research Services	Feb-81	3	Report examines the marine transportation of bulk petroleum products to and within rural Alaska, particularly in the Y-K Valley areas and western coastal areas. Report proposes a petroleum refinery at the point where the Alyeska Pipeline crosses the Yukon River for economic and logistical analysis. The question inherent in the study is whether opportunity might be present to gather together significant portions of rural transportation systems and markets into a significantly larger volume operations, creating economy-of-scale that might help lower cost of petroleum products in rural Alaska. Also examines the potential effects on fuel costs if a Bering Sea oil discovery were to go to production. Discusses Bethel's, Dillingham's, St. Michael's, & Nome's current (as of 1981) barge and transportation systems serving communities upriver and along the coast.
527	Evaluation of Arctic and Ruby Creek Deposits memo	DOWL / Paper Copy	Kennecott Minerals Company / C.D. Broadbent	24-Feb-81	2	Memo presents results of financial evaluations of Arctic and Ruby Creek deposits. Results suggest that production from the Arctic and Ruby Creek deposits is viable and can be highly profitable at the projected metal prices, provided that the State completes a railroad to the district and all railroad facilities, concentrate cars, reloading facilities, and ocean freighters would be available and would not require a capital investment by Kennecott. The transportation costs are based on shipping concentrates and materials via the potential rail line extension (Arctic to Nenana), which would be constructed entirely on Alaskan government expense, followed by ocean freight to Japan (out of Whittier). Includes resource estimates & economic tabulations.
528	Yukon River Ferry Economic Analysis - Executive Summary, Volume One: Main Report, and Volume Two: Appendices	ARLIS / Paper Copy	DOT&PF / Louis Berger and Associates, Inc.	Mar-81	3	The purpose of the analysis was to determine the economic and financial feasibility of operating a ferry service on the Yukon River. Service would be directed primarily towards freight transportation on the lower Yukon (the portion of the river within the WAAPS study area). A ferry-and-barge combination system was proposed for this section of the river, with capacity for passengers, freight, and refrigerated containers. The economic analysis concluded that the existing tug and barge service along with air service were more cost-effective than the proposed ferry system. Therefore, the proposed system was not economically or financially feasible.
529	Western and Arctic Alaska Transportation Study - Phase III: Project Evaluation Final Report, Volume I: Introduction, Conclusion, and Recommendations	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	May-81	3	Phase III emphasizes the formulation of capital investment programs and associated capital and maintenance budgets. Volume I includes a brief description of the major modes and resource development analyzed; summary of findings; transportation requirements for mineral resource development; budgetary requirements; environmental impacts; and the public involvement program. Provides significant information and conclusions from each of the following report volumes from Phase III.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
530	Western and Arctic Alaska Transportation Study - Phase III: Project Evaluation Final Report, Volume II: Aviation Infrastructure	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	May-81	4	Volume II includes forecasts of aviation activity and requirements, description of alternatives and summary of airport system needs; airport system cost analysis; economic evaluation of aviation investment programs; conclusions and funding priority.
531	Western and Arctic Alaska Transportation Study - Phase III: Project Evaluation Final Report, Volume III: Marine Infrastructure	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	May-81	4	Volume III includes a description of the existing marine transportation system; analysis of port capacity; traffic forecasts; and analysis alternatives to provide adequate capacity in the future for the ports of Bethel, Nome, Kotzebue, St. Michael, Barrow, and small coastal and river dock and off-loading sites.
532	Western and Arctic Alaska Transportation Study - Phase III: Project Evaluation Final Report, Volume IV: Highways	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	May-81	2	Volume IV includes identification and analysis of new routes, reconstruction, and local roads and trails projects; analysis of benefits from routine maintenance; and evaluation of airport access routes as part of joint highway-airport projects. New routes, reconstruction projects, and local service roads and trails were considered. A significant conclusion from this report is that major new roads did not seem economically feasible at the time, but short connecting roads were feasible when the benefit of connecting a village to an airport is combined with the benefits of airport improvements. The Nome-Kotzebue Road is the only potential regional connecting route addressed in this report; all other regional connectors are considered to be dependent upon mineral development and are addressed in Volume V.
533	Western and Arctic Alaska Transportation Study - Phase III: Project Evaluation Final Report, Volume V: Transportation Infrastructure for Mineral Development	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	May-81	1	Volume V details potential for mineral development in the WAATS area and marketing considerations; analysis of transportation alternatives for the Noatak and Ambler mining districts; discussion of land status issues and State involvement in research and development programs. Discussions about each identified mining district, design considerations, construction and maintenance costs, cost analysis, and land use and status are included.
534 RTA #128	Western and Arctic Alaska Transportation Study Summary Report	DOWL / PDF file & Paper Copy	DOT&PF / Louis Berger & Associates, Inc.	Dec-81	1	Document is a summary of the 1980/1981 Western and Arctic Alaska Transportation Study (3 Phases). Study area includes the North Slope Borough, the NANA and Bering Straits regions, and portions of the Calista region. Conclusion regarding highways from this report was that major new roads (i.e., the Western Access Road connecting Fairbanks and Nome) did not seem economically feasible at the time. Short connector roads, in conjunction with airport improvements did seem economically feasible. The method used to evaluate the economic justification for highway projects was a comparison of estimated construction and maintenance costs with projected user benefits from the route. Three areas identified as having considerable mineral potential which would need large investments in transportation infrastructure: Noatak District - slurry pipeline, Ambler District - railroad (not economically feasible at the time), & Lost River - development not feasible at the time. Figure 4-1: Alternative Transportation Infrastructure for Mineral Development. Includes socioeconomic and traffic forecast summaries to 2000.
535	Interior Alaska Transportation Study - Volume I, Modal Inventory	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates, Inc. with Alaska Transportation Consultants, Inc.	1983	2	Inventory of highways (traffic, tariffs, maintenance & infrastructure costs), aviation (facilities, tariffs, M&O costs, subsidies and regulations), public transportation, railroad (fleet, operations, traffic, tariffs, costs, subsidies, rail users), pipelines, river transportation (infrastructure, fleet, traffic), and the study area environment. Study area overlaps WAAPS study area but is not all-inclusive (Figure 1-1). Also includes descriptions of various governmental agencies' roles in transportation.
536	Interior Alaska Transportation Study - Volume II, Socioeconomic Forecasts and Resource Potential	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates, Inc. with Alaska Transportation Consultants, Inc.	1983	3	Addresses the socioeconomic factors that determine demand for transportation in the Interior. Population, employment, and income forecasts. Analysis of mineral industry, agriculture, forestry, tourism, and fisheries potential. *Estimates and forecasts are obsolete. This document falls under many of the Resources categories, although approximately half of the area being analyzed falls outside of the WAAPS study area.*

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537	Interior Alaska Transportation Study - Volume III, Transportation Demand Forecasts	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates, Inc. with Alaska Transportation Consultants, Inc.	1983	3	Resource development (minerals, agriculture, forestry, tourism) and traffic forecasts and highway, aviation, railroad, and river traffic forecasts. Forecasts are obsolete and about half of the area being analyzed falls outside of the WAAPS region. Document may be most useful as a forecasting model/methodology.
538	Interior Alaska Transportation Study - Volume IV, Project Identification and Evaluation	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates, Inc. with Alaska Transportation Consultants, Inc.	1983	2	Transportation system improvements (upgrades) and extensions (new projects) identified. Highway improvements and extensions, airport improvements, railroad extensions, and riverway improvements identified with potentially viable projects analyzed further. Maintenance costs/funding issues addressed on p.116-124, specifically indicating the relative cost to maintain the Dalton Highway as compared to all other Interior highways. Summary of projects and major issues identified provided on p. 128-129.
539 RTA #17	An Analysis of the Transportation of Ore Concentrates from the Ambler Mining District to Ports in North America and Japan	DOWL / Paper Copy	Bear Mining Creek Company / Parker Associates, Inc. & others	10-Jan-83	1	Three rail or road routes to port sites in western AK and one rail and road route to existing railroad considered. Thorough descriptions, including materials sources, terrain, and such, of each route are provided in pages 20-47. Shipment through a port site at Krusenstern determined to be the cheapest method. Major conclusions on page 9 should be considered. Recommends establishing a transportation authority to work on long term problems and move towards the most expeditious means of meeting the region's total transportation needs. No regional transportation plan existed at the time of this report. Definitive conclusion on best transportation mode not reached due to lack of complete information in many aspects (mineral production rates, State's plans for development, etc.). Management and ownership options of transportation facilities included. Transportation and facility construction cost estimates included.
540	Feasibility Analysis - Kotzebue Deepwater Port / Airport - Executive Summary	DOT&PF / Paper Copy	City of Kotzebue / Tetra Tech & Wright Forssen Associates	Mar-83	3	Summary of all the siting, planning, and preliminary engineering efforts for the analysis. The analysis was undertaken to determine the feasibility of developing a deepwater port and related facilities to serve projected shipping increases within the northwest Alaska region served by Kotzebue. Cape Blossom emerged as the best location for a deepwater port.
541	Resource Development Transportation Projects	DOWL / PDF file	Unknown	1984 (?)	2	Provides good data on segments within the WAAPS study area that compare road and sometimes rail construction costs to resources in each segment. Provides historical context for evaluating resources today. First page is a map of routes.
542	Arctic Evaluation Update memo	DOWL / Paper Copy	Kennecott Minerals / R.R. Dimock	8-Aug-84	2	Brief summary (no details or explanations included) of 3 different transportation scenarios. *Case #1 - State pays for railroad to Red Dog Port* is the only economically viable option. *Case #2 - Kennecott pays for railroad to Red Dog Port* & *Case #3 - State pays for railroad to Red Dog Port and charges Kennecott a no-interest User Fee over the mine life to return capital* are both economically unviable. Includes figure showing potential rail routes and port sites for Ambler District. Includes non-detailed resource estimates & economic tabulations.
543	Arctic, Alaska Project, Pre-AFD Report	DOWL / Paper Copy	W.J. Brown	Apr-85	2	For this feasibility study, transportation is expected to be by trucking 200+ miles over a winter road from Arctic to Krusenstern then overseas freighter out of Krusenstern to U.S. or Japan. At the time of the report, this was considered an economically viable option. An alternative route would involve trucking 200+ miles on a winter road to Prospect Creek, trucking another 240 miles on Dalton Hwy to Fairbanks, then 400+ miles by rail to Whittier for overseas freighter transfer. Mining claims on Ambler area shown in Ambler District Location Map. Rail, permanent road, air, and slurry pipeline transport options discounted based on prohibitive costs. Pages 27-31 show rough transportation cost breakdowns. Includes resource estimates & economic tabulations.
544	Senate Transportation Committee RS 2477 Task Force Report	ARLIS / Paper Copy	Senate Transportation Committee / Malcolm B. Roberts and Valerie Taliman Chavez	17-Jan-86	2	Contains summaries of possible RS 2477 Rights-of-Way in National Parks and in National Wildlife Refuges. Trail information was derived from the 1974 Alaska Existing Trails Inventory. Maps of each park and refuge are provided with trails indicated. Includes draft RS 2477 ROW Policy and Procedures document prepared by DNR and DOT&PF.

NOTE: Additional references and resource documents can be found in the *References* sections in each of the Working Papers produced for Phase I of WAAPS.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
545	Senate Transportation Committee RS 2477 Task Force Phase II Report	ARLIS / Paper Copy	Senate Transportation Committee / Malcolm B. Roberts and Valerie Taliman Chavez	25-Jul-86	4	Includes maps and trail descriptions for federal Conservation System Units (CSUs). These units include four National Parks and three National Wildlife Refuges not included in the Phase I Report, eight CSUs managed by the BLM (conservation areas, recreational areas, and Wild & Scenic River Systems), and RS 2477s in the Tongass and Chugach National Forests. The Unalakleet River National Wild and Scenic River System is the only unit in this report that lies within the WAAPS area.
546	Senate Transportation Committee RS 2477 Task Force Phase III Report	ARLIS / Paper Copy	Senate Transportation Committee / Malcolm B. Roberts and Valerie Taliman Chavez	15-Jan-87	2	Includes maps of federal lands not previously mapped with RS 2477 trail information, recommendations on actions for the State to take to validate and use the rights-of-way it owns (p. 4-5), and eight committee-selected transportation corridors that the authors feel could help significantly in the task of diversifying Alaska's economy. The Nenana-Kobuk-Ambler corridor falls within the WAAPS area. Maps and trail descriptions for BLM-managed lands include the Northwest, Seward Peninsula, Tanana, and Yukon-Koyukuk Planning Regions.
547	Engineering and Project Evaluations Memorandum - Arctic Deposit	DOWL / Paper Copy	Kennecott Corporation / M.P. Randolph	29-Aug-90	1	Economics of developing Arctic deposit are highly sensitive to changes in capital costs and copper prices. Transportation identified as the key cost item in all valuations. As of the date of this memo, the economics remained unattractive, but the recommendation was to reconsider development at a time when capital costs and copper prices favor development. Transportation of product by rail to Cape Darby identified as most likely transportation scenario in this memo. NANA support identified as critical if Arctic is to be brought into production. Additional regional development would increase economic viability of Arctic development (Cominco's Sun & Smucker deposits mentioned). Includes resource estimates & economic tabulations.
548 RTA #133	Western Arctic Coal Transportation Project	DOWL / PDF file	Arctic Slope Consulting Group / Manalytics, Inc.	Mar-91	4	This report examines port facilities for transporting coal from Aluaq Mine to various Alaska destinations. It has little value to the WAAPS as the report is confined to the port facilities.
549 RTA #119	Truck versus Rail Freight System Cost Comparison: Conrail and I-80 Pennsylvania Corridor	DOWL / PDF file	CONRAIL / Texas Research & Development Foundation	Sep-91	4	This report offers good comparative data ingredients for making road-rail cost comparisons, but the location and conditions of the exercise add little direct value to the WAAPS purpose of analyzing development of remote transportation infrastructure.
550 RTA #94	Railroad Extension to Tanana - Cost-Benefit Analysis	DOWL / PDF file	DOT&PF Northern Region Planning / Edwin M. Rhoades, Dynortran and James Barker, Interior Development	Mar-92	2	This report offers good information on routing between Nenana and the Ambler Mining District. Otherwise, it is of little value as the cost-benefit analysis overstates benefits by a large measure.
551	Map of Proposed Corridor Centerlines	DOWL & AGI / Electronic Copy - Map	DNR	11-Feb-93	1	Numbered corridor map (100 total) with an attached sheet that has DOT&PF / Jerry Brossia prioritized routes.
552 RTA #1, #2, & #108	State Land Selection Access Corridor Study	DOWL & AGI / PDF file	DNR / Jerry Brossia & R.L. Odsather	08-Mar-93	1	This is a compiled history of all the documents, route descriptions, legal information, geologic, geologic hazards, energy, major trunks, memos, correspondence, supporting reports, and other information collected during the study behind the route selections during the 1990s. Created by Jerry Brossia, State Pipeline Coordinator, and R.L. Odsather, Deputy Coordinator. 100 total routes identified and alignments provided: 17 major corridors, consisting of 74 total routes, and an additional 26 linkage routes. Routes selected were based on present technology and provided the best multiple use infrastructure with the least environmental, financial, and community impact. All of the major corridors have preliminary location engineering work completed, and ~60% are geologized five miles on either side of centerline. Maps included provide the best known information as of June 15, 1992. Route descriptions include source of route, termini, benefits, physical description, probable modes, timeframe, land status, ROW situation, major physical constraints, and major social, economic, or environmental considerations. Approximately 28 routes lie within or in very close proximity to the WAAPS study area boundaries.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
553	State Land Selection Access Corridor Study - *ADDITIONAL information*	Joint Pipeline Office / Paper Copies, Maps	DNR / Joint Pipeline Office	Undated	1	More detailed and thorough information for each route identified in the *State Land Selection Access Corridor Study* can be found at the JPO library. Viewing of the information is available on an as-requested and in-person basis. The additional information for each route includes data quality maps, geologic hazards maps, materials maps, geology maps, USGS topo maps with routes overlaid, land status maps, and information from the Executive Summary of the full study.
554	Map of RS2477 Overlays on Access Corridors	DOWL & AGI / Electronic Copy - Map	DNR	Jul-93	1	RS2477 overlays on access corridors and land ownership (state, private, federal) - 42 x 34 size
555	Memo: State Selections Project Organization and Work Plan	DOWL & AGI / PDF file	DNR Division of Land / Dick Mylius	22-Jul-93	4	3-page memo from Dick Mylius, Land Selections Project Manager. Proposes top priorities for the project and organizational changes. Detailed work plan NOT attached, as indicated.
556	Memo: Response to the 22-Jul-93 State Selections Project Organization and Work Plan memo	DOWL & AGI / PDF file	DNR Division of Land / Jerry Brossia	27-Jul-93	4	2-page response to the 22-Jul-93 State Selections Project Organization and Work Plan memo from Jerry Brossia, State Pipeline Coordinator
557 RTA #58	State of Alaska - Major Corridor Descriptions	DOWL & AGI / PDF file	State Pipeline Coordinators Office / O.D. Odsather	Sep-93	1	A summary of why each of the 17 Major Trunk Corridors was selected during State Land Selection. Purpose, benefits, and use are described for each of the selected major corridors.
558 RTA #33 & #34	DeLong Mountains Transportation System Additional Use Study Phases 1 & 2	DOWL / PDF file	Alaska Industrial Development and Export Authority / CH2M Hill	1993 and 1994	3	This is a major study of regional transportation needs/opportunities that could be addressed by the DeLong Mountain Terminal at the Red Dog Mine. It addresses local community and resources development needs that remain relevant today. It has little direct value to WAAPS from a road corridor selection standpoint, but does offer good data on transportation economics and needs.
559 RTA #96	Reconnaissance of Navigation Improvements - Western and Arctic Coasts, Alaska	DOWL / PDF file	US Army Corps of Engineers / Tryck, Nyman and Hayes	Sep-97	4	This report examines port facilities along the Bering and Chukchi Sea coasts. It has little direct value to WAAPS, although it does provide good commodity transport information.
560	Arctic - On-site metal Production	DOWL / Paper Copy	Kennecott Minerals / Roger J. Sawyer	05-Nov-97	2	Preliminary study on the production of metal on site. On-site production would reduce transportation costs; may afford opportunity to air freight product out of state, thus may not not require costly access road or slurry pipeline to the coast; mandates source of power at site. Includes resource estimates & economic tabulations.
561	Arctic Project Interim Report - Evaluation of Potential for Additional Resources and Conceptual Level Economic Evaluations of the Arctic Resource	DOWL / Paper Copy	Kennecott Minerals / J. Earnshaw	Jun-99	2	A year-round road, a winter ice road, air freight, and a combination of ice road & barging were considered as transportation options for getting Arctic product to market. The air freight method emerged as the preferred alternative due to a much greater gross margin over the life of the project for air transportation versus surface transportation. Appendix includes breakdown of costs/revenue by transportation method. Includes resource estimates & economic tabulations.
562	Alaskan Multi-Modal Right-of-Way Corridors	DOWL / PDF file	JPO / O.D. Odsather	Oct-99	2	Overview of findings for multi-modal ROW corridors and the process used to develop the transportation corridors. This report does not focus on the WAAPS area, but does lay out an articulate case for project development in remote areas and provides a good guide for approaching the Right of Way and Environmental aspects of project development in the WAAPS area. Review should accompany the full Access Corridor Report.
563	Aviation Access to Remote Locations in Alaska - Recommendations to Increase Aviation Access to Medical Facilities	DOWL / Paper Copy	FAA	May-01	4	Report to document extent of the problem of aviation access in remote locations in Alaska, emphasizing access to medical care. Every facet of the community benefits with improved aviation access--economic, educational, cultural, and political. A statement is made that even communities on the road system rely on aviation for emergency medical transport, but 201 communities in Alaska rely exclusively on aviation as it is the single means of access to medical care.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
564 RTA #103	Resource Transportation Analysis - Phase I - Potential Corridors Identification	DOWL / PDF file	DOT&PF / CH2MHill & Others	Aug-01	2	This major analysis of transportation corridors in Northwest Alaska encompasses many of the WAAPS area route considerations and is a valuable resource for base data on routes. It includes a compilation of prior studies in the region in an updated format. It has substantial data useful to the WAAPS analysis, both economic and corridor descriptions. Existing and Potential Resource Developments, Existing and Potential Tidewater Port Sites, Overland Transportation, Existing Facilities and Infrastructure, Mapping of Potential Corridors, and Development Issues and Concerns are discussed in chapters of this report. The eleven potential transportation corridors studied linking resource districts to tidewater are described briefly and depicted in pages ES-4 to ES-8. A more thorough description of these corridors is provided in Chapter 6: Mapping of Potential Corridors, which also includes a list of references used to identify the corridors.
565	Yukon-Kuskokwim Delta Regional Transportation Plan	DOWL / PDF file	DOT&PF	Mar-02	2	Most of geographical region covered in this report lies south of the WAAPS study area. The Roads portion of the study concluded the following: A. Constructing new roads in the Y-K Delta's coastal tundra sections is not practical primarily due to wetland/permafrost soils and an absence of gravel sources that combine to preclude cost-effective road construction. Maintenance costs would also be exceptionally high. B. The inland portion of the study area does have suitable terrain and soils for standard road construction. The Ruby-McGrath and Ophir-Donlin Creek links were identified as practical construction projects that could significantly contribute to the region's economic development. Mine owners in the district indicate opportunities for public/private construction-stage partnerships and road maintenance agreements. Most of the proposed road corridor lies within the boundaries of the NW AK Transportation Plan.
566	Nome Gravel Export Feasibility Study Draft Report	DOWL / Paper Copy	NovaGold Resources Inc. / AMEC	20-Jun-02	3	Study of the feasibility of exporting aggregate from Nome to port destinations in San Francisco Bay and Japan. Infrastructure & Operating Requirements, Terminal Operating & Maintenance Costs, Aggregate Shipping Costs, and an overall Cost Summary of Development Options are provided. Appendix D contains Market Research on aggregates.
567	Survey of Geology, Geologic Materials, and Geologic Hazards in Proposed Access Corridors, Alaska	DOWL / Paper Copy	DNR / DGGS	2003	1	Support document to the 376 1:250,000-scale geologic-materials, data-quality, derivative geologic-hazards, non-derivative geologic-hazards, and geologic maps produced by DGGS. Presents results of 1992 DGGS efforts to (1) prepare 1:250,000-scale maps of the geology, geologic materials, and geologic hazards for 10-mile-wide corridors containing proposed access routes and traversing 78 quadrangles (poor-quality copy of figure included); (2) establish the quality of the data from which these maps were prepared; and (3) document the results of the study. Information presented on maps includes geology, geologic materials, geologic hazards, permafrost, flooding, avalanches, and faults. This document provides criteria for geology/hazard/materials delineations in Tables 1-9. *Document only useful as support to maps*.
568	BP Exploration (Alaska) Alaska Gas Pipeline Project Infrastructure Upgrade Study	DOWL / PDF file	BP Exploration (Alaska) / Fluor	Feb-03	4	Recommends and breaks down cost estimates for upgrades to existing roads, railroads, and ports that support the gas pipeline project. Other than upgrades to Dalton Highway, no transportation relevant to WAAPS study area.
569	Resource Transportation Analysis - Phase II - Dalton Highway to Nuiqsut and NPR-A Access	DOWL / Paper Copy	DOT&PF / CH2MHill & Northern Economics, Inc.	Nov-03	4	Geographical region considered in this report lies outside WAAPS study area. Issues identified include: Distances separating AK from Asian markets are longer than those from equatorial and southern hemisphere mines; Seasonal shipping is expensive and creates spikes in coal and other mineral supply chains; Infrastructure costs for long overland routes and all-season ports make resource development unaffordable for mining firms; Shipping costs are relatively high even where transportation infrastructure is in place; and many arctic residents oppose overland access to mines. Report may serve as a small-scale model of what to consider in the much larger WAAPS process.
570	Resource Transportation Analysis Phases I and II Executive Summary	DOWL / PDF file	DOT&PF / CH2M Hill	2004	4	This is a summary of transportation routes to be examined in individual analyses. They include three routes on the North Slope, one at the Deadfall Syncline Mine, and the Donlin Creek Mine access. There is no useful data for the WAAPS analysis.

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571	Northwest Alaska Transportation Plan, Community Transportation Analysis	DOWL / Paper Copy	DOT&PF	11-Feb-04	1	Section 1.4.4 addresses roads & provides map of proposed Yukon River Highway (Map 1-3); Chapter 5 specifically addresses roads and includes Recommended Road Projects. Report also addresses winter trails; aviation; ports, harbors, & shipping; and tourism. Land status map (Map 1-2).
572	Resource Transportation Analysis Phase II - Yukon River Port and Road Network	DOWL / PDF file	DOT&PF / CH2M Hill & Northern Economics	Jul-04	2	Study conducted to identify components of an integrated port and road network that would best meet the transportation needs associated with development of the mineralized zone between the Yukon and Kuskokwim rivers. Focus of this study is a port on the Yukon River and a road to the Donlin Creek area--slightly to the south of the WAAPS study area. Port at Holy Cross determined to be feasible from an engineering standpoint, and the estimated economic benefits outweight the estimated costs. Key topics: geology and topographical conditions, *engineering requirements for port and road infrastructure*, *benefits and costs of port development*, potential segments for road development, requirements for shipping on the Yukon River, and *preliminary environmental and permitting considerations*. Appendix B: Summary of Aggregate Materials Availability and Mineral Resource Potential. Appendix F: Environmental and Regulatory Considerations. Appendix I: Transportation Cost Calculations.
573	DRAFT Economic Assessment of Noatak Road and Airport Development Alternatives	DOWL / PDF file	DOT&PF / Northern Economics	May-05	3	Very localized economic analysis of road and airport alternatives - Noatak, Red Dog Mine, DMTS area.
574	Ambler District Access Study - Phase I Summary Route Identification and Screening Analysis	DOWL / Paper Copy	NovaGold Alaska, Inc. / NANA/DOWL Engineers and CH2M Hill	Jun-05	1	Ambler study may act as a good model on which to base WAAPS study. 56 transportation routes considered (map included of all routes). Overland corridors, ports, and airlift access considered. The criteria used when considering overland transportation corridors included a) environmental issues such as proximity to conservation units, the number/size of major river crossings, permitting issues, and impacts to the natural environment; b) economic analysis (e.g., capital construction costs and maintenance costs, and economic impacts to regional communities); c) social impacts resulting from opening the region to public access; and d) potential secondary benefits such as employment opportunities and the ability to use the transportation corridor for fuel transport or other energy options. Scoring criteria for all transportation routes considered are detailed. Eleven alternatives identified for Phase II analysis. Appendix A: Historical Reports and Associated Routes lists which Transportation Alternatives (relevant to Ambler District) were discussed in each of the documents used for the Ambler study, all of which are also being reviewed for the WAAPS project and are listed in this bibliography.
575	Ambler District Access Study - Phase II Alternative Refinement	DOWL / Paper Copy	NovaGold Alaska, Inc. / NANA/DOWL Engineers and CH2M Hill	Oct-05	1	Twelve routes analyzed--maps included. Each alternative evaluated against environmental, geotechnical, and cost criteria, as well as the criteria used in Phase I. Appendix B: Geotechnical Analysis includes geological and materials information for the corridors considered. Each map included throughout the report references source data (for GIS use?). Report includes cost estimates for route alternatives. Primary environmental issues for each corridor identified in Appendix A: Environmental Issues Summary, p. 4-13 to 4-14).
576	City of Nenana - Totchaket Project	DOWL / PDF file	City of Nenana / PND Engineers, Inc.	Jun-07	2	A re-examination of land development potential in the area first considered in the February 1981 *Nenana Agricultural Transportation Systems* study. This study concentrates on multi-use of the subject area (multiple resources vs. just agricultural). Study indicates that agricultural development would, in fact, be *re*-development since this area of the state once had strong agriculture. Surveys, soil studies, test borings, and land ownership research have been conducted for this route, although most work is outdated. A development budget is presented--may be a good model for WAAPS work. Road & bridge design drawings and cost estimates are provided.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
Use 600-699	**Engineering**					
600	Report and Recommendations for Engineering Service Requirements - Transportation Corridor Nenana-Dunbar Area to Kobuk River Valley	DOWL / Paper Copy	State of Alaska / De Leuw, Cather, & Associates and Tryck, Nyman & Hayes	Mar-68	1	Recommends procedures for the design of a rail or highway transportation facility from the Nenana-Dunbar area northwest to the vicinity of the Kobuk River Valley through the preliminary design phase, and discusses requirements for carrying through to completion of final design, estimate of costs, and preparation of contract drawings and specifications. This route is proposed since, on the basis of known mineral deposits at the time, it offers the greatest potential for stimulation of the Alaskan economy. At the time, the study area had been completely mapped but not at a scale adequate for detailed engineering study. Soils reports did not exist for the area, and hydrological and meteorological data was limited. May provide good information on general conditions to consider, but report is probably very outdated, with a large amount of new information available since its publication. Mentions the Inter-Agency Technical Committee for Alaska, which is a group still in existence that may have water resources data for the study area. Chapter III and Appendix II document Available Information at the time. PLATE 6: very good figure showing "practicable and feasible railroad and highway routes" (alignments of previous studies).
601	Western Access Road Project S-0145(1) Reconnaissance Study	DOWL / PDF file	Alaska Department of Highways Western District & US DOT, FHWA	Nov-73	2	This reconnaissance engineering study looks at a 320-mile road from the Kobuk mineral district to Nome. It examines routes through topography maps and teams of engineers examining routes by helicopter. It is an excellent overview of the challenges of construction, the soil and topography conditions along the North-South-Common routes. It recounts issues associated with maintenance and operations, driver conditions and challenges of Rights of Way that remain germaine today.
602	Western Access Road Project S-0145(1) Reconnaissance Soils Report	DOWL / PDF file	Alaska Department of Highways Western District & US DOT, FHWA	Dec-73	2	Reconnaissance field investigation of the Northern and Southern routes and aerial inspection. Soils and material sites recommendations provided.
603 RTA #75 & #76	Northwest Alaska Resource Development Transportation Alternatives Study: Phases I and II	DOWL / PDF file	Alaska Industrial Development and Export Authority / CH2M Hill	1992	2	This report is excellent for its in-depth analysis of the several studies conducted for Arctic Slope Regional Corporation related to the development of the Aluaq Mine. Also called Deadfall Syncline, the mine is near tidewater and near the Delong Mountain Terminal. At the time this study was done, the focus remained on moving coal from Omalik Lagoon or Nome. Neither model was cost-effective at the time of the study. However, the study does look at the routes from the Selawik area to Nome that may be useful for the WAAPS.
Use 700-799	**Land Ownership / Management**					
700	Northwest Area Plan - Public Review Draft	ARLIS / Paper Copy	DNR	Jun-88	3	Study area includes the Seward Peninsula and Norton Sound, the Lisburne Peninsula up to Icy Cape, and the Kobuk River Valley. Major Draft Plan Proposals: 1. Economic Development: Provide jobs & income through the management of state lands and resources to support a vital, self-sustaining local and statewide economy; 2. Public Use: Provide diverse opportunities for public use of state lands, including such uses as hunting, fishing, recreation, and firewood collection; 3. Private Land: Provide opportunities for private ownership of state land; 4. Quality of Life: Maintain or enhance the quality of the natural environment and cultural resources and the character of existing communities; 5. Fiscal Costs: Minimize the cost of providing necessary government services and facilities; 6. Public Safety: Protect public safety. Refers to previously-identified corridors (Western Access Corridor from Prospect to Kougarok, Chicago Creek coal-mining-area to Kotzebue route, and the Northern Access Corridor) and recommends that no authorization be granted for activities that could foreclose options for future development of these corridors.
701	Proposed Resource Management Plan and Final Environmental Impact Statement for the Utility Corridor Planning Area, Arctic District, Alaska	ARLIS / Paper Copy	Department of the Interior Bureau of Land Management, Arctic District	1989	4	Does not provide much information that would guide corridor identification and refinement. However, it may serve as a useful reference in potential future Phases of the project that consider long-term impacts to land bordering the ultimate transportation corridor.
702	BLM Land Use and Ownership Map	DOWL / PDF file	BLM	24-Jun-05	2	Provides good data on land ownership for the WAAPS project.

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Use 800-899	**Communities**					
800	Western and Arctic Alaska Transportation Study - Survey Summary Report	DOWL / PDF file	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	Aug-80	3	Summary of survey results conducted in communities on the North Slope, the Bering Straits region, and the Calista Region for the WAATS project.
801 RTA #129	Western and Arctic Alaska Transportation Study - Survey Report	DOWL / Paper Copy & PDF file	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	1981	3	Survey conducted in communities on the North Slope, the Bering Straits region, and the Calista Region. Purpose of the survey was to assess transportation and public facilities needs and to provide information about overall community preferences for future economic development. Topics include baseline demographics, employment and subsistence patterns, problems faced by communities, current transportation use patterns, and preferences for future public facilities and services. Outdated data--survey report may serve as a useful guide on the type of information to collect for present and future consideration.
Use 900 - 999	**Environmental**					
900	DRAFT Preliminary Environmental Data Analysis for the Yukon Kuskokwim Rivers Transportation Corridors	DOWL / PDF file	DOT&PF	Undated	3	Preliminary examination of available environmental data in the Yukon Kuskokwim Rivers Transportation Corridor project area. Project area is south of the WAAPS study area. Indicates baseline data for the region is lacking--Conclusions identify Environmental data gaps.
901	Western Access Road Project S-0145(1) Environmental Impact Statement	DOWL / PDF file	U.S. Department of Transportation Federal Highway Administration / Alaska Department of Highways, Western District	Nov-73	1	EIS for proposed ~340-mile road to be constructed between Kougarok (Nome-Taylor) Road and Kobuk. Concludes that environmental impacts of the road would be far more beneficial than detrimental and that the detrimental effects would be largely temporary (equipment movement, water crossings, vegetation stripping). The road would make development of mineral resources possible and could increase the standard of living in affected villages. The Southern Route is preferred to the Northern Route due to availability of materials and fewer maintenance problems. Railroad and hovercraft modes also considered and determined to be less useful, beneficial, and/or economically-desirable than a road. The road, while not connected to the interior road system, would be of self-sufficient importance and benefit to the people of the region and to Alaska as a whole to justify construction. Preliminary engineering specifications are provided (p. 36-44). Report includes land use, demographics, resource information, archaeology, and history of the region. Probable impacts described in p. 70-88. Southern Route is detailed in p. 94-95. Route maps over topographic contours provided in Appendix G.
902	Western and Arctic Alaska Transportation Study - Phase I: Data Collection Final Report, Volume V: Environmental Impacts of Transportation Development	DOWL / Paper Copy	DOT&PF / Louis Berger and Associates with Philleo Engineering & Architectural Service, Inc.	Feb-80	1	Volume V includes environmental descriptions of each of four regions (Arctic-North Slope, NANA, Bering Straits, and Yukon-Kuskokwim), and the potential impact of different transportation modes upon them.
903 RTA #42 & #43	Environmental Impact Statement, Final, Red Dog Mine Project, Northwest Alaska, Volumes 1 & 2 with Appendices	DOWL / PDF file	U.S. Department of the Interior & EPA	Sep-84	4	Preferred alternative involved a transportation corridor through Cape Krusenstern National Monument and an ANILCA Title XI permit. The act requires that there be no economically feasible and prudent alternative route and that the proposed transportation corridor be compatible with the purposes for which the unit was established. ANILCA Title XI Right-of-Way Application included as Appendix 6 in Volume 2. ***Ultimate road does cross through the monument.*
904	Memorandum: Preliminary Identification of Significant Resources in Lands Available for State Selection	DOWL & AGI / PDF file	The Nature Conservancy	30-Oct-92	2	The Nature Conservancy (TNC) of Alaska has made an initial compilation of existing information regarding the surface values of lands available for state land selection. This is a preliminary identification of ecological resources in lands being evaluated for state entitlement. TNC has evaluated and will continue to evaluate these lands for unique and significant habitat features, species, and natural values. Resource values and special areas identified for Units 15, 19, 22 (see Index Map from June 1993 Estimated Mineral Potential document) within WAAPS study area.

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Reference #	Title	Location / Document Type	Organization / Author	Pub. Date	Value Ranking 1 - High 4 - Low	Comments / Notes
905	Kobuk-Seward Peninsula Proposed Resource Management Plan and Final Environmental Impact Statement	DOWL / Paper Copy & Web Page http://www.blm.gov/ak/st/en/prog/planning/ksp/ksp_documents/ksp_draft_rmp_eis.html	U.S. Department of the Interior, BLM / BLM Fairbanks District Office and Anchorage Field Office	Sep-07	1	3-Volume publication. Issues of primary concern in the development of this plan include: (1) Manage recreational use of public lands to reduce conflicts between sport and subsistence hunting and to prevent negative impacts on subsistence hunting opportunity; (2) Maintain and protect subsistence opportunities; (3) Determine which areas should be made available for mineral exploration and development; and (4) Provide access to BLM-managed lands for various purposes, including recreation, subsistence activities, and general enjoyment of public lands, while protecting natural and cultural resources. Map 1-1: Land Status. Map 2-24: Summary of Mineral Management, Alternative D. Map 2-21: Proposed Areas of Critical Environmental Concern (ACEC), Alternative D. Table 2-22: Summary and Comparison of Effects on Resources by Alternatives. Chapter III: Affected Environment contains many useful maps (e.g., permafrost, precip, vegetation, oil and gas basins, coal resources, subsistence use areas, etc.). Appendix A: Standard Oil and Gas Lease Terms, Oil and Gas Lease Stipulations, and Required Operating Procedures. *Includes good information/maps for all categories of resources. Extensive bibliography--may include sources of GIS information.*
Use 1000-1999	**Other Documents**					
1000	RTA Library	DOWL / PDF file	DOT&PF / Various	2004	2	This file is important to the WAAPS analysis as it contains the reference data for all studies included in the Resource Transportation Analysis. It contains studies by name and author, many of which have been annotated in this bibliography. The library can serve as a central reference point for work useful to Phase II of the WAAPS analysis.
1001	Mine Power Study - Arctic Project - Ambler Mining District, Alaska	DOWL / Paper Copy	Alaska Gold Company, A Nova Gold Subsidiary / Stone & Webster Management Consultants, Inc.	17-Feb-06	1	Documents investigation and characterization of potential sources of reliable power and supplemental electric energy for a potential future hard rock mining and milling operation.
1002	Statistical Report of the Power Cost Equalization Program, Fiscal Year 2007 (July 1, 2006 - June 30, 2007), Nineteenth Edition	DOWL / PDF file	State of Alaska / Alaska Energy Authority	Feb-08	4	Report provides statistical data on the Power Cost Equalization (PCE) program. The cost of electricity to residents in rural Alaska is typically three to five times higher than for residents in urban areas of the state. Statistics include communities participating, residents served, utility companies participating, power used, historical trends.
1003	Nome Region Energy Assessment	DOWL / Paper Copy	National Energy Technology Laboratory / Alaska Energy Authority & Others	Mar-08	2	An analysis of the technologies available to the City of Nome for electric power production. Alternatives analyzed are a) a barge-mounted coal-fired power plant using imported coal; b) wind power; c) geothermal power plaant at Pilgrim Hot Springs; and d) natural gas from Norton Sound. Tidal/wave energy, hydroelectric dams, and coalbed natural gas were considered but did not appear viable.
1004	Banner Wind, LLC - Harnessing the Wind in Nome, Alaska	DOWL / Paper Copy	Bering Straits Native Corporation & Sitnasuak Native Corporation / Western Community Energy	2008	2	Primarily a photo album of the installation of 18 wind generators in Nome during 2008. The wind energy is expected to serve as a "long-term, fixed price hedge against wildly fluctuating diesel prices." Lists benefits to rural development.

ACRONYMS

ADFG	Alaska Department of Fish and Game
ARLIS	Alaska Resources Library & Information Services
BLM	Bureau of Land Management
DCCED	Alaska Department of Commerce, Community, and Economic Development
DGGS	Alaska Department of Geological and Geophysical Surveys
DNR	Alaska Department of Natural Resources
DOT&PF	Alaska Department of Transportation and Public Facilities
FAA	Federal Aviation Administration
JPO	Joint Pipeline Office
USGS	United States Geological Survey
RTA	Resource Transportation Analysis

NOTE: Additional references and resource documents can be found in the *References* sections in each of the Working Papers produced for Phase I of WAAPS.

APPENDIX C

Minerals Resource Paper

REPORT ON MINERALS
WESTERN ALASKA ACCESS PLANNING STUDY

Prepared for:

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February 2009

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LIST OF ACRONYMS

ANILCA ....Alaska National Interest Lands Conservation Act
ARDF..U.S. Geological Survey Alaska Resource Data File
CIM..Canadian Institute of Mining and Metallurgy
CRD .... synchronous carbonate-hosted massive sulfide
ADGGS.. Alaska Division of Geological and Geophysical Surveys
NI .... Canadian National Instrument
REE...rare-earth elements
USGS .... US Geological Survey
VMS... volcanogenic massive sulfide
WAAPS.. Western Alaska Access Planning Study
Y-K .... Yukon-Koyukuk

EXECUTIVE SUMMARY: MOST IMPORTANT FINDINGS

- The Western Alaska Access Planning Study (WAAPS) area contains a significant part of Alaska's mineral endowment. It has produced millions of ounces of gold and silver and millions of pounds of tin. Furthermore, it has demonstrated resources that greatly exceed the historic totals in quantity and value. In addition to historically valuable gold, silver, and tin, the region has copper, lead, zinc and a host of rarer metals. Only the Pebble region exceeds the study area in copper resource.

- Large parts of the region are remote with limited surface transportation, and this remoteness has (1) inhibited exploration and hence discovery of minerals and (2) been a major factor in preventing development of all but rich deposits of gold.

- At reasonable metal prices, resource development costs could at least be offset by mine development and sale of metals.

- Identified multi-modal corridors exist that seem (1) legally permittable, (2) topographically feasible, and (3) in many cases, in alignment with natural mineral trends.

- Resource locations suggest that staged development could be productive.

1.0 INTRODUCTION

The Western Alaska Access Planning Study (WAAPS) area extends about 550 miles westerly from Fairbanks to the tip of the Seward Peninsula, and about 350 miles southerly from the south flank of the Brooks Range to the vicinity of Flat. The WAAPS area occupies a substantial part of twenty-eight (28) 1:250,000 quadrangles in the U.S. Geological Survey (USGS) system (Figure 1). The region contains a significant part of Alaska's hard mineral endowment.

The extreme southeast part of the WAAPS area coincides with part of the Fairbanks North Star Borough, an area with extensive gold production. This area has a road system that has been critical to the development of gold production. For the purpose of this study, the area around Fairbanks, which includes Ester Dome, is excluded.

The primary source document for this study is the U.S. Geological Survey ARDF (Alaska Resource Data File). This data file lists nearly all the known mineral deposits in the twenty-eight 1:250,000 quadrangles within the study area. A map of the study area and quadrangles is shown below in Figure 1. Many of the USGS reports have been supplemented by information from company files or news releases in order to include the most up-to-date information possible on existing mineral deposits in this study.

In the ARDF system each prospect, mine, or mineral occurrence has a unique identification consisting of a two-letter abbreviation of the quadrangle, followed by a three-digit site identification. For example a mine site within the Nome quadrangle could be identified as NM 005. Excluding the Fairbanks area, the USGS has identified about almost 1,900 mineral sites in the study area's 28 quadrangles. Many of these sites were excluded from further analysis because of limited size of the resource, land status, or access difficulty. This study uses 463 deposits as the basis for analysis. Table 1 in Section 1.1 provides the details of these deposits including: quadrangles, quadrangle abbreviations, the number of sites identified, and those evaluated by quadrangle.

Supplementary tables providing information for each site are available in an Excel file from ADOT&PF documenting the location of each prospect, its legal ownership, and basic geological characteristics, as noted in the ARDF system, or other sources. The contents of that Excel file are described in Appendix A to this report. Production figures are given where known, as are un-mined tonnage and grade. The calculation of net resource values was beyond the scope of the study.

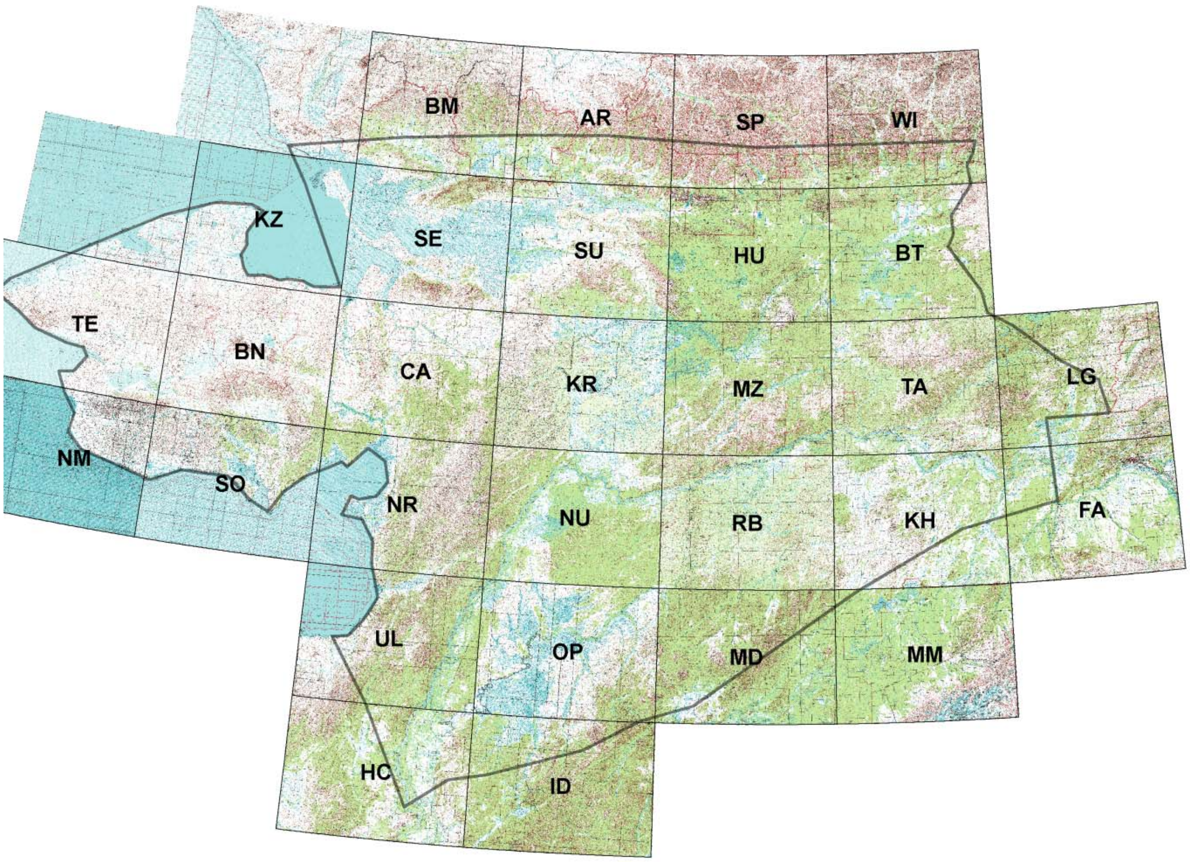

Figure 1: Index Maps of USGS 1:250000 Scale Maps

Source: Compiled by Hawley Resource Associates, 2009 from U.S. Geological Survey Quadrangle Maps

1.1 Resources

In terms of either past production or potential value, the major metals identified in this study are gold (Au), silver (Ag), copper (Cu), lead (Pb), and zinc (Zn). The region has also produced, or has substantial potential to produce, other metals such as tin (Sn), antimony (Sb), molybdenum (Mo), and uranium (U), and non-metals such as fluorite, the ore of fluorine (F), and a few other substances.

The highest valued, presently defined resource of copper and base metals is in a nearly east-west belt along the south-flank of the Brooks Range. Copper, lead, zinc, substantial amounts of gold and silver, and rare metals such as cobalt and germanium are contained in volcanogenic massive sulfide (VMS) deposits or synchronous carbonate-hosted massive sulfide (CRD) deposits within that belt.

Table 1: USGS Quadrangles, Abbreviations and Sites Analyzed

Quadrangle	Abbreviation	Identified Sites	Sites Analyzed
1 Baird Mountain	BM	21	7
2 Ambler River	AR	65	14
3 Survey Pass	SP	43	7
4 Wiseman	WI	160	26
5 Kotzebue	KZ	4	1
6 Selawik	SE	9	4
7 Shungnak	SU	13	6
8 Hughes	HU	26	10
9 Bettles	BT	18	7
10 Teller	TE	106	31
11 Bendeleben	BN	142	36
12 Candle	CA	50	20
13 Kateel River	KR	None	
14 Melozitna	MZ	30	20
15 Tanana	TA	139	52
16 Livengood	LG	186	12
17 Nome	NM	312	48
18 Solomon	SO	175	29
19 Norton Bay	NR	12	4
20 Nulato	NU	20	13
21 Ruby	RB	62	22
22Kantishna River	KH	8	3
23 Fairbanks	Not used		
24 Unalakleet	UL	5	3
25 Ophir	OP	34	19
26 Medfra	MD	81	25
27 Holy Cross	HC	3	1
28 Iditarod	ID	179	42
Total		**1884**	**463**

Source: Compiled by Hawley Resource Associates, 2009.

Two areas, Nome and Livengood, have large known gold resources, while other parts of the study area contain substantial gold resources. The largest amounts of tin and tin-affiliated substances such as tungsten, beryllium, and fluorite are concentrated in the north half of the Seward Peninsula, but are also quite widespread throughout the region.

In addition to areas that are historically known to contain mineral resources, there have been recent discoveries of new mineral districts exemplified by the Reef Ridge oxide zinc district north of Medfra and the Illinois Creek district south of Galena. Many of the mineral deposits occur along linear east-west trends that could enhance the economic viability of transportation corridors.

The WAAPS region has small coal fields that have potential for local use, either as fuel or as a source of coal-based methane. Section 4.0 of this report summarizes information on the minor coal basins as well as other possible energy sources, such as uranium (U) and thermal springs.

Mineral resources of the WAAPS area fall naturally into three categories based on unit value: first, substances like gold, platinum metals, and silver of very high unit value that are priced at dollars per ounce; second, the less common metals such as tin, molybdenum, tungsten, and beryllium that are priced at dollars per pound; and third, relatively common industrial metals such as copper, lead, and zinc that, until the very recent past, have sold for cents per pound. The high value metals can afford to be transported by air, the less common metals can support truck transportation, and industrial metals are typically moved by rail, although transport via truck is done over short distances.

1.2 General Geologic Setting

The WAAPS region is underlain by rocks ranging in age from Late Precambrian to Tertiary and occurring in several well defined stratigraphic basins. As shown in Figure 2 and Figure 3, the Yukon-Koyukuk (Y-K) basin is located centrally to the entire region (Einaudi and Hitzman, 1986: Piercey and others 2008). The Y-K basin is mainly filled with volcanic rocks of Early-Mid Cretaceous age that are roughly triangular in shape. Rocks west and north of the triangle are, respectively, mainly early Paleozoic basement (Seward Peninsula) and arc/back arc metamorphosed volcanic complexes of Devonian-Mississippian age (Brooks Range). The southeast flank of the basin is the metamorphic Ruby Arch (geanticline). Late Paleozoic and early Mesozoic mafic-ultramafic rocks of the Angayucham ophiolitic complex underlie the volcanic-sediments of the Y-K basin. These rock types form a nearly complete rim around the north and southeast flanks of the basin, separating the Y-K basin rocks from the schistose rocks of the Brooks Range, Seward Peninsula, and Ruby Arch.

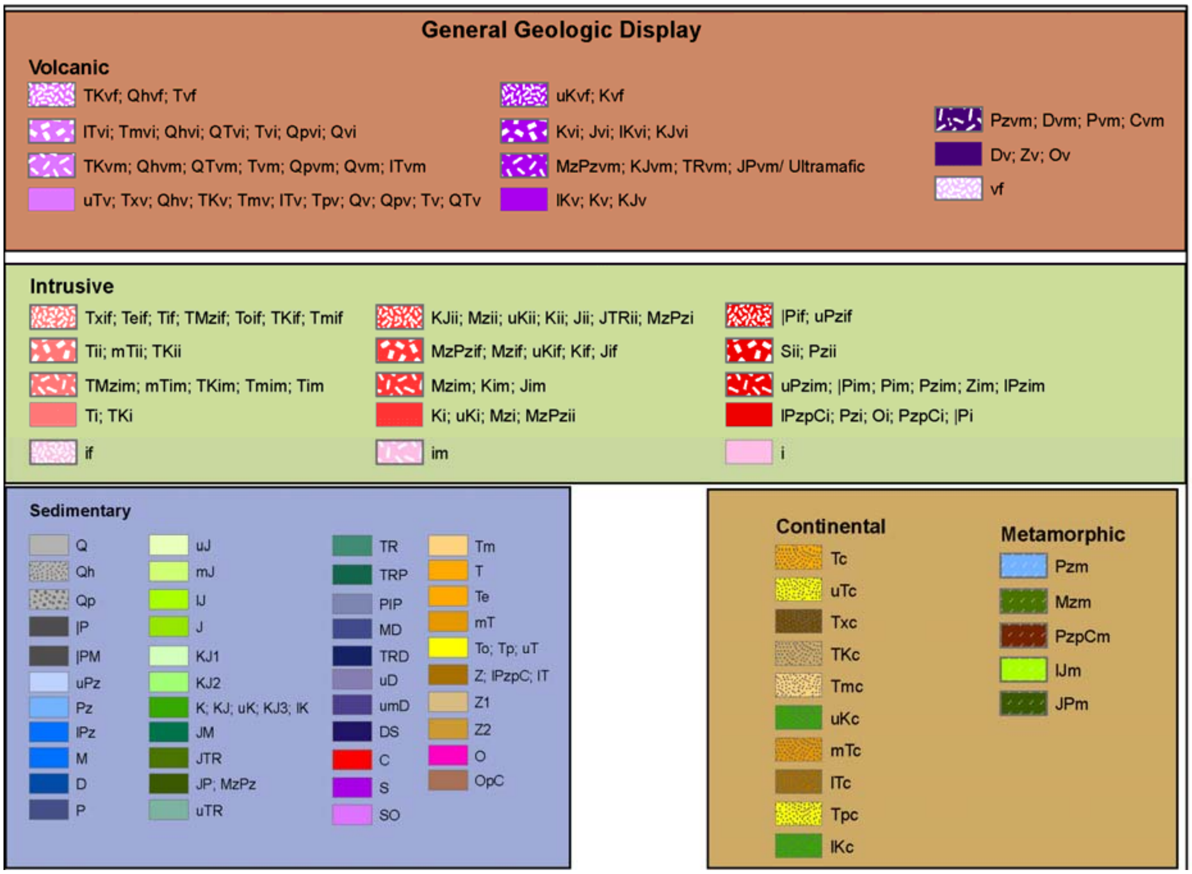

Figure 2: General Geology Map Legend

Source: Beikman, 1980.

Note: The definitions for the abbreviations shown here are presented in Appendix B.

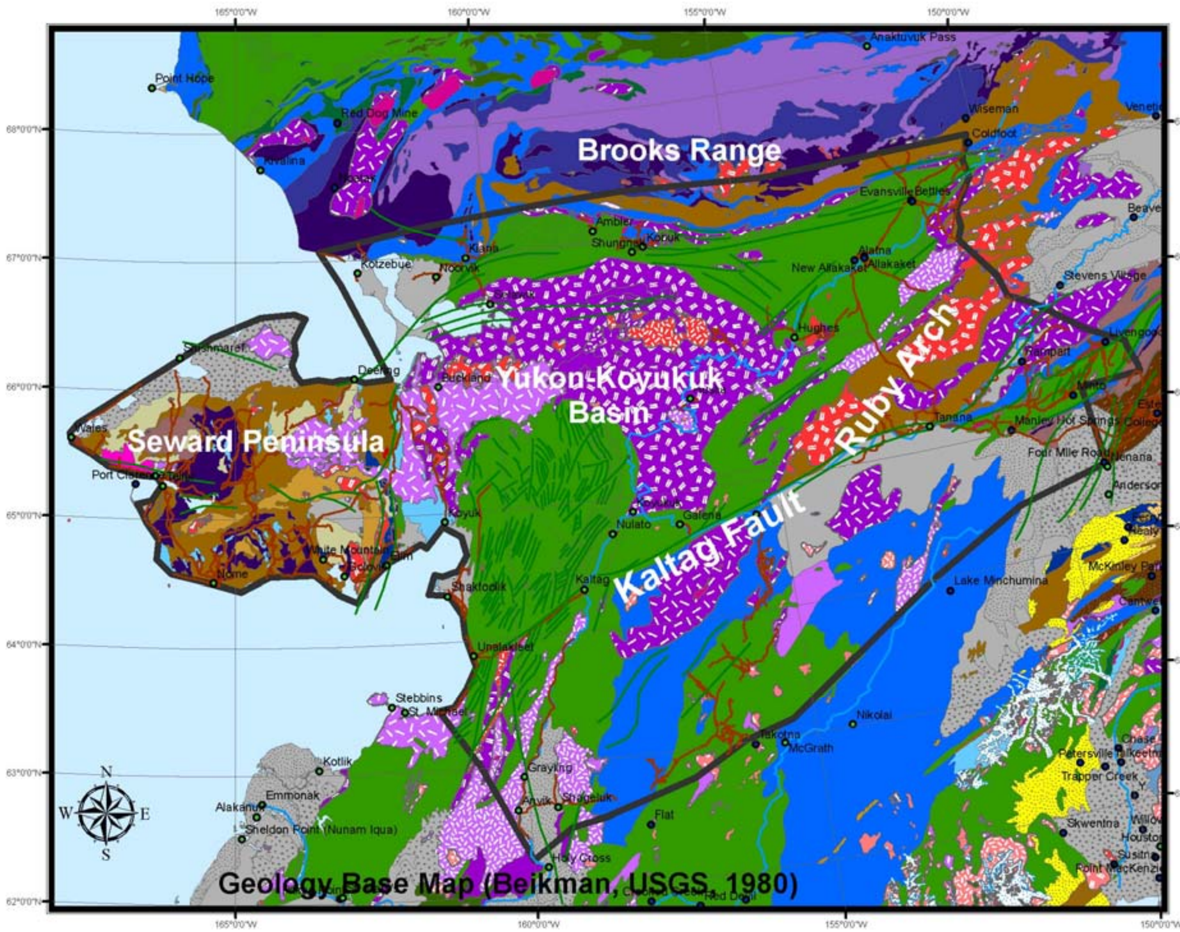

Figure 3: Geology Base Map

Source: Beikman, USGS, 19080)

As shown in Figure 3 the Ruby Arch is cut off to the south and displaced several tens of miles westward by the left-lateral Kaltag fault.

Lying between Ruby geanticline (Arch) and rocks of the Yukon-Tanana terrane are structurally complex rocks largely of Paleozoic to early Mesozoic age. Scattered through the WAAPS region are relatively small basins that are filled with Cretaceous and Tertiary sedimentary rock. With the possible exception of the Nenana basin, the basins lack potential for oil and, probably, conventional natural gas. They may, however, contain coal-related methane. Thick coal seams occur in the Chicago Creek and Boulder Creek areas on the Seward Peninsula.

Granitic intrusive rocks of varying ages intrude the largely layered Cretaceous or older rocks of the region. An east-west belt of granite of Devonian-Mississippian age crops out in the Brooks Range north of the Ambler schist belt. The granite is accompanied by metamorphosed skarn deposits. Granite masses of Late Cretaceous age cut Y-K basin rocks in a belt that extends about due west from the Zane Hills, then turns abruptly almost due south at the structural boundary between Paleozoic basin rocks of the Seward Peninsula and the Cretaceous rocks of the Y-K basin. The granitic series, locally alkalic and undersaturated, is anomalously rich in uranium (U), thorium (Th) and rare-earth elements (REE). An approximate east-trending series of granites also occurs in the western Seward Peninsula; they are of Late Cretaceous age and are so-called tin-granites. A series of large granite bodies (batholiths) trends northeasterly along the axis of the Ruby geanticline.

1.3 Mineral Terranes

Mineral deposits of specific types tend to occur in association with certain rock types. As examples, nearly all tin deposits world-wide are affiliated with late stage granites enriched in fluorine and boron. In contrast, deposits of chromium, nickel, and platinum metals occur with early stage dark colored igneous rocks. Many copper and base metal massive sulfide ores occur with ancient submarine volcanic units. Recognition of these favorable mineral terranes has predictive value for prospecting and aids in regional studies, such as this one, that seek to organize deposits and their values. This report uses a derivative geologic map of mineral terranes (Figure 4 and Figure 5) as a base for the mineral resource maps for this report (C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995).

A mineral terrane map that also shows all modeled mineral deposits in the study area is shown as Figure 6. Figure 7 uses the same base but also shows federal conservation areas. Placer deposits, generally of gold, are derived from several primary sources. They are widely distributed in the study area; the distribution of the largest placer mines (>than 100,000 ounces produced) and many small and medium-sized placer mines is shown in Figure 8.

