An Ex-Ante Cost-Benefit Analysis of All-Terrain Vehicle Transportation Corridor in Southwest Alaska
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This research explores the construction of a geotextile ATV corridor connecting two separate village subsets, Oscarville-Napakiak and Akiak-Akiachak, in the Kuskokwim River delta. Cost-benefit analysis was used to compare the costs of constructing a geotextile trail to the benefits derived from the reduction of injuries, fatalities, and fuel consumption observed on the existing river transportation corridor during a 20-year period. Secondary data was collected for population estimates, fatality and injury rates, while the rapid rural appraisal approach was used to access the traffic rates between each village subset. The results reveal that the construction of a geotextile ATV corridor in the Alaskan bush would prove to be an economically feasible transportation alternative.

by Lee Elder and Andy Seidl

INTRODUCTION

Communities in the Alaskan bush face infrastructure challenges that the general public in the continental United States have not experienced since the turn of the 20th century. Although many of these bush communities currently have access to air transport, all terrain vehicle (ATV),[1] and boat travel, the infrastructure is far from the level of quality, convenience, and safety many people in the United States enjoy.

The development of transportation corridors in the Alaskan bush has been hindered in part by the lack of a well-developed cash economy, the high cost of development, and the general inaccessibility of particular regions. Traditional "bricks and mortar" approaches to land-based transportation for cars and trucks are very likely to be inefficient solutions in a region where the human populations are low and dispersed and snow machines and four-wheelers are the preferred travel alternatives.

Currently there are approximately 6.97 million ATV users in the United States and this number is expected to grow by 32% to 9.28 million by 2010 (United States Environmental Protection Agency 2005). The boom of recreational ATV use in the United States calls into question whether or not trails can be constructed to provide land managers and government agencies an alternative to deal with trail degradation and safety improvements in their own particular locations.

This research estimates the benefits and costs (B-C) associated with the development of an ATV trail in rural southwestern Alaska from the perspective of the region's current and future residents. The *ex ante* B-C analysis weighs the benefits from improved safety and decreases in fuel costs against the fixed and variable costs of trail construction. This accounting is evaluated relative to the riverine transportation corridor currently used by local residents. To our knowledge this is the first attempt to incorporate safety improvements in a B-C analysis for transportation in Alaska. Likewise, it is the first attempt to compare a riverine transportation corridor to a land route alternative in the region.

Study Site

Oscarville, Napakiak, Akiak, and Akiachak villages lie within the boundaries of the Yukon Delta National Wildlife Refuge (YDNWR) in southwestern Alaska. Napakiak lies approximately 15 miles southwest of Bethel, the regional commercial and population center, while Oscarville lies approximately six miles southwest of Bethel. Akiachak is 18 miles and Akiak 42 miles northeast of Bethel. The 2003 population of Napakiak was 380 people, while Oscarville had a population of 62 people.

Akiachak had a population of 633, while Akiak was home to 337 people.

The areas near and around these villages are classified as either Kuskokwim flood plain or tundra uplands. Local soils are perennially frozen at shallow depths and permafrost is as thick as 450 feet in areas. The area is intersected with creeks and sloughs, and thaw lakes are common throughout the area (State of Alaska Department of Transportation 1981).

Local transportation is by boat in the warm months and by snow machine, cars, and trucks when ice thickness permits. The Kuskokwim River is either between breakup and freezeup for approximately two months per year. Therefore individuals are unable to continually travel by using the Kuskokwim River corridor safely (J. Weiss, pers. comm.).

Importantly from a B-C analysis perspective, the number of people in the region currently unemployed and not actively seeking work is extremely high. Napakiak has a jobless rate of 54.3% and unemployment in Oscarville is about 50% of the resident population. Akiak and Akiachak have a jobless population of 55.3% and 58.2%, respectively (Alaska Department of Commerce Community and Economic Development 2005).

LITERATURE REVIEW

There have been many rural road improvement analyses performed, however, none have analyzed ATV trail development. Therefore, the contributing literature is focused on B-C analyses of road projects. Below are some studies that provided some parameters and background for the current research.

Olsen (1986) evaluated 13 improvements on Alaska's Dalton Highway, a 28 foot wide gravel surfaced road, by exploring tangible benefits resulting from reduced operating costs. He explored options such as a 30 foot wide gravel road to that of paving the entire 416 miles of highway. Olsen (1986) concluded that no improvements were justifiable to the Dalton Highway unless traffic volume increased. Notably, he pointed out intangible benefits such as safety, environmental impacts, and development possibilities should be incorporated to provide a better understanding of the separate road improvements.

The current research is quite similar to research by Waters and Meyers (1987) where an *ex ante* B-C analysis was performed for the Coquihalla Highway in Canada. Waters and Meyers (1987) estimated benefits from fatality/injury, time, and operating costs reductions on the new highway alignment. A major discrepancy between the research in this paper and Waters and Meyers (1987) research is the methodology employed to determine traffic rates, which in their case, was based on surveys. Surveys were not ideal for the current research because of the likelihood of sampling bias as well as the cost effectiveness of doing so. This research uses Rapid Rural Appraisal (RRA) in the determination of traffic rates. RRA is a relatively quick way of gleaning data from a particular area by developing a rapport with the communities of interest (Chambers 1981). Therefore, the community leaders of each village were contacted by phone on more than one occasion and then provided a simple questionnaire to estimate what the current travel rates were between each village for boats, ATVs, and snowmachines.

Similarly, the research in this study and the Waters and Meyers (1987) research used fatality/injury rate reductions from the same literature. Waters and Meyers (1987) used previous research from Pacquette and Wright (1979) to arrive at a 33% reduction in fatalities and injuries.

The evaluation of safety benefits for transportation alternatives requires the determination of statistical life and injury values. Boardman et al. (2001) provides an overview of the many different studies and research performed in statistical life and injury value estimates. Ultimately, Boardman et al. (2001) suggests that the most plausible range is between $2.5 million and $4.0 million in 1999 dollars. He based this assessment primarily on Miller's (1990) findings where 67 analyses are examined and re-evaluated using uniform values for travel time and discount rates to convert risk aversion estimates into values.

Waters and Meyers (1987) and Boardman et al. (1994) estimated the value of time saved for business travelers at the average gross wage for British Columbia hourly and salaried employees, whereas leisure travelers value their time at 25% of the same rate. The opportunity costs of labor in these villages are close to zero because of the high unemployment rates. Furthermore, these trips would more than likely be leisure trips and would be calculated by a small percentage of the average regional wage rate. For this reason, time in transit costs were excluded from the analysis.

General Approach

The likely benefits of the ATV trail include safety improvements and fuel savings, while the costs associated with trail construction include labor, capital and shipping. The probable size and direction of excluded impacts is discussed in the concluding remarks. The assumed project life is 20 years (2005-2024) and the discount rate is 7%, reflecting a typical pretax return on private investments (Office of Management and Budget 2004). Sensitivity analyses are conducted to explore the robustness of the estimates to the variation within the relevant ranges of the focal variables.

