APPENDIX I

The Economic Benefits and Socioeconomic Effects of the Yukon River Road Corridor

The Economic Benefits and Socioeconomic Effects of the Yukon River Road Corridor

Prepared for the

DOWL HKM

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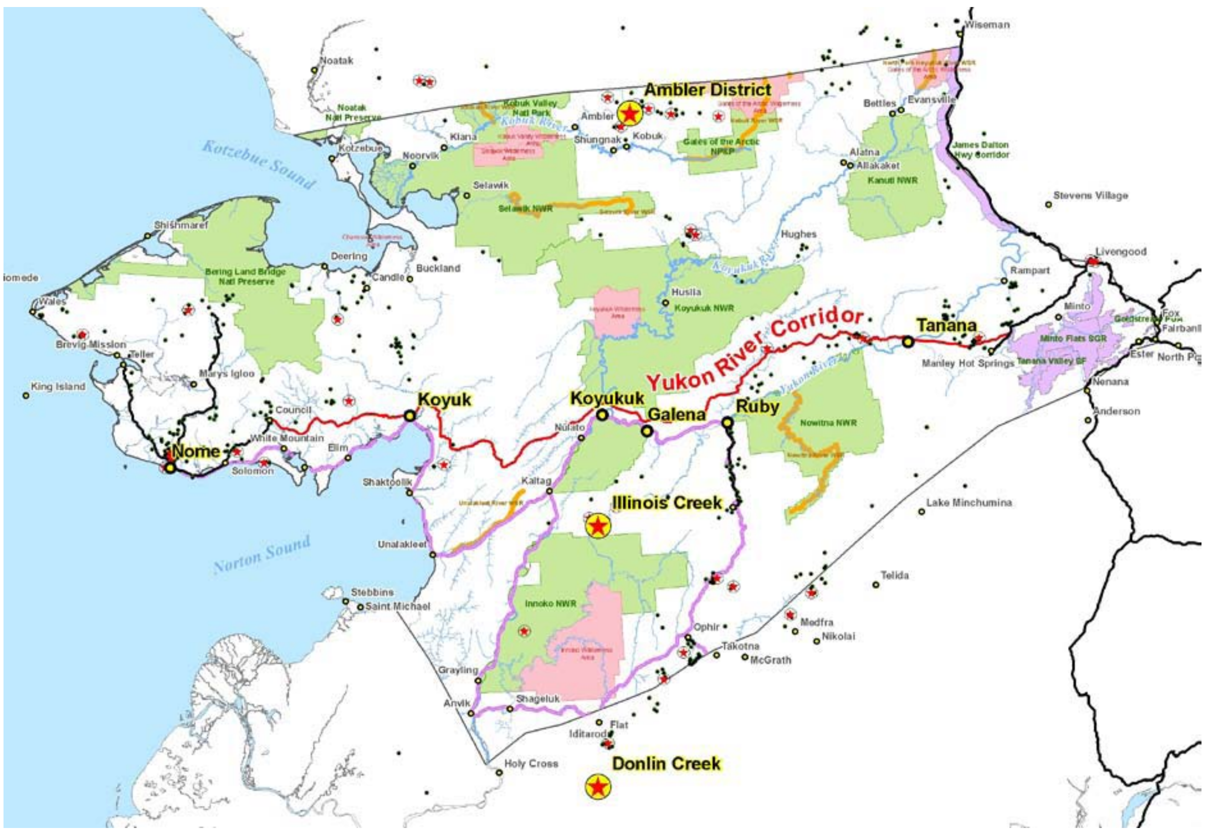
Abbreviations

ADOLWD	Alaska Department of Labor and Workforce Development
LNG	Liquefied natural gas
Btu	British thermal units
MMBtu	Million British thermal units
PCE	Power Cost Equalization
GVEA	Golden Valley Electric Association
ROW	Right of Way

Executive Summary

This analysis uses a case study approach to quantitatively and qualitatively look at the expected socioeconomic effects of the Yukon River Road Corridor across communities in the region, as well as benefits to potential mines. The analysis' case study approach selected six communities along one of the proposed road corridors as case study communities: Tanana, Galena, Ruby, Koyukuk, Koyuk, and Nome. In addition, the analysis looked at the road's effect on the Donlin Creek, Ambler, and Illinois Creek mineral deposits as well as estimating the effect of the road on a "generic" placer mine (see Figure ES-1). Focusing on specific communities and mines allowed the study team to provide specific examples of the socioeconomic effects and to provide a better overall assessment of the possible community-level and mining socioeconomic impacts of a road connection.

Figure ES-1. Yukon River Corridor and Case Study Communities and Mines



Source: DOWL HKM, 2009.

This study concludes that the Yukon River Road Corridor would result in significant benefits to, and socioeconomic changes in, the communities located along the corridor. For example, the analysis estimates that cargo and bypass mail delivery costs could decrease roughly \$18.1 million per year while the diesel and fuel oil transportation savings could save another \$1.1 million dollars per year. At the same time, conversion to an economy based on trucked propane as opposed to diesel and heating fuel could replace the \$1.1 million savings per year with savings of \$13.5 million per year. These estimated benefits only include the six case study communities; the study estimates base savings from changes in how cargo, mail, and fuel are delivered at roughly \$3,900 per capita within these communities. There are approximately five additional communities with a combined population of 770 within 20 miles of the proposed road corridor. While the benefits of the corridor would decline as one moves further away from road, extrapolating the $3,900 per person per year estimate to the population of the non-case study communities yields an additional savings of $3 million per year. Other communities located on the road or within a reasonable distance from the road would likely experience similar savings with some reductions in per capita savings the farther the community is from the road itself. Lastly, large infrastructure projects built along the road corridor, such as the development of high power transmission lines, could experience one-time construction-phase savings of hundreds of millions of dollars per project. In summary, the study came to the following additional conclusions:

Distillate Fuel (Heating and Diesel Fuels)

- Most communities will switch from receiving their fuel shipments by barge to obtaining their fuel by truck. While barge transportation provides the least cost method of shipping large quantities of fuel over long distances, such as to Nome, truck is less expensive for shorter distances, and the fact that fuel can be obtained throughout the year with truck delivery will substantially reduce the effect of inventory carrying costs and cash flow issues. However, barge transportation may continue to be used by those entities that can obtain zero interest loans for bulk fuel purchases. Entities that do not have access to this program and have a high cost of capital would switch to fuel delivery by truck. The study estimates that within the six case study communities, the switch from barge to truck would save roughly $1.1 million per year. Non-case study communities in the study area are likely to experience similar savings.

Table ES-1. Estimated Annual Fuel Cost Savings, Six Case Study Communities

	Community Savings ($)						
Scenario	Tanana	Ruby	Galena	Koyukuk	Koyuk	Nome	Total
Without Corridor Cost ($)	155,000	162,000	1,061,000	71,000	173,000	2,166,000	3,788,000
With Corridor Cost ($)	31,000	49,000	328,000	22,000	117,000	2,166,000	2,713,000
Savings ($)	124,000	113,000	733,000	49,000	56,000	0	1,075,000

Source: Northern Economics, Inc. estimates based on Bureau of Transportation Statistics, 2009; Office of Coast Survey, 2009; Ruby Marine, 2009; Sweeney, 2009; Sweetsir, 2009, Jansen 2009, and Logistic Solution Builders, n.d.

- Truck deliveries of fuel will likely replace airborne deliveries as transportation by truck will be cheaper than deliveries by air tankers. In the case study communities, these deliveries only occur in emergency situations, so it is difficult to quantify the estimated savings except to say that the savings would be substantial on an incident-by-incident basis.

Freight and Bypass Mail

- Perishables and non-durable consumables could continue to move via bypass mail in many cases. However, the bypass mail program will truck mail to hub locations located on the new road and then fly goods from the hubs to outlying villages. This change will likely enhance Galena’s role as a regional hub and lower the amount of traffic out of airports in Fairbanks and Unalakleet. While the road will result in savings for the bypass mail program, communities may notice a decrease in the quality of perishables, which are currently delivered with one or two day service via air transport.
- The road would enable trucking firms to compete with aviation traffic for high value items and time sensitive deliveries.

- Except for oversize equipment and materials, much of the current deck cargo on barges would move to truck delivery with the availability of a road.
- The study estimates that total savings associated with freight and the bypass mail program will total nearly $18.1 million per year within the six case study communities. Total savings within the entire region will likely be higher.

Table ES-2. Estimated Annual Cargo and Bypass Mail Cost Savings, Six Case Study Communities

	Community Savings ($)						
Scenario	Tanana	Ruby	Galena	Koyukuk	Koyuk	Nome	Total
Without Corridor Cost ($)	459,000	584,000	1,529,000	252,000	1,028,000	20,258,000	24,110,000
With Corridor Cost ($)	92,000	79,000	366,000	43,000	209,000	5,270,000	6,059,000
Difference ($)	367,000	505,000	1,163,000	209,000	819,000	14,988,000	18,051,000

Source: Northern Economics, Inc. estimates based on Bureau of Transportation Statistics, 2009; Office of Coast Survey, 2009; Ruby Marine, 2009; Sweeney, 2009; Sweetsir, 2009, Jansen 2009, and Logistic Solution Builders, n.d.

Mining

- If the corridor is built and a river crossing or a ferry is available at Ruby, there could be interest in building a mining road from the Donlin/Flat mineral districts to Poorman. This crossing, and the road, would allow the project to bring fuel and supplies into Donlin at a much lower cost than bringing a year's worth of fuel up the Kuskokwim River on a barge during the summer shipping season. Other mines in the region could also seek to build spur roads to connect to the Western Alaska Access Project to obtain similar benefits and to ship some concentrates via the road. The study estimates that the road corridor would lower potential annual mine transportation costs by roughly $120 million, reducing costs from $315 million (without road) to $195 million (with road).
- The study estimates that the development of Donlin, Ambler, the equivalent of Illinois Creek, and the equivalent of 15 placer mines could employ nearly 1,600 people in a study area with roughly 6,500 workers.
- The state's experiences at the Red Dog Mine and other mines show that mining wages are significantly higher than the pre-mine local average. ADOWLD data from early 2009 indicate that mining jobs average roughly $7,000 per month in wages compared to the statewide average for all industries of $3,800 per month and local averages of $2,900 (Nome Census Area) and $2,600 (Yukon Koyukuk Census Area).

Energy and Infrastructure

- The study concludes that trucked propane fuel would be cheaper than barged distillate fuel and a road corridor would eliminate the need for 10-month storage of fuel currently found in these communities. The study estimates that complete conversion to trucked propane would save roughly $13.5 million per year within the six case study communities.[1] This estimate is the estimated energy cost savings and does not include the cost of conversion.

[1] This scenario eliminates the savings of converting from barged diesel to trucked diesel. Thus, it is important to realize that all of the savings discussed in this report are not additive.

Table ES-3. Annual Fuel Cost Savings with Trucked Propane

	Community Savings ($)						
Scenario	Tanana	Ruby	Galena	Koyukuk	Koyuk	Nome	Total
Current MMBtu Consumed	30,000	20,000	160,000	10,000	40,000	850,000	1,110,000
Barged Diesel Cost per MMBtu ($)	20.67	23.48	21.48	30.81	18.74	17.48	18.416
Trucked Propane Cost per MMBtu ($)	5.11	5.51	5.58	5.65	6.05	6.47	6.27
Cost Change per MMBtu ($)	-15.56	-17.97	-15.9	-25.16	-12.69	-11.01	-12.15
Total Annual Cost Savings ($)	-466,800	-359,400	-2,544,000	-251,600	-507,600	-9,358,500	-13,487,900

Source: Northern Economics, Inc. estimates based on AVEC, 2009; Sweetsir, 2009. and Logistic Solution Builders, n.d.

- A road would reduce the cost of constructing a gas pipeline or an electrical transmission line to western Alaska. In particular, the availability of a road and some type of energy infrastructure in the region could substantially reduce the cost of living for the communities, and reduce operating costs at potential mines. However, a large industrial load is necessary for the energy infrastructure to be feasible; community demand alone is not large enough to support the capital costs of such energy infrastructure.
- The study estimates that a road corridor would reduce the cost of building pipeline and electrical transmission infrastructure by between 30 and 50 percent per unit mile. Using simple estimates, the study concludes that the road corridor could reduce the cost of a pipeline to Donlin Creek from Manley Hot Springs by between $0.8 and $1.0 billion and the cost of an electrical transmission system by $100 to $200 million.

Passenger Travel

- It is unclear how a road corridor will change long distance personal travel. Undoubtedly, some people will choose to drive from the case study communities to communities that they currently reach by air travel, while others may choose to forego the additional expense of lodging, meals, and wear on their vehicles and continue to travel by air. As the magnitude of these changes is exceptionally unclear, the study does not estimate a savings associated with personal travel. What is clear is that personal travel patterns will change and that the biggest change may be increased travel between communities within the corridor that are currently restricted on surface transportation to water in the summer and snowmachine in the winter.

Other Socioeconomic Effects

- The potential socioeconomic effects of the proposed road connection on the case study communities are complex. The direction and magnitude of these effects are likely to be mixed and unevenly distributed within and between communities depending on individual demographic, economic, and social circumstances.
- Resource development, specifically mining, has the potential to increase the region's standard of living and per capita income by providing additional employment opportunities.
- Subsistence users along the road corridor will experience increased access to subsistence areas and the potential for increased competition from recreational user groups and subsistence users who have not traditional used an area.

1 Introduction

Purpose and Approach

This analysis uses a case study approach to quantitatively and qualitatively look at the expected socioeconomic effects of the Yukon River Road Corridor across communities in the region, as well as benefits to potential mines. *The purpose of this corridor would be to facilitate community and resource development in the study area of western Alaska*.