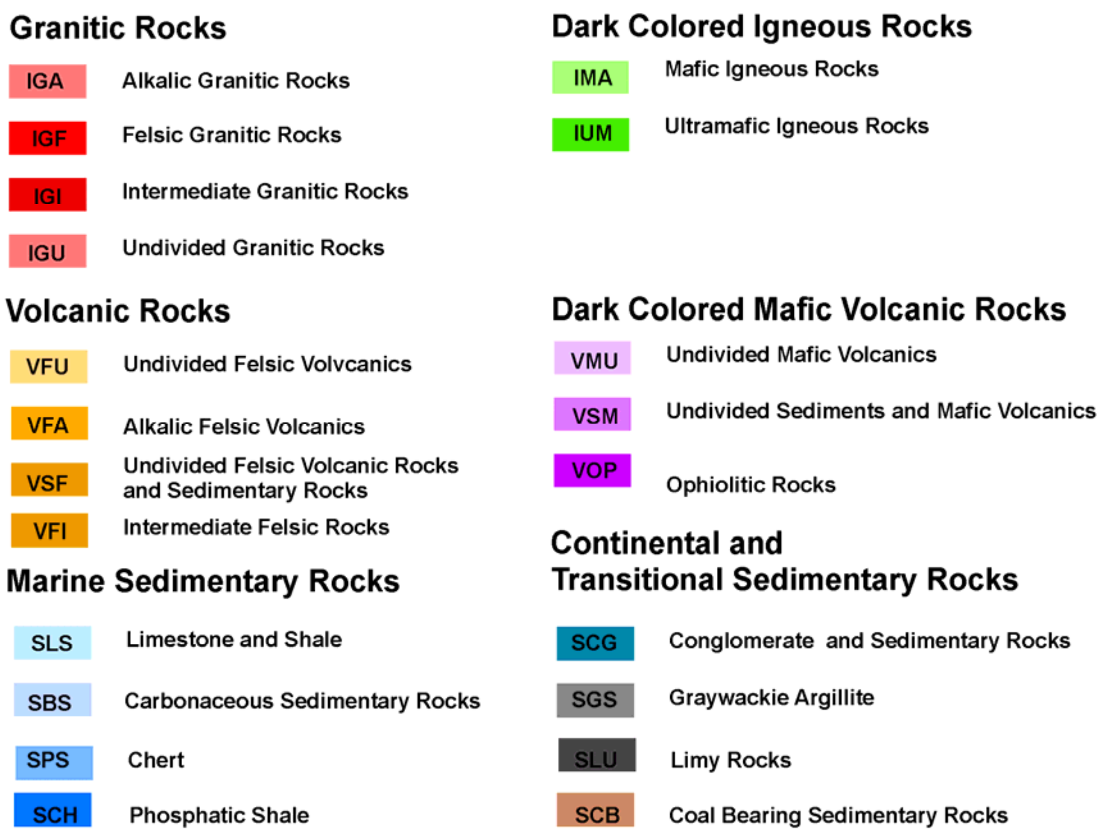

Figure 4: Explanation for Mineral Terrane Map

Source: C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

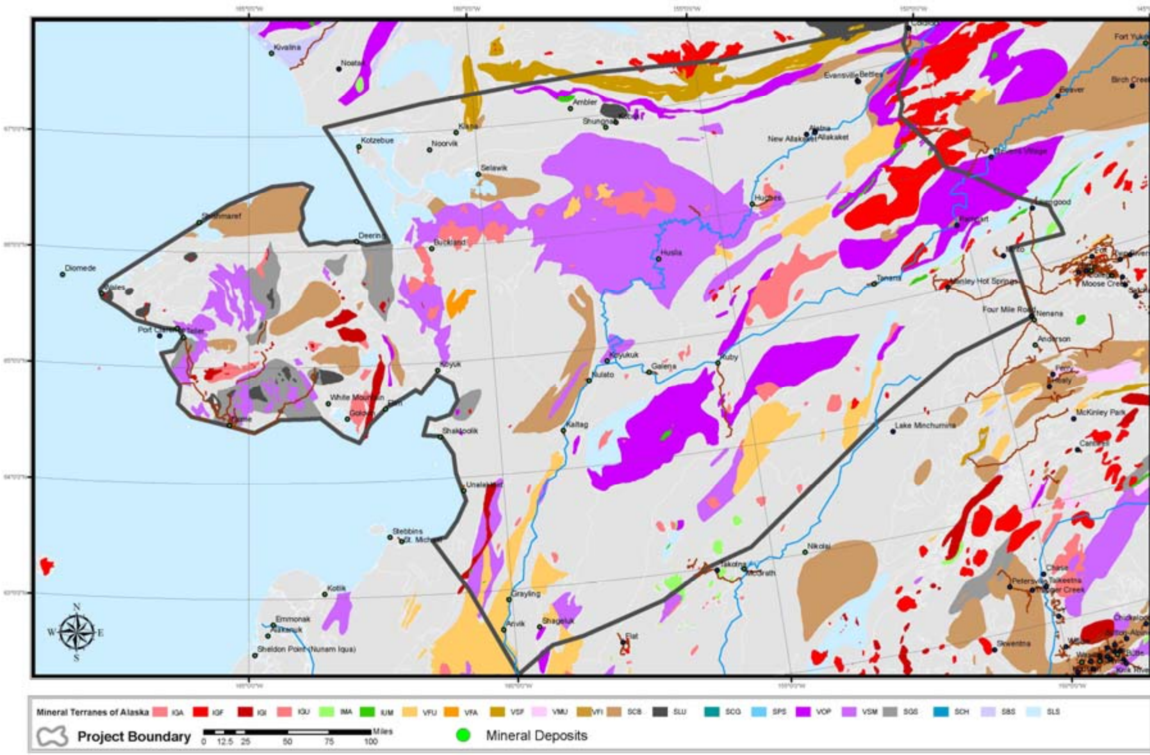

Figure 5: Mineral Terrane Map

Source: C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

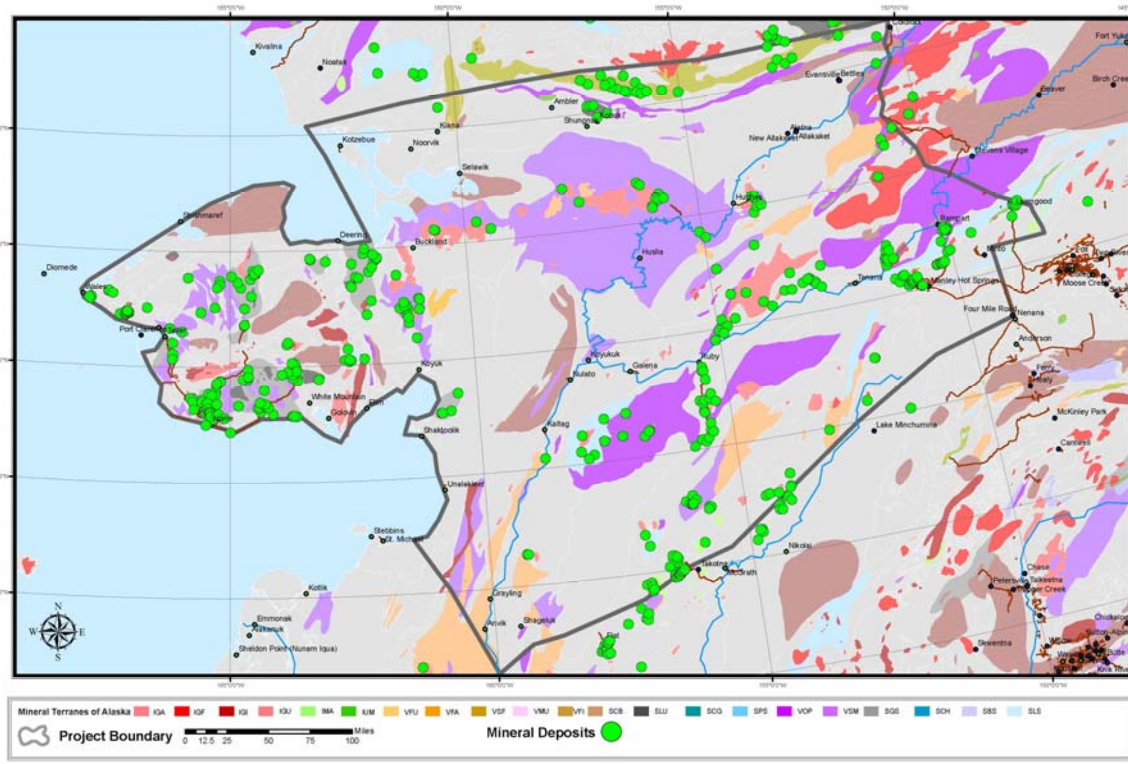

Figure 6: Mineral Terrane map and All Modeled Mineral Deposits

Source: Hawley Resource Associates, 2008 derived from C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

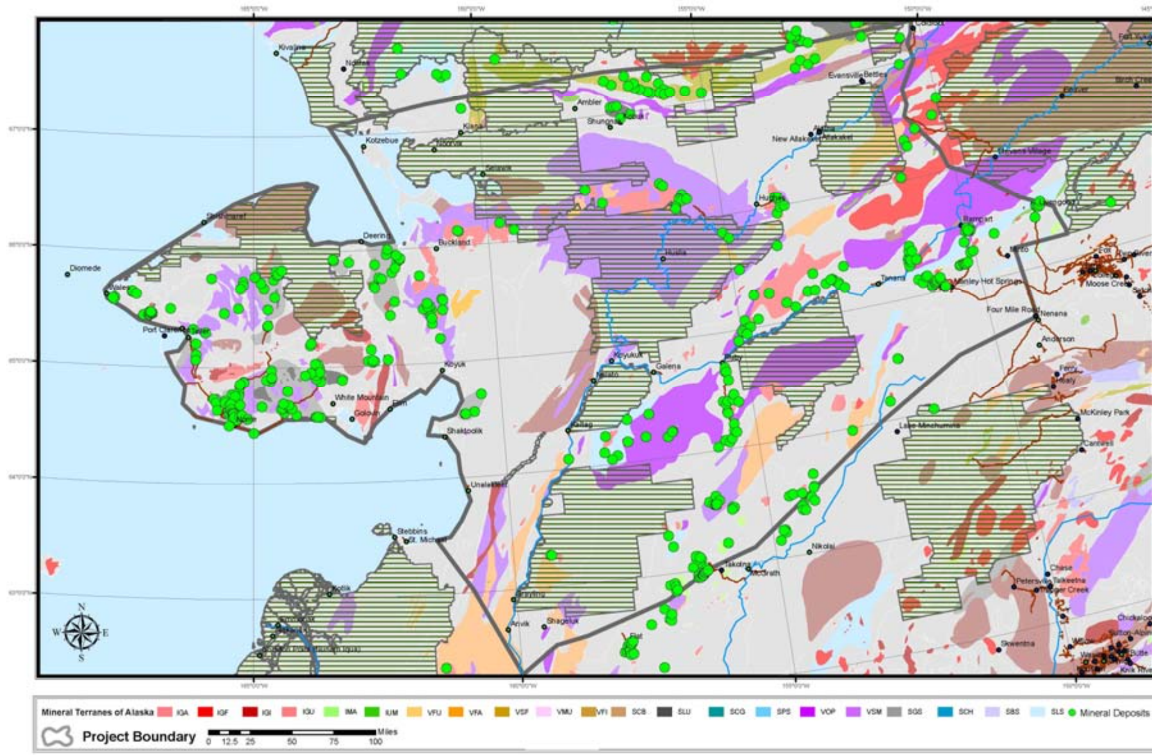

Figure 7: Mineral Terranes and Federal Conservation Areas

Source: Hawley Resource Associates, 2008 derived from C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

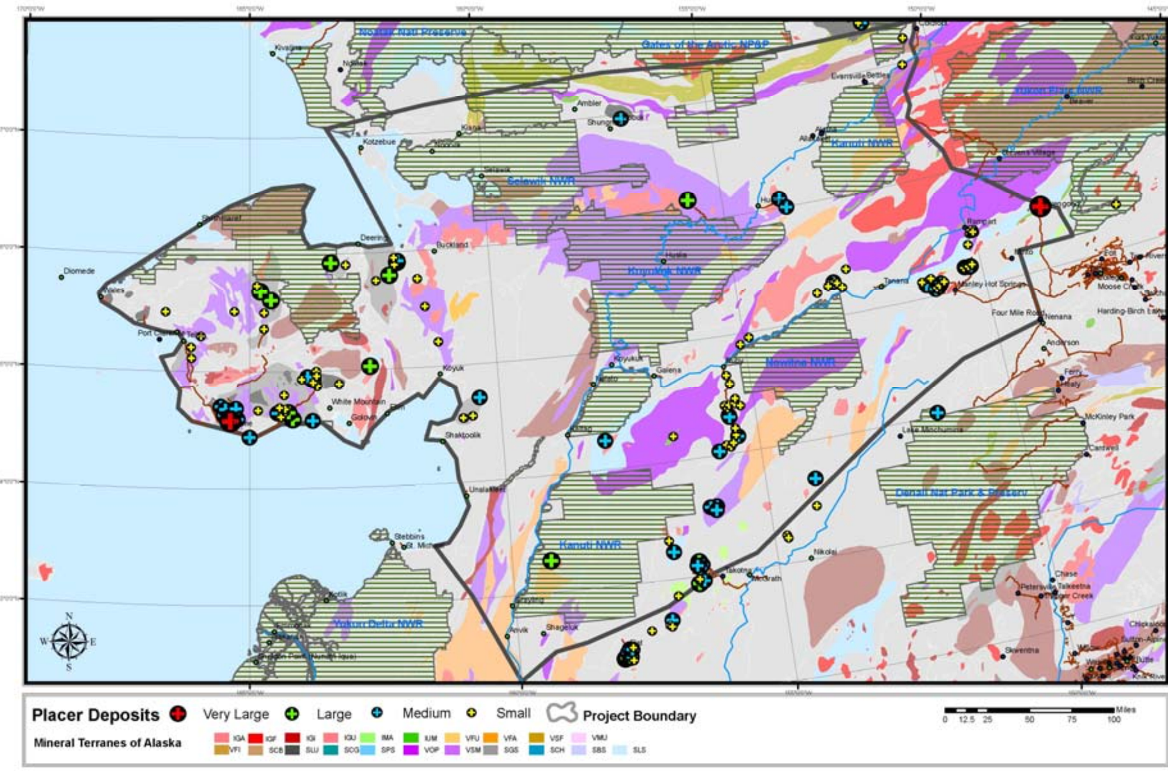

Figure 8: Placer occurrences

Source: Hawley Resource Associates, 2008 derived from C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

1.4 Geologic Models for Mineral Deposits

Mineral deposits in the WAAPS region are divided into two main classes: placer deposits, generally of gold, and lode or hard rock deposits. Placer gold deposits are further divided by the size of the deposit, as described in Table 2.

Table 2: Placer Gold Deposit Divisions by Size

Class	Name	Range In Ounces Of Gold Produced
Small	PlAuS	<10,000 (ounces)
Medium	PlAuM	>10,000 to <100,000
Large	PlAuL	>100,000 to <1,000,000
Very Large	PlAuVL	>1,000,000

Except for the gold placer deposits and a few tin placers, all other mineral deposits in this summary are lode or hard rock. The major lode deposits of the study area are: (1) stratabound high sulfide deposits hosted in layered sedimentary and volcanic rocks, and (2) disseminated low sulfide deposits hosted in granitic rocks—so-called porphyry type. Low-sulfide vein deposits hosted in and formed with metamorphic rocks are relatively small individually, but when eroded over a large area can form large or very large placer gold deposits, as at Nome. Lode deposits are further described and classified in Table 3.

Table 3: Table of Lode Classes

Abbrev	Name	Metals	Content Sulfide	Remarks And Description
Deposits In Layered Volcanic Or Sedimentary Rock				
VMS	Volcanogenic massive sulfide	Cu-Pb-Zn (Au and Ag)	High	Also called Kuroko or Bimodal
CRD	Carbonate Replacement Deposit	Cu (Pb-Zn-Co-Ag)	Med-High	
SEDEX	Sedimentary exhalative	Pb-Zn (Ag)	High	Red Dog type; only one deposit
Deposits Affiliated With Granitic Igneous Rocks				
PoCu	Porphyry copper	Cu (Au, Mo)	Low	Mainly disseminated deposits in granite and country rocks
Po (x)	x equals Au, Mo, W, U, Sn, Hg?	As given	Low	Generally more acidic granite
PoCarb	Carbonatite	U, Th, REE, Zr	Low	CO2-rich alkalic intrusions
Skarn	Contact deposit	Zn-Cu (W, Sn)	Variable	In granitic contact zone grades into porphyry
Deposit Affiliated With Mafic-Ultramafic (MUM) Igneous Rocks				
MUM		Cr-Ni-Cu-PGE	Variable	Chromite deposits mainly in region
Vein Deposits, Variable				
Vein met		Au-W	Low	In metamorphic host rocks
Vein polymet		Cu-Pb-Ag (Au_)	Moderate	Possibly grades to CRD, skarn
Vein Sn		Ag-Cu-Sn	Moderate	Grades to PoSn, Sn or W Skarn
Polymet				
Other				
EPT	Epithermal deposit	Au-Ag-Hg-Sb	Low	Shallow volcanic-related deposits

Source: Hawley Resource Associates, 2008.

2.0 PRODUCTION

Past production gives some indication of the mineral endowment of a region. The WAAPS area, excluding the area near Fairbanks, has produced about 9.8 million ounces of gold, about 1 million ounces of silver—mainly as a byproduct of gold mining, more than 3 million pounds of tin and smaller amounts of rarer minerals such as cinnabar (mercury), scheelite or wolframite (tungsten) and stibnite (antimony). Over half of the gold produced in the study area came from the Nome gold district, which produced more than 5 million ounces of gold. It also includes the Innoko, Ruby-Long, Livengood, Hogatza, Fairhaven (Candle), and Council districts, each of which have produced or have resources in excess of 500,000 ounces of gold.

The Flat-Iditarod district is only a few miles south of the study area boundary and has yielded more than 1.4 million ounces of gold. If this district is included, the identified gold production in the study area is excess of 11 million ounces. Additionally, the Donlin Creek area is only about 40 miles south of the study area boundary. It has historic placer gold production of about 100,000 ounces, and has an un-mined lode resource of about 30 million ounces of gold.

There are also more than 400 small placer mines in the WAAPS area that lack production records and are poorly known geologically. Many of these small mines occur in and near clusters of larger mines. The details of the small placer mines are not included in this study. In aggregate, however, they probably contributed at least 200,000 ounces of gold and this amount is included in the estimate of the WAAPS area gold production.

Available silver production records are very incomplete. Historic silver production in the region has been about 1 million ounces. Small shipments of copper and lead ore have also been made from Omilak (No. 235) and Independence (No. 229).[1]

[1] Number references are to the numbering system used by USGS in the ARDF data base and used to identify the deposits within the WAAPS area. The data for these deposits are contained in the Excel file that can be obtained from ADOT&PF.

3.0 UN-MINED RESOURCES

This report section summarizes the un-mined mineral resources of the WAAPS study area in two ways: by commodity, and by area. The term "mineral resource" is used as defined in Canadian Institute of Mining and Metallurgy (CIM) and referenced in Canadian National Instrument (NI) 43-101, namely: A mineral resource is "a concentration or occurrence of natural, solid, inorganic, or fossilized mineral material in or on the Earth's crust in such form and quantity and of such a grade or quality that it has reasonable prospects for economic extraction." Mineral resources are further subdivided into measured, indicated, and inferred categories based generally on the quantity and quality of information available on a prospect. Under 43-101 guidelines, inferred resources are not comingled with measured and indicated resources. In this study, inferred resources are or may be comingled with measured and indicated. All measured and indicated—and essentially all inferred—resources have been drilled in varying degrees. Currently active projects such as Arctic (No. 7) and Livengood lode (No. 77), are being explored under 43-101 guidelines and their resources are reported here using 43-101 filing information. Older or inactive projects are treated more generally, but in many cases available information is based on 43-101 guided studies. So-called cutoff grades—approximations of deemed operational costs—are reported when available from existing studies.

To give some idea of the relative value of the resources, gross dollar values have been calculated for major mineral deposits and areas using four price ranges—low, medium, high and current (in Table 4). Medium is an average of high and low, and current is an average of the three months ending January 16, 2009. Low and high values are also based on mineral prices over representative time periods.

Table 4: Representative Low-Medium-High Mineral Price Data (in US$)

Per Ounce	**Low**	**Medium**	**High**	**Current**
Gold	337.235	579.369	821.508	792
Silver	5.443	9.428	13.413	10.02
Per Pound				
Copper	0.9632	2.188	3.413	1.5422
Lead	0.2763	0.5954	0.9145	0.5330
Zinc	0.4618	0.8764	1.2909	0.5740
Tin	2.603	4.4814	6.3596	5.02

Basis for Low Price: 10 year average 1/1/96-12/31/05
High: ~3 year average: 1/1/2006-11/30/2008. Gold is increased by $100 per ounce.
Medium: Average of low and high values
Current: 3 month average ending January 16, 2009
Source: Raw data from Metalprices.com, 2008, averaged monthly

The low commodity price reflects a long period of nearly flat or even declining metal prices that ended about 2005 when Asian demand mineral resources began to increase. The high commodity price includes the years with major increases in base metal prices. In order to partly account for continued high precious metal prices in the medium commodity price, $100 was added to the calculated gold price of the estimate.

Gold and silver seem to be holding or advancing in price but base metal prices could approach low market prices until the world economy regains strength. Copper and perhaps lead could outperform zinc because of their importance in the renewable energy market.

3.1 Commodity Summaries

In terms of gross metal value, the most valuable deposits in the study area are the copper and base metal resources of the south flank of the Brooks Range. As modeled here, the south Brooks Range resource consists of 85 million tons of ore containing 4.42 billion pounds of copper, 1.75 billion pounds of lead, and 8.36 billion pounds of zinc with total values of $9.67 billion, $1.03 billion, and $7.36 billion, respectively; an overall total of $18.46 billion using medium price assumptions. Accompanying these metals as byproducts are more than 1.4 million ounces of gold and 185 million ounces of silver valued at more than $2.5 billion with medium commodity price assumptions. The total gross value for precious and base metals in the South Brooks region is about $20.96 billion. The gross value would increase by about $10 billion if increased world demand results in high commodity prices.

The present model expands on the generally similar estimate described in Rhoads and Barker (1992). Rhoads and Barker cited as reference geologist T. E. Smith, who was then the Alaska State Geologist. Converting Smith's numbers to Imperial measure, Smith reported 72.7 million tons of ore that contained (with 90 percent probability) 4.38 billion pounds of copper, 7.69 billion pounds of zinc and 1.8 billion pounds of lead. The more recent model by Rhoads and Barker contains much more gold and silver than indicated by the previous calculation, mainly because of the recognition of high precious metals in the zinc-rich ores at Smucker and Sun (Picnic Creek). Rhoads and Barker reported 904,000 ounces of gold and 137,375,000 ounces of silver calculated by Smith. Smith estimated that there was a 50 percent chance of finding an additional 65 million tons of ore of similar tons and grade, nearly doubling the estimated resource.

Substantial amounts of copper and base metals also occur at Waterpump Creek, Omar, Cirque, and Reef Ridge. Of these prospects, all except Cirque have been drilled at least in reconnaissance fashion. Cirque is well exposed and has been mapped and sampled in detail on the surface.

As shown in Figure 9, copper and base metal occurrences in the WAAPS area are all included in a bulk commodity group where they are also classed geologically as VMS, CRD, and Skarn. All these types of deposits are massive types that yield dense concentrates of intermediate value. Low-sulfide ores such as copper porphyries also would yield dense concentrates that need bulk transport (see Figure 10).

Gold is the second most valuable commodity of the WAAPS area. The major un-mined gold resources at Nome are modeled at 3.04 million ounces and Livengood at 4.02 million ounces—a total of 7.06 million ounces valued (medium) at $4.89 billion. Substantial gold resources also exist in the Hogatza area, the Innoko district, the Seward Peninsula away from Nome, and undoubtedly in several other less known areas or districts. Because of its inherent high-unit value, gold is not nearly as transport sensitive as copper and the other base metals.

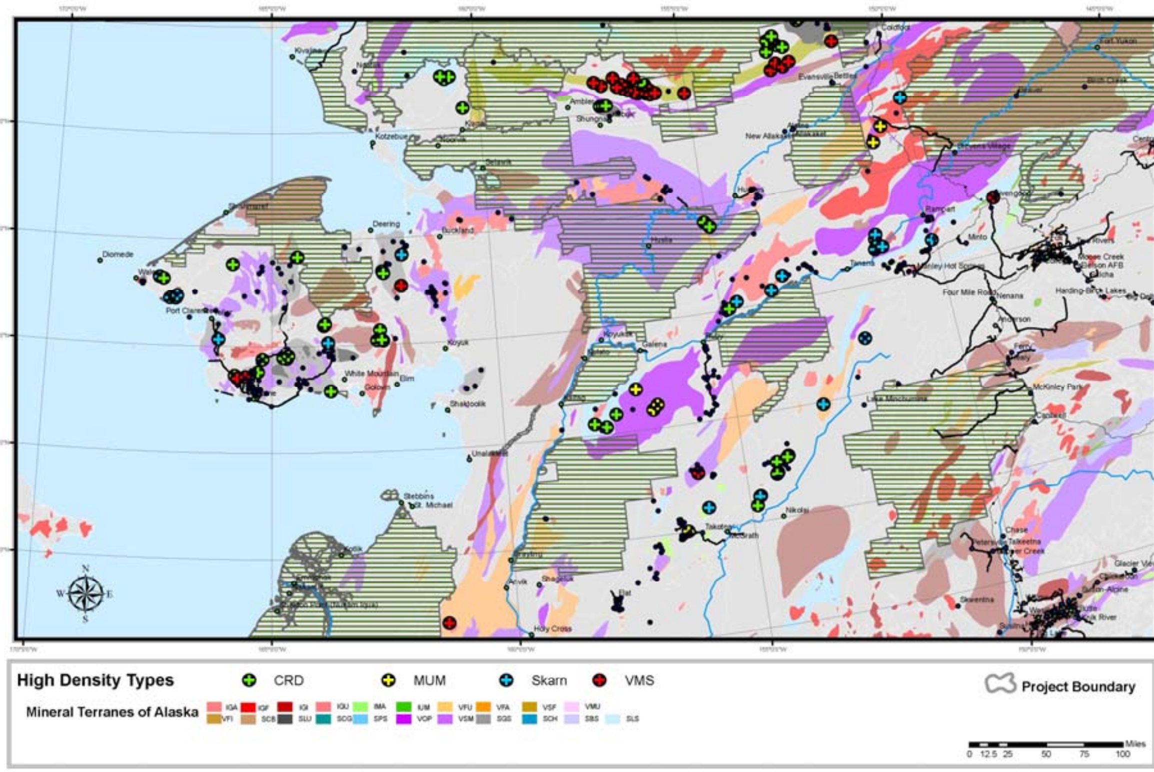

Figure 9: Bulk Commodities (Cu-Pb-Zn) in VMS, CRD, and Skarn-type deposit

Source: Hawley Resource Associates, 2008 derived from C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

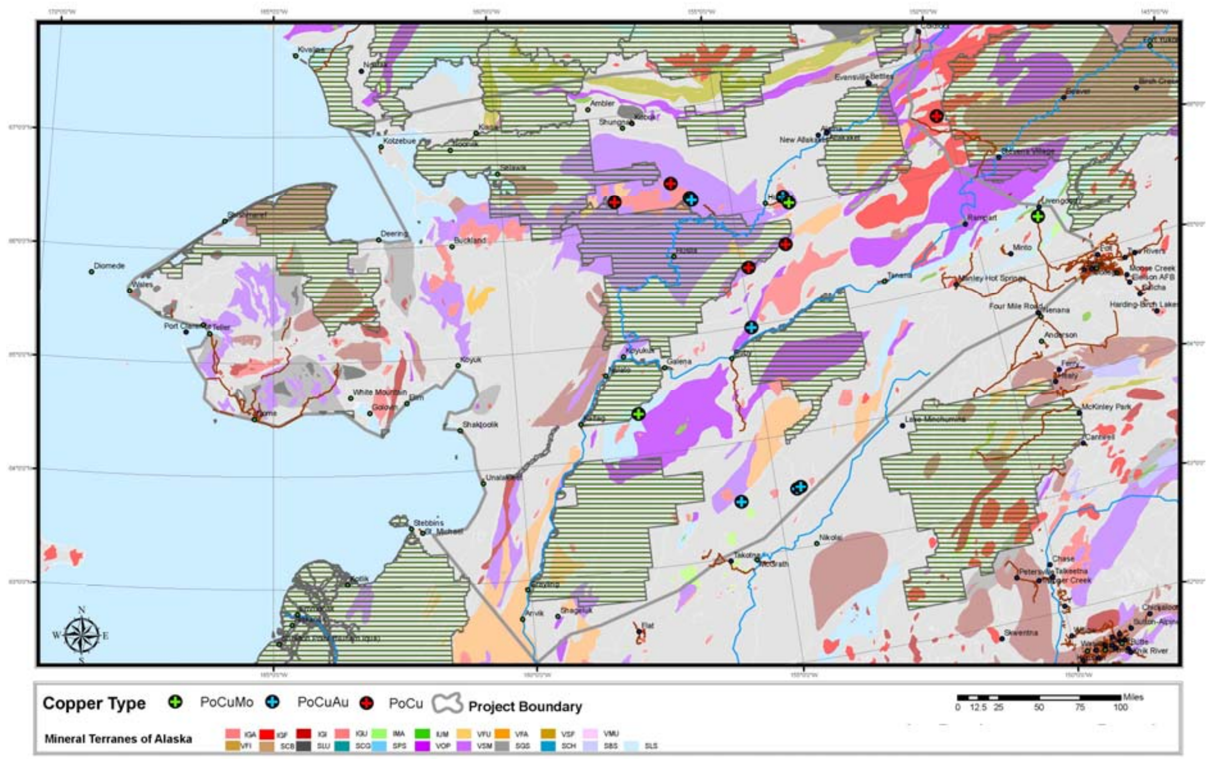

Figure 10: Porphyry copper-type deposits

Source: Hawley Resource Associates, 2008 derived from C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

The inferred or better tin resource within three deposits—Kougarok, Gemini, and Won-South—is about 5.07 million tons that contains about 54 million pounds of metallic tin. Alaska's largest tin resource is in the Lost River deposit on the Seward Peninsula which is a geologically complex mineral body. Resources at Lost River are contained in veins, skarn, carbonate replacement deposits and greisen. The Lost River deposit contains significant amounts of fluorite, beryllium, and tungsten in addition to tin. The largest known mineral zone is a tin skarn that contains more than 23.5 million tons of open-pit type that grades 0.26 percent tin, 16.4 percent fluorite, and 0.04 percent tungsten trioxide (WO3). The complex deposit is represented by numbered deposits from no. 344 (Rapid River) to No. 354 (Ida Belle) also no. 463—Lost River exogreisen. The approximate total resource at Lost River is about 40 million tons (Sheardown, 2009). Including the fluorite-beryllium-tungsten as tin equivalent suggests a minimum grade of 0.3 percent tin equivalent (about 240 million pounds of tin-equivalent).

There was insufficient information to calculate even an inferred resource for tin deposits near Tofty, for those in the Ruby-Poorman area, and those near Innoko in the Beaver Mountains. Although not quantifiable, the value of the tin-related ore deposits could be a very significant addition to the total value of minerals in the WAAPS region.

The study area also has potential to produce uranium, thorium, and rare earth minerals. A resource of about 1 million pounds of uranium oxide in a sandstone-type uranium deposit was reported at Boulder Creek (or Death Valley No. 233) on the eastern Seward Peninsula (Dickinson, Cunningham, and Ager, 1987). Recent drilling at Boulder Creek indicated that ore is not as continuous as assumed in 1987, and that the resource should be downgraded (Triex Minerals, 2008). However, new uranium occurrences were found nearby and may compensate for the loss of resource at Boulder Creek; thus, the present resource is still assumed to be 1 million pounds of uranium oxide.

Alkalic granites in a trend that starts in the Zane Hills near Hughes and continue westward into the Seward Peninsula are characteristically enriched in uranium, thorium, and REE as are granites along the Ruby Arch. These granitic belts within the study area do not have quantified resources but are highly prospective.

Tin and other metals such as uranium, tungsten, and molybdenum are of higher value and therefore less sensitive to transport than copper porphyries. Deposits of the rarer and more valuable metals (on a per unit value basis) are widely distributed in the study area and appear to offer substantial opportunities for development. Porphyry deposits classed as tungsten (W), gold (Au) uranium (U), and unusual carbonatite (Po carb) deposits are shown in Figure 11.

3.2 Regional Summaries

The most important known resource areas within the WAAPS area are, in approximate order of resource value, (1) Southern Brooks Range, (2) Livengood, and (3) Nome. Other districts with high resource values also include: Western Brooks Range, Hogatza, Seward Peninsula exclusive of Nome, Innoko, Manley-Eureka, Tanana, Illinois Creek, and Reef Ridge.

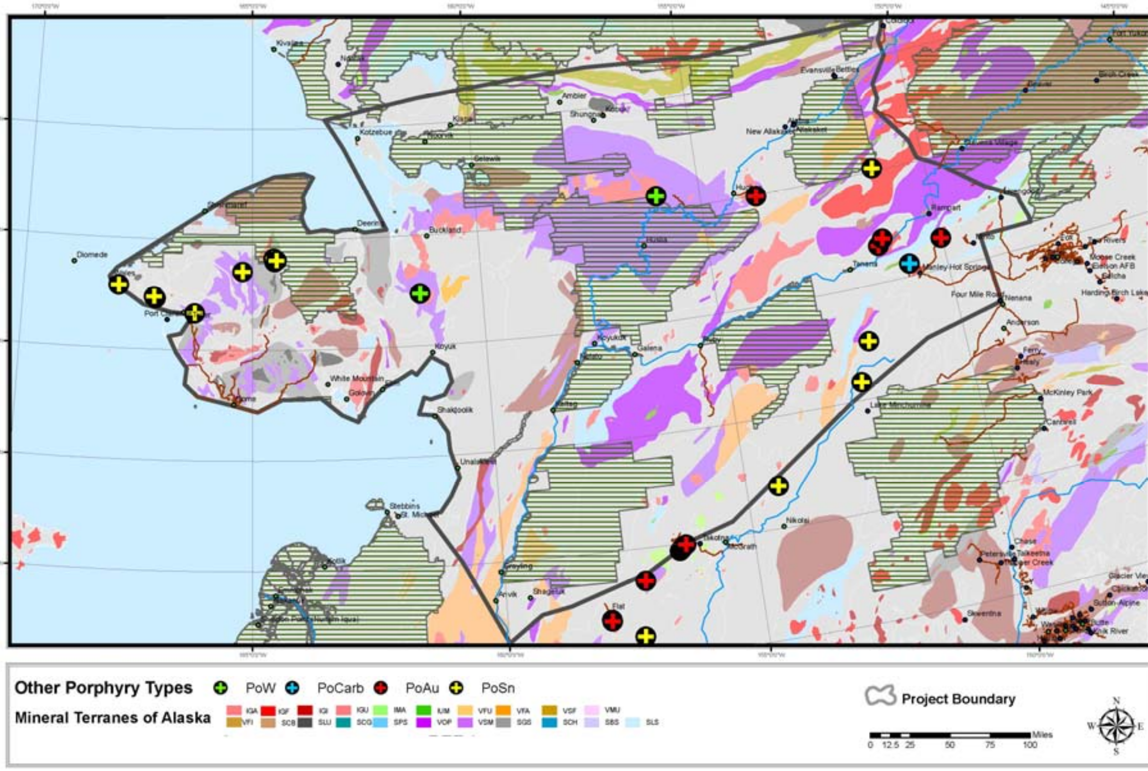

Figure 11: Other porphyry types, including gold, molybdenum, uranium, and tin

Source: Hawley Resource Associates, 2008 derived from C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

3.2.1 Southern Brooks Range

Geographically, the southern Brooks Range mineral belt trends about due east-west on the south flank of the Brooks Range commencing near the Kobuk River and extending eastward for at least 60 miles (See Figure 11). Preliminary material and hazard sites have been identified in the region (ADGGS, 2003). Geologically, the mineral belt consists of volcanogenic schist, also in an easterly trend, flanked to the south by irregular carbonate-rich areas on a schist basement. Mineral deposits occur in both the volcanogenic rocks (VMS) and in the carbonate section (CRD).

The southern Brooks Range belt has been explored since about the late 1950s. Between the 1950s and 1987, an estimated $39.5 million in exploration expenditures had been spent and since 1987 additional expenditures of about $20 million for exploration seems reasonable. Exploration activities have identified numerous deposits. The largest, best known and most important deposits are Bornite (CRD), Arctic (VMS), Sunshine (VMS), Smucker (VMS), BT

(VMS), and Sun or Picnic Creek (VMS). The VMS deposits are high-grade massive sulfide deposits that range from copper-rich (Arctic—4 percent) to zinc-rich (Sun and Smucker—5 to 7 percent zinc). All the VMS deposits have important amounts of silver and gold, which are particularly abundant in the zinc-rich deposits at Smucker and Sun.

Bornite, the mineral deposit near Kobuk in the south Brooks Range, is mainly a copper deposit, but it contains possible large amounts of zinc, cobalt, and germanium. Additional drilling will be needed to determine the amounts of these elements and to identify the boundaries of the deposit.

Bornite has been studied as a very high grade (+12 percent copper) deposit and a larger bulk deposit (100 million tons) with grade of about 1.25 percent copper using a cut-off grade of 0.5 percent copper. In order to compare with the massive sulfide VMS deposits, Bornite was calculated at a cutoff of 4 percent copper, yielding an average grade of 8.05 percent copper and contained copper content of 704 million pounds of copper in the deposit.

Offsetting the estimate of financial value of resource minerals are certain but unknown losses in mine dilution, milling, and concentrate acceptability at smelters. On the other hand, less than half of the mineral belt has been well explored. It is geologically reasonable to assume that further exploration will expand the schist belt resource and that high-dollar value elements like cobalt and germanium will be found in mineable concentrations in Bornite-type ores.

Development of the district is dependent on transportation modes and location. Previous studies have identified four main alternatives:

1. Southwesterly from Bornite approximately directly to the Seward Peninsula road system at Council and to a port site probably at Nome (Alaska, 1993)

2. About due east from Bornite through the so-called “boot” to the Dalton Highway east of Bettles (Alaska, 1993).[2]

3. Southeasterly to Alatna, thence to Tanana, west to Ruby, south to Poorman, due West to the coast near Unalakleet (RS 2477 maps and Alaska, 1993)

4. Southwesterly to Alatna, thence to Tanana thence to Nenana. Railroad assumed (Rhoads and Barker, 1992: Tudor-Kelly-Shannon, 1972).

Each option has positives and negatives which are further examined in the summary section of this report (section 5.0).

3.2.2 Livengood

The existence of mineral resources in the Livengood district has been known since about 1915. An intermediate scale placer camp has been located in the Livengood district since then. A pre-World War II drilling campaign blocked out a placer mining resource of about 1,000,000 ounces of gold. About one-half of this resource is presumed to have been mined, leaving an inferred placer gold resource of about 500,000 ounces.

Extensive exploration at Livengood began in the 1970s, but has only found notable success since 2005. The indicated and inferred resource of gold with a cut off of about 0.0146 ounces of gold per ton or greater, is 4.02 million ounces of gold at an average grade of about 0.023 ounces per ton (International Tower Hill, 2008). In contrast, if the cut off of 0.0200 ounce is assumed, there are 2.56 million ounces at a grade of about 0.0295 ounces per ton. The grades are low, but it appears that the ore can be heap leached and produced economically.

Based upon the estimate of 4.02 million ounces of gold, the gross value of the gold resource ranges from $1.36 billion to $3.3 billion, depending on commodity price assumptions (see Table 4).

[2] The “boot” refers to a portion of the Gates of the Arctic National Park and Preserve that extends south of the main portion of the park and surrounds that portion of the Kobuk River that is designated as a wild and scenic river. The shape of this southerly extension vaguely resembles a boot.

Livengood has favorable transportation logistics. It is essentially on the pipeline corridor and the Dalton Highway.

3.2.3 Nome

The Nome district is a gold camp that also has produced silver as a by-product. It has produced about 4.8 million ounces of gold from the core of the district—almost all as placer, and dominantly from on-shore sources.

The on-shore placer resource at Nome has been depleted, but a resource of about 3 million ounces of gold remains as 1 million ounces of remaining onshore placer outside of Nome proper, somewhat more than 1 million ounces of off-shore gold, and about 950,000 ounces of hard rock gold at Rock Creek and Big Hurrah, which are located about seven miles from Nome.

The City of Nome is also a transportation hub, with a modern port and jet-capable airport, and with roads leading northwest to Teller, north to Kougarok, and east-northeast to Council. Relatively short extensions to these roads could provide access to other resources. A bridge and extension to the Teller road or a ferry could give access to the Lost River area, which is rich in tin, tungsten, fluorine, and beryllium. A short extension to the Kougarok road would provide access to tin deposits, and an extension to the Council road would provide access to uranium and coal deposits.

3.2.4 Other Areas

Seven additional mining areas appear to have substantial development possibilities. These areas are briefly discussed in the following subsections.

3.2.4.1 Western Brooks Range

This isolated area is about 90 to100 miles west of the west end of the southern Brooks Range belt. It shares geology with the southern belt, but is separated from the southern belt by a National Park. Access from the east, west, or south is limited by wetlands and the east part of Kotzebue Sound.

The western Brooks Range contains the historic Klery Creek placer area and at least two deposits of Bornite type—Omar and Frost—and possibly two more at Powdermilk and Eskimo. Omar has had a few drill holes and has an inferred resource of about 144 million pounds of copper grading about 9 percent copper metal. Like Bornite, these deposits have potential for cobalt.

Due to the isolated location of the western Brooks Range, access to the mineral resources is challenging. If access could be created to the north shore of the Seward Peninsula, there are two southerly routes from the north shore that might connect to a WAAPS corridor. One of the possible south alignments is through Granite Mountain. The second is on a massive sulfide belt extending south of Independence (No. 229). Deposit No. 185 (Ahua) west of Omar is the only Sedex deposit recognized in this area, and it may contain black-shale-hosted natural gas.

3.2.4.2 Hogatza or Hog River

The Hogatza (or Hog River) area has substantial placer deposits, and access to this area could help with providing access to the southern Brooks Range belt. Hog River itself has produced about 310,000 ounces of placer gold since the 1950s and has a remaining resource of about 125,000 ounces (Taiga Mining Co., 2008). Together with nearby Utopia Creek and a few other less-developed placers in the region, the areas could produce 500,000 ounces of gold.

Opportunities also exist to develop mineral deposits in the alkali granite of the Zane Hills and massive sulfides near Utopia. Development of resources in this area could tie in to a south Brooks Range corridor.

3.2.4.3 Illinois Creek

Hard rock resources in the Illinois Creek district were discovered about 1980 and explored intensively, mainly by Anaconda Mining. Three deposits: Illinois Creek, Waterpump Creek, and Honker contain inferred or better classed resources. The Honker deposit has an inferred resource of 250,000 ounces of gold. Illinois Creek has been mined and has a remaining resource of about 250,000 ounces of gold. Waterpump Creek contains mainly silver-base metal resources, including about 1.74 million ounces of silver.

A promising porphyry copper-molybdenum deposit is at Round Top. Drilling found grades of as much as 1.8 percent copper and also a possible secondary enriched zone containing the copper-rich mineral chalcocite.

The Illinois Creek district has been deeply weathered and much of the exposed mineralization is in oxide form as gossan. The district needs a metallurgical study to fully understand its potential production levels, but it appears to be a major district with substantial resources of gold, silver, copper, lead, zinc, and perhaps molybdenum.

Resource exploration and mining has been supported by a C-130 (Hercules)-scale landing field at Illinois Creek and by 10-mile long tractor trail from the Yukon River near Kaltag. It could also be accessed from the east by a spur road that would connect with the Ruby-Poorman road. Development of the district could be of substantial long term benefit to a WAAPS corridor and would provide surface access to the Unalakleet area. A possible road and railroad port site is located at Blueberry Point a few miles north of Unalakleet. Better access to and from the Unalakleet area is a priority for Bering Straits Native Corporation and a WAAPS corridor could be a key element in improving access to the community of Unalakleet.

3.2.4.4 Tanana

The area centered on Tanana and extending east and west for about 70 miles along the Yukon contains numerous small placer deposits and possibly significant lode gold deposits at or near the Ring Hill – Monday Creek prospect. The gold deposits are also tin-bearing.

The area has mining trails and airfields and is generally accessible via the Yukon River for bulk transport. The area is about 22 air miles west-northwest of the Parks Highway near Boulder Creek. Access to the highway system would require a bridge or ferry, possibly near Twelve-Mile Island. A railroad extension to Tanana has been proposed in the past.

3.2.4.5 Manley-Eureka

The Manley-Eureka mining area contains placer gold and placer tin deposits as well as carbonatite ores. The area includes placer gold areas at Hot Springs, Glen Gulch, and

American Creek. The Manley-Eureka area has good access by gravel roads connecting the mining areas to the Dalton Highway near Livengood.

3.2.4.6 Innoko

The Innoko district contains an estimated 600,000 ounces of gold. Placer potential can be found in the Innoko Flats and along Ganes Creek. The potential exists for Donlin Creek gold deposits in the Innoko Uplands and complex metal deposits (silver, copper and tin) could exist in the Beaver Mountains. In general, there is reasonable transportation within the district through winter trails and access to the Kuskokwim River.

3.2.4.7 Reef Ridge or Medfra area

This district-sized area is about due north of Medfra, a landing on the Kuskokwim. It contains the Nixon Fork (No. 404) mine, a gold copper skarn, several other skarn occurrences, and important zinc oxide replacement deposits. The Reef Ridge or Medfra area also contains several Sn Polymet veins and porphyry copper-type occurrences. The zinc oxide deposits are represented by Nos. 396-402 including Reef Ridge (No. 402) itself, the best known of the zinc deposits, Sn Polymet veins are represented by nos. 388, 390-392, and porphyry type deposits Nos. 393-395. Except for Nixon Fork, the potential for mineral resources within the area is poorly understood. It is highly prospective and is a high priority area for exploration for Doyon, Limited, which has proposed a road leading southeast from Poorman that would connect to the short Nixon Fork-Medfra road.

3.3 Geologic Data Gaps

Only five relatively small areas within the WAAPS area have been studied by the State of Alaska's aerial geophysical program and geologically mapped at scales of about 1:63,360 (one inch = one mile). The areas from west to east are the Nome area and Solomon area (both on the Seward Peninsula), the Ruby-Poorman area, and Manley-Rampart area, and a small area near Livengood (see Figure 12). The great majority of the region is not covered by any detailed geological surveys, although local areas of high interest for the mineral resource industry (such as the Southern Brooks Range and Lost River) have been mapped in great detail.

In general, the state contracts with private geophysical contactors to fly geophysical surveys at a less detailed scale than what is typical for detailed mine work. In meetings held with ADGGS in January 2009, target areas identified for geophysical surveys were along the Yukon west and north of Tanana, the Illinois Creek area, and Reef Ridge area. Previous state-sponsored surveys triggered industry response with the creation of more detailed surveys, claim staking, and drilling. Typical expenditures for such geophysical surveys are on the order of hundreds of thousand dollars.

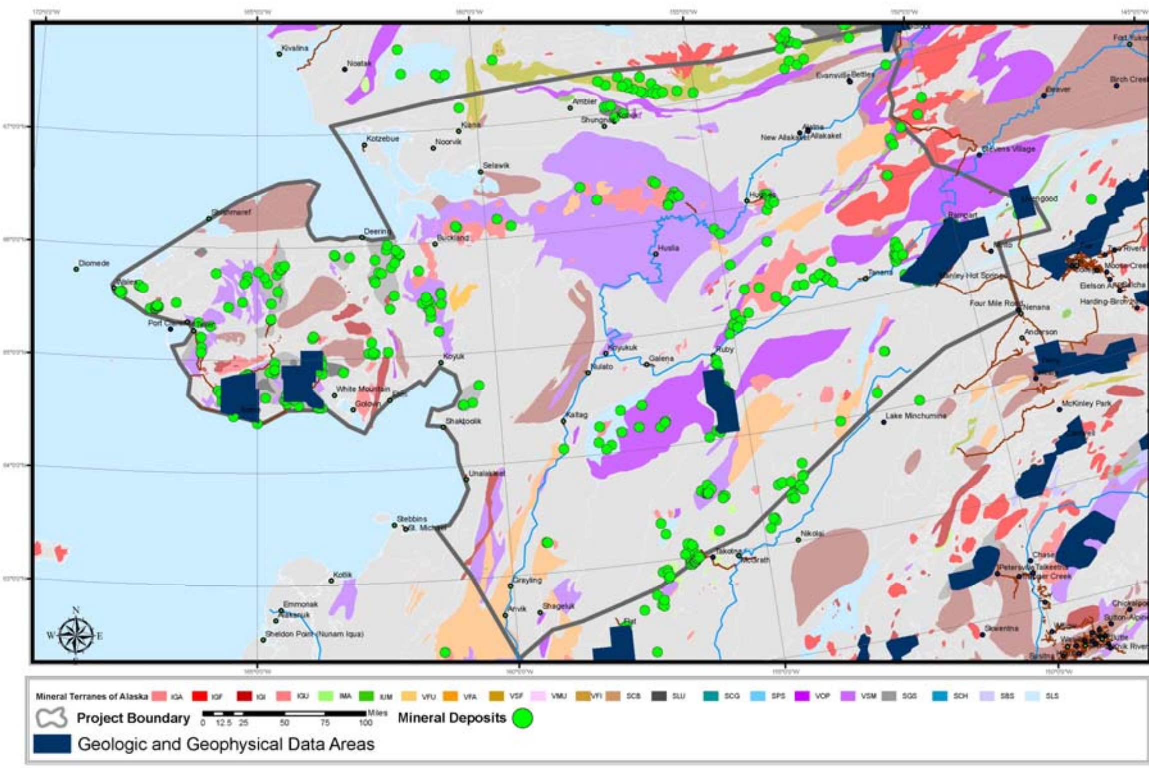

Figure 12: Geophysical Surveys

Source: Hawley Resource Associates, 2008 with base map derived from C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

4.0 ENERGY RESOURCES

The study of possible energy sources in the region was pursued opportunistically since they conveniently relate to the analysis of hard minerals. For example, sedimentary basins that contain sandstone-type uranium deposits or placer deposits also contain coal. Also, some of the largest and highly prospective thermal springs of the area are hosted in or near abnormally radioactive granite (see Figure 13).

The Boulder Creek sandstone uranium deposit occurs in a small coal basin. Although the basin is small, basin-forming conditions must have been favorable as the coal seam is locally more than 140-feet thick. Coal at Chicago Creek, which is in and near placer gold and hard rock deposits on the north-side of the Seward Peninsula, are as much as 60 feet thick. Other identified coal basins with potential for local use are at Nulato above Kaltag and on a narrow basin that extends northeasterly along the Yukon from Tanana past Rampart. Coal is also exposed along the Kobuk west of Ambler (Merritt and Hawley, 1986).

Although no substantial conventional oil and gas resources are likely to exist in the region, except for possibly the Nenana basin near Fairbanks, the small coal basins could furnish locally significant deposits of thermal coal or coal-bed methane.

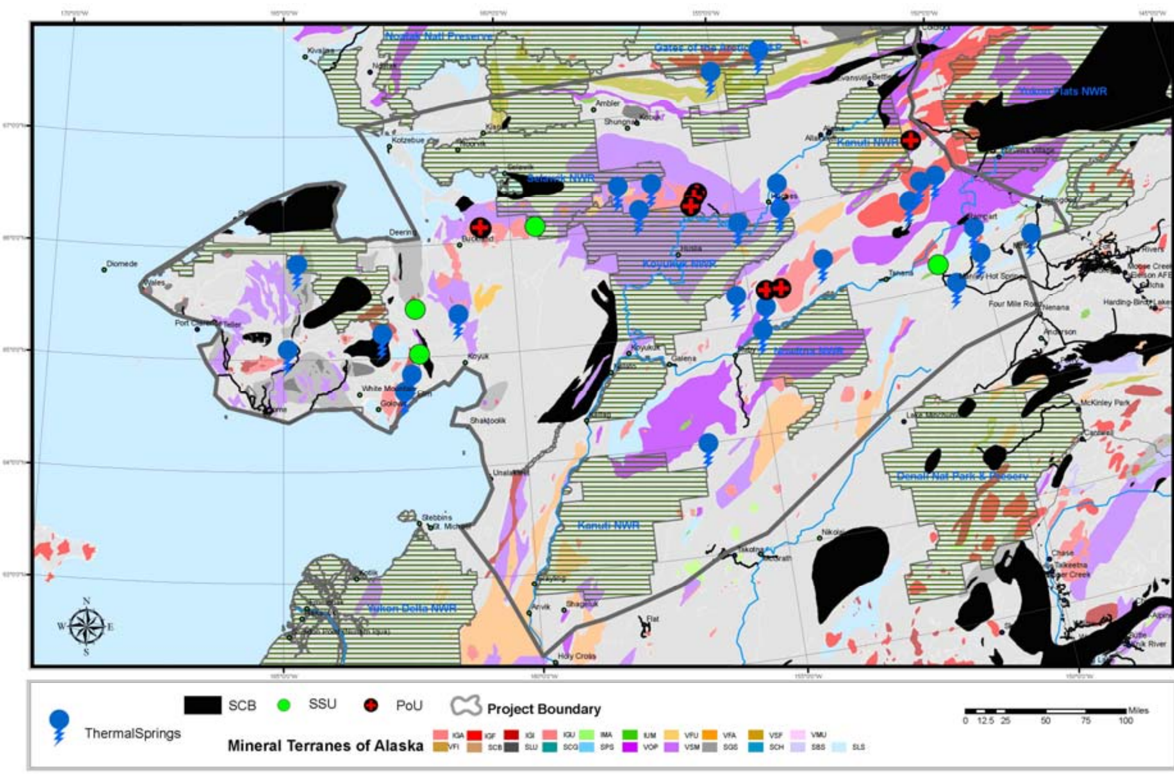

Figure 13: Energy summary

Source: Hawley Resource Associates, 2008 with base map derived from derived from C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

5.0 SUMMARY OF DEPOSITS AND CORRIDOR OPTIONS

A review of USGS and mining industry data suggested that there were more than 400 mineral deposits worthy of evaluation for this WAAPS report. These deposits are documented in this report and its appendices. A more detailed understanding of the geographic distribution and commodity content of deposits is critical to their possible development. In any particular region, successful development will depend on the identification of a few critical deposits that have the size and richness to warrant development. The deposits listed in Table 5 below and those shown in Figure 14 appear to be sufficiently large and valuable to influence the development of smaller deposits and the location of resource corridors.

Table 5: Significant Deposits, Commodities, and General Location

Name	No.	Commodities	Location
Bornite	3	Cu (Ag, Zn, Co, Ge)	Southern Brooks
Arctic	7	Cu, Zn, Pb (Au, Ag)	Same
Sunshine Ck	10	Zn,Cu, Pb (Ag, Au)	Same
Smucker	13	Zn, Pb, Cu (Ag. Au)	Same
BT	17	Zn, Cu, Pb (Ag, Au)	Same
Sun	21	Zn, Cu, Pb (Ag. Au)	Same
Boston Ridge	28	U, Th, REE	Alatna Basin
Hogatza (pl)	32	Au (U, REE)	Alatna Basin
Livengood Ck (pl)	72	Au (Sn, W)	Pipeline
Livengood Lode	77	Au (Ag?)	Pipeline
Ring Hill	86	Au (Sn?)	Yukon River
Tofty Ridge	123	REE, U, Th.	Hot Springs Dist.
Sheri	141	U	Yukon River
Frost	182	Cu? (Co?)	W. Brooks Range
Omar	183	Cu (Zn, Co)	Same
Christmas Mtn	207	Au (Sb)	Norton Sound
Independence	229	Ag (Pb,Zn)	NE Seward Pn
Boulder Ck	233	U	SE Seward Pen
Round Top	251	Cu (Ag, Mo?)	Illinois Ck Dist
Honker	254	Au	Illinois Ck Dist
Waterpump Ck	255	Ag (Pb, Zn)	Illinois Ck Dist
Illinois Ck	256	Au (Cu, Ag)	Illinois Ck Dist
Big Hurrah	266	Au (W?)	Nome area
Bluff (lode)	286	Au (W)	Same
Rock Ck (lode)	311	Au (W?)	Same
Nome Dist	331	Au (W?)	Same
Nome Offshore	332	Au	Same
Lost River	344-354	Sn, Fl (W, Be, Ag)	NW Seward Pen
Kougarok	357	Sn, Nb	NC Seward Pen
McLeod	367-369	Mo	Illinois Ck
Wyoming	388	Sn (Ag)	Medfra
Won-Gem	390-392	Sn (Ag)	Medfra
Reef Ridge District	396-402	Zn (Pb)	Mwdfr
Cirque	413	Cu (Ag)	Innoko
Innoko Uplands	461	Aui	Innoko

Source: Hawley Resource Associates, 2008.

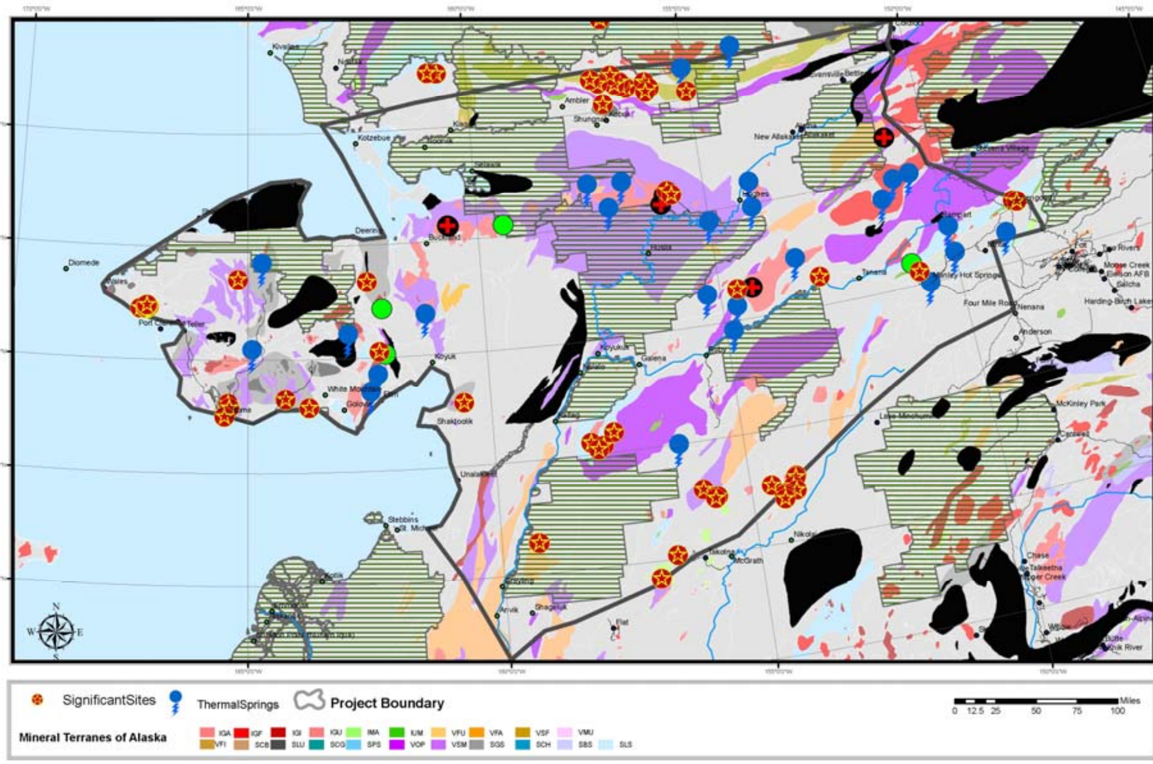

Figure 14: Most significant Occurrences

Source: Hawley Resource Associates with base map derived from derived from C.C. Hawley & Associates, 1982 and U.S. Bureau of Mines, 1995.

Access challenges in the region range from relatively simple and inexpensive at Livengood and nearby areas given their proximity to the Dalton Highway, to more complex, difficult and costly access for the central Brooks Range. Access is good but seasonal for sites along the Seward Peninsula as well as along the Yukon River. Reef Ridge and Illinois Creek have access to rivers, the Kuskokwim and Yukon Rivers respectively, and surface access could be developed at both locales. Brooks Range access remains the greatest challenge, but with the possibility of the greatest reward due to the size and value of these deposits, which are also the most studied.

Four possible access routes were noted earlier in this report. These routes are (1) southwest from the Bornite area almost in direct line to Council and then connecting Council to Nome, (2) east either through the Boot or south of it to the Dalton Highway near Bettles, (3) southeasterly toward Tanana, then approximately due west on a new surface route to the Seward Peninsula, and (4) southeasterly as above, but continuing from Tanana to Nenana.

Routes 1 and 2 are identified on RS 2477s maps and the map used to guide state land selections for transportation. The fourth route was advocated by Tudor-Kelly-Shannon in 1972 and Rhoads and Barker (1992). Some studies were more or less silent on mode, but the Tanana-Nenana option recommended rail, connecting to the Alaska Railroad at Nenana.

Some of the suggested route options may have fatal flaws. Route 1 has a high proportion of wetlands, and would require either Congressional action or the use of Title 11 from Alaska National Interest Lands Conservation Act (ANILCA) as it crosses a federal conservation area. The use of Title 11 to go across the boot is uncertain, and the route would require transporting concentrate or metal hundreds of miles to a seaport. The 1993 access study completed by the State of Alaska proposes turning south at Ruby, then turning west through the prospective Illinois Creek area to the Yukon River and reaching the coast near Unalakleet district. This alternative would provide quicker access to water—at Blueberry Point just north of Unalakleet.

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APPENDIX A

EXPLANATION FOR MINERAL RESOURCE TABLES, WAAPS

Hard mineral resource data for the WAAPS study are summarized in an Excel Work Book with six stacked tables (sheets) whose general contents are summarized below:

Sheet 1: Project name and numbers, ownership, location including corridor

Sheet 2: Project status and geology

Sheet 3: Commodities, precious metals, reliability of data, production and resource

Sheet 4: Commodities, copper and base metals lead and zinc

Sheet 5: Commodities, rarer metals including tin and uranium

Sheet 6: References, summary

SHEET 1: Location and Ownership

- Site Number (No) The number (Arabic) that follows all mineral locations through the series of sheets.
- Site Name: The commonly known name of a mineral locality (Unnamed is a permissible entry)
- ARDF: USGS designation for site in their Resource Data File, as AR012 is the 12th site on the Ambler River 1:250,000 Quadrangle
- Latitude and Longitude and USGS 1:63,360 quadrangle, as: SP A-6: Survey Pass A-6 1:63,360 quad
- Ownership: Three permissible entries, F=Federal; S=State, and N=Native
- Corridor: Common name of corridor if designated, as Pipe Line, Fairbanks-Nome, Southern Brooks Range, Ruby-Poorman
- Remarks and Alternate location by Township and Range or Geographic Feature

SHEET 2: Geology

- Site No. Common number, all sheets

- Status: Three permissible entries: Mine if it has been or is in production or has bankable feasibility: Prospect if it has been drilled; Occurrence for site with only surface geologic, geochemical, or geophysical work

- Model (geologic type): See text

- Age: Geologic, as Cretaceous, Tertiary, Devonian

- Ore Mineralogy:

asp: Arsenopyrite	Au: Native gold
ba: Barite	Be: Beryl and chyrosoberyl
brt: Bertrandite (Be)	bef: Betafite (U)
bn: Bornite (Cu)	cc: Chalcocite (Cu)
cpy: Chalcopyrite (Cu)	chr: Chromite (Cr)
cb: Cinnabar (Hg)	cv: Covellite (Cu)
cr: Carrollite (Co)	cs: Cassiterite (Sn)
en: Enargite (Cu+As)	Fl: Fluorite (F)
gn: Galena (Pb)	hm: Hematite (Fe)
mgt: Magnetite (Fe)	mb: Molybdenite (Mo)
mal: Malachite (Cu)	owy: Owyheeite (Ag,Pb sulfosalt)
py: Pyrite	REE: (Misc RE elements)
PGE: Unspecified Pt-group minerals	sph: Sphalerite (Zn)
sch: Scheelite (W)	sm: Smithsonite (Zn)
sn: Stannite (Sn)	Sfx: Complex sulfosalts
stb: Stibnite (Sb)	tn: Tennantite (Cu+As)
tt: Tetrahedrite (Cu+Sb)	ur: Uraninite (U)
UTh: Misc. U-Th minerals	wf: Wolframite (W)

- Remarks: Short summary of most important aspects of site

SHEET 3: Precious Metals, Resources

- Common number all sheets
- Production of gold, in ounces
- Reliability of resource data: Unless stated resources are geologic rather than mining. Permissible entries are: M+I, Measured plus Indicated, generally similar to Proven and Probable of some classifications. Based on sufficient number of sample points that a high probability exists for grade and tonnage of ore as given. Inf, Inferred. Tonnage and grade of ore is based on geologic extrapolation from known sample points; has a lesser probability that grade and tonnage of ore stated exists. M+I+Inf, Measured plus Indicated plus Inferred. Summary of ore likely to exist based on physical measurement and geologic extrapolation, a general resource number
- Tons: (millions-Imperial): Where known, the approximate tonnage of ore in the various resource categories
- Cut-off Grade, Au ounces/ton: Where known, the approximate break-even cost of production of ore, here based on gold grade: Often not known at early resource appraisal stage leading to overstatement of mineable ore.
- Au Grade in Ounces/Ton: Reported grade used with Tonnage to compute amount of Au (or Ag) in ore
- Resource Au: Tons (millions) x Grade of ore = Ounces of gold in deposit
- Repeated as to Ag

SHEET 4: Copper and Base Metals

Calculation Sheet for Copper and Common Base Metals Lead and zinc

Uses same measure of reliability as Precious Metals. Calculates amounts of copper, lead, and zinc in billions of pounds.

SHEET FIVE: Tin and Rare Metals

Rarer metals: Tin (Sn) production given in lbs metallic Sn where known (assumed 60% metallic tin in a cassiterite concentrate). For other metals such as U (uranium) production or resource given in Remarks column.

SHEET 6: References

This sheet gives the author and date for main source used at a site; full references are given in an embedded Word file (see Sheet 7).

SHEET 7: Embedded Word File with Complete References

This sheet contains an embedded Word file which gives detailed references.

GENERAL

Except for some very recent discoveries, the mineral sites are those of the Alaska Resource Data Files of the USGS, which list mineral occurrences according to 1:250,000 scale quadrangle maps. Not all of the USGS sites are used. Sites known to be in Federal Conservation Areas are not used, nor are mineral sites in which primary authority (or other data) indicates that there is little opportunity for a deposit of substantial size to exist. Most small gold placer sites (as less than about 1000 ounces production) were omitted.

CORRIDORS

Corridors used in this study are listed below along with a generalized geographic location and in some cases justification for designation. With a very few exceptions, such as part of Western Brooks Range, the corridors do not cross Federal Conservation areas; generally they are on State of Alaska, BLM Public Lands and some Native lands.

1. Fairbanks-Nome: Generalized route local variations, as:

    A. Five-mile Camp option. Route begins near 5 mile camp north of Yukon River and proceeds generally WSW to a point near Tanana where it meets alinement from Tofty. Also Bettles option: Westerly to Hughes, southerly to Tanana

B. Fairbanks-Nome TO: Tofty-Tanana Option. Road begins near Livengood and follows existing roads to near Tofty; at either Twelve Mile or Sixteen Mile Island it would cross the Yukon then proceed generally W through Tanana to the north bank of Yukon at Ruby. Depending on construction feasibility route would continue on north shore of Yukon past Galena; it would leave Yukon and proceed upstream on Nulato River, then NW to join with Nome road above Council. If construction feasibility does not exist past Ruby, route might divert south along Ruby Poorman road to a point near Illinois Creek then westerly to cross the Yukon below Kaltag. Options from that point would include proceeding NW to join Seward Peninsula road system or to a port site at Blueberry Point on Norton Sound.

C. Nenana-Tanana Option. This option proposes a 120 mile rail extension from Nenana to just below Tanana and a 150 mile extension to the Copper belt. Economics of the route would be improved with discovery of gas in the Nenana basin: the route could improve opportunities for agriculture and forestry.

2. Pipe Line: Parallel to Dalton Highway; mostly mineral locations on Livengood and Wiseman quadrangles.

3. Southern Brooks Range: Approximate E-W alinement on south flank of the Brooks Range that connects all major copper deposits in Ambler belt. Is about 60 miles in length straight line; about 100 miles long following reasonable topography

4. Southern Brooks-Tanana: Public land route from Brooks Range to near Tanana on Fairbanks-Nome route

5. Ruby-Poorman: Existing state road and extension to near Ophir or Takotna Landing. (Probable ferry at Ruby to Fairbanks-Nome highway)

6. Rampart: From Eureka on Fairbanks-Nome roadway to Rampart

7. Western Brooks Range: This corridor runs approximately N-S and extends from the Brooks Range west of National Park near Omar Creek and connects with the Fairbanks-Nome route at two optional points, one to the south of Granite Mountain (abbreviated as WMR-GMO), the other somewhat to the west and extending south from the Candle-Kugruk area (abbreviated as WBR-C0).

8. Seward Peninsula System: There are three main existing Seward Peninsula highways: Nome-Teller extending NW from Nome to Teller; Nome-Taylor extending about N to the Taylor-Kougarok area, and Nome-Council extending northeasterly from Nome to Council. Each might have extensions to mineral areas, as Nome-Teller to Lost River; Nome-Taylor extending north to Hot Springs Park area, and Nome-Council could extend east to the Death Valley (Boulder Creek) coal-uranium area.

9. Medfra: From a point near Poorman on the Ruby-Poorman Road to Reef Ridge zinc district (Doyon Block Ten), thence southerly to Nixon Fork and Medfra on the Kuskokwim.

APPENDIX B: GEOLOGIC UNIT DESCRIPTIONS

These are the geologic unit descriptions from Beikman, H.M., 1980, Geologic map of Alaska:

U.S. Geological Survey Special Map, scale 1:2,500,000, 2 sheets.

The numeric CODE used in the digital coverage precedes the geologic unit label.

STRATIFIED SEDIMENTARY SEQUENCE

Mainly marine. Includes some volcanic rocks.