BENEFIT CALCULATION

Population

Transportation demand is dependent upon the size of the population. Therefore, village population projections over the 2005-2024 period were established using the historic average growth rate (1.5%) over the 1991-2003 period for the Bethel Census Area. Historical rates are assumed to be the best predictor of future population growth lacking specific additional information.

Safety Improvements: Fatality and Injury Rates

The ATV trail is expected to provide a safer travel alternative to river travel. As a result, injury and fatality reductions attributable to the ATV trail can be considered benefits of the proposed project. Typically, such benefits are calculated on the basis of accidents/fatalities per mile traveled. However, available fatality data from the Alaska Division of Public Health, Bureau of Vital Statistics (M. Mathew, pers. comm.) and injury data from the Alaska State Trauma Registry (M. Moore, pers. comm.) facilitated only the calculation of potential improvements in safety per capita rather than per mile traveled (Table 1). The most recent transportation fatality data are for 1994-2003, whereas the most recent data for transportation related injuries are for the years of 1991-2001.

There is little objective information from which an *ex ante* estimate of the degree of safety improvement attributable to the ATV trail relative to current riverine transport routes can be derived. As previously discussed, Boardman et al. (1994), used secondary data from the Canadian Ministry of Transportation for an *ex post* analysis of a transportation corridor. He found a 50% reduction in fatalities and injuries occurred due to the improved road types. However, no research provides safety and fatality rates for a riverine transportation corridor. Lacking superior information, it is assumed that a 50% reduction in per capita transportation related injuries and fatalities would occur as a result of the project.

For our purposes, a conservative value of life, based on estimated wages lost, of $2.7 million is assumed (Boardman et al. 2001). Using a simplistic approach proposed by Miller (1990) the value of $2.7 million can be

Table 1: ATV, Snow Machine and Boating Facilities and Injuries/Rates

	Fatalities (1994 2003)	Injuries (1991 2001)	Fatalities Population (1994 2003)	Injury Population (1991 2001)	Fatality Rate	Injury Rate
Oscarville Napakiak	1	8	4,121	4,368	0.0243%	0.1832%
Akiak Akiachak	2	26	8,925	9,374	0.0224%	0.2774%

Fatality and injury rates are expressed in terms of the percentage of the total community population over the course of the observation period that sustained fatalities and injuries.

supported by assuming a working adult of 38 years of age values the remaining hours of life at the arbitrary wage rate of $15. The remaining lifespan of an Alaskan Native American would be approximately 31 years and discounted by 2.5% the present value would be $2.9 million, well within the range proposed by Boardman et al. (2001). [2]

Table 2 uses the annual costs of fatalities and injuries in Oscarville-Napakiak (O-N) as an example of how the present value of safety is determined for the ATV trail. Table 2 provides the calculations for fatality and injury costs provided in the first row of Table 3. The annual fatality rates as were determined in Table 1 are multiplied by the statistical life value of $2.7 million and then accordingly multiplied by the 2005 combined populations for Oscarville and Napakiak. This value is then discounted by 7% to arrive at the present value of fatalities and injuries for 2005.[3] For O-N these values are presented in the last column of Table 2. The only difference between the first two rows of Table 2 is the 50% difference in fatality rates. Once the present values of fatalities and injuries for the with and without trails scenarios have been determined they are then subtracted from one another, as provided in the bottom two rows of Table 2, to provide the net present value of safety benefits from ATV trail development.

Table 3 contains the safety benefits for the years following 2005. Table 3 contains changes in population growth and discount factors for the 2005-2024 period (columns 2 and 3). The further into the future the value of fatalities and injuries are evaluated, the greater the effects of the discount factor. For example, the second row of Table 3 (2006) reveals a discount factor of .87; therefore, 87% of the actual value determined in 2006 is to be used because the future value of money is higher than the present value of money.

Row 2 of Table 3 also reveals a population of 462 and is the estimated future population in 2006 as the result of the application of the assumed 1.5% population growth rate. The computation of Table 3 uses the same formulas as provided in Table 2. The only dynamic variables from row to row in Table 3 are the population and discount factors. As indicated by the last two rows of Table 2, the present value of fatalities with trail construction is subtracted from the present value of fatalities without trails. These totals are summed over the

Table 2: Fatality and Injury Net Benefit Calculations

2005	O N Annual Fatality		Statistical Life Value		Population		Discount Factor		Present Value
Fatality Calculations									
Without Trail	0.00024	X	$2,737,534	X	455	X	0.93	=	$282,766
With Trail (50% reduction in without trail rate)	0.00012	X	$2,737,534	X	455	X	0.93	=	$141,383
	O N Annual Injury Rate		Statistical Injury Value		Population		Discount Factor		Present Value
Injury Calculations									
Without Trail	0.00183	X	$61,540	X	455	X	0.93	=	$47,976
With Trail (50% reduction in without trail rate)	0.00092	X	$61,540	X	455	X	0.93	=	$23,988
	Present Value w/o ATV Trail		Present Value with ATV Trail						Net Present Value
Net Present Value of Fatality Benefit	$282,766		$141,383			=			$141,383
Net Present Value of Injury Benefit	$47,976		$23,988			=			$23,988

*computations may be slightly off due to rounding error

20-year period to provide the total net present value of safety because of trail construction. In the case of Oscarville-Napakiak, the total present value of fatalities as a result of not constructing a trail is $3,588,188 whereas injury costs are $608,791 over the next 20 years. A 50% reduction in both fatality and injury rates creates a net benefit of $1,794,094 and $304,396, because of the construction of the ATV trail between Oscarville and Napakiak (Table 3).

As outlined previously, the estimated present value of fatalities between Akiak and Akiachak is determined by using the same methodology as for Oscarville-Napakiak. The formulas illustrated in Figure 1 were used to show that when the ATV trail is not constructed, the estimated present value of fatalities between Akiak-Akiachak is $7,270,902, while the cost of injuries is $2,023,172 (Table 4).

This difference is much greater than that of the cost associated with the O-N trail because of the higher population in the Akiak-Akiachak (A-A) region. A 50% reduction in the fatality and injury rates as the result of trail development generates a fatality cost of $3,635,451 and an injury cost of $1,011,586 and an analogous benefit of trail construction relative to the without-trail option.