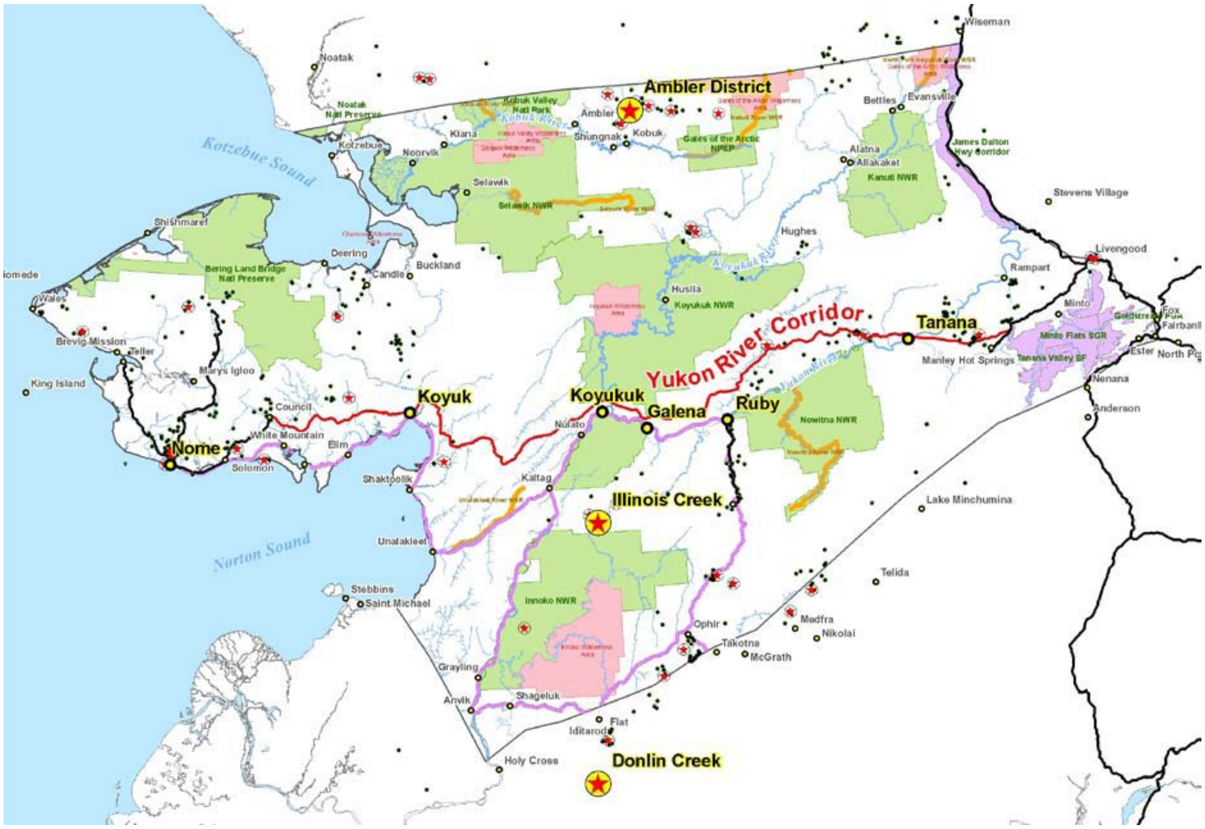
The first sections of the socioeconomic analysis focus on a number of benefit areas: personal travel, fuel, freight, mining, energy infrastructure, and bypass mail/air cargo. For each area the study team conducted multiple interviews with industry experts and local stakeholders to determine possible economic effects of a road connection.

In addition to the economic benefit areas, the analysis examines other potential socioeconomic effects of a road connection, including impacts on employment and income, population, public services, and subsistence. Both positive and negative aspects of the project with respect to these additional impact areas are discussed. The intent is to illustrate the range of complex and conflicting socioeconomic effects of the proposed project.

1.1 Study Area

The study team selected six communities along one of the proposed road corridors as case study communities: Tanana, Galena, Ruby, Koyukuk, Koyuk, and Nome. In addition, the analysis looked at the road's effect on the Donlin Creek, Ambler, and Illinois Creek mineral deposits as well as estimating the effect of the road on a "generic" placer mine. Focusing on specific communities and mines allowed the study team to provide specific examples of the socioeconomic effects and to provide a better overall assessment of the possible community-level and mining socioeconomic impacts of a road connection. The team anticipates that other communities and mines in this corridor, as well as communities and mines in alternative corridors, would experience similar potential benefits and costs to those effects described for the case study communities. Figure 1 shows the location of the six case study communities and the mineral resources along the preferred Yukon River Corridor.

Figure 1. Yukon River Corridor and Case Study Communities and Mines



Source: DOWL HKM, 2009.

1.1.1 Case Study Communities

As noted above this analysis uses a case study approach focusing on six communities: Tanana, Galena, Ruby, Koyukuk, Koyuk, and Nome. The study team selected these communities, in consultation with the client, for their proximity to the road corridor and their ability to be representative of the communities within the study area. This benefits and socioeconomic effects quantified in this analysis are estimates for these six communities only, but the analysis expects similar benefits and effects for non-case study communities in the study area. For this reason, it is important to realize that the quantified benefits include in this analysis do not represent the sum total of the benefits which might be expected within the study area. Instead, the quantified benefits and effects are representative of the magnitude of benefits and effects the State of Alaska and local communities should expect from the construction of the road corridor.

1.1.2 Mineral Deposits and Proposed Mines

The study area is rich with mineral resources, but with the exception of high-value gold mines and placer deposits, there have been few developments of the other mineral resources due to the remoteness, arctic and sub-arctic conditions, and lack of transportation infrastructure within the study area. The analysis uses a case study approach in estimating the effect of the road corridor on mineral development. The case study mines are Donlin Creek, the Ambler Mining District, Illinois Creek, and a "generic" placer mine. As with the case study communities, the case study mines are unique entities that are representative of the study area's potential. In addition, the estimates associated with these case studies are not necessarily estimates of the entire potential of the study area, but are indicative of the magnitude of benefits and effects which the state might expect with the development of the road corridor.

1.1.3 Other Resources

This socioeconomic effects analysis focuses on the Yukon River Corridor Route's potential community-level social and economic effects and the route's potential to lower mineral resource development costs. Prior scoping-level analyses detailed in the Inventory Report of the Western Alaska Access Planning Study focused on the potential of a Western Alaska transportation corridor to benefit the development of other resources such as fisheries; agriculture and timber; oil and gas; and recreation and tourism. This research estimated that the gross estimated resource value of all of these categories combined, including mineral resources and community economic activity, is $45.6 billion in 2009 dollars over a 50-year study period. Within this total, mineral resources ($25 billion) and community economic activity ($20.2 billion) accounted for $45.2 billion or 99.1 percent. For the remaining resources, the Inventory Report reached the following conclusions:

- Any future oil & gas development is likely to focus on the localized use of coal or coal bed methane resources. In general, with the exception of the Nenana Basin, the study area does not contain the sedimentary basins that support deep sub-surface oil and natural gas deposits. Thus, the large scale development of energy resources in the study area is unlikely.
- Fishery resources could derive limited benefits from the development of a road, but even with a road, fish processors in the study area would remain at a competitive disadvantage to processors located in other parts of Alaska. Benefits would be most likely to accrue to small-scale niche processors who could obtain fuel and other supplies at lower prices, but these processors would continue to ship their higher-value product out by plane.
- Road access to recreational areas would increase visits by reducing travel costs, provide new dispersal sites for the staging of off-road vehicles such as rafts and snowmachines, and create demand for tourist related services by lowering the cost of access. However, mass tourism would still be constrained by the area's relative expense, competition from established "remote" locations in Alaska, the short peak visitor season in summer, a lack of tourist related infrastructure, and Alaska Native concerns regarding impacts on subsistence resources.
- The road will spur limited development of forestry resources for local use where higher value forestry resources coincide with modest distances to local markets that will use the forest products for firewood and framing timber. Study area forest resources are unlikely to make their way to international markets on a large scale given the high cost of transporting logs even with the road.
- Alaska's agricultural resources have traditionally served local markets. Market experience has generally indicated that agricultural production in the state is limited in size and products are priced too high to compete outside of Alaska. These conditions are unlikely to change with the road.

2 Existing Conditions

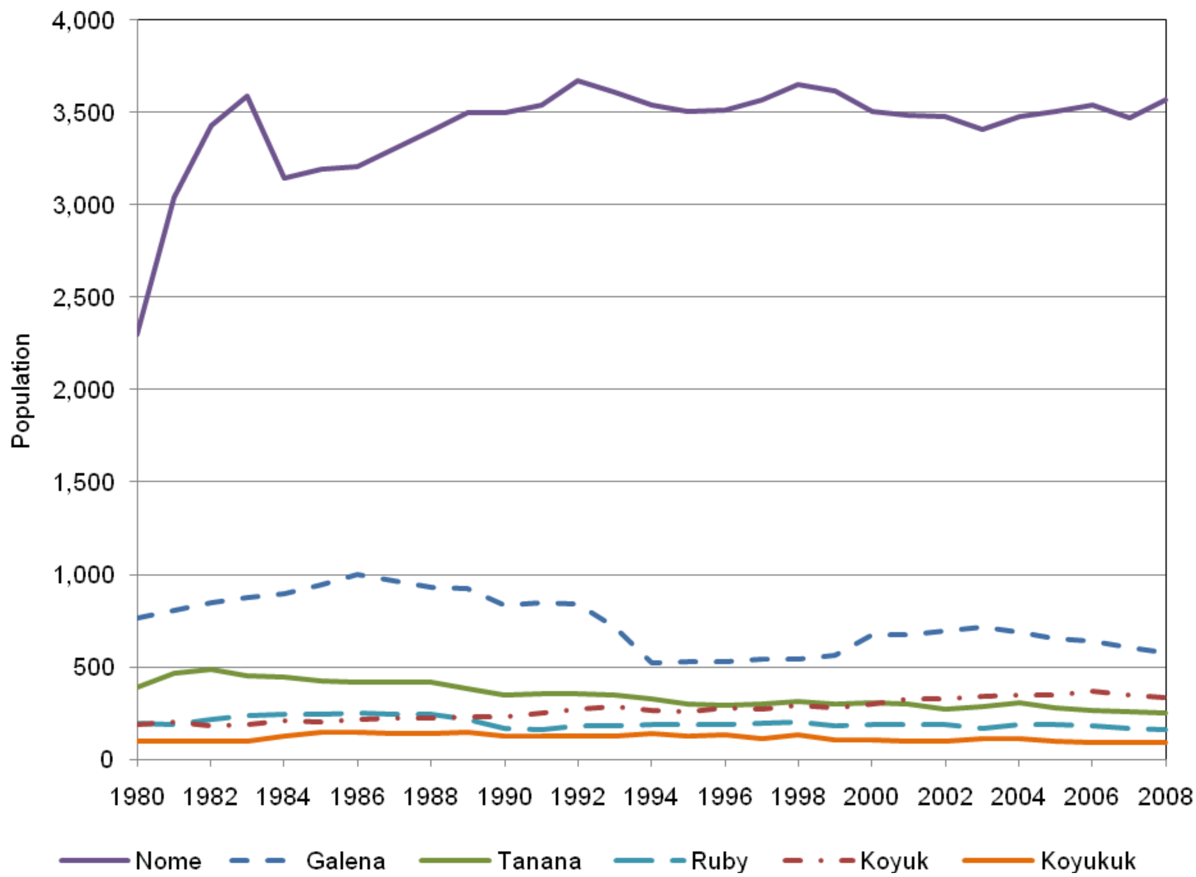
This section presents brief socioeconomic profiles that describe existing conditions within the six case study communities. The first two parts provide comparative demographic and economic statistics, while the third part describes the current public infrastructure in each community, with particular emphasis on the transportation and energy facilities.

2.1 Demographic Characteristics

2.1.1 Population Size

As shown in Figure 2, the populations of Tanana, Koyukuk, Ruby and Galena have exhibited a slight steady decrease, while that of Koyuk has shown an overall increasing trend. The population of Nome has been fairly stable over the past decade.

Figure 2. Case Study Community Population, 1980 to 2008

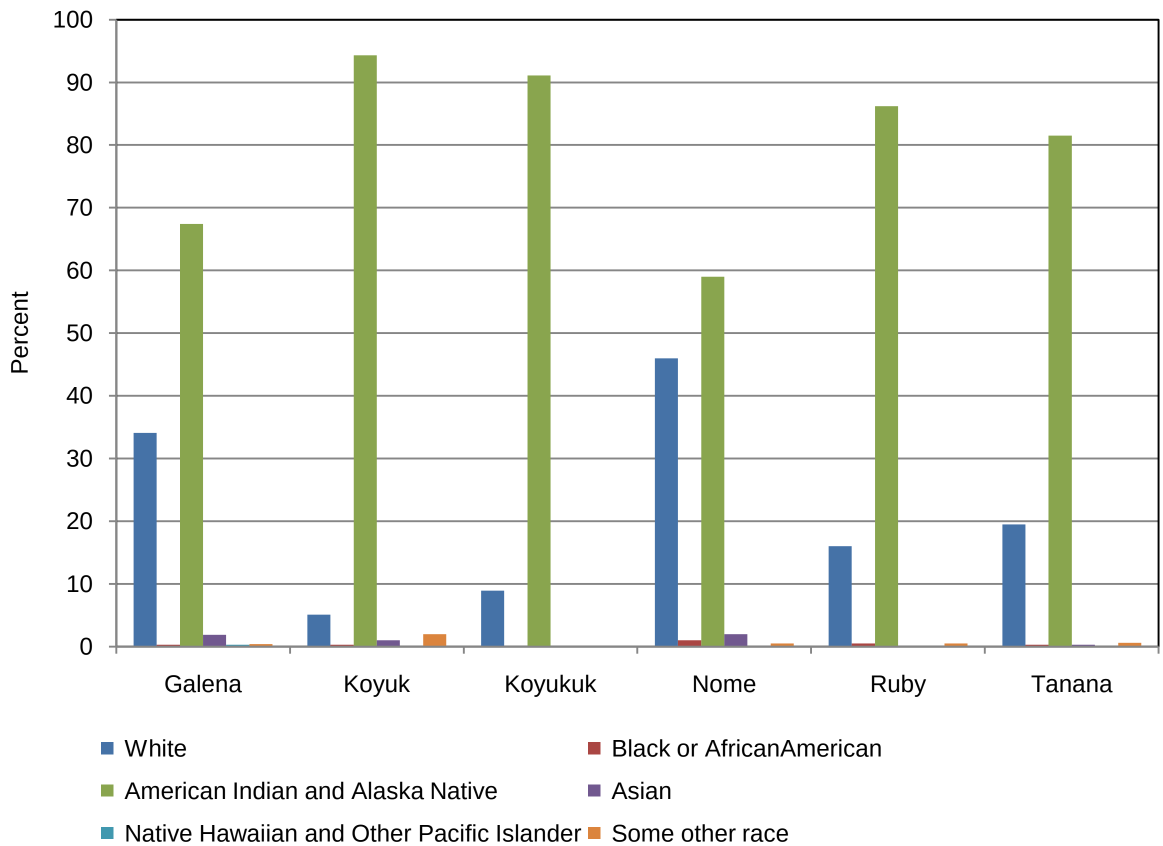


Source: Alaska Deparment of Labor and Workforce Development

2.1.2 Race/Ethnicity

Figure 3 shows that in 2000 the racial/ethnic composition did not vary greatly across the case study communities, with the exception of Nome. Alaska Natives made up the largest proportion of the population in all communities, but Nome also had a substantial Caucasian segment.