In part metamorphosed

1002 Qh HOLOCENE DEPOSITS - Alluvial, glacial, lake, estuarine, swamp,

landslide, flood plain, and beach deposits

1001 Q QUATERNARY DEPOSITS - Alluvial, glacial, lake, eolian, beach, and

volcanic deposits. Includes the marine Bootlegger Cove Clay

1003 Qp PLEISTOCENE DEPOSITS - Alluvial, glacial, dune sand, loess, and

reworked sand and silt deposits

1015 Tp PLIOCENE ROCKS - Sandstone, siltstone, and conglomerate. Includes

Tachilni Formation on the Alaska Peninsula and Tugidak Formation on

Tugidak and Chirikof Islands

1013 uT UPPER TERTIARY ROCKS - Sandstone, siltstone, shale, mudstone, and

conglomerate of Miocene and Pliocene age. Includes upper part of

the Sagavanirktok Formation on the Arctic Coastal Plain, and the

Yakataga Formation in the Gulf of Alaska area

1016 Tm MIOCENE ROCKS - Sandstone, siltstone, conglomerate, argillite,

graywacke, and basaltic rocks. As shown, includes Bear Lake

Formation on the Alaska Peninsula, Narrow Cape Formation (Oligocene

or Miocene) on Kodiak and Sitkinak Islands, and Chuniksak Formation

(Miocene?) on Attu Island

1017 To OLIGOCENE ROCKS - Volcanic conglomerate, sandstone, volcanic

breccia, shale, and siltstone. As shown, includes the Meshik

Formation and Stepovak Formation of Burk (1965) on the Alaska

Peninsula and the Sitkinak Formation on Sitkalidak, Sitkinak, and

Chirikof Islands

1018 Te EOCENE ROCKS - Sandstone, siltstone, and shale interbedded with

mafic flows and sills of the Andrew Lake Formation on Adak Island

1011 T TERTIARY ROCKS - Sedimentary rocks concealed beneath Quaternary

cover on Point Hope and volcanogenic sedimentary rocks and flows,

dikes, and sills on the Alaska Peninsula and Umnak Island

1012 mT MIDDLE TERTIARY ROCKS - Siltstone, sandstone, organic shale, and

locally, volcanic rocks. Includes Poul Creek, Katalla, and Topsy

Formations ranging from Oligocene to Miocene age in Gulf of Alaska

area

1014 lT LOWER TERTIARY ROCKS - Interbedded sedimentary, volcanogenic, and

volcanic rocks of Paleocene, Eocene, and Oligocene age on the Alaska

Peninsula and Aleutian Islands and intensely deformed marine and

continental clastic rocks of Paleocene and Eocene age in the Gulf of

Alaska area. Includes the Tolstoi and Belkofski Formations of Burk (1965) in the Alaska Peninsula; the Ghost Rocks Formation on Kodiak Island; the Amchitka and Banjo Point Formations on Amchitka Island; Gunners Cove Formation on Rat Island; the Krugloi Formation on Agattu Island; and Kulthieth, Kushtaka, and Tokun Formations and clastic rocks of the Orca Group in the Gulf of Alaska area

1112 uK UPPER CRETACEOUS ROCKS - Shale, sandstone, and conglomerate of the Ninuluk Formation of the Nanushuk Group and the Seabee and Schrader Bluff Formations of the Colville Group in the Arctic Coastal Plain and Foothills; nonmarine and marine clastic rocks, siltstone, and shale of the Chignik and Hoodoo Formations on the Alaska Peninsula; graded beds of sandstone and slate of the Kodiak Formation on Kodiak and Afgonak Islands; sandstone and mudstone of Shumagin Formation on Shumagin and Sanak Islands

1111 K CRETACEOUS ROCKS - Volcanic graywacke, mudstone, and sandstone with some coal-bearing rocks in the Yukon-Koyukuk province; graywacke and shale of the Kuskokwim Group in the Kuskokwim Mountains; and shelf deposits of sandstone, siltstone, shale and limestone of the Kennicott, Moonshine Creek, Schulze, Chititu, and MacColl Ridge Formations in the southern Wrangell Mountains; the Matanuska Formation in the Matanuska Valley; and the Kaguyak Formation on the Alaska Peninsula

1113 lK LOWER CRETACEOUS ROCKS - Graywacke, sandstone, shale, siltstone, and conglomerate of part of the Tiglukpuk Formation of former usage, Okpikruak, Fortress Mountain, Torok, and Kukpowruk Formations in the western Arctic Foothills; the Kongakut Formation, Bathtub Graywacke, and Tuktu and Grandstand Formations in the eastern Brooks Range and Arctic Foothills; unnamed graywacke, argillite, conglomerate, and minor limestone southeast of the mouth of the Kuskokwim River; interlayered submarine and subaerial andesitic fragmental volcanic rocks, flows, tuffs, and volcaniclastic rocks of the Chisana Formation north of the Wrangell Mountains; and unnamed graywacke, argillite, and minor andesite on Etolin Island

1121 KJ CRETACEOUS AND JURASSIC ROCKS - Argillite, shale, graywacke,

quartzite, conglomerate, lava, tuff, and agglomerate. Almost barren of fossils and probably includes rocks ranging in age from Early Jurassic to Late Cretaceous. In places moderately to highly metamorphosed (amphibolite facies)

1122 KJ1 CRETACEOUS AND UPPER JURASSIC ROCKS - Graywacke, slate, argillite,

minor conglomerate, volcanic detritus, and interbedded mafic volcanic rocks. Includes Valdez and part of Yakutat Groups and Sitka Graywacke. Mildly metamorphosed, locally to greenschist

1123 KJ2 LOWER CRETACEOUS AND UPPER JURASSIC ROCKS - Shallow and deep water

clastic deposits (Oxfordian to Barremian) north of the Wrangell Mountains; includes sandstone, arkose, siltstone, and limestone of the Staniukovich Formation (Burk, 1965) and Herendeen Limestone on the Alaska Peninsula; and slate, graywacke and conglomerate of the Seymour Canal Formation on Admiralty and Kupreanof Islands

1124 KJ3 LOWER CRETACEOUS AND UPPER JURASSIC(?) ROCKS-Melange of flysch,

greenstone, limestone, chert, granodiorite, glaucophane-bearing

greenschist, and layered gabbro and serpentinite. Melange consists

of Upper Jurassic(?) and Lower Cretaceous pelitic matrix enclosing

blocks several kilometers in dimension of Permian to Lower Jurassic

rocks. Includes the Uyak Formation, McHugh Complex, melange within

the Yakutat Group, and Waterfall Greenstone and Khaz Formation of

the Kelp Bay Group

1132 uJ UPPER JURASSIC ROCKS - Sandstone, siltstone, shale, and conglomerate

on the Alaska Peninsula, Cook Inlet area, and southern flank of the

Talkeetna Mountains. Includes the Chinitna and Naknek Formations

1133 mJ MIDDLE JURASSIC ROCKS - Argillite, graywacke, and conglomerate

southeast of the Kuskokwim River and sandstone, shale, siltstone,

and conglomerate on the Alaska Peninsula and Cook Inlet area where

it includes the Kialagvik and Shelikof Formations and Tuxedni Group

1134 lJ LOWER JURASSIC ROCKS - Sandstone and argillite interbedded with

volcanic flows and pyroclastic rocks of the Talkeetna Formation in

the Cook Inlet area and southern Talkeetna Mountains

1131 J JURASSIC ROCKS - Shale, siltstone, and sandstone. Includes the

Kingak Shale along the northern front of the Brooks Range, Glenn

Shale (which includes rocks of Triassic and Cretaceous age) in the

east-central part of the State, the Nizina Mountain Formation and

Kotsina Conglomerate along the southern Wrangell Mountains, and unnamed slaty detrital rocks on Gravina and Annette Islands

1151 JTR JURASSIC AND(OR) TRIASSIC ROCKS - Chert and argillite north of the Porcupine River; limestone with minor dolomite, shale, and chert of the Chitistone Limestone, Nizina Limestone, McCarthy Formation, and Lubbe Creek Formation along the southern Wrangell Mountains; and hornfels and phyllite of the Hazelton(?) Group in southeast Alaska

1153 uTR UPPER TRIASSIC ROCKS - Limestone, shale, and chert of the Kamishak Formation in the Cook Inlet area; a shelf facies of limestone, tuff, tuffaceous conglomerate and breccias at the southern tip of the Kenai Peninsula (west of the Border Ranges fault) and equivalent rocks on Shuyak, Afognak, and Kodiak Islands; a deep water flysch and melange facies of chert, pillow basalt and associated graywacke, argillite, and minor ultramafic rocks (east of the Border Ranges fault) on the southern Kenai Peninsula; chert, limestone, sandstone, and greenstone of the Whitestripe Marble and Pinnacle Peak Phyllite (both Triassic?) on Chichagof and Baranof Islands, of the Hyd Group on Admiralty Island and Keku Straits area, and of the Nehenta and Chapin Peak Formations on Gravina Island

1152 TR TRIASSIC ROCKS - Shale, chert, and limestone of the Shublik Formation and quartzitic sandstone of the Karen Creek Sandstone on the north flank of the Brooks Range

1154 TRP TRIASSIC AND PERMIAN ROCKS - Sandstone, siltstone, and shale of the Sadlerochit Group on the north flank of the Brooks Range; mafic volcanic rocks, red beds, limestone, and calcareous argillite in the

Chulitna River area; argillite, limestone, siltstone, conglomerate, and abundant gabbroic sills in the east-central Alaska Range where it includes the upper part of the Mankomen Group; and schist, graywacke, slate, conglomerate, phyllite, andesite flows and tuffs on Admiralty Island where it includes the Barlow Cove Formation

1141 JP JURASSIC, TRIASSIC, AND PERMIAN ROCKS - Shale, siltstone, and chert,

and graywacke in the Brooks Range. Includes upper part of Nuka Formation and Siksikpuk and Shublik Formations

1100 MzPz MESOZOIC AND PALEOZOIC ROCKS - Sandstone, shale, chert, dolomite and

conglomerate, in a discordant rock sequence of unknown provenance that includes rocks of Mississippian, Triassic, Jurassic, and Cretaceous age in the western Brooks Range (includes Nuka Formation); Lower Jurassic, Pennsylvanian, and Permian rocks, in part covered by Tertiary sedimentary rocks and intruded by granitic rocks of Tertiary age in north-central Chugach Mountains: and slate, quartzite, schist and phyllite with interlayered beds of marble, layered gneiss and amphibolite of Ordovician to Jurassic or Cretaceous age along the west flank of the Coast Mountains

1161 P PERMIAN ROCKS - Chert, shale, and siltstone of the Siksikpuk and

Echooka Formations in the central Arctic Foothills and volcanic argillite and graywacke with local chert, pillow flows, limestone, and dolomite of the Cannery, Pybus, and Halleck Formations on Admiralty, Kuiu, and Kupreanof Islands

1162 PIP PERMIAN AND PENNSYLVANIAN ROCKS - Basaltic to andesitic lavas and derivative volcaniclastic rocks, tuffs, minor gabbro, and local shallow-water sedimentary rocks metamorphosed to greenschist facies, and locally, amphibolite facies. Includes Skolal Group, Strelna Formation (Permian), and Tetelna Volcanics in the Wrangell and Talkeetna Mountains. Consists of unnamed phyllite, slate, schist, greenschist, amphibolite, gneiss, and migmatite in St. Elias Mountains

1163 IP PENNSYLVANIAN ROCKS - Siltstone, sandstone, and limestone of the

Klawak Formation and Ladrones Limestone on Prince of Wales Island

1164 IPM PENNSYLVANIAN AND MISSISSIPPIAN ROCKS - Limestone, conglomerate,

shale, dolomite, and chert of the Kekiktuk Conglomerate and Kayak Shale (both of Mississippian age) of the Endicott Group and the Alapah and Wahoo Limestones of the Lisburne Group

1171 M MISSISSIPPIAN ROCKS - Conglomerate, shale, limestone with

subordinate chert and dolomite of the Kekiktuk Conglomerate and Kayak Shale of the Endicott Group and the Utukok Formation and Wachsmuth and Alapah Limestones of the Lisburne Group on the northern flank of the Brooks Range. Limestone, dolomite, and inter-bedded chert of the Iyoukeen Formation on Chichagof Island and Peratrovich Formation on Prince of Wales Island

1142 JM JURASSIC TO MISSISSIPPIAN ROCKS - Unnamed slate and quartzite

northwest of Porcupine River and Lisburne and Sadlerochit Groups and

Kingak Shale at northeast front of Brooks Range

1155 TRD TRIASSIC TO DEVONIAN ROCKS - Radiolarian chert, slate, and argillite

1166 uPz UPPER PALEOZOIC ROCKS - Argillite, chert, shale, limestone, and siltstone. Greenstone, limestone, shale, clastic sedimentary rocks, schist, gneiss, and undifferentiated metamorphic rocks east of Juneau

1165 Pz PALEOZOIC ROCKS - Limestone, marble, dolomite, and chert on Seward Peninsula and St. Lawrence Island; limestone, slate, and conglomerate in central Alaska Range; argillite and graywacke slightly metamorphosed west of Chulitna River; flysch, conglomerate, limestone and pillow basalt southwest of Mount McKinley; marble, in places containing tremolite in Wrangell Mountains where it includes parts of a Devonian section designated the Kaskawulsh Group in the Yukon Territory (Canada); and sedimentary, metasedimentary, and metavolcanic rocks in southeastern Alaska

1172 MD MISSISSIPPIAN AND(OR) DEVONIAN ROCKS - Sandstone, graywacke, quartzite, and conglomerate. Includes the Noatak Sandstone in western Brooks Range and Kekiktuk and Kanayut Conglomerates in eastern Brooks Range

1173 D DEVONIAN ROCKS - PhyIlite, hornfels, graywacke, and sandstone on the Seward Peninsula; pyroclastic rocks and ash flows interbedded with sedimentary rocks metamorphosed to schist and gneiss on north-central flank of Alaska Range; limestone east of Kuskokwim Bay;

clastic rocks and limestone of the Kennel Creek Limestone (which may also include Silurian rocks) and Cedar Cove Formation on Chichagof Island; schist, phyllite, marble, and amphibolite of the Retreat Group and Gambler Bay Formation on Admiralty and Kupreanof Islands and equivalent rocks to the north and south; and limestone, shale, graywacke, conglomerate and basaltic rocks of the St. Joseph Island Volcanics (Devonian?), Wadleigh Limestone, and Port Refugio Formation on Prince of Wales Island

1174 uD UPPER DEVONIAN ROCKS - Shale, sandstone, chert, conglomerate, and quartzite in eastern and central Brooks Range and limestone and dolomite in western Brooks Range. Includes Hunt Fork Shale, Kanayut Conglomerate, Kugururok Formation, and Eli Limestone (Middle and Upper Devonian)

1175 umD UPPER AND(OR) MIDDLE DEVONIAN ROCKS - Conglomerate, graywacke, phyllite, shale, sandstone, siltstone, and limestone. Includes Nanook Limestone in Shublik Mountains

1176 DS DEVONIAN AND SILURIAN ROCKS - Limestone, dolomite, marble, and shale of the Katakturuk Dolomite and the Skajit Limestone in Brooks Range and Karheen Formation in Prince of Wales Island

1181 S SILURIAN ROCKS - Graywacke, shale, siltstone, limestone, sandstone, and argillite. Includes siltstone, mudstone, limestone, conglomerate, sandstone, graywacke, minor red beds and volcanic rocks of the Rendu Formation, and Willoughby Limestone in Glacier Bay area; the Point Augusta Formation on Chichagof Island; Bay of

Pillars Formation on Admiralty, Kuiu, and Prince of Wales Islands;

and Kuiu Limestone and Heceta Limestone on Prince of Wales Island

1182 O ORDOVICIAN ROCKS - Limestone and shale on Seward Peninsula;

argillite, chert and limestone of the Hood Bay Formation on

Admiralty Island

1183 SO SILURIAN AND ORDOVICIAN ROCKS - Graywacke, conglomerate, shale,

siltstone, tuff, lava, and local limestone of the Descon Formation

on Prince of Wales Island

1184 C CAMBRIAN ROCKS - Siltstone, sandstone, and phyllite

1185 OpC ORDOVICIAN, CAMBRIAN, AND PRECAMBRIAN ROCKS - Phyllite, sandstone;

siltstone, limestone, chert, and quartzite

1167 lPz LOWER PALEOZOIC ROCKS - Includes rocks of Cambrian through Devonian

age, in places metamorphosed to greenschist and amphibolite facies.

Sedimentary rocks include limestone, dolomite, argillite, chert, and

graywacke and metasedimentary rocks include schist, quartzite,

slate, greenstone, carbonate rocks, and phyllite. Includes Holitna

Group in Kuskokwim Mountains, Tonzona Group along Kuskokwim River,

rocks formerly included in Birch Creek Schist in Yukon-Tanana

Upland, unmetamorphosed rocks of the Funnel Creek, Adams, Hillard,

Road River, McCann Hill and Hillard Formations, and Puppets

Formation on Gravina and Annette Islands

1191 lPzpC LOWER PALEOZOIC AND(OR) PRECAMBRIAN ROCKS - Sandstone, limestone,

shale, chert, phyllite, argillite, and quartzite of the Neruokpuk

Formation in the northeast Brooks Range; quartz-mica schist, mafic greenschist, calcareous schist, chloritic schist, phyllite and quartzite along south flank of Brooks Range and southwest through Kokrine-Hodzana Highlands; schist and quartzite of the Birch Creek Schist of former usage in Yukon-Tanana Highlands; highly metamorphosed clastic rocks including the Keevy Peak Formation in the north flank of Brooks Range; and volcanogenic greenschist with interstratified marble in Prince of Wales, Long and Dall Islands, where it includes the Wales Group and possibly Descon Formation

1192 Z PRECAMBRIAN Z ROCKS - Siltite, phyllite, graywacke, quartz schist,

and graphitic schist of slate of the York region on Seward Peninsula; schist, gneiss, and small amounts of amphibolite and marble east of Kuskokwim Bay; quartz wacke, semi-schist, phyllite, and argillite of the Neruokpuk Formation in northeastern Brooks Range; phyllite, slate, and siltstone east of Fort Yukon; and limestone, dolomite, sandstone, shale, and basalt of the Tindir Group north of Tintina fault

1193 Z1 YOUNGER PRECAMBRIAN Z ROCKS - Schistose, argillaceous, dolomitic

limestone and tactite on Seward Peninsula

1194 Z2 OLDER PRECAMBRIAN Z ROCKS - Schist, gneiss, and migmatic and

metamorphic rocks, including rocks equivalent to slate of the York region, in the Kigluaik and Bendeleben Mountains on the Seward Peninsula

CONTINENTAL DEPOSITS

1211 Tpc PLIOCENE CONTINENTAL DEPOSITS - Pebble to boulder conglomerate,

coarse sandstone, siltstone, claystone, and thin lignite beds.

Includes Nenana Gravel (Pliocene?)

1212 uTc UPPER TERTIARY CONTINENTAL DEPOSITS - Sandstone, siltstone,

claystone, minor conglomerate, and coal beds. Includes upper part

of Kenai Group in Cook Inlet area and Nenana Gravel and related

unnamed rocks in west-central Alaska Range. Rocks range in age from

Oligocene(?) through Pliocene

1221 Tmc MIOCENE CONTINENTAL DEPOSITS - Sandstone, siltstone, shale,

claystone, conglomerate, and coal beds. Includes the Sanctuary,

Suntrana, Grubstake, and Lignite Creek Formations in central Alaska

Range and the Frederika Formation in Wrangell Mountains

1222 mTc MIDDLE TERTIARY CONTINENTAL DEPOSITS - Sandstone, siltstone,

claystone and coal beds. Includes the Healy Creek Formation in

central Alaska Range, the Gakona Formation in east-central Alaska

Range, and the Tsadaka Formation in Matanuska Valley. Rocks range in

age from Oligocene through Miocene

1223 lTc LOWER TERTIARY CONTINENTAL DEPOSITS - Claystone, siltstone,

sandstone, conglomerate, and coal beds. Includes lower part of

Sagavanirktok Formation in the Arctic Coastal Plain and the

Chickaloon and Wishbone Formations in the Matanuska Valley. Rocks

range in age from Paleocene through Oligocene

1224 Txc PALEOCENE CONTINENTAL DEPOSITS - Conglomerate, sandstone, coaly shale, and shale. Includes Cantwell Formation in central Alaska Range

1225 Tc TERTIARY CONTINENTAL DEPOSITS - Sandstone, coal, conglomerate and shale of the Kootznahoo Formation on Admiralty, Kuiu, Kupreanof, and Zarembo Islands

1226 TKc TERTIARY AND CRETACEOUS CONTINENTAL DEPOSITS - Conglomerate, breccia, sandstone, arkose, mudstone, shale, tuffaceous rocks, and lignite. Includes Arkose Ridge Formation (Cretaceous?) in Matanuska Valley

1231 uKc UPPER CRETACEOUS CONTINENTAL DEPOSITS - Sandstone and conglomerate and interbedded shale, clay, silt, and bentonite of the Niakogon Tongue of the Chandler Formation of the Nanushuk Group and the Prince Creek Formation of the Colville Group on the Arctic Coastal Plain; shale and siltstone in the Yukon-Koyukuk basin; and pebble conglomerate around the margins of the basin

1232 lKc LOWER CRETACEOUS CONTINENTAL DEPOSITS - Shale, claystone, siltstone, sandstone, conglomerate, coaly shale and coal, ironstone, and bentonite. Includes Corwin Formation (Lower and Upper Cretaceous) of Nanushuk Group and Killik Tongue of Chandler Formation of Nanushuk Group on Arctic Coastal Plain

METAMORPHIC ROCKS

1311 lJm LOWER JURASSIC METAMORPHIC ROCKS - Intercalated blueschist, quartz

mica schist, greenschist with subordinate amphibolite, marble, and

metachert at southern tip of Kenai Peninsula and on Afognak Island

1321 Mzm MESOZOIC METAMORPHIC ROCKS - Small masses of metamorphosed

sedimentary, volcanic, and igneous rocks, largely of pre-Cretaceous

age, scattered throughout the Aleutian Range batholith. Amphibolite

facies schist along north side of Matanuska Valley

1322 JPm JURASSIC, TRIASSIC, AND PERMIAN METAMORPHIC ROCKS - Metasedimentary,

metaplutonic,and metavolcanic rocks near Anchorage and along south

side of Matanuska Valley

1331 Pzm PALEOZOIC METAMORPHIC ROCKS - Hornfels, schist, amphibolite, minor

marble, and undivided metamorphic rocks north of Icy Strait in

southeastern Alaska, and gneiss, schist, phyllite, and

undifferentiated metasedimentary and metaigneous rocks in the Yukon-

Tanana Upland

1341 PzpCm PALEOZOIC AND(OR) PRECAMBRIAN METAMORPHIC ROCKS - Metasedimentary

and metaigneous rocks, including schist and gneiss of many different

compositions, primarily of the greenschist and amphibolite fades, in

the Yukon-Tanana Upland. Formerly included in the Birch Creek

Schist

VOLCANIC ROCKS

101 Qhvf HOLOCENE FELSIC VOLCANIC ROCKS - Rhyolite to dacite

201 Qhvi HOLOCENE INTERMEDIATE VOLCANIC ROCKS - Trachyte to andesite

301 Qhvm HOLOCENE MAFIC VOLCANIC ROCKS - Basalt

401 Qhv HOLOCENE UNDIFFERENTIATED VOLCANIC ROCKS

202 Qpvi PLEISTOCENE INTERMEDIATE VOLCANIC ROCKS - Trachyte to andesite

302 Qpvm PLEISTOCENE MAFIC VOLCANIC ROCKS - Basalt

402 Qpv PLEISTOCENE UNDIFFERENTIATED VOLCANIC ROCKS

203 Qvi QUATERNARY INTERMEDIATE VOLCANIC ROCKS - Trachyte to andesite

303 Qvm QUATERNARY MAFIC VOLCANIC ROCKS - Basalt

403 Qv QUATERNARY UNDIFFERENTIATED VOLCANIC ROCKS

204 QTvi QUATERNARY OR TERTIARY INTERMEDIATE VOLCANIC ROCKS - Trachyte to

andesite

304 QTvm QUATERNARY OR TERTIARY MAFIC VOLCANIC ROCKS - Basalt

404 QTv QUATERNARY OR TERTIARY UNDIFFERENTIATED VOLCANIC ROCKS

405 Tpv PLIOCENE UNDIFFERENTIATED VOLCANIC ROCKS

205 Tmvi MIOCENE INTERMEDIATE VOLCANIC ROCKS - Trachyte to andesite

406 Tmv MIOCENE UNDIFFERENTIATED VOLCANIC ROCKS

407 uTv UPPER TERTIARY UNDIFFERENTIATED VOLCANIC ROCKS

408 Txv PALEOCENE UNDIFFERENTIATED VOLCANIC ROCKS

206 lTvi LOWER TERTIARY INTERMEDIATE VOLCANIC ROCKS - Trachyte to andesite

305 lTvm LOWER TERTIARY MAFIC VOLCANIC ROCKS - Basalt

409 lTv LOWER TERTIARY UNDIFFERENTIATED ROCKS

102 Tvf TERTIARY FELSIC VOLCANIC ROCKS - Rhyolite to dacite

207 Tvi TERTIARY INTERMEDIATE VOLCANIC ROCKS - Trachyte to andesite

306 Tvm TERTIARY MAFIC VOLCANIC ROCKS - Basalt

410 Tv TERTIARY UNDIFFERENTIATED VOLCANIC ROCKS

103 TKvf TERTIARY AND(OR) CRETACEOUS FELSIC VOLCANIC ROCKS - Rhyolite to

dacite

307 TKvm TERTIARY AND(OR) CRETACEOUS MAFIC VOLCANIC ROCKS - Basalt

411 TKv TERTIARY AND(OR) CRETACEOUS UNDIFFERENTIATED VOLCANIC ROCKS

104 uKvf UPPER CRETACEOUS FELSIC VOLCANIC ROCKS - Rhyolite to dacite

208 lKvi LOWER CRETACEOUS INTERMEDIATE VOLCANIC ROCKS - Trachyte to andesite

412 lKv LOWER CRETACEOUS UNDIFFERENTIATED VOLCANIC ROCKS

105 Kvf CRETACEOUS FELSIC VOLCANIC ROCKS - Rhyolite to dacite

209 Kvi CRETACEOUS INTERMEDIATE VOLCANIC ROCKS - Trachyte to andesite

413 Kv CRETACEOUS UNDIFFERENTIATED VOLCANIC ROCKS

210 KJvi CRETACEOUS AND(OR) JURASSIC INTERMEDIATE VOLCANIC ROCKS - Trachyte

to andesite

308 KJvm CRETACEOUS AND(OR) JURASSIC MAFIC VOLCANIC ROCKS - Basalt

414 KJv CRETACEOUS AND(OR) JURASSIC UNDIFFERENTIATED VOLCANIC ROCKS

211 Jvi JURASSIC INTERMEDIATE VOLCANIC ROCKS - Trachyte to andesite

309 TRvm TRIASSIC MAFIC VOLCANIC ROCKS - Basalt

310 JPvm JURASSIC, TRIASSIC, AND PERMIAN MAFIC VOLCANIC ROCKS - Basalt

311 MzPzvm PALEOZOIC AND MESOZOIC MAFIC VOLCANIC ROCKS - Basalt

312 Pvm PERMIAN MAFIC VOLCANIC ROCKS - Basalt

313 Dvm DEVONIAN MAFIC VOLCANIC ROCKS - Basalt

415 Dv DEVONIAN UNDIFFERENTIATED VOLCANIC ROCKS

416 Ov ORDOVICIAN UNDIFFERENTIATED VOLCANIC ROCKS

314 Cvm CAMBRIAN MAFIC VOLCANIC ROCKS - Basalt

315 Pzvm PALEOZOIC MAFIC VOLCANIC ROCKS - Basalt

417 Zv PRECAMBRIAN Z UNDIFFERENTIATED VOLCANIC ROCKS

106 vf FELSIC VOLCANIC ROCKS, AGE UNKNOWN - Rhyolite to dacite

INTRUSIVE ROCKS

501 Tmif MIOCENE FELSIC INTRUSIVE ROCKS - Granite to granodiorite

701 Tmim MIOCENE MAFIC INTRUSIVE ROCKS - Gabbro

502 Toif OLIGOCENE FELSIC INTRUSIVE ROCKS - Granite to granodiorite

601 mTii MIDDLE TERTIARY INTERMEDIATE INTRUSIVE ROCKS - Syenite to diorite

702 mTim MIDDLE TERTIARY INTERMEDIATE INTRUSIVE ROCKS - Syenite to diorite

503 Teif EOCENE FELSIC INTRUSIVE ROCKS - Granite to granodiorite

504 Txif PALEOCENE FELSIC INTRUSIVE ROCKS - Granite to granodiorite

505 Tif TERTIARY FELSIC INTRUSIVE ROCKS - Granite to granodiorite

602 Tii TERTIARY INTERMEDIATE INTRUSIVE ROCKS - Syenite to diorite

703 Tim TERTIARY MAFIC INTRUSIVE ROCKS - Gabbro

801 Ti TERTIARY UNDIFFERENTIATED INTRUSIVE ROCKS

506 TKif TERTIARY AND(OR) CRETACEOUS FELSIC INTRUSIVE ROCKS - Granite to

granodiorite

603 TKii TERTIARY AND(OR) CRETACEOUS INTERMEDIATE INTRUSIVE ROCKS - Syenite

to diorite

704 TKim TERTIARY AND(OR) CRETACEOUS MAFIC INTRUSIVE ROCKS - Gabbro

802 TKi TERTIARY AND(OR) CRETACEOUS UNDIFFERENTIATED INTRUSIVE ROCKS

507 TMzif TERTIARY AND(OR) MESOZOIC FELSIC INTRUSIVE ROCKS - Granite to

granodiorite

705 TMzim TERTIARY AND(OR) MESOZOIC MAFIC INTRUSIVE ROCKS - Gabbro

508 uKif UPPER CRETACEOUS FELSIC INTRUSIVE ROCKS - Granite to granodiorite

604 uKii UPPER CRETACEOUS INTERMEDIATE INTRUSIVE ROCKS - Syenite to diorite

803 uKi UPPER CRETACEOUS UNDIFFERENTIATED INTRUSIVE ROCKS

509 Kif CRETACEOUS FELSIC INTRUSIVE ROCKS - Granite to granodiorite

605 Kii CRETACEOUS INTERMEDIATE INTRUSIVE ROCKS - Syenite to diorite

706 Kim CRETACEOUS MAFIC INTRUSIVE ROCKS - Gabbro

804 Ki CRETACEOUS UNDIFFERENTIATED ROCKS

606 KJii CRETACEOUS AND(OR) JURASSIC INTERMEDIATE INTRUSIVE ROCKS - Syenite

to diorite

510 Jif JURASSIC FELSIC INTRUSIVE ROCKS - Granite to granodiorite

607 Jii JURASSIC INTERMEDIATE INTRUSIVE ROCKS - Syenite to diorite

707 Jim JURASSIC MAFIC INTRUSIVE ROCKS - Gabbro

608 JTRii JURASSIC AND(OR) TRIASSIC INTERMEDIATE INTRUSIVE ROCKS - Syenite to

diorite

511 Mzif MESOZOIC FELSIC INTRUSIVE ROCKS - Granite to granodiorite

609 Mzii MESOZOIC INTERMEDIATE INTRUSIVE ROCKS - Syenite to diorite

708 Mzim MESOZOIC MAFIC INTRUSIVE ROCKS - Gabbro

805 Mzi MESOZOIC UNDIFFERENTIATED INTRUSIVE ROCKS

512 MzPzif MESOZOIC AND PALEOZOIC FELSIC INTRUSIVE ROCKS - Granite to

granodiorite

610 MzPzii MESOZOIC AND PALEOZOIC INTERMEDIATE INTRUSIVE ROCKS - Syenite

to diorite

806 MzPzi MESOZOIC AND PALEOZOIC UNDIFFERENTIATED INTRUSIVE ROCKS

709 Pim PERMIAN MAFIC INTRUSIVE ROCKS - Gabbro

513 IPif PENNSYLVANIAN FELSIC INTRUSIVE ROCKS - Granite to granodiorite

710 IPim PENNSYLVANIAN MAFIC INTRUSIVE ROCKS - Gabbro

807 IPi PENNSYLVANIAN UNDIFFERENTIATED INTRUSIVE ROCKS

514 uPzif UPPER PALEOZOIC FELSIC INTRUSIVE ROCKS - Granite to granodiorite

711 uPzim UPPER PALEOZOIC MAFIC INTRUSIVE ROCKS - Gabbro

611 Sii SILURIAN INTERMEDIATE INTRUSIVE ROCKS - Syenite to diorite

808 Oi ORDOVICIAN UNDIFFERENTIATED INTRUSIVE ROCKS

712 lPzim LOWER PALEOZOIC MAFIC INTRUSIVE ROCKS - Gabbro

612 Pzii PALEOZOIC INTERMEDIATE INTRUSIVE ROCKS - Syenite to diorite

713 Pzim PALEOZOIC MAFIC INTRUSIVE ROCKS - Gabbro

809 Pzi PALEOZOIC UNDIFFERENTIATED INTRUSIVE ROCKS

810 lPzpCi LOWER PALEOZOIC AND(OR) PRECAMBRIAN UNDIFFERENTIATED INTRUSIVE

ROCKS

811 PzpCi PALEOZOIC AND(OR) PRECAMBRIAN UNDIFFERENTIATED INTRUSIVE ROCKS

714 Zim PRECAMBRIAN Z MAFIC INTRUSIVE ROCKS - Gabbro

515 if FELSIC INTRUSIVE ROCKS, AGE UNKNOWN - Granite to granodiorite

715 im MAFIC INTRUSIVE ROCKS, AGE UNKNOWN - Gabbro

812 i UNDIFFERENTIATED INTRUSIVE ROCKS, AGE UNKNOWN

ULTRAMAFIC ROCKS

901 Tu TERTIARY ULTRAMAFIC ROCKS

902 TKu TERTIARY AND(OR) CRETACEOUS ULTRAMAFIC ROCKS

903 Ku CRETACEOUS ULTRAMAFIC ROCKS

904 Mzu MESOZOIC ULTRAMAFIC ROCKS

905 JPu JURASSIC, TRIASSIC, AND PERMIAN ULTRAMAFIC ROCKS

906 MzPzu MESOZOIC AND PALEOZOIC ULTRAMAFIC ROCKS

907 IPu PENNSYLVANIAN ULTRAMAFIC ROCKS

908 Ou ORDOVICIAN ULTRAMAFIC ROCKS

909	lPzu	LOWER PALEOZOIC ULTRAMAFIC ROCKS
910	Pzu	PALEOZOIC ULTRAMAFIC ROCKS
911	u	ULTRAMAFIC ROCKS, AGE UNKNOWN

APPENDIX D

Oil and Gas Resource Paper

EVALUATION OF HYDROCARBON POTENTIAL
WESTERN ALASKA ACCESS PLANNING STUDY

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February 2009

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LIST OF ACRONYMS

2-D	two-dimensional
C	Centigrade
DOWL	DOWL HKM
F	Fahrenheit
MMS	Minerals Management Service
OCS	Outer Continental Shelf
Socal	Standard Oil of California
TCF	Trillion Cubic Feet of Natural Gas

EXECUTIVE SUMMARY

The Western Alaska Access Planning Study area was evaluated for potential hydrocarbon resources that might impact the location of a transportation corridor. The Nenana basin near Fairbanks has the highest hydrocarbon potential and is considered to have moderate potential for economic gas resources and low potential for oil. The Nenana basin is in close proximity to the existing highway system and is not dependent on a WAAPS corridor for development if sufficient resources are discovered.

The offshore Hope and Norton basins adjacent to the study area have moderate potential for gas. However, the petroleum industry has not expressed an interest in these basins since exploration in the 1980s and it is uncertain when interest in these regions might occur. All other areas within the study area are considered to have low to very low potential for conventional oil and gas resources. Surface or near-surface coals are present in several areas, but the potential for coalbed methane is uncertain because of limited or absent subsurface information. Coalbed methane potential is thought to be highest in the Nenana basin.

The value of potential oil and gas resources in the study area is unknown and exploration to date has not identified a geologic system within the study area that can generate and trap oil and gas resources. The Nenana basin has the greatest potential of any basin within the study area but, as noted above, would not be dependent on a WAAPS corridor. There is no basis for estimating a value of potential oil and gas production within the study area at this time.

1.0 INTRODUCTION

The Alaska Department of Transportation & Public Facilities has initiated a study of the region between Fairbanks and Nome for locating a potential transportation corridor. This report is an evaluation of the hydrocarbon potential of the study area to help inform any decision on the locations of a transportation corridor. In general, the hydrocarbon potential of the onshore area under consideration is low to very low, although the Nenana basin has moderate potential for gas.

The hydrocarbon potential of central Alaska is essentially confined to sedimentary rocks that were deposited and preserved in depositional lows called basins. Sedimentary rocks host the vast majority of hydrocarbons around the world because some fine grained sedimentary rocks contain organic matter of sufficient quality and quantity to produce oil or gas when heated in the subsurface. Oil or gas (or both) is produced from these source rocks depending on the type of organic matter and the subsurface temperature. After generation, oil or gas typically migrates vertically or laterally away from the source rock and may be trapped in reservoir rocks having adequate porosity and permeability. Reservoir rocks may be clastic rocks, such as sandstone or conglomerate, or possibly carbonate rocks, such as limestone and dolomite. Hydrocarbon traps are formed by structures or stratigraphies which juxtapose low permeability sealing rocks (shales) and reservoir rocks in appropriate geometry. An evaluation of the hydrocarbon potential of an area usually begins with an evaluation of the geology, in particular, the presence, size, and distribution of sedimentary basins and whether source and reservoir rocks are contained therein.

2.0 REGIONAL DISCUSSION

Figure 1 shows the sedimentary basins in Alaska and the ADOT&PF Western Alaska Access Planning Study area. The study area generally extends from Fairbanks and the Dalton Highway westward to Kotzebue, Nome, and the Bering Sea. The study area is adjacent to two offshore basins, Hope and Norton, located in the Chukchi and Bering Seas, respectively.

Figure 1: Map of the sedimentary basins of Alaska and the location of the study area
Map is after Kirchner, 1988.

Figure 2 shows a closer view of the study area and its relationship to the sedimentary basins in central Alaska. The offshore basins have been deleted from Figure 2. Figure 2 shows that most of the study area does not contain sedimentary rocks as defined by the sedimentary basins. Most of the study area, colored pink in Figure 2, would be considered to have very low to no oil and gas potential because appropriate sedimentary rocks to generate and reservoir hydrocarbons are absent. The Nulato well drilled near Galena, discussed in section 4 below, is typical of these large areas with very low to no hydrocarbon potential. Certain areas outside of the sedimentary basins, however, may have limited coal bed methane potential if coal is present at depth. This possibility is discussed in section 5.

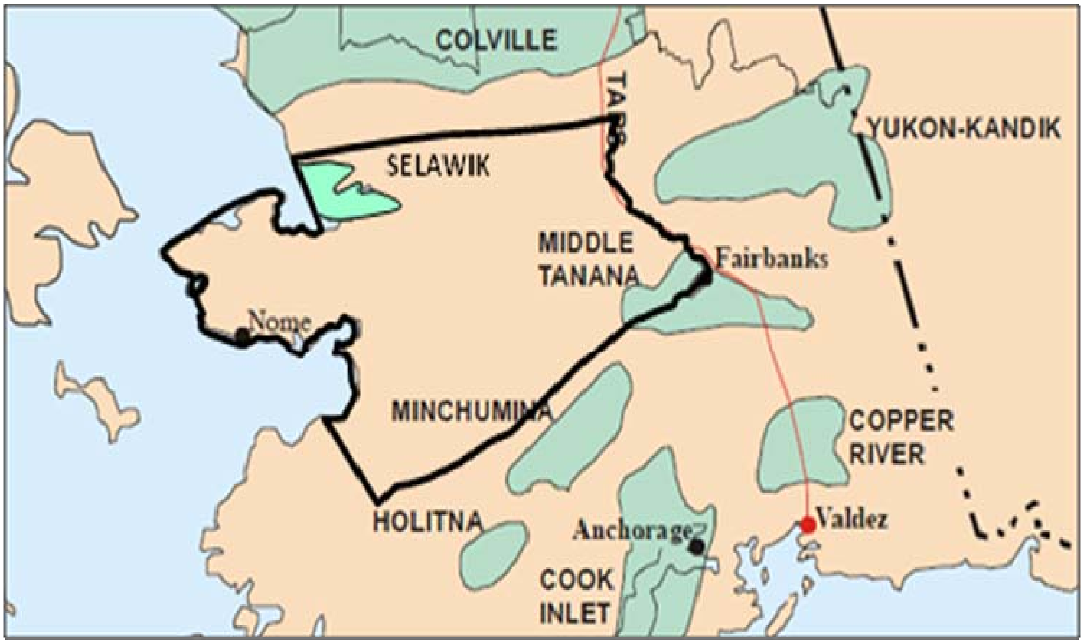

Figure 2: The Interior onshore basins of Alaska and the WAAPS area

An additional regional resource used to evaluate the hydrocarbon potential of the study area is the thermal maturity map by Johnsson and Howell (1996), shown in Figure 3. Given appropriate source rocks, oil is generated in the subsurface if temperatures are within a range indicated by “Mature I-Ro 0.6-1.3” in Figure 3 (middle orange brown color). The highest oil potential is usually associated with mature source rocks, that is, rocks with an appropriate thermal history. A larger format of this map is included in Appendix A.

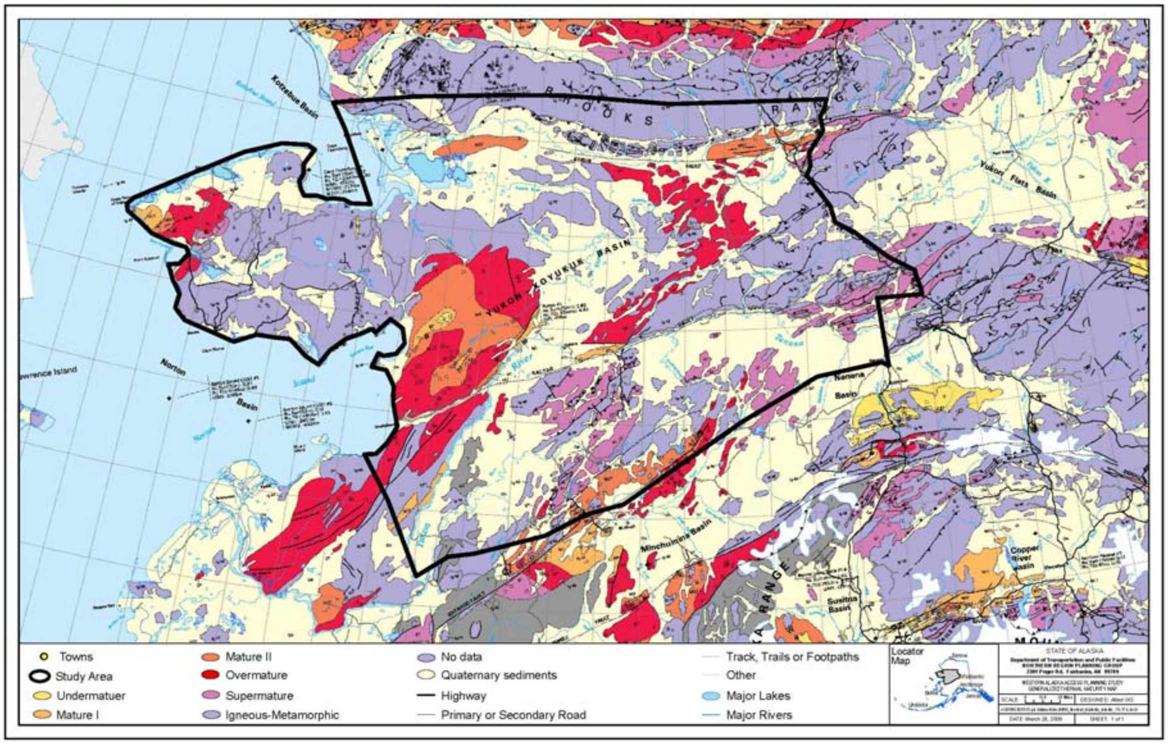

Figure 3: Thermal maturity map of central Alaska showing the highest temperature experienced by sampled rocks

Thermogenic oil is generated in the "Mature I" temperature range. Map by Johnsson and Howell, 1996.

An inspection of Figure 3 shows that many of the rocks in the study area are igneous and metamorphic, shown in blue colors, and would have no potential for oil and gas. Of the remaining sedimentary rocks, most are overmature to supermature for oil generation. Overmature or supermature rocks would generally be considered to have little or no oil and gas potential and these rocks together encompass most of the study area. This implies that oil and gas potential is limited to smaller regions which might have a more appropriate thermal history.

Most oil and gas provinces have oil and/or gas seeps at the surface. Estimates of trapped oil and gas as a percentage of generated hydrocarbons varies from <10% to as high as 30% or more. These values imply that the large majority of generated oil and gas either stays in the subsurface as disbursed staining or escapes to the surface where it is degraded and lost. Faults and permeable sedimentary layers often provide fluid pathways to the surface. A map of oil and gas seeps and shows can be a good indication of whether hydrocarbons are present in a sedimentary system. Figure 4 shows a map of reported oil and gas seeps and shows in central Alaska along with the outline of the study area. Reported oil or gas shows from wells are also included on this map. A larger format of this map is included in Appendix A.

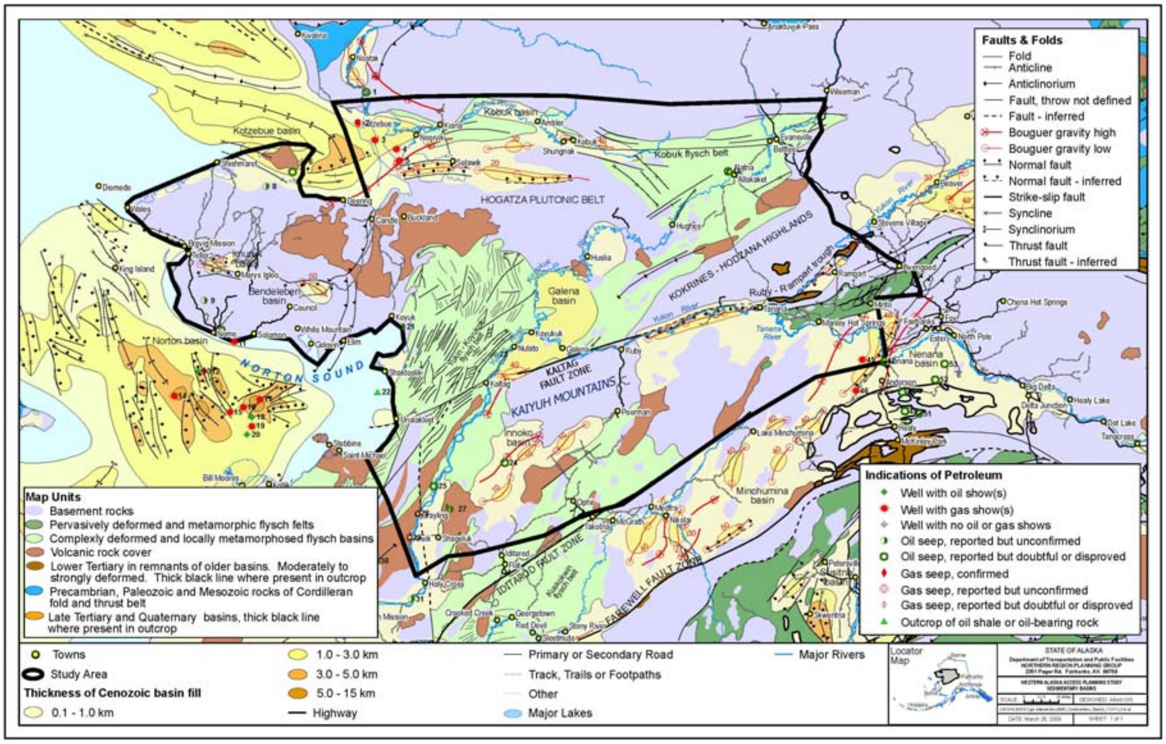

Figure 4: Reported oil and gas shows in the study area.

Troutman and Stanley, 2002

An important observation is Figure 4 shows no confirmed surface oil seeps onshore in the study area. The offshore areas of the Norton and Hope basins shown in Figure 4 also have no confirmed oil seeps. Similarly, no confirmed oil shows are reported for wells in the onshore study area, which includes wells in the Nenana, Selawik, and Galena areas. Wells in the offshore Norton basin have absent to weak oil shows, although a small amount of free high-sulfur oil was found in Outer Continental Shelf (OCS) Y-0430 well (#20, Figure 4) while coring Paleozoic(?) schist. The reported oil shale (#22, Figure 4) on Besboro Island in Norton Sound was investigated and is regarded by the U.S. Geological Survey as doubtful.

Unlike oil, gas has been found in various wells in the study area. Several wells near Kotzebue found shallow gas that is rich in methane and contained only traces of ethane and longer molecules. This gas is likely biogenic and originated from decaying organic matter at shallow depth. No well in the Kotzebue area measured significant amounts of gas during a flow test. Two wells in the Middle Tanana (Nenana) basin found minor gas. The drilling mudlog for the Nenana 1 well (#45, Figure 4) indicates minor gas associated with coal below about 2,050 feet. Similarly, the Totek Hills 1 well (#46, Figure 4) found numerous indications of methane gas associated with coal, but no evidence of oil. Gas flow rates were not tested in either of these Nenana wells. Another deep well, Nulato 1, is located in the center of the study area near Galena and had no indications of oil or gas. Several wells in the offshore Norton basin had gas shows during drilling, but these shows were not tested. In addition, a large carbon dioxide seep was located offshore in the Norton basin which contains trace amounts (0.1%) of oil.

Overall, the lack of significant oil or gas surface seeps, well shows, and well flow tests in the onshore study area seem to indicate a generally low to very low potential for hydrocarbons. The Totek Hills 1 well has the best gas shows of wells in the study area and these shows were generally methane associated with coal seams. The potential productivity of these methane shows is unknown.

In order to further evaluate the hydrocarbon potential of the study area this report discusses the potential of sedimentary basins in or adjacent to the study area. The onshore basins are discussed in order of their estimated potential for oil and gas, beginning with the Nenana basin. Following discussion of the basins, the Nulato 2 well, coalbed methane and the offshore basins are briefly discussed.

1. Middle Tanana basin (also called the Nenana basin)
2. Selawik basin
3. Minchumina and Holitna basins
4. Nulato 1 well
5. Coalbed Methane potential
6. Offshore Hope basin
7. Offshore Norton basin

2.1 Middle Tanana or Nenana basin

The Middle Tanana or Nenana basin has the highest hydrocarbon potential of any basin in the study area. The oil potential of the Nenana basin is estimated as low to very low and the gas potential of the Nenana basin to be moderate. Figure 5 shows the location and extent of the Nenana basin, which covers more than 8,500 square miles. As the legend indicates, the Nenana basin contains generally less than 1 kilometer (3,281 feet) of sedimentary section. However, a sedimentary depocenter adjacent to a northeast trending fault coincides with a strong gravity low and one to three kilometers (3,281 to 9,843 feet) of sedimentary rocks are present, according to Kirschner (1988). Already in 1988, two wells had been drilled in the Nenana basin (Nenana 1, total depth at 3,062 feet, and Totek Hills 1, total depth at 3,590 feet) and these wells still provide the only available direct subsurface information for the Nenana basin.

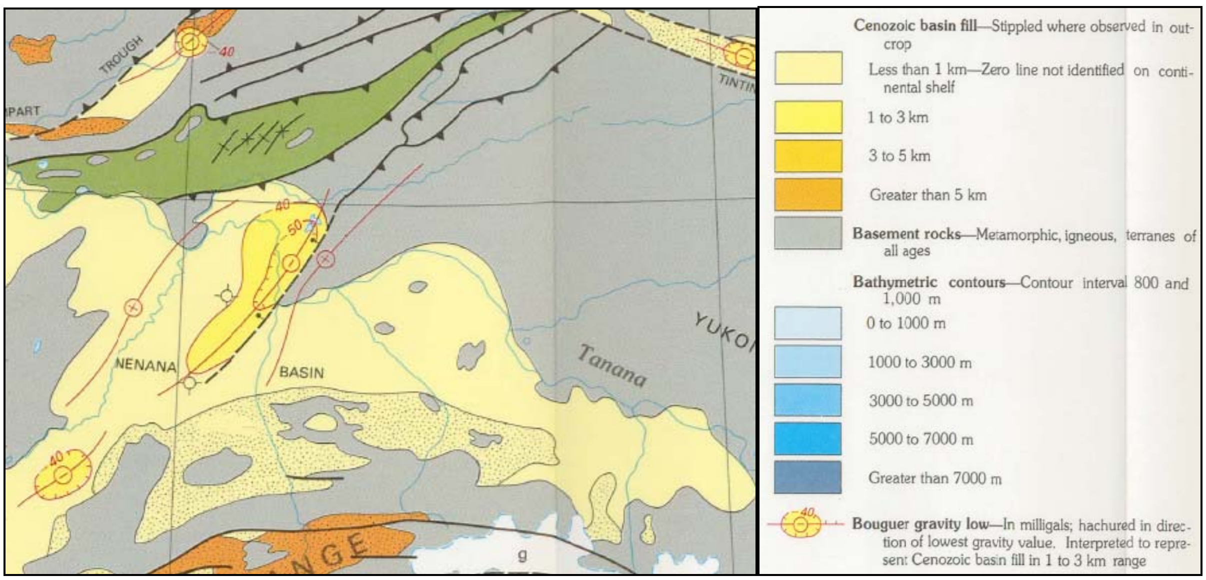

Figure 5: Middle Tanana or Nenana basin

From Kirschner, 1988.

A more detailed map of the center of the Nenana basin is shown in Figure 6. Figure 6 shows more than 12,000 feet of Tertiary sedimentary rocks concentrated in a NE trending basin, and sediment thickness reaches a maximum of >18,000 feet (Myers, 2004). The interpreted basin thickness is based on the strong gravity low (Figure 7) which reflects the relatively low density sediment filling the Nenana basin compared to the surrounding rocks. This thickness of sediment is adequate for generation of conventional, thermogenic oil and gas if appropriate source rocks and geothermal gradients are present. The two wells in the basin are located on the western and southern flanks of the basin and have not tested the deeper basin sediments.

The two Nenana basin wells had no oil shows and moderate gas shows. Both wells detected gas on the mud log that is associated with coal seams, but the gas was not tested in either well. Coal seams are widespread in the subsurface and exposed at the surface, and are mined in the Healy area. Figure 8 shows the schematic stratigraphy of the Nenana basin and hypothesizes the composition of the deeper, undrilled sediment. A hypothetical thick lacustrine (lake deposit) section in the deeper parts of the basin, shown schematically in Figure 8, could be adequate oil source rocks, but at present there is no direct indication that these oil source rocks exist or that oil has been generated in the Nenana basin.

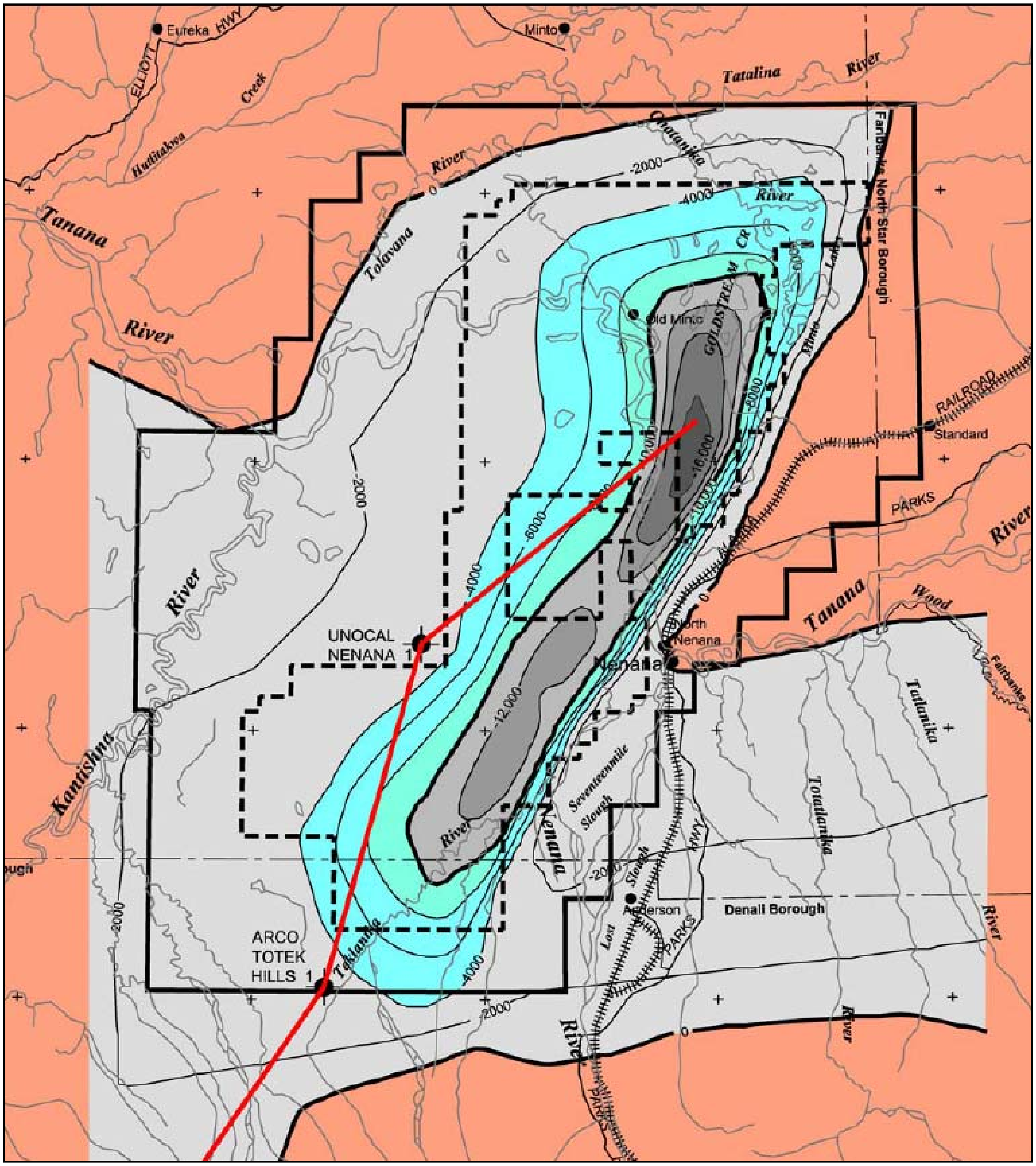

Figure 6: Thickness of sedimentary (Tertiary) rocks in the Nenana basin

Contour interval = 2000 feet.

Source: Myers, 2004

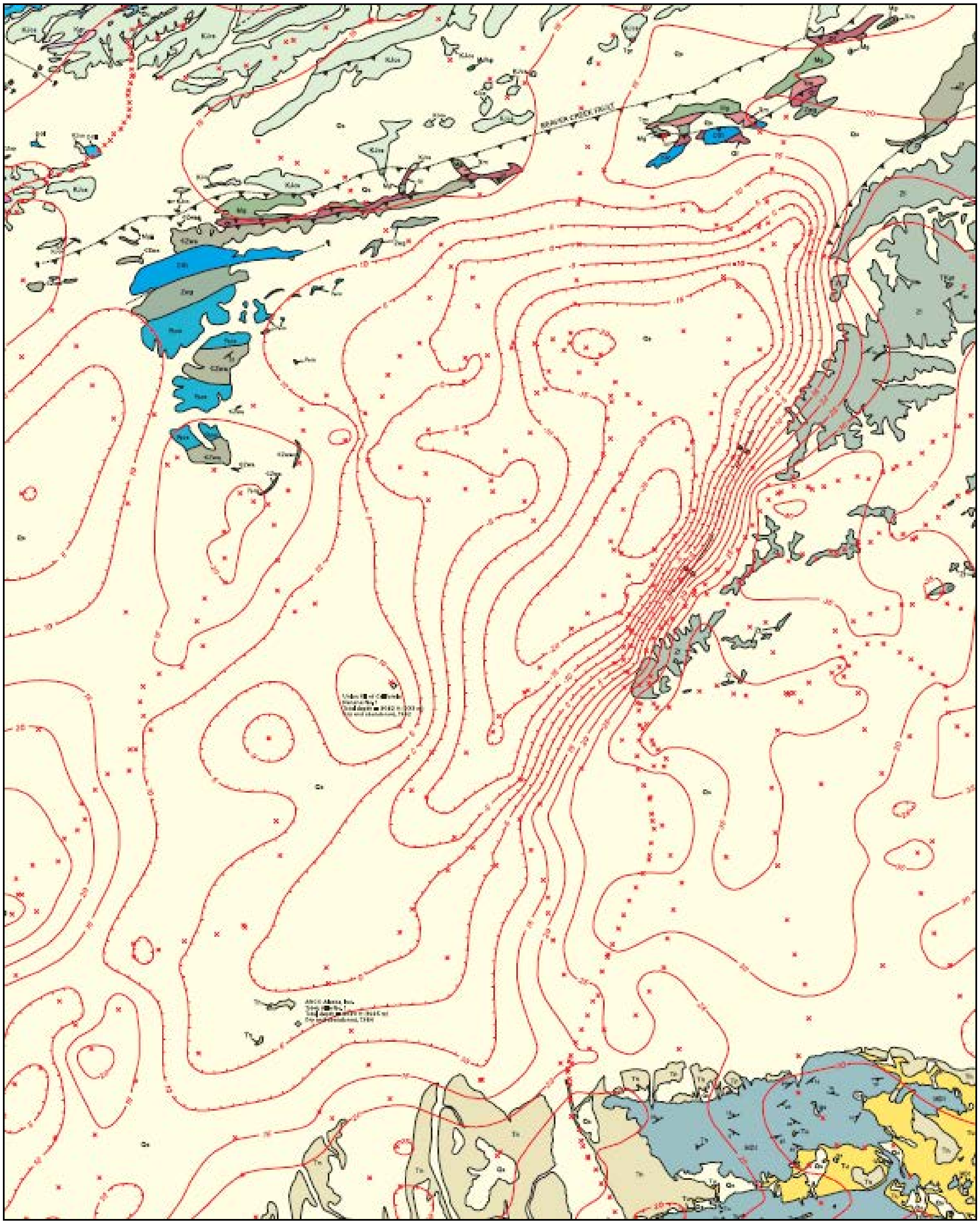

Figure 7: Gravity map of the Nenana basin showing low density sediments

From USGS Map I-2543

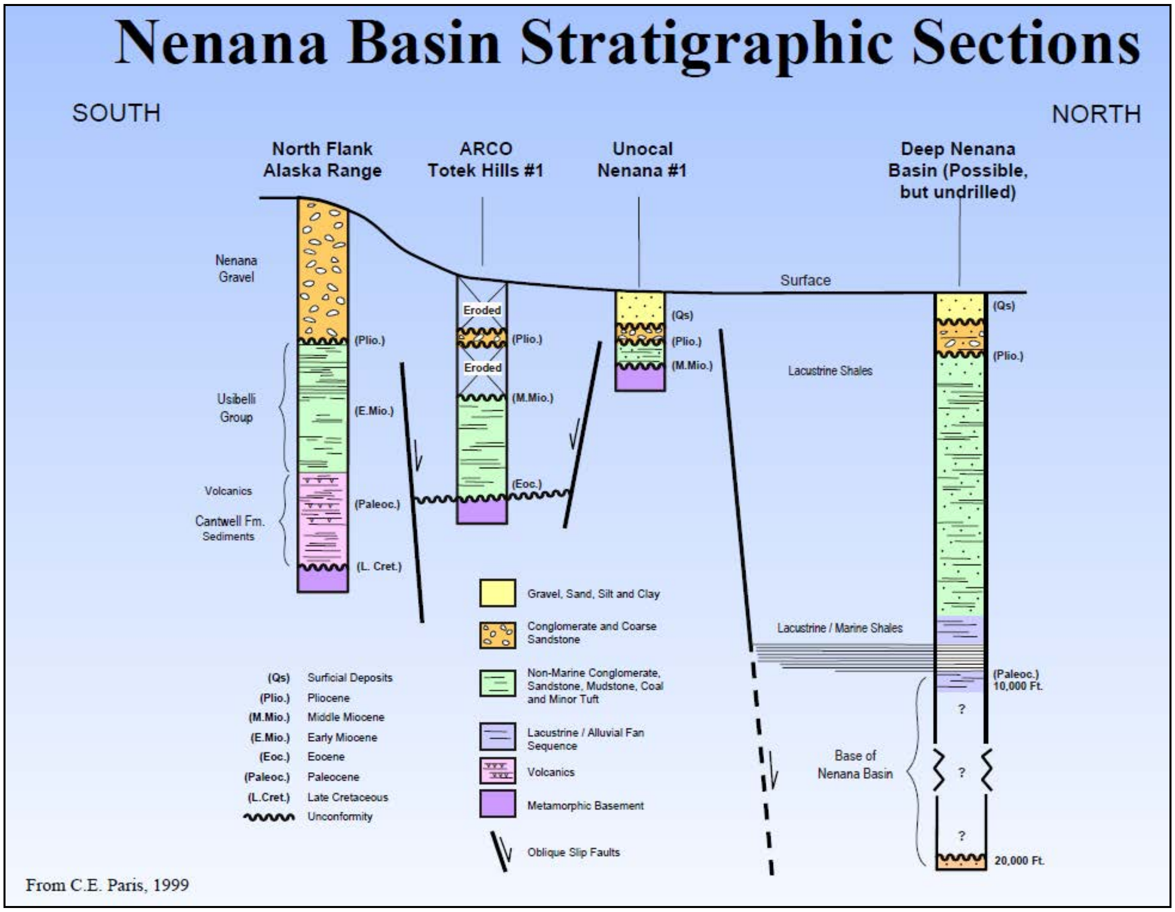

Figure 8: Schematic stratigraphy of the Nenana basin and possible sedimentary section in the undrilled, deeper part of the basin

Source: Paris, 1999, and found in Swenson, 2005

The Nenana basin is considered "under-explored" (Swenson, 2005). About 350 miles of two-dimensional (2-D) seismic in the southern and central basin was shot by Shell in 1981-1982. Andex Resources received an exploration license in the Nenana basin, which expires in 2009. After conducting a variety of exploration activity, Andex attempted to bring in a partner to further explore and drill in the Nenana basin. It is believed that they were unsuccessful in finding a partner.