Table 3: Fatality/Injury Cost and Resulting Benefit for Oscarville-Napakiak ATV Trail

Year	Discount Factor	Oscarville Napakiak						
		Population	Without Trail		With Trail		Benefit	
			Fatality Value	Injury Value	Fatality Value	Injury Value	Fatality Value	Injury Value
2005	0.93	455	$282,766	$47,976	$141,383	$23,988	$141,383	$23,988
2006	0.87	462	$268,248	$45,512	$134,124	$22,756	$134,124	$22,756
2007	0.82	469	$254,476	$43,176	$127,238	$21,588	$127,238	$21,588
2008	0.76	476	$241,411	$40,959	$120,705	$20,480	$120,705	$20,480
2009	0.71	483	$229,016	$38,856	$114,508	$19,428	$114,508	$19,428
2010	0.67	491	$217,258	$36,861	$108,629	$18,431	$108,629	$18,431
2011	0.62	498	$206,104	$34,969	$103,052	$17,484	$103,052	$17,484
2012	0.58	506	$195,522	$33,173	$97,761	$16,587	$97,761	$16,587
2013	0.54	513	$185,484	$31,470	$92,742	$15,735	$92,742	$15,735
2014	0.51	521	$175,961	$29,854	$87,980	$14,927	$87,980	$14,927
2015	0.48	529	$166,927	$28,322	$83,463	$14,161	$83,463	$14,161
2016	0.44	537	$158,356	$26,868	$79,178	$13,434	$79,178	$13,434
2017	0.41	545	$150,226	$25,488	$75,113	$12,744	$75,113	$12,744
2018	0.39	553	$142,513	$24,180	$71,257	$12,090	$71,257	$12,090
2019	0.36	561	$135,196	$22,938	$67,598	$11,469	$67,598	$11,469
2020	0.34	570	$128,255	$21,760	$64,128	$10,880	$64,128	$10,880
2021	0.32	579	$121,670	$20,643	$60,835	$10,322	$60,835	$10,322
2022	0.30	587	$115,424	$19,583	$57,712	$9,792	$57,712	$9,792
2023	0.28	596	$109,498	$18,578	$54,749	$9,289	$54,749	$9,289
2024	0.26	605	$103,876	$17,624	$51,938	$8,812	$51,938	$8,812
Present Value			$3,588,188	$608,791	$1,794,094	$304,396	$1,794,094	$304,396

*Population increases are estimated using the population growth (1.5%) determined from the Bethel Census Area over the 1991 2003 period.

Table 4: Fatality/Injury Cost and Resulting Benefit for Akiak-Akiachak ATV Trail

Year	Discount Factor	Akiak Akiachak						
			Without Trail		With Trail		Benefit	
		Population	Fatality Value	Injury Value	Fatality Value	Injury Value	Fatality Value	Injury Value
2005	0.93	999	$572,981	$159,435	286,490	$79,718	$286,490	$79,718
2006	0.87	1,015	$543,563	$151,250	271,782	$75,625	$271,782	$75,625
2007	0.82	1,030	$515,656	$143,484	257,828	$71,742	$257,828	$71,742
2008	0.76	1,045	$489,181	$136,118	244,591	$68,059	$244,591	$68,059
2009	0.71	1,061	$464,066	$129,129	232,033	$64,565	$232,033	$64,565
2010	0.67	1,077	$440,240	$122,499	220,120	$61,250	$220,120	$61,250
2011	0.62	1,093	$417,637	$116,210	208,819	$58,105	$208,819	$58,105
2012	0.58	1,110	$396,195	$110,244	198,098	$55,122	$198,098	$55,122
2013	0.54	1,126	$375,854	$104,584	187,927	$52,292	$187,927	$52,292
2014	0.51	1,143	$356,557	$99,214	178,278	$49,607	$178,278	$49,607
2015	0.48	1,161	$338,251	$94,120	169,125	$47,060	$169,125	$47,060
2016	0.44	1,178	$320,884	$89,288	160,442	$44,644	$160,442	$44,644
2017	0.41	1,196	$304,410	$84,704	152,205	$42,352	$152,205	$42,352
2018	0.39	1,214	$288,781	$80,355	144,390	$40,178	$144,390	$40,178
2019	0.36	1,232	$273,954	$76,229	136,977	$38,115	$136,977	$38,115
2020	0.34	1,251	$259,889	$72,316	129,945	$36,158	$129,945	$36,158
2021	0.32	1,270	$246,546	$68,603	123,273	$34,301	$123,273	$34,301
2022	0.30	1,289	$233,888	$65,081	116,944	$32,540	$116,944	$32,540
2023	0.28	1,308	$221,880	$61,739	110,940	$30,870	$110,940	$30,870
2024	0.26	1,328	$210,488	$58,570	105,244	$29,285	$105,244	$29,285
Present Value			$7,270,902	$2,023,172	$3,635,451	$1,011,586	$3,635,451	$1,011,586

*Population increases are estimated using the population growth (1.5%) determined from the Bethel Census Area over the 1991 2003 period.

Traffic Rates and Forecasts

Both the benefits and costs of transportation alternatives are dependent upon the traffic volume. Most transportation B-C analyses have the benefit of examining traffic on similar pre-existing roads or the roads being evaluated (Boardman et al. 1994). Because of the lack of preexisting data and the high cost associated with primary data collection, the traffic counts for the proposed transportation corridor had to rely in part on RRA and on assumptions about road alternative effects used in the previously published literature (Boardman et al. 1994 and Walter and Meyers 1987). These travel rates were used as the baseline in assessing traffic rates and fuel costs.

Fuel Savings Benefit Calculations

Estimated fuel consumption rates by travel mode and travel patterns were used to gauge fuel costs. Travel between the two sets of villages is likely to increase with improvements in the safety, convenience, ease of travel, and with decreases in the cost of travel. Waters and Meyers (1987) estimate that the construction of a new transportation corridor would cause 50% of traffic on alternative routes to be diverted to the new corridor. Lacking better information, this 50% switch was adopted as indicative of the expected rate of change between river travel and the proposed alternative ATV trail route. However, this assumption cannot be applied to snow machine travel, because it occurs in the winter months when the ATV corridor would not serve as a substitute for boat travel. Travel will be forecast to increase at the rate of population growth only, lacking specific information to adjust the forecast according to other endogenous factors. Table 5 below outlines traffic rate forecast as well as the method of determining the traffic rates for each mode of transportation in the analysis. The determined traffic rate estimates in the current research are similar to the 10-20 vehicles daily estimates as determined in previous research of the area (State of Alaska Department of Transportation 1981).

Total fuel consumption costs include ATV, boat and snow machine travel. However, variation between the status quo and the alternative will come only from shifts from boat travel to ATV in the warm months. As provided in Table 6, the fuel consumption rates for each method of travel were determined through a combination of RRA and the application of previous research (Davis et al. 1999).