Figure 3. Case Study Community Racial/Ethnic Composition, 2000



Source: U.S. Bureau of the Census, Census 2000

2.1.3 Other Demographic Characteristics

In 2000, the median age among all the communities ranged from 24.7 to 34.2 years (Figure 4). A lower median age typically indicates more children in a community in comparison to the number of adults. Koyuk, which had the lowest median age, also had the largest average family and household size, while Tanana, with the highest median age, had a relatively small average family and household size. In all the case study communities, the percentage of people who graduated from high school was substantially lower than the percentage for the state as a whole.

Figure 4. Case Study Community Miscellaneous Demographic Characteristics, 2000

	Alaska	Galena	Koyuk	Koyukuk	Nome	Ruby	Tanana
Median Age	32.4	28.5	24.7	30.2	32.4	33.0	34.2
Average Family Size	3.3	3.4	4.3	3.3	3.4	3.6	3.4
Average Household Size	2.7	2.8	3.7	2.6	2.8	2.8	2.6
Population over 16 years old and in the labor force	326,596	366	107	52	1724	72	131
Percent high school graduate or higher	88.3	81.3	70.7	78.9	80.1	64.5	77.5

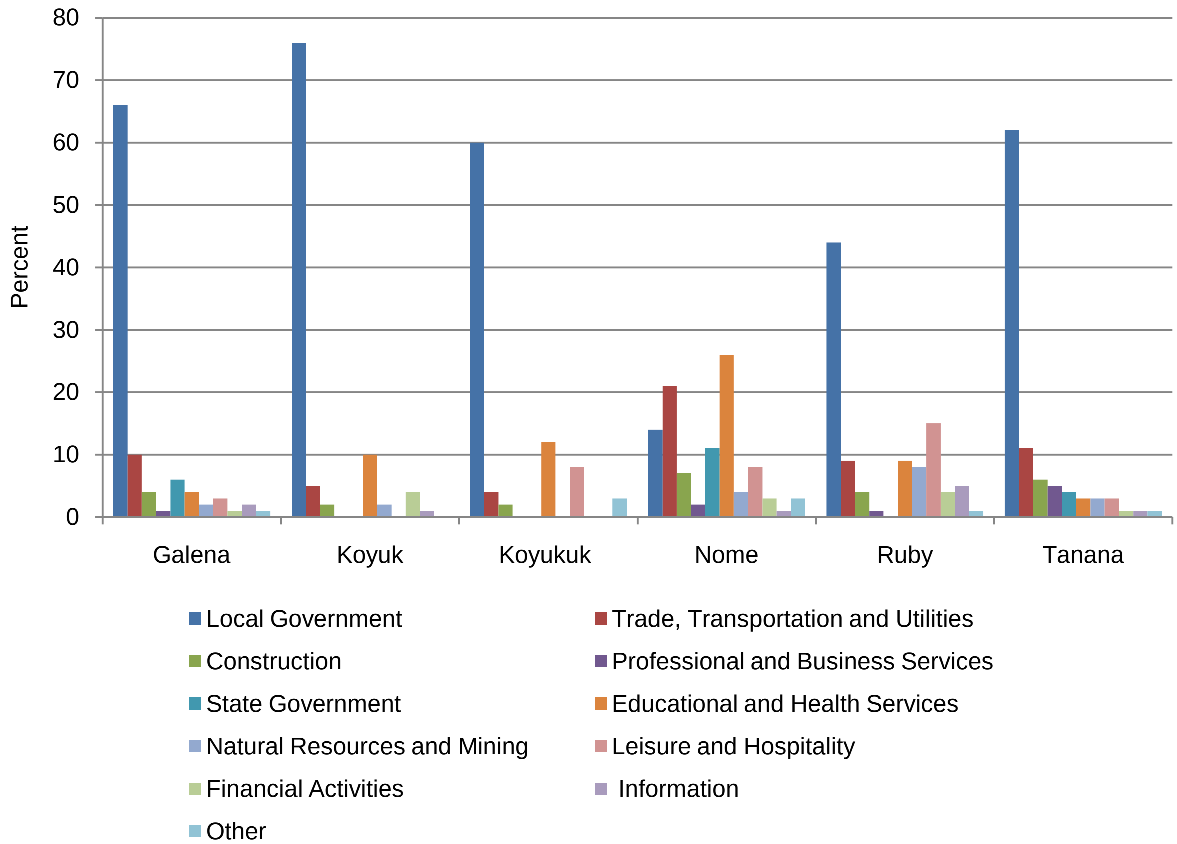
Source: U.S. Bureau of the Census, Census 2000

2.2 Economic Characteristics

2.2.1 Employment by Industry

Figure 5 shows that local government is clearly the dominant employer in every case study community except Nome. Nome has a comparatively diverse economy, which reflects its position as a regional hub. The data in Figure 5 only include wage and salary workers covered by unemployment insurance; they do not include self-employed persons. Many individuals in the case study communities are self-employed owner-operators of businesses involved in fishing, trapping, crafts-making, or other activities.

Figure 5. Case Study Community Employment by Occupation, 2008

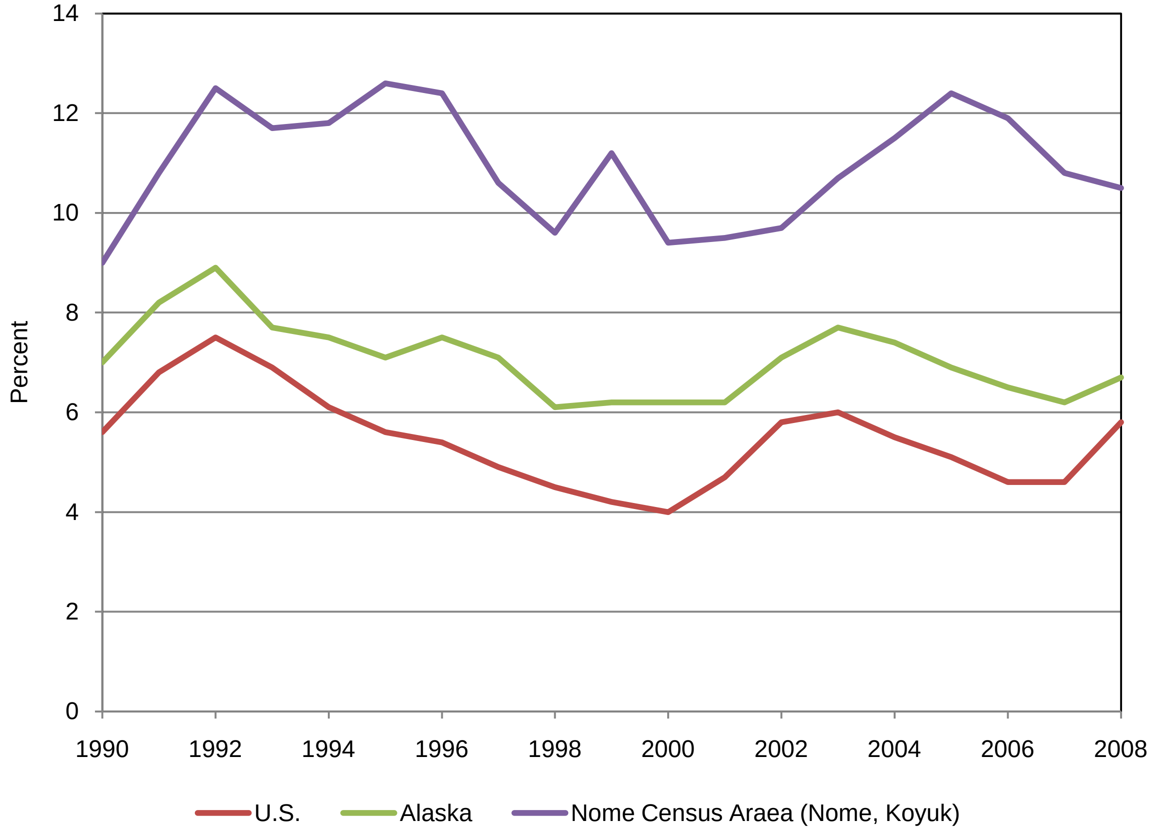


Source: Alaska Deparment of Labor and Workforce Development

2.2.2 Unemployment

Time series unemployment data are not available at the community level. Figure 6 shows the historical unadjusted annual unemployment rate for the Nome Census Area, which includes Nome and Koyuk, and Yukon-Koyukuk Census Area, which includes the other case study communities. During the 1990-2008 period, both census areas had significantly higher unemployment rates than the rest of the state (ADOLWD, 2009). It is important to note that the unemployment estimates do not include underemployed workers or discouraged workers—those who have given up looking for work because they could not find a job. It is likely that the persistent lack of employment opportunities in some of the case study communities has led many individuals to give up looking for work.

Figure 6. Census Area Unemployment Rate, 1990 to 2008



Source: Alaska Department of Labor and Work Force Development

2.3 Income

Table 1 shows income characteristics for each case study community in 2000. Four of the six communities had a per capita income well below the state figure, and all the communities except Nome had a higher poverty rate.

Table 1. Case Study Community Income, 2000

	Alaska	Galena	Koyuk	Koyukuk	Nome	Ruby	Tanana
Per Capita Income ($)	$22,660	$22,143	$8,736	$11,341	$23,402	$9,544	$12,077
Median Family Income ($)	$59,036	$70,250	$20,625	$31,250	$68,804	$26,667	$34,028
Median Household Income ($)	$51,571	$61,125	$30,417	$19,375	$59,402	$24,375	$29,750
Percent Below Poverty Level	9.4	10.2	28.0	35.1	7.6	32.3	23

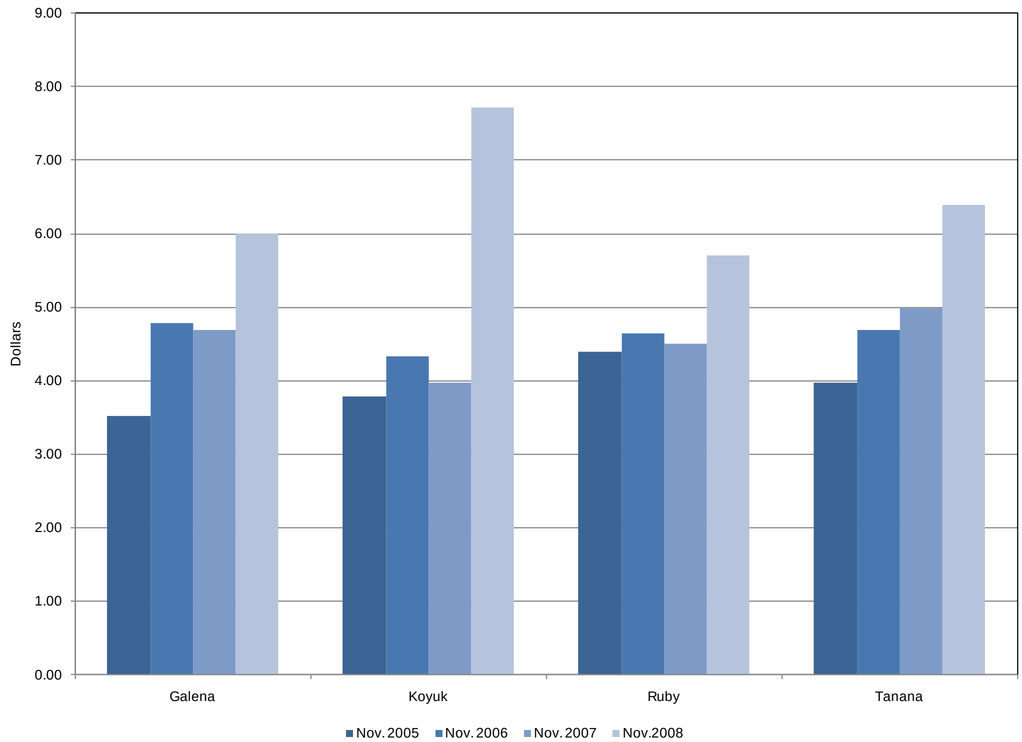
Source: U.S. Bureau of the Census, Census 2000

2.3.1 Fuel Costs

Figure 7 shows gasoline fuel costs in those case study communities for which data are available, while Figure 8 presents heating fuel costs. All communities experienced a dramatic increase in fuel prices in

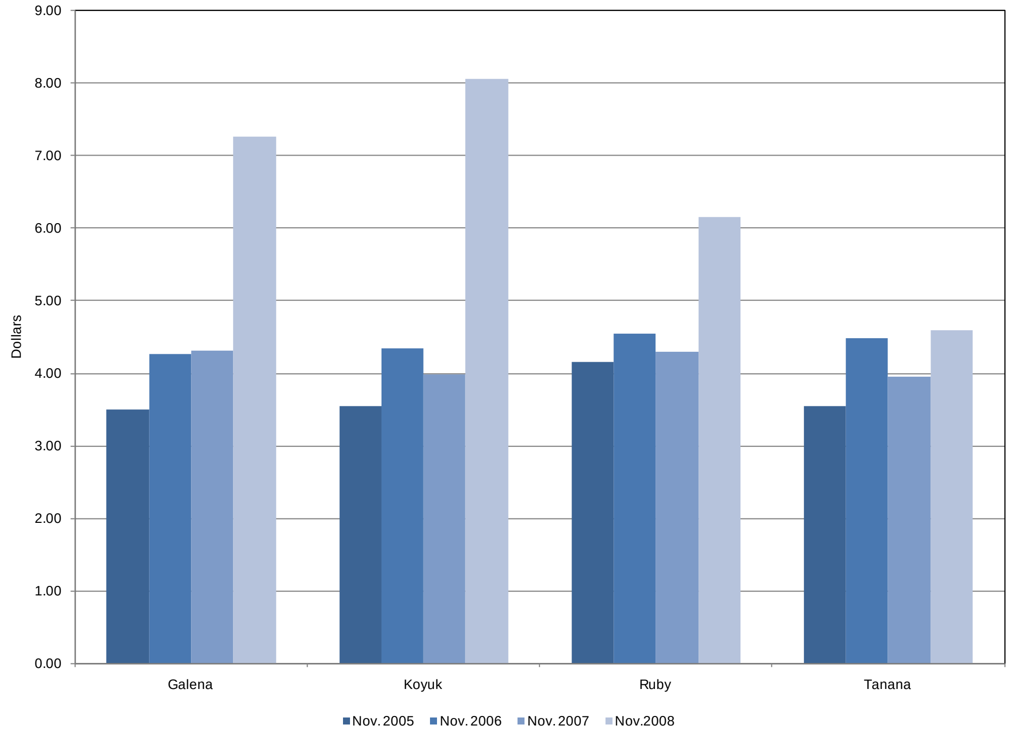
2008. Average winter fuel prices are expected to be lower in winter 2009/2010 due to the decrease in oil prices.

