Gravina Access Project
Economic Impact Assessment

Agreement No: 36893013
DOT&PF Project No: 67698
Federal Project No: ACHP-0922(5)

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
6860 Glacier Highway
Juneau, Alaska 99801

and

HDR Alaska, Inc.
712 W. 12th Street
Juneau, AK 99801

Prepared by:

Northern Economics, Inc.
880 H Street, Suite 210
Anchorage, AK 99501

April 2003

Table of Contents

List of Tables

List of Figures

Executive Summary

Scope of the Study

This draft memorandum describes the direct and indirect economic effects on the Ketchikan Gateway Borough, the City of Ketchikan, and the City of Saxman that would likely arise from implementation of each of the nine proposed build alternatives of the Gravina Access Project (GAP). Nine build alternatives to improve access between Gravina Island and Revillagigedo (commonly called Revilla) Island in the Ketchikan Gateway Borough of southeastern Alaska, and the No Action alternative, were evaluated. Although differing in scope, cost, and effects, each alternative can be classified as one of four types: No Action, improved ferry service (Alternatives G2, G3, and G4), bridges in proximity to the airport (Alternatives C3(a), C3(b), C4, and D1), and bridges that cross Pennock Island (Alternatives F1 and F3). This analysis also separately examined the potential economic impacts of Alternative F3 if West Channel were modified (dredged) to improve the navigability of that channel for large cruise ships. Descriptions of the alternatives are provided in Sections 1.2 and 2.1. Figure 1.1 shows the proposed route of each alternative.

The Alternatives

Table ES-1 lists each alternative considered for the various GAP options. Section 2.1 provides a more complete description of the GAP alternatives.

Table ES-1. GAP Bridge and Ferry Alternatives

Alternative	Description
No Action	Existing ferry service
C3(a)	200-foot High Bridge – Airport Area to Signal Road
C3(b)	120-foot High Bridge – Airport Area to Signal Road
C4	200-foot High Bridge – Airport Area to Cambria Drive Area
D1	120-foot High Bridge – Airport Area
F1	Pennock Island Crossing – 200-foot High Bridge over East Channel and 120-foot High Bridge over West Channel
F3	Pennock Island Crossing – 60-foot High Bridge over East Channel and 200-foot High Bridge over West Channel
F3 with channel modifications	Pennock Island Crossing – 60-foot High Bridge over East Channel and 200-foot High Bridge over West Channel – Dredge West Channel to -40 feet, mean lower low water
G2	Additional Ferry Route from Peninsula Point
G3	Additional Ferry Route from Plaza Mall
G4	Additional Ferry Route Adjacent to Existing Ferry

Source: http://www.gravina-access.com/design_center/Default.htm

Economic Effects

Table ES-2 summarizes some of the economic effects of the access alternatives on the Ketchikan Gateway Borough under the low, medium, and high scenarios. Some of the key points presented in Table ES-2 are:

- The bridge alternatives that cross Pennock Island (F1 and F3) have the highest life cycle costs because two bridge structures and a longer road system are involved, which increases the construction cost.
- The bridge alternatives that preclude or constrain cruise ships from transiting Tongass Narrows (C3(b), D1, and F3) result in reduced port calls and spending in the community, and potentially a monetary loss to the local economy. However, the higher construction costs of the Pennock Island alternatives (F1 and F3) result in the largest net monetary effect on the local economy.

- The bridges located near the airport (C3(a), C3(b), C4, and D1) provide the greatest benefits to persons traveling between Gravina and Revilla Islands because of the shorter trip times and elimination of the ferry toll. User benefits for the Pennock Island alternatives are about 40 percent of those for the airport bridges because the roadway distance is longer and travel-time savings are subsequently less. The longer transit time for the ferries with Alternatives G2 and G3 offsets any potential timesavings from the terminals being closer to the origin or destination. More frequent service with alternative G4 results in benefits compared to the No Action alternative, but which are much lower than for the bridge alternatives.
- Other economic costs include the cost of public lands used for transportation and potential time delays for passengers traveling on local flights[1]. The value of public lands is based on the opportunity cost of using public lands for transportation instead of an alternate use. The bridge alternatives located near the airport have the greatest potential to result in time delays for passengers traveling on local flights, while the bridge alternatives crossing Pennock Island are anticipated to have fewer effects on local flights.
- The bridge alternatives that provide unimpeded access for cruise ships (C3(a), C4, F1, and F3 with channel modifications) provide the most employment in the community. Substantial construction costs and the increase in disposable income due to the elimination of the ferry toll account for these employment levels. The bridge alternatives that impede cruise ship travel could result in job losses over time.
- The Pennock Island alternatives provide access to more land that is developable and result in more population and land being served compared to the other alternatives. High levels of development on Gravina Island are not considered possible with any of the ferry alternatives.

[1] Local flights are floatplane flights that are restricted under certain weather conditions by Special Visual Flight Rules (SVFR). Bridge alternatives would limit the number of SVFR operations and cause delays.