Tertiary outcrops near the Nenana basin and the Totek Hills well contain abundant coals of the Usibelli Group. Gas associated with these coals in the Nenana basin may be shallow and biogenic in origin, and/or may be deep and thermogenic. Both of these scenarios will yield gas dominated by methane. Figure 9 shows a map of the widespread distribution of coal in the Nenana area. Gas associated with coal can potentially be found throughout the coal distribution belt. It remains to be seen, however, if the Nenana basin has the appropriate seal facies and trapping geometries for accumulation of a significant gas resource, but it seems likely that significant gas has been generated in the basin. In general, fluvial sands associated with coals often exhibit adequate porosity and permeability to act as fluid conduits and reservoir rocks.

In summary, the oil potential in the Nenana basin is estimated to be low to very low and the gas potential as moderate. Biogenic gas resources may be found at relatively shallow depths associated with coal, or thermogenic gas may be found in conventional reservoirs at depth.

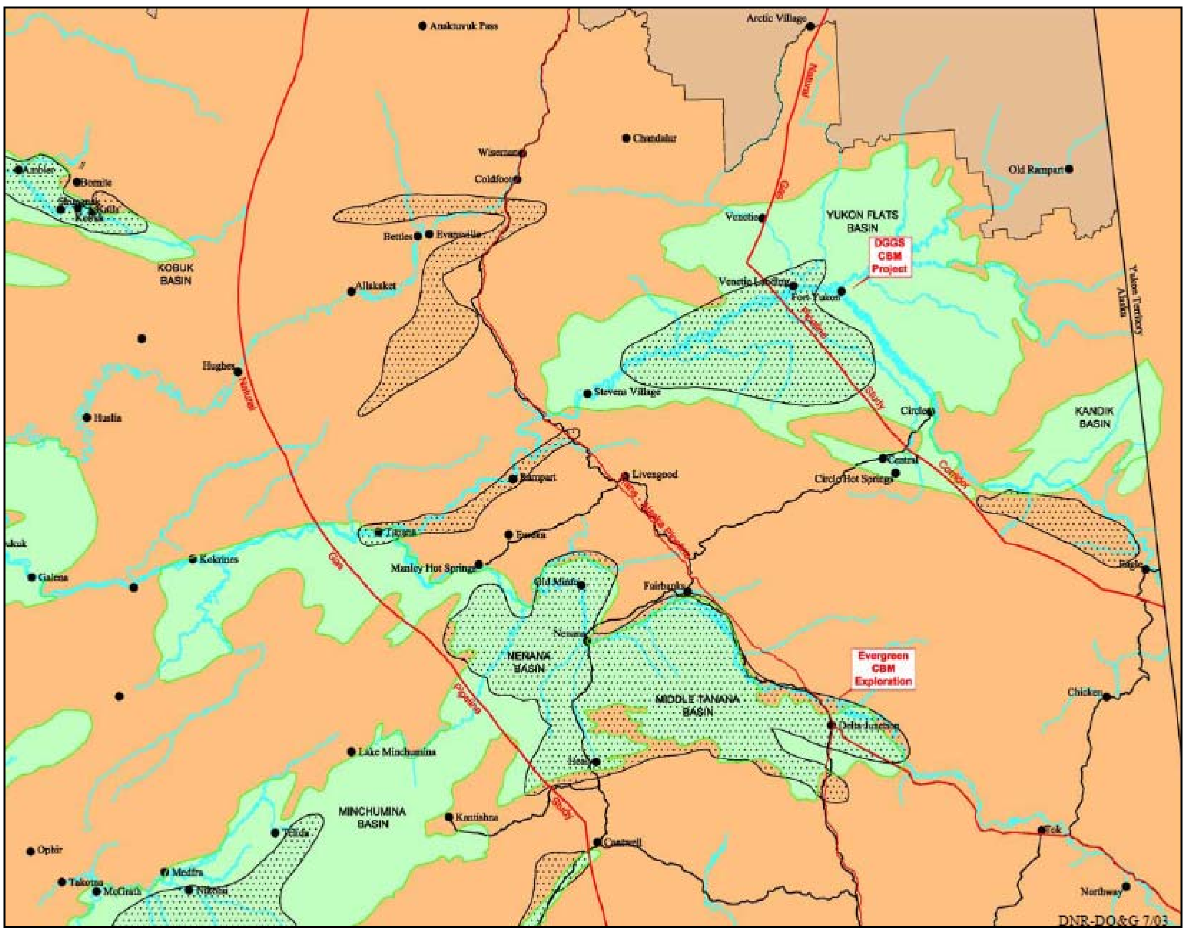

Figure 9: Distribution of coal in central Alaska

The coal is denoted by the stippled areas.

Source: Myers, 2004

2.2 Selawik basin

The Selawik basin is located near Kotzebue (Figure 10) in western Alaska. The Selawik basin is here considered a separate basin from the offshore Hope basin because the pre-Quaternary stratigraphy lacks continuity between the two basins and the basins differ in hydrocarbon potential.

The stratigraphy of the Selawik basin is known from two wells (Figure 11) drilled in 1974-1975 by Standard Oil of California (Socal). All sedimentary rocks are considered Brookian, that is, derived from a rising Brooks Range and are Tertiary in age. The rocks encountered in the wells are shown schematically in Figure 12. The oldest sedimentary rocks are Eocene in age and overlie still older metamorphic schist and marble. Unit 2 is volcanic and volcaniclastic sediments dated at about 40 million years (Decker et al, 1987) and are poor candidates for oil and gas resources. The Eocene rocks are overlain by alternating marine and non-marine clastic sequences, some of which contain thin coals. A significant unit not encountered in the wells is thick pre-Eocene (Paleocene) coals present at Chicago Creek on the northern Seward Peninsula.

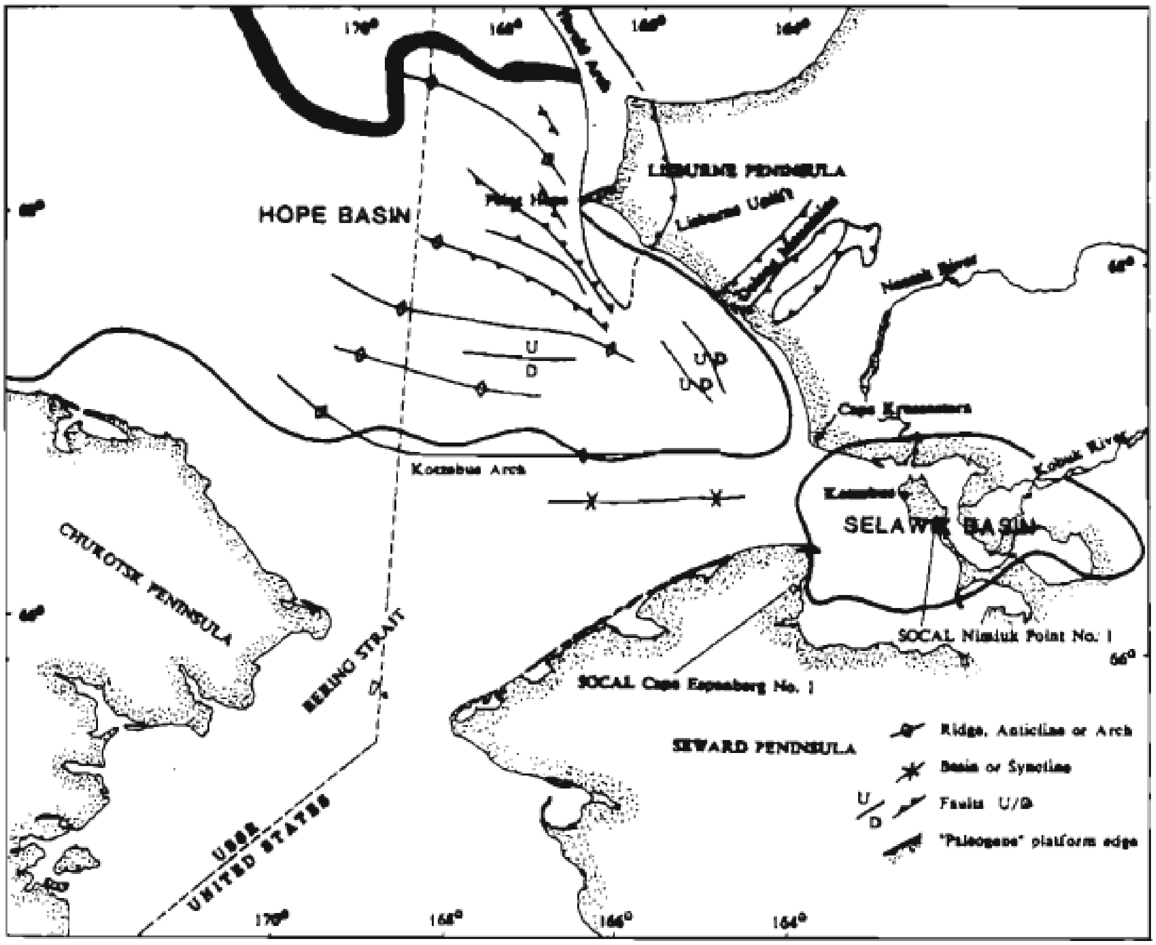

Figure 10: Location of the Selawik basin near Kotzebue

From Decker et al, 1987.

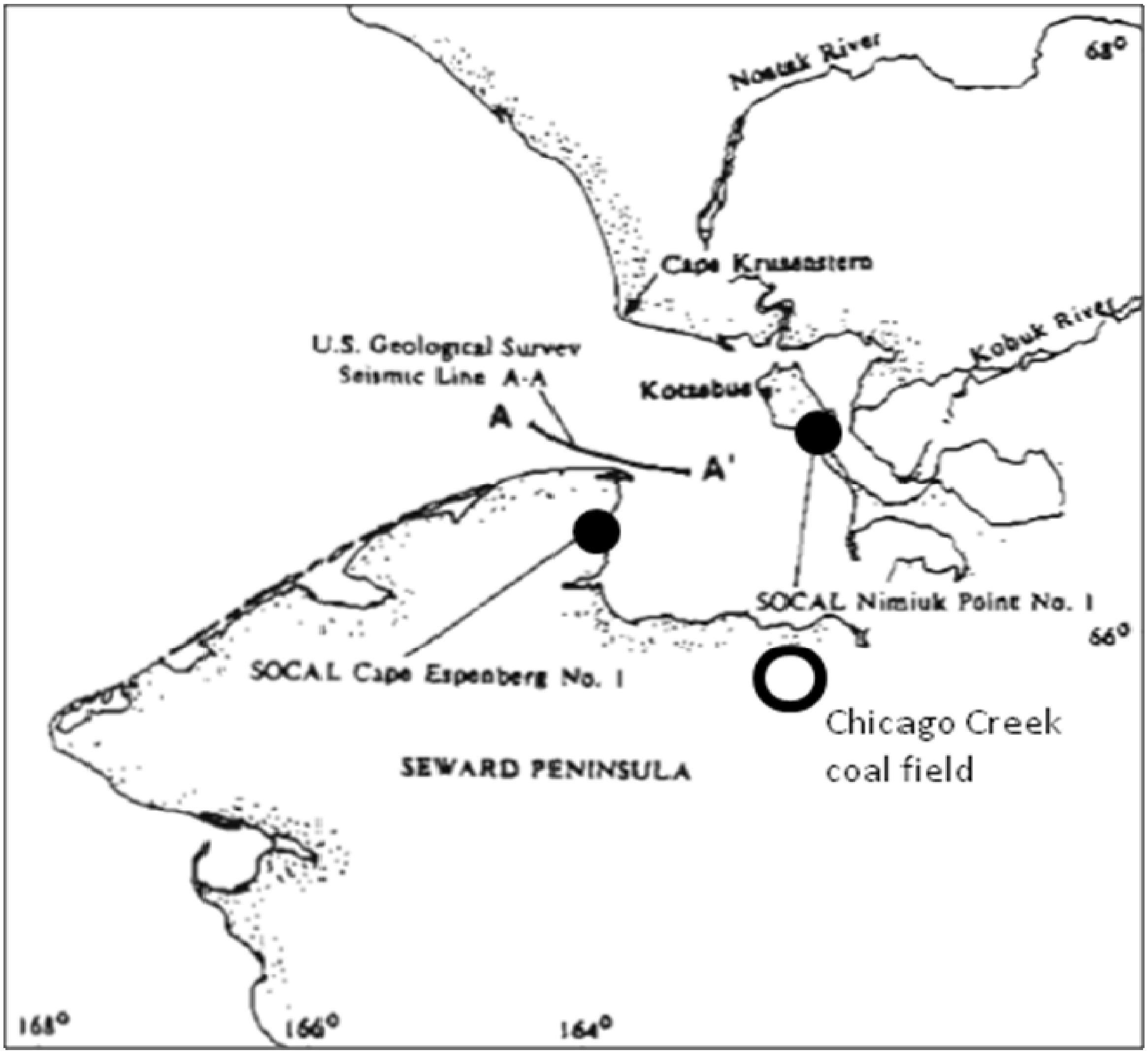

Figure 11: Location of two wells drilled in the Selawik basin, Cape Espenberg 1 and Nimiuk Point 1., and the Chicago Creek coal field

After Decker et al, 1987

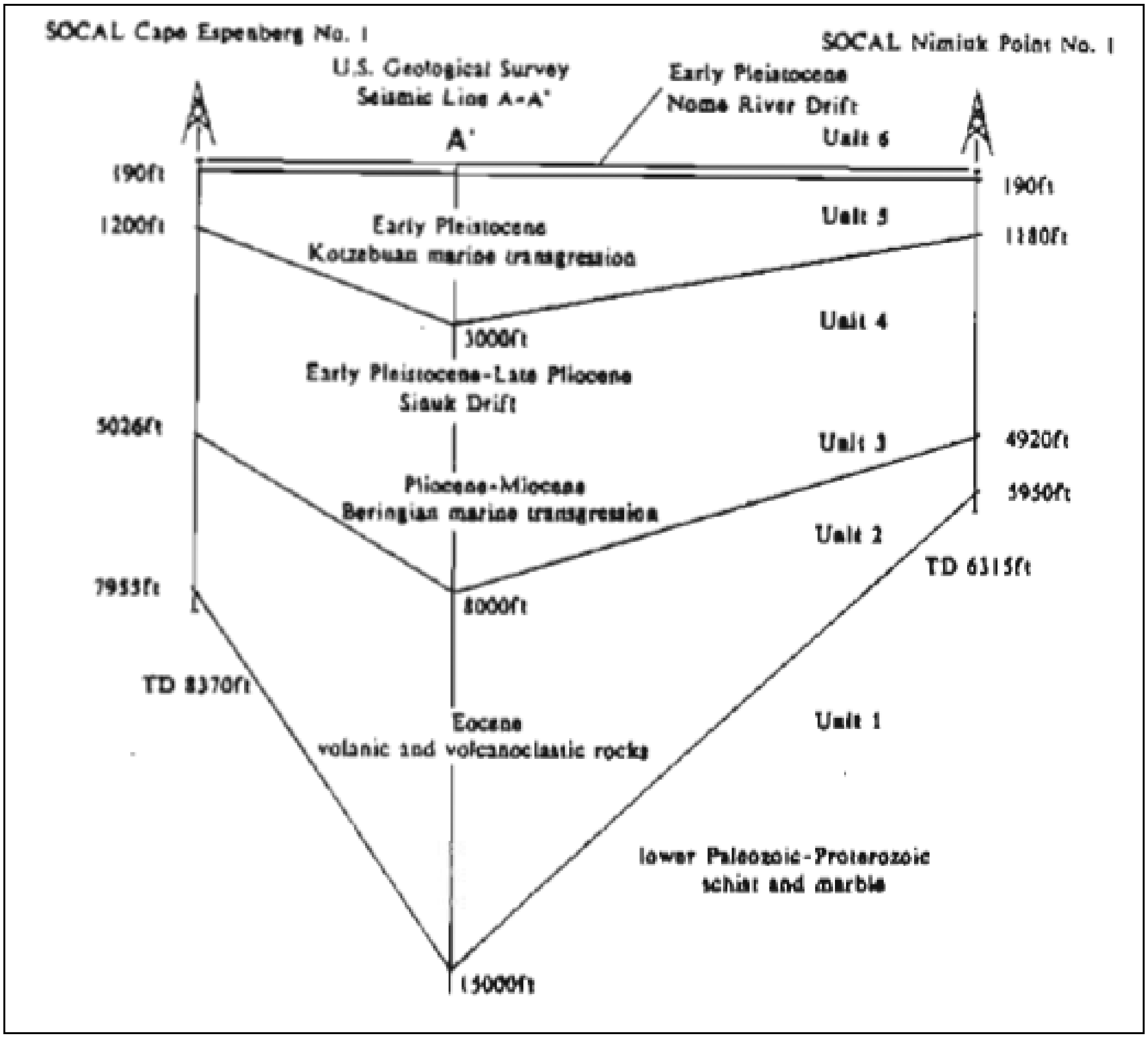

Figure 12: Stratigraphy drilled in the Selawik basin.

All rocks in Units 2-6 are Eocene or younger in age

From Decker et al, 1987

Analysis of the rocks in and around the Selawik basin indicate that the older Cretaceous rocks are very low in organic matter and overmature, having been excessively heated in the past. The Tertiary clastic rocks also contain low to very low organic matter, except for some coals, and are undermature in the exploration wells, having been too cool to generate thermogenic hydrocarbons. In addition, the organic matter present in the Tertiary section is woody and gas-prone and unlikely to generate oil. This leads to the conclusion expressed by Decker et al (1987): "…the volume of high organic carbon source rock within the Neogene deposits is extremely low, and there is no evidence that oil or gas generation has ever occurred."

The only realistic hope for hydrocarbons in the Selawik basin appears to be biogenic methane associated with coals. However, thick Paleocene coals at Chicago Creek (Figure 11) are absent in the two exploratory wells, and only "thin coal, lignite and wood fragment horizons" are present (Decker et al, 1988). Goff et al (1986) reported in the Selawik basin that "Both (wells) showed the presence of a rather thick section of coal-bearing Tertiary rocks…" and the Cape Espenberg well "encountered numerous lignite beds between 2,500 feet and 4,000 feet depth." Note that these descriptions by Goff et al (1986) do not give the thickness of the coal beds themselves. The uppermost Unit 6 in the Selawik basin is of glacial origin and contains wood fragments (Goff et al, 1986). The small to trace amounts of gas associated with coal in the Cape Espenberg and Nimiuk Point wells indicates these coals are unlikely to be associated with significant gas resources.

In summary, the chance for oil resources in the Selawik basin appears to be very low to absent. Appropriate oil source rocks have not been found and the Tertiary rocks are thermally undermature for oil generation. The low thermal maturity also implies the chance of significant thermogenic gas reserves is very low to absent. There is a somewhat better chance of finding shallow biogenic gas associated with possibly thicker coals in the Selawik basin. However, because little gas and no thick coals were found in the two exploration wells, the chance of significant biogenic coal gas in Selawik basin appears low.

2.3 Minchumina and Holitna basins

The Minchumina and Holitna basins lie south and outside of the study area (Figure 1 and Figure 2), but are briefly considered here. As shown in Figure 4, no hydrocarbon seeps or shows are observed in either of these basins and the oil and gas potential is considered to be low to very low. No wells have been drilled in these basins. Figure 13 shows the Holitna sedimentary basin as outlined by a gravity low.

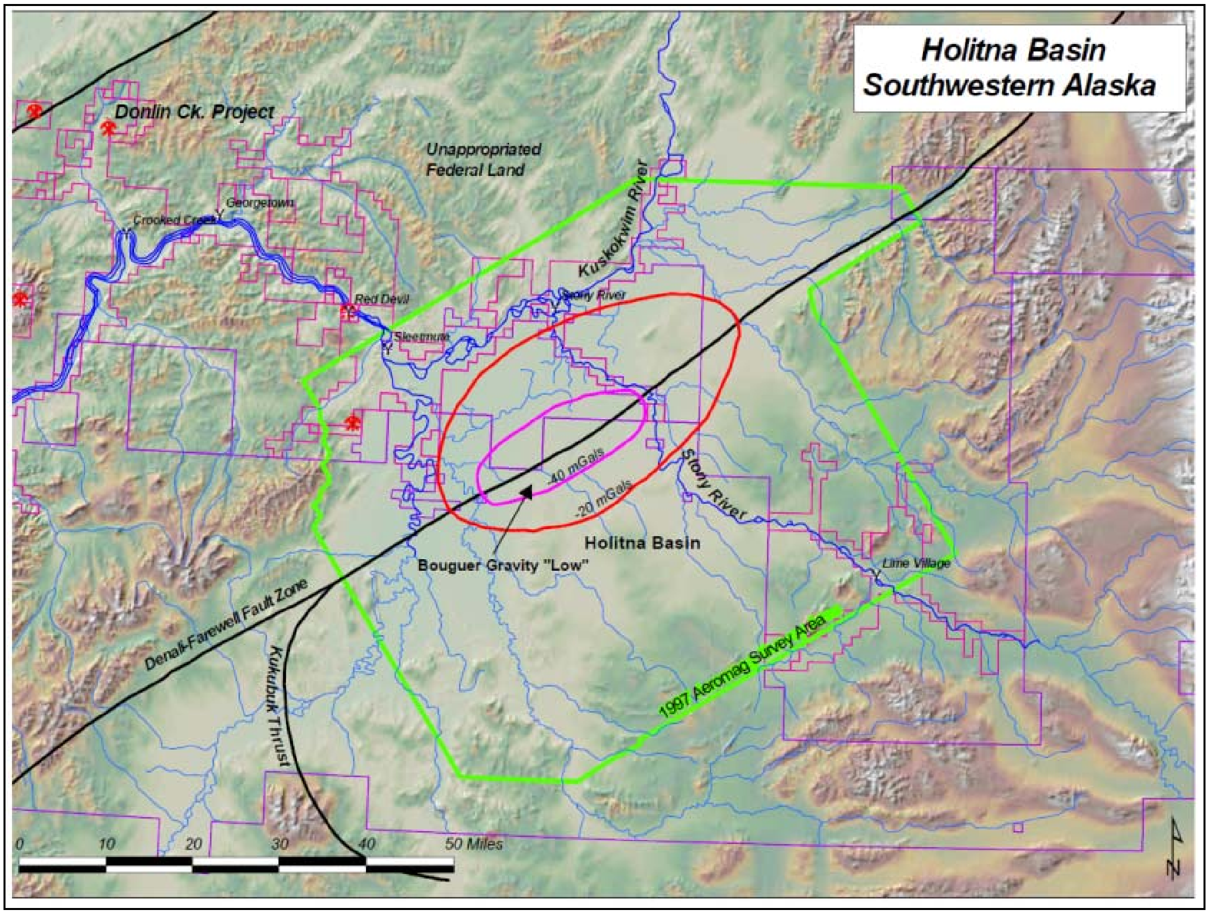

Figure 13: Holitna basin defined by gravity

Source: http://www.calistacorp.com/docs/maps/holitna_map.pdf

Relatively little is known of the subsurface geology in the Minchumina and Holitna basins. This statement occurs in the Kuskokwim planning document (undated)

> The Kuskokwim area's potential for oil and gas is poorly understood. Based on preliminary exploratory work, the Holitna and Minchumina sedimentary basins are thought to have low potential for oil and gas.
>
> http://dnr.alaska.gov/mlw/planning/areaplans/kuskokwim/pdf/ch2_subsurface.pdf

A 2-year study (1998-2000) by the Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys (DGGS) concluded the:

> …oil potential in the (Holitna) basin overall is low, but indicated the need for an additional sub-basin study to evaluate the presence of shallow gas reserves.
>
> http://www.dced.state.ak.us/dca/aeis/Bethel/Oil/Bethel_Oil_Narrative.htm

In additional comments concerning the older Paleozoic rocks, Le Pain notes:

> Past studies of the (Holitna) region have suggested poor to fair petroleum potential for Paleozoic strata", but adds that recent samples yielding oil window maturity suggest that "the petroleum potential of Paleozoic rocks in the (Holitna) region has not been adequately evaluated.
>
> Source: SIAL Geosciences Inc., and On-line Exploration Services Inc., 1998

Coal may be present in the Minchumina and Holitna basins and may be associated with small reserves of coal gas. Figure 14 shows a map of coal resources in central Alaska and small coal fields are found along the southern margin of the Minchumina and Holitna basins. It is possible these coals extend into the subsurface of the basin. The possibility for coalbed methane is discussed further in section 5.

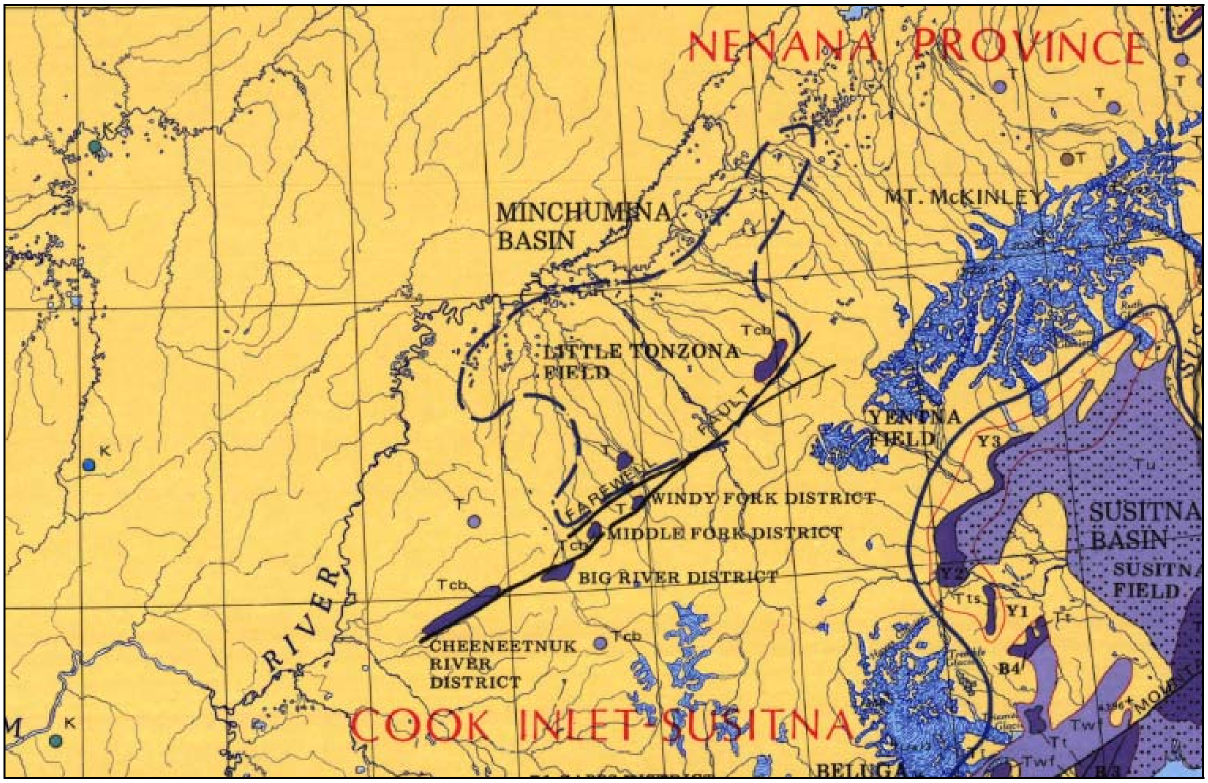

Figure 14: Coal resources near the Minchumina and Holitna basins

Source: Merritt and Hawley, 1986

In summary, the oil and gas potential of the Minchumina and Holitna basins is thought to be low to very low, but little is known of the subsurface geology. Gas associated with coal may be present in the basin, but thermogenic oil and gas is unlikely.

2.4 Nulato #1 well

The Nulato #1 well was drilled west of Galena (Figure 4) in the center of the study area. The Nulato well is one of very few deep wells drilled in Cretaceous and older rocks. Nulato #1 was drilled in 1959-60 to about 3,662 meters (12,015 feet) and is located on a surface anticline. It encountered rocks of Cretaceous age throughout and did not penetrate the Cretaceous into older units. Duplication of section indicates that thrust faults were present in the well. Analyses of the cuttings show the rocks are hard and fractured, and have been heated considerably in the subsurface. Quartz filled fractures observed in core are consistent with this heating. The well report indicates “no good reservoir beds were noted”. No shows of oil or gas were found in the well.

The Nulato well is remarkable in the very high thermal maturity encountered throughout the section. Figure 15 is a plot of the vitrinite reflectance values, which is a measure of thermal maturity, and shows that all well samples are highly overmature for oil. Vitrinite maturity of 0.6 – 1.3 is appropriate for oil generation, and values above about 2.0 can crack hydrocarbons to methane. The Nulato samples have been heated to high temperatures in the subsurface.

The high thermal maturity of the Nulato well highlights the very low hydrocarbon potential of many rocks in the Alaska interior. These high maturities are also shown in Figure 3. Large areas of central Alaska have been heated to temperatures unsuitable for oil preservation and have very low to no oil potential.

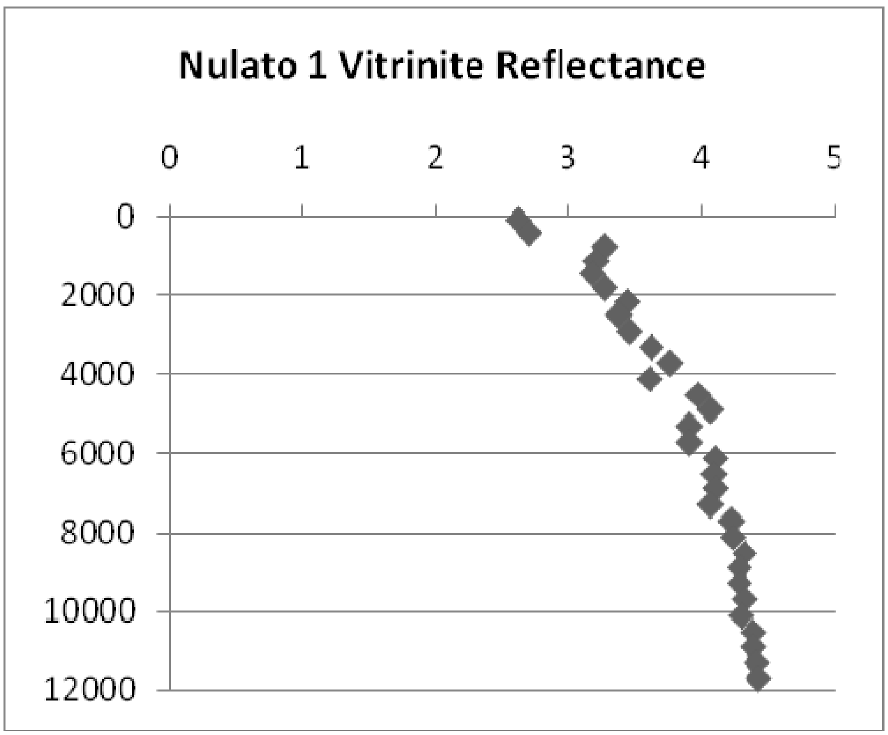

Figure 15: Vitrinite reflectance from the Nulato 1 well

Source: Alaska Oil and Gas Conservation Commission well files, GMC Report 015

2.5 Coalbed methane

Methane gas is often associated with coal beds. This gas may be biogenic or thermogenic in origin, and sometimes both. Biogenic methane is produced by methanogenic bacteria from decaying organic matter at very shallow depths and temperatures. Biogenic methane contains few heavier hydrocarbon components. Since biogenic gas is produced by bacteria in the shallow environment, subsurface heating is not required. Thermogenic gas is usually produced after burial and significant heating at depth, and high temperatures crack organic matter to gas. Some or all of the produced biogenic or thermogenic gas can be adsorbed into the organic structure of the coal. The volume of adsorbed gas increases significantly with depth (pressure), and successful coalbed methane production usually occurs from a depth of perhaps 2000 feet to about 5000 feet. Coalbed methane is not produced below about 6000 feet because of decreasing coal permeability with depth.

Many coals contain trace to small amount of methane, but successful coalbed methane projects require a minimum thickness of coal at the proper depth range, significant adsorbed gas volumes in the coal, appropriate thermal rank, and coal dewatering characteristics that allow gas to flow at economic rates. Gas shows in coal are encouraging, but most coals contain gas in volumes too small to be considered viable coalbed methane targets. Surface or near surface coal typically contains too little gas to have economic importance. The viability of coalbed methane is determined by drilling and pressure coring coal at depth, thereby retaining adsorbed gas in the coal sample for desorption and measurement in the lab. Encouraging results may lead to production testing of the well. Coalbed methane wells usually dewater over a period of many months to a year before lowered subsurface water pressure permits significant gas flow. Proper disposal of large volumes of produced water is a sensitive environmental issue in many coalbed methane fields.

The coalbed methane potential of much of central Alaska is unknown, but coals are common in several basins. Subsurface coals are particularly common in the Nenana (Middle Tanana) basin, which probably has the highest coalbed methane potential in the study area. Based on the Nenana basin well data, at least thin coals are present at several thousand feet depth, where they may be viable coalbed methane targets if found to be sufficiently thick and gas saturated.

Shallow coals are found on the Seward Peninsula as a series of isolated, structurally controlled fields of Tertiary age (See Figure 16). The following information comes from Merritt and Hawley (1986) unless noted otherwise. At Chicago Creek, one bed alone is up to

80 feet thick. Drilling in the Chicago Creek area is evidently limited to about 300 feet in depth, as shown in the cross section in Figure 18. The Chicago Creek occurrence is located in a narrow graben and seams dip from 45° to 70°. It is uncertain if these coals are present over a significant area at several thousand feet, the depth typically needed for viable coalbed methane prospects.

Other coal fields in the central Alaska province may have coalbed potential, but available information is usually limited to sparse data on outcrops or from near-surface mining. The Koyukuk area (Figure 17) contains Late Cretaceous coals with the thickest coal being in the Tramway Bar field. Here, one seam of three is 17.5 feet thick and dips at 56°. The Nulato field in the Koyukuk basin contains seams <4 feet thick. Little exploration has occurred in the Koyukuk basin for coal and subsurface coal is probably present. Coal beds in the Kobuk coal fields have generally shallow dips at < 30° and are part of broad, open folds, except near faults. Outcropping seams are less than 3 feet thick. Thin coals are also present in wells from the Selawik basin, but these coals encountered by the wells are too thin to be coalbed methane targets. Thicker coals might be present in other parts of the basin and may possibly have potential for coalbed methane.

Coal fields are also present in the Minchumina and Holitna basins (Figure 17). Tertiary coals in the Little Tonzona field contain multiple benches and are locally thick, up to 30 feet, with coal beds up to 17 feet thick in the nearby Windy Fork district. These are impressive thicknesses of coal. It is unknown if these coals extend into the subsurface, but drilling for coalbed methane has been proposed to locate gas for local use. A best interest finding for the Holitna Basin Exploration License published October 2, 2006, by Director, Alaska Department of Natural Resources, Oil and Gas Division, concludes that:

> A coalbed methane play depends on gas generated and stored in thick, extensive coalbeds, on favorable coal rank, and on appropriate basin hydrogeology. Surface exposures of coals observed in the Holitna Basin area do not appear to meet the coal criteria.

This conclusion is evidently reached because the exposed coals are too low in thermal rank. It is possible that coals at depth may have higher, more appropriate rank. It is believed that no drilling has occurred in the Holitna Basin area to test for deeper coals.

It is obvious from the above discussion that relatively little is known about the subsurface extent and character of coal in the central Alaska province. Surface descriptions and mapping are useful, but subsurface geophysical exploration and subsequent drilling are needed to find and document possible coals at depth. Once found, subsurface coals must be carefully pressure cored and desorbed to measure their methane content. If these indications are positive, a field production test is needed to demonstrate appropriate dewatering characteristics and flow potential. Because surface coal is common in parts of the central Alaska province, there is theoretical potential for coalbed methane production. However, proving viable production requires a significant exploration and evaluation effort.

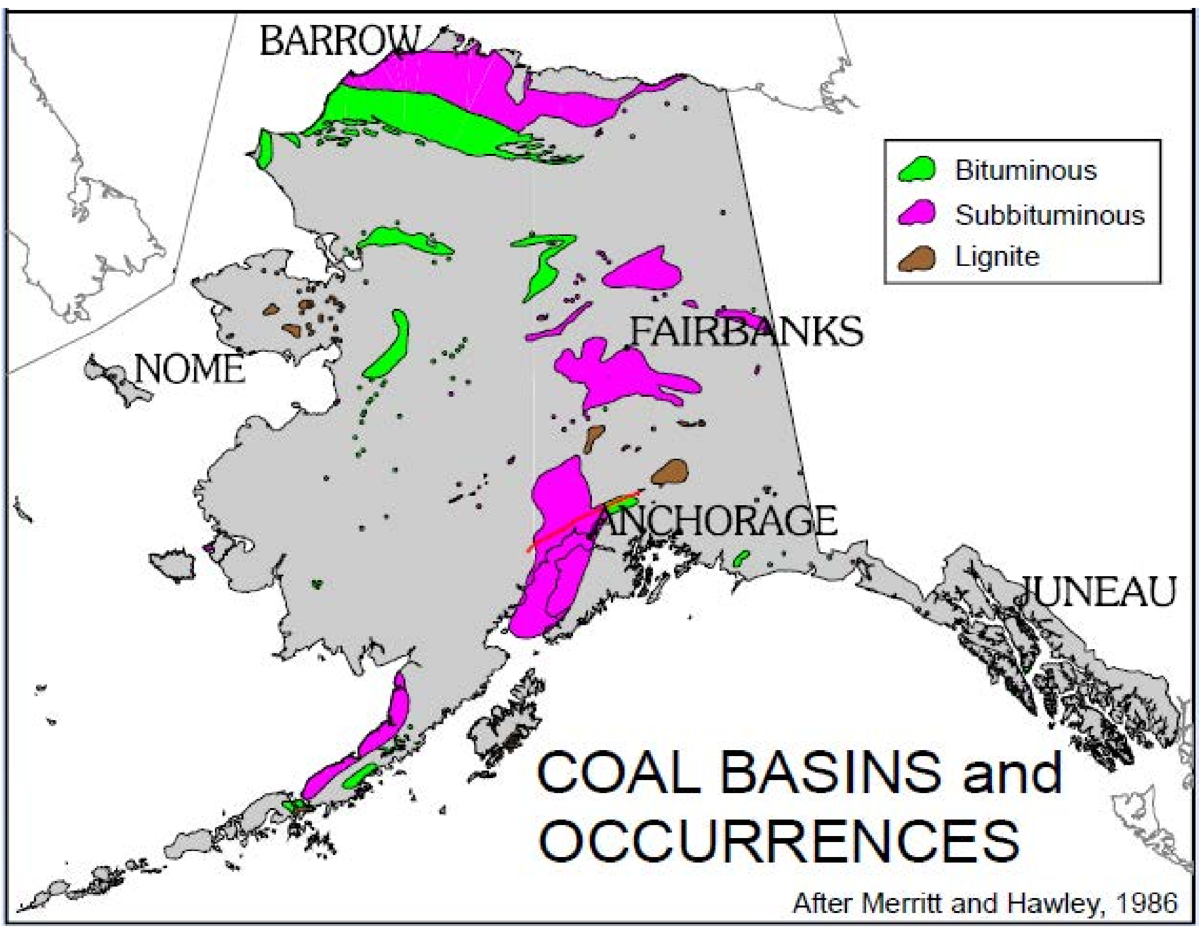

Figure 16: Coal basins and occurrences in Alaska

Source: Myers, 2003.

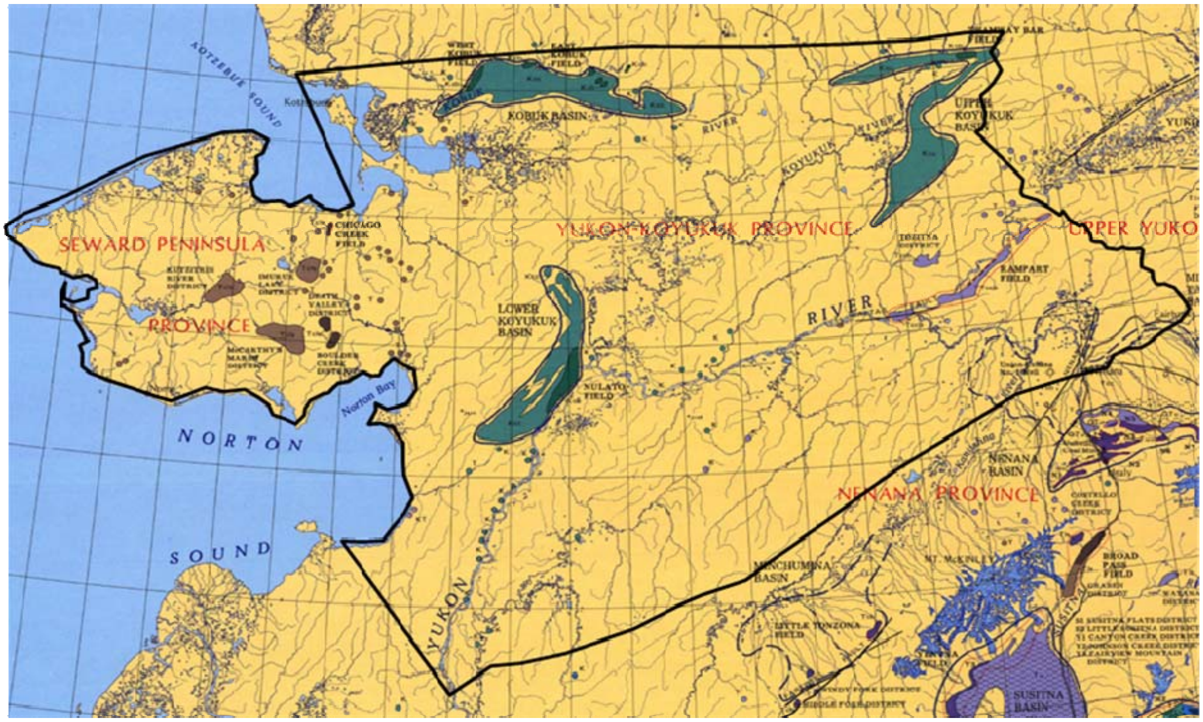

Figure 17: Coal Resources of Alaska and the study area

Source: Merritt and Hawley, 1986

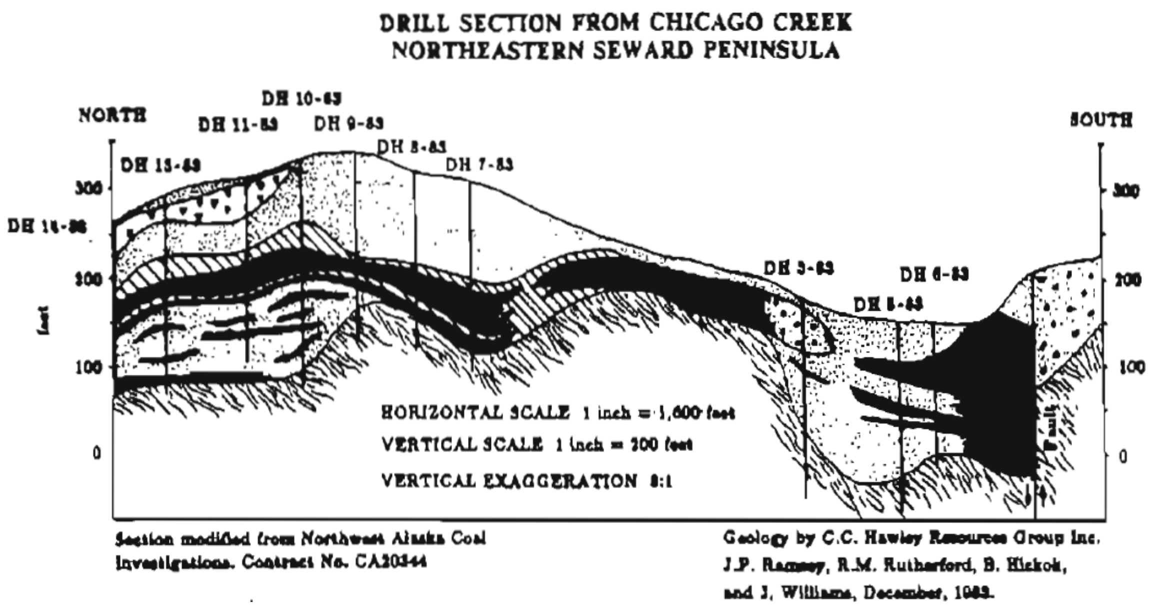

Figure 18: Cross section from Chicago Creek showing subsurface coal

From Decker et al, 1987.

2.6 Offshore Hope basin

The Hope basin is located offshore west of the Lisburne Peninsula and northwest of the Seward Peninsula. The Hope basin is undrilled and the geology of the Hope basin is inferred from seismic and gravity data, and by analogy to areas onshore and the adjoining Selawik basin. As shown in Figure 19, the Hope basin is believed to contain up to about 3,000 meters (9,842 feet) of stratified section, presumably sedimentary rocks, as observed on seismic data. Gravity data (Figure 20) also helps to outline the deeper parts of the Hope basin. The relationship of the Hope basin and nearby wells can be seen in Figure 22.

Decker et al (1987) reviewed the stratigraphy of the Hope basin as interpreted by Grantz et al (1976) and Eittreim et al (1977), and presented their own views based on correlation to wells in the Selawik basin to the southeast. There are significant differences and uncertainties amongst these authors concerning the rocks present in the undrilled Hope basin, but most of the section appears to be Tertiary with a possible Paleogene or Cretaceous section at depth. Extensional tectonics has dominated the Hope basin during the Tertiary and preserved sedimentary rocks in a series of east-west trending horsts and grabens. These structures probably form a variety of fault and rollover structural traps in the Hope basin.

Potential source rocks possibly correlative to the Hope basin occur onshore and in the Selawik basin and have very poor oil potential. Cretaceous outcrops in the Waring Mountains contain low to very low organic carbon and are thermally highly overmature (Decker et al, 1987). Conversely, strata in the onshore Nimiuk Point and Cape Espenburg wells are thermally undermature and generally woody and gas-prone. If correlative rocks in the Hope basin have similar characteristics, they would be poor to very poor sources for oil.

The thermal gradient measured in the Cape Espenburg well is 48° centigrade (C)/kilometer (215° Fahrenheit (F)/mile), a value significantly higher than an average continental gradient of about 30° C/kilometer (154° F/mile). Applying this gradient to the Hope basin indicates that oil window thermal maturity might occur at depths of 2,500 to 3,300 meters (8,200 to 10,800 feet) (Decker et al, 1987). Sedimentary rocks are thought to be present at about these depths in the Hope basin.

Porosity and permeability in sampled rocks from outcrops onshore are generally low. Figure 21 shows log derived porosity with depth in the Cape Espenburg and Nimiuk Point wells. While shallow sediments show significant porosity, these mineralogically immature sediments rapidly lose porosity with burial.

In summary, the Hope basin appears to contain sedimentary rocks to a depth sufficient for oil-window thermal maturity. Structural extension in the Hope basin has likely created small to moderate size traps related to faults and associated stratigraphic rollovers and truncations. Some sandstones at depth, particularly in the Neogene section, may have sufficient porosity and permeability to be viable petroleum reservoirs. These features of the Hope basin are positive. However, rocks containing oil-prone organic material have not been found on the Lisburne Peninsula onshore or in outcrops or wells in the adjoining Selawik basin. Woody and coaly organic material is much more likely than oil-prone kerogens in Hope basin, and these materials would generate gas during heating. No oil or gas seeps are known in or adjacent to the Hope basin, and there is no evidence of an active petroleum system in the Hope basin or nearby. A summary of Alaska gas potential by Sherwood and Craig (2001 and quoting earlier reports) estimates conventional gas in Hope basin at 3.4 trillion cubic feet (TCF), as shown in Table 1. This value compares to Chuckchi Sea estimated volumes of 60 TCF and Alaska North Slope estimated volumes of 64 TCF.

Based on these data, the oil potential of the Hope basin is low, and the gas potential of the Hope basin is low to probably moderate.

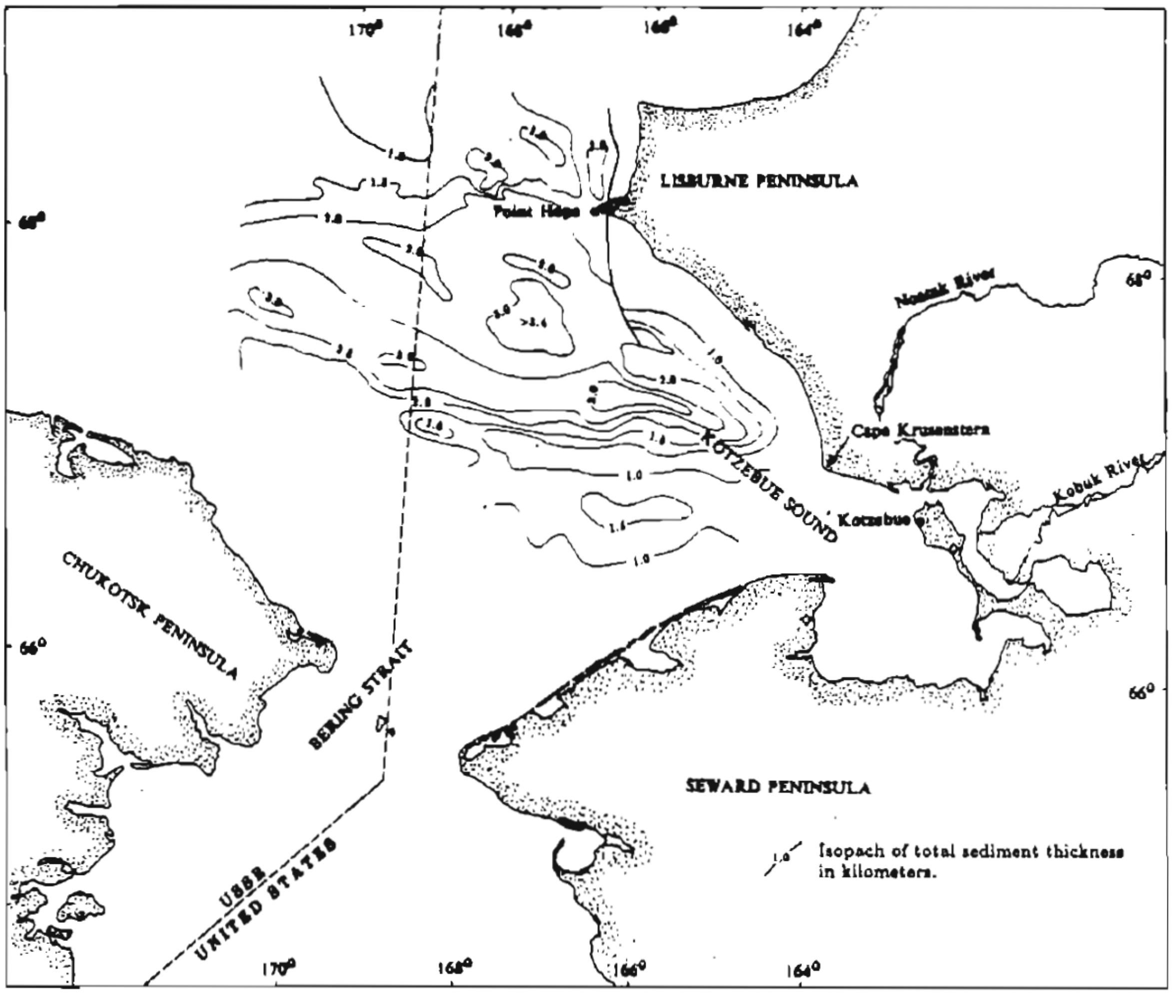

Figure 19: Sediment thickness in the offshore Hope basin

Thickness contours are given in kilometers.

Source: Decker et al, 1987.

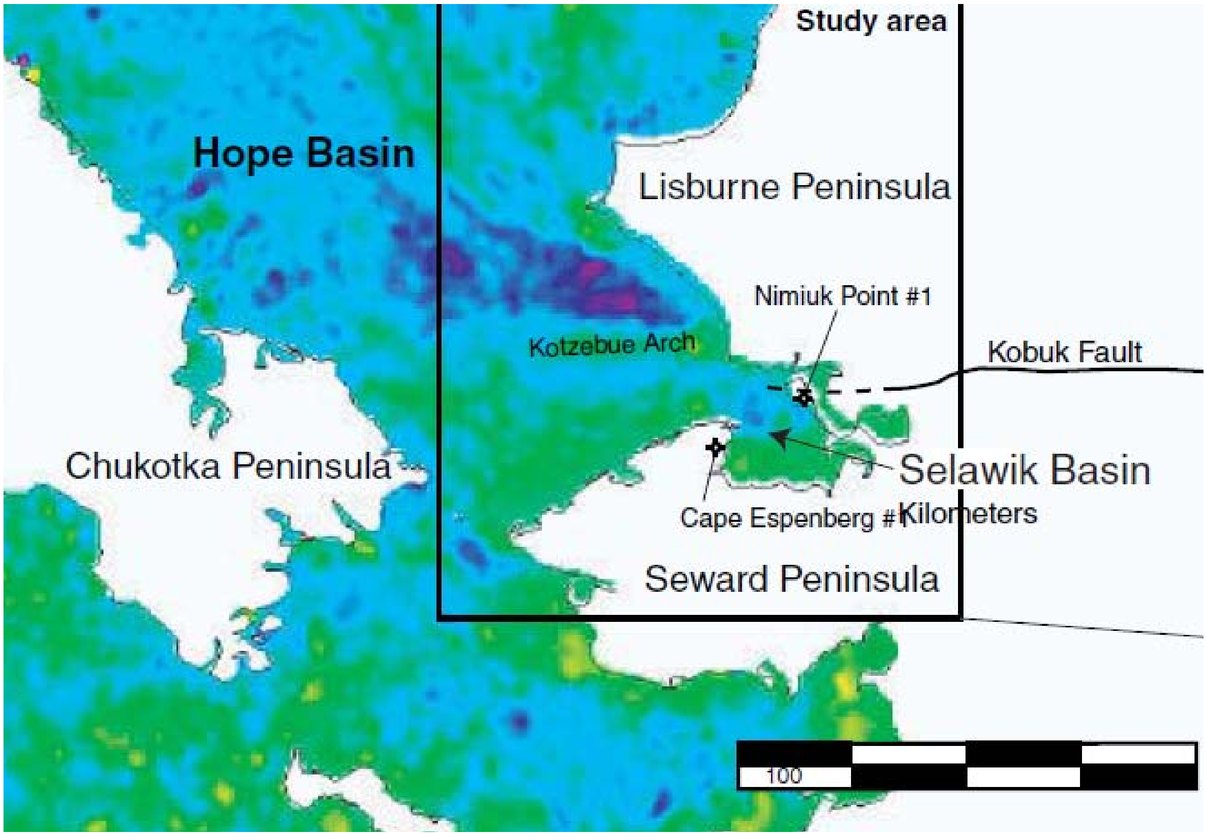

Figure 20: Seasat gravity map of the Hope basin near Alaska

Gravity data are from Klemperer et al (2002) and found on-line at http://www.geo.wvu.edu/~jtoro/download/GSA03_poster1.pdf.

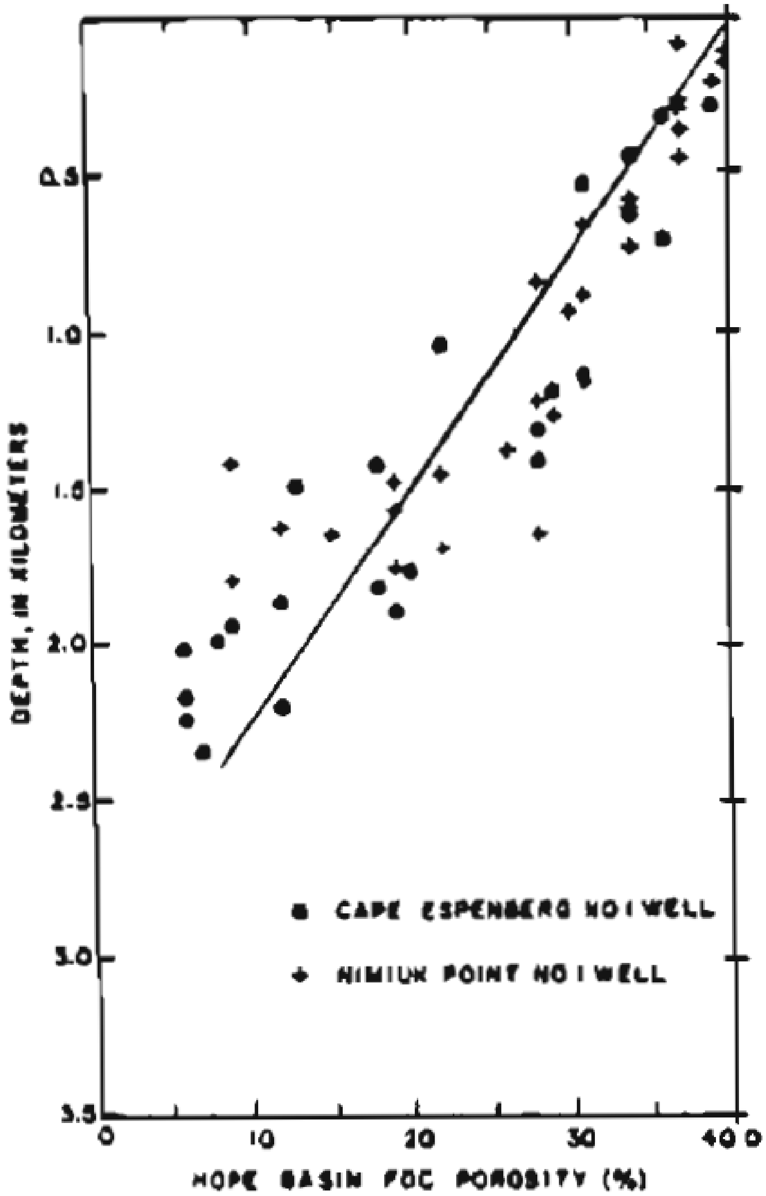

Figure 21: Log porosity vs. depth in wells from the Selawik basin

Porosity decreases rapidly with depth, a typical characteristic of immature sediments.

Source: Decker et al, 1987.

Table 1: Estimate of Alaska total gas resource (TCF)

Hope basin	3.4
Norton basin	2.7
Central Alaska onshore	3
North Slope	64
Chukchi Sea	60
Beaufort Sea	32

Sherwood and Craig, 2001

2.7 Offshore Norton basin

The offshore Norton basin lies southwest of the Seward Peninsula and has several indications of oil and gas in wells and seeps. Figure 22 shows the location of the Norton basin and shows of oil and gas in the basin.

Eight wells have been drilled in the Norton basin. Two COST wells preceded the lease sale on March 15, 1983, in which 59 leases were issued for bids totaling $317 million. In the next two years after the sale, Exxon drilled 5 exploration wells and Arco drilled one well. As described in the legend accompanying Figure 22, all wells had indications of gas and 3 wells had some minor indication of oil. The best oil show is probably Exxon OCS Y-0430 which reported free oil with 2% sulfur in a basement core taken near total depth. This oil show evidently does not appear on the mud log, but was detected during core analysis. None of the gas or oil shows were tested.

There are no indications of industry interest in the Norton basin since the exploration activity of 1984 and 1985. A planned lease sale scheduled for 1986 was cancelled due to lack of interest. All 59 offshore leases have been relinquished or expired. Subsequent calls of interest for Norton basin have not indicated industry interest. Nevertheless, increased prices may someday renew interest in Norton basin, particularly for gas.

The MMS estimates that recoverable reserves in the Norton basin are 0.05 billion barrels of oil and 2.71 TCF of gas (Federal Register, 2003 and Table 1). These estimates appropriately place the gas potential of Norton basin much higher than the oil potential. An example of supporting data for this conclusion is given in Figure 23 which plots the composition of organic matter recovered from the COST #1 well from the Norton basin on a van Krevelen diagram. On this plot, hydrogen-rich oil-prone organic material plots along the Type I trend, and occasionally along the Type II trend. The samples all plot along the Type III trend, typical of woody and coaly material. During heating in the subsurface, Type III organic material generates gas with no liquid hydrocarbons.

Based on the above data, the gas potential of the Norton basin is estimated as moderate. Production and transportation of gas requires significant investment in infrastructure to produce LNG or convert the gas to a transportable product, such as fertilizer. Also, increasing gas prices will potentially make other discovered and stranded gas deposits around the world economic, and these deposits will compete globally with remote areas like the Norton basin for gas development. It is unclear if industry would be interested in Norton basin gas even in a high price environment for the near or intermediate future.

The oil potential of the Norton basin is probably low. Minor and trace amounts of oil were observed in three wells, but these shows did not warrant a test. No confirmed oil seeps are present in or around the Norton basin. The Norton basin does not appear to contain a prolific and robust oil system and if oil is trapped in the Norton basin, fields are likely to be small.

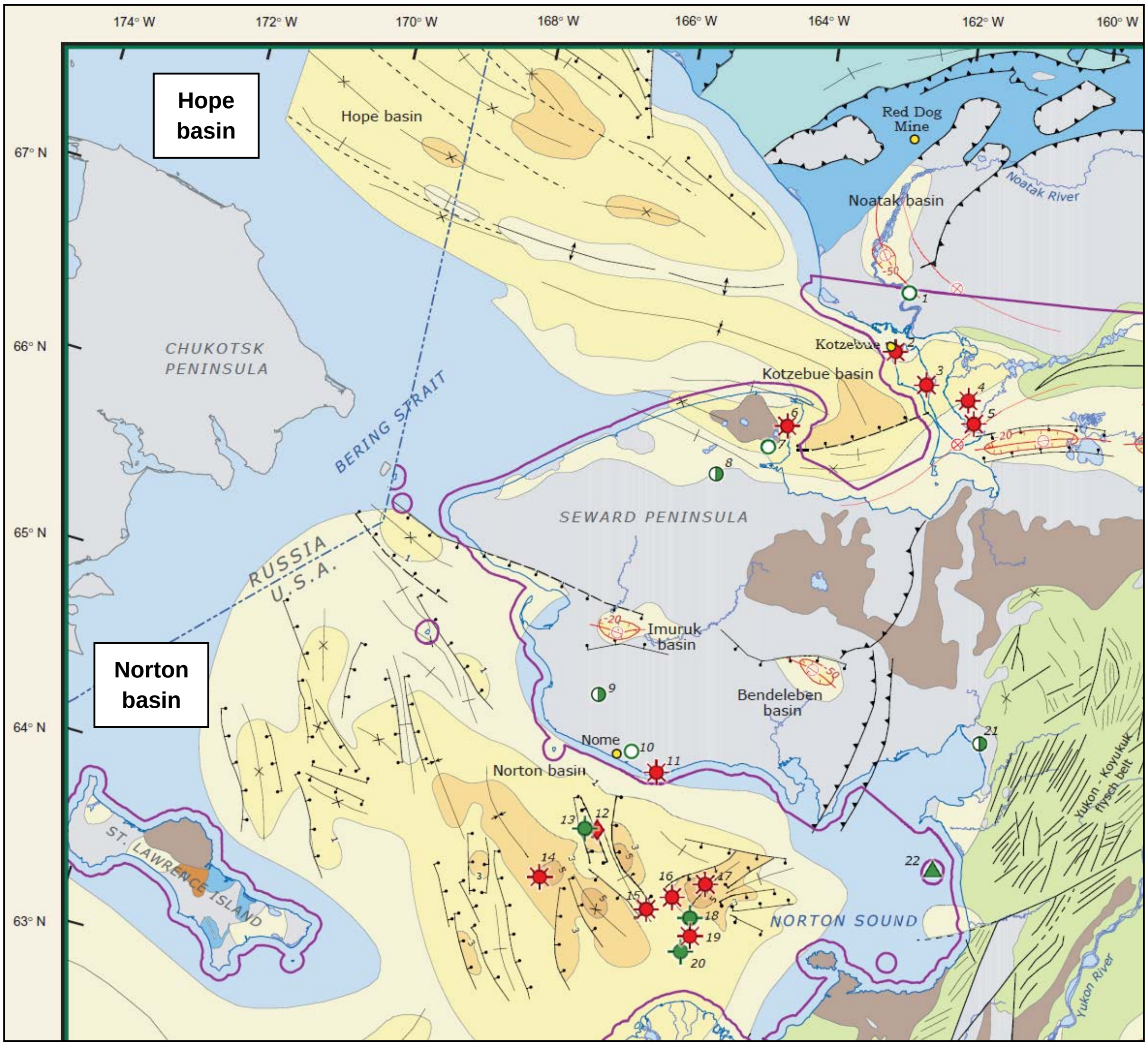

Figure 22: Oil and gas shows in outcrop and wells in northwestern Alaska

The offshore areas shown are the Hope and Norton basins.

Map and legend (on following page) from Troutman and Stanley, 2002.