Figure 7. Case Study Community Gasoline Fuel Cost



Source: Alaska Department of Commerce, Alaska Energy Authority.

Figure 8. Case Study Community Heating Fuel Cost



Source: Alaska Department of Commerce, Alaska Energy Authority.

2.3.2 Subsistence

Many of the residents of the case study communities are dependent to varying degrees on fish and game resources for their livelihood. In addition to fishing and hunting for cash income, subsistence activities continue to figure prominently in the household economies and social welfare of many western Alaska residents, particularly among those living in the smaller villages (Wolfe and Walker 1987). To some extent, subsistence harvesting helps offset unemployment and the high cost of living in western Alaska (Fried and Windisch-Cole 2005). According to a 2009 survey, the cost of food in Nome is nearly 70 percent above the Anchorage level (Fried and Robinson 2009). In the outlying villages, grocery prices are even higher because of additional transportation costs. Therefore, subsistence remains vital to basic well-being (Fried and Windisch-Cole 2005). Salmon, caribou, sheefish, seal, and moose are the most important subsistence resources in the region, but small game and berries also contribute (Fried and Windisch-Cole 2005; Wolfe and Walker 1987).

2.4 Public Infrastructure

The following information was drawn mainly from the Alaska Department of Commerce, Community and Economic Development Community Database and Power Equalization Program.

2.4.1 Galena

Transportation

Transportation into and out of the community is limited to airplane from mid October to May. The former Galena Air Force Base is now a state owned airport equipped with a 7,254 foot long paved runway as well as a 2,786 foot long ski strip. Galena serves as a major transportation hub for the Yukon-Koyukuk region because it has one of few runways in the area capable of landing large aircraft. In the summer months, barges use river access to ship supplies into the community. There are no roads connecting Galena to other communities; however, in the winter months frozen rivers allow access by way of snowmachine and dog sled to Ruby, Koyukuk, Kaltag, and Nulato.

Energy

The City of Galena provides electrical power to the community using a diesel-powered generator with an installed capacity of 5,000 kilowatts. Galena is part of the power cost equalization subsidy program, and the residential price is currently $0.398 per kWh. As are the other case study communities, Galena is inaccessible by road, relying on river cargo in the brief summer for the bulk of its fuel needs. This means the community must store large volumes of fuel oil. There are numerous bulk fuel tank owners with a total fuel capacity of 2,055,250 gallons. The two largest tank farms, which are owned by Yukon Fuel Company and the city power plant, have a capacity of 1,297,750 and 630,000 gallons, respectively. In 2004, the Galena city council accepted a tentative proposal to build a nuclear power facility. The small self-contained nuclear plant is a prototype that the Japanese-owned Toshiba Corporation hopes to sell to other small communities in the United States and Canada.

Table 2 shows general consumer and fuel price data for Galena. Since 2004, the number of residential customers has shown a decreasing trend, while fuel prices have tended to increase.

Table 2. Galena Consumer and Fuel Price Data, 2002 to 2008

	Number of Customers				Total Fuel Used		
Year	Residential	Community Facilities	Total kWh Generated	Total kWh Sold	Gallons	Cost $	Average $/gal (not retail)
2008	223	13	7,772,042	6,908,893	574,806	1,664,301	2.90
2007	232	13	8,237,909	4,193,015	604,786	2,090,836	3.46
2006	237	11	8,826,194	4,691,006	666,692	2,042,100	3.06
2005	270	12	2,029,535	1,587,033	146,608	273,732	1.87
2004	304	12	9,466,799	7,192,172	724,076	1,053,531	1.46
2003	NA	NA	NA	NA	NA	NA	NA
2002	243	12	8,200,749	7,111,593	594,641	872,629	1.47

Notes: 2002 includes of 8 months of data; 2005 includes 3 months of data.
Source: Alaska Department of Commerce, Community and Economic Development, Power Equalization Program

Other Infrastructure

A flood in 1971 required the people of Galena to move city offices, the health clinic, schools, and more than 150 homes inland approximately 1.5 miles. Although the air force station closed in 1993, the community continues to use the station facilities for the Galena School District. Water for the community is collected from wells and treated before either being piped or delivered to consumers. The piped and delivered rate is 6 and 8 cents per gallon, respectively. Only 28 houses and the public school are connected to the city water and sewer system. The majority of residences use a flush/haul system or have individual septic tanks. In 1997, the city opened its first landfill and now collects refuse for its residents.

The Galena School District operates four schools, including the Galena Interior Learning Academy, a statewide boarding school for grade 9-12 students that is Alaska's longest operating residential secondary vocational school. The University of Alaska Fairbanks operates an Interior-Aleutians Campus center in the community. The health clinic is equipped with an x-ray, laboratory, dental, dental x-ray, and dark room. Galena has a local police department as well as an Alaska State Troopers post. The community fire department is run by volunteers.

2.4.2 Koyuk

Transportation

Transportation into and out of the community is limited to air or sea because there are no roads connecting Koyuk to other villages. The state-maintained gravel runway was recently renovated and accommodates daily flights to and from Nome and Unalakleet. There is no port in Koyuk, and supplies must be lightered to shore. Construction has begun on an 18-mile road segment connecting Koyuk to Six Mile Point, and the city has requested funding for a port feasibility study.

Energy

A few years ago, the Alaska Village Electric Cooperation built an automated, modular-style power plant and bulk fuel tank farm in Koyuk. The diesel-powered generator has an installed capacity of 771 kilowatts. Koyuk is part of the power cost equalization subsidy program, and the residential price per kilowatt hour is $0.472. The total fuel tank capacity for all tank owners is 254,550 gallons, with Koyuk Native Corporation and the Alaska Village Electric Cooperation accounting for 98,800 and 71,250 gallons, respectively.

Table 3 shows general consumer and fuel price data for Koyuk. Since 2002, the number of residential customers has been fairly stable, while fuel prices have shown an increasing trend.

Table 3. Koyuk Consumer and Fuel Price Data, 2002 to 2008

	Number of Customers				Total Fuel Used		
Year	Residential	Community Facilities	Total kWh Generated	Total kWh Sold	Gallons	Cost $	Average $/gal (not retail)
2008	97	13	1,349,544	1,276,427	101,994	257,727	2.53
2007	94	14	1,292,120	1,247,460	97,261	183,999	1.89
2006	103	15	1,401,553	1,328,466	102,707	191,562	1.87
2005	98	12	1,432,168	1,357,756	99,763	187,200	1.88
2004	94	11	1,397,278	1,345,208	96,010	145,060	1.51
2003	90	11	1,209,975	1,153,394	84,169	93,588	1.11
2002	91	10	1,159,042	1,105,248	81,859	100,849	1.23

Source: Alaska Department of Commerce, Community and Economic Development, Power Equalization Program

Other Infrastructure

There are 51 residences on the west side of the community connected to a pipe water and sewer system. There is also a community washeteria and central watering point. Education facilities in Koyuk include an elementary and high school. The community has a health clinic operated by the Norton Sound Health Corporation. Koyuk does not have a city police department, but there is a Village Public Safety Officer Program. The Village Public Safety Officers and other volunteers run the fire department.

2.4.3 Koyukuk

Transportation

During the winter when the Yukon River is frozen, Koyukuk is only assessable by airplane. Supplies are shipped into Koyukuk by barge in the summer months. The city is equipped with a state owned gravel runway. Residents use snowmachines and ATVs on local trails to travel to the neighboring villages of Chance and Nulato.

Energy

The city provides electricity with a diesel-powered generator that has an installed capacity of 245 kilowatts. Koyukuk is part of the power cost equalization subsidy program, and the residential price per kilowatt hour is $0.45. Bulk fuel storage is provided by the Yukon Koyukuk School District (10,800 gals.); city lease from the Yukon Koyukuk School District (63,800); Alaska Department of Transportation & Public Facilities (1,000); Army National Guard (3,000); and city fuel depot (20,400).

Table 4 shows general consumer and fuel price data for Koyukuk. The number of residential customers has shown a decreasing trend, while fuel prices have tended to increase.

Table 4. Koyukuk Consumer and Fuel Price Data, 2002 to 2008

	Number of Customers				Total Fuel Used		
Year	Residential	Community Facilities	Total kWh Generated	Total kWh Sold	Gallons	Cost $	Average $/gal (not retail)
2008	44	4	97,444	74,154	9,335	38,795	4.16
2007	49	5	168,291	204,664	1,455,277	3,719,572	2.56
2006	NA	NA	NA	NA	NA	NA	NA
2005	37	5	243,110	186,548	19,726	38,132	1.93
2004	48	3	353,250	221,190	20,820	39,362	1.89
2003	52	2	291,776	262,478	23,279	35,041	1.51
2002	52	2	259,940	20,022,388	31,047	48,236	1.55

Notes: 2005 includes of 8 months of data.

Source: Alaska Department of Commerce, Community and Economic Development, Power Equalization Program

Other Infrastructure

The school and washeteria are the only buildings that are connected to city water. Households are not plumbed and have to use honeybuckets. Water is collected from wells and treated at the washeteria before being delivered to residents. The local school provides grade P-12 education to 12 local students. A community health clinic operated by Tanana Chiefs Conference Health Services provides limited emergency care. There is no local police department or Village Public Safety Officers Program in Koyukuk. The village is served by an Alaska State Trooper post in Galena. The city fire department and EMS are run by volunteers.

2.4.4 Nome

Transportation

Nome serves as a regional transportation hub. The community has two state owned airports, one of which has recently undergone an $8.5 million improvement project. Scheduled jet flights are available, as well as charter and helicopter services. There is also a city-run gravel airstrip that serves small planes. In 1950, a 3,350 foot long sea wall was constructed at a cost of over $1 million to protect the port and city from storms. The port and berthing facilities can accommodate vessels with a draft of 18 feet. Cargo unloaded in Nome is lightered to surrounding communities. Nome is connected to over 350 miles of roads that are accessible from mid May till the end of October.

Energy

The city-operated Nome Joint Utilities System supplies electricity to Nome's residents. The diesel-powered plant has an installed capacity of 10,895 kilowatts. Nome is not eligible to participate in the power cost equalization subsidy program. Bulk fuel storage is provided by Chevron/Arctic Lighterage (5,233,000 gals.); Bonanza Fuel (3,055,000); Air National Guard (20,000); and MarkAir (20,000).

Table 5 shows general consumer and fuel price data for Nome. The number of residential customers has increased at a fairly constant rate. Although Nome's fuel prices tend to be lower than those in the other case study communities, its fuel prices have increased substantially.

Table 5. Nome Consumer and Fuel Price Data, 2002 to 2008

	Number of Customers				Total Fuel Used		Average
Year	Residential	Community Facilities	Total kWh Generated	Total kWh Sold	Gallons	Cost $	$/gal (not retail)
2008	1,686	79	35590281	32,103,278	2,219,328	5,237,614	2.36
2007	1,622	95	30088983	27,894,288	1,857,614	4,297,907	2.31
2006	1,615	74	30392934	28,237,555	1,907,272	3,337,728	1.75
2005	1,609	68	30107819	27,480,797	1,887,981	2,250,137	1.19
2004	1,593	61	30123392	27,226,457	1,906,371	1,876,727	0.98
2003	1,578	66	28584115	25,846,679	1,788,827	1,704,934	0.95
2002	1,543	61	28884216	26,773,813	1,817,582	1,860,377	1.02

Source: Alaska Department of Commerce, Community and Economic Development, Power Equalization Program

Other Infrastructure

Currently, 95 percent of Nome residences are plumbed. The other residents use honeybuckets and have water delivered. Water is collect at a well located at Moonlight Springs and treated at the Snake

River Power Plant before being stored. Water is then heated and piped to residences by way of a wooden utilidor. A private company collects refuse and hauls it to the local landfill.

The local hospital, which is operated by the Norton Sound Health Corporation, is a qualified acute care facility and can medevac a patient to other regional hospitals. There are five schools in Nome, with a total student population of 683. Nome has its own police department as well as an Alaska State Troopers post. The Nome Volunteer Fire Department is responsible for fire and emergency services.

2.4.5 Ruby

Transportation

Ruby is primarily accessed by small airplanes. The state-owned airfield is equipped with a 4,000-foot long gravel runway. Small float planes can also land on the Yukon River. During the summer months, barges are able to ship supplies into the area. Ruby does not have a port or docking facilities, but there is a boat launch and barge unloading area. Ruby is connected to Long Creek Mine by a 35-mile long road.

Energy

They city-operated, diesel-powered plant has an installed capacity of 600 kilowatts. Ruby does not participate in the power cost equalization subsidy program. Bulk fuel storage is provided by the Dineega Fuel Company (194,800 gals.); Yukon Koyukuk School District (65,610); city (12,000); and Alaska Department of Transportation & Public Facilities (4,000).

Table 6 shows general consumer and fuel price data for Ruby. Both the number of consumers and fuel prices have shown an increasing trend.

Table 6. Ruby Consumer and Fuel Price Data, 2002 to 2008

	Number of Customers				Total Fuel Used		
Year	Residential	Community Facilities	Total kWh Generated	Total kWh Sold	Gallons	Cost $	Average $/gal (not retail)
2008	131	18	NA	471,506	26,400	83,728	3.17
2007	124	19	NA	495,854	45,514	175,075	3.85
2006	125	12	1,064,706	557,054	42,637	129,549	NA
2005	110	14	599,820	549,994	60,771	159,509	2.62
2004	109	14	NA	232,583	24,861	43,642	1.76
2003	98	12	416,512	570,372	59,180	103,040	1.74
2002	96	13	669,588	574,249	60,040	137,223	2.29

Source: Alaska Department of Commerce, Community and Economic Development, Power Equalization Program.

Other Infrastructure

Nearly 40 percent of the households in Ruby have individual wells and septic tanks. The rest of the population hauls water from the washeteria and uses outhouses. The community has one school, which is attended by 33 students. The city health clinic, which is operated by Tanana Chiefs

Conference Health Services, provides limited care services, and emergency care is provided by volunteers.