Table 5: Daily Traffic Projections for Alternative Methods of Travel

		Without Trail Construction (round trips)						**With Trail Construction (round trips)**					
		Oscarville-Napakiak			Akiak-Akiachak			Oscarville-Napakiak			Akiak-Akiachak		
	Year	Boat	ATV	SM	Boat	ATV	SM	Boat	ATV	SM	Boat	ATV	SM
Step 1: Determine current transporatation rates w/o trail construction through phone interviews and questionnaires	➡ 2005	2.00	1.50	5.50	13.25	25.50	25.50	1.00	2.50	5.50	6.63	32.13	25.50
Step 2: Apply population growth rate of 1.5% to the subsequent year of analysis. (i.e. 2 X .015 + 2 2.03)	➡ 2006	2.03	1.52	5.58	13.45	25.88	25.88	1.02	2.54	5.58	6.72	32.61	25.88
	2007	2.06	1.55	5.67	13.65	26.27	26.27	1.03	2.58	5.67	6.83	33.10	26.27
	2008	2.09	1.57	5.75	13.86	26.66	26.66	1.05	2.61	5.75	6.93	33.59	26.66
	2009	2.12	1.59	5.84	14.06	27.06	27.06	1.06	2.65	5.84	7.03	34.10	27.06
Step 3: Reduce existing boat transportation rates by 50% and apply this decrease as an increase to ATV transportation rates (i.e. Daily boat transporation for O-N 2 - (.5 X 2) (1)+ 1.5 2.5 for projected daily ATV transportation)	2010	2.15	1.62	5.93	14.27	27.47	27.47	1.08	2.69	5.93	7.14	34.61	27.47
	2011	2.19	1.64	6.01	14.49	27.88	27.88	1.09	2.73	6.01	7.24	35.13	27.88
	2012	2.22	1.66	6.10	14.71	28.30	28.30	1.11	2.77	6.10	7.35	35.65	28.30
	2013	2.25	1.69	6.20	14.93	28.73	28.73	1.13	2.82	6.20	7.46	36.19	28.73
	2014	2.29	1.72	6.29	15.15	29.16	29.16	1.14	2.86	6.29	7.57	36.73	29.16
	2015	2.32	1.74	6.38	15.38	29.59	29.59	1.16	2.90	6.38	7.69	37.28	29.59
	2016	2.36	1.77	6.48	15.61	30.04	30.04	1.18	2.94	6.48	7.80	37.84	30.04
	2017	2.39	1.79	6.58	15.84	30.49	30.49	1.20	2.99	6.58	7.92	38.41	30.49
Snow machine traffic rates remain constant regardless if there is a trail developed or not. This is because winter time travel will be restricted to snow machines only.	2018	2.43	1.82	6.67	16.08	30.95	30.95	1.21	3.03	6.67	8.04	38.99	30.95
	2019	2.46	1.85	6.77	16.32	31.41	31.41	1.23	3.08	6.77	8.16	39.57	31.41
	2020	2.50	1.88	6.88	16.57	31.88	31.88	1.25	3.13	6.88	8.28	40.16	31.88
	2021	2.54	1.90	6.98	16.81	32.36	32.36	1.27	3.17	6.98	8.41	40.77	32.36
	2022	2.58	1.93	7.08	17.07	32.84	32.84	1.29	3.22	7.08	8.53	41.38	32.84
	2023	2.61	1.96	7.19	17.32	33.34	33.34	1.31	3.27	7.19	8.66	42.00	33.34
	2024	2.65	1.99	7.30	17.58	33.84	33.84	1.33	3.32	7.30	8.79	42.63	33.84

Table 6: Fuel Cost for Separate Travel Methods

Oscarville - Napakiak			
	Boat	ATV	Snowmachine
Miles/per gallon*	5	55	15
Miles round trip	14	23	23
Fuel Cost per gallon	$3.65	$3.65	$3.65
Gallons/round trip	2.75	0.42	1.53
Fuel expenditure per trip	$10.04	$1.53	$5.60
Cost per mile	$0.72	$0.07	$0.24
Akiak-Akiachak			
	Boat	ATV	Snowmachine
Miles/per gallon*	5	55	15
Miles round trip	25	16	16
Fuel cost per gallon	$3.45	$3.45	$3.45
Gallons/round trip	5	0.29	1.07
Fuel expenditure per trip	$17.25	$1.00	$3.68
Cost per mile	$0.69	$0.06	$0.23

*ATV and snow machine mpg estimates were determined by using the average per hour consumption as determined by Davis et al. (1999). Boat mpg estimates for both communities were developed using Oscarville-Napakiak estimates.

The benefits of boat fuel savings are apparent in Tables 8 and 9. These totals are determined by the methodology outlined in Table 7. The table uses 2005 O-N data to illustrate how the data in the first row of Table 8 was determined. Fuel costs without trail construction are determined first and are provided in the top four rows of Table 7. It was determined that the fuel benefits of ATV trail construction would only come from a shift of the current boat traffic to ATV travel. Therefore, benefits are derived in a 120 day period where ATV travel would serve as a substitute for boat travel. There are approximately four months of the year (120 days) where the Kuskokwim River would prove to be a safe alternative for ATV travel. Snow machine travel is assumed to last for eight months or approximately 245 days and is not treated as a substitute for either boat or ATV travel in the current analysis. The second column of Table 7 depicts the daily number of round trips for 2005 and was determined from a series of phone interviews and questionnaires. The final row of Table 7 reveals that after total fuel costs are determined for the with and without-trail alternatives they are subtracted from one another and discounted to provide the 2005 present value of net fuel benefit. This value is summed over the years of analysis (2005-2024) and provides the total net present value of fuel benefit in the final rows of both Table 8 and Table 9.

Table 7: Fuel Costs Net Benefit Calculations

2005	Days of Usage		Round Trips (per day)		Costs per Round Trip		Total Fuel Costs
Without Trail Construction							
Annual Boat Fuel Costs	120	X	2.00	X	$10.04	=	$2,409
Annual ATV Fuel Costs	120	X	1.50	X	$1.53	=	$275
Annual Snowmachine Fuel Costs	245	X	5.50	X	$5.60	=	$7,542
Total Fuel Costs							$10,225
With Trail Construction							
Annual Boat Fuel Costs	120	X	1.00	X	$10.04	=	$1,205
Annual ATV Fuel Costs	120	X	2.50	X	$1.53	=	$458
Annual Snowmachine Fuel Costs	245	X	5.50	X	$5.60	=	$7,542
Total Fuel Costs							$9,204
	Total Fuel Costs w/o ATV Trail		Total Fuel Costs with ATV Trail		Discount Factor		Present Value of Net
Net Present Value of Benefit Calculations	$10,225		$9,204	X	0.93	=	$955

*Computations may be slightly off due to rounding error.

A-A has a much higher fuel consumption benefit present value than O-N, with A-A having $140,993 more in fuel consumption benefits. This is attributed to the traffic projection estimates for both community subsets. Due to trail construction, daily ATV traffic for O-N is slightly more than three trips per day by 2024, whereas A-A daily ATV traffic increases to approximately 43 trips per day by 2024. This is logical since Akiak and Akiachak are further removed from the population hub of Bethel than that of Oscarville and Napakiak. Akiak and Akiachak have more dependence on one another for services and goods where as Oscarville and Napakiak rely heavily on Bethel for services and goods. Without trail construction, daily ATV traffic between O-N is approximately two trips and approximately 34 trips for Akaik-Akiachak.