Figure22 (continued): Legend

12	Gas seep, confirmed	In 1976, a submarine seep of gas was discovered in Norton Sound about 25-30 miles (40-50 km) south of Nome (Cline and Holmes, 1977; Kvenvolden and Claypool, 1980). Subsequent sampling and analysis showed that the gas consisted of about 98 percent CO_2 with minor amounts of hydrocarbons consisting of gas-range (C_1 to C_4) and gasoline-range (C_5 to C_8) molecules (Kvenvolden and Claypool, 1980). The molecular and isotopic characteristics of the hydrocarbons suggest that they formed by thermal alteration of marine and (or) nonmarine organic matter buried within Norton basin, whereas the CO_2 probably formed from decarbonation of carbonate rocks by heat or fluids (Kvenvolden and Claypool, 1980).
13	Well with oil show(s)	The ARCO OCS Y-0436 Well No. 1 in Norton Sound was drilled in 1984 on the Birch prospect to a total depth of 10,950 ft (3,338 m) and abandoned as a dry hole. The well was located about 33 miles (53 km) southwest of Nome in about 65 ft (20 m) of water. The mudlog indicates strong shows of methane at depths of 1,200-3,600 ft (366-1,097 m); sporadic, weak shows of oil at 7,800-8,400 ft (2,377-2,560 m); and numerous minor shows of gas (including methane, ethane, and higher alkanes) at many intervals below 8,400 ft (2,560 m). However, none of these shows were considered worthy of a drill stem test (Smith, 1994, p. 37).
14	Well with gas show(s)	The COST Well No. 1 in Norton Sound was drilled in 1980 to a total depth of 14,683 ft (4,475 m) and abandoned as a dry hole. The well was located in about 90 ft (30 m) of water in the St. Lawrence subbasin, about 54 miles (87 km) southwest of Nome. Biogenic methane was reported at depths shallower than 6,000 ft (1,800 m) and traces of thermogenic hydrocarbons were found at depth, but no significant oil shows were encountered in this well (Turner and others, 1986, p. 103).
15	Well with gas show(s)	The Exxon OCS Y-0414 Well No. 1 in Norton Sound was drilled in 1984 on the South Teton prospect to a total depth of 3,636 ft (1,108 m) and abandoned as a dry hole. The well was located about 63 miles (101 km) southeast of Nome in about 54 ft (16 m) of water. The mudlog shows moderate to strong shows of methane at about 1,200-2,100 ft (366-640 m); minor shows of methane below 2,200 ft (671 m); and a trace of oil at about 3,450-3,470 ft (1,052-1,058 m). No drill stem tests were conducted (Desautels, 1988, p. 522-524; Smith, 1994, p. 37).
16	Well with gas show(s)	The Exxon OCS Y-0407 Well No. 1 in Norton Sound was drilled in 1985 on the Yellow Pup prospect to a total depth of 7,867 ft (2,398 m) and abandoned as a dry hole. The well was located about 62 miles (99 km) southeast of Nome in about 55 ft (17 m) of water. The mudlog depicts moderate to strong shows of methane at about 2,100-3,100 ft (640-945 m) and sporadic, weak to moderate shows of gas associated with coal-bearing intervals at about 3,200-3,300 ft (975-1,006 m), 5,250-5,850 ft (1,600-1,783 m), and 7,150-7,600 ft (2,179-2,316 m). Some of the gas is thought to be of thermogenic origin, but no oil shows were encountered (Desautels, 1988, p. 527) and no drill stem tests were conducted (Smith, 1994, p. 37).
17	Well with gas show(s)	The Exxon OCS Y-0398 Well No. 1 in Norton Sound was drilled in 1985 on the Cascade prospect to a total depth of 6,913 ft (2,107 m) and abandoned as a dry hole. The well was located about 62 miles (99 km) southeast of Nome in about 55 ft (17 m) of water. The mudlog depicts numerous small indications of methane throughout the well, and many of the methane shows at 2,800-5,400 ft (853-1,646) appear to be associated with coal-bearing intervals. Minor fluorescence was noted on the mudlog at 4,930-4,940 ft (1,503-1,506 m) and 5,370-5,430 ft (1,637-1,655 m), but no oil shows were encountered and no drill stem tests were conducted (Desautels, 1988, p. 526; Smith, 1994, p. 37).
18	Well with oil show(s)	The COST Well No. 2 in Norton Sound was drilled in 1982 to a total depth of 14,889 ft (4,538 m) and abandoned as a dry hole. The well was located in about 49 ft (15 m) of water in the Stuart subbasin, about 68 miles (110 km) southeast of Nome. Biogenic gas was found in near-surface sandstones, and minor shows of gas, oil, and solid bitumen were reported from Eocene strata below depths of about 10,000 ft (3,000 m) (Turner and others, 1986, p. 117, p. 121). Oil from a show at 12,240 ft (3,731 m) is paraffinic and thought to have been generated from nearby nonmarine source rocks (Desautels, 1988, p. 518-519). A strong show of gas was encountered in sandstone at about 12,210 ft (3,722 m) (Smith, 1994, p. 43).

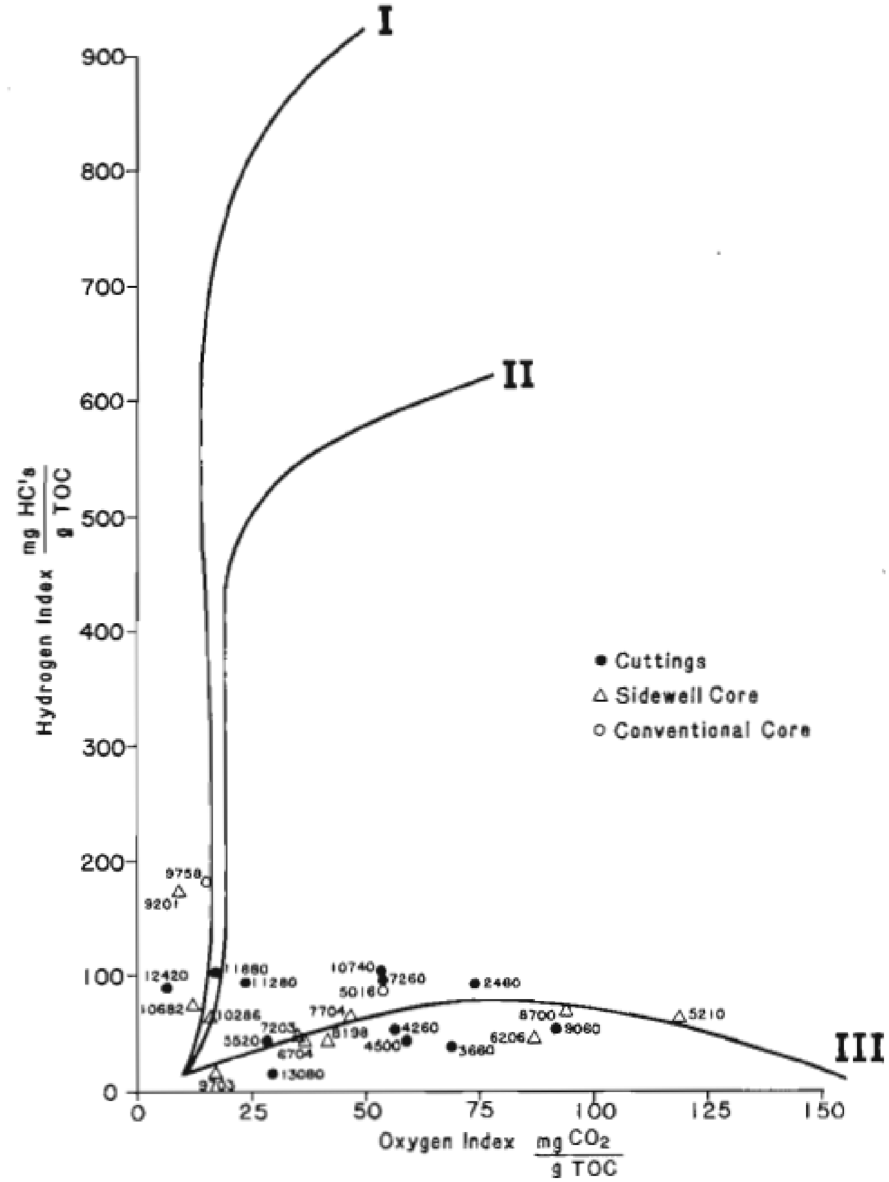

Figure 36. Van Krevelen Diagram.
(Selected pyrolysis analyses by Geochem Laboratories, Inc.)

Figure 23: Van Krevelen diagram from COST Well #1, Norton basin, Alaska

These and other data from the COST well indicate organic material from rock samples is primarily humic (Type III) and gas prone.

3.0 CONCLUSION

The Department of Transportation study area includes portions of the Nenana and Selawik sedimentary basins and is adjacent to the Minchumina and Holitna basins, and the offshore Hope and Norton basins. For the onshore basins, the Nenana basin has the highest potential for hydrocarbons in the study area. The chance of finding economic oil resources in the Nenana basin is considered low and the chance of finding economic gas is considered moderate. The Selawik basin has a very low to absent chance for oil and a low chance for gas. The Minchumina and Holitna basins have very low chance of oil and a low chance of gas. The coalbed methane potential of the study area is largely unknown, but the presence of coal indicates the potential for coalbed methane. The area with the highest potential of coalbed methane resources is probably the Nenana basin.

The location of the Nenana basin should be considered when evaluating the resources of the study area. It's proximity near the Parks Highway, however, suggests that planning a long distance transportation corridor should not be unduly influenced by possible resources already relatively near a transportation. The low chance of other hydrocarbon resources in the study area suggests that other resource concerns besides hydrocarbon potential may take precedent in the planning process.

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APPENDIX E

Agriculture and Forestry Resource Paper

AGRICULTURE AND FORESTRY
WESTERN ALASKA ACCESS PLANNING STUDY

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February 2009

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LIST OF ACRONYMS

ARLIS .... Alaska Resources Library and Information Services
BF .... Board foot
CF .... Cubic foot
DNR .... Department of Natural Resources
GIS .... Geographical Information Systems
NASS .... National Agricultural Statistics Service
NC .... Northern Commercial Company
NPFL .... Non-productive forestland
SNAP .... Scenarios Network for Alaska Planning
UAF .... University of Alaska, Fairbanks
USDA .... US Department of Agriculture

EXECUTIVE SUMMARY

Project objectives for the agricultural and forestry resources analysis include:

- Review literature on agricultural and forestry resources
- Contact state representatives within the Division of Forestry and the Division of Agriculture on potential resources
- Describe current utilization
- Describe potential for development

Analysis

The agricultural and forestry resource analyses within the study area are based on overviews, not detailed field-based inventories. GIS mapping allowed analysis of resource mapping from several sources to be combined for more analytical acre calculations.

Alaska's history of agricultural and forestry resource development is unique in many ways, from Alaska's Russian background, starting in 1743 and extending to 1867; to territorial status within the United States for 92 years; and eventually to its current status as a state for 50 years.

Alaska's distance from the contiguous United States helped generate a development model that is different from most states'. Alaska's agriculture started with Russian managers trying to reduce the high cost of imported foods. Agriculture in the contiguous states, however, followed railroads westward towards the Pacific Ocean, traversing prairie lands that were much easier to prepare for crops. In Alaska, homesteaders cleared forests as part of land preparation and this increased costs and decreased tillable acreage.

Agricultural, Forestry Resource Characteristics

The following points help describe conditions within the study area:

1. The study area is highly variable. Climatic conditions range from transitional conditions on the Bering Sea near the western area boundary to mid-continental conditions near Fairbanks and the Dalton Highway on the east.

2. Growing conditions are best on thawed ground near river systems and on south-facing slopes. Annual precipitation ranges from 10 to 12 inches annually with variable amounts of snow and rain, depending on local conditions.

3. Overall, the number of plant-growing days is lower in the west, with tundra and lichens as the most common ground cover, and higher to the east, with upland white spruce and birch forests.

4. Agriculture in the project area consists mostly of small, residential gardens.

5. Forest development generally consists of firewood utilization (including driftwood) and small sawmills operated on a demand basis with a few workers. Peak utilization of forest resources occurred along the Yukon River during the Gold Rush years of 1898 to 1903 with approximately 40,000 cords of wood harvested for riverboat fuel.

6. Most of the 23 million acres suited for agricultural development are on the Seward Peninsula as reindeer grazing lands. There are limited areas of intensive management.

7. There are approximately 36 million acres of forests within the study area, with 35 million acres consisting of “fair” or “low” potential commercial growth.

Agricultural Acres and Initial Gross Production Value

Table 1 displays three categories of agricultural classification, estimates of acres utilized, and dollars per acre gross production value, along with an overall gross value by category. These are based on 2007 agricultural statistics published by the US Department of Agriculture for Alaska, National Agricultural Statistics Service. These are an annual estimate and, for a ten-year period, these gross production values suggest an overall value of approximately $3.1 million.

Table 1: Agricultural Lands, Three Gross Production Value Estimates

Ag Land Class	Gross Acres	Acres Utilized	$ per Acre	Total Value
Upland	3,721,400	1,088	$45.00	$48,960
Lowland	5,340,600	861	$10.00	$8,610
Reindeer	14,124,200	12,700,780	$0.02	$254,016
Total	23,186,200	12,702,729		$311,586

Source: Northern Economics, NASS data, 2007.

Forestry Acres and Initial Gross Production Value

Table 2 illustrates results for three classifications of forest resource, estimated acres, harvest levels (on a 100-year rotation), volumes in cords per acre, gross production value per cord, and overall value. As with agriculture, these are an annual estimate and a ten-year value of gross production value is approximately $79 million.

Table 2: Forest Lands, Gross Valuation

Forest Land	Total Acres	Est. Harvest	Cords/ acre	Cords/ Year	Value/ Cord	Value/ Acre	Total Value
High potential	369,600	370	30	11,088	$250	$7,500	$2,772,000
Fair potential	8,405,000	841	22	18,491	$250	$5,500	$4,622,750
Low potential	27,010,500	270	12	3,241	$150	$1,800	$486,189
Total	35,785,100	1,480		32,820			$7,880,939

Source: Northern Economics.

1.0 AGRICULTURAL AND FORESTRY FRAMEWORK

Similar to other project resource analyses, the agricultural and forestry analyses are overviews, not detailed, ground-based inventories of agricultural and forestry resources. Rather, these analyses provide engineers and planners with sufficient information to make informed decisions regarding potential transportation corridors within the study area. There are a considerable number of more detailed and site-specific analyses, but this report provides a project-level perspective of agriculture and forestry resource values. Other project team members will address land ownership, permafrost conditions, river crossings, terrain limitations, and similar factors.

1.1 Approach

The basic approach for this report is:

- Conduct a literature search for specific resources within the study area, using public and private resources, current and historical. Examples include the University of Alaska, the Alaska Resources Library and Information Services (ARLIS), the Loussac Library Alaska Collection, and several public agency web sites.
- Contact knowledgeable agency and non-agency staff regarding reports, maps, detailed area data, and opinions
- Develop a geographically based resource summary, using GIS mapping and database files
- Provide initial gross resource values, tied to map locations.

1.2 Study Area Overview

These sections provide general information about agricultural resources and forests within the study area.

1.2.1 Location

For the most part, developable agricultural and forestry areas are located on thawed ground alongside major river systems. In particular, the Yukon River and its major tributary, the Koyukuk, cross most of the study area from upper elevations in the north and east towards lower elevations to the south and west, near Norton Sound. There are several areas along the Kobuk River east of Kotzebue that grow reasonable stands of trees and, with a long enough growing season (mostly along the eastern part of the river), small gardens are productive. Figure 1 displays the Yukon and Kobuk Rivers; the Koyukuk flows from a point west of Bettles towards the southwest, joining the Yukon at the City of Tanana. It also shows agricultural and grazing lands within the Southcentral and Interior portions of Alaska (Selkregg, 1974).

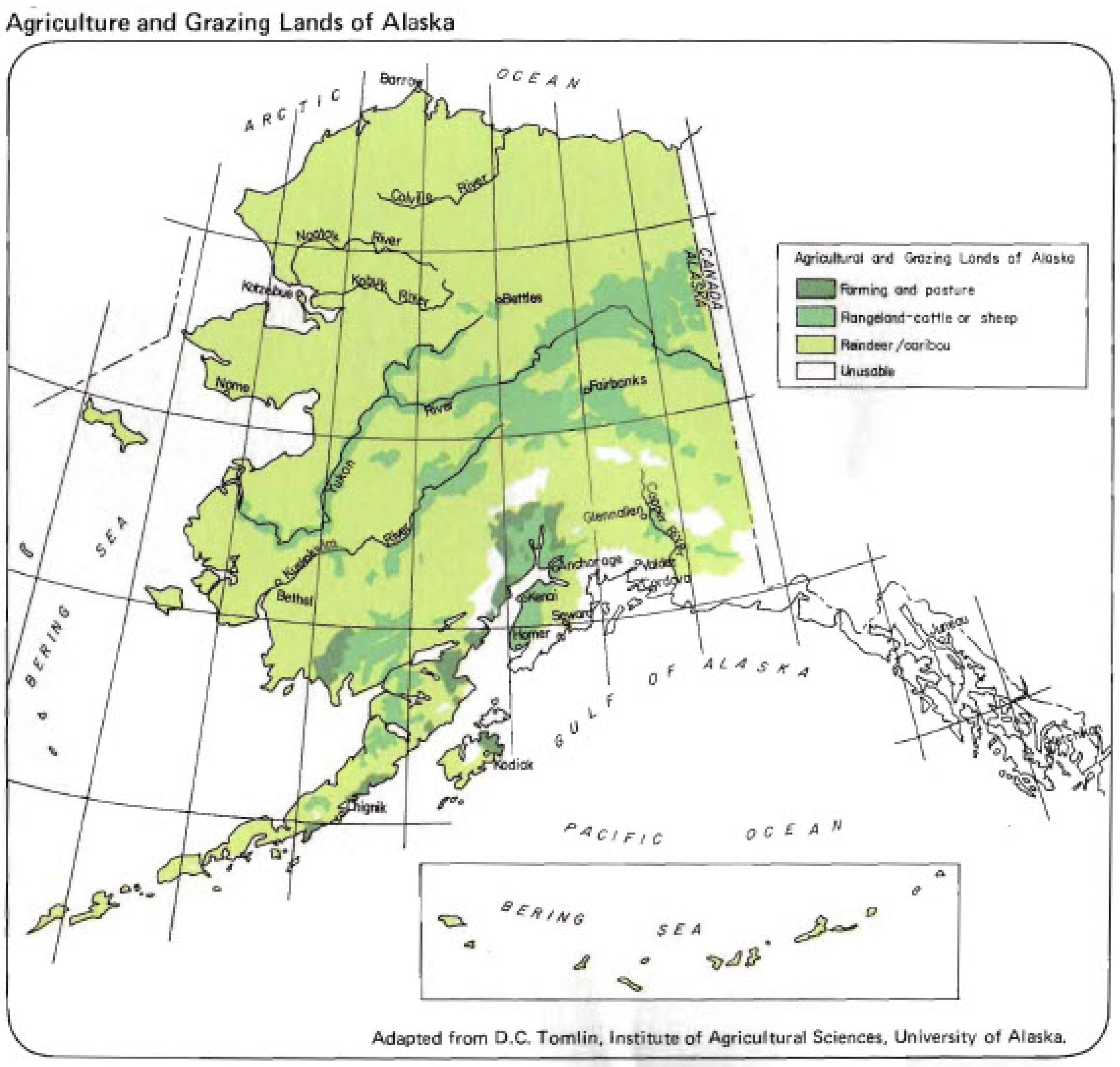

Figure 1: Agricultural and Grazing Lands of Alaska

Source: Selkregg, 1974

1.2.2 Product Characteristics

In general, both food and wood products are typically high volume (or high weight) and relatively low-value commodities. A cord of air-dried birch firewood, for example, can weigh approximately 4,000 pounds (or two tons at 2,000 pounds per ton) and have a retail value of $250 per cord or $0.06 per pound of product. Transportation costs to move two tons of firewood generally limit the distance these products can be hauled and still be profitable. Food products require attention to preservation and appearance before delivery to final consumers.

1.2.3 Food and Wood Transportation

Transportation within the study area is limited to short, local and regional roads; river-borne tugs and barges; and a considerable number of small to large aircraft. Heavy and bulky commodities, such as food and wood, have traditionally been transported by water, using barges, sternwheelers and, more recently, river tugs.

Year-round transportation systems such as roads and railroads can reduce costs, especially when compared to more expensive airfreight or seasonal salt-water ports. These can reduce costs of daily living for food and fuel. As an example, when the Alaska Railroad connected Fairbanks with Seward in 1923, food consumption began to shift from locally grown and preserved products to canned, preserved and frozen products hauled northward by rail.

Another recent example is fresh produce hauled by truck to Alaska; Costco estimates year-round delivery times of up to 66 hours, from shipments along the west coast to receipt of produce in Anchorage (Journal of Commerce, 2002). Much of this improvement is due to paving of the Alaska Highway.

1.2.4 Farms and Gardens

Agricultural activity in the study area is characterized by small gardens, generally under an acre in size, in many locations; reindeer herding in the Seward Peninsula; and somewhat larger farms (five acres and larger) in the eastern part of the study area. Vegetables are the most common row crop, while hay grown as animal feed has the largest agricultural acreage.

Almost all gardens are for residents and village use, though there are commercial gardens in Fairbanks (Tanana Valley) and Palmer (Matanuska-Susitna Valley).

1.2.5 Grazing Lands

There are rangeland areas on the western portion of the study area, particularly on the Seward Peninsula, that support reindeer herding, an endeavor reserved for Alaska Natives. The availability of range habitat (mainly lichens for wild caribou or domesticated reindeer) within the study area has fluctuated over the years due to overgrazing by larger herds. Figure 2 illustrates reindeer herds in 1926 and 1968 (Selkregg, 1974) with crosshatched areas reflecting the reduction in rangeland over the 42 years noted. There were an estimated 10,000 animals in 1905, 640,000 in 1932 and 15,000 in 2006 (NASS, 2007).

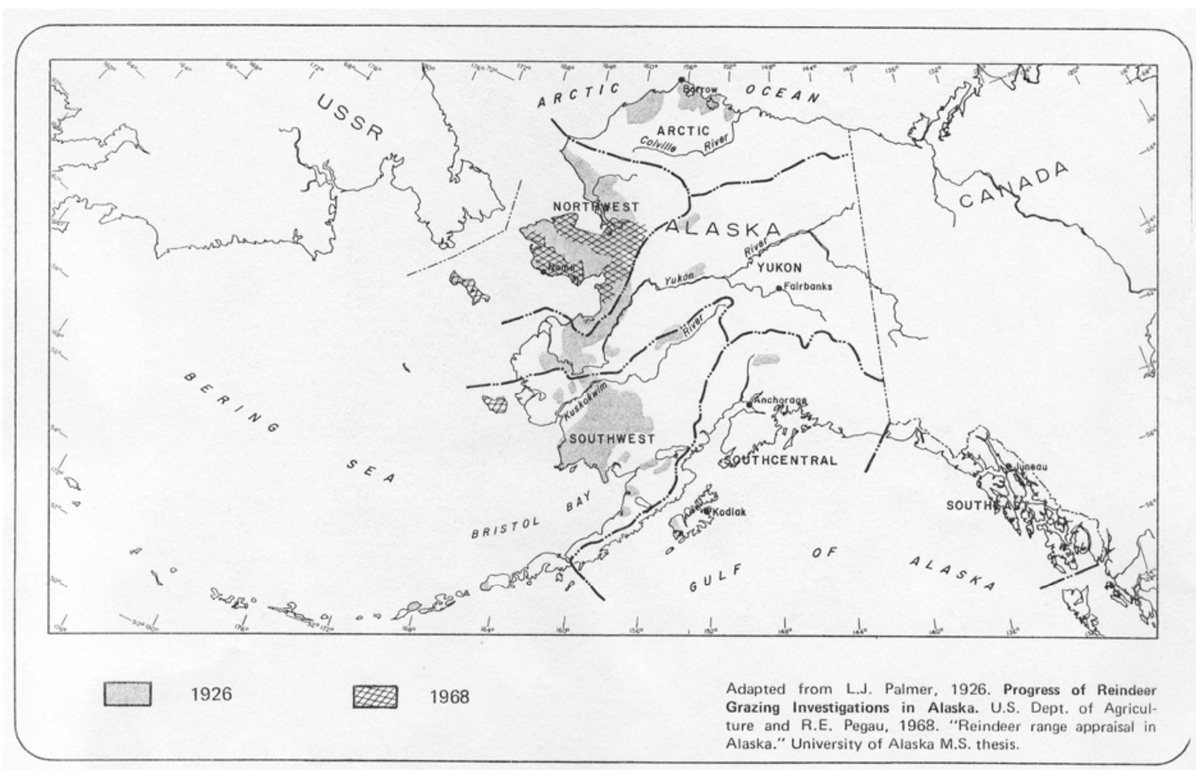

Figure 2: Alaska Reindeer Herds, 1926 and 1968

Source: Selkregg, 1974

While reindeer grazing lands have decreased in area due to reduced lichen growth, concentrations of these herds are still located on the Seward Peninsula. In 2006, there were an estimated 15,000 reindeer in Alaska on Seward Peninsula, Nunivak, and Umnak Islands and other areas (USDA NASS, 2007). Grazing permits now include the entire Seward Peninsula, reflecting a somewhat larger acreage than that shown in Figure 2.

1.2.6 Forestry Activity

Similar to agriculture, forestry activity is also small-scale and residentially focused due to limited demand. Primary uses are firewood and rough, green, construction materials such as lumber and houselogs. Firewood processing by small groups and individual residents is very prevalent with small sawmills (employing five or fewer workers) manufacturing rough, green spruce lumber and timbers cut from forests along river systems.

Medium-sized sawmills (employing five or more workers) are common on the eastern portion of the study area in the Tanana Valley State Forest near Fairbanks. These mills sell products to larger markets, both retail and wholesale. Figure 3 illustrates the commercial potential for lands within the study area and adjacent to it on the northeast (toward Fort Yukon) and southeast toward Delta Junction (Reid, Collins, 1981).

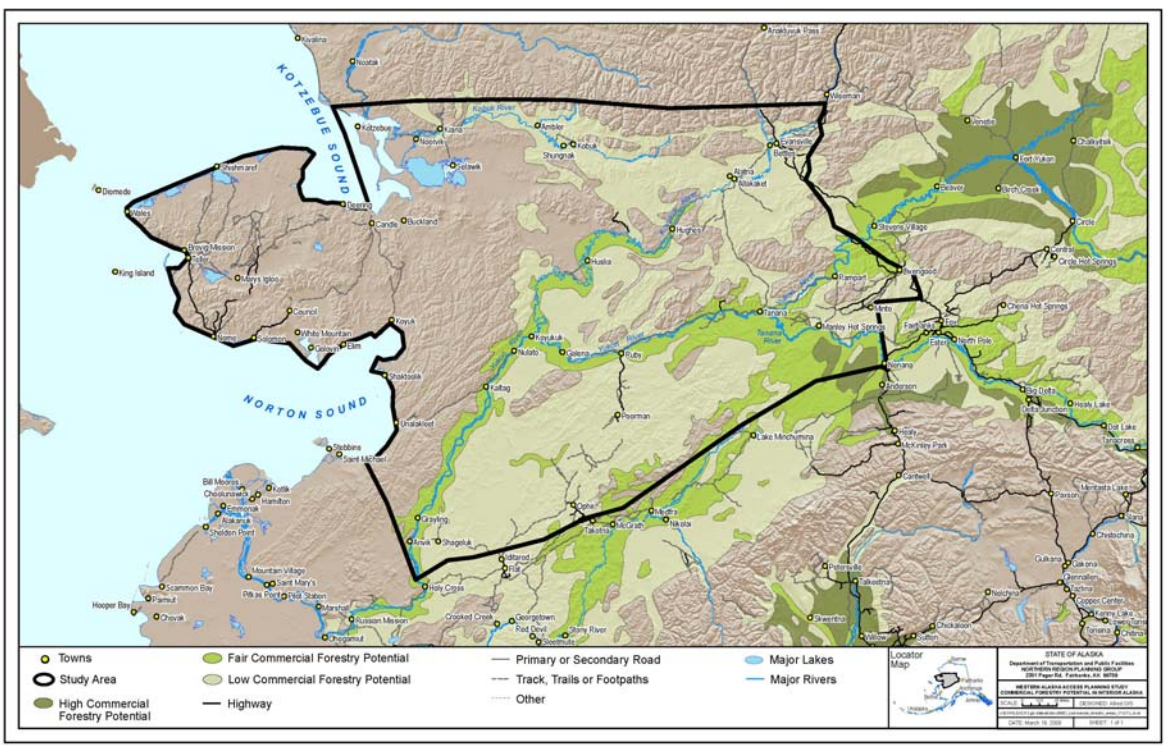

Figure 3: Commercial Forestry Potential

Source: Reid, Collins, 1981.

Resource potential displayed in Figure 3 is based on Alaska's 1:1,000,000 scale exploratory soil survey, published in 1979. Each of the mapped units was evaluated for agricultural and commercial forest suitability as well as limitations within the broader land resource area.

Since this initial evaluation, there have been a number of more detailed analyses, including, for example, fieldwork and sustained yield analyses on the Tanana Valley State Forest (Parsons and Associates, 2001). Information in Figure 3 should be considered a broad overview, with a number of changes due to fire, recent field data, improved mapping, and more refined data-analysis software. Data collected for the Exploratory Soil Survey is still the most comprehensive evaluation of the entire study area.

1.2.7 Resource Values

Gross resource values in this analysis were calculated from the specific methodologies described at the end of each resource analysis. These are based on the project's time-based scope of 50 years and, like the resource data, they are an overview of relative values suitable for comparing potential road corridors. Net resource values, equivalent to an oil wellhead price, will be projected for the next round of resource work.

Agricultural and forestry resources reproduce and grow within constraints imposed by three main variables, which are discussed further in the following sections.

2.0 PRODUCTION FACTORS

Production of food or wood in the study area depends on three intertwined production factors: biology, economic constraints, and social factors.

2.1 Biology

The potential future growth of forestry and agricultural resources is constrained by the necessary requirements for plant growth. These requirements include:

- Adequate number of growing days
- Soil temperature
- Soil moisture content

One of the key variables for plant growth is climate. Climate relates to the number of growing days, with agricultural crops generally requiring 80 growing days (defined as days without a hard frost) (Cox, 2008).

Figure 4 illustrates growing days in the study area; ranging from under 70 days per season in the coastal area, also called a transition zone (from cold maritime to interior conditions), to 130 to 160 days in the eastern or mid-continental part of the area. The number of days shown on the map is adapted from current data and several climatic models (SNAP – Scenarios Network for Alaska Planning) from the University of Alaska, School of Natural Resources and Agricultural Science, Fairbanks (UAF, 2008) that extend results through several future decades. Base temperatures for agricultural crops are generally lower than those for tree growth though 80-day growing seasons are considered the minimum required for crop production. Overall, the number of growing days will increase, based on SNAP models, whether due to global warming or other, more cyclical, impacts.

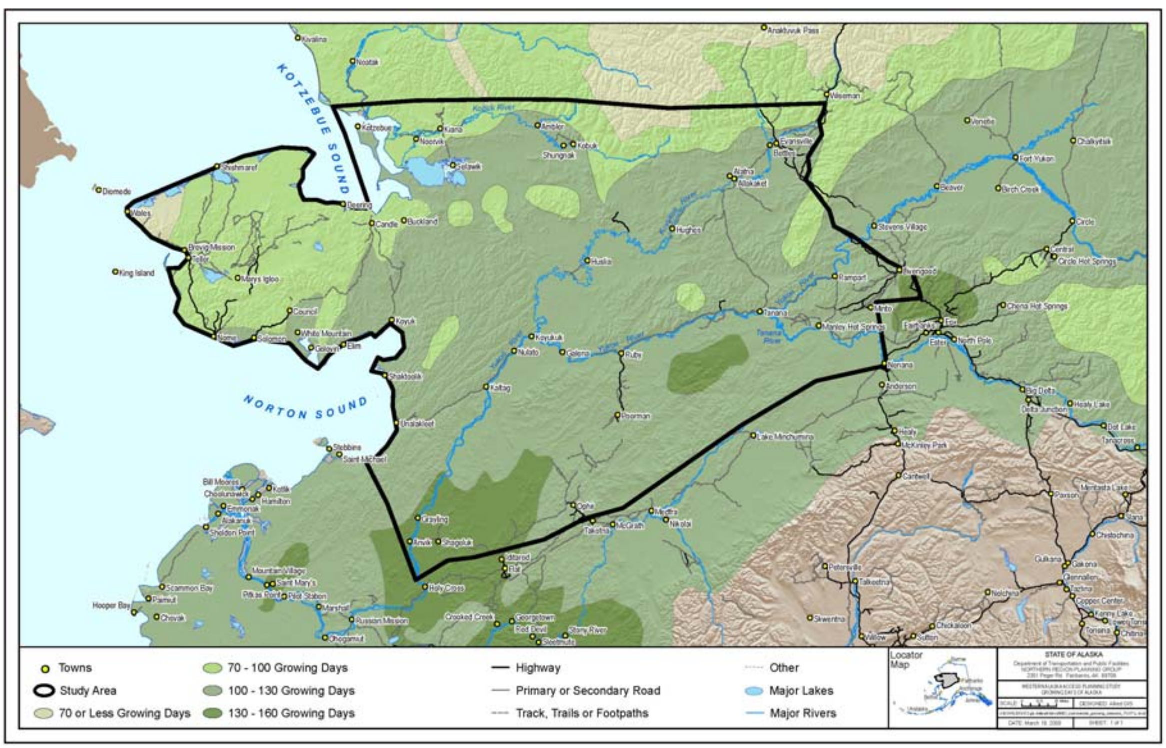

Figure 4: Growing Season Days

Source: Adapted from UAF, SNAP, 2008.

Thawed ground (no permafrost near the soil surface) is found alongside river systems in the middle and eastern portion of the study area. Farther away from rivers, permafrost is located closer to the surface, where cold soil impairs root and plant growth.

Like agricultural crops, trees grow faster on warmer ground and they occupy more acreage than agricultural soils due to greater cold adaptability. Black spruce, in particular, is a tree species that occupies considerable acreage within the study area because of its ability to withstand colder soils. Trees grow well on south-facing slopes that warm soil temperatures more quickly than other areas; generally, trees can grow on slopes that are steeper than those used for small-scale agriculture.

Water can be a limiting factor for crop growth as small gardens and row crops may need irrigation. Forest growth is less limited by water than most agricultural crops, and trees generally grow well with normal soil moisture; within the study area, annual precipitation ranges from 10 inches near Fairbanks to 12 inches at Tanana (Shulski and Wendler, 2007).

2.2 Economic Constraints

Agricultural and forestry resources are local throughout much of the study area and, where and when feasible, their consumption can reduce the high cost of imported commodities. Many local residents grow food for year-round consumption, along with subsistence hunting and fishing. Forest resources are vital for fuel-wood products, construction materials, and as habitat for other food sources such as game animals.

Given the remoteness of the study area, import prices for both food and wood products are very high relative to the prices paid in other parts of the state and country. High prices are a common theme in the study area, and have been the standard for years, dating back to first contact with western civilization. The Russian-American Company established fur trading outposts in the area and documented high costs for food and wood in the late 1700s (Fedorova, 1973).

Alaska costs are higher than most cities in the United States, but rural Alaska experiences the highest costs. Figure 5 illustrates current weekly food and heating oil costs for various communities across Alaska and Portland, Oregon for a family of four, with children ages 6 to 11, as compiled by the University of Alaska (Alaska Economic Trends, 2008).

	Food at Home for a Week[1]	One Gallon Heating Oil	One Gallon Gasoline
Anchorage	$134.05	--	--
Barrow	$288.57	--	$4.45
Bethel	$237.67	$4.75	$4.84
Cordova	$197.41	$4.76	$4.43
Delta	$153.30	$3.57	$3.41
Fairbanks	$127.59	$3.69	$3.24
Glennallen	$162.57	$3.71	$3.59
Homer	$171.46	$4.10	$3.82
Juneau	$141.12	$4.03	$3.49
Kenai	$142.02	--	$3.59
Ketchikan	$142.18	$3.89	$3.47
King Salmon	$266.85	$4.04	$4.29
Kodiak	$177.65	$4.18	$3.94
Kotzebue	$261.73	$4.45	$5.50
Mat-Su	$118.64	$3.65	$3.36
Nome	$223.48	$3.80	--
Portland, Ore.	$103.68	$4.43	$3.33
Seward	$174.90	$3.82	$3.75
Sitka	$162.22	$3.81	$3.56

Figure 5: Rural Alaskans Pay More, March 2008

Source: UAF, Cooperative Extension March 2008.

Within the study area, weekly food costs for Kotzebue were $261.73 while the same food cost $134.05 in Anchorage and $103.68 in Portland, Oregon. Fuel oil costs in parts of rural Alaska have remained high, due to twice-yearly deliveries; recent cost estimates in the Northwest Arctic Borough included a $9.35 per gallon fuel oil cost in Ambler, as stated on public radio. The high cost of fuel oil has forced many lower-income residents to burn firewood.

Overall, household incomes in the study area are generally lower than more urban parts of Alaska, because of limited job availability and limited economic activity. High costs for imported food and fuel provide strong financial incentives for residents of the study area to use local produce, animals, and trees.

In areas without trees, driftwood (if available) generates heat. Figure 6 and Figure 7 show driftwood use at the City of Tanana washeteria.

Figure 6: City of Tanana, Washeteria, Wood Boiler Fuel

Source: Bartz Englishoe and Associates, 2008. Used with permission.

Figure 7: City of Tanana, Washeteria Wood Fuel, Interior Storage

Source: Bartz Englishoe and Associates, 2008. Used with permission.

2.3 Social Factors

Socially and culturally, resident populations are closely connected with resources of the land. Alaska Natives comprise the major ethnic group within the study area with some villages close to 100 percent Native; traditionally they have been hunters and, on the coast and along many water bodies, fishers, for several thousand years. There are no records or folklore to suggest Alaska natives in the north cultured any plant material (Dearborn, 1979). Food was difficult to obtain and difficult to store during certain times of the year, especially in late winter.

One Alaska native in southwest Alaska stated (Fienup-Riordan, 2008):

> Partly because food was difficult to acquire, it was highly valued and treated with great respect. Paul John (May 2004:6) spoke eloquently of how the careful treatment of food – comparable to dancing with masks – was a form of prayer, asking that animals return in abundance. When animals and fish arrive and the weather on the ocean was good, they began to hunt and harvest. They called the time when they no longer experienced a shortage of food “ciringluteng” [to have an abundance of food].

Recently, high costs of imported foods have stimulated many within the study area to return to subsistence or traditional ways of living. For others, gardening in warmer months has provided an opportunity to supplement diets with vegetables such as cabbage, turnips, carrots, and potatoes (Dearborn, 1979).

More detailed information on agricultural and forestry resources within the study area is contained in the following sections. There is an emphasis on development of agricultural and forestry resources as many of the same factors that limited development over the past 200 years are still present, though in different form and scope.

3.0 AGRICULTURE

As noted in Alaska's Heritage (Alaska Humanities Forum, 2008):

> Agriculture is the business of cultivating the soil, producing crops, and raising livestock. In Alaska, raising livestock has included fur farming and reindeer herding…Agriculture in Alaska has always fallen below mining, fishing, trapping, and recently, tourism, in its significance to the Alaska economy. Yet, there has been great interest in Alaska's agricultural potential during the American era of Alaska's history.

There was no known agriculture within the study area prior to Russian contact (Dearborn, 1979). Alaska natives were hunters and gatherers of animals and fish with less focus on plant materials, other than for fuel or buildings (homes, cabins, etc.). Commercial farms (for the most part) do not exist due to the remoteness, high cost, and small labor pool available; instead, small-scale farms and home-based gardens are common.

Agriculture in Alaska has been small-scale since employees of the Russian-American Company first grew vegetables at Kodiak around 1785 (Black, 2003). Small, local gardens that can be carefully tended have been the most successful; gardens located at schools, missions, and homes are mentioned in many historical accounts. Larger-scale agricultural attempts have centered on areas expected to be more productive, such as those near Fairbanks, Delta Junction, and Point MacKenzie, but results have been erratic.

Figure 8 illustrates upland and lowland soils within the study area. As shown, Rampart and Fairbanks have more upland soils (generally those soils above river terraces) that are relatively more productive than lowland soils, found along old river bottoms and along current stream banks. Outside of the study area, farms in the Matanuska-Susitna Valley are generally considered as the most productive within Alaska (USDA NASS, 2007) followed by the Tanana Valley, and the Kenai Peninsula.

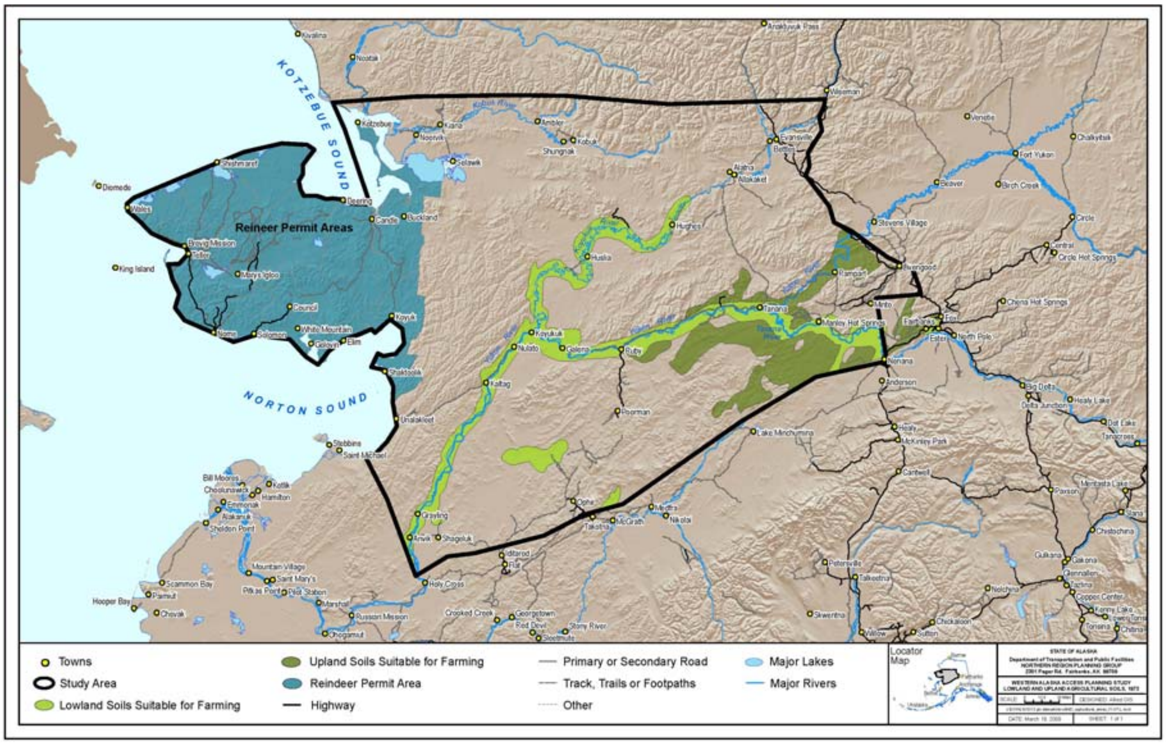

Figure 8: Upland and Lowland Agricultural Soils

Source: Selkregg, 1974.

The following sections describe many different details about agricultural activities within the study area, including history of agriculture, commercial agriculture, and the value of agricultural lands.

3.1 History of Agriculture

Agricultural activity within the study area arrived with Russian contact. Although farms and grain production in Siberia were common in high latitudes (Fedorova, 1973) it was the attraction of Alaska furs (fur seal, sea otter, beaver, fox, sable) that drew Russians to the area. These explorers operated under provisions of a charter granted to the Russian-American Company. Company managers were profit-oriented and growing local food (crops or animals) meant lower costs for supplying their employees.

The following sections provide further details about Russian agricultural activities, followed by a description of agricultural activities since the establishment of Alaska as a U.S. territory.

3.1.1 Russian, 1743 to 1867

Initial Russian exploration at Unalaska around 1743 extended eastward to Kodiak. After Kodiak was settled, further exploration headed in three main directions. First, in Southeast Alaska, Sitka was colonized and company managers expanded operations to the west coast of North America at Fort Ross, California. Crops in Sitka were primarily root vegetables, while California grew grains on ranchos, one of the first exports from North America to Alaska.

Gardens established by Russian-America Company employees successfully produced root vegetables in 1785 (Black, 2003). There are also reports that American whaling crews planted seeds on northbound voyages and then returned to these untended gardens in the fall to harvest vegetables and other plants (Babcock, 1995). These were typical agricultural developments during the initial Russian years.

The second exploration surge was directed northward from Kodiak into the Gulf of Alaska, Cook Inlet, and southeast Alaska. In 1844, several Russian settlements were labeled as agricultural (Fedorova, 1973) and were established to provide company employees with less expensive local food: Kachemak, Kasilof, Kenai, Knik and Matanuska. Other agricultural settlements included Seldovia and Tyonek. The third Russian development effort occurred from 1819 to 1867 and included the Yukon and Kuskokwim river drainages.

Within the study area, Nulato was the northernmost Russian development, established in 1838. Other settlements within the study area included St. Michael, destined to become an important riverboat overwintering location. A primary agricultural product at St. Michael was grass that served as hay for winter cattle feeding.

In summary (Fedorova, 1973) gives the following insights about the struggle of Russian agricultural activities:

> Neither on Sitka, nor on Kad'iak and Unalashka did experiments in raising grain prove successful. Even in the fertile soil of Kenai Bay, where the climate is moderate, did grains – rye and barley – have time to ripen in the short summer. However some vegetable crops – potatoes, rutabagas and turnips – quickly spread throughout the region and became established among

> the Aleuts and Tlingit. Cabbages and sometimes cucumbers were grown on the shores of Kenai Bay. Between 1810 and the 1860s the Russian and Creole population were supplied with local vegetables as far as possible from Company kitchen-gardens….for various reasons, primarily the lack of work-hands, cattle-breeding did not receive proper development and meat for the population of the colonies constantly had to be imported from the metropolis of California.

3.1.2 U.S. Territory

After Alaska was sold to the United States in 1867, extensive agricultural surveys were completed and eventually commercial crops were successfully tested in the eastern part of the study area, while reindeer herding was established on the Seward Peninsula around 1900. Primary access was by riverboat as only limited roads existed and the Alaska Railroad was developed after 1910. Limited access, especially in winter, meant higher food costs; this encouraged growth of local gardens and commercial farming near Fairbanks after the gold rush in 1898.

A report in 1880, from Captain George W. Bailey of the US Revenue Marine Service (now Coast Guard), is excerpted from a news account (NY Times, March 29, 1880):

> Sixty-two of the creoles live on Wooded Island [near Kodiak] where they find employment in a sawmill and in cultivating 10 acres of oats and 2 acres of potatoes. These 12 acres seem to comprise, at present, the greater part of the "agricultural resources of Alaska."…At Ounalaksa [sic], the largest commercial port of the Aleutian Islands, sufficient grass is cut and cured to feed 15 cows and 25 sheep during the long Winter, and there are three small gardens in which good turnips and watery potatoes are raised."

For the territorial years, from 1867 to 1959 (Shortridge, 1972):

> Agriculture, as the traditional way of transforming frontier regions into settled ones, is an excellent indicator of the overall images Americans have held for

> this land…Farming in Alaska was expected to develop in accordance with the precedents established on earlier agricultural frontiers in the United States…

However, farming in Alaska did not follow the expected pattern with little of the westward expansion seen in the contiguous United States (Snodgrass, 1982). The western US was occupied and developed by a combination of transportation, such as the railroads, and the lure of low-cost land that was easy to farm. Alaska’s agricultural land rarely had ready transportation and clearing land from mature forest for croplands is much more difficult than breaking prairie grassland (Snodgrass, 1982).

Agricultural development was summarized in the early 1950s, prior to Alaska Statehood, by a publication of the Alaska Agricultural Experiment Station, in Palmer (Mick and Johnson, 1954):

> …gardens followed the miners and, where horses were brought in to transport freight, a few native grasslands were mowed for hay and later plowed to grow oats and potatoes. Timber was cut for fuel or building materials, and small-scale land clearing followed more or less accidentally. By 1898 there was sufficient interest in Alaska’s agricultural potential to warrant the U.S. Department of Agriculture opening an experimental station at Sitka. In the next two decades six more experimental farms were established. Of these, the Rampart Station in the Yukon Valley was the northernmost; the others were at Fairbanks, Copper Center, Matanuska, Kenai, and Kodiak.

Development of Alaska agriculture is unique in many ways and the development of the School of Agriculture is one example. The Alaska Agricultural Experiment Stations were established in 1898, and the School of Agriculture was established afterwards, in 1922. In virtually all other states, the sequence was reversed due to statehood provisions. Alaska did not become a state until 1959, however.

The experiment stations at Fairbanks and Palmer were transferred to the college in 1931 (UAF, 2008). The college was named the University of Alaska in 1935, eventually becoming the University of Alaska Fairbanks as other campuses developed. These initial experiments showed crops could be grown in Alaska and helped dispel the notion of a frozen north, unable to provide for itself.

Current research at the University of Alaska Fairbanks includes vegetable cultivars, grains, grasses, potatoes, and berries. Animal and poultry management is ongoing as well as soils, revegetation, forestry, and rural development. Many of the techniques developed near Fairbanks can be used in the study area.

In general, food production was thought to be the base from which other resource development would proceed. However, the agricultural experiment was less successful than expected and agricultural production was insufficient to promote the development of other resources.

3.1.3 Statehood

After Alaska became a U.S. State in 1959, the approach toward agricultural development began to focus on new farms and larger-scale clearing. The discovery and shipment of oil from Prudhoe Bay further affected Alaska's approach towards agricultural development. In 1977, then Governor Jay Hammond attempted to bolster Alaska's food and economic self-sufficiency using proceeds from oil revenues. First, the Alaska Permanent Fund was established to provide revenues after oil dried-up; second, the Alaska Renewable Resources Corporation was established to provide debt and equity financing for renewable projects (fisheries, forestry, agriculture, and renewable energy); and third, Alaska attempted to develop agricultural projects at Delta Junction (barley) and Point MacKenzie (dairy farms). Of these three efforts, only the Permanent Fund and its annual dividend payouts still thrive. Remnants of the two other projects still exist.

3.1.3.1 State Agricultural Projects

The state spent approximately $41 million between the years 1978 to 1982 to develop the agricultural industry, starting with the Delta Barley project (Davies, 2008). The second major project was at Point MacKenzie, with dairy farms as the primary focus. As the mid 1980s saw dropping oil prices, project setbacks, and a new administration, administration support for these two active projects was reduced. A third potential project, the Totchaket area west of Nenana was proposed but never developed. The 175,000 acres of prime agricultural soils were located between the Tanana and Kantishna Rivers. Although the area is outside of the study area, it could be accessed via a series of bridges and perhaps spur, or secondary, roads.

Agricultural efforts failed for a number of reasons (Davies, 2008). Projected prices for agricultural products were not as high as expected (including barley and milk). Crops failed at Delta due to weather, grasshoppers, and a herd of wild bison that trampled the barley. Certain farmers were inexperienced while others could not meet required loan payments due to higher-than-expected costs and lower-than-projected payments. The Matanuska Maid cooperative dairy at Palmer declared bankruptcy in 1984 and the state took it over. After several years of state ownership, Matanuska Maid was closed in 2008 and its assets were sold.

One private program in the study area did achieve some success. The Marston Garden project helped residents in the Kobuk and Koyukuk river drainages along with other western Alaska communities to developed small gardens. The initiator was General "Muktuk" Marston, who developed a non-profit organization to provide roto-tillers, seeds, supplies, and advice to villages that requested assistance. There are currently 24 villages listed as project participants, including six within the study area, that are supported by the foundation from its Palmer base.

3.2 Commercial Agriculture

As discussed earlier, most commercial agriculture in the study area was developed in the late 1890s near Fairbanks. As provisions of the Homestead Act were extended to territorial residents, they began to stake land for development and eventual ownership. At the same time, the US Department of Agriculture opened a series of experimental stations starting at Sitka, in 1898, followed by stations at Kodiak, Kenai, Copper Center, Fairbanks, Matanuska, and (within the study area) Rampart. Figure 9 shows beets, carrots, and turnips grown in Rampart at the School Garden sometime during the 1896 to 1913 era. Only the Fairbanks and Matanuska stations remain active due to budget reductions and limited agricultural development needed to stimulate further research.

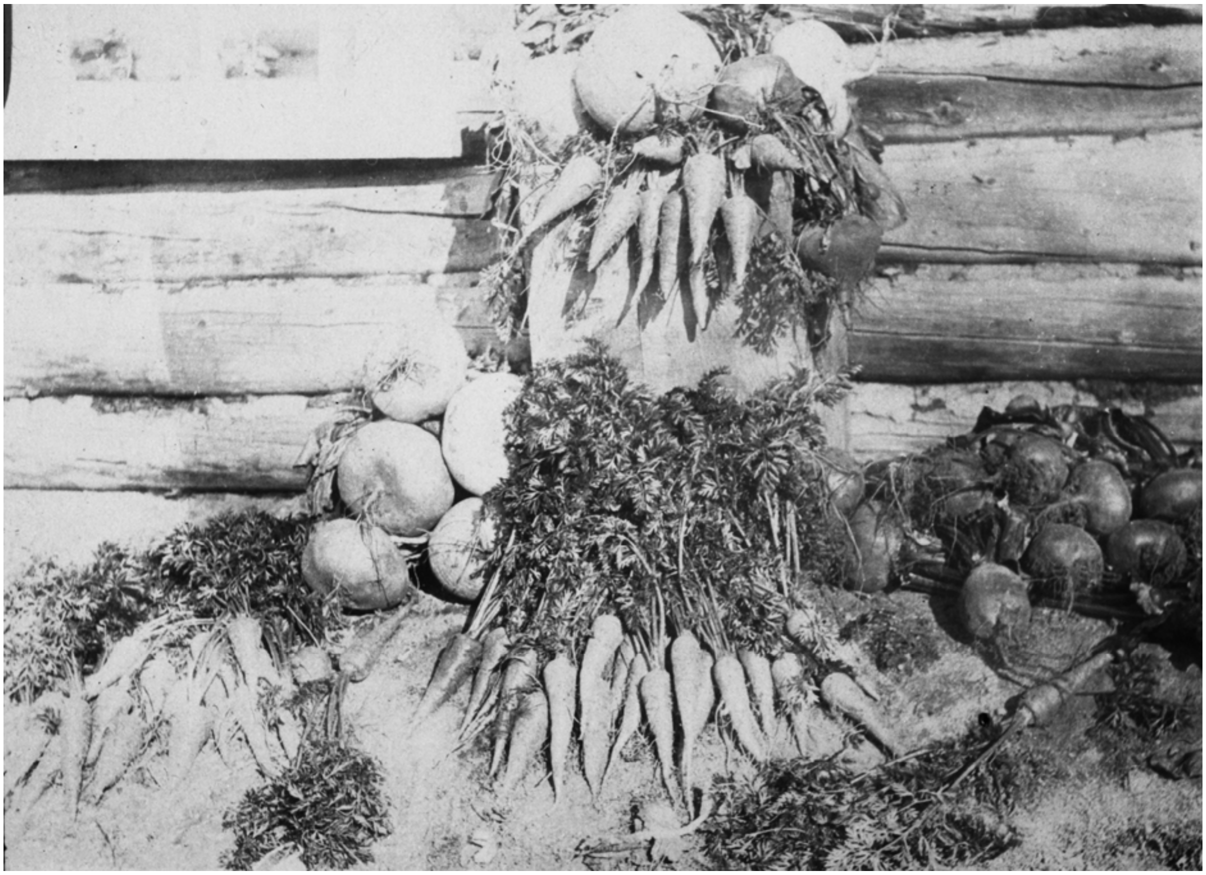

Figure 9: Rampart Alaska, School Vegetables

Source: University of Alaska Archives, Lawyer and Cora Rivenburg Photograph Collection, 1910-1912. Used by permission.

Other gardens and agricultural development occurred with many visitors noting the gardens that were developed and maintained at Holy Cross, starting before 1900. Figure 10 shows a picture of the mission garden in 1914. In 1888 the Sisters at the Holy Cross Catholic Mission developed a 22 square-foot garden that later grew to 10 acres (Babcock 1995).

Figure 10: Holy Cross, Gardens, 1914

Source: University of Washington Archives. Used with permission.

3.2.1 Census of Agriculture 2002

The United States Department of Agriculture completes the Census of Agriculture every five years. The most recent survey available is 2002, while the 2007 Census of Agriculture is expected to be available in early 2009 (USDA, 2008). Table 3 illustrates farm data for the study area, base year 2002. The western part of the study area is within the Aleutian area and the eastern portion of the area is within the Fairbanks area.

Table 3: Aleutian and Fairbanks Farm Data, 2002

Area	Farms, 2002	Farm Acreage	Average Size	Total Market Value, Production	Production Value, per Farm	Government Payments, average per farm	Net Cash Farm Income
Aleutian	36	706,988	19,639	$9,130	N/D	N/D	($17,433)
Fairbanks	187	109,990	588	$5,285,000	$28,261	$27,537	$8,285
Total	223	816,978	3,664	$5,294,130	$23,740	Unk	Unk

Source: USDA, National Agricultural Statistics Service, 2002.

For the Aleutians, the average market value of 2002 farm production was $254 per farm, or $0.013 per acre. This low amount is likely a reflection of reindeer herding, with lower production values than crops, as the average reported farm size is quite large at 19,600 acres (rounded).

For the Fairbanks reporting area (including parts of the study area), $28,261 was the average production value per farm in 2002, or $48.05 per acre. Average farm size was 588 acres and typical crops included barley, oats, potatoes, and hay; livestock was primarily beef, with smaller amounts of hogs and sheep (NASS, 2007).

3.2.2 Reindeer Herding

Reindeer were introduced to Alaska in 1891 due to a crash in the local caribou herd population. Sixteen reindeer were imported from Siberia on the revenue cutter Bear, with Amaknak Island as their first stop. They were introduced on the Seward Peninsula in 1892 and are still found in this area today (Jernsletten and Klokov, 2002). Animal counts rose to 10,000 in 1905 and 640,000 in 1932. In 2006, there were an estimated 15,000 reindeer (USDA NASS, 2007) with most of them on the Seward Peninsula. The Reindeer Act of 1937 restricted ownership of reindeer to Alaska Natives, though the Act has been challenged as not applying to imported livestock.

3.3 Gross Valuation of Agricultural Lands

The acres utilized for agricultural activities and their production value is described in this section. Table 4 illustrates the gross resource values for agricultural land within the study area as shown in Figure 8.

Gross agricultural values are based on NASS statistics and represent gross farm product values, not net values or production values. These are coarse estimates based on land classification and do not reflect adjustments for land ownership, management policies, or actual on-the-ground inventories. Rather, the values provide an order-of-magnitude value that is useful for planning and initial route analysis.

Upland values are from NASS statistics for Fairbanks farm product values in dollars per acre. Reindeer grazing values are based on NASS data for the Seward Peninsula and reflect reindeer product values on a dollars (or cents) per acre basis. Lowland figures are adjusted downward from Fairbanks values based on a ratio of estimated productivity.

Table 4: Agricultural Lands, Three Gross Production Value Estimates

Ag Land Class	Gross Acres	Acres Utilized	$ per Acre	Gross Value
Upland	3,721,400	1,088	$45.00	$48,960
Lowland	5,340,600	861	$10.00	$8,610
Reindeer	14,124,200	12,700,780	$0.02	$254,016
Total	23,186,200	12,702,729		$311,586

Source: Northern Economics, NASS data, 2007.

4.0 FORESTRY

There are two principal forest types in Alaska: the coastal forest and the interior forest. The coastal forest is located along the maritime climatic zone, from Ketchikan north and then west to Kodiak. The interior forest is located north of Girdwood and extends to the Brooks mountain range in the north, east to Canada, and west to the central portion of the study area. The interior forest is only forest type within the study area.

Within the study area, there are five principal tree species: white spruce, black spruce, paper birch, cottonwood, and aspen. The first two are coniferous and the latter three are deciduous. In addition, there are scattered stands of larch (or tamarack), willow, and alder.

This section of the report describes forest uses, which extend back to Ice Age times, their current uses, and their resource potential within the study area.

4.1 Historical Use of Forest Products

Historic forestry activity was limited to driftwood collection for homes and heating and, after Russian contact, with sawmills and rough lumber for homes, fish drying racks, and boardwalks. Russian explorers noted Aleuts in a treeless area lived in huts or yurts made of driftwood, also called barabaras (Fedorova, 1973). Limited development of forest products occurred in the mid to late 1800s as mills in coastal Alaska provided timber for fishing and mining interests in the study area. Manufactured lumber was transported by sailboats, initially, and then by steamers.

A notable expansion of wood consumption occurred along the Yukon River as steamboats requiring firewood for fuel flourished in shallow waters. From 1897 to 1902, Northern Commercial Company steamships used 48,438 cords of firewood, consuming one to five cords of wood an hour per steamship, and up to 40 cords per day for power generation in Fairbanks (Alaska Humanities Forum, 2008 and Kitchener, 1954).

4.1.1 Pre-Russian

Many homes in the study area were built with driftwood, often worked into the earth (especially in the western part of the study area) for added insulation. Figure 11 shows a picture of this type of home.

Figure 11: Wood and Earthen Home
Source: University of Alaska library, R. C. Force Papers, 1900-1910. Used by permission.

4.1.2 Russian

Attempts to transplant Sitka spruce to the Aleutian Chain in 1805 by the Russian Priest Veniaminov are the first recorded in North America (Alden and Bruce, 1989). Russian immigrants needed trees for fuel, construction, and ship repair and when they arrived, there were no trees in the Aleutians.

As Russian settlers moved north toward Norton Sound and into the Interior, along the Kuskokwim and Yukon Rivers, they built forts, trading posts, and homes from logs and rough-sawn lumber.

Residents burned wood as a heating fuel, with many homes in treeless areas on the western part of the study area heated solely with driftwood. Driftwood is available in treeless areas because as stream banks are undercut by high water flows, trees fall into rivers and drift downstream. Residents collected these trees and cut them into firewood. This same approach is used today in Tanana and other riverside areas within the study area. Residents use boats to reach driftwood, tie lines to the trees, and then drag them to shore. Figure 12 illustrates driftwood logs harvested from the Yukon and cut into smaller firewood lengths.

Figure 12: Tanana, Driftwood Logs, Cut Firewood

Source: Northern Economics Inc. 2007

4.1.3 US Territory

As the United States assumed control of the Alaska Territory after its purchase in 1867, use of forest resources remained about the same up until gold was discovered in the late 1890s. Figure 13 shows a sternwheeler (the Sarah) and wood barge on the Yukon River.

Figure 13: Yukon Sternwheeler with Firewood Barge

Credit: Library of Congress, Prints & Photographs Division, Lot 11453-1, no. 475 [P&P].

The steamboat era started in 1869 with Alaska Commercial's *Yukon,* a wood-fired vessel that was 49 feet long and approximately 12 feet wide. It burned one cord of wood per hour going upstream against the 4-5 mph current and 0.5 cords per hour when going downstream (Marshall, 1981). The steam boilers drove paddles in the rear, much like riverboats on the Mississippi River.

Competition began in 1891 with the North American Transportation company also scheduling boat and barge service. There were three steamers in 1892, seven in 1896, and approximately 40 during the years 1897 to 1900 (Marshall, 1981).

The largest three sternwheelers were 223 feet in length and 42 feet in width, burning wood in 1,000 hp boilers at rates of 1 to 5 cords per hour. Wood purchased for sternwheelers was specified at 4 feet in length and with a 5-inch minimum diameter and within 50 feet of the river. Companies soon established wood yards where vessels could “wood up” and not have to stop two or three times each day and cut wood. Wood was hauled to boats with carts.

Although coal was occasionally located and burned in homes and boats (especially in the lower 200 to 400 miles of the Yukon where the only other option was driftwood), oil became a common fuel source. Oil was burned starting in 1903 with an estimated 50,000 barrels imported in 1907, but wood was still used as a fuel for many years.

The Northern Commercial Company (NC), a successor to the Russian-American Company, burned a considerable amount of firewood. NC records reported steamship fuel wood consumption of 48,438 cords for the years 1897 to 1902. This wood volume represents over 3,200 acres of harvest (at 15 cords average volume per acre) or approximately 550 acres per year, making this six-year period one of the most significant in terms of harvesting. Within the study area, this is the likely peak or high point of forest resource use, even though it was over 100 years ago.

In Fairbanks, the Northern Commercial Company also installed a 75-horsepower wood-fed boiler and engine (during the winter of 1903/04) to furnish electricity to its store, much like its facility in Nome. Demand grew wildly and by 1905, the company was furnishing power from a 240 horsepower boiler and lighting over 3,000 electric bulbs (Kitchener, 1954). Horse-drawn sleds carried load of up to seven cords on frozen rivers.

The boilers were fed initially with wood at an estimated 40 cords per day, eventually turning to coal from Healy and finally in 1950, the City of Fairbanks began to generate its own power with NCC selling its equipment in 1952 to the Healy River Coal Corporation.

4.1.4 Statehood

The first statewide forest inventory was published in 1967 by the US Forest Service (Hutchinson, 1967). It suggested the interior had over 22.5 million acres of commercial forest. Within the study area, forestland was located and evaluated based on the Soil Conservation Service’s Exploratory Soil Survey (USDA, 1979). Discussions with soils specialists indicate several sites within the study area have more detailed analysis, soil mapping, and forest inventory, but there is no single project-level agricultural or soil mapping, so the total amount of agricultural land within the study area is still approximate (Cox, 2008).

The Exploratory Soil Survey contained both mapping units and symbols that denote soil differences along with land and climate differences. The map ratings include estimates of commercial forestry for each map unit and these were consolidated into a map titled "Commercial Forestry Potential in Interior Alaska." (Marshall, 1981). This map was digitized and illustrated previously as Figure 3.

Part of the study area includes the western portion of the Tanana Valley State Forest. Figure 14 illustrates the study area and the Tanana State Forest that is located near Manley Hot Springs. This intensively managed forest represents a high level of forest utilization (Parsons and Associates, 2001) within a multiple-use context. It is not typical of most forests in the study area.