2.4.6 Tanana

Transportation

During the winter months Tanana is only accessible by air, but in the summer it also accessible by river. The local airport is owned and operated by the state and is equipped with a lighted 4,400-foot long gravel runway. Small float planes also land on the Yukon River. Tanana has 35 miles of maintained roads that are used to access subsistence resources. The city does not have a port, but it does have docks and an area for barges to unload supplies.

Energy

The privately owned Tanana Power Company supplies electricity to Tanana's residents at a rate of $0.569 per kilowatt hour. Power is derived from a diesel-powered generator and wind turbine, with a combined power capacity of 2,000 kilowatts. The power cost equalization program subsidizes the cost of electricity in Tanana.

Table 7 shows general consumer and fuel price data for Tanana. The number of consumers has been fairly stable, while fuel prices have shown an increasing trend.

Table 7. Tanana Consumer and Fuel Price Data, 2002 to 2008

	Number of Customers				Total Fuel Used		
Year	Residential	Community Facilities	Total kWh Generated	Total kWh Sold	Gallons	Cost $	Average $/gal (not retail)
2008	116	11	1,264,325	1,092,479	93,988	261,955	2.79
2007	113	11	1,422,715	1,280,092	104,243	319,655	3.07
2006	114	11	1,331,337	1,217,592	99,823	260,146	2.61
2005	117	12	1,371,949	1,213,725	102,472	175,606	1.71
2004	117	11	1,378,060	1203547	104,270	140,193	1.34
2003	118	11	1,309,561	1169122	98,168	121,791	1.24
2002	105	10	1,362,938	1187756	94,380	164,339	1.74

Source: Alaska Department of Commerce, Community and Economic Development, Power Equalization Program

Other Infrastructure

Too'gha, Inc. supplies Tanana residents with water from three wells near the Yukon River. The hospital/clinic, tribal council building, and regional elders' residences are the only structures that have piped water and sewer. The rest of the community hauls water from the local washeteria and uses honeybuckets. The city landfill operates an incinerator and has recycling facilities. The city's one school is attended by 38 students. The hospital is able to treat limited emergency services. The hospital facilities include a health clinic, counseling center, tribal office, and regional elders' residence. Tanana has its own police department, and Alaska State Troopers from Fairbanks also serve the community. Emergency responders from the Tanana Tribal EMS are responsible for fire and rescue services.

3 Transportation Effects

This section describes changes in personal and commodity (i.e., cargo, building materials, and consumables) transportation patterns and costs. In general, the vast majority of personal transportation occurs by airplane while fuel moves by barge, and most cargo moves by bypass mail/air cargo. Vehicles, equipment, and other cargo that cannot move by air travels by barge. The Yukon River Corridor will change the movement of people and goods throughout the region.

3.1 Case Study Communities

Table 8 shows the estimated volume of freight and fuel that is annually transported by tug and barge to the case study communities, and the total transportation cost associated with these volumes. These volume and cost numbers should be considered as representative of the order of magnitude of such volumes and costs, since volumes to any community can increase substantially if a large construction project is underway. In addition, there are different commodity rates that could be used and result in different costs, and transportation for fuel and construction projects is often put out for competitive bid and published tariff rates would not apply. Fuel transportation costs shown here are based on interviews with industry and utility representatives, and an analysis of fuel costs for utilities along the Yukon River, which are often the largest purchasers of fuel in a community.

Table 8. Current Community Transportation Volumes and Costs, Barge ($)

	Community					
Commodity	**Tanana**	**Ruby**	**Galena**	**Koyukuk**	**Koyuk**	**Nome**
Freight						
Volume (pounds)	257,000	163,000	591,000	90,000	339,000	3,635,000
Transport cost ($ per pound)	0.19	0.21	0.22	0.24	0.44	0.26
Subtotal ($)	**49,000**	**34,000**	**129,000**	**22,000**	**148,000**	**948,000**
Fuel						
Volume (gallons)	200,000	185,000	1,200,000	75,000	302,000	6,321,000
Transport cost ($ per gallon)	0.77	0.88	0.88	0.95	0.57	0.34
Subtotal ($)	**155,000**	**162,000**	**1,061,000**	**71,000**	**173,000**	**2,166,000**
Total Barge Transport Cost ($)	**204,000**	**196,000**	**1,190,000**	**93,000**	**321,000**	**3,114,000**

Source: Estimates by Northern Economics, Inc. from information provided by Office of Coast Survey, 2009; Ruby Marine, 2009; Sweeney, 2009; Sweetsir, 2009.

The seasonal nature of tug and barge transportation in the study area substantially affects the transportation costs to the case study communities. All of the capital costs and other fixed costs must be amortized during the short summer shipping season, which increases the costs for each pound of freight or gallon of fuel transported. A longer shipping season would require less capital equipment and reduce the cost of transportation.

As noted earlier, most personal travel is by air, although skiffs are used in the summer and snowmachines in the winter to travel between communities. Bypass mail and air cargo are used extensively to transport food and other supplies to the case study communities. Table 9 shows the estimated costs paid by the community for personal travel and bypass mail and air cargo in 2008 from data collected by the Bureau of Transportation Statistics.

Table 9. Current Community Transportation Costs, Air

	Community					
Transport Mode	Tanana	Ruby	Galena	Koyukuk	Koyuk	Nome
Passenger Traffic ($)	810,000	350,000	2,850,000	400,000	990,000	31,480,000
Bypass Mail Cost ($)	240,000	460,000	670,000	150,000	580,000	9,240,000
Air Cargo ($)	170,000	90,000	730,000	80,000	300,000	10,070,000
Total Air Transport Cost ($)	1,220,000	900,000	4,250,000	630,000	1,870,000	50,790,000

Source: Northern Economics, Inc. estimates based on Bureau of Transportation Statistics, 2009.

Table 10 is a modified version of Table 9; passenger traffic costs have been removed, and the barge freight category has been added to the table along with the bypass mail and air cargo categories to arrive at total transportation costs for each case study community. This change was made to facilitate comparison with truck transportation costs.

Table 10. Total Community Freight Transportation Costs

	Community					
Transport Mode	Tanana	Ruby	Galena	Koyukuk	Koyuk	Nome
Barge ($)	49,000	34,000	129,000	22,000	148,000	948,000
Bypass Mail Cost ($)	240,000	460,000	670,000	150,000	580,000	9,240,000
Air Cargo ($)	170,000	90,000	730,000	80,000	300,000	10,070,000
Total Freight Transport Cost ($)	459,000	584,000	1,529,000	252,000	1,028,000	20,258,000

Source: Northern Economics, Inc. estimates based on Bureau of Transportation Statistics, 2009; Office of Coast Survey, 2009; Ruby Marine, 2009; Sweeney, 2009; Sweetsir, 2009.

Table 11 presents information on potential transportation costs for freight and fuel if the Yukon River corridor is constructed and truck transportation becomes available. As expected, truck transportation costs are considerably less expensive than the costs of air transportation. Substantial savings would accrue to the U.S. Postal Service and community residents and businesses using air cargo. Truck is also less expensive than barge for freight shipments, even to Nome. However, fuel deliveries by barge to Nome are less expensive than by truck although the truck transport cost is less for all other communities.

Table 11. Total Community Freight and Fuel Transportation Costs with Corridor

	Community					
Commodity	Tanana	Ruby	Galena	Koyukuk	Koyuk	Nome
Freight						
Barge freight volume (pounds)	257,000	163,000	591,000	90,000	339,000	3,635,000
Truck Transport cost ($ per pound)	0.12	0.15	0.15	0.16	0.18	0.21
Subtotal ($)	**31,000**	**24,000**	**89,000**	**14,000**	**61,000**	**751,000**
Air Cargo						
Air cargo volume (pounds)	297,000	100,000	699,000	56,000	110,000	11,760,000
Truck Transport cost ($ per pound)	0.12	0.15	0.15	0.16	0.18	0.21
Subtotal ($)	**36,000**	**15,000**	**105,000**	**9,000**	**20,000**	**2,429,000**
Bypass Mail						
Mail volume (pounds)	211,000	268,000	1,141,000	129,000	715,000	10,119,000
Truck Transport cost ($ per pound)	0.12	0.15	0.15	0.16	0.18	0.21
Subtotal ($)	**25,000**	**40,000**	**172,000**	**20,000**	**128,000**	**2,090,000**
Freight Subtotal ($)	**92,000**	**79,000**	**366,000**	**43,000**	**209,000**	**5,270,000**
Fuel						
Fuel volume (gallons)	200,000	185,000	1,200,000	75,000	302,000	6,321,000
Truck Transport cost ($ per gallon)	0.15	0.26	0.27	0.29	0.39	0.49
Subtotal ($)	**31,000**	**49,000**	**328,000**	**22,000**	**117,000**	**3,104,000**
Total Truck Transport Cost ($)	**123,000**	**128,000**	**694,000**	**65,000**	**326,000**	**8,374,000**

Source: Northern Economics, Inc. estimates, 2009 from data provided by from data provided by Logistic Solution Builders, n.d., and Jansen, 2009.

The transport cost comparison assumes that under current conditions freight is barged from Anchorage directly to Nome and offloaded. Freight destined for Koyuk is then lightered to that community. Other freight is assumed to be trucked from Anchorage to Nenana, loaded onto a barge, and then transported to the respective communities on the Yukon River. Fuel is barged directly from Anchorage to Nome and then to Koyuk, or trucked from North Pole refineries to Nenana and then barged to Yukon River communities. Under the "with corridor" condition, the communities would receive shipments directly via truck.

The study estimates that total fuel, cargo, and bypass mail costs would drop by roughly $1.1 million, $9.2 million, and $8.9 million per year respectively if all of the case study communities availed themselves of the lowest cost options.

Table 12. Estimated Annual Cargo, Fuel, and Bypass Mail Savings

Category	Community Savings ($)						
	Tanana	Ruby	Galena	Koyukuk	Koyuk	Nome	Total
Fuel Savings ($)	124,000	113,000	733,000	49,000	56,000	0	1,075,000
Cargo ($)	152,000	85,000	665,000	79,000	367,000	7,838,000	9,186,000
Bypass Mail ($)	215,000	420,000	498,000	130,000	452,000	7,150,000	8,865,000
Total ($)	**491,000**	**618,000**	**1,896,000**	**258,000**	**875,000**	**14,988,000**	**19,126,000**

Source: Northern Economics, Inc. estimates, 2009 from data provided by Logistic Solution Builders, n.d.; Jansen, 2009; Sweetsir, 2009; Ruby Marine, 2009; Sweeney, 2009.

The Yukon River Corridor would also enable the use of automobiles for personal travel. Table 13 presents an estimate of the cost of vehicle travel from each case study community to the primary air travel destination as identified from Bureau of Transportation Statistics. In most instances, the distances are so great that the airfare is less than the full cost of operating a vehicle in these communities if the driver is the only occupant. Of course, many people only consider fuel costs when thinking of an automobile trip as opposed to considering the full operating cost of the vehicle, and this fact could result in more travel than would be expected from the comparison in Table 13. However, average speed on the Yukon River corridor is anticipated to be about 35 miles per hour on gravel roads and 60 miles per hour on paved roads, so travel time from Nome or other communities on the Seward Peninsula to Anchorage or even Fairbanks is likely to deter some vehicle travel, especially in winter months.

Table 13. Estimated Air and Vehicle Travel Cost by Passenger

Information/Cost Item	Case Study Community					
	Tanana	Ruby	Galena	Koyukuk	Koyuk	Nome
Primary destination	Fairbanks	Nome	Fairbanks	Fairbanks	Nome	Anchorage
One-way airfare ($)	188	195	182	266	95	116
Road miles to destination	218	348	375	418	158	1088
Driving time for one-way trip (hours)	6.2	9.9	10.7	11.9	4.5	26.8
Full cost of operation ($)	0.82	0.82	0.82	0.82	0.82	0.82
Nights of lodging and meals @$125 per person	0	0	0	0	0	2
Cost per vehicle passenger ($)						
Driver only	179	285	307	343	129	1,142
Two passengers	89	143	154	171	65	571
Four passengers	45	71	77	86	32	285

Source: Northern Economics, Inc, 2009 based on Published Air Fares, 2009; Internal Revenue Service, 2009.

The study area is very large and the distances from the Seward Peninsula to the Dalton Highway are long, so it is anticipated that most personal travel by vehicle on the corridor will be between communities within the study area, with Tanana being the exception with travel being oriented to Fairbanks, which is outside of the study area boundary. It is unclear how the road corridor will change long distance personal travel. Undoubtedly, some people will choose to drive from the case study communities to communities that they currently reach by air travel, while others may choose to forgo the additional expense of lodging, meals, and wear on their vehicles and continue to travel by air. As the magnitude of these changes is exceptionally unclear, the study does not estimate a savings associated with personal travel. What is clear is that personal travel patterns will change, and that the biggest change may be increased travel between communities within the corridor that are currently restricted to water and air travel in the summer, and snowmachine in the winter.

3.2 Potential Mines

The study area is rich with mineral resources, but with the exception of high-value gold mines and placer deposits, there have been few developments of the other mineral resources due to the remoteness, arctic and sub-arctic conditions, and lack of transportation infrastructure. Discussions with sponsors of selected potential mines in the study area, persons knowledgeable of these resources, and a review of published reports resulted in the estimated volumes of freight, fuel, and concentrates that might move to and from these potential mines if they were developed.

Table 14. Potential Mine Annual Transportation Volumes by Mode, Pounds

	Inbound				Outbound
	Freight (pounds)		Fuel (gallons)		Concentrate (pounds)
Potential Mines	Barge/ACV	Air	Barge/ACV	Air	Barge/ACV
Ambler	36,000,000	160,000	10,000,000	0	912,500,000
Donlin Creek	240,000,000	4,800,000	80,000,000	0	0
Illinois Creek	14,000,000	100,000	4,000,000	0	182,500,000
Placer Mines		400,000		200,000	0

Source: Miller, 2009; Hawley, 2009; Hughes, 2009; Fueg, 2009; North Pacific Mining Corporation, 1993; Donlin Creek, LLC., 2009.
Note: ACV is air cushion vehicle (e.g., hovercraft).