Table 8: Fuel Cost and Resulting Benefits for Oscarville-Napakiak Trail

	Without Trail Construction				With Trail Construction				
Year	Boat	ATV	Snowmachine	Total	Boat	ATV	Snowmachine	Total	Benefit
2005	$2,409	$275	$7,542	$10,225	$1,205	$458	$7,542	$9,204	$955
2006	$2,445	$279	$7,655	$10,379	$1,223	$465	$7,655	$9,342	$905
2007	$2,482	$283	$7,769	$10,534	$1,241	$472	$7,769	$9,482	$859
2008	$2,519	$287	$7,886	$10,692	$1,260	$479	$7,886	$9,624	$815
2009	$2,557	$292	$8,004	$10,853	$1,278	$486	$8,004	$9,769	$773
2010	$2,595	$296	$8,124	$11,016	$1,298	$493	$8,124	$9,915	$733
2011	$2,634	$300	$8,246	$11,181	$1,317	$501	$8,246	$10,064	$695
2012	$2,674	$305	$8,370	$11,348	$1,337	$508	$8,370	$10,215	$660
2013	$2,714	$309	$8,495	$11,519	$1,357	$516	$8,495	$10,368	$626
2014	$2,754	$314	$8,623	$11,691	$1,377	$524	$8,623	$10,524	$594
2015	$2,796	$319	$8,752	$11,867	$1,398	$531	$8,752	$10,682	$563
2016	$2,838	$324	$8,884	$12,045	$1,419	$539	$8,884	$10,842	$534
2017	$2,880	$328	$9,017	$12,225	$1,440	$547	$9,017	$11,004	$507
2018	$2,923	$333	$9,152	$12,409	$1,462	$556	$9,152	$11,169	$481
2019	$2,967	$338	$9,289	$12,595	$1,484	$564	$9,289	$11,337	$456
2020	$3,012	$343	$9,429	$12,784	$1,506	$572	$9,429	$11,507	$433
2021	$3,057	$349	$9,570	$12,976	$1,528	$581	$9,570	$11,680	$410
2022	$3,103	$354	$9,714	$13,170	$1,551	$590	$9,714	$11,855	$389
2023	$3,149	$359	$9,859	$13,368	$1,575	$599	$9,859	$12,033	$369
2024	$3,197	$365	$10,007	$13,568	$1,598	$608	$10,007	$12,213	$350
Present Value									$12,106

Table 9: Fuel Cost and Resulting Benefits for Akiak-Akiachak Trail

	Without trail construction				With Trail Construction				
Year	Boat	ATV	Snowmachine	Total	Boat	ATV	Snowmachine	Total	Benefit
2005	$27,428	$3,071	$22,991	$53,489	$13,714	$3,869	$22,991	$40,574	$12,071
2006	$27,839	$3,117	$23,336	$54,292	$13,919	$3,927	$23,336	$41,182	$11,450
2007	$28,256	$3,164	$23,686	$55,106	$14,128	$3,986	$23,686	$41,800	$10,862
2008	$28,680	$3,211	$24,041	$55,933	$14,340	$4,046	$24,041	$42,427	$10,304
2009	$29,111	$3,260	$24,402	$56,772	$14,555	$4,106	$24,402	$43,063	$9,774
2010	$29,547	$3,308	$24,768	$57,623	$14,774	$4,168	$24,768	$43,709	$9,272
2011	$29,990	$3,358	$25,139	$58,488	$14,995	$4,231	$25,139	$44,365	$8,795
2012	$30,440	$3,408	$25,516	$59,365	$15,220	$4,294	$25,516	$45,030	$8,343
2013	$30,897	$3,460	$25,899	$60,255	$15,448	$4,358	$25,899	$45,706	$7,914
2014	$31,360	$3,511	$26,287	$61,159	$15,680	$4,424	$26,287	$46,391	$7,507
2015	$31,831	$3,564	$26,682	$62,077	$15,915	$4,490	$26,682	$47,087	$7,121
2016	$32,308	$3,618	$27,082	$63,008	$16,154	$4,558	$27,082	$47,794	$6,755
2017	$32,793	$3,672	$27,488	$63,953	$16,396	$4,626	$27,488	$48,510	$6,408
2018	$33,285	$3,727	$27,901	$64,912	$16,642	$4,695	$27,901	$49,238	$6,079
2019	$33,784	$3,783	$28,319	$65,886	$16,892	$4,766	$28,319	$49,977	$5,766
2020	$34,291	$3,840	$28,744	$66,874	$17,145	$4,837	$28,744	$50,726	$5,470
2021	$34,805	$3,897	$29,175	$67,877	$17,403	$4,910	$29,175	$51,487	$5,189
2022	$35,327	$3,956	$29,613	$68,895	$17,664	$4,983	$29,613	$52,260	$4,922
2023	$35,857	$4,015	$30,057	$69,929	$17,929	$5,058	$30,057	$53,043	$4,669
2024	$36,395	$4,075	$30,508	$70,978	$18,197	$5,134	$30,508	$53,839	$4,429
Present Value									$153,099

Summary of Benefit Estimates

The vast majority of ATV trail construction benefits are attributed to safety improvements. A 50% reduction in current transportation fatalities and injuries creates a combined benefit of $2,098,490 for O-N and a benefit of $4,647,037 for A-A. In comparison, the benefit of reducing fuel consumption is $12,106 for O-N and $153,099 for the Akaik-Akiachak trail. The total present value of benefits for O-N and A-A are $2,110,596 and $4,800,136, respectively, during the 20-year life of the ATV project.

COST CALCULATION

Construction

Construction cost estimates includes materials, shipping, and labor and are dependent on distance, number of bridges, and variability in terrain. The Bethel to Napakiak Road Reconnaissance Study (BNRRS) was used to estimate the length of the O-N trail as approximately 11.5 miles (State of Alaska Department of Transportation 1981). The length of the Akaik-Akiachak trail will be approximately eight miles, which was determined by examination of aerial photography and topographical maps of the area. Sales quotes were used for specific material costs and shipping costs. Labor costs were estimated through consultations with a trail development specialist and through methodologies provided by previous research and these procedures are outlined in the research below.

Materials Costs. The anticipated material costs of trail construction include: geotextiles [4], bridge superstructure, miscellaneous materials, and the fill materials required for bridge construction. These costs are provided in the second column of Table 10. Material costs for trail construction were obtained through a variety of sources. The geotextiles and bridge superstructure costs estimates were collected through consultations with private companies potentially interested in the project. Miscellaneous material costs were estimated through consultations with a trail development specialist, Anchorage-based hardware stores, and, in the instance of screws, from price quotes. The material cost estimates for bridge fill materials were obtained from the BNRRS estimates for a 24-foot-wide bridge designed for car and truck traffic over the same span of the river. The proposed ATV bridge is merely eight feet wide and can support a vehicle load of 10,000 pounds, substantially less than would be needed to support two-way car and truck traffic. In consultation with an engineer, the bridge-crossing material costs for the ATV compatible bridge is estimated to be 45% of the BNRRS bridge material costs (M. Gurkin, pers. comm.).