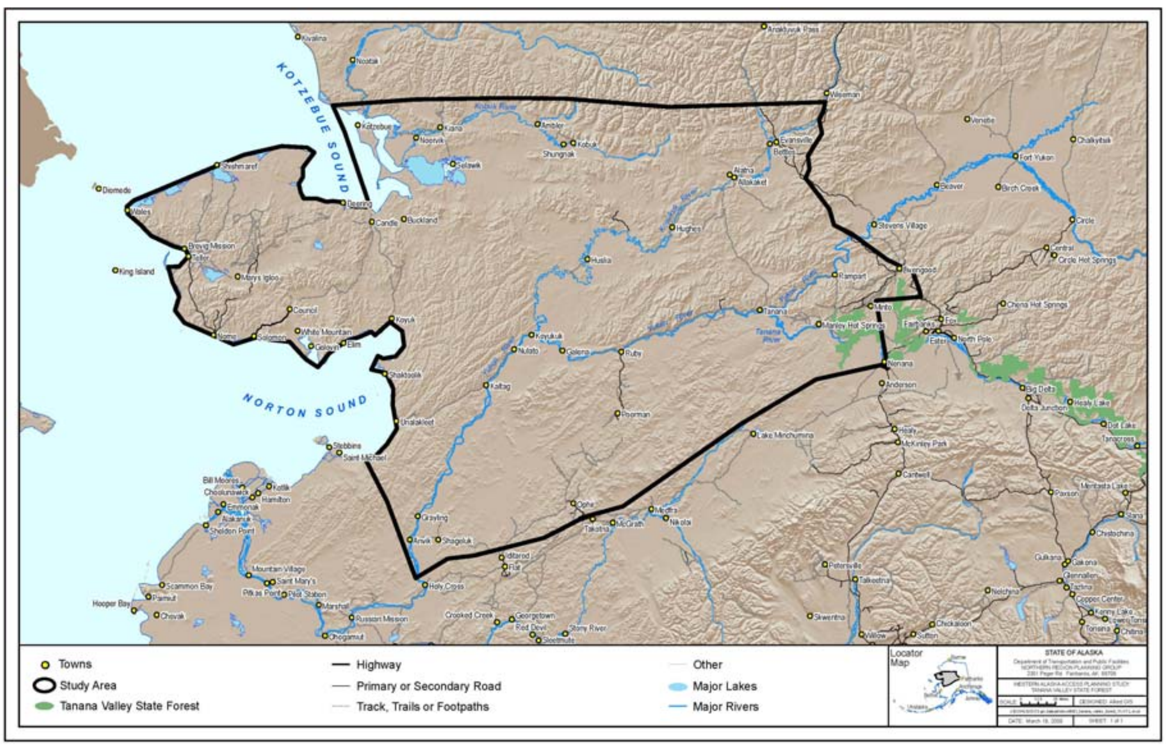

Figure 14: Tanana Valley State Forest

Source: DNR.

4.2 Forest Resource

Forest resources are described in this section including a description of land with high commercial forest potential and forests with low commercial forest potential.

Table 5 displays study area land classifications, by cover type. Approximately half or 36 million of the 72 million acres of land within the study area is forested land or land with a potential for forestry. The other approximately 36 million acres is tundra, with non-forested categories such as lichens, suitable for reindeer grazing, as well as mountains, glaciers, and water. Estimated water acreage is based on water classified within the GIS program at a relatively high altitude; actual acreages will vary.

Table 5: Western Alaska Access Study Area, Land Classification by Cover Type.

Study Area, Land Classification	**Acres**	**% of total**
Total Area	73,325,623	100
Total Water	664,879	0.9
Total Land	**72,660,744**	**99.1**
Forest		
High potential	369,630	0.5
Fair potential	8,404,951	11.5
Low potential	27,010,470	36.8
Subtotal Forest	**35,785,050**	**48.8**
Non-forest		
Tundra	**36,875,693**	**50.3**

Source: Northern Economics; Allied GIS; Reid, Collins 1981.

Available field data for the study area is shown for the high and low forest potential categories in the following sections. The higher potential forestlands are found on the eastern portion of the study area, near Fairbanks and Rampart, while lower potential forests are found alongside rivers, inland, or at higher latitudes and elevations.

4.2.1 Log Export

In the early 1980s, strong housing markets in Japan led to harvesting and round log export from private native lands near Nenana. Two operations developed; a Japanese exporter based in Oregon first exported white spruce logs from Seward and ITT Rayonier, Inc., led the second effort (Parsons, 2009).

Forest inventories showed the developed lands had a very uniform distribution of white spruce, with little evidence of forest fires or other disturbances that introduced patches of paper birch, aspen, or cottonwood. These attributes contributed to lower production costs and more stems of harvestable wood per acre, when compared to other forests in the Interior and Southcentral regions.

Mechanized and hand-felling techniques were common, with logs hauled by truck across ice roads to a rail siding near Nenana. A "working circle" radius of 25 to 30 miles provided enough resource to generate several ship loads at the dock in Seward. Rail costs from Nenana to Seward were greater than logging costs from stump to siding; scheduling rail cars (whether gondolas or flats) was problematic due to higher priorities for oil and gas freight.

As Japanese markets turned down in the middle 1980s, operations ceased and log export has been limited to more coastal areas, such as Afognak, Kodiak, Icy Bay, and most of Southeast Alaska.

Markets in Japan have shifted from interior post-and-beam construction to less expensive concrete structures. In addition, Russian white wood has met Asian demand for what remains of interior wood products. It is unlikely that export markets will rise to a level that would make project area logs marketable again, at least in the foreseeable future.

4.2.2 High Commercial Forest Potential

A detailed timber inventory was conducted in 1989 within the Tanana State Forest, at the confluence of the Kantishna and Tanana Rivers. The inventory (or "cruise") was designed to provide volume information for a land exchange with the State of Alaska, requiring more detail than normal. This type of forest, found within the study area, should be considered representative of the "high potential commercial forest" category.

Seventy-four sample trees were measured, felled, and bucked to derive defect information, along with log taper and internal (hidden) defect. Following this work, 234 field samples were measured with a combined standard error of average volume of 6.9 percent at the 95 percent confidence level. Variable log lengths were recorded on sample trees in an effort to maximize log quality (or grade). In addition, export and industry log grading rules were applied to each of the three species graded over the 2,627 forested acres. A total of 1,005 trees were sampled; 509 were graded for log quality using both export (market-based) and industry standard log rules and grades (Sanders and Kerr, 1989). For this analysis, cords of firewood are listed after board foot (BF) and cubic foot (CF) volumes. Log sorts and grades are shown to indicate the relative log quality from high (export sawlogs) to low (utility grade). Table 6 summarizes study results.

Table 6: Timber Data, Three Species, Kantishna River, 1989

Species	Log Sort/Grade	Net BF/Ac	Net CF/Ac	Cords/Ac	% by Species
Spruce	No. 2 Saw	41	9	0.1	
Spruce	No. 3 Saw	166	49	0.6	
Spruce	No. 4 Saw	787	234	2.8	
Spruce	Export #1 Saw	424	119	1.4	
Spruce	Export #2 Saw	5,731	1,870	22.0	
Spruce	Utility	221	71	0.8	
Spruce	Subtotal	7,370	2,352	27.7	95
Birch	No. 3 Saw	22	7	0.1	
Birch	No. 4 Saw	82	28	0.3	
Birch	Utility	136	54	0.6	
Birch	Subtotal	240	89	1.0	4
Cottonwood	No. 1 Saw	8	3	0.0	
Cottonwood	No. 2 Saw	6	3	0.0	
Cottonwood	No. 4 Saw	3	1	0.0	
Cottonwood	Utility	19	7	0.1	
Cottonwood	Subtotal	36	14	0.2	1
Total		7,646	2,455	28.	

Source: Reid, Collins, Timber Resource Management Plan for Five Villages in the NANA Region. 1981.

Note: BF is board feet, net, Scribner log rule; CF is cubic foot.

Results from this study indicate that a high potential forestland within the study area averages approximately 30 cords of wood per acre, with 95 percent of it as spruce.

4.2.3 Low Commercial Forest Potential

Reid, Collins Alaska Inc., a forestry consulting firm, completed a timber survey for five villages in the NANA region in 1981. Table 7 illustrates results from the NANA region. These results provide information from forest labeled as "low commercial forest potential" (Hogan, 1981).

The estimated acres are forested land within land selections associated with each of the five villages. The US Forest Service, State and Private Forestry branch provided the villages with an overall land management plan, including three forest classifications. Category P2 is the most productive forest and is found near Kobuk and Shungnak, generally as white spruce; P1 acres are somewhat less productive but exceed the US Forest Service minimum threshold for commercially viable forests. Other acres, labeled NPFL for Non-productive Forest Lands, are typically slow-growing black spruce in dense stands with permafrost. These forests do not meet the minimum standard for commercial forests by Forest Service definition, but they are often utilized for firewood by many residents.

Table 7: Forest Statistics, Five Villages, NANA Region, 1981

Area	Est. Acres	P2 Acres	P1 Acres	NPFL	Total
Ambler	9,442		18,835	17,075	35,910
Kiana	31,135		5,853	43,862	49,715
Kobuk, Shungnak	35,970	4,412	10,601	56,155	71,168
Selawik	125,250		820	1,170	1,990
Total	201,797	4,412	36,109	118,262	158,783
Percent of total		2	18	59	79
Cubic Feet per Acre		**CF/Ac, P2**	**CF/Ac, P1**	**CF/NPFL**	**Total**
Ambler			354	366	720
Kiana			607	444	1,051
Kobuk, Shungnak		1551	689	662	1,351
Selawik			607	444	1,051
Cords per Acre		**Cords/P2**	**Cords/P1**	**Cords/NPFL**	**Total**
Ambler			4.2	4.3	8.5
Kiana			7.1	5.2	12.4
Kobuk, Shungnak		18.2	8.1	7.8	34.1
Selawik			7.1	5.2	12.4

Source: Reid, Collins 1981.

Average volume per acre, for the five villages, is approximately 12 cords with a range from 8.5 (Ambler) to 34.1 (Kobuk, Shungnak). The overall average of 12 cords is used for low commercial potential forestland.

4.3 Forest Lands, Gross Valuation

The same basic valuation methodology used for agricultural lands is used for forestland. The estimated utilization or harvest levels are much less than the total available acreage and reflect current and "most likely conditions" over the project period. Estimated harvest volumes per acre are based on field sampling for high and low potential lands; the "fair" commercial potential is a best estimate from the project forester. Harvest levels are projected and could vary by 50 to 100 percentof the estimate.

Harvest values are estimated from current market prices obtained by phone interviews with foresters, wood buyers, and local agencies in Fairbanks, Tanana, and Kotzebue. Values per cord reflect average retail prices for Fairbanks (high potential) and Tanana (high to fair potential). Values for low potential lands are based on a per-sled load amount discussed with land managers for NANA and recent prices in villages near Kotzebue.

Table 8 illustrates results.

Table 8: Forest Lands, Gross Valuation

Forest Land	Total Acres	Est. Harvest	Cords/ acre	Cords/ Year	Value/ Cord	Value/ Acre	Total Value
High potential	369,600	370	30	11,088	$250	$7,500	$2,772,000
Fair potential	8,405,000	841	22	18,491	$250	$5,500	$4,622,750
Low potential	27,010,500	270	12	3,241	$150	$1,800	$486,189
Total	35,785,100	1,480		32,820			$7,880,939

Source: Northern Economics. Acres are rounded to the nearest 100.

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APPENDIX F

Fisheries Resource Paper

FISHERIES RESOURCES

WESTERN ALASKA ACCESS

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February 2009

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LIST OF ACRONYMS

CDQ .... Community Development Quota
DOWL .... DOWL HKM
IPHC .... International Pacific Halibut Commission
NSEDC .... Norton Sound Economic Development Corporation

EXECUTIVE SUMMARY

Commercial fisheries in the study area harvest primarily salmon, red king crab, Pacific halibut, and Pacific herring. The harvest of fish and shellfish species is also an important component of the subsistence economy in the study area, and during a commercial fishing season, many local residents participate in both commercial and subsistence harvest activities. Under State of Alaska and federal subsistence use priorities, commercial fishing (and sport fishing) in the study area may be restricted if subsistence needs are not met.

The salmon fisheries of the study area occur in the Norton Sound, Port Clarence, and Kotzebue Sound Districts and much of the Upper Yukon Area (Districts 4, 5, and 6). Commercial salmon fisheries in the Norton Sound, Port Clarence, and Kotzebue Sound Districts are only allowed to use set gillnets, which are operated from outboard powered skiffs. Most of the salmon catch is delivered to facilities operated by Norton Sound Seafood Products, a division of the Norton Sound Economic Development Corporation (NSEDC). Both Unalakleet and Nome have airports with jet service, which helps lower the cost of flying fresh fish to Anchorage, where it is sold locally or distributed to Lower 48 markets on passenger and cargo flights.

The decline in the number of salmon returning to rivers that drain into Norton Sound and Kotzebue Sound caused many subsistence and commercial fisheries to be restricted or closed in the early years of this decade. Moreover, dockside prices for Alaska wild salmon fell due to competition from farmed salmon. As shown in Table 1, harvest, ex-vessel revenue, and effort decreased dramatically; however, production in the commercial fisheries showed a substantial improvement beginning in 2005.

Table 1: Harvest, Ex-Vessel Revenue and Participation in the Norton Sound District Commercial Fisheries, 1990 – 2007

Fishery	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Harvest (Thousands of Pounds)																	
Norton Sound District Salmon Fisheries	1,074	1,176	1,497	1,221	3,177	1,021	1,973	715	1,796	194	709	236	18	163	338	692	937	1,184
Kotzebue Sound District Salmon Fisheries	1,428	1,942	2,360	599	1,148	2,343	631	1,158	452	1,094	1,371	1,847	-	218	421	623	1,041	1,210
Norton Sound King Crab Fishery	48	10	28	101	183	246	155	91	28	31	195	241	213	258	307	391	443	315
Halibut Fisheries	3	-	-	3	22	-	-	-	26	41	8	-	104	67	89	58	51	-
Norton Sound Gillnet Herring Roe and Bait Fisheries	7,377	5,703	-	6,681	1,535	8,396	6,580	5,026	3,033	4,080	5,461	2,972	2,001	2,899	-	3,513	1,345	66
Norton Sound Beach Seine Herring Roe Fishery	434	760	-	1,061	-	828	981	513	-	-	-	-	-	-	-	-	-	-
	Ex-Vessel Revenue (Thousands of Dollars)																	
Norton Sound District Salmon Fisheries	472	414	464	369	863	356	344	327	351	83	154	63	4	65	137	366	483	691
Kotzebue Sound District Salmon Fisheries	552	550	592	231	253	313	56	187	70	176	247	323	-	26	64	125	229	243
Norton Sound King Crab Fishery	247	27	63	127	402	706	351	179	45	99	623	897	1,285	1,004	944	1,338	1,123	894
Halibut Fisheries	5	-	-	4	34	-	-	-	22	59	17	-	194	186	260	170	170	-
Norton Sound Gillnet Herring Roe and Bait Fisheries	1,676.1	1,239.2	-	960.3	222.0	2,990.9	3,080.5	439.2	303.3	519.2	495.7	281.9	137.5	155.1	-	299.5	73.0	21.1
Norton Sound Beach Seine Herring Roe Fishery	145	231	-	142	-	283	381	48	-	-	-	-	-	-	-	-	-	-
	Number of Persons Fishing																	
Norton Sound District Salmon Fisheries	130	129	115	128	124	107	99	105	93	58	79	51	12	30	36	40	60	74
Kotzebue Sound District Salmon Fisheries	149	136	142	113	108	91	54	68	44	59	64	65	3	4	43	41	43	46
Norton Sound King Crab Fishery	12	11	16	20	62	98	51	17	16	12	19	29	35	38	29	35	30	34
Halibut Fisheries	1	-	-	1	14	-	-	-	9	8	4	-	11	9	11	10	8	-
Norton Sound Gillnet Herring Roe and Bait Fisheries	278	187	1	215	170	167	204	169	41	104	78	66	47	32	1	56	42	8
Norton Sound Beach Seine Herring Roe Fishery	5	5	-	5	2	4	5	3	-	-	2	-	-	-	-	-	-	-

Note: To comply with data confidentiality restrictions under Alaska Statute 16.05.815, harvest and revenue data have been estimated for those years when fewer than four persons participated in the fisheries. The estimates are based on the averages of reported data.

Source: Alaska Commercial Fishing Entry Commission at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm

The Norton Sound red king crab commercial fishery, which occurs in the Norton Sound Section (Q3), has had a superexclusive designation and has become a small-scale local fishery. The NSEDC and Yukon Delta Fisheries Development Association CDQ groups were allocated a portion of the summer harvest beginning in 1998, although no CDQ harvest occurred until the 2000 season. Most of the crab harvested in the fishery has been processed in the Norton Sound Seafood Center in Nome. Production in the fishery during the 1990-2007 period has shown an overall increasing trend (Table 1).

Catches of Pacific halibut occur in small commercial longline fisheries around St. Lawrence Island in International Pacific Halibut Commission (IPHC) Area 4D and along the coastal areas adjacent to Norton Sound in IPHC Area 4E. The harvests in these fisheries are predominantly made by local fishers residing in NSEDC member communities. Halibut are delivered to a processing plant in Savoonga and the Norton Sound Seafood Center.

Arrival of Pacific herring on the spawning grounds is greatly influenced by climate and oceanic conditions, particularly the extent of the Bering Sea ice pack. Most herring spawning populations appear near the eastern Bering Sea coast immediately after ice breakup between mid-May and mid-June. Spawning progresses in a northerly direction and may continue into July or August along portions of the Seward Peninsula or within the Chukchi Sea. The largest abundance of herring in the Arctic-Yukon-Kuskokwim Region is in the Norton Sound District. Gillnets and beach seines are the only legal commercial herring fishing gear within Norton Sound (Banducci et al. 2007).

Since 1997, poor market conditions have been the primary reason for the low level of harvest, ex-vessel revenue, and effort in the commercial gillnet herring sac roe and bait fishery in Norton Sound (Table 1). However, stock status and climatic factors also have had an adverse effect. Further, the present market desires a high roe percent and larger size fish—these criteria have been difficult to achieve with beach seine gear, and in recent years no buyer interest has existed for herring harvested from beach seines.

The Upper Yukon Area has accounted for only a small fraction of the commercial harvest of king salmon in the Yukon River, but much of the summer chum salmon harvest has occurred in that area. Fish wheels and set gillnets are the legal gear types for commercial salmon fishing in the Upper Yukon Area. Low commercial harvests occurred between 1997 and 2002 because of low summer chum salmon runs (Table 2). Summer chum salmon runs have exhibited improvements since 2001; however, future commercial harvests of summer chum salmon may be adversely affected by potentially poor king salmon runs, as king salmon are incidentally harvested in fisheries directed at chum salmon. In addition, in most of the Upper Yukon Area, summer chum salmon flesh is difficult to market due to the high cost of transportation and the degradation caused by fresh water and advancing sexual maturity. While the summer chum salmon roe quality is considered to be excellent, roe production may be constrained by the state's wanton waste law, which prohibits the discarding of stripped carcasses.

Table 2: Harvest, Ex-Vessel Revenue and Participation by Community in the Upper Yukon Commercial Fish Wheel and Gillnet Salmon Fisheries, 1990 – 2007

Fishery	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Harvest (Thousands of Pounds)																	
Fish Wheel Salmon Fisheries	819.1	766.5	361.0	98.8	356.6	1,132	616.0	284.2	19.0	60.5	-	-	35.2	195.6	167.7	575.8	570.2	188.1
Gillnet Salmon Fisheries	104.0	127.2	75.8	45.0	48.7	77.0	82.5	50.6	3.0	20.0	-	-	9.7	9.5	12.9	9.2	19.5	6.6
	Ex-Vessel Revenue (Thousands of Dollars)																	
Fish Wheel Salmon Fisheries	623.5	725.9	607.1	225.0	439.1	1,186	877.6	180.3	15.9	58.2	-	-	18.5	47.2	38.9	94.5	104.6	70.7
Gillnet Salmon Fisheries	173.8	160.4	154.1	95.3	98.8	179.1	198.3	54.6	3.0	20.8	-	-	6.7	10.4	12.8	9.6	12.8	9.4
	Number of Persons Fishing																	
Fish Wheel Salmon Fisheries	117	110	111	88	73	106	107	63	22	25	-	-	12	20	14	15	26	24
Gillnet Salmon Fisheries	34	35	32	35	30	36	29	22	6	13	-	-	12	7	9	6	10	6

Source: Alaska Commercial Fishing Entry Commission at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm

Construction of a highway between the contiguous Alaska highway system and the highway system on the Seward Peninsula has the potential to foster additional development of commercial fisheries in the study area. However, even if road transportation proves to be a less expensive alternative to air or marine service, it will likely continue to cost more to ship fish products to Lower 48 or foreign markets from study area communities than it does from processing plants on the coast of southeast or southcentral Alaska. Moreover, resource and other constraints, such as regulatory limitations on waste, may pose significant challenges for further commercial development of commercial fisheries in the study area.

1.0 OVERVIEW OF FISHERIES IN THE STUDY AREA

This working paper evaluates the potential for development of commercial and subsistence fisheries in the study area, including the potential quantity, quality, value, marketability, and geographic location of fishery resources. The working paper on recreation resources and tourism describes sport fisheries potential.

The commercial salmon fisheries of the study area occur in the Arctic Management Area and Yukon Management Area of the Alaska Department of Fish and Game. The study area includes the Norton Sound, Port Clarence, and Kotzebue Sound Districts of the Arctic Management Area, while in the Yukon Management Area the study area encompasses much of the Upper Yukon Area (Districts 4, 5, and 6). The commercial salmon fisheries in the study area catch five species of salmon: king salmon *Oncorhynchus tshawytscha*, chum salmon *O. keta*, coho salmon *O. kisutch*, pink salmon *O. gorbuscha*, and sockeye salmon *O. nerka*. In addition to salmon, commercial fisheries in the study area harvest red king crab *Paralithodes camtschaticus*, Pacific halibut *Hippoglossus stenolepis*, and Pacific herring *Clupea pallasi*.

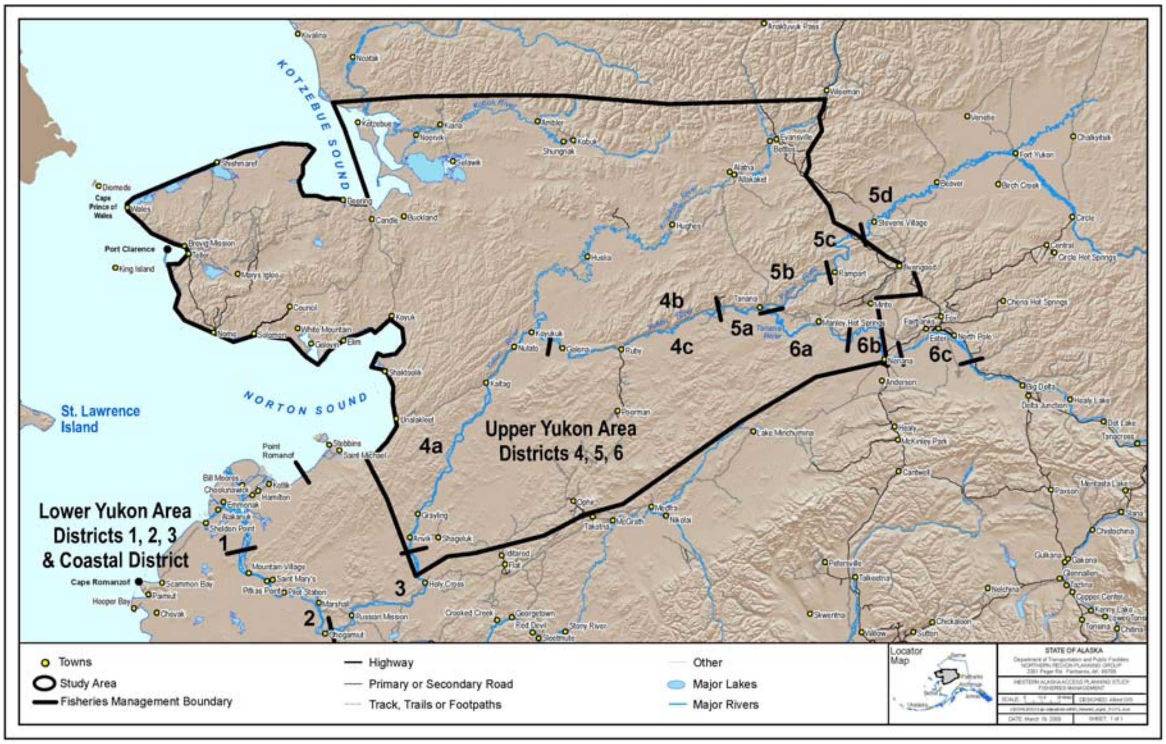

Figure 1: Fishery Management Areas in the Study Area
Source: Bue and Hayes (2008)

Miscellaneous species such as inconnu (sheefish) *Stenodus leucichthys*, whitefish *Coregonus* sp. and *Prosopium* sp., Dolly Varden *Salvelinus malma*, Arctic Char *Salvelinus alpinus*, Arctic lamprey *Lamperta japonica* and burbot *Lota lota* may also be caught in the study area for commercial or subsistence purposes. Subsistence fishing for these species has few restrictions other than the general statewide provisions. Most species may be taken at any time with no harvest limits and no required permits. Commercial harvest may be prohibited in some freshwater areas, but commercial endeavors are allowed in many areas under terms of a permit. The commercial fisheries for the miscellaneous species tend to be limited or experimental operations and occur sporadically. Restricted markets outside the study area greatly limit commercial activity (Hayes et al 2008; Soong et al. 2008). The available data on commercial and subsistence fisheries for miscellaneous species are summarized in Appendix 1.

There are approximately 18,000 people in the study area, the majority of whom are Native Alaskans (Yup'ik, Iñupiat, and Athabascan Indian), residing in more than 40 villages scattered along the coast and major river systems. Nearly all of the local residents are dependent to varying degrees on fish and game resources for their livelihood. Most commercial fishers and many buying station workers are resident Native Alaskans. In addition, the harvest of fish and shellfish species is an important component of the subsistence economy in the study area. During a commercial fishing season, many residents participate in both commercial and subsistence harvest activities. The cash income derived from the commercial salmon fishery has assisted many area residents in their subsistence lifestyle. For example, income earned from commercial fishing is often used to obtain hunting and fishing gear such as nets, boats, and outboard motors, which are utilized in subsistence activities (Hayes et al. 2008).

The Alaska State Legislature and Alaska Board of Fisheries have designated subsistence use as the highest priority among beneficial uses of fishery resources. Further, the Alaska National Interest Lands Conservation Act of 1980 mandates that rural subsistence users have a priority over other users to take wildlife on federal public lands where recognized customary and traditional use patterns exist. Under these state and federal subsistence use priorities, commercial fishing (and sport fishing) in the study area may be restricted if subsistence needs are not met.

2.0 NORTON SOUND, PORT CLARENCE, AND KOTZEBUE SOUND

2.1 Salmon

Norton Sound, Port Clarence, and Kotzebue Sound salmon management districts include all waters from Point Romanof in southern Norton Sound to Point Hope, and St. Lawrence Island (Figure 1). These management districts are over 65,000 mi^2, and have a coastline exceeding that of California, Oregon, and Washington combined. Commercial fishing gear is restricted to set gillnets, which are operated from outboard powered skiffs (Banducci et al. 2007). Most of the salmon catch is delivered to facilities operated by Norton Sound Seafood Products, a division of the Norton Sound Economic Development Corporation (NSEDC) (a Community Development Quota (CDQ) group created under the Magnuson-Stevens Fishery Conservation and Management Act). Norton Sound Seafood Products operates facilities throughout the region including the Unalakleet plant, the Norton Sound Seafood Center in Nome, and buying stations at Elim, Golovin, and Shaktoolik (NSEDC undated). NSEDC also owns two custom-built 39-ft combination tendering/fishing vessels, and a custom-built refrigerated sea water barge. These vessels, the *Golovin Bay*, the *Norton Bay*, and the *Besboro* are designed and constructed specifically for conditions in Norton Sound and the Bering Sea and are intended to be used in support of the fisheries in the region (NSEDC undated). Both Unalakleet and Nome have airports with jet service, which helps lower the cost of flying fresh fish to Anchorage, where it is sold locally or distributed to Lower 48 markets on passenger and cargo flights.

The Norton Sound District extends from Cape Douglas south to Point Romanof. The area open to commercial salmon fishing is divided into six subdistricts. Each subdistrict contains at least one major spawning stream with commercial fishing effort located in the ocean near stream mouths. Except for Nome Subdistrict, commercial fishing can only occur if salmon runs are sufficient and a commercial market opens; Nome Subdistrict is managed intensively for subsistence use. The Port Clarence District encompasses all waters from Cape Douglas north to Cape Prince of Wales. The area open to commercial salmon fishing is adjacent to the communities of Brevig Mission and Teller (Menard 2008).

Commercial fishing in the Norton Sound District typically begins in June and targets king salmon if sufficient run strength exists. Emphasis switches to chum salmon in July and the coho salmon fishery begins the fourth week of July and closes in September. Pink salmon may be abundant in even numbered year returns. A pink salmon-directed fishery may replace or may be scheduled to alternate periods with the historical chum-directed fishery (Banducci et al. 2007). Salmon management in the Norton District changed significantly during the mid to late 1990s because of limited market conditions and marginal returns of many salmon stocks within the district (Banducci et al. 2007). The decline in the number of salmon returning to rivers that drain into Norton Sound caused many subsistence and commercial fisheries to be restricted or closed (Alaska Department of Fish and Game 2008). Moreover, dockside prices for Alaska wild salmon fell due to competition from farmed salmon (Knapp et al. 2007). As shown in Table 3, harvest, ex-vessel revenue, and effort decreased dramatically; however, production in the commercial fisheries showed a substantial improvement beginning in 2005.

Table 3: Harvest, Ex-Vessel Revenue and Participation by Community in the Norton Sound District Commercial Salmon Fisheries, 1990 – 2007

Community	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Harvest (Thousands of Pounds)																	
Unalakleet	652.6	715.9	1,046.1	527.9	1,742.5	630.9	849.4	457.9	568.3	147.7	261.2	130.2	10.3	116.7	224.5	453.5	641.3	691.3
Shaktoolik	226.7	284.4	302.6	441.3	1,104.5	283.0	843.4	108.8	779.6	34.7	272.0	34.7	6.1	33.9	93.6	170.3	198.6	327.4
Elim	66.8	44.9	95.7	117.7	192.9	57.9	192.6	59.1	309.4	-	136.6	18.5	-	-	-	-	35.0	113.4
Outside Area	9.7	8.6	2.1	16.7	37.5	2.8	18.7	6.4	59.5	8.7	7.9	0.7	1.2	12.7	20.2	51.1	62.1	20.6
Golovin	89.4	73.6	-	50.0	23.6	34.7	22.5	56.9	39.6	-	19.7	51.9	-	-	-	17.0	-	-
Nome	19.5	17.3	39.5	16.7	27.2	8.4	18.7	14.2	39.6	2.9	7.9	-	-	-	-	-	-	-
Koyuk	4.9	13.6	8.4	42.0	27.2	2.8	18.7	-	-	-	-	-	-	-	-	-	-	-
Teller	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.9
White Mountain	4.9	17.3	-	8.3	9.1	-	9.4	7.1	-	-	3.9	-	-	-	-	-	-	-
Kotzebue	-	-	2.1	-	12.5	-	-	2.1	-	-	-	-	-	-	-	-	-	-
Noorvik	-	-	-	-	-	-	-	2.1	-	-	-	-	-	-	-	-	-	-
Total	1,074.4	1,175.6	1,496.6	1,220.6	3,177.0	1,020.6	1,973.4	714.9	1,796.0	193.9	709.1	236.0	17.6	163.2	338.3	691.9	937.0	1,183.6
	Ex-Vessel Revenue (Thousands of Dollars)																	
Unalakleet	322.3	269.0	327.9	186.1	533.3	239.8	188.9	225.2	163.9	63.5	81.8	37.6	2.1	45.6	90.4	239.0	332.6	416.2
Shaktoolik	89.8	90.9	88.5	113.2	232.6	81.2	117.0	51.7	118.8	14.5	42.1	9.8	1.2	13.9	38.3	90.6	100.9	193.2
Elim	27.9	17.6	32.3	34.3	55.5	22.2	25.9	26.3	46.2	-	20.6	4.9	-	-	-	-	17.8	56.1
Outside Area	3.1	2.5	0.7	4.0	8.4	0.8	2.3	3.0	9.6	3.6	1.8	0.5	0.2	5.3	8.2	27.2	31.9	10.2
Golovin	19.7	18.6	-	12.1	13.2	9.0	4.2	13.4	6.4	-	4.5	10.1	-	-	-	9.1	-	-
Nome	6.3	4.9	12.3	4.0	7.4	2.4	2.3	3.3	6.4	1.2	1.8	-	-	-	-	-	-	-
Koyuk	1.6	5.0	2.0	13.0	7.4	0.8	2.3	-	-	-	-	-	-	-	-	-	-	-
Teller	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.3
White Mountain	1.6	4.9	-	2.0	2.5	-	1.2	1.7	-	-	0.9	-	-	-	-	-	-	-
Kotzebue	-	-	0.7	-	2.8	-	-	1.0	-	-	-	-	-	-	-	-	-	-
Noorvik	-	-	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	-
Total	472.3	413.5	464.4	368.7	863.1	356.2	344.2	326.6	351.4	82.8	153.6	62.9	3.6	64.9	136.9	365.8	483.2	691.0
	Number of Persons Fishing																	
Unalakleet	65	66	60	57	64	57	51	51	51	42	37	27	5	20	24	26	36	42
Shaktoolik	22	21	23	22	22	20	18	15	18	12	17	11	6	8	9	10	17	16
Elim	25	24	20	28	23	17	19	23	17	-	15	5	-	-	-	-	3	11
Outside Area	2	1	1	2	3	1	2	3	3	3	2	3	1	2	3	3	4	2
Golovin	10	9	-	6	4	8	4	8	2	-	5	5	-	-	-	1	-	-
Nome	4	2	4	2	3	3	2	2	2	1	2	-	-	-	-	-	-	-
Koyuk	1	4	6	10	3	1	2	-	-	-	-	-	-	-	-	-	-	-
Teller	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
White Mountain	1	2	-	1	1	-	1	1	-	-	1	-	-	-	-	-	-	-
Kotzebue	-	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
Noorvik	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Total	130	129	115	128	124	107	99	105	93	58	79	51	12	30	36	40	60	74

Source: Alaska Commercial Fishing Entry Commission at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm

The Kotzebue District salmon fisheries occur from Cape Prince of Wales to Point Hope. The Kotzebue District is divided into three subdistricts. Subdistrict 1 has six statistical areas open to commercial salmon fishing. Within the Kotzebue District chum salmon are the most abundant anadromous fish. Other salmon species (king, pink, coho, and sockeye) occur in lesser numbers, as do Dolly Varden and sheefish (Menard 2008). The Kobuk River is thought to support up to 60 percent of the commercial catch of chum salmon in the Kotzebue District (Menard and Kent 2007).

Commercial salmon harvests and ex-vessel revenue in the Kotzebue District were low during the 2002-2005 period as buyers began to purchase less salmon (Table 4). Fishing effort also decreased with the substantial price declines and lack of market (Menard 2008). However, in recent years there has been a marked improvement in production in the commercial fisheries.

Table 4: Harvest, Ex-Vessel Revenue and Participation by Community in the Kotzebue District Commercial Salmon Fisheries, 1990 – 2007

Community	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Harvest (Thousands of Pounds)																	
Kotzebue	1,140	1,492	1,859	496	942	1,933	517	924	384	972	1,182	1,483	-	109	325	592	991	1,131
Outside Area	200	184	315	39	85	237	67	130	27	61	84	182	-	-	64	15	25	53
Ambler	26	140	97	15	57	49	29	51	27	25	21	91	-	109	-	-	-	-
Selawik	9	27	12	22	22	49	10	26	14	25	21	91	-	-	32	15	25	26
Noorvik	17	41	37	15	11	25	10	-	-	-	21	-	-	-	-	-	-	-
Nome	9	15	15	5	20	25	-	28	-	11	42	-	-	-	-	-	-	-
Kiana	9	27	12	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Buckland	-	-	12	-	11	25	-	-	-	-	-	-	-	-	-	-	-	-
Nenana	9	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shishmaref	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	1,428	1,942	2,360	599	1,148	2,343	631	1,158	452	1,094	1,371	1,847	-	218	421	623	1,041	1,210
	Ex-Vessel Revenue (Thousands of Dollars)																	
Kotzebue	440	423	467	191	207	258	46	149	60	156	213	260	-	13	49	119	218	227
Outside Area	77	52	79	15	19	32	6	21	4	10	15	32	-	-	10	3	5	11
Ambler	10	39	24	6	12	7	3	8	4	4	4	16	-	13	-	-	-	-
Selawik	3	8	3	8	5	7	1	4	2	4	4	16	-	-	5	3	5	5
Noorvik	7	12	9	6	2	3	1	-	-	-	4	-	-	-	-	-	-	-
Nome	3	4	4	2	4	3	-	5	-	2	8	-	-	-	-	-	-	-
Kiana	3	8	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Buckland	-	-	3	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-
Nenana	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shishmaref	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	552	550	592	231	253	313	56	187	70	176	247	323	-	26	64	125	229	243
	Number of Persons Fishing																	
Kotzebue	120	110	112	95	89	75	42	57	39	51	55	57	2	2	37	39	41	43
Outside Area	19	13	18	9	9	9	7	6	2	4	4	4	-	-	4	1	1	2
Ambler	3	4	5	2	4	2	3	2	2	1	1	2	1	2	-	-	-	-
Selawik	1	2	1	3	2	2	1	1	1	1	1	2	-	-	2	1	1	1
Noorvik	2	3	3	2	1	1	1	-	-	-	1	-	-	-	-	-	-	-
Nome	1	1	1	1	2	1	-	2	-	2	2	-	-	-	-	-	-	-
Kiana	1	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Buckland	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Nenana	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shishmaref	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	149	136	142	113	108	91	54	68	44	59	64	65	3	4	43	41	43	46

Note: To comply with data confidentiality restrictions under Alaska Statute 16.05.815, harvest and revenue data have been estimated for those years when fewer than four persons participated in the fisheries. The estimates are based on the averages of reported data.

Source: Alaska Commercial Fishing Entry Commission at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm

Subsistence fishing has long been an important food gathering activity for people of the Norton Sound and Kotzebue Sound drainages, but fish abundance and fishing activities vary from community to community. Subsistence fishers operate gillnets or seines in the main rivers, and to a lesser extent in coastal marine waters capturing primarily salmon, whitefish, Dolly Varden, and sheefish. Beach seines are used to catch schooling or spawning salmon and other species of fish. Some fishers base their fishing effort out of their village, while others move seasonally to fish camps where they stay for several days to several weeks. Along the Noatak and Kobuk rivers, where chum salmon runs are strong, household subsistence activities in middle and late summer revolve around catching, drying, and storing salmon (Banducci et al. 2007). Subsistence salmon harvests for each district are presented in Table 5.

Table 5: Salmon Subsistence Harvest (Number of Fish) by Species and District, 1994 – 2005

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	Norton Sound District											
King	7,212	7,766	7,255	8,998	8,295	6,144	4,149	5,576	5,469	5,290	3,169	4,087
Chum	24,776	43,014	34,585	26,803	20,032	19,398	17,283	20,213	17,817	13,913	3,200	12,008
Pink	70,821	38,594	64,724	27,200	51,933	20,017	38,308	30,261	64,354	49,674	61,813	53,236
Sockeye	1,161	1,222	1,182	1,892	1,214	1,177	682	767	763	801	383	774
Coho	22,108	23,015	26,304	16,476	19,007	14,342	17,062	14,550	15,086	14,105	8,225	13,896
Total	126,077	113,612	134,050	81,370	100,480	61,078	77,484	71,367	103,490	83,782	76,770	84,000
	Port Clarence District											
King	203	76	194	158	289	89	72	84	133	176	278	152
Chum	2,294	6,011	4,707	2,099	2,621	1,936	1,275	1,910	2,699	2,425	2,505	2,478
Pink	4,309	3,293	2,236	755	7,815	786	1,387	1,183	3,394	4,108	5,918	6,593
Sockeye	2,220	4,481	2,634	3,177	1,696	2,392	2,851	3,692	3,732	4,436	8,688	8,532
Coho	1,892	1,739	1,258	829	1,759	1,030	935	1,299	2,194	1,434	1,131	726
Total	10,918	15,600	11,029	7,019	14,179	6,233	6,521	8,167	12,152	12,578	18,520	18,481
	Kotzebue Area											
King	135	228	550	464	383	9	211	11	3	40	54	--
Chum	48,175	102,880	99,740	57,906	48,979	94,342	65,975	49,014	16,880	19,201	23,348	--
Pink	3,579	2,059	951	1,181	2,116	841	75	36	8	583	1,259	--
Sockeye	33	935	471	528	392	478	75	14	9	53	18	--
Coho	478	2,560	317	848	461	1,334	2,557	768	56	1,042	1,502	--
Total	52,400	108,662	102,029	60,925	52,330	97,004	68,893	49,844	16,955	20,918	26,181	--

Notes:

1) Norton District includes Gambell and Savoonga in 1997 and 1998.
2) Kotzebue Area normally includes Ambler, Kiana, Kobuk, Kotzebue, Noatek, Noorvik, and Shungnak.
3) Kotzebue Area includes Deering and Whales; does not include Kotzebue in 1994.
4) Kotzebue Area Includes Shismaref in 1995.
5) Kotzebue Area does not include Ambler in 2001.
6) Kotzebue Area includes only Noatak and Noorvik in 2002.
7) Kotzebue Area does not include Kotzebue in 2004.
8) No data collected for Kotzebue Area in 2005.

Source: Fall et al. (2007a)

2.2 Red King Crab

The Norton Sound red king crab commercial fishery occurs in the Norton Sound Section (Q3), which consists of all waters in Registration Area Q north of the latitude of Cape Romanzof, east of 168º west, and south of the latitude of Cape Prince of Wales. Regulation changes adopted in 1993 changed participation in the fishery to that of small boats. A superexclusive designation went into effect for the fishery in 1994—this designation stated that a vessel registered for the fishery may not be used to take king crab in any other registration area during that registration year. The summer harvest in the fishery is the only Alaska source of summer king crab. A small harvest of red king crab also occurs during the winter months, with most of the crab being sold locally or utilized for subsistence (Welch 2005). Fishing occurs through cracks or holes cut in the ice with the use of hand lines and pots. Unstable ice conditions have adversely affected catches in recent years. During years of stable ice conditions, approximately 100 fishers averaged 100 crabs each (Soong et al. 2008).

The NSEDC and Yukon Delta Fisheries Development Association CDQ groups were allocated a portion of the summer harvest beginning in 1998, although no harvest occurred until the 2000 season (Banducci et al. 2007). Only fishers designated by the two CDQ groups are allowed to participate in this portion of the fishery. In 2000, Norton Sound Seafood Products expanded its activity to purchase, process, and market Norton Sound red king crab (NSEDC undated). Most of the crab harvested in the Norton Sound fishery have been processed in the Norton Sound Seafood Center in Nome since the facility opened in 2002 (Alaska Department of Fish and Game 2008). Production in the fishery during the 1990-2007 period showed an overall increasing trend (Table 6).

Table 6: Harvest, Ex-Vessel Revenue and Participation by Community in the Norton Sound Commercial King Crab Fishery, 1990 – 2007

Community	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Harvest (Thousands of Pounds)																	
Nome	48.1	10.1	19.6	16.1	53.8	67.1	20.1	4.6	3.4	11.6	62.2	121.4	112.4	95.1	118.1	156.5	217.5	186.1
Outside Area	-	-	7.1	83.7	113.5	121.5	112.4	79.3	23.5	15.1	95.1	58.2	25.7	65.2	44.0	41.6	31.4	18.1
Unalakleet	-	-	1.6	0.3	12.7	48.3	13.9	6.9	1.1	3.9	37.8	43.5	57.8	61.7	94.8	93.9	88.4	44.4
Shaktoolik	-	-	-	-	1.9	7.9	2.8	-	-	-	-	-	-	14.9	25.2	68.7	91.7	49.8
Elim	-	-	-	0.9	0.8	0.8	-	-	-	-	-	17.4	17.4	7.1	25.2	16.7	-	8.3
Golovin	-	-	-	-	-	0.1	-	-	-	-	-	-	-	7.1	-	13.0	14.3	8.3
Teller	-	-	-	-	-	-	-	-	-	-	-	-	-	7.1	-	-	-	-
Nenana	-	-	-	-	-	-	5.5	-	-	-	-	-	-	-	-	-	-	-
White Mountain	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Total	48.1	10.1	28.3	101.0	182.7	245.8	154.7	90.8	28.0	30.6	195.0	240.6	213.4	258.2	307.4	390.5	443.3	315.1
	Ex-Vessel Revenue (Thousands of Dollars)																	
Nome	246.6	26.8	43.3	20.2	118.7	194.8	45.6	9.1	5.5	37.2	219.2	427.9	677.6	362.2	358.1	534.6	542.8	527.7
Outside Area	-	-	15.8	104.9	249.3	347.0	255.2	156.1	37.8	49.1	283.9	268.7	154.9	257.2	133.4	142.0	82.0	51.3
Unalakleet	-	-	3.6	0.4	27.8	138.8	31.6	13.6	1.8	12.4	119.6	143.5	348.1	244.2	299.7	324.9	231.5	126.7
Shaktoolik	-	-	-	-	4.3	22.8	6.3	-	-	-	-	-	-	58.0	76.5	234.8	228.8	141.3
Elim	-	-	-	1.2	1.6	2.3	-	-	-	-	-	57.4	104.7	27.6	76.5	57.2	-	23.7
Golovin	-	-	-	-	-	0.3	-	-	-	-	-	-	-	27.6	-	44.4	37.4	23.7
Teller	-	-	-	-	-	-	-	-	-	-	-	-	-	27.6	-	-	-	-
Nenana	-	-	-	-	-	-	12.5	-	-	-	-	-	-	-	-	-	-	-
White Mountain	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-
Total	246.6	26.8	62.7	126.6	401.6	706.3	351.2	178.8	45.1	98.7	622.7	897.4	1,285.4	1,004.2	944.3	1,337.9	1,122.5	894.4
	Number of Persons Fishing																	
Nome	12	11	12	9	15	30	14	2	6	6	11	15	18	16	12	17	16	18
Outside Area	-	-	3	7	18	37	30	12	8	4	4	7	6	11	8	6	2	4
Unalakleet	-	-	1	1	15	15	5	3	2	2	4	5	9	6	5	5	6	5
Shaktoolik	-	-	-	-	2	6	1	-	-	-	-	-	-	2	2	5	5	5
Elim	-	-	-	3	12	8	-	-	-	-	-	2	2	1	2	1	-	1
Golovin	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1	1	1
Teller	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Nenana	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
White Mountain	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Total	12	11	16	20	62	98	51	17	16	12	19	29	35	38	29	35	30	34

Source: Alaska Commercial Fishing Entry Commission at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm

2.3 Pacific Halibut

Small commercial longline Pacific halibut fisheries are prosecuted in study area offshore waters (Table 7). Catches occur along the coastal areas adjacent to Norton Sound in International Pacific Halibut Commission (IPHC) Area 4E (East Bering Sea Coast). Halibut are delivered to the Norton Sound Seafood Center, which is operated by the Norton Sound Seafood Products (NSEDC undated). In addition, halibut harvests around St. Lawrence Island in IPHC Area 4D (Central Bering Sea) are delivered to a processing facility Savoonga, which is also operated by the Norton Sound Seafood Products, where they are cleaned and chilled, and then flown to Nome (NSEDC undated). From Nome, frozen product is shipped via air to Anchorage (Lean 2008).

Table 7: Harvest, Ex-Vessel Revenue and Participation by NSEDC Communities in the Commercial Longline Halibut Fisheries, 1990 – 2007

Community	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Harvest (Thousands of Pounds)																	
Nome	2.8	-	-	2.8	3.1	-	-	-	2.9	25.9	5.7	-	94.7	44.5	56.6	40.3	50.5	-
Unalakleet	-	-	-	-	-	-	-	-	-	5.2	1.9	-	9.5	7.4	16.2	5.8	-	-
Shaktoolik	-	-	-	-	-	-	-	-	-	-	-	-	-	7.4	8.1	11.5	-	-
Outside Area (St. Lawrence Island communities)	-	-	-	-	18.7	-	-	-	23.1	10.4	-	-	-	-	-	-	-	-
Elim	-	-	-	-	-	-	-	-	-	-	-	-	-	7.4	8.1	-	-	-
Total	2.8	-	-	2.8	21.7	-	-	-	26.0	41.4	7.7	-	104.2	66.8	88.9	57.6	50.5	-
	Ex-Vessel Revenue (Thousands of Dollars)																	
Nome	4.7	-	-	3.4	5.0	-	-	-	2.5	37.0	13.0	-	175.9	124.0	165.9	119.2	169.5	-
Unalakleet	-	-	-	-	-	-	-	-	-	7.4	4.3	-	17.6	20.7	46.8	17.0	-	-
Shaktoolik	-	-	-	-	-	-	-	-	-	-	-	-	-	20.7	23.4	34.1	-	-
Outside Area (St. Lawrence Island communities)	-	-	-	-	28.5	-	-	-	19.8	14.8	-	-	-	-	-	-	-	-
Elim	-	-	-	-	-	-	-	-	-	-	-	-	-	20.7	23.4	-	-	-
Total	4.7	-	-	3.4	33.5	-	-	-	22.3	59.2	17.3	-	193.5	186.0	259.5	170.3	169.5	-
	Number of Persons Fishing																	
Nome	1	-	-	1	1	-	-	-	1	5	3	-	10	6	7	7	8	-
Unalakleet	-	-	-	-	-	-	-	-	-	1	1	-	1	1	2	1	-	-
Shaktoolik	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	-	-
Outside Area (St. Lawrence Island communities)	-	-	-	-	13	-	-	-	8	2	-	-	-	-	-	-	-	-
Elim	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
Total	1	-	-	1	14	-	-	-	9	8	4	-	11	9	11	10	8	-

Note: To comply with data confidentiality restrictions under Alaska Statute 16.05.815, harvest and revenue data have been estimated for those years when fewer than four persons participated in the fisheries. The estimates are based on the averages of reported data.

Source: Alaska Commercial Fishing Entry Commission at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm

Pacific halibut are also used for personal consumption by residents in the study area. Subsistence harvests of halibut in the Norton Sound subarea of Area 4E only totaled 56 pounds during the 2003-2006 period (Fall et al. 2007b). However, CDQ groups operating exclusively in Areas 4D and 4E may retain sublegal halibut (less than 32 inches) from their commercial catches for home use. In 2007, a total of 4,516 pounds net weight of halibut was retained by the NSEDC (Table 8).

Table 8: Reported Amount of Sublegal Halibut Retained by the NSEDC, 2002 – 2007

2002	2003	2004	2005	2006	2007
Retained (Pounds)					
4,371	2,961	4,242	3,136	3,407	4,516

Source: Williams (2008)

2.4 Pacific Herring

Arrival of Pacific herring on the spawning grounds is greatly influenced by climate and oceanic conditions, particularly the extent of the Bering Sea ice pack. Most herring spawning populations appear near the eastern Bering Sea coast immediately after ice breakup between mid-May and mid-June. Spawning progresses in a northerly direction and may continue into July or August along portions of the Seward Peninsula or within the Chukchi Sea. The largest abundance of herring in the Arctic-Yukon-Kuskokwim Region is in Norton Sound. Gillnets and beach seines are the only legal commercial herring fishing gear within Norton Sound (Banducci et al. 2007).

Since 1997, poor market conditions have been the primary reason for the low level of harvest, ex-vessel revenue and effort in the commercial gillnet herring sac roe and bait fishery (Table 9). Herring roe markets have deteriorated as the consumption of salted herring roe declines in Japan. However, stock status and climatic factors also have had an adverse effect on commercial fishing for “spring herring” in Norton Sound (Banducci et al. 2007). Further, the present market desires a high roe percent and larger size fish—these criteria have been difficult to achieve with beach seine gear and in recent years no buyer interest has existed for herring harvested from beach seines (Table 10) (Banducci et al. 2007). No large-scale effort to develop a herring sac roe fishery in Port Clarence and Kotzebue Sound has occurred because of late ice breakup and fishery timing. Both Port Clarence and Kotzebue fishers have been unable to attract a sac roe buyer for their relatively late fishery due to poor market conditions (Banducci et al. 2007). Subsistence harvest of herring and herring roe on kelp in Norton Sound and Kotzebue Sound is not documented, but is believed to be relatively small (Soong et al. 2008).

Table 9: Harvest, Ex-Vessel Revenue and Participation by Community in the Norton Sound Commercial Gillnet Herring Roe and Bait Fisheries, 1990 – 2007

Community	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Harvest (Thousands of Pounds)																	
Outside Area	3,094	2,079	-	2,254	495	3,033	3,013	2,199	1,534	1,768	2,218	1,415	849	722	-	1,095	405	-
Unalakleet	2,635	1,906	-	2,529	266	2,940	1,756	979	722	883	1,294	362	399	492	-	779	241	66
Shaktoolik	771	854	-	962	438	1,608	1,127	1,198	377	1,020	1,150	962	720	1,570	-	1,220	642	-
Elim	325	566	-	520	230	720	357	379	-	335	605	233	33	76	-	384	56	-
Nome	161	107	-	109	39	-	178	107	400	25	31	-	-	38	-	35	-	-
Kotzebue	78	100	-	76	11	75	66	31	-	-	-	-	-	-	-	-	-	-
Koyuk	195	31	-	144	44	-	34	36	-	-	31	-	-	-	-	-	-	-
Golovin	117	60	-	86	12	21	17	36	-	49	-	-	-	-	-	-	-	-
Manley Hot Spring	-	-	-	-	-	-	33	31	-	-	-	-	-	-	-	-	-	-
Galena	-	-	-	-	-	-	-	-	-	-	132	-	-	-	-	-	-	-
Nenana	-	-	-	-	-	-	-	31	-	-	-	-	-	-	-	-	-	-
Total	7,377	5,703	-	6,681	1,535	8,396	6,580	5,026	3,033	4,080	5,461	2,972	2,001	2,899	-	3,513	1,345	66
	Ex-Vessel Revenue (Thousands of Dollars)																	
Outside Area	737.2	465.2	-	324.1	71.2	1,089.0	1,420.3	197.0	153.4	222.7	199.9	117.4	59.0	39.4	-	93.7	20.7	-
Unalakleet	618.0	395.1	-	363.7	38.5	1,060.9	809.2	83.5	72.2	116.5	120.4	65.2	26.3	26.1	-	66.3	16.8	21.1
Shaktoolik	151.4	185.6	-	138.2	63.5	557.3	525.1	100.8	37.7	128.4	103.5	79.8	50.0	83.2	-	103.7	32.7	-
Elim	56.8	125.0	-	74.6	33.4	249.3	168.8	32.6	-	42.9	54.5	19.3	2.3	4.2	-	32.7	2.9	-
Nome	36.5	24.6	-	15.7	5.7	-	85.8	9.9	40.0	2.9	2.8	-	-	2.1	-	3.1	-	-
Kotzebue	17.2	22.7	-	11.0	1.6	26.8	31.2	2.9	-	-	-	-	-	-	-	-	-	-
Koyuk	33.7	7.0	-	20.7	6.4	-	16.3	3.3	-	-	2.8	-	-	-	-	-	-	-
Golovin	25.1	13.9	-	12.4	1.8	7.6	8.1	3.3	-	5.8	-	-	-	-	-	-	-	-
Manley Hot Spring	-	-	-	-	-	-	15.6	2.9	-	-	-	-	-	-	-	-	-	-
Galena	-	-	-	-	-	-	-	-	-	-	11.9	-	-	-	-	-	-	-
Nenana	-	-	-	-	-	-	-	2.9	-	-	-	-	-	-	-	-	-	-
Total	1,676.1	1,239.2	-	960.3	222.0	2,990.9	3,080.5	439.2	303.3	519.2	495.7	281.9	137.5	155.1	-	299.5	73.0	21.1
	Number of Persons Fishing																	
Outside Area	107	51	-	75	60	60	89	75	18	51	28	35	27	11	-	19	13	-
Unalakleet	104	84	-	84	65	72	73	51	13	24	22	9	7	6	-	14	11	8
Shaktoolik	30	25	-	25	21	20	21	23	6	18	15	15	11	12	-	17	16	-
Elim	16	14	-	15	13	13	11	12	-	8	10	7	2	2	-	5	2	-
Nome	6	4	1	6	4	-	4	3	4	1	1	-	-	1	1	1	-	-
Kotzebue	2	2	-	2	1	1	2	1	-	-	-	-	-	-	-	-	-	-
Koyuk	6	2	-	5	4	-	2	1	-	-	1	-	-	-	-	-	-	-
Golovin	7	5	-	3	2	1	1	1	-	2	-	-	-	-	-	-	-	-
Manley Hot Spring	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
Galena	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Nenana	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Total	278	187	1	215	170	167	204	169	41	104	78	66	47	32	1	56	42	8

Note: To comply with data confidentiality restrictions under Alaska Statute 16.05.815, harvest and revenue data have been estimated for those years when fewer than four persons participated in the fisheries. The estimates are based on the averages of reported data.

Source: Alaska Commercial Fishing Entry Commission at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm.

Table 10: Harvest, Ex-Vessel Revenue and Participation by Community in the Norton Sound Commercial Beach Seine Herring Roe Fishery, 1990 – 2007

Community	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Pounds Harvested (Thousands)																	
Outside Area	347	760	-	848	-	621	981	342	-	-	-	-	-	-	-	-	-	-
Unalakleet	87	-	-	212	-	207	-	171	-	-	-	-	-	-	-	-	-	-
Total	434	760	-	1,061	-	828	981	513	-	-	-	-	-	-	-	-	-	-
	Ex-Vessel Revenue (Thousands of Dollars)																	
Outside Area	116	231	-	114	-	212	381	32	-	-	-	-	-	-	-	-	-	-
Unalakleet	29	-	-	28	-	71	-	16	-	-	-	-	-	-	-	-	-	-
Total	145	231	-	142	-	283	381	48	-	-	-	-	-	-	-	-	-	-
	Number of Persons Fishing																	
Outside Area	4	5	-	4	1	3	5	2	-	-	2	-	-	-	-	-	-	-
Unalakleet	1	-	-	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-
Total	5	5	-	5	2	4	5	3	-	-	2	-	-	-	-	-	-	-

Note: Harvest and revenue data are confidential for those years when fewer than four persons participated in the fishery.

Source: Alaska Commercial Fishing Entry Commission at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm

A commercial and subsistence fishery for Pacific herring also exists in the Cape Romanzof District, which consists of all state waters from Dall Point to 62º north latitude. Table 11 shows the harvest, value, and effort in the commercial fishery during the 1990-2004 period. In recent years, residents of Hooper Bay and Scammon Bay have generally accounted for the entire catch. The recorded average annual subsistence harvest of herring over the 1975-2005 period was 6.14 tons, while the annual subsistence harvest of herring roe on kelp averaged 570 pounds during the 1993-2004 period (Hayes et al. 2008).

Table 11: Harvest, Ex-Vessel Revenue and Participation in the Cape Romanzof District Herring Fishery, 1990 – 2004

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Harvest (Short Tons)														
329	526	530	371	456	541	752	879	727	533	500	137	102	81	25
Ex-Vessel Revenue (Millions of Dollars)														
0.15	0.21	0.16	0.11	0.12	0.33	0,64	0.19	0.13	0.13	0.08	0.01	0.01	0.01	0.01
Number of Persons Fishing														
95	80	73	41	55	49	63	65	41	57	46	23	21	11	10

Source: Hayes et al. (2008)

3.0 UPPER YUKON

The Yukon River is the largest river in Alaska and the fifth largest drainage in North America. With the possible exception of a few fish taken near the mouth or in the adjacent coastal waters, only salmon of Yukon River origin are harvested in the Yukon Area (Hayes et al. 2008). The Upper Yukon Area (Districts 4, 5, and 6) is the Alaskan portion of the Yukon River drainage upstream of Old Paradise Village (river mile 301). It is this portion of the Yukon River drainage that lies within the study area.

King salmon begin entering the mouth of the Yukon River soon after ice breakup, during late May or early June, and continue through mid July. The chum salmon return is made up of a genetically distinct early summer chum salmon run and a later fall chum salmon run. The summer chum salmon run occurs from early June to mid July at the mouth, while the fall chum salmon run occurs from mid July to early September (Hayes et al. 2008).

Management of the Yukon Area commercial salmon fishery is complex due the mixed stock nature of the fishery, increased efficiency of the commercial fleet, allocation issues, and the complication of state/federal dual management regimes for the subsistence fishery in approximately half the drainage (Hayes et al. 2008). Commercial fishing may be allowed along the entire 1,224 miles of the Yukon River in Alaska and along the lower 225 miles of the Tanana River (Bue and Hayes 2008). King, chum, and coho salmon are harvested in Yukon River commercial fisheries. In recent years, king salmon have become a highly sought-after species in the Yukon River commercial salmon fisheries. However, the Upper Yukon Area has accounted for only a small fraction of the commercial harvest of king salmon in the Yukon Area (Figure 2). In contrast, much of the summer chum salmon harvest has occurred in the Upper Yukon Area (Figure 3).

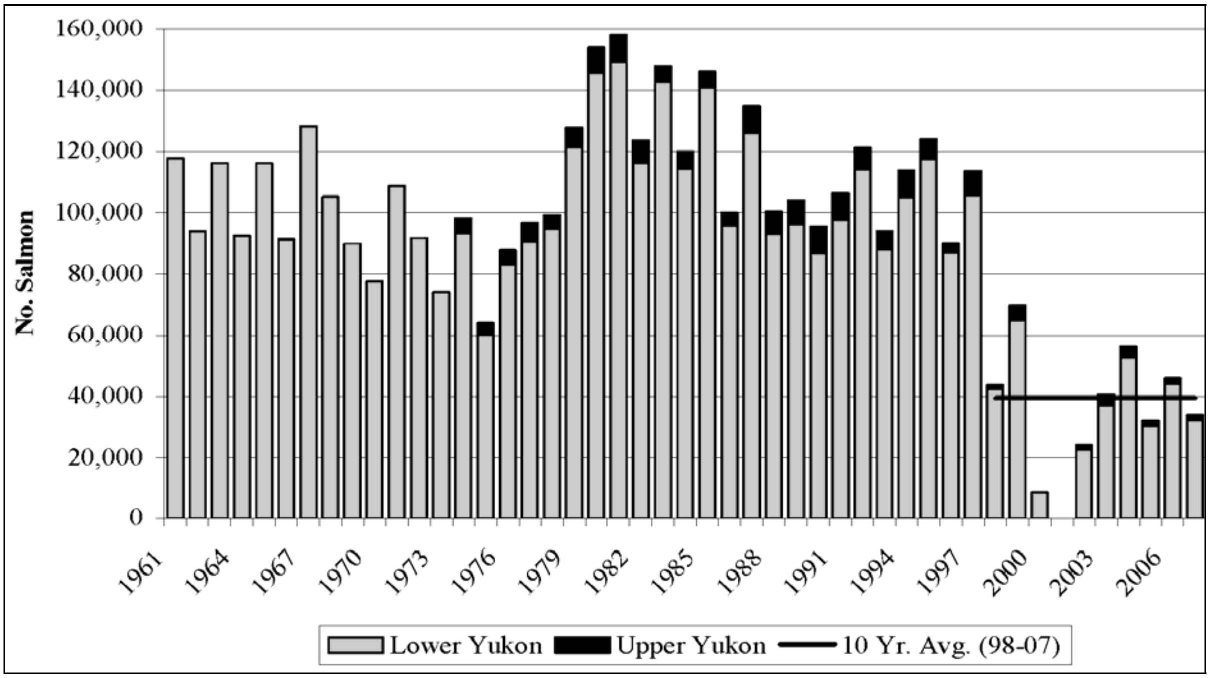

Figure 2: Alaskan Commercial Harvest of Yukon River King Salmon, 1961-2007

Source: Bue and Hayes (2008)

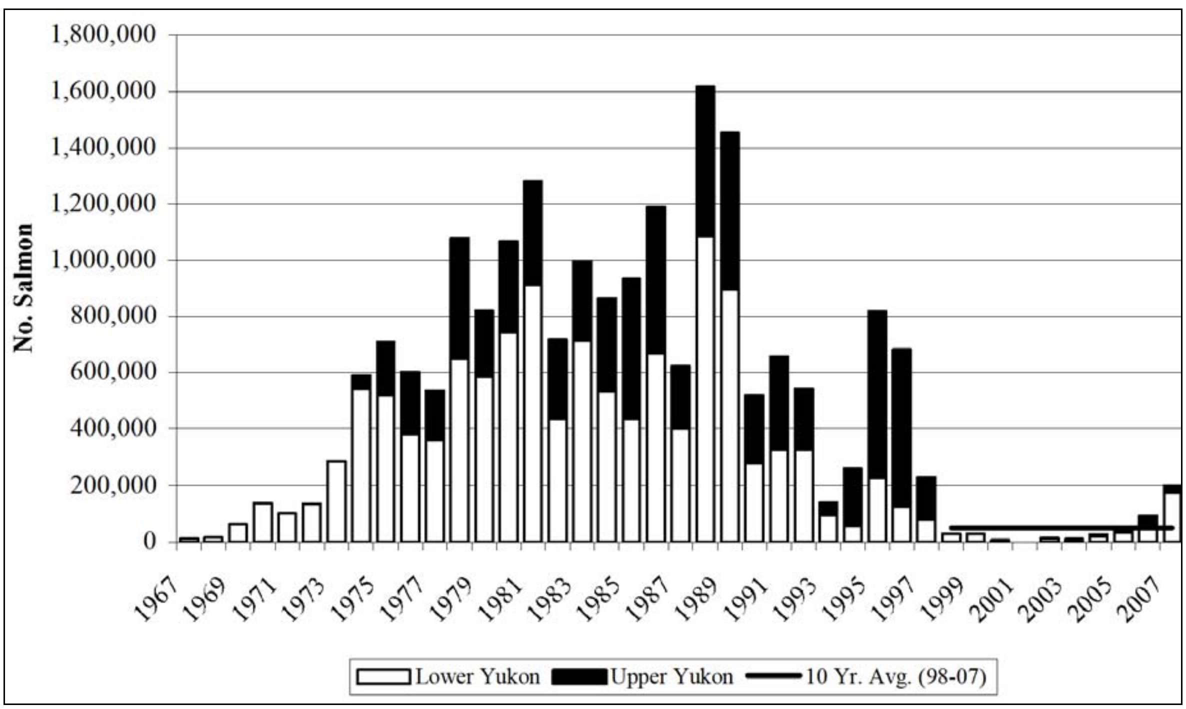

Figure 3: Alaskan Commercial Harvest of Yukon River Summer Chum Salmon, 1967-2007

Source: Bue and Hayes (2008)

Fish wheels and set gillnets are the legal gear types for commercial salmon fishing in the Upper Yukon Area, with fish wheels accounting for roughly 95 percent of the commercial harvest of summer chum salmon (Hayes et al. 2008). All of the active Upper Yukon commercial fish wheel operations are resident owned (Alaska Department of Commerce, Community and Economic Development 2005). Yukon Area subsistence fishers use drift gillnets, set gillnets, and fish wheels to harvest salmon. Set gillnets are utilized throughout the Yukon Area, whereas drift gillnets are only allowed from the mouth of the Yukon River to 18 miles below the community of Galena. Although fish wheels are a legal gear type for subsistence fishing throughout the drainage, they are essentially only used in the Upper Yukon Area (Hayes et al. 2008).