Table 15 shows the potential transportation costs to some known mineral resources using existing tug and barge operations, with hovercraft also being employed in the case of Ambler. Previous proprietary transportation studies completed by mining companies for the resources in the vicinity of Ambler and Illinois Creek used the transportation systems modeled in this analysis. The potential placer mines may be representative of large placer mines that could exist or be discovered in the study area in the vicinity of the Yukon River Corridor or along the spur roads. Such placer mines are assumed to be located 25 miles from the spur roads or the corridor. In their assumed locations, all fuel and freight is brought in via air carriers in the absence of a Yukon River Corridor. The placer mines are assumed to operate for 180 days per year while the other mines operate year-round. The Ambler mining district is assumed to provide 5,000 tons of ore per day to a mill and the Illinois Creek district would provide 2,000 tons of ore per day to a mill.

Table 15. Potential Mine Annual Transportation Costs, Existing Transportation System ($)

	Inbound				Outbound	
	Freight		Fuel		Concentrate	
Potential Mines	Barge/AVC	Air	Barge/ACV	Air	Barge/ACV	Total
Ambler (1)	23,300,000	600,000	13,100,000	0	81,400,000	118,400,000
Donlin Creek (1)	92,700,000	14,400,000	39,400,000	0	0	146,500,000
Illinois Creek (1)	3,200,000	400,000	3,700,000	0	40,200,000	47,500,000
Placer Mines (10)		1,600,000		800,000	0	2,400,000
Total Cost						**314,800,000**

Source: Northern Economics, Inc. estimates based on ; Office of Coast Survey, 2009; Miller, 2009; Ruby Marine, 2009; Hawley, 2009; Sweeney, 2009; Hughes, 2009; Sweetsir, 2009; Fueg, 2009.; North Pacific Mining Corporation, 1993; Donlin Creek, LLC., 2009.
Note: ACV is air cushion vehicle (e.g., hovercraft).

The mineral resources in the vicinity of the Ambler mine are assumed to have barge service to Kotzebue and then freight, fuel, and concentrates would be moved with a fleet of hovercraft with a 15-ton capacity. Donlin Creek transportation would be ocean-going barges to Bethel and then sets of smaller tugs and barges would take fuel and freight upriver to a landing where a 75-mile road would connect to the mine. The high value of the gold from Donlin Creek or a placer mine would mean that the gold would be flown to markets, and this transportation mode would not change even if road access were available, so no attempt is made to estimate this air transportation cost. Illinois Creek is assumed to be served by tug and barge from Nenana to Galena, and then an approximately 75-mile road to the mine. Concentrates from Illinois Creek are assumed to be trucked to Nome and stored there until the summer shipping season.

The tug and barge costs are based on published rates for freight (Ruby Marine, 2009) and since fuel rates are not published, a spreadsheet model for tug and barge service that was developed as part of the Yukon River Port and Road Transportation Study (CH2MHill, 2004) to evaluate transporting fuel and supplies to the Donlin Creek mine. This model was updated to 2009 costs using capital costs for new equipment that have been recently put in service on the Yukon River and elsewhere in western Alaska (Sweeney, 2009; Sweetsir, 2009), and corroborated with feedback on model costs. The fuel transport cost estimates should be considered indicative since different combinations of tug and barge sets, or different equipment would result in different transport costs.

Air cushion vehicle (ACV) costs are derived from an ongoing study being prepared for the Western Federal Lands Division of the Federal Highway Administration and the Alaska Department of Transportation by Robert Peccia and Associates. The ACVs being evaluated in that study would transport passengers and vehicles, including trucks hauling concentrates, on the Stikine River or other possible river corridors in the vicinity of Wrangell, Alaska. This information was corroborated with data from an analysis of operating costs for a smaller ACV operating between King Cove and Cold Bay, Alaska (Northern Economics, 2007).

Table 16 presents estimates for truck transport to and from these potential mine sites. Ambler would be accessed via an estimated 276 mile spur road from Tanana, and Donlin Creek would be accessed via a 263 mile spur road from Ruby, with a ferry crossing and winter ice bridge at the Yukon River. Illinois Creek would be trucked to Galena with a ferry crossing and winter ice bridge at the Yukon River, and then a 75 mile road to the mine. A comparison of Table 15 and Table 16 shows that the "with corridor scenario" reduces annual transportation costs by roughly $120 million. While these savings are substantial, the cost savings alone may still be insufficient to result in an economically feasible project from an investor's perspective. It will likely take the combined savings of multiple road benefits (e.g., lower trucking costs, lower energy infrastructure costs) to make a difference in the development of some mineral resource locations.

Table 16. Potential Mine Annual Trucking Costs

	Inbound		Outbound	
Potential Mines	**Freight**	**Fuel**	**Concentrate**	**Total**
Ambler (1)	6,000,000	3,400,000	90,400,000	99,800,000
Donlin Creek (1)	46,500,000	34,100,000	0	80,600,000
Illinois Creek (1)	2,300,000	1,300,000	10,500,000	14,100,000
Placer Mines (10)	70,000	80,000	0	150,000
Total Cost ($)				**194,650,000**

Source: Northern Economics, Inc. estimates based on CH2MHill, 2004; Jansen, 2009; Logistics Solution Builders, n.d.

Under the Ambler development concept, there is no road from Ambler west to the Kotzebue Sound region or to the Seward Peninsula due to the federal conservation lands in the area. Concentrates would need to be trucked back to Tanana and then to Nome or to a Southcentral Alaska port, which would be only slightly longer than the distance to Nome. This analysis anticipates that given such a choice, the mine developer would elect to truck to Southcentral Alaska where they could ship concentrates throughout the year.

The trucking costs were developed from information on trucking costs in Canada in 2005 (Logistics Solution Builders, Ltd., n.d.) prepared for Transport Canada. This information was updated to reflect changes in currency values, increases in the producer price index for truck transportation, and to reflect operations for winter and gravel roads for several different equipment configurations. These cost estimates were then reviewed by industry representatives for its reasonableness and an average cost estimate of $3 per mile, plus terminal costs, was deemed to be representative.

The potential transportation cost savings could approach $120 million per year if these mine concepts or similar mines were operating (See Table 17). Additional savings could accrue to the mines by the ability to transport fuel and supplies throughout the year, thereby eliminating the need to stockpile a year's worth of fuel and supplies and incur the inventory carrying cost for that material. As an example, the Ambler, Donlin Creek, and Illinois Creek mine concepts described here would use an average of about 94 million gallons of distillate fuels per year. Assuming an average blended rate of $3.00 per gallon delivered at the mine site, this would require $282 million in capital or operating capital loans to acquire and transport. With an assumed cost of capital of six percent, the inventory carrying cost would be about $8 million per year. Similar orders of magnitude savings may be associated with the other supplies that need to be held in inventory. In addition, there could be substantial capital savings associated with a much smaller fuel tank farm.

Table 17. Comparison of Potential Mine Transportation Annual Cost Savings

	Inbound		Outbound	
	Freight	Fuel	Concentrate	Total
Without Corridor Cost ($)	136,200,000	57,000,000	121,600,000	314,800,000
With Corridor Cost ($)	54,870,000	38,880,000	100,900,000	194,650,000
Savings ($)	81,330,000	18,120,000	20,700,000	120,150,000

Source: Northern Economics, Inc., estimates based on North Pacific Mining, 1993; CH2M Hill, 2004; Jansen, 2009; Logistics Solution Builders, n.d.; Sweetsir, 2009; Ruby Marine, 2009; Sweeney, 2009; Office of Coast Survey, 2009; Hawley, 2009; Hughes, 2009; Fueg, 2009; Donline Creek Mine, LLC, 2009.

4 Energy and Infrastructure Effects

As noted previously, for the case study communities, road access would lower the cost of energy by reducing the transportation cost for distillate fuels and also reduce the need to store large quantities of fuel until the barge arrives the following year. However, crude oil remains at a very high price and expectations are for the real price of crude to increase in the future. To address this issue, several entities have proposed the use of liquefied natural gas (LNG) or propane to reduce the cost of energy in the Fairbanks region and throughout rural Alaska. The following subsection addresses the potential use of LNG/propane in the study area.

4.1 LNG/Propane

Propane is widely used in the study area, primarily for cooking, although residents in some communities use propane for heating purposes as well. Typically, large bottles of propane are barged to each community and stored for use during the winter, although propane can be delivered by cargo aircraft as well. LNG is presently manufactured in the Point Mackenzie area in the Matanuska-Susitna Borough and trucked to Fairbanks where it is re-gasified and put into a natural gas distribution system that primarily serves the downtown core area of the city. LNG is not presently used within the study area.

In the near term, it is not anticipated that LNG will be a viable alternative fuel for use within the study area for two reasons. First, the technology for re-gasifying LNG and distributing natural gas requires skills that are not found in many rural communities. Second, the use of LNG would require a piped distribution system for the community, which would be a significant capital cost for a community and its residents. Given these reasons, the use of propane is more likely in the study area and this analysis focuses on propane.

Propane can be used to replace distillate fuels for electric power, cooking and water heating, and space heating. It is not anticipated that propane would replace diesel fuel for other equipment and vehicles. Propane has lower energy content than distillate fuels, with about 91,000 British thermal units (Btu) per gallon compared to 135,000 to 138,000 Btu per gallon of distillate fuels. A gallon of propane has about two-thirds of the energy content of a gallon of diesel fuel. This lower energy content means that to have the same energy available for heating or to run equipment, about 50 percent more gallons of propane must be transported to, and stored in, an off-road system community. Since propane tanks are pressure vessels and cost about 60 percent more than distillate tanks, the combination of substantial tank farm capital costs and transportation costs overwhelm the savings associated with lower propane price. For these reasons PND, Inc. (2005) found that propane was not a feasible alternative fuel in communities where 9 months or more storage was required, unless there was a subsidy for the tank farm. Without a road, all of the case study communities fit this definition and are not likely candidates for propane conversion, even though they have some of the highest fuel costs in the state.

With a road corridor, the “propane story” changes substantially and propane provides significant cost savings to the case study communities. With the road, the importance of storage issues diminishes as the communities can receive regular shipments of propane instead of needing to take all of their propane during the summer barge delivery season. The Alaska Natural Gas Development Authority has made public its plans to develop a propane plant at Prudhoe Bay on the North Slope to produce propane, and truck the propane to Fairbanks and other locations. Seasonal barge shipping from Prudhoe Bay could also serve coastal Alaska. Table 18 compares the cost per million British thermal units (MMBtu) for diesel delivered to communities by barge using the costs collected by the Power

Cost Equalization (PCE) program of the Alaska Energy Authority in 2008. Local utilities are often the largest purchasers of diesel fuel, and their costs are among the lowest in any given community. The table uses those same PCE prices, subtracts the estimated barge transport cost and then adds the estimated delivery cost by truck to estimate the cost per MMBtu that might be achieved with truck delivery.

Table 18. Comparison of Delivered Prices for Diesel Fuel and Propane

Transport mode	Case Study Community					
	Tanana	Ruby	Galena	Koyukuk	Koyuk	Nome
Barge						
2008 Diesel cost per gallon ($)	2.79	3.17	2.90	4.16	2.53	2.36
Diesel cost per MMBtu ($)	20.67	23.48	21.48	30.81	18.74	17.48
Truck						
Diesel cost per MMBtu ($)	16.06	18.85	16.92	25.88	17.34	18.58
Propane cost per MMBtu ($)	5.11	5.51	5.58	5.65	6.05	6.47

Source: AVEC, 2009.

Truck transportation could reduce the cost of distillate fuels in all of the study communities except Nome, which is the most distant community. In all cases, with the availability of truck transportation, propane is the most cost-effective fuel for the case study communities. Truck delivery would eliminate the need for storage for long periods of time and reduce the capital cost, making propane accessible and affordable to community residents and businesses. A natural gas pipeline or high voltage electrical transmission lines in proximity to the corridor could provide similar energy savings for community residents and businesses.

The study concludes that trucked propane fuel would be cheaper than barged distillate fuel and a road corridor would eliminate the need for long-term storage of fuel currently found in these communities. The study estimates that complete conversion to trucked propane would save roughly $13.5 million per year.[2] This estimate is the estimated energy cost savings and does not include the cost of conversion.

Table 19. Annual Fuel Cost Savings with Trucked Propane

Scenario	Community Savings ($)						
	Tanana	Ruby	Galena	Koyukuk	Koyuk	Nome	Total
Current MMBtu Consumed	30,000	20,000	160,000	10,000	40,000	850,000	1,110,000
Barged Diesel Cost per MMBtu ($)	20.67	23.48	21.48	30.81	18.74	17.48	18.416
Trucked Propane Cost per MMBtu ($)	5.11	5.51	5.58	5.65	6.05	6.47	6.27
Cost Change per MMBtu ($)	-15.56	-17.97	-15.9	-25.16	-12.69	-11.01	-12.15
Total Annual Cost Savings ($)	-466,800	-359,400	-2,544,000	-251,600	-507,600	-9,358,500	-13,487,900

Source: Northern Economics, Inc. estimates based on AVEC, 2009; Sweetsir, 2009. and Logistic Solution Builders, n.d.

[2] This scenario eliminates the savings of converting from barged diesel to trucked diesel. Thus, it is important to realize that all of the savings discussed in this report are not additive.

4.1.1 Energy Infrastructure

The study examined the potential for the Yukon River Corridor to benefit electrical power and broadband transmission lines, pipelines, and other utility/transportation links. Key informant interviews indicate that a constructed road offers significant benefits to the cost of construction and the cost of maintaining these types of systems compared to a Greenfield environment (Petrie, 2009; Wyman 2009). A construction pad, in the form of a road, is in place, and equally important is that the corridor generally will have a secure right of way (ROW) and all needed permits to expedite utility transmission construction projects.

The study's key informant interviews indicate that construction cost savings associated with utilities can be significant—as high as 30 to 50 percent per unit mile. The most important and potentially immediate utility benefit of the proposed corridor is pipeline construction in the eastern sector of the route and towards Donlin Creek. If the Yukon River Corridor is extended west to a point across from Ruby, a pipeline could be laid along the north shore to a river crossing point to Ruby, where the pipeline could follow the Poorman Road south and west to the Flat and Donlin mining districts. Further, a gas line that runs southwest along the river to get below Kuskokwim River navigation challenges may provide a redistribution point for gas along the lower Kuskokwim River. An alternative to this approach is a pipeline from a barge center at Paimiut Slough on the Yukon River along a road to Kalskag for redistribution to Kuskokwim River and Bering Sea coast communities including Bethel.