The proposed trails are approximately 6.5 feet wide, with the exception of the 8 foot wide bridge crossings, and will be constructed using both Geoblock and SolGrid with a layer of TrailGrid beneath both. This relatively new technology provides serviceable trails that sustain ATV traffic and pose little threat to the environment. The construction of such a road reduces surface runoff, increases infiltration,[5] resists erosion and enhances ground water recharge when compared to asphalt or concrete pavement (Meyer 2002). The National Park Service (NPS) considered these attributes when faced with the possible closure of the only ATV trail into the Palmer Hay Flats State Game Refuge (Presto Products Company n.d.). Rather than closing the ATV corridor or constructing an expensive traditional trail, NPS constructed a geotextile trail through the wetland, which preserves the wetlands natural vegetation.

Geoblock and SolGrid are used in combination because of the characteristics of both materials. Geoblock expands and contracts because of the extreme temperature variation in Alaska. In some instances 12 inches of variance was observed in the length of a 100 foot section of Geoblock on some existing trails in Alaska (Meyer 2002). Therefore, the construction of a trail 46’ x 6.5’ of Geoblock connected to 6.5’ x 6.5’ of SolGrid in a repeating pattern was determined to be the most practical option. SolGrid allows for the Geoblock to contract or expand since SolGrid has expansion components. Material costs are identical for Option A and B except for that of the bridge material costs (Table 10). The material costs of Geoblock for both trails were estimated from quotes from GeoChem Inc. and SolPlast Inc. The O-N trail, both

Table 10:Trail Construction Cost

<table>
<tr><td colspan="5">Oscarville-Napakiak Option A</td></tr>
<tr><th rowspan="2">Designation</th><th rowspan="2">Material</th><th rowspan="2">Labor</th><th colspan="2">Shipment</th></tr>
<tr><th>To Seattle</th><th>To Bethel</th></tr>
<tr><td>Misc. Material</td><td>$28,694</td><td rowspan="4">$97,152</td><td>NA</td><td>NA</td></tr>
<tr><td>Geoblock</td><td>$743,888</td><td>$58,124</td><td rowspan="5">$522,371</td></tr>
<tr><td>SolGrid</td><td>$115,051</td><td>$16,209</td></tr>
<tr><td>TrailGrid</td><td>$83,835</td><td>$3,700</td></tr>
<tr><td>Big R Bridge</td><td>$737,862</td><td>$184,465</td><td>NA</td></tr>
<tr><td>E.T. Techtonics Bridge</td><td>$31,875</td><td>$7,969</td><td>$6,000</td></tr>
<tr><td>Sub-Total</td><td>$1,741,205</td><td>$289,586</td><td>$84,033</td><td>$522,371</td></tr>
<tr><td colspan="4">Total Cost</td><td>$2,637,195</td></tr>
</table>

<table>
<tr><td colspan="5">Oscarville - Napakiak Option B</td></tr>
<tr><th rowspan="2">Designation</th><th rowspan="2">Material</th><th rowspan="2">Labor</th><th colspan="2">Shipment</th></tr>
<tr><th>To Seattle</th><th>To Bethel</th></tr>
<tr><td>Misc. Material</td><td>$28,694</td><td rowspan="4">$97,152</td><td>NA</td><td>NA</td></tr>
<tr><td>Geoblock</td><td>$743,888</td><td>$58,124</td><td rowspan="4">$441,115</td></tr>
<tr><td>SolGrid</td><td>$115,051</td><td>$16,209</td></tr>
<tr><td>TrailGrid</td><td>$83,835</td><td>$3,700</td></tr>
<tr><td>E.T. Techtonics Bridge</td><td>$31,875</td><td>$7,969</td><td>$6,000</td></tr>
<tr><td>Swalling Bridge</td><td>$562,500</td><td>$187,500</td><td>NA</td><td>NA</td></tr>
<tr><td>Sub-Total</td><td>$1,565,843</td><td>$292,621</td><td>$84,033</td><td>$441,115</td></tr>
<tr><td colspan="4">Total Cost</td><td>$2,383,612</td></tr>
</table>

<table>
<tr><td colspan="5">Akiak - Akiachak</td></tr>
<tr><th rowspan="2">Designation</th><th rowspan="2">Material</th><th rowspan="2">Labor</th><th colspan="2">Shipment</th></tr>
<tr><th>To Seattle</th><th>To Bethel</th></tr>
<tr><td>Misc. Material</td><td>$24,053</td><td rowspan="4">$67,584</td><td>NA</td><td>NA</td></tr>
<tr><td>Geoblock</td><td>$517,414</td><td>$40,428</td><td rowspan="4">$315,173</td></tr>
<tr><td>SolGrid</td><td>$87,408</td><td>$11,276</td></tr>
<tr><td>TrailGrid</td><td>$58,374</td><td>$3,700</td></tr>
<tr><td>E.T. Techtonics Bridge</td><td>$31,875</td><td>$7,969</td><td>$6,000</td></tr>
<tr><td>Sub-Total</td><td>$719,124</td><td>$75,553</td><td>$61,404</td><td>$315,173</td></tr>
<tr><td colspan="4">Total Cost</td><td>$1,171,254</td></tr>
</table>

Labor cost for bridges are equivalent to 25% of the bridge material cost

Option A and B, will require 334,570 square feet (ft^2) of Geoblock, 55,940 ft^2 of SolGrid, and 364,320 ft^2 of TrailGrid; this comes to $743,888, $115,051, and $83,835, respectively for a total geotextile cost of $942,774. A-A will require 232,745 ft^2 of Geoblock, 38,915 ft^2 of SolGrid, and 253,440 ft^2 of TrailGrid. The A-A trail material costs are $517,414 for Geoblock, $87,408 for SolGrid, and $58,374 for TrailGrid, or $663,196 in total.

Bridge Material. The O-N trail will require the construction of two bridges, while A-A will require one. Bridge material costs include the bridge-superstructure and fill-material costs. Bridge-superstructure costs were established from sales quotes from prefabricated bridge manufactures and construction firms. Fill material costs were determined by a combination of examining cost estimates from previous research and from sale quotes (M. Gurkin, pers. comm.).

Oscarville-Napakiak Bridge Alternatives

The O-N trail will require two separate river crossings, with one being 300 feet and the other being 75 feet. The 300 foot bridge crossing for the O-N trail is evaluated by examining two separate alternatives. Option A evaluates the use of a prefabricated bridge produced by Big R bridges. Option B assesses a bridge constructed by Swalling Construction, an Anchorage based construction firm (Table 10).