Table 12 shows the fluctuations in the subsistence fishery catch in the Upper Yukon districts from 1993 to 2004.

Table 12: Salmon Subsistence Harvest (Number of Fish) by Species in the Upper Yukon Area, 1993 – 2004

1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
King salmon											
33,973	31,457	28,119	25,097	32,767	32,522	27,192	16,101	26,167	23,924	34,107	33,323
Summer chum salmon											
37,955	46,360	44,400	35,420	32,574	26,364	20,269	11,798	8,002	22,093	25,972	20,163
Fall chum salmon											
64,449	113,318	120,819	116,726	86,542	53,661	78,225	11,989	27,761	15,727	51,006	57,420
Coho salmon											
11,455	34,178	22,941	23,948	18,932	12,904	15,684	11,205	18,940	12,598	20,023	17,773

Source: Hayes et al. (2008)

Summer chum salmon commercial harvests in the Upper Yukon Area increased greatly during the 1980s as a result of regulation changes (e.g., mesh size specifications and earlier openings), greater availability of processing facilities and tendering, higher ex-vessel prices, development of Japanese markets, and the occurrence of several very large runs. However, low commercial harvests occurred between 1997 and 2002 because of low summer chum salmon runs (Table 13 and Table 14). The duration of fishing periods dramatically decreased, and fishing time became based increasingly on in-season run assessment (Hayes et al. 2008).

Summer chum salmon runs have exhibited improvements since 2001, with a commercially harvestable surplus in-season in each of the last five years (2003-2007). However, future commercial harvests of summer chum salmon may be adversely affected by potentially poor king salmon runs, as king salmon are incidentally harvested in fisheries directed at chum salmon. The Yukon River king salmon run has been extremely poor in recent years; whether this is attributable to dramatically increasing bycatch harvest in the Bering Sea pollock trawl fishery or to ocean conditions or some other suite of environmental factors remains unknown (Bue and Hayes 2008). The increased strength of recent fall chum salmon runs has renewed interest for commercial fishing in upriver districts. The fish are smoke-cured and sold as "strips" or are sold whole. However, transportation costs are a major limiting factor in the fishery, with fish buyers only operating near Nenana (Joint Technical Committee of the Yukon River US/Canada Panel 2008).

Table 13: Harvest, Ex-Vessel Revenue and Participation by Community in the Upper Yukon Commercial Fish Wheel Salmon Fisheries, 1990 – 2007

Community	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Harvest (Thousands of Pounds)																	
Anvik	6.9	19.9	6.7	1.8	14.1	30	37.5	12.9	-	-	-	-	-	-	-	-	-	2.7
Grayling	7.1	11.8	11.5	3.3	10.7	19	19.7	12.9	-	-	-	-	-	-	-	-	-	2.7
Kaltag	57.8	46.9	20.6	3.5	13.7	41	47.2	21.7	-	-	-	-	-	-	-	-	-	-
Nulato	53.6	33.9	17.8	2.5	10.7	33	36.4	12.2	-	-	-	-	-	-	3.0	-	10.2	5.4
Koyukuk	9.1	10.6	5.1	3.3	10.7	13	13.1	8.6	-	3.2	-	-	-	-	-	-	-	-
Huslia	4.5	-	-	-	5.4	6	6.6	-	-	-	-	-	-	-	-	-	-	-
Galena	61.2	46.8	26.0	8.6	38.4	147	77.4	26.7	0.6	3.2	-	-	-	-	-	19.4	10.2	-
Ruby	26.6	22.5	20.4	11.0	16.1	7	6.6	8.6	-	9.5	-	-	-	8.2	-	-	-	-
Tanana	36.1	95.7	13.4	9.0	7.9	36	52.8	20.6	1.6	13.0	-	-	3.4	8.2	9.0	58.3	8.9	8.1
Manley Hot Spring	112.7	50.3	29.8	5.0	16.1	19	40.1	8.6	6.0	7.2	-	-	3.4	8.2	9.0	58.3	30.6	5.4
Minto	-	-	-	1.7	-	6	6.6	-	-	-	-	-	-	-	-	-	-	-
Rampart	4.5	5.3	5.1	3.3	10.7	13	6.6	8.6	0.6	3.2	-	-	-	2.7	-	-	10.2	-
Nenana	300.8	244.5	140.8	23.7	115.9	577	141.5	75.5	6.7	5.3	-	-	26.0	157.5	143.7	381.4	376.0	134.2
Outside Area	137.9	178.2	64.0	22.0	86.2	184	124.3	67.4	3.6	15.9	-	-	2.3	10.9	3.0	58.3	124.1	29.5
Total	819.1	766.5	361.0	98.8	356.6	1,132	616.0	284.2	19.0	60.5	-	-	35.2	195.6	167.7	575.8	570.2	188.1
	Ex-Vessel Revenue (Thousands of Dollars)																	
Anvik	30.2	80.3	30.4	15.3	52.2	104	111.5	9.6	-	-	-	-	-	-	-	-	-	3.3
Grayling	31.1	49.4	52.1	5.4	11.9	38	30.1	9.6	-	-	-	-	-	-	-	-	-	3.3
Kaltag	76.4	90.6	93.4	30.6	49.8	145	142.0	26.5	-	-	-	-	-	-	-	-	-	-
Nulato	90.8	72.2	80.5	21.7	11.9	116	109.5	14.8	-	-	-	-	-	-	1.9	-	2.7	6.6
Koyukuk	7.5	9.0	8.6	5.4	11.9	25	20.1	6.4	-	2.6	-	-	-	-	-	-	-	-
Huslia	3.8	-	-	-	6.0	13	10.0	-	-	-	-	-	-	-	-	-	-	-
Galena	84.8	106.2	106.2	43.3	67.8	265	174.0	15.2	0.5	2.6	-	-	-	-	-	3.7	2.7	-
Ruby	25.7	19.2	23.7	13.1	17.9	26	10.0	6.4	-	7.9	-	-	-	4.0	-	-	-	-
Tanana	19.0	34.9	16.2	9.1	6.9	63	37.6	12.8	1.4	14.8	-	-	2.1	4.0	5.7	11.2	11.3	9.9
Manley Hot Spring	32.1	18.7	18.1	8.1	17.9	16	7.8	6.4	5.2	8.1	-	-	2.1	4.0	5.7	11.2	8.0	6.6

Community	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Minto	-	-	-	2.7	-	13	10.0	-	-	-	-	-	-	-	-	-	-	-
Rampart	3.8	4.5	8.6	5.4	11.9	25	10.0	6.4	0.5	2.6	-	-	-	1.3	-	-	2.7	-
Nenana	123.2	116.5	84.0	23.2	78.5	168	79.7	32.7	5.6	6.3	-	-	13.0	28.7	23.9	57.4	56.9	29.9
Outside Area	95.1	124.3	85.4	41.7	94.5	167	125.2	33.5	2.8	13.2	-	-	1.4	5.3	1.9	11.2	20.5	11.2
Total	623.5	725.9	607.1	225.0	439.1	1,186	877.6	180.3	15.9	58.2	-	-	18.5	47.2	38.9	94.5	104.6	70.7
	Number of Persons Fishing																	
Anvik	7	7	7	4	5	6	8	3	-	-	-	-	-	-	-	-	-	1
Grayling	5	5	6	2	2	3	3	3	-	-	-	-	-	-	-	-	-	1
Kaltag	11	13	13	14	9	15	14	9	-	-	-	-	-	-	-	-	-	-
Nulato	15	12	15	9	2	8	11	4	-	-	-	-	-	-	1	-	1	2
Koyukuk	2	2	2	2	2	2	2	2	-	1	-	-	-	-	-	-	-	-
Huslia	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-
Galena	21	17	15	15	11	20	22	8	1	1	-	-	-	-	-	1	1	-
Ruby	9	8	7	7	3	4	1	2	-	3	-	-	-	3	-	-	-	-
Tanana	6	7	6	4	4	8	11	6	4	6	-	-	3	3	3	3	4	3
Manley Hot Spring	6	4	5	3	3	4	4	2	4	4	-	-	3	3	3	3	3	2
Minto	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Rampart	1	1	2	2	2	2	1	2	1	1	-	-	-	1	-	-	1	-
Nenana	14	14	14	8	12	13	12	11	6	4	-	-	4	6	6	5	8	9
Outside Area	19	20	19	17	17	19	16	11	6	5	-	-	2	4	1	3	8	6
Total	117	110	111	88	73	106	107	63	22	25	-	-	12	20	14	15	26	24

Source: Alaska Commercial Fishing Entry Commission at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm

Table 14: Harvest, Ex-Vessel Revenue and Participation by Community in the Upper Yukon Commercial Gillnet Salmon Fisheries, 1990 – 2007

Community	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Harvest (Thousands of Pounds)																	
Anvik	17.0	11.3	7.3	2.8	8.6	18.7	21.7	5.1	-	-	-	-	-	-	-	-	-	-
Grayling	10.1	8.8	9.3	2.7	5.8	14.3	23.7	2.5	-	-	-	-	-	-	-	-	-	-
Kaltag	5.7	3.8	7.3	1.3	3.3	5.3	4.2	-	-	-	-	-	-	-	-	-	-	-
Galena	5.6	7.5	10.4	2.7	3.3	3.5	4.2	5.1	-	2.4	-	-	-	-	-	-	-	-
Ruby	5.7	-	2.4	1.3	-	1.8	-	-	-	-	-	-	-	-	-	-	-	-
Tanana	17.0	21.9	4.8	11.4	5.0	5.3	2.8	5.1	1.2	2.4	-	-	1.1	2.7	1.4	2.2	2.0	1.1
Manley Hot Spring	5.7	3.8	4.8	-	-	-	-	-	-	-	-	-	-	-	-	2.2	2.0	1.1
Rampart	-	26.4	4.8	4.0	3.3	5.3	1.4	5.1	-	4.8	-	-	3.4	2.7	-	-	2.0	-
Nenana	5.7	3.8	-	1.3	1.7	3.5	-	-	-	-	-	-	-	-	1.4	-	-	-
Outside Area	31.4	40.1	24.6	17.5	17.5	19.4	24.5	27.8	1.8	10.5	-	-	5.1	4.1	10.0	4.8	13.7	4.4
Total	104.0	127.2	75.8	45.0	48.7	77.0	82.5	50.6	3.0	20.0	-	-	9.7	9.5	12.9	9.2	19.5	6.6
	Ex-Vessel Revenue (Thousands of Dollars)																	
Anvik	24.7	21.0	15.9	23.5	32.4	66.9	64.2	5.3	-	-	-	-	-	-	-	-	-	-
Grayling	47.6	34.3	41.5	22.6	21.8	50.6	70.1	2.7	-	-	-	-	-	-	-	-	-	-
Kaltag	8.2	7.0	15.9	2.1	4.9	8.0	10.4	-	-	-	-	-	-	-	-	-	-	-
Galena	5.9	14.0	11.3	4.3	4.9	5.3	10.4	5.3	-	2.4	-	-	-	-	-	-	-	-
Ruby	8.2	-	5.3	2.1	-	2.7	-	-	-	-	-	-	-	-	-	-	-	-
Tanana	24.7	14.4	10.6	13.3	7.4	8.0	6.9	5.3	1.2	2.4	-	-	0.8	3.0	1.4	2.3	1.3	1.6
Manley Hot Spring	8.2	7.0	10.6	-	-	-	-	-	-	-	-	-	-	-	-	2.3	1.3	1.6
Rampart	-	9.7	10.6	6.4	4.9	8.0	3.5	5.3	-	4.9	-	-	2.5	3.0	-	-	1.3	-
Nenana	8.2	7.0	-	2.1	2.5	5.3	-	-	-	-	-	-	-	-	1.4	-	-	-
Outside Area	37.9	46.0	32.2	18.8	19.8	24.3	32.9	30.8	1.8	11.0	-	-	3.5	4.4	9.9	4.9	9.0	6.3
Total	173.8	160.4	154.1	95.3	98.8	179.1	198.3	54.6	3.0	20.8	-	-	6.7	10.4	12.8	9.6	12.8	9.4
	Number of Persons Fishing																	
Anvik	3	3	3	4	4	5	4	2	-	-	-	-	-	-	-	-	-	-
Grayling	5	5	5	6	4	5	6	1	-	-	-	-	-	-	-	-	-	-
Kaltag	1	1	3	1	2	3	3	-	-	-	-	-	-	-	-	-	-	-
Galena	4	2	4	2	2	2	3	2	-	1	-	-	-	-	-	-	-	-
Ruby	1	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Tanana	3	4	2	4	3	3	2	2	2	1	-	-	1	1	1	1	1	1
Manley Hot Spring	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1
Rampart	-	4	2	3	2	3	1	2	-	2	-	-	3	1	-	-	1	-
Nenana	1	1	-	1	1	2	-	-	-	-	-	-	-	-	1	-	-	-
Outside Area	15	14	10	13	12	12	10	13	4	9	-	-	8	5	7	4	7	4
Total	34	35	32	35	30	36	29	22	6	13	-	-	12	7	9	6	10	6

Source: Alaska Commercial Fishing Entry Commission at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm

In most of the Upper Yukon Area, summer chum salmon flesh is difficult to market due to the high cost of transportation and the degradation caused by fresh water and advancing sexual maturity. In contrast, the summer chum salmon roe quality is considered to be excellent by the industry (Hayes et al. 2008). Chum are the salmon-caviar top-quality standard; the flavor that makes for bland flesh makes for delicate eggs that are in high demand in Asian and European markets (Golden 2008).

Commercial roe fisheries began in 1978 in the Upper Yukon Area (the only sales of salmon roe in the Lower Yukon Area occurred in 1996). The high value of chum salmon roe resulted in increased sales from 1980 to 1997. After 1997, the Upper Yukon Area summer chum commercial fishery was dormant for several years due to poor salmon runs, depressed market prices and other factors, but was renewed in 2007. Because of the early large summer chum salmon roe fishery in Subdistrict 4-A and difficulty in estimating the associated harvest, the guideline harvest range for Subdistrict 4-A was established in 1990 as 113,000 to 338,000 summer chum, or the equivalent of 61,000 to 183,000 pounds of roe, or some combination of fish and pounds of roe. In addition, regulations were adopted stipulating that no more than 183,000 pounds of summer chum salmon roe from Subdistrict 4-A harvests could be sold annually. Once the roe cap is reached, fishing effort could continue, but only the sale of chum salmon in the round would be allowed. Subdistrict 5-A was removed from the guideline harvest ranges for king and summer chum and a separate guideline harvest range of 0 to 4,000 pounds of fall chum salmon roe was established in 1998 (Hayes et al. 2008). Fishers may not transfer between districts in the Upper Yukon Area.

The aforementioned difficulties of marketing the flesh may limit the development of the summer chum salmon roe fishery. Although the stripped carcasses have little or no commercial value, they cannot be discarded because under Alaska Statute 16.05.831, commonly referred to as the "wanton waste law," "a person may not waste salmon intentionally, knowingly, or with reckless disregard for the consequences." "Waste" means the failure to utilize the majority of the carcass, excluding viscera and sex parts, of a salmon intended for (1) sale to a commercial buyer or processor; (2) consumption by humans or domesticated animals; or (3) scientific, educational, or display purposes. If fish are discarded, the person who does the wasting is liable for the penalty under the statute. Over the years, Yukon fishers have been prosecuted for wasting even small amounts of fish (Rapids Research Center undated). Consequently, flesh utilization has become a limiting factor on production of high value chum salmon roe in the Upper Yukon Area. While local residents typically feed many summer chum to their sled dogs (Hayes et al. 2008), the quantity of chum salmon needed for this purpose and other types of personal use is limited.

Besides fluctuating stocks and regulatory limitations on waste, other challenges face the chum salmon roe fishery in the Upper Yukon Area. Output from Alaska's private nonprofit hatcheries has increased dramatically since the mid-1990s, which has reportedly undermined the roe market for Upper Yukon River fishers. As part of their cost-recovery programs, the salmon hatcheries sell a portion of their returns each year to generate revenues to fund ongoing operations. In some years, hatcheries and processors have applied for and received waivers to AS 16.05.831 that allow them to recover roe without further utilization of the salmon carcass (Knapp et al. 2007). Critics of this practice argue that the influx of hatchery fish and the roe stripping of these fish has depressed roe prices, making a roe fishery in the Upper Yukon Area less economically viable (Rapids Research Center undated; Yukon River Drainage Fisheries Association 2005).

In addition, in 2006, the Alaska Department of Environmental Conservation issued regulations for roe fishers who remove roe at their fish camps for later delivery to a processor. Under the regulations, fishers who remove roe at their fish camps are considered "processors." As processors, roe fishers need a Department of Environmental Conservation-permitted facility in which to remove roe and will need to abide by regulations for cleaning, sanitation, and handling. To some extent, the regulations acknowledge that Yukon River roe fishers operate in remote locations without electricity or running water and process small numbers of fish; however, adhering to the new regulations takes additional effort from fishers. For example, the covered building that the regulations require can be expensive to build, especially when supplies have to be barged in (Robbins 2006).

4.0 POTENTIAL EFFECTS OF ROAD ACCESS

Construction of a highway between the contiguous Alaska highway system and the highway system on the Seward Peninsula has the potential to foster additional development of commercial fisheries in the study area. For Norton Sound and Kotzebue Sound commercial fisheries, the Western Alaska Transportation Access project could provide regional seafood processing facilities with a transportation option for bringing supplies (equipment, packaging, etc.) in and shipping product out. Currently, most salmon, crab, halibut, and herring products are flown from Unalakleet or Nome to Anchorage where they are sold locally or distributed to Lower 48 markets on passenger and cargo flights. A road would allow product to be packed in refrigerated vans and trucked to Anchorage. During the backhaul, the vans could be loaded with packing materials and other processing supplies.

Coastal seafood processing facilities in the study area may also be considering the option of transporting product by sea. For example, frozen product could possibly be packed in refrigerated vans and hauled to Seattle or Anchorage on ocean-going barges during the summer months. To date, however, this option has proved unfeasible for the processing facilities in the study area because they don't have a sufficiently large product base to attract barge companies with the capacity to haul refrigerated vans (Tremaine 2008).

Moreover, road transportation could offer some logistical advantages over a marine transportation alternative. For example, some local fishers from Nome and Kotzebue have expressed interest in participating in a herring spawn-on-kelp fishery. However, the herring fishery is typically opened by emergency order; consequently, it is difficult for fishers to decide whether or not to order the large amount of salt required to preserve and store product. Typically, fishers cannot make that decision early enough to have the salt delivered by barge. A road, on the other hand, would allow them to schedule an expeditious salt delivery. In addition, a road network connecting villages would facilitate deliveries of fuel; fishers have occasionally had to cease fishing operations do to a lack of fuel (Tremaine 2008).

However, even if road transportation proves to be a less expensive alternative to air or marine service, it will likely continue to cost more to ship fish products to Lower 48 or foreign markets from Norton Sound and Kotzebue Sound coastal villages than it does from processing plants on the coast of southeast or southcentral Alaska; consequently, processing facilities on Norton Sound and Kotzebue Sound will remain at a competitive disadvantage relative to plants in those other parts of Alaska.

Construction of a highway between the contiguous Alaska highway system and the highway system on the Seward Peninsula would also provide an option for transporting incoming supplies and outgoing product in the Upper Yukon Area. Most fish wheel operations in the region are geographically remote and suffer from lack of services and infrastructure (Alaska Department of Commerce, Community and Economic Development 2005). A road could improve access to markets through more efficient transportation. For example, Knapp et al. (2001) describe a successful fish processing operation in Circle that consists of heading, gutting and freezing fish at the fishing site and trucking the season's catch in a freezer van to Fairbanks at the end of the season. Similarly, salmon have occasionally been purchased in Nenana by Inlet Fish Producers Inc., which trucks the fish to its processing facilities on the Kenai Peninsula (Klein 2008). In addition, a road could facilitate the transportation of building materials and equipment into the region so that processing facility owners can remodel and retrofit their plants to meet Alaska Department of Environmental Conservation standards.

However, resource and market constraints will continue to pose significant challenges for further commercial development of Upper Yukon Area salmon fisheries. The extremely low Yukon River salmon returns in recent years are a reminder of one of the risks faced by fish processing plants in the study area. The marketing effort developed by the Yukon River Drainage Fisheries Association has been highly successful in recent years in helping bring Yukon River wild salmon to consumer markets. In particular, Yukon River king salmon have acquired a reputation in large-scale niche markets in the Lower 48 as one of the world's premier salmon—this reputation is based, in part, on the fact that Yukon River king salmon have a higher oil content than any other salmon (Maureenclancy.com 2008; Mowry 2007). Yet, the ability of the fishing industry to capitalize on that reputation is severely constrained by the shortage of fish available for harvest in the Yukon River commercial king salmon fishery. As Knapp et al. (2001) point out, a processing plant can't make money unless it can get fish to process.

In some years, similar resource limitations have also constrained the Upper Yukon commercial summer chum salmon fishery. In 2000, for example, Kaltag Fisheries Association secured more than $1 million in state and federal grants to build a seafood processing plant that would comply with stricter processing rules imposed by the Alaska Department of Environmental Conservation. The new plant, which was designed to expand value-added production as well as improve processing of its primary product, chum salmon roe, was scheduled to open in 2001; however, so few salmon swam upriver that year that the facility could not be used (Manning 2001).

More recently, Yukon River summer chum salmon have shown marked improvement in abundance, and the current market for chum salmon roe is strong (Golden 2008). The number of harvesters supplying fish to the Kaltag plant increased from one in 2007 to seven in 2008, while the number of processors employed at the plant increased from 10 to 35 (Burnham 2008). However, increased exploitation of the commercially harvestable surplus for roe may eventually be restricted by the low value of summer chum salmon flesh. As discussed above, the roe is at its highest value when the fish are ready to spawn, but the color and texture of the flesh has greatly deteriorated at that point. To avoid violating the state's wanton waste law, harvesters/buyers who are roe-stripping have to find alternative uses for the flesh once subsistence needs have been met.

Chum salmon carcasses may hold particular economic promise for production of protein fishmeal and other products. In most Alaska fisheries, the fish flesh is the primary product. Processing thus removes much of the nutrient value, leaving relatively low-nutrient waste. Therefore, achieving similar nutrient levels to those found in meal from whole fish reduction fisheries (sardines, anchovies, menhaden, herring, etc.) is difficult in most Alaska waste-based fishmeal production (Alaska Department of Commerce, Community and Economic Development undated). However, chum salmon byproducts have an advantage in this regard, as all parts of the fish except the eggs are used. Currently, a number of southeast Alaska roe producers have the flesh processed in a fishmeal plant in Sitka, which sells the meal in 1,000-pound totes overseas, where it appears as cheap frozen protein portions in China or the Ukraine (Golden 2008).

The downside of fishmeal is that it is a low-value commodity (Bennett 2002), although fishmeal prices have shown an upward trend due to increasing demand in the aquaculture industry. A number of Alaska-based manufacturers are developing ways to convert stripped chum salmon carcasses into higher-priced products: at its Sitka plant OmegaSea, Ltd. mixes chum salmon with other ingredients to produce a variety of high quality aquarium fish foods (Alaska Department of Commerce, Community and Economic Development undated); the

Arctic Paws Yummy Chummies facility in Anchorage uses chum salmon for pet food (Alaska Department of Commerce, Community and Economic Development undated; Bauman 2008); and Juneau-based Alaska Protein Recovery LLC, which operates the processing barge *Alaskan Venturer*, is investigating the possibility of using salmon byproducts to manufacture nutraceuticals (Bauman 2007). Markets for these various fish waste products appear strong enough to support further development.

A road may make it more feasible to transport chum salmon carcasses (or ground up remains) from Upper Yukon Area fishing sites to a central processing plant in Fairbanks or some other location. However, given the inherently higher costs of processing carcasses in Western Alaska because of higher capital costs and greater distance to markets, it is likely that flesh utilization will remain a limiting factor on production of high value roe in the Upper Yukon.

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APPENDIX 1

Commercial and Subsistence Fisheries for Miscellaneous Fish Species

Table 15: Commercial Miscellaneous Finfish Harvest in the Kotzebue District, 1966–2007

Year	Sheefish		Dolly Varden	
	Number	Pounds	Number	Pounds
1966	NA	NA	3325	NA
1967	4000	26000	367	2606
1968	792	4752	3181	21949
1969	2340	15209	1089	NA
1970	2206	NA	2095	NA
1971	73	720	3828	23353
1972	456	4071	7746	56545
1973	2322	15604	640	4608
1974	1080	6265	2605	20580
1975	2543	24161	NA	NA
1976	2633	19484	NA	NA
1977	566	5004	NA	NA
1978	2879	26200	1229	9094
1979	0	0	2523	12523
1980	1175	8225	3049	17015
1981	278	1836	3	16
1982	2629	17376	3447	23648
1983	1424	13395	190	1108
1984	927f	10403	347	2104
1985	342f	3902	454	3177
1986	26	312	5	34
1987	670	5414	1261	8704
1988	943	7373	752	4967
1989	2335	16749	3093	20293
1990	687	5617	604	4219
1991	852	8224	6136	40747
1992	289	2850	1977	11951
1993	210f	1700	76	540
1994	0	0	149	767
1995	226	2240	2090	13195
1996	308	3002	188	1153
1997	0	0	3320	23203
1998	254	2400	349	2640
1999	0	0	1502	11352
2000	0	0	7	44
2001	19	200	0	0
2002	30	300	0	0
2003	122	1250	20	160
2004	37	474	124	846
2005	--	--	181	1158
2006	0	0	0	0
2007	0	0	0	0

Notes:

1) NA – Information not available.
2) Sheefish season was from October 1 to September 30. Year indicated would be the year the commercial season ended. For example, the year 1980 would represent October 1, 1979 to September 30, 1980.
3) Sheefish weight data are not exact, in some instances total catch poundage was determined from average weight and catch data.
4) Dolly Varden were incidentally caught and sold during the commercial salmon fishery.
5) In 1969, Dolly Varden number includes 269 taken by permit.
6) In 1971, Dolly Varden number includes 179 taken by permit.
7) In 1974, 1975 and 1993, sheefish number not always reported. Estimates were based on average weight from reported sales which documented the number of fish.
8) In 1974, Dolly Varden number includes 234 taken during commercial sheefish fishery.
9) In 1981, 1983, 1984 and 1985, limited Dolly Varden market; many fish were taken home or dumped.
10) In 1982, Sheefish number estimate based on historical average weight.
11) In 2005, less than 4 deliveries of sheefish, data confidential under Alaska Statute 16.05.815. Prior to 2005, confidentiality was waived by permit holders.

Source: Soong et al. (2008)

Table 16: Subsistence Miscellaneous Finfish Harvest in the Kotzebue District, 1995–2003

	Number of Fish		
	Sheefish	Whitefish	Char
1995	9,465	NA	5,762
1996	6,953	NA	5,692
1997	9,805	84,851	4,763
1998	5,350	39,754	3,872
1999	8,256	56,326	NA
2000	7,446	7,097	3,315
2001	3,838	30,976	2,702
2002	4,310	25,607	3,242
2003	7,813	73,242	6,386

Notes:

1) NA – Information not available.
2) Sheefish normally includes Noorvik, Kiana, Ambler, Shungnak, and Kobuk.
3) Whitefish normally Includes Noorvik, Kiana, Ambler, Shungnak, Kobuk, and Noatak.
4) Char includes Noatak.
5) Data for 2001 does not include Ambler.
6) Data for 2002 includes only Noorvik for sheefish, and Noorvik and Noatak for whitefish.
7) Data for 2003 includes Noatak, Noorvik, Kiana, Ambler, Shungnak, and Kobuk for sheefish. Char includes all these except Kobuk.

Source: Division of Subsistence (2004)

Table 17: Commercial Miscellaneous Finfish Harvest in the Upper Yukon Area, 1971–2004

	Healy Lake		Lake Minchumina				Tanana River		Yukon River					
	Whitefish		Whitefish		Burbot		Whitefish		Burbot		Whitefish		Lamprey	
Year	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
1971			3,277	9,831	0	0	0	0	0	0	0	0	0	0
1972	2,605	3,950	718	2,154	0	0	0	0	0	0	0	0	0	0
1973	2,187	3,915	1,697	5,037	0	0	0	0	0	0	0	0	0	0
1974	1,885	3,390	854	2,562	0	0	0	0	0	0	0	0	0	0
1975	1,357	2,375	0	0	0	0	0	0	0	0	0	0	0	0
1976	1,440	2,625	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	1,336	2,306	0	0	0	0	0	0	0	0	0	0	0	0
1980	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	76	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	72	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	837	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	1	0	0	2,070	0	0
1990	0	0	0	0	1	0	809	0	0	0	985	2,078	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	921	1,400	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	908	1,160	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	99,988	25,697
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971-2004 Average	0	0	0	0	0	0	0	0	0	0	0	0	19,998	5,139

Notes:

1) Numbers reflect fish harvested with the intent of commercial sale.
2) NA – Information not available.
3) In 1998, requests for commercial whitefish fishing permits in the Tanana River were denied because of the additional pressure placed on non-salmon species during poor salmon runs.
4) Number of lamprey equals pounds of lamprey divided by the average lamprey weight (0.257). Harvest took place in Grayling area.

Source: Hayes et al. (2008)

Table 18: Subsistence Miscellaneous Finfish Harvest in the Upper Yukon Area, 2002–2004

	Large Whitefish		Small Whitefish		Pike		Sheefish	
	Estimated Number	CI (95%, ±)	Estimated Number	CI (95%, ±)	Estimated Number	CI (95%, ±)	Estimated Number	CI (95%, ±)
	2002							
District 4	10,730	4,574	11,471	5,078	2,321	679	2,663	642
District 5	7,813	903	9,464	2,916	1,589	1,386	1,420	1,361
Total	18,543		20,935		3,910		4,083	
	2003							
District 4	13,250	6,427	11,599	1,580	8,264	5,795	3,968	955
District 5	5,579	1,601	4,426	906	1,381	692	1,395	324
Total	18,829		16,025		9,645		5,363	
	2004							
District 4	8,746	1,785	10,387	6,064	3,499	1,014	3,753	744
District 5	8,060	2,578	4,862	1,085	1,477	680	3,330	742
Total	16,806		15,249		4,976		7,083	

Notes:

1) CI – confidence interval
2) Large whitefish are considered those 4 pounds or larger and small whitefish are less than 4 pounds.

Source: Hayes et al. (2008)

APPENDIX G

Recreation and Tourism Resource Paper

RECREATION RESOURCES AND TOURISM

WESTERN ALASKA ACCESS

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February 2009

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LIST OF ACRONYMS

ATV .... all-terrain vehicle
AVSP .... Alaska Visitor Statistics Program
DOWL........ DOWL HKM
EIS........ Environmental Impact Statement

EXECUTIVE SUMMARY

The primary tourism and recreational assets of the study area include its national parklands and Alaska Native culture. The two largest communities in the study area, Nome and Kotzebue, are major gateways for accessing these assets because of their frequent airline connections to Anchorage. In addition, Nome has become a port of call for expedition-class cruise ships. Smaller communities in the study area are reached by scheduled and charter air taxi services. Both Nome and Kotzebue have fairly well-developed tourist related infrastructure and businesses, but tourist facilities in the outlying villages are generally limited.

The major outdoor recreation activities in the study area include hunting, fishing, trapping, gathering of edible plants and berries, hiking and backpacking, photography, camping and picnicking, wildlife viewing (predominantly bird watching), river rafting, boating and driving off-highway vehicles (primarily snowmachines). Many of these activities occur in national parks, monuments, preserves and wildlife refuges and along rivers protected under the National Wild and Scenic River System. Most outdoor recreation areas in the study area can be accessed only by “bush” plane; however, Nome is the originating point for three major state roads providing vehicle access to popular natural attractions. In addition to the variety of natural area recreation opportunities, the study area has a number of cultural assets through its Iñupiat, Yup’ik and Athabascan Indian history and connection to the gold rush era.

Further development of recreation resources and tourism in the study area is a challenge for several reasons, including competition with other tourist destinations that offer similar attractions but are cheaper and quicker to visit; the limited pool of “niche market visitors” that might be interested in visiting the area.; the short visitor season; the lack of private and public tourist-related infrastructure in much of the study area; and concerns among many village residents about impacts of increased visitation on their traditional lifestyle, especially to subsistence uses of fish and wildlife resources.

Construction of a highway between the contiguous Alaska highway system and the highway system on the Seward Peninsula would improve direct access to the study area’s natural and

cultural resources, thereby helping serve the increasing demand by Alaska residents and out-of-state visitors for recreation opportunities in Alaska. Moreover, the improved accessibility would create new opportunities for recreation and tourist-related economic activities which, in turn, would generate jobs and income and contribute to the local tax base. However, the enhanced access and tourism development that follows may also have a number of negative consequences. There will likely be a higher incidence of conflicting recreational activities, and congestion may diminish the quality of the recreational experience. Developing and maintaining the tourist industry in a community requires added maintenance costs and puts pressure on public services. Some residents may view the opening of new areas to the general public as an exacerbation of existing threats to subsistence opportunity and culture.

1.0 CURRENT RECREATION RESOURCES AND TOURISM IN THE STUDY AREA

1.1 Overview

This working paper evaluates the potential for development of recreation resources and tourism in the study area, including the potential quantity, quality, value, marketability, and geographic location of recreation resources.

The primary tourism and recreational assets of the study area include its national parklands, Alaska Native culture, adventure and ecotourism opportunities, as well as its "north of the Arctic Circle" allure (Northwest Arctic Borough Economic Development Commission and Alaska Department of Commerce and Economic Development, undated). The two largest communities in the study area, Nome and Kotzebue, are considered major gateways for accessing many of these assets.[1]

Nome is a well-established tourism destination (Alaska Department of Commerce, Community and Economic Development, 2007). It is the largest community in Northwest Alaska and, together with Kotzebue, serves as a transportation hub for the region. There is twice-daily, nonstop jet service from Anchorage to Nome. In conjunction with this jet service, Alaska Airlines offers Nome day and overnight tours (Alaska.org, undated). In addition, cruise ship tourism is important to Nome's economy as a port of call for small, expedition-class cruise ships (ships that carry a maximum of approximately 100 passengers), which attract visitors interested in culture, wildlife and adventure (Alaska Department of Commerce, Community and Economic Development, 2007). Cruise Line Agencies reports that 786 cruise passengers stopped in Nome in the summer of 2005, some of whom boarded their vessel in Nome and may have spent the night there (McDowell Group, 2006). These cruise ships often dock just long enough to pickup and off-load passengers that are flown by charter jet, and to refresh supplies—their short time in Nome's harbor gives passengers only a brief opportunity to visit Nome's attractions, usually with a tour guide (Land Design North, 2003). For independent tourists and those tour package and cruise ship visitors who overnight

[1] Fairbanks is also a major gateway for travel to many of the recreational sites in the study area; however, this community is located outside of the study area.

in Nome, the community currently offers three hotels, eight bed and breakfasts and apartments and nine restaurants (TravelAlaska.com, undated).

Primary visitor access to Kotzebue is by daily, commercial jet service from Anchorage, with some flights routed through Nome. Until about three years ago, the majority of visitors to Kotzebue purchased the tour package from Tour Arctic, which is owned and operated by NANA Development Corporation (Northwest Arctic Borough Economic Development Commission and Alaska Department of Commerce and Economic Development, undated). The tour included a general community overview, a visit to the Iñupiat Culture Camp and a visit to the NANA Museum of the Arctic (which will soon be replaced by the Northwest Arctic Heritage Center). Several hundred of these visitors also purchased a day trip to the village of Kiana, which affords general flightseeing opportunities and cultural walking tours. However, the tour package offered by Tour Arctic has been suspended due to the declining number of tourists visiting Nome and Kotzebue as part of air package tours (Atkinson, 2008).

Kotzebue has one hotel (the 76-room Nullagvik Hotel, which is owned and operated by NANA Development Corporation), two bed and breakfasts and three restaurants (TravelAlaska.com, undated). At times, NANA Development Corporation has had a small fleet of tour buses on location in Kotzebue as well (Northwest Arctic Borough 2004). Smaller communities in the study area are reached by scheduled and charter air taxi services based in Nome, Kotzebue, Ambler, Kiana, Galena, Unalakleet and Bettles. Kiana, Bettles, Galena and Unalakleet are among the few outlying villages in the study area that offer commercial lodges for tourists and hunters.

Alaska Visitor Statistics Program (AVSP) data on visitor volume in the study area are available only for the “Bering Strait region,” which includes two communities (Gambell and Savoonga) outside of the study area (McDowell Group, 2006). However, given that the majority of visitors who overnight in the Bering Strait region do so in Nome or Kotzebue, the AVSP estimate is a good measure of visitation in the study area. According to the latest available AVSP data, an estimated 5,000 out-of-state visitors overnighted in the Bering Strait region between May and September, 2005 (McDowell Group, 2006). Volume was determined using estimated visitor volume to the state and percentages of non-cruise visitors who reported visiting the Bering Strait region. Three-quarters of Bering Strait visitors were traveling to Alaska for vacation/pleasure purposes, with 18 percent traveling to visit friends or relatives, and 8 percent traveling for business/pleasure. Bering Strait visitors spent an average of $2,550 per person while in Alaska, and $802 per person while in the Bering Strait region. The average statewide spending by Bering Strait visitors was greater than what the average rural Alaska visitor spends, statewide: $2,550 per person versus $1,767 among all rural visitors (McDowell Group, 2006).

It is estimated that tourism brings $3.7 million per year into the Nome area economy alone. As local beneficiaries (e.g., tourism industry workers, local business owners, and Native artisans) spend their earnings, the multiplier effect of these dollars circulating in the region is $4.9 million (Alaska Department of Transportation and Public Facilities, 2004).

The Northwest Arctic Borough (2004) indicates that visitor volume in the Northwest Arctic Borough in 2004 was substantially less than what it was in the mid-1990s. While a sharp decline in the world economy may be partially responsible for the falloff in tourist travel to the region, it has also resulted from reduced tourism marketing by NANA Development Corporation (Northwest Arctic Borough, 2004). As noted above, the number of tourists visiting Nome and Kotzebue as part of air package tours has been steadily dropping in recent years. As the demographics of Alaska cruise passengers change (passengers have less income, less time to spend), the extra money for a one- or two-day air package tour to Nome and/or Kotzebue is not affordable and/or does not appear to provide a good product for the cost (Alaska Department of Transportation and Public Facilities, 2004; Land Design North, 2003).

1.2 Natural Resources

According to AVSP data for the Bering Strait region, the most-enjoyed aspect of the region is its outdoors/scenic beauty, mentioned by 43 percent of visitors (McDowell Group, 2006). In addition, part of the region’s appeal is its remote location; it was mentioned by 25 percent of visitors as the reason they chose to visit the region and 36 percent said it was what they enjoyed most.

The major outdoor recreation activities in the study area include hunting, fishing, trapping, gathering of edible plants and berries, hiking and backpacking, photography, camping and picnicking, wildlife viewing (predominantly bird watching), river rafting, boating and driving off-highway vehicles (primarily snowmachines) (U.S. Department of the Interior, Bureau of Land Management, 2007). The thousands of square miles of public lands in the study area offer visitors abundant opportunities to pursue these activities. About one-quarter of the land within the study area is federally owned and protected as parks, monuments, preserves, and wildlife refuges. As shown in Figure 1, these federal lands include the following:

- Koyukuk National Wildlife Refuge
- Kanuti National Wildlife Refuge
- Gates of the Arctic National Park and Preserve
- Selawik National Wildlife Refuge
- Noatak National Preserve
- Cape Krusenstern National Monument
- Kobuk Valley National Park
- Bering Land Bridge National Preserve
- Innoko National Wildlife Refuge
- Nowitna National Wildlife Refuge

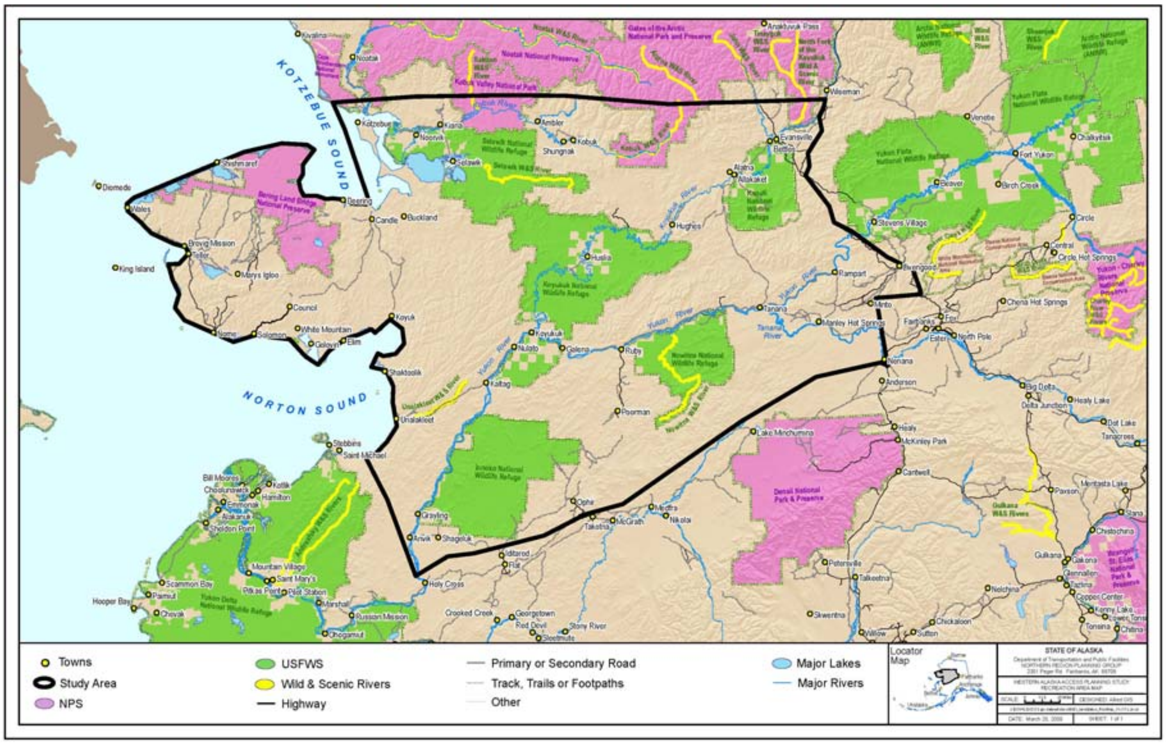

Figure 1: National Parks, Monuments, Preserves, Wildlife Refuges and Wild and Scenic Rivers in the Study Area

Source: Alaska Department of Natural Resources at http://www.asgdc.state.ak.us/ and http://www.dggs.dnr.state.ak.us/pubs/pubs?reqtype=digitaldata; National Park Service at ttp://www.nps.gov/gis/data_info/park_gisdata/ak.htm; DGGS =

The National Park Service's general management plans for the parks, monuments and preserves in the study area seek to limit ground access in order to maintain the natural, aesthetic and scenic values of the areas. Most visitors access the conservation areas by small, fixed-wing "bush" plane, starting from local villages. Some visitors to the Gates of the Arctic National Park and Preserve hike in from the Dalton Highway or the village of Anaktuvuk Pass. The winter season provides other options for accessing the areas, including skis, snowmachine and dog sled.

The limited ground access restricts the number of residents and visitors who travel into these federal conservation areas. Figure 2 shows that annual visitation in the areas by recreational users has fluctuated widely from year to year, but the number of visitors in any one area has generally been fewer than 10,000.

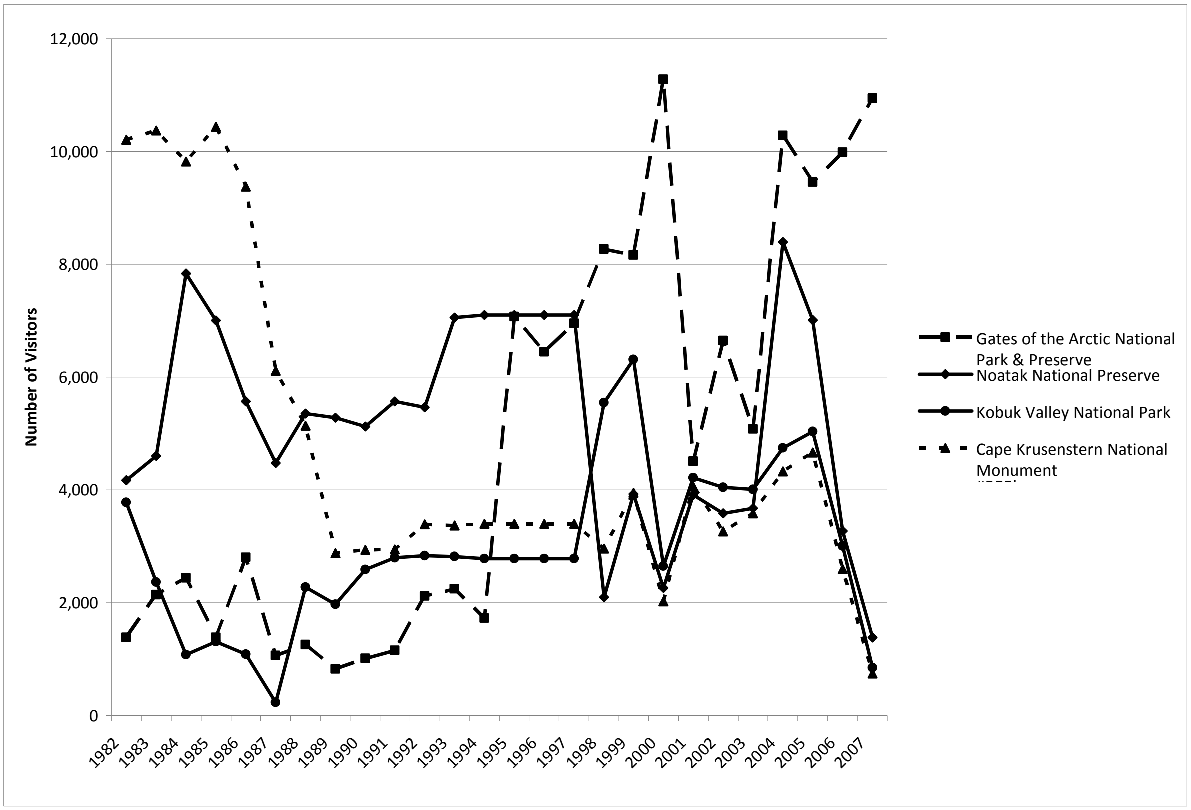

Figure 2: Annual Visitation in Major National Parks, Preserves and Monuments in the Study Area, 1982-2007

Source: National Park Service at http://www.nature.nps.gov/stats/state.cfm?st=ak

The limited ground access, together with the virtual absence of on-site visitor amenities and services, has meant that the national parks, monuments and preserves in the study area attract a particular type of tourist. The following description of Kobuk Valley National Park by the National Park Service (2008) applies to most of the national parks, monuments, preserves and wildlife refuges in the study area:

> You'll find no roads, no gift shops, and no parking facilities within the monument. No trails exist; nor do campgrounds. In fact, the park headquarters and visitor center are not within the monument; both facilities are in the town of Kotzebue, Alaska—an airplane ride away.
>
> Kobuk Valley's visitor isn't your average tourist. They tend to be skilled backcountry explorers familiar with surviving potential high winds, rain, and snow — and that's in the summer months.

Apart from its facilities in Kotzebue, the National Park Service has field offices for Gates of the Arctic National Park and Preserve in Bettles and Anaktuvuk Pass and a visitor center in Coldfoot, located on the Dalton Highway. Administrative Offices for Bering Land Bridge National Preserve are located in Nome and include a small interpretive center that offers limited exhibits and films as well as special programs.

In addition to national parks, monuments, preserves and wildlife refuges, the study area includes several rivers protected under the National Wild and Scenic River System (Figure 1), including the following:

- Kobuk
- North Fork of the Koyukuk
- Tinayguk
- Salmon
- Selawik
- John
- Alatna
- Nowitna
- Unalakleet

These rivers received their designation under the Wild and Scenic Rivers Act because they “possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values.” Licensed operators offer visitors guided rafting and fishing trips on these rivers. The above nine rivers represent more than one-third of all the wild and scenic rivers in Alaska.

Nome is the originating point for three major state roads providing vehicle access to a mix of natural and cultural attractions: Teller Highway, Council Road and Kougarok Road. These 250 miles of road were originally constructed to provide access to villages, subsistence resources and mines, but their popularity in recent years has grown due to the recreational freedom they provide for tourists (Alaska Department of Commerce, Community and Economic Development, 2007). Four-wheel drive rental vehicles available in Nome, although expensive, allow independent travelers to use the roads to see wilderness areas on their own to a degree that is unusual in northern Alaska. In addition, several tour operators use buses for guided trips along the roads (Land Design North, 2003). In recent years, the road system has become the backbone of Nome’s attraction to both independent and package tour bird watching travelers seeking the chance to add to their life lists (Land Design North, 2003). For example, the Coffee Dome on the Kougarok Road is the only road-accessible place in North America where the Bristle-Thighed Curlew can be seen (Land Design North, 2003.

Salmon Lake, located 40 miles north of Nome on the Kougarok Road, has the only developed public campground in the study area with road access; the campground is managed by the Bureau of Land Management. The lake and facilities are primarily used by local residents, although there is increasing interest by non-resident visitors. The nearby Kigluaik Mountains have also been seeing increased visitor use in recent years. These mountains have recently been identified as a Special Recreation Management Area by the Bureau of Land Management. In addition to road access to the Kigluaik Mountains, helicopter charters are now available out of Nome to view some of the spectacular vistas (U.S. Department of the Interior, Bureau of Land Management, 2007).

Sport fisheries in the study area target seven species of Pacific salmon, Dolly Varden, sheefish, Arctic grayling, northern pike, lake trout, Arctic char and, to a small degree, burbot. As shown in Table 1, the estimated annual number of angler days for the 1994-2007 period averaged 15,684 (range 13,323 to 19,647) for the Seward Peninsula-Norton Sound Drainages; 5,753 (range 3,729 to 8,495) for the Northwest Alaska Drainages; and 12,066 for the Yukon River Drainages (range 10,127 to 18,677) (Jennings et al., 2007, updated with data from Alaska Department of Fish and Game).[2] The Unalakleet River is the most heavily utilized river in the study area because of its relative accessibility. The village of Unalakleet

[2] Seward Peninsula-Norton Sound Drainages: All waters north of the Yukon River drainage, south of the Selawk River-Kotzebue Sound area, and west of the Yukon-Koyukuk river drainages. Area includes Pastol Bay and all salt water north and west of it in Norton Sound as well as saltwater adjacent to the Seward Peninsula, including Spafarief Bay in Kotzebue Sound the southern half of Eschscholtz Bay, and Saint Lawrence Island.

Northwest Alaska Drainages: All waters and drainages of the Kotzebue area including drainages of the Selawik, Kobuk, Noatak, Wulik and Kivalina Rivers. All salt water in the northern half of Eschscholtz Bay, including Chamisso Island area, and the northern half of Kotzebue Sound to and including Point Hope.

Yukon River Drainages: All Yukon River drainages (including the Alaska portion of the White River drainage but excluding the Tanana River drainage), from the south side of the Brooks Range to the Bering Sea: and from the Canadian border to the Bering Sea; and all drainages of the Koyukuk and Alatna Rivers.

is located at the mouth of this river where it flows into Norton Sound. Many streams located along the southern half of the Seward Peninsula between Koyuk and Teller (including the Fish, Niukluk, Bonanza, Eldorado, Nome, Snake, Sinuk, Feather, Tisuk, Pilgrim, and Kuzitrin Rivers) are accessible via the Nome road system (Alaska Department of Fish and Game, 2008). Many less-accessible rivers in the study area, such as the Kobuk, Upper Yukon, and Koyukuk Rivers, are popular aircraft-supported sport fishing destinations.

Table 1: Estimates of the Number of Angler-Days Fished in the Study Area, 1994-2007

	Seward Peninsula-Norton Sound Drainages	Northwest Alaska Drainages	Yukon River Drainages
1994	18,922	6,036	12,872
1995	19,647	8,495	18,677
1996	13,783	5,571	10,678
1997	13,850	3,729	12,725
1998	13,616	3,801	10,127
1999	15,006	6,771	12,906
2000	18,443	7,056	11,327
2001	10,955	5,904	10,560
2002	18,325	6,417	15,044
2003	12,403	6,121	9,117
2004	13,323	5,704	13,109
2005	17,067	3,118	8,965
2006	17,572	6,786	11,423
2007	16,667	5,027	11,394
Average	15,684	5,753	12,066

Source: Jennings et al. (2007) updated with data from Alaska Department of Fish and Game

The study area includes several game management units and controlled use areas administered by the Alaska Department of Fish and Game (Figure 3). In the last 20 to 30 years, some of these areas have become a popular fall destination for sport hunting. A number of factors have contributed to the study area's increasing popularity among big game hunters, including its plentiful caribou, moose, Dall sheep, and bear; its scenic landscape; its abundance of gravel bars and other spots suitable for landing aircraft and the increasingly restrictive and competitive hunting in more accessible parts of the state (Georgette and Loon, 1988; U.S. Department of the Interior, Bureau of Land Management, 2007). As shown in Figure 4, the study area's growing popularity is reflected in the increasing number of licensed hunters for moose.

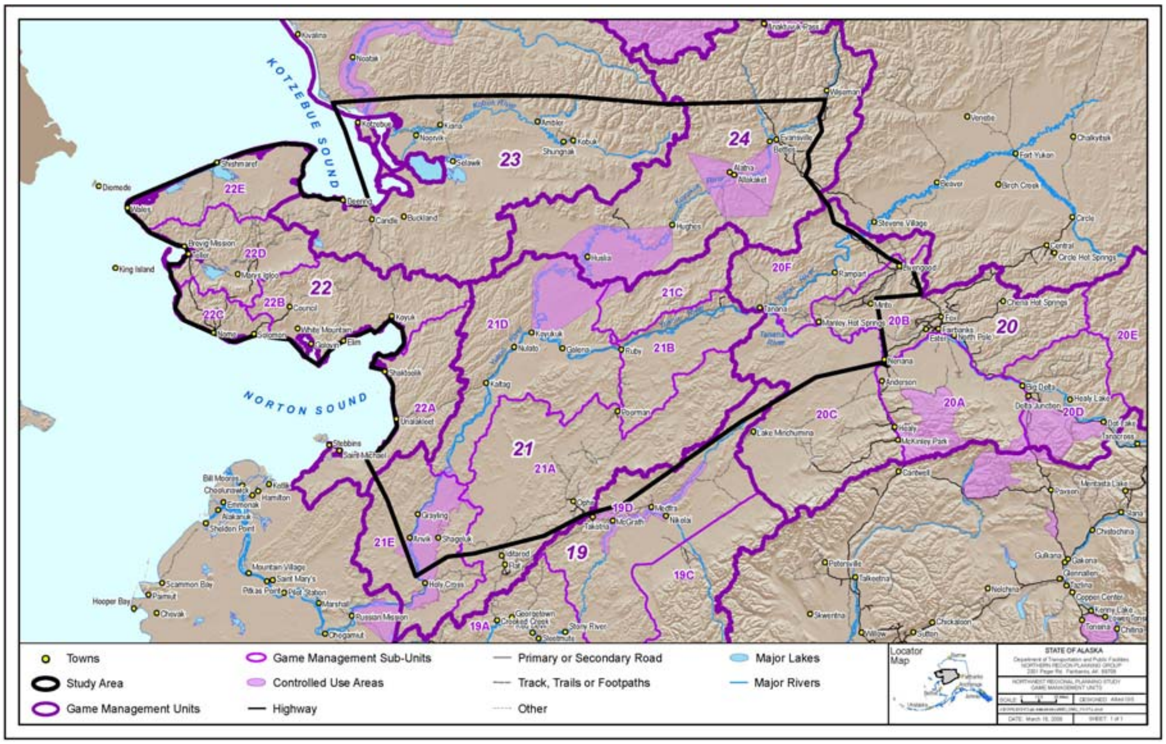

Figure 3: Game Management Units and Controlled Use Areas in the Study Area

Source: Alaska Department of Natural Resources at http://www.asgdc.state.ak.us/

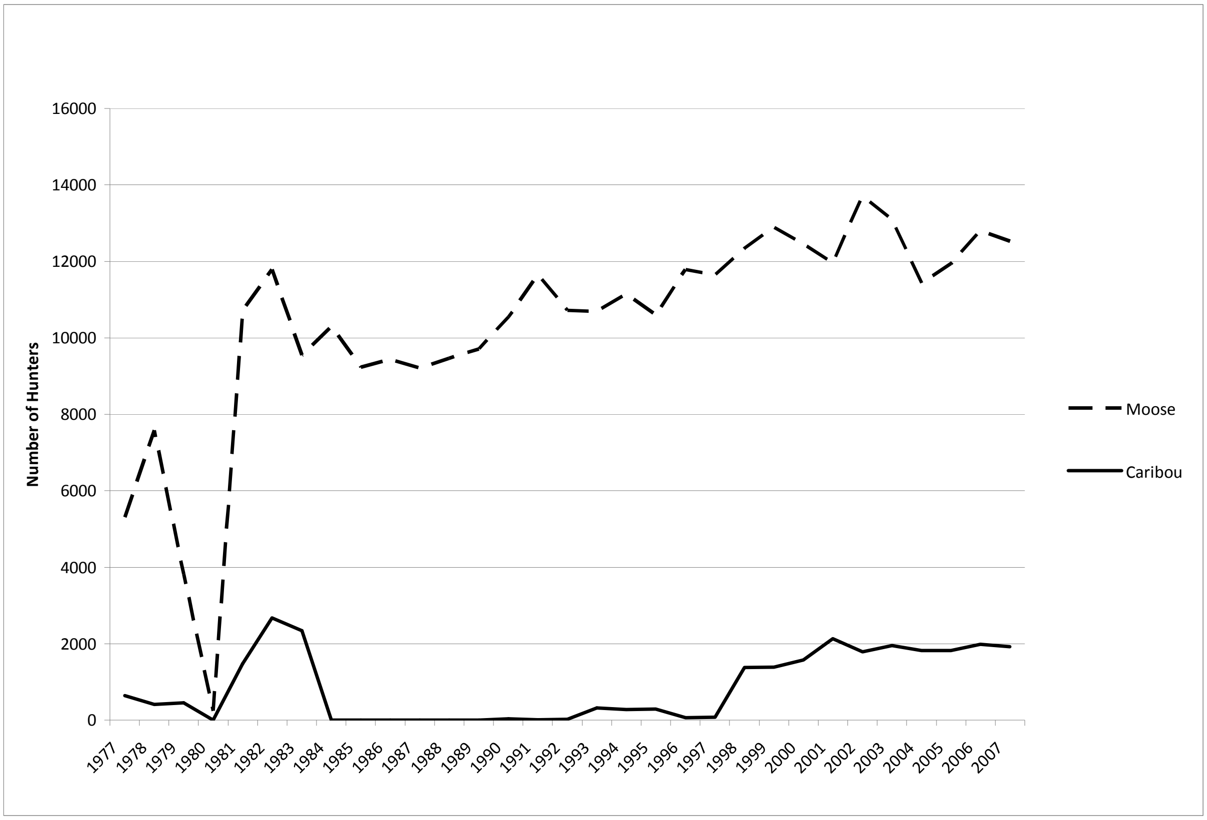

Figure 4: Number of Licensed Persons Who Hunted Caribou and Moose in the Study Area, 1977-2007

Note: The following game management units were included in the study area: 19D; 20B, C, F; 21A, B, C, D, E; 22A, B, C, D, E; 23; 24A, B, C, D.

Source: ADF&G at http://www.wildlife.alaska.gov/index.cfm?fuseaction=harvestreports.main

Another outdoor recreational activity that has gained considerable popularity in the study area is the use of off-road motorized vehicles, including all-terrain vehicles (ATVs) or "four-wheelers," and snowmachines. In the summer and fall, ATVs support fishing and hunting activities. During the winter months, snowmachines offer backcountry and hill climbing recreational experiences, and an increasing number of visitors are being drawn to organized events that center on snowmachine use such as the Iron Dog race and events centered on the Iditarod National Historic Trail (U.S. Department of the Interior, Bureau of Land Management, 2007). In the last ten years, the use of these off-road vehicles has led to the development of an extensive network of trails between the upper Kobuk River communities and around the Nome road system (Lean, 2008).

1.3 Cultural and Historical Resources

In addition to the variety of natural area recreation opportunities, the study area has a number of cultural assets through its Iñupiat, Yup'ik and Athabascan Indian history. These Alaska Native cultures are some of the oldest, most intact indigenous cultures in the world (Alaska Department of Transportation and Public Facilities 2004). Fascination with these cultures has attracted tourists to Kotzebue, Nome and other areas of Northwest Alaska since the 1940s (Smith, 1989).

Most of the study area's activities and products that appeal to the cultural tourist are concentrated in Kotzebue (PDC Inc. Engineers, 2007). The NANA Museum of the Arctic's Iñupiat Cultural Camp, often included in air package tours, provides opportunities for village youth and elders to explain and demonstrate various aspects of the Iñupiat lifestyle to visitors, including information about traditional clothing, foods, harvesting and survival techniques (TravelAlaska.com, undated; PDC Inc. Engineers, 2007). Native artifacts are also on display at the Kotzebue Senior Center, which welcomes visitors to potlatches, musicals, and dance celebrations (TravelAlaska.com, undated). LaVonne's Fish Camp, a privately operated culture camp located five miles from Kotzebue, offers tourist and elderhostel accommodations (LaVonne's Fish Camp, 2008).

The National Park Service is constructing a new visitor services/administration building—the Northwest Arctic Heritage Center—in Kotzebue. The multi-use facility will be located on the site formerly occupied by the NANA Museum of the Arctic, which was built in 1976. The new facility will offer cultural information, performing arts, visitor information, museum space, and other types of interpretive and educational information. The structure is expected to be completed by February 2010 (National Park Service, 2008).

In Nome, the Carrie McLain Museum houses historical photos and exhibits about Native culture, Eskimo art and the gold rush (TravelAlaska.com, undated). The administrative office for the Bering Land Bridge National Preserve is located in Nome and has a small interpretive center that offers limited exhibits and films as well as special programs (National Park Service, 2006). Other historic sites in Nome include the gold-rush-era Board of Trade Saloon and St. Joseph's church. The Iditarod Dog Sled Race brings worldwide attention to the area while filling hotel rooms with tourists during part of the winter season (Alaska Department of Transportation and Public Facilities, 2004). Teller Highway provides direct access to the village of Teller, a subsistence village with a small local store and gift shop selling Alaska Native crafts, and indirect access to the villages of Brevig Mission and Port Clarence (Land Design North, 2003).

Kiana is one of the study area's few outlying communities that provide opportunities for the cultural tourist (PDC Inc. Engineers, 2007). The village offers walking tours and riverboat trips that feature the subsistence lifestyle of the residents and allow visitors to see traditional skills in use.

2.0 CONSTRAINTS TO FURTHER DEVELOPMENT OF RECREATION RESOURCES AND TOURISM IN THE STUDY AREA

As discussed above, the study area's rich natural and cultural heritage is a strong attractant for tourists and recreationists. However, further development of recreation resources and tourism in the study area is a challenge for several reasons. Among the greatest inhibitors to tourism development for this region is the problem of access. This includes the challenge of motivating greater numbers of visitors to spend the time and dollars required to travel to the area, as well as issues related to limited access to the area's natural and cultural assets (Northwest Arctic Borough Economic Development Commission and Alaska Department of Commerce and Economic Development, undated). Most of the major recreational resources, such as the national park lands, are difficult to reach. Even the main transportation hubs of Nome and Kotzebue are remote and expensive destinations (Alaska Department of Transportation and Public Facilities, 2004).

To add to the challenge, tourist destinations in the study area now compete more heavily for the visitor's time and attention with other opportunities in Alaska. A number of other visitor industry products have been developed in Alaska in the past 20 years that showcase gold rush history, Alaska Native culture, and wildlife viewing (Land Design North, 2003). Visitors to Alaska can now experience these things without traveling to the Arctic or sub-Arctic. While Nome has an active marketing program managed by the Nome Convention and Visitors Bureau, the program has limited resources to successfully compete with destinations that are cheaper and quicker to visit (Land Design North, 2003).

Further, the development of tourism in the study area is limited by the potential pool of Alaska tourists that might be interested in visiting the area. Alaska has two general tourism markets: “mainstream visitors” who tend to stay on the main tourist “pipeline” (i.e., large cruise ships and the rail belt), and “niche market visitors” who tend to travel independently and off the beaten path (Land Design North, 2003). Aside from the cruise ship passengers who briefly stop in Nome, most visitors to the study area are in the latter group; they tend to be focused on hunting and fishing, wildlife viewing, culture and adventure (e.g., river rafting). In contrast to Alaska’s expanding market for mainstream visitors, niche market visitors currently represent only 10 to 20 percent of all Alaska’s visitors and numbers are flat or even declining (Land Design North, 2003). As discussed above, some mainstream visitors visit Nome and Kotzebue as part of air package tours, but the number of these tours has fallen due to changes in the demographics of Alaska cruise passengers and other factors.

Another constraint to development of tourism in the study area is the short visitor season, and even during that season visitors may have to contend with harsh Arctic/subarctic conditions. For example, bad weather and high water can reduce aircraft access to sport hunting and fishing areas (Alaska Department of Transportation and Public Facilities, 2004; Georgette and Loon, 1990). Strong storm and wind conditions can close Nome’s harbor, thereby forcing cruise ships to bypass the community (Land Design North, 2003).