A review of the Michael J. Baker 2009 In-State Gas Demand Study for the Alaska Natural Gas Development Authority indicated that "with road" construction costs for in-state natural gas transmission pipelines would average between $4.2 and $5.1 million per mile, depending on whether the analyzed portion of the pipeline was 12 or 24 inches in diameter (Baker, 2009). Construction of a pipeline from Manley Hot Springs to the Donlin Creek Mine would follow roughly 450 miles of road if the Yukon River Corridor Road were built. At the unit costs mentioned in Baker, 2009, a natural gas pipeline to Donlin from Manley (which would also need to be connected to the larger natural gas system) would cost between $1.8 and $2.2 billion. By comparison, a pipeline built without the benefit of an existing road and corresponding right-of-way might cost as much as $2.6 to $3.2 billion, assuming a 40 percent cost reduction associated with the existence of the road.

The Yukon River Corridor Route would lower the cost of electrical transmission project within the corridor route on a unit basis. For example, Golden Valley Electric Association (GVEA) indicates that their transmission line projects average roughly $500,000 per mile with existing road corridors, but can reach as high as $750,000 to $1,000,000 per mile when GVEA needs to utilize temporary ice roads, such as it did for the Northern Intertie Project (Wyman, 2009; Wright, 2009). The study's interviews with GVEA indicate that these cost differentials reflect the difference between a project that uses a seasonal ice road and one that can use a permanent year-round road system. Construction via an ice-road only allows a four month construction period and requires extensive logistical planning to pre-position labor, camps, materials, and construction equipment. A year-round construction season alleviates many of these logistical issues. At a minimum cost of roughly $1 million per mile, a transmission system from Manley Hot Springs to the Donlin Creek area would cost over $450 million if the project relied on seasonal ice roads. If the transmission project experienced the estimated benefits associated with a permanent road as described by the key informants, the cost of that project could be reduced by $100 to $200 million depending on the actual average cost per mile and the reduction received. Key informants noted that the "without road" costs of such a transmission system would be substantially higher than $1 million per mile under some scenarios. Work completed for the State of Alaska's 2009 Regional Integrated Resource Plan indicated that the remote transmission systems associated with the Susitna Hydro project could cost as much as $4.5 million per mile (Black and Veatch, 2009).

In summary, the road corridor is likely to result in substantial cost savings for infrastructure projects. However, it is impossible at this time to provide specific savings estimates as there have not been detailed analyses of specific projects.

5 Other Economic and Social Effects

This section examines other potential socioeconomic effects of the proposed road connection on the case study communities, including impacts on employment and income, population, public services, and subsistence. Both the positive and negative aspects of the project with respect to these impact areas are discussed. The intent is to illustrate the range of complex and conflicting socioeconomic effects of the proposed project.

5.1 Employment and Income

5.1.1 Potential Positive Effects

Jobs and income are important factors for individual and social well-being and quality of life (Haley et al. 2008). Given the high unemployment rate in the case study communities, it is likely that many residents would welcome the increased potential for economic development afforded by road construction in the study area. The following discussion describes the possible employment and income effects of the industrial expansion anticipated to occur as a result of the proposed road connection, with a focus on mining and tourism. These two economic sectors are the most likely to experience a substantial expansion as a result of the proposed road connection.

5.1.1.1 Mining

The Red Dog Mine in the Northwest Arctic Borough demonstrates that a mining operation can substantially increase employment opportunities for local residents. The Red Dog Mine is a joint venture between NANA and Teck Cominco, Inc., one of the world's largest zinc concentrate producers. The Red Dog Mine is the state's largest operating mine, and is one of the principal employers in the Northwest Arctic Borough. It exerts a strong influence on the area's economy (Fried and Windisch-Cole 2005). The mine's workforce represents approximately 17 percent of the borough's wage and salary employment (Fried and Windisch-Cole 2005). NANA shareholders account for 203 (55.5 percent) of the Red Dog Mine's 370 full-time employees and 91 percent of the 42 part-time employees (Tetra Tech, Inc. 2009).

Since the mine opened in 1989, NANA shareholders have earned a total of $244.0 million in payroll, which is 44 percent of the total payroll generated at the mine over the past two decades. NANA shareholders earned $20.9 million in payroll in 2007, half of the mine's total payroll that year (Tetra Tech, Inc. 2009). Prior to Red Dog's opening, per capita net earnings in the Northwest Arctic Borough showed a decreasing trend, and wages were well below the statewide average (Fried and Windisch-Cole 2005; Tetra Tech, Inc. 2009). Just one year after the mine became operational, the local average wage rose above that of the state, and per capita income has increased fairly steadily ever since (Fried and Windisch-Cole 2005; Tetra Tech, Inc. 2009). Nearly all of this increase in wealth can be attributed to the mine (Fried and Windisch-Cole 2005). According to Teck Cominco, the average annual wage at the Red Dog mine is $73,900. Not only are these well-paying jobs, but they represent stable year-round employment, a scarce phenomenon nearly everywhere else in rural Alaska (Fried and Windisch-Cole 2005).

These findings suggest that mineral development could also increase jobs and personal income in the case study communities, particularly if there are local hire preferences and job training programs. In the case of the Red Dog Mine, local employment is fostered by the agreement between Teck

Cominco and NANA, which stipulates measures for the education, training and employment of NANA shareholders at the mine (Haley et al. 2009).

The level of mining-related employment that might be generated by the proposed road connection would depend on the size and scope of the individual operations. Table 20 shows the total increase in mine employment that is projected to occur as a result of the proposed road connection. The proposed Donlin Creek project estimates a workforce of between 2,100 and 3,040 for the exploration, construction, and operation phases of the mining project. The majority of these workers would be employed during the construction phase, with only 600 to 800 jobs required for mine operations. A "generic" placer mine would support a small workforce of between 10 and 20. Employment levels at two current mining operations in the state, the aforementioned Red Dog Mine and the Greens Creek Mine located on Admiralty Island near Juneau, are indicative of the number of jobs that would be created by development of the Ambler or Illinois Creek mineral deposits. As discussed above, the Red Dog Mine employs around 370 full-time workers. Greens Creek Mine employs about 270 workers (Hecla Mining Company 2009). Should the proposed Ambler or Illinois Creek mine employ a similar number of people, the effect on employment in the case study communities would be substantial. To put the potential increase in jobs in perspective, in 2008, the average monthly employment was 3,800 in the Nome Census Area, and 2,122 in the Yukon-Koyukuk Census Area according to the Alaska Department of Labor and Workforce Development. A mine workforce of 370 would represent about 10 percent of the total workforce in the Nome Census Area, and approximately 17 percent of the total workforce in the Yukon-Koyukuk Census Area. The total projected increase in mine employment (1,590) represents about one-quarter of the combined workforce in the two census areas. The state's experiences at Red Dog and other mines show that mining wages are significantly higher than the pre-mine local average. ADOWLD data from early 2009 indicate that mining jobs average roughly $7,000 per month in wages compared to the statewide average for all industries of $3,800 per month and local averages of $2,900 (Nome Census Area) and $2,600 (Yukon Koyukuk Census Area). With these averages, mining development in the area could add over $133 million in new, annual wages to the area.

Table 20. Projected Mine Employment

Mine	Number of Mines	Employment per Mine	Total Employment
Ambler	1	370	370
Donlin Creek	1	700	700
Illinois Creek	1	370	370
Placer Mines	10	15	150
Total Employment			**1,590**

Source: Northern Economics, Inc.

5.1.1.2 Tourism

With the exception of Nome and Galena, the tourism industry currently plays a minor role in the economies of the case study communities. Construction of a road would facilitate additional tourism development in the region by improving direct access to recreation areas along the roadway. Areas that are now accessible only by aircraft or walking would become 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. Improved access to recreational resources in the region would serve the increasing demand by Alaska residents and out-of-state visitors for outdoor recreation opportunities in Alaska.

Larger numbers of independent tourists in vehicles traveling on the proposed road connection would create demand for service facilities along the road network, including food, lodging, fuel, and souvenirs. Moreover, an increase in visitors means new opportunities for outdoor recreation and tourist-related economic activities such as tour and guide services related to hunting, fishing, wildlife viewing, and river rafting. The money spent in the region on these services and activities can have a “ripple effect" throughout the regional economy, creating additional employment, income, and sales. Tourism can also be an important source of government revenue. For instance, revenues for Nome are about even for February and April each year, but in March, when the Iditarod Great Sled Race takes place, revenues exceed that average by about $50,000, and bed taxes bring in an additional $109,000 (Bauman 2005). In summary, an expansion of the tourism industry can create new jobs, boost local businesses, diversify and bring new money into the region’s economy, and contribute to the local tax base (Alaska Department of Commerce, Community and Economic Development undated).

An example of the effects of roads on tourism development can also be found in Nome. The city is the originating point for three major state roads leading to the villages of Teller, Council and Taylor. The roads provide vehicle access to a mix of natural and cultural attractions, and in recent years the popularity of these roads 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).

5.1.2 Potential Negative Effects

While on the whole, increases in employment and income would be beneficial for the case study communities, sudden large increases in income can also be socially disruptive. Attendant social problems include increases in alcohol consumption, drug abuse, tobacco use, property crime and violence, and environmental problems from new consumption, such as rising demand for solid waste disposal (Tetra Tech, Inc. 2009).

Rapid economic growth can be a particular source of deteriorating health conditions and social strain within subsistence-based communities (Tetra Tech, Inc. 2009). Less time for hunting, a loss of hunting skills, and an increasing cost of hunting supplies have been cited as reasons for increased consumption of store-bought foods, high in saturated fats and refined sugar. These effects have, in some cases, contributed to an increase in the risk for chronic illnesses, such as diabetes, high blood pressure, obesity, and heart disease (Tetra Tech, Inc. 2009). Moreover, economic disparity within a village can also be exacerbated by mine related employment and dividends, and may alter the values underlying sharing networks fundamental to the subsistence socio-cultural system (Tetra Tech, Inc. 2009).

Rotating shifts at the mine involve long periods away from home, which have been blamed for marital discord and family dysfunction in analogous populations (Tetra Tech, Inc. 2009). Children of mine workers have less interaction with the employed parent. For example, social service personnel at the Maniilaq Association, a tribally operated, health and social services organization in Northwest Alaska, have commented that the prolonged absence of men who work at the Red Dog Mine creates a deficit of role models for male children, and furthermore, that the stress associated with reintegrating families when mine employees return home may, in individual cases, exacerbate problems such as domestic violence and alcohol use (Tetra Tech, Inc. 2009). To address these types of issues, Teck Cominco’s health insurance includes an employee assistance program that provides counseling to employees (or family members) who may have these types of problems (Tetra Tech, Inc. 2009).

Road construction and the expected economic development that follows could also become a source of social tension and stress because there is likely to be disagreement between and within communities over the extent to which this development represents a threat or an opportunity. The degree to which residents of rural Alaska should accept large-scale economic development projects is a complex issue potentially pitting cultural values against economic interests and dividing villages into opposing camps. For example, since the development of the Red Dog Mine, the creation of internal conflict within communities has been posed as a potential impact related to the mine (Tetra Tech, Inc. 2009). In particular, the mine has been a source of disharmony within the community of Kivalina due to wildlife disturbances and declines that have been attributed to mine operations (Tetra Tech, Inc. 2009).

Tourism may also make it more difficult for Alaska Native communities to preserve their social and cultural traditions, especially if there is no way for communities to control the number of visitors. Currently, small groups of visitors arrive in case study communities primarily by aircraft and typically accompanied by a guide or host. The small groups allow village residents to engage the tourists while respecting and showcasing the traditional ways of the local culture. A road would allow outsiders to travel independently to communities. They would be more likely to wander into areas of community activity that have not been designated for tourism (Sustainability of Arctic Communities 2009). The results could be socially and culturally disruptive. For example, Coates (1992) notes that the Alaska Highway has become a popular tourist attraction in Canada, which has created an influx of visitors to many of the First Nation communities along the route. While the increase of tourism has been a source of revenue in these communities that otherwise would not have existed, some residents feel a negative aspect of the highway is a loss of traditional culture because of outside influence (Coates 1992).

In addition, the presence of a road and other development can change the nature of tourism and recreational activity in an area, with fewer eco-tourists and high-end anglers and hunters. According to Alaska Visitors Statistics Program 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). Moreover, 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 National Park Service's general management plans for the national 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" planes departing 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.

As access into the region 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 region. 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. Furthermore, 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 region. The increased congestion and/or restrictions would likely induce some current hunters and anglers in the region to look for alternative, higher quality recreational sites. Some established commercial hunting and fishing guides may become concerned with maintaining their economic livelihood if the possible deterioration in the quality of sport hunting and fishing experiences in the region causes some current customers to seek recreation opportunities elsewhere.

Long-established big-game guides in the region are already complaining that opportunities to locate large male animals in uncrowded hunting conditions are rapidly diminishing in Game Management Unit 23 (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."

Concerns have also been raised about the effects that large-scale mining may have on the natural assets that attract visitors to Alaska. For example, the Alaska Wilderness Recreation & Tourism Association, an organization representing more than 300 nature-based tourism businesses, individuals, and organizations in Alaska, has voiced strong opposition to the proposed Pebble Mine, a large copper, gold, and molybdenum open pit mine planned for development in Southwest Alaska. The association argues that large-scale mining is incompatible with nature-based tourism opportunities that depend upon clean water, abundant fish and wildlife, and intact ecosystems (Alaska Wilderness Recreation & Tourism Association 2005).

5.2 Public Services

5.2.1 Potential Positive Effects

Access to basic services such as health care, police protection, and education is also vital to individual and social well-being (Edwards 2009). If barriers exist that prevent people from receiving fundamental services, the quality of their lives is diminished. The absence or poor provision of services can even jeopardize the sustainability of rural communities (Edwards 2009). One of the largest barriers to the provision of basic services in Alaska is accessibility— services such as health care, police protection, and education are more difficult to receive in the more remote locations (Edwards, 2009).

Some case study communities have no certified police officers and are served exclusively by the Alaska State Troopers based in Nome, Galena, or Fairbanks and/or by Village Public Safety Officers or Village Police Officers who have limited training and are not allowed to carry firearms. Because travel between villages is possible only by aircraft and watercraft, the Alaska State Troopers in western Alaska depend on airplanes and helicopters to do the routine patrol work that most state troopers do from behind the wheel of a patrol car. Although the Alaska State Troopers have a C-208 Caravan, Cessna 185, and R-44 helicopter, they routinely call upon the assistance of local commercial airlines because of the large volume of calls they receive (National Geographic Channel 2009). Response time can be severely delayed due to weather and waiting for flights (Northwest Arctic Borough Planning Department 2008). Reduced police protection can increase the exposure of village residents to crime, including violent crime (Edwards 2009). Alaska has the highest state-level crime rates in some categories, including the highest rate of forcible rape in the country (Edwards 2009). The proposed road connection would improve the accessibility of each case study community by the Alaska State Troopers, and this increased police protection would be expected to reduce local crime.