Option A superstructure costs were ascertained from a sales quote from Big R bridge manufactures (R. Warner, pers. comm.). This sale quote does not include fill material costs estimates. Fill material costs were obtained from the BNRRS for the Napakiak Slough crossing and adjusted to 2003 dollars.

Option B bridge costs were similarly ascertained from a sales quote (M. Swalling, pers. comm.). This sale quote included the costs for the total bridge construction project, inclusive of fill material cost.

Regardless of which 300 foot bridge alternative is selected, an additional bridge of 75 feet will be necessary for the O-N trail. The 75 foot crossing costs were obtained from E.T. Techtonics, a prefabricated bridge manufacture (E. Johansson, pers. comm.). Fill material costs for the 75 foot crossing are assumed to be trivial and are, therefore, omitted from the cost estimates.

Option A bridge material cost is $737,862 while Option B is $562,500. This difference is due to required piling for Option A, whereas Option B has no such requirement. Including the 75 foot bridge crossing, Option A bridge material costs account for 28% of the total construction cost of the O-N trail, while Option B bridge material costs account for 24% of the total trail construction costs.

Akiak-Akiachak Bridge

The A-A trail requires the construction of a 75 foot bridge. The sales quote as provided by E.T. Techtonics was used for the bridge cost estimate. Similarly, the fill material costs for the A-A trail are considered inconsequential and have been omitted from the current calculations. The bridge construction cost of $31,875 for the A-A trail accounts for 3% of the total trail construction costs.

Miscellaneous Material Cost. Miscellaneous material costs are the estimated costs associated with the trail construction. These costs were estimated from a combination of sources including Anchorage-based hardware stores, Meyer (2002), and consultations with a trail development specialist (K. Meyer, pers. comm.). Screws are the major component of miscellaneous material costs. The trail requires eighteen #8 ¾ inch stainless steel screws per linear foot. Because the trail from Oscarville to Napakiak is 60,720 feet, approximately 1.1 million screws are needed. The total cost of screws for the entire O-N trail is $13,771 and comprises 48% of the total miscellaneous materials cost. Similarly, the A-A trail requires 760,320 screws, equating to $9,580, which comprises 40% of the total miscellaneous materials cost for trail construction.

Shipping Costs

Alternatives for transporting the materials are severely limited because of the lack of both roads and rail lines in the area. Therefore, shipping can only be accommodated through waterway routes or small plane travel. Shipping costs from each material source was determined by each of the material providers to Seattle with the exception of miscellaneous cost. Shipping costs from Seattle to Bethel was determined by consultation with a Carlile Transportation Systems shipping line and these estimates are shown in the fifth column of Table 10 (B. Peterson, pers. comm.).

Labor Costs

The labor costs of the trails are divided into bridge construction and trail construction. B-C analyses typically assign the wage rate or less as the opportunity cost of labor employed in construction. Because the regional labor market is extremely slack, it is likely that the local opportunity cost of labor potentially employed by this project approaches zero; it is likely that the project would provide work to the currently unemployed or underemployed. Trail construction labor and bridge construction labor costs have been computed separately because of the difference between workers employed to accomplish each task. Trail construction can be a source of employment for local people. Because of the high jobless rate in the villages, the wage rate was adjusted downward by 50% to reflect the opportunity cost of trail construction labor relative to bridge construction labor. Bridge construction will require the use of heavy machinery and knowledge of soil characteristics to construct a safe crossing. Therefore, bridge construction will have to be outsourced. Outsourced labor is charged at its full rate as a cost of the project.

Including site preparation costs, Geoblock installation costs $320 for a trail 100 feet x 6.42 feet (K. Meyer, pers. comm.). This cost applied to the length of the 11.5-mile trail for O-N totals $194,304 in trail construction labor costs (Table 10). Consultation with a trail design specialist reveals that a crew of five people can complete 200-300 feet of Geoblock trail per day (K. Meyer, pers. comm.). It, therefore, can be expected that the construction will employ 15 workers for the summer. Similarly, the eight-mile A-A trail has a labor cost of $135,168 and will employ approximately 10 people.

Bridge construction will require the use of contractors, engineers and soil specialists. It is assumed that skilled labor from outside of the area will be necessary to complete the crossings. Construction costs figures for the 300 foot bridge and the 75 foot bridge were ascertained by using the same methodology used in the BNRRS where 25% of the bridge material costs were used as the labor charge. Site preparation costs for bridge construction are assumed to be included in this labor charge (M. Swalling, pers. comm.). A field visit by an engineer could give a closer approximation of site preparation costs. However, it was assumed that this cost is included in the bridge labor charge. Bridge labor costs are approximately equivalent for Options A & B, while the A-A trail has an approximate cost of $8,000 (Table 10).

Summary of Costs

The lowest cost is for the Akaik-Akiachak trail, totaling $1.2 million, followed by Option B with a total cost of $2.4 million, and the most expensive alternative is Option A with $2.6 million in expenses. Material costs account for more than 60% of the total construction costs for each option and village subset. The second major component of each village subset's costs is shipping costs, accounting for 22-32% of the total construction costs. The smallest proportion of costs is attributed to that of labor costs, which are between 7-12% for each village subset.

PROJECT FEASIBILITY

The net present value (NPV) along with the benefit cost ratio (BCR) and internal rate of return (IRR) for the base analysis were calculated and are provided in Table 11. Under our current analytical assumptions (e.g., 7% discount rate, 20-year project, zero scrap value, conservative value of life, 50% reduction in injuries and mortalities), only the A-A trail passes the positive net present value test for project feasibility (Table 11).

Table 11: Comparison of ATV Trail Alternatives

	Oscarville-Napakiak		Akiak-Akiachak
	Option A	Option B	
Project Benefits			
Fatality Benefit	$1,794,094	$1,794,094	$3,635,451
Injury Benefit	$304,396	$304,396	$1,011,586
Fuel Consumption Benefit	$12,106	$12,106	$153,099
Total Benefit	$2,110,596	$2,110,596	$4,800,136
Project Costs			
Material	$1,741,205	$1,565,843	$719,124
Labor	$289,586	$292,621	$75,553
Shipment	$606,404	$525,147	$376,577
Total Costs	$2,637,195	$2,383,612	$1,171,254
Net Benefits	-$526,599	-$273,015	$3,628,882
BCR	-0.80	-0.89	4.10
IRR	4.43%	5.56%	35.96%

Both options for the O-N trail reveal a higher cost than measured benefit. The total net benefits for A-A are $3.6 million, while Options A and B yield losses of about $527,000 and $273,000, respectively. As a result, the BCR is negative for both Options A and B and reaches 4.10 for the A-A alternative. IRR calculations reveal that Options A and B are robust only to discount rates of 4.4% and 5.6%, respectively, while the A-A route indicates a far higher expected return of 35.96%.