Also hindering expansion of the tourism industry is a lack of privately owned tourist-related infrastructure in the study area. For most of the villages, the absence of overnight lodging facilities, restaurants, retail outlets and guide services is a clear constraint to visitor traffic (Northwest Arctic Borough Economic Development Commission and Alaska Department of Commerce and Economic Development, undated; Northwest Arctic Borough, 2004). Game handling facilities (e.g., refrigerator/freezer space) for sport hunters in the study area are inadequate (Jacobson, 2008). Furthermore, there are little private capital, trained human resources or marketing resources for visitor-related development of this kind (Alaska Department of Commerce, Community and Economic Development, undated; Alaska Department of Transportation and Public Facilities, 2004; Northwest Arctic Borough, 2004).

Public tourist-related infrastructure is also limited in the study area. Nome's port facility has a lack of amenities (e.g., boardwalks, shelters) for cruise ship passengers (Land Design North, 2003). Especially over the past few years, maintenance funding has not been sufficient to keep Nome's three roads in good summer driving condition—these roads are especially challenging to maintain because of thawing and drainage events and other problems (Land Design North, 2003). Recreational areas have few, if any, visitor amenities or facilities (Alaska Department of Transportation and Public Facilities, 2004). For example, trail head posting and trail improvements, campgrounds and water and waste disposal facilities are absent in the national parks, monuments, preserves and wildlife refuges in the study area. The three roads originating from Nome have few amenities, services, and interpretation to enhance visitor enjoyment of the road system (Alaska Department of Transportation and Public Facilities, 2004; Land Design North, 2003). Moreover, the roads are generally buried under snow during the winter months (Land Design North, 2003).

Finally, and perhaps most important, there is a concern among many village residents in the study area about the potential effects of increased visitation on their traditional lifestyle, especially to subsistence uses of fish and wildlife resources (Northwest Arctic Borough Economic Development Commission and Alaska Department of Commerce and Economic Development, undated; Northwest Arctic Borough, 2004). There are approximately 18,000 people in the study area, the majority of whom are Native Alaskans, residing in more than 40 villages scattered along the coast and major river systems. Nearly all of the local residents are dependent to varying degrees on fish and game resources for their livelihood. Under State of Alaska and federal law, subsistence is the highest priority use of the state's fish and game resources.

There are several documented incidences of resource user conflicts within the study area. In 2004, the tribal governments of Koyuk and Shaktoolik protested a U.S. Bureau of Land Management decision to grant a commercial use permit to a hunting guide within the Koyuk and Shaktoolik Rivers. Conflicts over commercial recreational sport hunting were the root of the protest (U.S. Department of the Interior, Bureau of Land Management, 2007). In 1992, moose hunting pressure induced the Federal Subsistence Board to close all federal lands within the Kanuti Controlled Use Area to moose hunting, except for federally qualified subsistence users (U.S. Fish and Wildlife Service, 2008). The quantity of airplane traffic associated with fly-in sport fishing has disturbed Upper Kobuk residents, particularly near the Pah River where good sheefish fishing combined with safe landing sites attracts sport fishers (Georgette and Loon, 1990). Similarly, aircraft-supported big game hunting along the Noatak River is reported by local residents to be directly competing with and displacing them from hunting sites (Georgette and Loon, 1988). In general, Game Management Unit 23, which encompasses both the Kobuk and Noatak Rivers, has become an area of intense resource user conflict due to the increased level of use by non-local hunters over the past several years (Jacobson, 2008; U.S. Department of the Interior, Bureau of Land Management, 2007; Steinacher, 2006).

Steinacher (2006) summarizes the nature of the growing conflict among resource users as follows:

> Broadly, the problem is about what happens when different perspectives on hunting collide and access to wilderness, wildlife, and hunting opportunity is insufficient to meet everyone's needs. More specifically, it is about the increasing number of guides, transporters and visiting hunters converging on northwestern Alaska during the short fall hunting season—at the same time that local subsistence users (who have hunted in the region for generations) are getting their winter meat. The problem also embraces the issue of wasted meat, and the fear that too many people can love a very special place into ruin.

It is just not local residents engaged in subsistence activities who have expressed concern about the increased level of use by non-local hunters and fishers. Long-established big-game guides in the region complain that opportunities to locate large male animals in uncrowded hunting conditions are rapidly diminishing in Game Management Unit 23—they worry about their ability to maintain quality hunting experiences for clients and to operate profitable businesses (Jacobson, 2008; Steinacher, 2006). Even some non-local hunters have expressed concern. For example, Christensen and Watson (2002) reported that 96 percent of all hunters surveyed indicated that the perception of "few other hunters" had a major influence on their decision to hunt the Kobuk River area of the Gates of the Arctic National Park and Preserve, and the perception of remoteness had the greatest influence on their decision.[3] The surveyed hunters indicated that once they actually arrived in Gates of the Arctic, the number of people seen, low flying aircraft and the amount of human impact was "more than preferred."

It is important to note that local residents in the study area are reportedly less concerned about "floaters," i.e., non-hunting recreational parties traveling the river by canoe, kayak or raft, than they are about sport hunting and fishing activity (Georgette and Loon, 1988; 1990). It is also noteworthy that, while the number of hunters now exceeds what most locals and some non-locals consider acceptable, there are currently no biological concerns with respect to the effect of hunting and fishing on fish and wildlife populations in the study area—these populations are considered by the Alaska Department of Fish and Game to be healthy. Nevertheless, wildlife managers have begun to address the potential threat posed by rising levels of hunting pressure. For example, in 2000, the general hunt in the Koyukuk Controlled Use Area was changed to a limited drawing hunt, and in 2005, a limit was placed on non-resident moose harvest tickets for the Squirrel River (U.S. Department of the Interior, Bureau of Land Management, 2007). Moreover, with such high numbers of visiting hunters, wildlife managers are concerned about maintaining trophy bulls in game management units, such as Unit 23, which have generally low densities of moose (Steinacher, 2006).

Although the Alaska Board of Game has begun to tackle the resource user conflict problems in the study area (Jacobson, 2008), it is limited in its jurisdiction. Federal land management agencies in the area are considering options for controlling access, but transporters (i.e., aircraft owners who earn their living by dropping off and picking up sport hunters) typically fall outside of their jurisdiction (Steinacher, 2006).

3.0 POTENTIAL EFFECTS OF ROAD ACCESS

Construction of a highway between the contiguous Alaska highway system and the highway system on the Seward Peninsula would improve direct access to recreation opportunities along the roadway. Areas that are now accessible only by aircraft or walking would become

[3] Within the wilderness portion of Gates of the Arctic National Park and Preserve there is only subsistence hunting, but along the Kobuk River and in other parts of the Park/Preserve, outside of wilderness, there is non-guided private hunting in the autumn as well as subsistence use.

highway vehicle accessible, thereby reducing travel costs and/or travel time. In addition, a road would provide new dispersal points for outdoor recreation activities; for example, a road can play an important role as a “staging site” for off-road vehicles hauled by trailers, and provide access to waterways (Land Design North, 2003). Improved access to natural and cultural resources in the study area would help serve the increasing demand by Alaska residents and out-of-state visitors for recreation opportunities in Alaska.

However, as access into the study area by highway vehicles becomes possible there will likely be a higher incidence of conflicting recreational activities, especially between motorized (e.g., all-terrain vehicle and snowmachine users) and non-motorized (e.g., hikers, dog mushers, skiers) users of recreation resources in the study area. In addition, increased use is likely to adversely affect the quality of recreational experiences in some areas. For example, areas may become subject to intense sport hunting and fishing pressure, thereby creating the need for restrictions on hunting and fishing activities. The increased congestion and/or restrictions would likely induce some current sport hunters and anglers in the study area to seek alternative, higher quality recreational sites. Finally, some of the benefits of reduced travel time may decrease over time as people react to changes in accessibility by making more recreational trips, thereby increasing traffic congestion on roads into the study area.

As discussed in the preceding section, further development of recreation resources and tourism in the study area faces a number of challenges; however, road construction in the study area could potentially create new opportunities for recreation and tourist-related economic activities by increasing accessibility. Should this development occur, it would create new jobs, boost local businesses and diversify and bring new money into the study area’s economy and contribute to the local tax base (Alaska Department of Commerce, Community and Economic Development, undated). As the number and frequency of users of the study area’s recreation resources increase, more money would likely be spent in the study area on food, lodging, fuel, souvenirs and outdoor tour and guide services. In addition, these direct expenditures can have a “ripple effect" throughout the regional economy, creating additional employment, income, and sales.

On the other hand, developing and maintaining the tourist industry in a community requires added maintenance costs and puts pressure on public services (Alaska Department of Commerce, Community and Economic Development, undated). Moreover, the impacts of road access on recreation-related business activity may not be entirely positive; for example, some established commercial hunting and fishing guides may become concerned about maintaining their economic livelihood if the possible deterioration in the quality of sport hunting and fishing experiences in the study area causes some current customers to seek recreation opportunities elsewhere.

Given the high unemployment rate in the study area villages, it is likely that some local residents would welcome the increased potential for expanded tourism development afforded by road construction in the study area; however, other residents may view the opening of new areas to the general public as an exacerbation of existing threats to subsistence opportunity and culture.

A description of the potential impacts of road construction on subsistence activities in remote areas is provided in the Draft Environmental Impact Statement (EIS) for the Yukon Flats National Wildlife Refuge Proposed Land Exchange (U.S. Fish and Wildlife Service, 2008). The EIS notes that increased access allowed by the construction of roads creates direct routes for non-subsistence users into heavily used subsistence areas. Increased non-local access to traditional lands often reduces its value for traditional users by increasing the number of users with conflicting value systems. Moreover, increased hunting activity could cause changes in animal behavior and migration patterns. Changes in these patterns, the understanding of which are critical to traditional knowledge, could interfere with the timing and location of successful subsistence harvests, requiring gross changes in harvest strategy and modifications to traditional hunting patterns at increased costs in time, fuel, cash outlay and user safety as new areas further away from development gain importance for subsistence. The EIS further notes that rural access to the highway system could result in reduced cost of living, making life in some rural communities more attractive for some former residents and attracting new residents; however, new residents may bring businesses including hunting lodges that add to competition for subsistence resource users.

These EIS findings are consistent with an early study by Wolfe and Walker (1987), who observed that construction of roads and settlement entry into previously non-roaded areas produce changes associated with lower subsistence harvests, including increased competition for wild resources, increased habitat alteration, and changing community economic orientations away from mixed, subsistence-market adaptations.

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APPENDIX H

Global Influences Resource Paper

GLOBAL INFLUENCES AND ALASKA'S RESOURCES

WESTERN ALASKA ACCESS

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February 2009

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LIST OF ACRONYMS

BOE .... barrels of oil equivalents
CRB .... Commodity Research Bureau

EXECUTIVE SUMMARY

This paper provides an economic overview of Alaska's natural resource-dependent industries, including agriculture and forestry, tourism, mining, oil and natural gas production and fisheries. The potential for further development of these industries in Western Alaska is being investigated as part of the Western Alaska Access Planning Study. Each industry is the subject of a separate resource paper that is contained in the study report.

Two overriding factors to keep in mind when considering the development of Alaska's natural resources in a global context are that Alaska resource industries typically have a very limited ability to influence prices for their products and Alaska's resource industries generally operate in high production cost environments.

Alaska's agricultural resources have traditionally served local markets because production by agricultural producers in the state is too limited and at too high a price to compete outside of Alaska. Alaska forestry and forest product industries have been challenged by abundant, alternative sources of supply and falling demand, which have driven world lumber prices downward, and by cutting restrictions and litigation.

Following the terrorist attacks of 2001, Alaska was seen as a safe and affordable tourism destination, and the Alaska tourism industry enjoyed an extended period of increasing air visitor arrivals. Moreover, cruise ship passengers have come to represent an increasingly larger portion of Alaska's overall visitor market, with cruise passenger volume increasing by 49 percent between 2001 and 2007. While the number of cruise ship passengers has climbed, growth of other types of visitors has slowed due to the rising price of fuel, including gasoline and aviation fuel, and to the downturn in the U.S. economy.

Alaska's mining industry includes exploration, mine development, and mineral production. With the recent run-up of mineral prices, mining exploration and development in Alaska has increased dramatically. The emergence of rapidly developing economies around the world and increased liquidity in financial markets has resulted in increased demand for, and speculation in, base and precious metals. However, the markets for metals have also become more volatile.

Inflation-adjusted oil prices reached an all-time low in 1998, but just ten years later they reached a record high. On the other hand, after years of pumping, fields in Alaska are drawing less oil from the ground. Alaska's oil production has dropped from nearly 2,000 barrels of oil equivalents (BOE) per day in 1989 to just under 750 BOE/day in 2007. In comparison, marketed natural gas production has remained relatively constant at just over 200 BOE/day.

Currently, local users of Alaska's natural gas resources are somewhat insulated from the vagaries of the global marketplace; however, as external market prices are factored into natural gas contracts for local utilities and construction of an Arctic North Slope natural gas pipeline is considered, external markets for natural gas could exert more influence on Alaska natural gas production.

Typically, Alaska fisheries are divided into five major species groups: groundfish (which includes pollock and Pacific cod), shellfish, salmon, Pacific herring and Pacific halibut. The value of landings shows considerable year-to-year variation, much of which can be attributed to natural changes in stock abundance for certain species. However, during the 1990s, rapid and sustained growth in world farmed salmon production fundamentally transformed world salmon markets with respect to total supply, prices, products, timing of production, quality standards and organization of the industry. Statewide, the inflation-adjusted ex-vessel value of annual salmon catches dropped from more than $800 million in the late 1980s to less than $300 million for the 2000-2004 period. Most of this decline in value was due to a decline in prices rather than catches, and much of the decline in prices was due to competition from farmed salmon.

1.0 INTRODUCTION

This paper provides an economic overview of Alaska's natural resource-dependent industries, including historic and current prices, and demand for and supply of products. The industries examined are agriculture and forestry, tourism, mining, oil and natural gas production and fisheries. The paper provides examples of how global influences have affected measurable characteristics of these industries such as production and employment.

There are two overriding factors to keep in mind when considering the development of Alaska's natural resources in a global context. First, most of the products produced by Alaska's resource industries are sold in international markets, and these products generally account for only a small percentage of the overall world supply. Consequently, Alaska industries typically have a very limited ability to influence prices for their products, and resource development in Alaska is subject to the volatility of international commodity markets.

Secondly, Alaska's resource industries generally operate in high production cost environments where distances to markets are great and surface access (roads and railroads) is absent. The McDowell Group (2003) notes that high, relatively fixed transport costs exert powerful leverage on the prices to producers. A given percentage decline in a commodity's market price translates, after deducting fixed transport costs, into a much greater percentage decline in the farm gate or mine mouth price. Thus, a buffer in a producer's operating margin that might be reasonable elsewhere can quickly evaporate for remote producers in Alaska. In some cases, resources in Alaska are "stranded" and remain undeveloped because of these comparatively high costs.

2.0 AGRICULTURE AND FORESTRY

Alaska's agricultural resources have traditionally served local markets. Recent studies have concluded that production by agricultural producers in the state is too limited and at too high a price to compete outside of Alaska. The failed Delta barley project and Seward grain terminal project are testaments to the difficulties Alaska agricultural producers face competing in international markets. Both projects were victims in part of depressed commodity prices—costs of Alaska production were too high to weather any period of depressed prices (McDowell Group 2003).

Alaska forestry and forest product industries have also been challenged by external events that have occurred over the past decade. In particular, increased supplies of raw material in the global marketplace drove prices down and heated up competition. Gilbertsen and Robinson (2003) note that a series of mergers and consolidations within the international wood products industry have seen the emergence of several dominant corporations whose business perspective is global in scope. In seeking efficiencies, these companies have closed or consolidated plants in high cost areas and shifted investments to lower cost areas. In addition, during the 1990s an economic recession caused housing construction to decline in Japan, which at the time was the major market for Alaska forest products (Brackley et al. 2006; Gilbertsen and Robinson 2003).

Another factor that had a significant negative effect on Alaska forestry and forest product industries was the cutting restrictions unilaterally imposed by the U.S. Forest Service in the early 1990s that effectively ended the long-term harvest contracts upon which Alaska mills depended (Gilbertsen and Robinson 2003). Furthermore, environmental groups have continued litigation efforts to halt all timber harvest within the Tongass National Forest.

Table 1 presents a historical overview of Alaska timber supply by owner, supply by product and production of forest products. Round logs and rough-sawn green lumber are the traditional products shipped from Alaska; in general, both products are at the low end of the scale in terms of wholesale value and profitability (Brackley et al. 2006; Gilbertsen and Robinson 2003).

Table 1: Alaska Timber Supply, 1970-2005

Year	Timber supply by owner					Timber supply by product					Production of forest products			
	Total	National forest	Private	Other public	Timber imports	Total	Saw log exports	Lumber	Fiber or energy products	Timber imports	Saw log exports	Lumber	Fiber or energy products	Wood chip exports
	Million board feet, round wood equivalents[1]										*Million board feet*		*Thousand short tons*	
1970	596.2	539.5	0	56.7	0	594.2	53.3	264.1	276.8	0	47.8	302	288.5	19.9
1975	551.5	489.4	7.5	54.6	4	615.7	43.3	282.5	289.8	4	43.3	341.2	298.8	56.5
1980	603.9	411	146.8	46.1	25.5	661.6	149.8	197.7	314.1	25.5	149.8	239.9	327.1	83.7
1985	653	280.7	346.5	25.8	34.5	690.6	318.3	105.7	266.6	34.5	318.3	125.7	303	4.6
1990	1031.9	413.5	596.9	21.5	12.5	1089.7	574.7	167.4	347.6	12.5	574.7	204.2	379.2	48.5
1995	791.5	200.2	568	23.3	10.3	832.1	545.5	95.9	190.7	10.3	545.5	117	177.2	116.3
2000	596.2	539.5	0	56.7	0	478.2	359.4	80.7	38.1	0	359.4	98.4	0	141.9
2005	311.9	44.4	210.6	55.6	0	317.4	212.1	48.1	57.3	0	212.1	58.6	0	148.3

[1] Round wood equivalent is the volume of logs or other round products required to produce given quantities of lumber, plywood, wood pulp, paper or other similar products, after deducting the proportion of wood raw material input that is obtained not from logs or round wood but from plant byproducts or recycled wood fiber.

Source: Brackley et al. (2006)

As shown in Figure 1, with the drop in lumber prices and other factors, forestry-related employment in Alaska now stands at approximately one-fifth of what it was a decade ago.

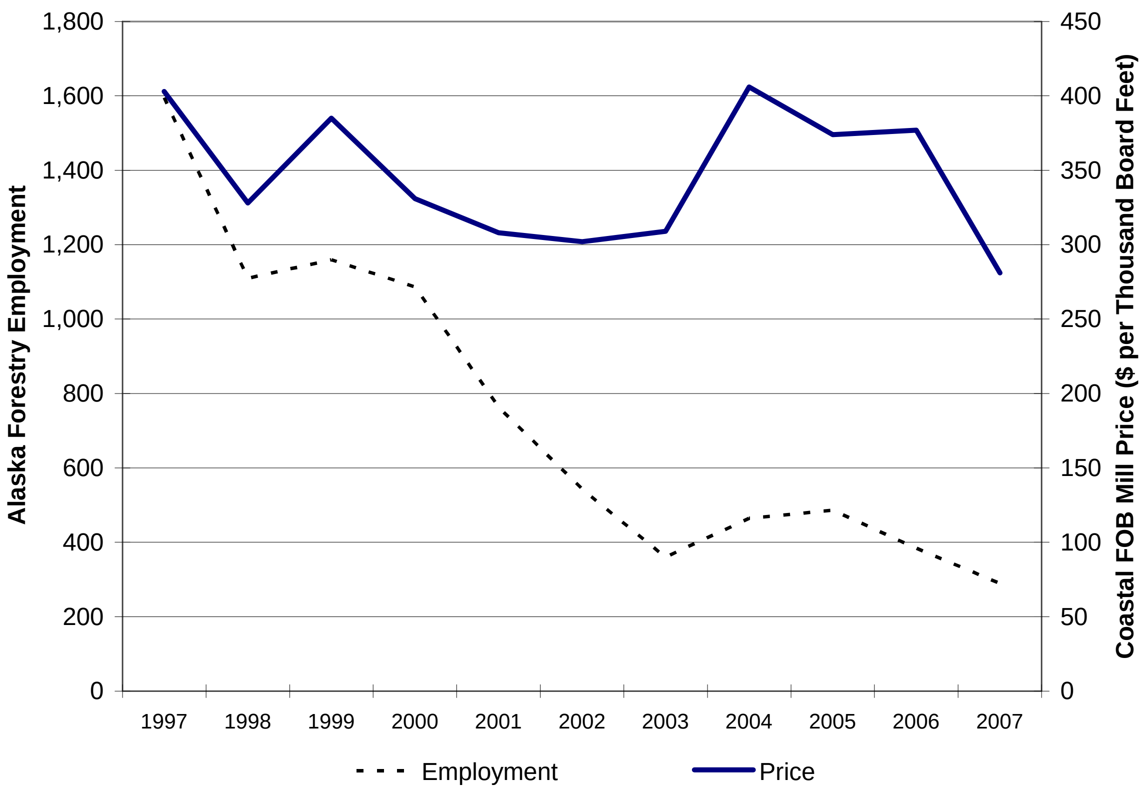

Figure 1: Alaska Forestry Employment and Lumber Prices, 1997-2007

Source: Warren (2007)

3.0 TOURISM

Tourism in Alaska can be considered a natural resource-dependent industry because the main reason many visitors come to the state is to enjoy its outdoors/scenic beauty. Data on visitor volume in Alaska show that the state's tourism industry is also subject to exogenous forces and events. For example, the annual number of individuals crossing the border from Canada into Alaska via the Alaska Highway has shown a downward trend (Figure 2). Much of the decline in the number of entering passengers is likely due to higher gasoline prices and a slowing U.S. economy. In addition, in 2004, wildfires in Alaska's interior and the Yukon Territory produced thick smoke in close proximity to the Alaska Highway, making travel along the highway less appealing.

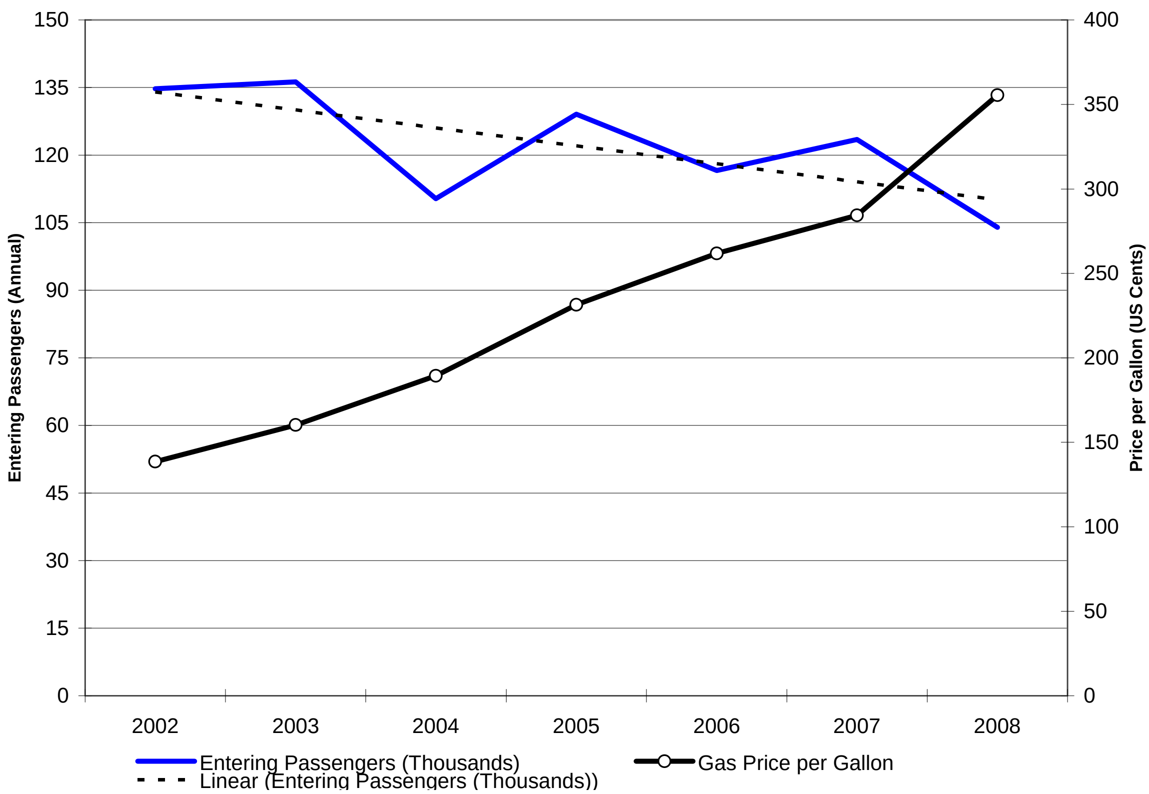

Figure 2: Alaska Highway Entering Passengers and Average Gasoline Prices, 2002-2008

Source: J. Davison, personal communication, October 27, 2008; Energy Information Administration at http://www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/mogas_history.html

Increasing fuel prices have affected more than road travelers. Following the events of September 11, 2001, Alaska was seen as a safe and affordable tourism destination, and the Alaska tourism industry enjoyed an extended period of increasing air visitor arrivals.

However, the total number of Alaska enplanements fell dramatically in 2008 as rising aviation fuel prices increased airfares (Figure 3).

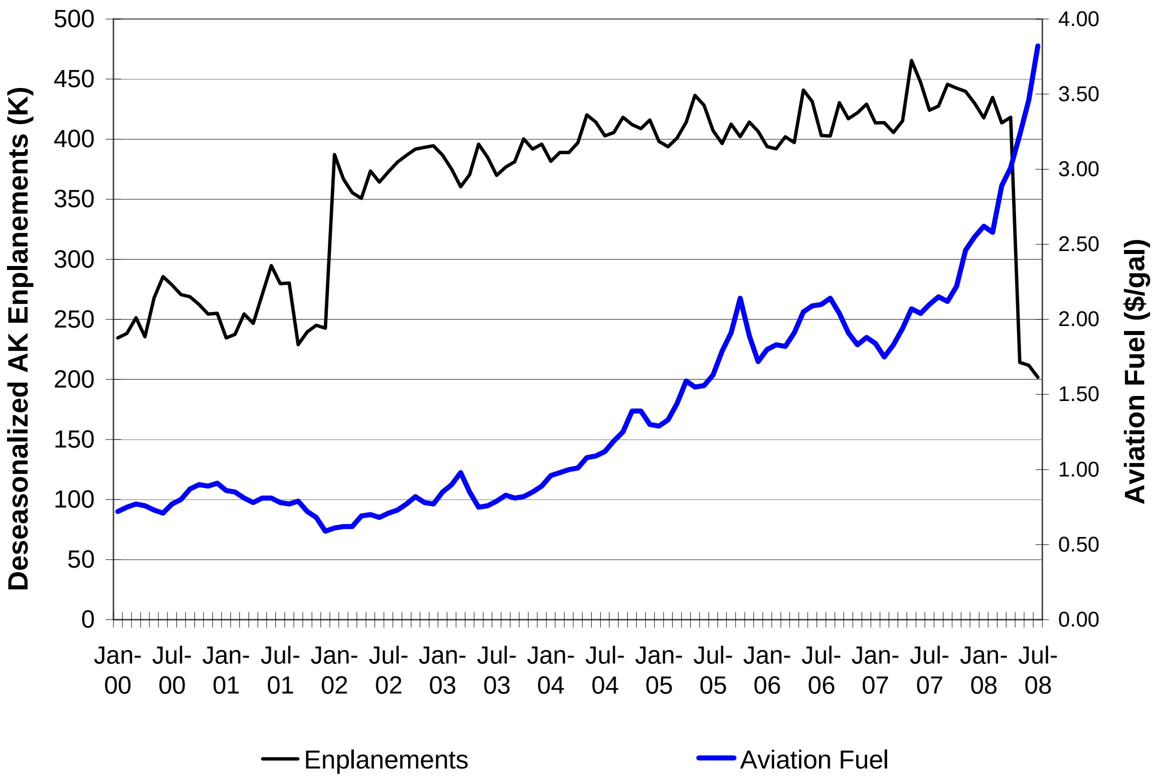

Figure 3: Alaska Enplanements and Aviation Fuel Prices, 2000-2008

Source: Research and Innovative Technology Administration at http://transtats.bts.gov/DL_SelectFields.asp?Table_ID=259&DB_Short_Name=Air%20Carriers; Research and Innovative Technology Administration at http://www.transtats.bts.gov/fuel.asp

Cruise ship passengers have come to represent an increasingly larger portion of Alaska's overall visitor market. Cruise passenger volume steadily grew from 690,600 in 2001 to 1,029,800 in 2007, an increase of 49 percent (McDowell Group 2007). However, as cruises have become more affordable, they have attracted a large clientele that spends less money on optional air and land tours (Land Design North 2003). This change in the demographics of Alaska cruise passengers, together with slowdown in the U.S. economy, may result in lower per capita spending in Alaska by cruise passengers.

4.0 MINERALS AND METALS MINING

The mining industry in Alaska and elsewhere has large barriers to entry because finding, developing, and producing the minerals and metals is time consuming and expensive. The development of new mines can take years or even decades and requires large amounts of venture capital. In addition, mineral and metal prices are highly cyclical; therefore, companies must time their exploration, development and production so that mines do not become active as mineral and metal prices decline.

Figure 4 shows the inflation-adjusted production value of the major metals mined in Alaska during the 1990-2007 period. Mineral exports consist primarily of zinc from Teck Cominco's Red Dog Mine, which is the largest zinc mine in the world. Relatively strong prices during the past few years have helped to sustain the high level of metal export values. Prices for lead, zinc, gold and silver all rose significantly from 2000 to 2007. Gold rose above $1,000 an ounce for the first time in history in 2008 after being below $400 an ounce as recently as 2003 (Fried and Robinson 2008).

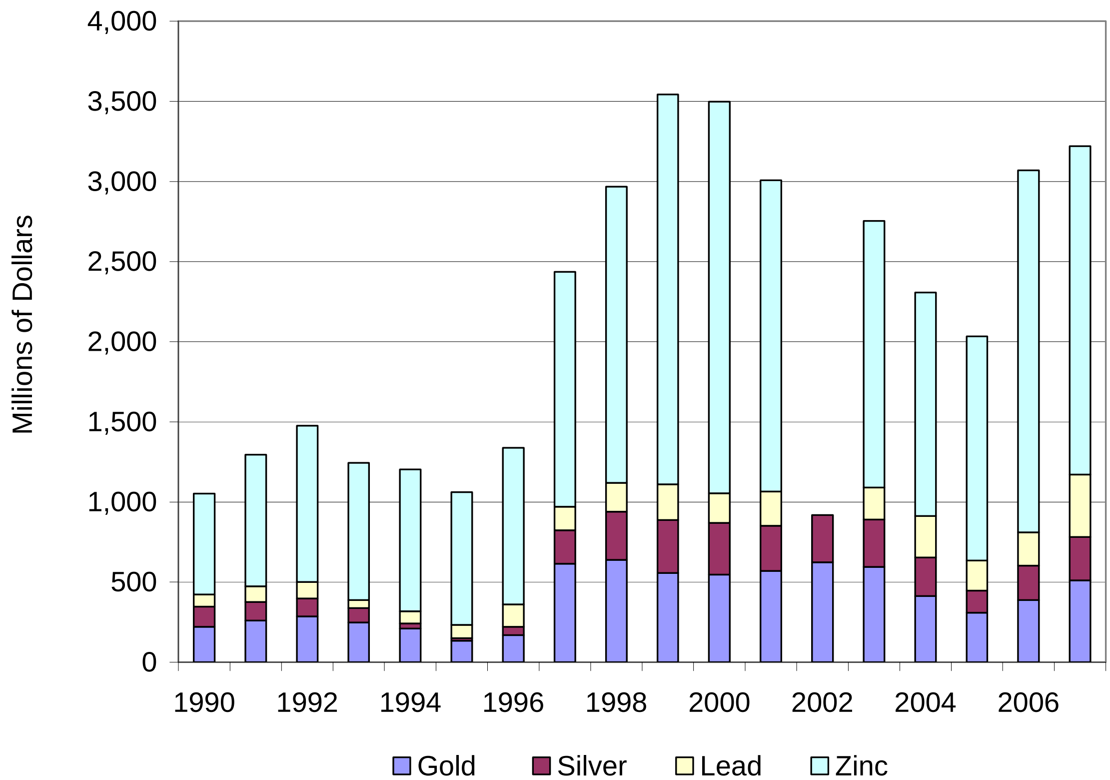

Figure 4: Real Value of Primary Metals Production in Alaska, 1990-2007

Notes:

1) The data have been adjusted for inflation based on Producer Price Index for metals and metal products/nonferrous metal ores.
2) Data for lead and zinc were not reported for 2002.

Source: Szumigala et al. (2008)

Figure 5 shows how base metal and precious metal prices have cycled over the last twenty years. The price fluctuation in the current cycle is much greater than in previous cycles. The emergence of rapidly developing economies around the world, including Brazil, Russia, India and China, as well as increased liquidity in financial markets resulted in increased demand for, and speculation in, base and precious metals.

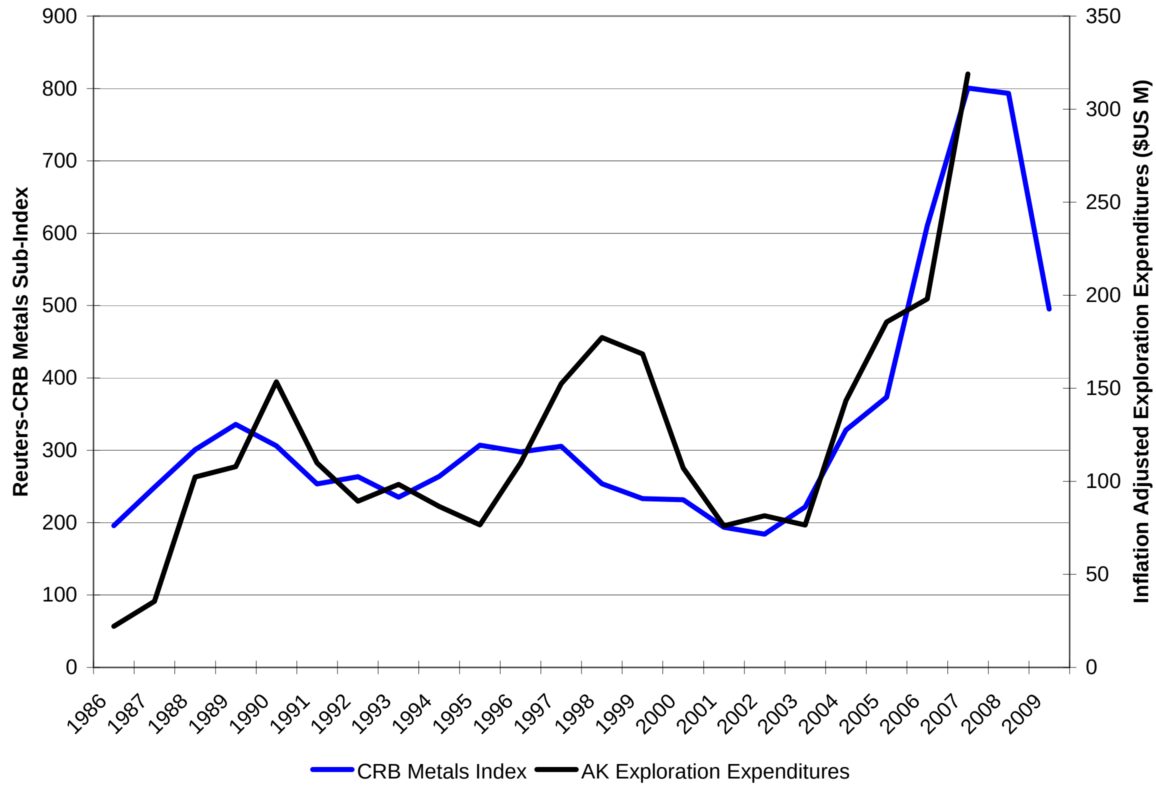

Figure 5: Alaska Mining Exploration Expenditures and World Metal Prices, 1986-2008
Source: Commodity Research Bureau at http://www.crbtrader.com/crbindex/charts.xls; Swainbank et al. (1999); Szumigala and Hughes (2004); Szumigala et al. (2008)

As one might expect with such high prices, exploration and development have increased dramatically (Fried and Robinson 2008). Figure 5 shows that exploration expenditures in Alaska are highly correlated with world metal prices. From 1987 through the early years of this decade, changes in exploration expenditures lagged behind the Commodity Research Bureau (CRB) metals index by a year or two. However, evidence of a lag has faded in recent years.

World metal prices fell sharply in the later half of 2008 after reaching record highs in the earlier part of the year. Gold fell 30 percent from its highs before regaining some value in early December. Base metal (i.e, copper, zinc, lead) prices have continued to fall and do not appear to have reached a bottom. The Commodities Research Board base metal index is down more than 50 percent while the price of some metals (e.g., copper and zinc) are down nearly 70 percent from their historical highs. The decline in world metal prices is the result of two primary factors: a decline in demand associated with the current global economic downturn and the removal of upward price speculators from the market. Following the burst of the tech bubble in early 2000 and the housing bubble in 2006/2007, the commodities markets were some of the remaining bull markets for global asset classes. The money which had previously flowed into equities and real estate now flowed into commodities and helped create the commodity bubble of 2007/2008. The removal of that money has deflated the bubble, and metal prices will not likely move upward or even stabilize until global supply and demand come back into balance.

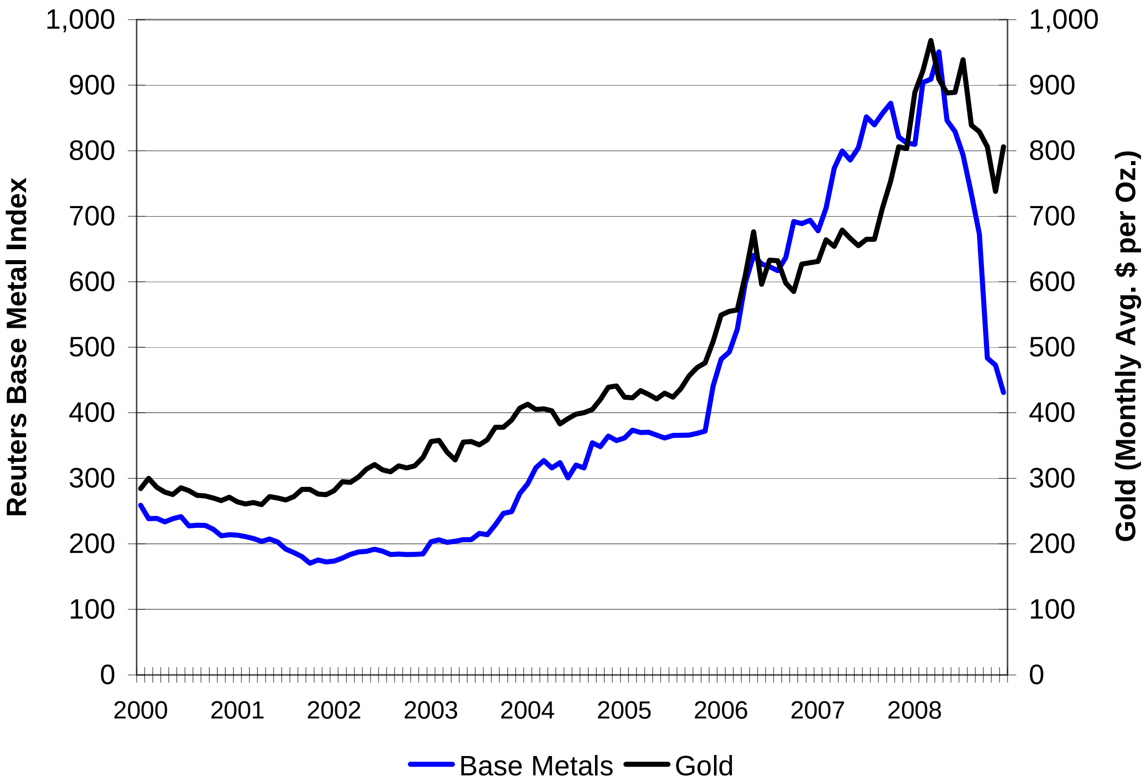

Figure 6: World Metal Prices 2000-2008

Source: Commodity Research Bureau at http://www.crbtrader.com/crbindex/charts.xls;

The decline in world metal prices is likely to affect exploration and development expenditures and employment in Alaska in 2009. Production employment should remain relatively constant in the short run. Whether the recent downturn results in fewer long-term jobs in exploration, development, and production will depend on the how long prices remain at or below their current levels.

5.0 OIL AND NATURAL GAS PRODUCTION

Alaska's oil and natural gas industries stand apart from other resource industries with respect to the relationship between production and world prices. Alaska's oil and natural gas resources require substantial long-term infrastructure investment. Consequently, once a field comes on stream, the production from that field does not generally change in response to the world price unless the price drops far enough below the field's marginal cost of production that it is cheaper for the producer to close the well than continue producing.

Inflation-adjusted oil prices reached an all-time low in 1998 as the "Tiger Economies" of East Asia spiraled into crisis, cutting oil demand; but just ten years later they reached a record high, possibly due to oil price speculation or other factors. However, Alaska's oil production decreased even as prices rose. After years of pumping, fields in Alaska are drawing less oil from the ground (although the Prudhoe Bay field still pumps more oil than any other site in the United States). Figure 7 shows that Alaska's oil production has dropped from nearly 2,000 BOE/day in 1989 to just under 750 BOE/day in 2007. In comparison, marketed natural gas production has remained relatively constant at just over 200 BOE/day.

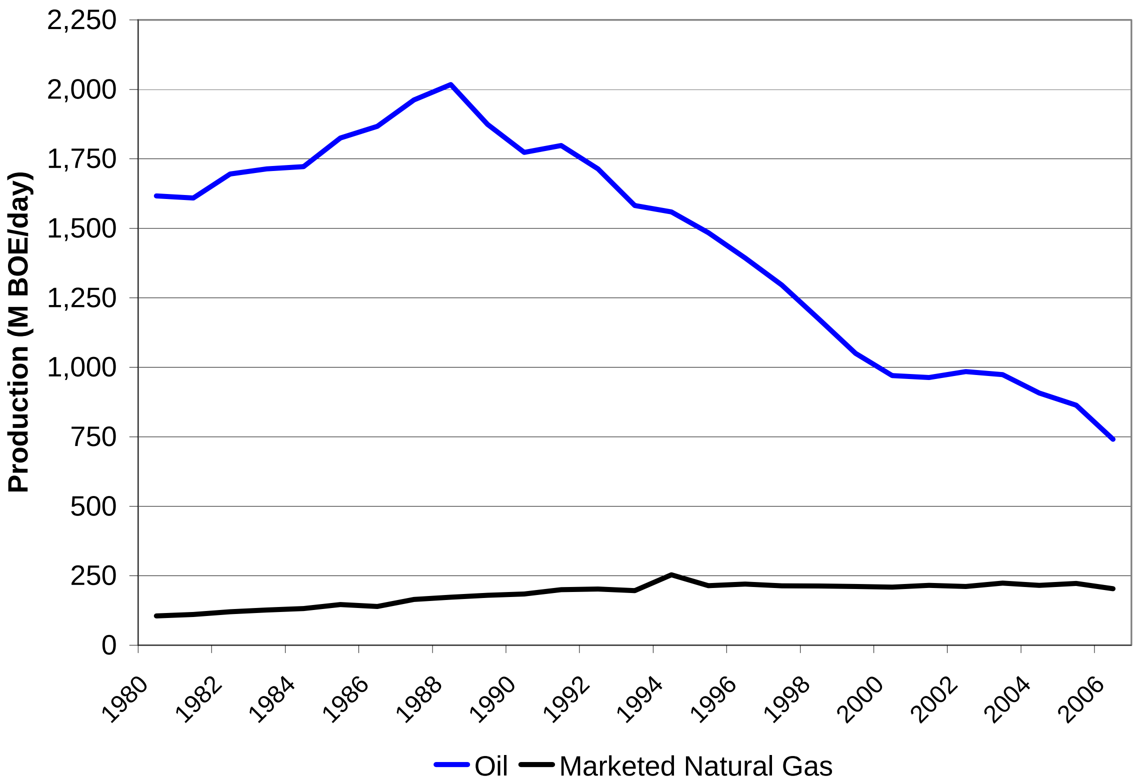

Figure 7: Alaska Oil and Natural Gas Production, 1980-2007

Source: Energy Information Administration at http://tonto.eia.doe.gov/dnav/ng/hist/n9010ak2m.htm; Energy Information Administration at http://tonto.eia.doe.gov/dnav/pet/hist/mcrfpak1m.htm

On the other hand, the high oil prices—and the belief that they will stay high—have stimulated exploration and development in Alaska (Fried and Robinson 2008). As shown in Figure 8, Alaska's oil industry employment levels are correlated with oil prices. When oil prices plunged in the late 1990s, record job losses followed (Fried 2008). The steady increase in oil prices after 2000 was, in time, accompanied by a recovery in the size of Alaska's oil workforce.

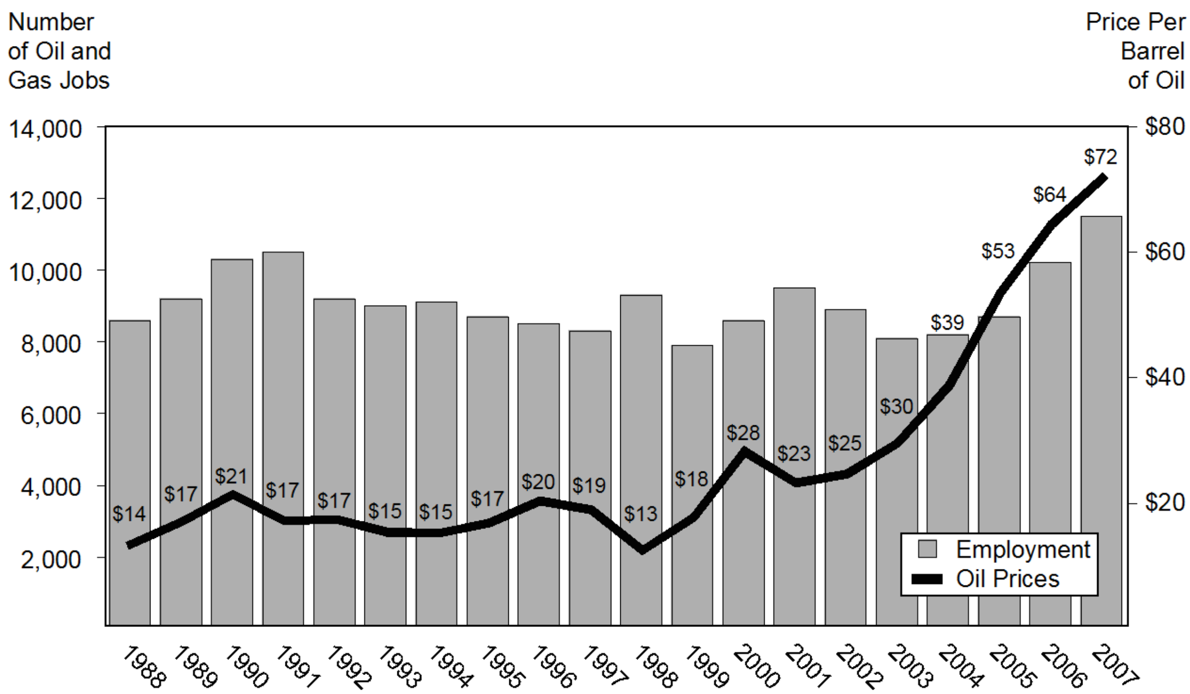

Figure 8: Alaska Oil Employment and Oil Prices, 1988-2007

Source: Fried (2008)

With the exception of the natural gas produced by the ConocoPhillips export facility on the Kenai Peninsula, Alaska's natural gas resources are consumed in state by markets in Southcentral Alaska and oil production facilities on the North Slope. Currently, these local users are somewhat insulated from the vagaries of outside markets; however, as external market prices are factored into natural gas contracts for local utilities (Bailey 2008) and construction of an Arctic North Slope natural gas pipeline is considered, external markets for natural gas could exert more influence on Alaska natural gas production than they have in the recent past.

6.0 FISHERIES

Typically, Alaska fisheries are divided into five major species groups: groundfish (which includes pollock and Pacific cod), shellfish, salmon, Pacific herring and Pacific halibut. Figure 9 shows the inflation-adjusted ex-vessel value of the Alaska harvest by species group from 1984 through 2007. The value of landings shows considerable year-to-year variation. Much of this fluctuation can be attributed to natural changes in stock abundance for certain species that create larger or smaller harvests in some years.

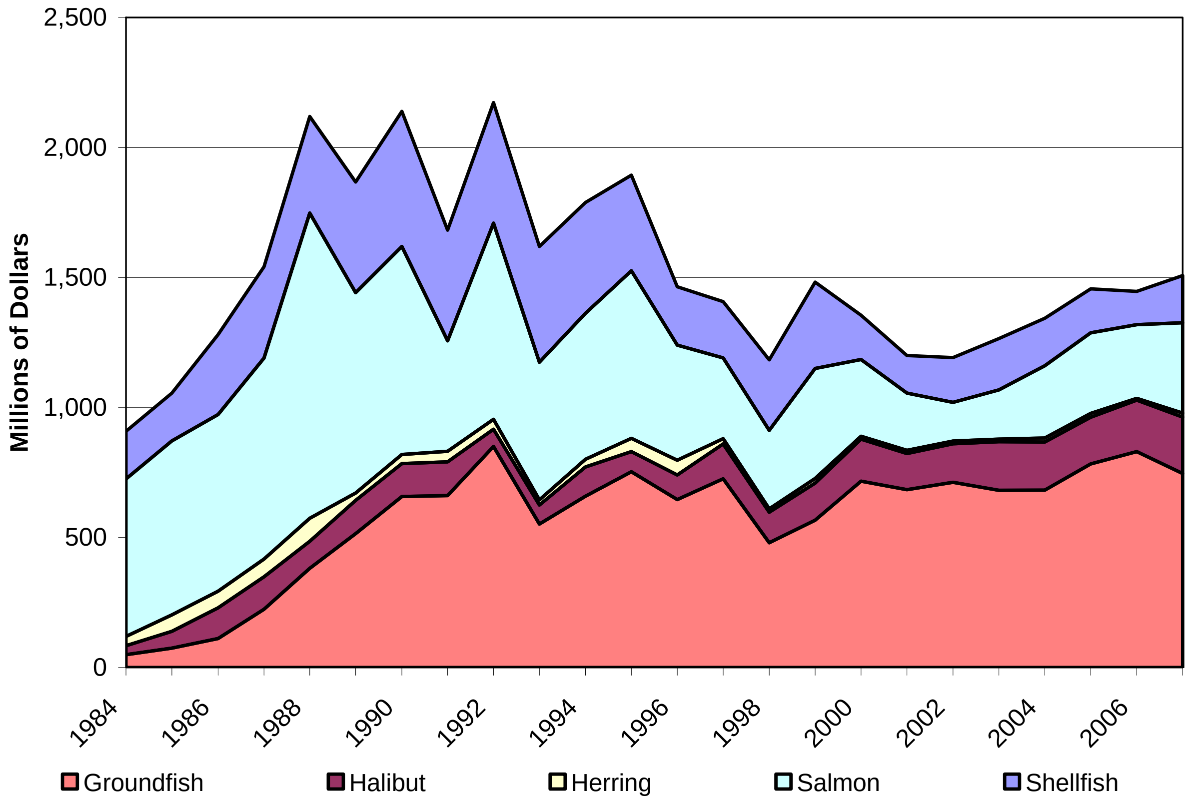

Figure 9: Real Ex-vessel Value of Alaska Seafood Harvest by Species Group, 1984-2007

Note: The data have been adjusted for inflation by applying Gross Domestic Product implicit price deflators.
Source: Hiatt et al. (2008)

The importance of species groups has changed over time. During the late 1980s, salmon generated about half of the total ex-vessel value of Alaska fisheries, while shellfish typically contributed more than one-fifth of the overall value. Beginning in the early 1990s, however, groundfish displaced salmon and shellfish as the most significant component of total value. Tremendous growth in the domestic groundfish catch occurred as American harvesters and processors took over the offshore groundfish fishery from foreign fleets. The rapid expansion and profitability of the fishery earned it the reputation as "the next Alaska gold rush." Since the 1990s, groundfish catches have stabilized, but they continue to dominate the overall value and volume of Alaska's harvest due to the growing demand for "whitefish" in domestic and overseas markets. In 2007, the groundfish fishery accounted for 50 percent of the ex-vessel value of all commercial fisheries off Alaska, while the salmon fishery was second with 20 percent of the total Alaska ex-vessel value.

Salmon are the dominant species in the commercial fisheries occurring in the study area. The catch is sold in U.S. and foreign markets and has long been an important source of cash income for village residents. However, during the 1990s, rapid and sustained growth in world farmed salmon production fundamentally transformed world salmon markets with respect to total supply, prices, products, timing of production, quality standards and organization of the industry (Knapp et al. 2007). Statewide, the inflation-adjusted ex-vessel value of annual salmon catches dropped from more than $800 million in the late 1980s to less than $300 million for the 2000-2004 period. Most of this decline in value was due to a decline in prices rather than catches (Figure 10), and much of the decline in prices was due to competition from farmed salmon (Knapp et al. 2007).

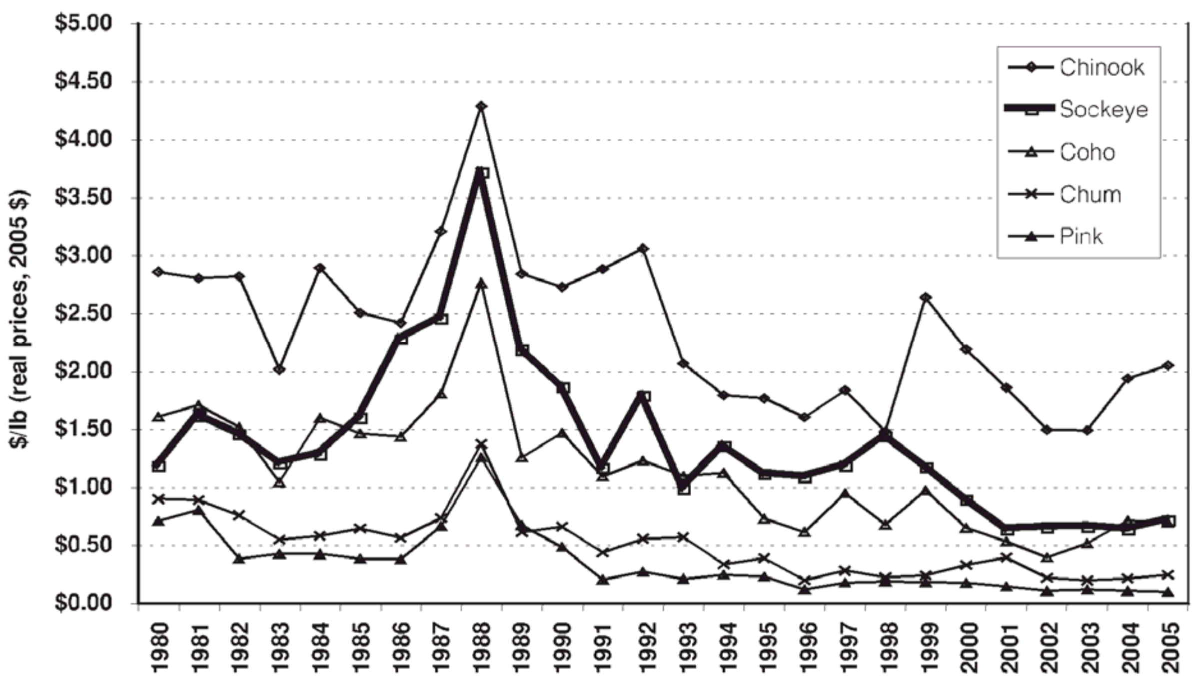

Figure 10: Average Real Ex-vessel Prices of Alaska Salmon, 1980-2005

Note: The data have been adjusted for inflation based on Anchorage Consumer Price Index.

Source: Knapp et al. (2007)

The economic condition of Alaska's salmon fisheries has shown some improvement in recent years. This increase was due to a combination of a larger harvest and modest increases in salmon prices (Alaska Department of Fish and Game undated). To meet the competitive challenges from the rapid expansion of aquaculture production, private and public marketing partnerships have emerged to promote the superior quality and flavor of Alaska salmon and other Alaska seafood products. Building the Alaska seafood brand through various promotional efforts has proven to be the best way to raise the product from a commodity status to a recognized brand (Alaska Department of Commerce, Community and Economic Development 2002).

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APPENDIX I

Development Scenarios Resource Paper

DEVELOPMENT SCENARIOS
WESTERN ALASKA ACCESS

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February, 2009

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ADOT&PF .... Alaska Department of Transportation & Public Facilities

1.0 INTRODUCTION

The next phase of the Western Alaska Access Planning Study will include a benefit-cost analysis for the proposed road over a 50-year study period. It is not possible to accurately predict economic conditions for such a lengthy study period, so this report describes a scenario planning approach to identify the range of possible futures that may occur. Scenario planning involves developing a small number of internally consistent views of the future that incorporate a number of assumptions and encompass a wide range of possible futures.

Scenario planning involves melding assumptions for those items for which we have some knowledge, such as population trends and demographics, with assumptions for those factors that cannot be known, such as the state of the global economy in 20 years, or the outcome of future political elections far in the future. The benefit of a scenario approach to an organization is that through planning to address the potential scenarios, the organization can learn to respond in a flexible and appropriate manner to a wide range of possible futures that are bounded by the scenarios. The term Development Scenarios, as used in this paper, refers to a set of related assumptions regarding future development in the study area over the next 50 years.

The following sections of this paper summarize the findings of the Global Influences resource paper and the influence that those findings have on the development scenarios; description of the general assumptions that are derived from the Global Influences paper and which form the basis of the low and high scenarios; and lastly, a table that provides assumptions for the major economic drivers in the study area for low, mid, and high scenarios.

2.0 BACKGROUND

The Global Influences and Alaska's Resources paper prepared by Northern Economics, Inc. (2008) as part of the Western Alaska Access Planning Study provides an economic overview of Alaska's natural resource-dependent industries, including agriculture and forestry, tourism, mining, oil and natural gas production and fisheries. Each of these industries is also the subject of a separate resource paper that is contained in the full study report. The Global

Influences paper had specific findings regarding each industry and also identified three major findings that are relevant to the development scenarios:

- Demand and price for Alaska's export commodities is set by the global economy and Alaska resource industries have a very limited ability to influence prices for their products
- Alaska's resource industries generally operate in a high production cost environment and Alaska producers may be the last entrants into the market as demand and prices rise, and the first producers out of the market as demand and prices decline.
- Low-value commodities may be viable only in local markets since transportation costs are likely to preclude exports except in extreme market conditions.

3.0 EVOLUTION OF THE DEVELOPMENT SCENARIOS

A benefit-cost analysis requires that the costs and benefits of a proposed action be compared to the costs and benefits of not proceeding with the proposed action. This requirement does not mean that the current condition, the status quo, is compared with the proposed action, but rather that the likely future without the proposed action be compared to the future that may exist with the proposed action. Over the 50-year study period, it is anticipated that some road connections would be developed in the study area, because the connections would have value independent of the other portions of the road. This situation would be the likely condition without the Western Alaska Access Project and is the low boundary for the development scenarios. The low development scenario is described below, followed by the high development scenario, and then the mid scenario.

3.1 Low Development Scenario

The low development scenario assumes that over the period from 2010 through 2060, a weak global economy results in low demand for Alaska's resources with the result that prices for oil, gas, minerals, and other commodities are low compared to historical averages as measured on a real 2008 dollar basis. These low prices in turn result in a state budget that is smaller than would be expected, with a minimal capital budget. Under this situation, the capital budget would be limited to matching funds for federal programs, with few other state-funded capital projects.

Low commodity prices and reduced state budgets result in low levels of economic activity in the study area. Expansion of eco-tourism and recreation-related businesses is the only significant source of growth in the regional economy. The study area population remains near current levels with study area residents migrating from the smaller villages to the regional and subregional centers. With limited economic activity in the region and without population growth, only a few links of the potential road to the Seward Peninsula are built during the study period. These links will be identified in the benefit-cost analysis as those links with the highest net benefits independent of the entire road system.

3.2 High Development Scenario

The high development scenario envisions a strong global economy generally throughout the study period resulting in high commodity prices for the state's resource-extraction industries. In turn, these high oil and mineral prices provide the basis for a growing state budget, and in particular, a large capital budget. The availability of capital construction funds for design, permitting, and construction enables the state to complete the road by 2020.

The high commodity prices also result in high levels of exploration and development activity within the study area, with several major mines coming on line at about the same time as the road is completed. The mines require an extensive amount of energy and induce an energy transmission system, either a natural gas pipeline extending from the proposed natural gas pipeline that would parallel the Dalton Highway, or an electrical transmission line connected to the electrical grid in the Railbelt with new electrical generation sources such as a Susitna Hydroelectric project or a geothermal project at Mount Spurr. The energy transmission system is completed shortly after the road is completed and prior to the mines opening.

The construction of the road and the transportation cost savings that result from it create conditions for high levels of economic activity in the study area for a number of years. Other mineral development occurs, and other resources are transported within the study area for local consumption. Population growth is slow but increases are seen at the village level as well as the regional and subregional hubs. Local employment also increases with mines hiring local residents for jobs. However, many jobs are filled by residents of Railbelt communities who are flown in on a rotational basis. The presence of a road and other development changes the nature of the tourism and recreational activity in the area with fewer eco-tourists and high-end fishers and hunters. Larger number of independent travelers in recreational vehicles and vehicles traveling on the road for business create demand for service facilities along the road network. Road access also results in greater pressure on fish and game resources in proximity to the road, and competition for subsistence resources.

3.3 Mid Development Scenario

The mid scenario anticipates that over the 50-year study period there will be times of strong global economic growth and periods when the global economy will contract, similar to the global business cycles experienced over the past 50 years. During periods of strong growth, demand for oil and other commodities will be high with resultant high prices, and during periods when the global economy slows or contracts, demand will fall and prices will decrease.

This cyclical situation results in periods of increasing state revenues and periods of decreasing state revenues, which affects the state’s capital budget. This mid scenario assumes that construction on the Western Alaska Access Project occurs during periods of budget surpluses and construction is put on hold when budget deficits exist. Completion of the road takes longer due to the on-again/off-again pattern of construction activity with the final road links completed in 2030 as compared to 2020 under the high development scenario.

Delay in completion of the road could hinder development of the mineral resources in the region and result in lower economic activity in the region as compared to the high development scenario. The level of economic activity would be higher than the low scenario as more road construction activity occurs in the mid scenario, and the presence of additional road links within the study area would generate additional economic activity. This additional economic activity could be increased local consumption of certain resources or additional tourism and recreation activity as portions of the study area are connected to the national highway system over time. Employment and population increases are very modest during the 20 years while road construction is ongoing, with higher growth rates occurring after the road is completed, the energy transmission system is in place, and major mines open in the study area. The effects of the mid scenario on fish and game resources and subsistence begin to resemble the high scenario after 2035 when the infrastructure development is complete and visitor numbers begin to increase. The increase in visitors and business travel in the area creates demand for service facilities along the road and in communities that are connected by spur roads to the Western Alaska Access Project.

3.4 Timing of Major Assumptions

A benefit-cost analysis compares the stream of benefits produced by a project over time with the stream of capital and operating costs incurred by the project over time and uses a discount rate to establish a net present value for each stream in the current year. The year in which each benefit or cost occurs becomes an important assumption since the timing affects the net present value estimate. Table 1 is a summary table for the major assumptions that affect the development scenarios, and proposed years for each event or assumption. These timing assumptions are being brought forward to solicit input from ADOT&PF. As additional stakeholder meetings take place in the next phase, comments from them on the timing assumptions should be evaluated.

Table 1: Scenario Assumptions for Western Alaska Access Planning Study, 2010-2060

Assumptions	Mid Case	High Case	Low Case
Petroleum			
Gas pipeline from North Slope	First gas in 2020	First gas in 2018	No gas pipeline
Chukchi Sea OCS	First oil in 2025; no gas within study period	First oil in 2020; first gas in 2030	No commercial discoveries
Norton Sound OCS	No oil or gas within study period	First oil in 2025	No oil or gas within study period
Nenana Basin	First gas into main pipeline in 2020	First gas to bullet line/Fairbanks in 2015	No gas within study period
Mining			
Metal prices	Near current prices	Near historic highs	Near historic lows
Metal volumes	Limited production; no new mines until 5 years after road completed	High production; major mines open 2 years after road completion	Only limited gold production
Transportation/utilities			
Corridor to Seward Peninsula	Road completed in 2030	Road completed in 2020	Segments built but road not completed within study period
Spur gas pipeline or electric transmission line in ROW	Completed in 2035	Completed in 2020	Not built within study period
Port of Nome	Support base for USCG and OCS in 2025	Support base for USCG and OCS in 2020	No change in status
Fiscal Assumptions			
State Oil/Gas Revenues	Oil price fluctuates between $50 and $100 (2006 $); gas at energy equivalent price	Oil averages about $100 per barrel (2006$) over long term; gas at energy equivalent price [1]	Averages about $50 per barrel (2006$) over long term; gas at energy equivalent price [1]
State Budget	Operating and capital budgets near FY 2006 levels in real $	Operating and capital budgets near FY 2008 levels in real $	Operating and capital budgets 2/3 of FY 2006 levels in real $
Study Area Population	Population increases at 0.025% until 2035 and 0.05% after that time with hubs growing and villages static	Population increases at 0.05% with growth in hubs and villages	Population remains near current level with outmigration from villages to hubs

4.0 REFERENCES

Northern Economics, Inc. 2008. Global Influences and Alaska's Resources. Prepared for DOWL HKM as part of the Western Alaska Access Planning Study.

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