[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.

In addition to law enforcement, there are a number of other ways in which the improved accessibility provided by the proposed road connection could result in a healthier, safer, and more comfortable living environment in the case study communities.

- The improved accessibility would facilitate evacuations for medical emergencies and natural disasters.
- It would lower transportation costs of healthcare and social service workers to each community, thereby potentially improving service delivery.
- It would facilitate the removal of solid, hazardous, and recyclable waste from communities. Currently, back-haul of waste material with airfreight is often unaffordable (Northwest Arctic Borough Planning Department 2008). With a road, each community could provide economical back-haul of unsightly and potentially dangerous waste material.
- The proposed road connection would provide the potential to improve access to gravel sources for each community.

Gravel access is an important cost factor in construction and maintenance of community infrastructure projects, including airports, landfills, community streets, and housing pads/subdivisions (Northwest Arctic Borough Planning Department 2008). Furthermore, the proposed road connection would provide the ability for communities to share heavy equipment such as graters, dump trucks, cranes, etc. This would improve the cost effectiveness of various community infrastructure construction and maintenance projects (Northwest Arctic Borough Planning Department 2008). Finally, the improved access afforded by the proposed road construction could enhance inter-village social development and exchange, thereby increasing social cohesion among communities. Affordable transportation is an important factor in the ability of communities to mutually participate in each other’s youth programs, cultural camps, and community celebrations (Northwest Arctic Borough Planning Department 2008).

In addition to these direct effects of the proposed road connection, the economic development that is expected to follow road construction could have additional positive impacts on public infrastructure and services in the case study communities. For example, payments by the operators of the Red Dog Mine to the Northwest Arctic Borough resulted in an improvement in the general well-being of borough residents through better funding of local services, including the local school district (Tetra Tech, Inc. 2009). Teck Cominco provides the Borough with its largest source of revenues through payments in lieu of taxes (Fried and Windisch-Cole 2005). Total payments to the Borough from 1988 to 2007 were $75,476,000 (NANA 2009). These payments, together with those that the mining company provides directly to the Northwest Arctic Borough School District, are an important source of funding for education in the Borough (Tetra Tech, Inc. 2009).

In addition to programs supporting K-12 education, Teck Cominco supports higher education for NANA shareholders by providing scholarships for students who want to pursue post-secondary education (Haley et al. 2009). The company’s first priority for these scholarships is given to those students who are pursuing studies that relate to employment at the Red Dog Mine, such as in mining operations, or apprenticeships for trades such as heavy duty mechanic, electrical, millwright and power generation (Haley et al. 2009).

5.2.2 Potential Negative Effects

As discussed in Section 5.1.2, rapid large increases in income in rural Alaska communities can lead to increases in alcohol and drug abuse, poor health, property crime and domestic violence, and environmental problems. This increased social disruption can place a severe strain on the limited public facilities and services offered in the case study communities.

A major concern that cuts across many of the above potential social disruption problems is that the proposed road connection could undermine enforcement of laws that regulate how alcohol comes into communities. Under Title 4 of the Alaska statutes, Alaska communities have the right to enact stricter liquor laws than those enforced by the state. They can choose to not regulate alcohol availability and thereby be considered "wet" communities; they can choose to go completely "dry" and ban all imports, sales and possession; or they can select some variation in between. Since the enactment of this "local option law," about two-thirds of Alaska's small rural communities have exercised their right to a referendum on alcohol control. Most communities holding elections have decided to adopt a strict form of prohibition: either banning importation or banning possession. Only a handful have chosen to allow a liquor outlet to open in the community (Berman and Hull 2000).

The reason many communities have opted to pass some control over alcohol is that the laws can have a measurable positive outcome, both on individuals and the larger community. The prevalence of binge drinking among Alaska Natives in "wet" villages, where alcohol is readily available, is twice as high (24.7 percent) as in dry villages (12.9 percent) (Alaska BRFSS, unpublished data, 1996; cited in Tetra Tech, Inc. 2009). In addition, a number of recent Alaska studies (e.g., Berman et al. 2000; Chiu et al. 1997; Landen et al. 1997) have associated strict community alcohol prohibition with a significant reduction in injuries and injury deaths. For example, Berman et al. (2000) estimated that communities that took advantage of the law may have succeeded in preventing about one fifth of all injury deaths that would have occurred had controls not been in effect. However, neither researchers nor community leaders are prepared to embrace alcohol control as the simple answer to the complex problem represented by alcohol abuse (Berman and Hull 2000). Moreover, prohibition may contribute to the problem of alcohol-related motor vehicle accidents by encouraging unsafe drinking and driving habits; for example, Berman et al. (2000) have identified this as a possible problem for dry Indian reservations in the Lower-48 States.

The Alaska State Troopers enforce local option statutes prohibiting the sale, importation, and/or possession of all alcohol in small communities, using the state court system. Enforcement of these alcohol laws can be difficult because the financial incentive to engage in "bootlegging"—selling alcoholic beverages in a dry community—is substantial; a bottle of whiskey that sells for $10 in an Anchorage liquor store may garner as much as $300 in a dry village (National Geographic Channel 2009). Most Alaska Native villages that passed more restrictive alcohol control options are not linked by road to bars or liquor stores outside community boundaries, making enforcement easier (Berman and Hull 1997; Berman and Hull 2000; Berman et al. 2000). Generally speaking, small communities in Alaska linked by road or ferry to larger towns where alcohol is sold have not tried to control alcohol through the local option law, apparently recognizing that enforcement is not practically possible. A similar observation was made with respect to First Nation communities in Canada—changes in alcohol control policy did little to decrease arrest rates for public drunkenness and assault in villages with road links to major towns, but had a marked positive effect in a more remote village (Smart 1979).

Table 21 shows that the only case study community that is dry is Koyuk, which banned the sale and importation of alcohol in 1981. The fact that other case study communities allow bars and/or stores that sell alcohol (Tanana allows the sale of alcohol under a community license only) is probably due to historical circumstances; past involvement in river transportation and commerce, mining and military activities, during which the sale and use of alcoholic beverages was prevalent, probably influenced the alcohol control policies of these communities, or lack thereof. Nevertheless, the concerns raised by community leaders (e.g., Northwest Arctic Borough Planning Department 2008) about possible adverse effects of road connections on enforcement of community alcohol control should be considered.

Table 21. Alcohol Control Status in Case Study Communities

Community	Status
Tanana	Community license or designated private store allowed
Ruby	Liquor store allowed
Galena	Bars and liquor stores allowed
Koyukuk	Liquor store allowed
Koyuk	Ban sale and importation
Nome	Bars and liquor stores allowed

Source: Berman and Hull (1997)

5.3 Population and Out-Migration

5.3.1 Potential Positive Effects

Unemployment is a major problem in many remote rural Alaska communities, including most of the case study communities, and the pursuit of economic opportunities appears to be a predominant cause of out-migration (Martin et al. 2008). As people leave, some of the jobs they support go away, and more people leave. When the population becomes very small, schools close, more jobs end, and even more people move away. The quality of life for people that remain gradually deteriorates because they have fewer friends and family members with whom to socialize locally. Eventually, some villages may simply disappear (Martin et al. 2008).

The local mining or tourism jobs that the proposed road connection may create could ease population loss by stemming out-migration. Most of the case study communities are small villages where even marginal increases in employment rates can be important in maintaining the community's economic viability. Furthermore, the decrease in the cost of living due to the lower transportation and energy costs together with the increase in public services and facilities (such as schools, public safety, and health care) that can accompany road construction and the economic development that follows, would be expected to reduce out-migration by making village life more affordable, safe, fulfilling and comfortable. The overall effect would be to help preserve the unique social and cultural environments of individual communities (Northwest Arctic Borough Planning Department 2008).

5.3.2 Potential Negative Effects

On the other hand, mining operations located in remote areas without road connections may do little to reduce out-migration, and may even encourage it. Local-level employment data illustrate that employment at the Red Dog Mine may have facilitated community residents to relocate to Anchorage, for lifestyle and/or economic reasons (Tetra Tech, Inc. 2009). Teck Cominco provides transportation between the mine and Anchorage (Tetra Tech, Inc. 2009). Moreover, steady employment has given workers the financial means to relocate (NANA 2009). Although NANA shareholders account for 203 of the mine's 370 full-time employees, only 100 mine employees reside in communities in the Northwest Arctic Borough. For example, 20 Kotzebue residents who worked at the mine moved to Anchorage (or elsewhere in Alaska) (Tetra Tech, Inc. 2009).

It is also important to note that road construction without economic development could result in a dramatic increase in out-migration in some case study communities. Martin et al. (2008) state that migration flows tend to follow transportation links. People follow transportation routes to places where there are jobs and where they have cultural ties. The researchers note that many people who grow up in rural Alaska have ties to urban places due to accumulated previous migration. With specific respect to out-migration in the case study communities, unless the proposed road connection leads to the creation of appropriate, satisfying jobs for the residents of those communities, it is likely that it will encourage a substantial number of village residents to migrate to more developed population centers such as Nome or Fairbanks.

5.4 Subsistence

5.4.1 Potential Positive Effects

Subsistence fishing and hunting continue to figure prominently in the household economies and social welfare of many western Alaska residents, particularly among those living in the smaller villages (Wolf 1984; Wolfe and Walker 1987). To some extent, subsistence harvesting helps offset unemployment and the high cost of living in western Alaska (Fried and Windisch-Cole 2005). According to a 2009 survey, the cost of food in Nome is nearly 70 percent above the Anchorage level (Fried and Robinson 2009). In the outlying villages, grocery prices are even higher because of additional transportation costs. Therefore, subsistence activities remain vital to basic well-being (Fried and Windisch-Cole 2005). Salmon, caribou, sheefish, seal, and moose are the most important subsistence resources in the region, but small game and berries also contribute (Fried and Windisch-Cole 2005; Wolfe and Walker 1987).

In addition to being an important source of nutrition, subsistence activities are central to the customs and traditions of many cultural groups in Alaska, including the Athabascans, Iñupiat and other Alaska Natives in the case study communities. Their customs and traditions encompass sharing, redistribution networks, cooperative and individual hunting, fishing, and ceremonial activities. Moreover, subsistence fishing and hunting are traditional activities that help transmit cultural knowledge between generations and maintain the connection of people to their land and environment (U.S. Fish and Wildlife Service 2008).

Many studies have examined the relationship between subsistence and wage economies and how both subsistence and wage activities are integrated into rural Alaskan socioeconomic systems. Social scientists have repeatedly found that in the mixed economy, local jobs and income are complements to participation in subsistence, not substitutes (Tetra Tech, Inc. 2009). Those communities most active in subsistence activities tend to be those who are also very involved in the wage economy. That is, monetary resources are needed to most effectively harvest subsistence resources (e.g., to purchase a boat, snow machine, four-wheeler, or all-terrain vehicle, fuel, guns and ammunition).

Most Alaska Natives in the case communities are involved in summer commercial salmon fishing in some form or another. For many, this is the primary source of cash income for the year, except for those residents living in larger communities such as Nome, where other employment may be available during the year. Commercial-fishing income is viewed by most of the smaller communities largely as a means of subsidizing subsistence pursuits during the remainder of the year. Participants in this mixed economy may also earn cash from public sector employment, construction, fire fighting, trapping, crafts-making, or other jobs. The combination of subsistence and wage activities provides the economic basis for the way of life so highly valued in rural communities (USFWS 2008).

Of course, not all jobs are the same. Kleinfeld, Kruse and Travis (1983; cited in Martin et al. 2008) note that one characteristic of a "good" job in rural Alaska is that it accommodates the time needed to pursue subsistence activities. For example, rotating work schedules at the Red Dog Mine (most of the mine’s employees work a two-week on and one week off schedule (Fried and Windisch-Cole 2005)) give employees considerable time off to continue to pursue their traditional lifestyle (NANA 2009).

The extended periods of free time, plus an unusually flexible leave policy, allow Red Dog employees to preserve the annual subsistence cycle (NANA 2009).

Finally, roads can also support local resident access to existing and new hunting, fishing, and gathering areas. A road system can facilitate access to build new camp sites or maintain existing camp sites with fewer chances of getting lost (Northwest Arctic Borough Planning Department 2008).

5.4.2 Potential Negative Effects

The opening of new areas to the general public for recreation or the introduction of a large-scale mining operation may be viewed as an exacerbation of existing threats to the subsistence opportunity for Alaskans in the case study communities.

In recent years, there has been growing concern among many village residents in western Alaska about the detrimental 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 several documented incidences of resource user conflicts within the region (BLM 2007, Steinacher, 2006). 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. Bureau of Land Management 2007). In 1992, hunting pressure on the moose population 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 (U.S. 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 important to note that local residents in the region are reportedly less concerned about "floaters"—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. 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. 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 region, 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).

It is likely that some residents will be concerned that the proposed road connection could significantly contribute to current threats to their subsistence lifestyle. A description of the potential impacts of road construction on subsistence activities in remote areas is provided in the *Draft Environmental Impact Statement 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 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.

Concerns are also likely to be raised about the possible effects of large-scale mining on subsistence resources. An assessment of public health impacts of the Red Dog Mine found that existing mine operations may have affected the consumption of subsistence food by residents of Kivalina because of changes to caribou movement and distribution patterns as well as local concerns about potential contamination of meat and other subsistence resources (Tetra Tech, Inc. 2009). In addition, despite the rotating shifts and flexible leave policy discussed above, disruptions in subsistence resource consumption patterns may be experienced by Red Dog Mine workers who would normally participate in subsistence activities, but instead maintain regular work schedules (Tetra Tech, Inc. 2009). As incomes increase and a worker is subject to labor market rigidities that lock him/her into the wage-consumption cycle, time constraints may reduce the frequency and duration of trips to harvest subsistence resources.

Based on a household survey, Berman and Martin (2008) concluded that the availability of place-specific subsistence opportunities can have a significant effect on the desire of rural Alaska residents to stay or leave. The researchers suggest that a major, permanent loss of a keystone subsistence resource could lead to rapid out-migration from rural communities. These findings support the notion that subsistence and social relationships are the most important reasons people choose to remain in small communities, despite the lower (cash-based) standard of living (Poppel et al. 2007; cited in Haley et al. 2009).

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