SENSITIVITY ANALYSIS

Sensitivity analysis is typically undertaken to assess the stability of the B-C estimates to feasible variation in the important model variables. In this case, project duration and value of life provided the likely important sources of variation, and therefore were subjected to sensitivity analysis. First, the project was evaluated based upon a 15, 25, and 30-year time horizon in addition to the original 20-year project lifetime. Secondly, the implications of higher published values of human life are explored on the justification that lost wages do not reflect the value of a human life to society, only the value of their professional life.

Project Life Adjustment

The base model's 20-year life evaluation was changed to reflect multiple project lives, including 15 years, 25 years, and 30 years (Table 12). The results for Option A and the A-A route are robust to changes in project life; policy recommendations regarding these two options do not change with project length. Moreover, the A-A route is highly robust to changes in project life, indicating less than 0.5% difference in annual expected return by doubling the length of the project. However, Option B meets the feasibility criteria when project life extends to 30 years, but not for 25 years or less. As transportation infrastructure planning could potentially extend to 30 years, this may be an important finding with regard to Option B.

Statistical Life Value

The value of a statistical life in the base analysis is $2.7 million (Boardman et al. 2001). The sensitivity analysis changed the value of life to Boardman et al. (2001) upper bound estimate of $4.38 million, though even more recent high-end estimates can exceed $6-$7 million (Viscusi

Table 12: Project Life Adjustments

	Oscarville-Napakiak		Akiak-Akiachak
	Option A	Option B	
Net Benefit			
15-Year	-$867,007	-$613,423	$2,854,704
20-Year	-$526,599	-$273,015	$3,628,882
25-Year	-$265,053	-$11,470	$4,223,703
30-Year	-$64,100	$189,484	$4,680,718
BCR			
15-Year	-0.67	-0.74	3.44
20-Year	-0.80	-0.89	4.10
25-Year	-0.90	-1.00	4.61
30-Year	-0.98	1.08	5.00
IRR			
15-Year	1.47%	2.78%	35.62%
20-Year	4.43%	5.56%	35.96%
25-Year	5.93%	6.95%	36.04%
30-Year	6.78%	7.71%	36.06%

and Aldy 2003). Under these conditions, all project options become economically feasible, but their relative ranks do not change, as all were equally risk-reducing in our calculations. Locally low wages, high unemployment and short life spans tend to reduce the appropriate value-of-life estimate in this case from a human capital perspective. However, high rates of participation in nonmarket and quasi-market activities (e.g., hunting, fishing), in relatively small and tight-knit communities increase the appropriate value of each life from a social-capital perspective. Depending on the analytical perspective and the objectives of the policy, it could be reasonable to argue for high or low statistical values of life in this case.

Table 13: Statistical Life Value Adjustment

	Oscarville-Napakiak		Akiak-Akiachak
	Option A	Option B	
Project Benefits			
Fatality Benefit	$2,870,551	$2,870,551	$5,816,721
Injury Benefit	$304,396	$304,396	$1,011,586
Fuel Consumption Benefit	$12,106	$12,106	$153,099
Total Benefit	$3,187,053	$3,187,053	$6,981,407
Project Costs			
Material	$1,741,205	$1,565,843	$719,124
Labor	$289,586	$292,621	$75,553
Shipment	$606,404	$525,147	$376,577
Total Costs	$2,637,195	$2,383,612	$1,171,254
Net Benefits	$549,857	$803,441	$5,810,153
BCR	1.21	1.34	5.96
IRR	9.43%	10.84%	51.75%

Summary of Sensitivity Analysis

Our calculations are generally robust to changes in project life and variation in the statistical value of a life. In all cases the relative attractiveness of each option remains the same, but the magnitudes of the net benefit calculations vary. A long project life pushes Option B into economically feasible ranges, while the other two alternatives do not change importantly. Changing the value of life simply inflates the benefits proportionately, and pushes all options into the feasible range.

CONCLUSIONS AND LIMITATIONS

Evaluation of the trail construction alternatives reveals that Akaik-Akiachak trail would be the best alternative for trail construction dollars relative to the other alternatives. O-N ATV trail options provide no net benefit under the base analysis. Sensitivity analysis results further strengthen findings for Akaik-Akiachak and O-N Option A. Some doubts as to the benefits from O-N Option B exist as a result of sensitivity analysis. If the life of the ATV trail were to extend for 30 years, then positive net benefits would be realized.

Limitations in the research include the methodology used in ascertaining traffic projections, the number of fatalities/injuries for travel between the villages, and the exclusion of particular costs. Traffic-rate estimates could be improved by field visits and first-hand evaluation during different seasons of the year. Fatality and injury rates were compiled by evaluating deaths in the area over the specified time period. It should be noted that these deaths might have been for trips to other villages or as the result of recreation where no specific destination was ever assumed.

In addition, engineering costs, geotextile quantity alternatives, maintenance costs, subsistence values, time in transit, and existence values have all been excluded from this evaluation. A precise estimate of engineering costs was financially infeasible for this analysis. This could add a significant amount of costs for site preparation in relation to bridge construction. The analysis assumed that the entire length of the trail would be covered with geotextiles. In reality a visit to the site would provide a closer approximation of necessary geotextile material. Maintenance costs have been excluded as the result of consultation with the trail specialist, which stipulated that maintaining the trail would require only four-five days of work for two people. Time in transit costs were not equated because the opportunity costs of labor are low due to high levels of unemployment and the expected time-savings benefit would be low. Existence values for wildlife have been omitted as the result of discussions with a Yukon Delta National Wildlife Refuge (YDNWR) biologist, which determined that the effects of subsistence hunting would be inconsequential.

Moreover, the future may depart from our assumptions about it. Specifically, how economic activity will react to the development of an ATV trail. There may be more transportation to Napakiak from Oscarville for goods and services that are not available locally. The effect that this might have has not been included in the current analysis.

Endnotes

1. For purposes of this research, ATV's are small, open-motor vehicles having one seat and three or more wheels fitted with large tires. They are designed chiefly for use over roadless, rugged terrain and weigh less than 1,000 pounds.

2. From the human-capital perspective, the opportunity cost of labor is close to zero. However there is a high level of non-market activity in this area that simply cannot be ignored. From the social-capital perspective these communities' subsistence activities support the food supply with eggs and birds in the spring, salmon in the summer, and caribou in the winter.

3. The discount factors as presented in Tables 3 and 4 are calculated using the following formula.

$$\text{Discount Factor} = \frac{1}{(1+r)^{1,2\ t}}$$

where,

r = discount rate
t = discount period

4. Geotextiles are a soil-stabilization apparatus constructed using man-made materials. They are usually made of plastic, rubber, or some similar material.

5. It allows water to penetrate and pass to the ground surface due to the cellular structure of the material.

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