Table ES-2. Summary of Economic Effects on Ketchikan Gateway Borough 2001-2025

	Alternative										
	Bridge							Ferry			
Measures of Economic Effects	**C3(a)**	**C3(b)**	**C4**	**D1**	**F1**	**F3**	**F3 with channel mod.**	**G2**	**G3**	**G4**	**No Action**
Life Cycle Costs (Net Present Value[1], 2001-2025, Millions of 2003$)											
	158.3	132.8	157.6	106.1	191.4	168.4	179.4	90.0	98.0	88.0	12.6
Net Monetary Effect on Ketchikan[2] (Net Present Value[1], 2001-2025, Millions of 2003$)											
Low	74.6	51.4	81.6	48.9	91.2	84.1	92.9	42.8	48.9	42.0	5.3
Medium	67.9	11.6	74.9	9.1	89.8	51.9	92.3	42.8	48.9	42.0	5.3
High	61.3	(56.7)	68.3	(59.2)	88.5	(32.3)	91.6	42.8	48.9	42.0	5.3
Net Benefits to Users (Net Present Value, 2001-2025,[3] Millions of 2003$)											
Low	47.9	54.6	55.8	60.5	15.4	12.2	12.1	(0.2)	(0.2)	1.9	0
Medium	55.2	62.3	64.2	70.0	27.1	22.6	22.6	(0.2)	(0.2)	2.0	0
High	60.5	68.0	70.4	76.9	36.7	31.1	31.1	(0.2)	(0.1)	2.1	0
Other Economic Costs[4] (Net Present Value, 2001-2025,[3] Millions of 2003$)											
Low	(0.6)	(0.9)	(1.6)	(0.2)	(0.6)	(0.0)	(0.0)	(1.0)	(4.1)	(0.4)	0
Medium	(7.0)	(7.3)	(8.0)	(6.7)	(1.8)	(0.7)	(0.7)	(1.0)	(4.1)	(0.4)	0
High	(13.4)	(13.7)	(14.4)	(13.1)	(3.1)	(1.3)	(1.3)	(1.0)	(4.1)	(0.4)	0
Total Employment[5] (Number of Employees, Cumulative for 2003- 2025)											
Low	1,182	550	1,245	497	1,341	1,263	1,332	442	457	436	83
Medium	1,091	(439)	1,153	(492)	1,334	126	1,335	442	457	436	83
High	955	(3,051)	1,018	(3,104)	1,315	(3,244)	1,332	442	457	436	83
Other Measures											
Additional Population[6] served in 2025 on Gravina and Pennock Islands:											
Low	40	40	40	40	40	40	40	40	40	40	40
Medium	730	730	730	730	1,170	1,170	1,170	130	130	130	n.a.
High	1,540	1,540	1,540	1,540	2,630	2,630	2,630	n.a.	n.a.	n.a.	n.a.
Additional Acres of Land Served in 2025 on Gravina and Pennock Islands:											
Low	20	20	20	20	20	20	20	20	20	20	20
Medium	310	310	310	310	490	490	490	70	70	70	n.a.
High	680	680	680	680	1,120	1,120	1,120	n.a.	n.a.	n.a.	n.a.

n.a.: Not applicable. Due to higher travel costs and lesser convenience, the No Action alternative is not anticipated to achieve more than a low level of development, and the improved ferry alternatives are not anticipated to result in a high level of development on Gravina Island.

1 Net present value calculated with a 4.2 percent real discount rate per the *Office and Management Budget Circular A-94* supplement issued November 2001.

2 Includes direct and secondary (indirect and induced) effects of local construction, and operations and maintenance expenditures, and reduced cruise-related and aviation-related spending.

3 From *Quantification of User Economic Benefits for the Gravina Access Project*, November 2002 (Appendix A). Prepared by HLB Decision Economics, Inc. for HDR Alaska, Inc. Benefits are calculated in comparison to the No Action alternative.

4 Includes time delay for passengers traveling on local flights and opportunity cost for using public lands for rights-of-way.

5 Employment is cumulative total of jobs over the 2003 to 2025 study period, which incorporates the construction period and 20 years of operating life. Employment includes direct and secondary (indirect and induced) employment. Negative numbers reflect the potential reductions from employment levels that might occur, given the assumptions on levels of reductions in cruise-related and aviation-related spending.

6 Full-time permanent residents; additional seasonal residences are anticipated on Gravina Island.

The life cycle costs reflect the total expenditures for construction, operations, and maintenance for each alternative through 2025, less the remaining equity or salvage value of each alternative at the end of the period.

The monetary gains to the Ketchikan community (including the City of Saxman) reflect the direct and secondary effects of local construction, operations and maintenance expenditures, and the potential reductions (from the effect of certain bridge alternatives on cruise-related and air charter spending), as well as the effect of tolls on the economy. User benefits are calculated as a comparison to the No Action alternative. User benefits are primarily travel-time savings and lower travel costs. The employment effects are the sum of jobs created from the beginning of the construction period (2003) through the end of 20 years of operations (2025). The employment figures are the sum of the total number of jobs per year. For example, if a construction job lasts three years, it accounts for three jobs in the table. The construction period is anticipated to last three years with operations commencing in 2006. It is estimated that the local share of construction spending for a bridge would directly contribute between \$32 million and \$54 million to the economy of Ketchikan during the construction period. Secondary effects will contribute an additional \$14 million to \$23 million. Similarly, if expanded ferry service is selected as the preferred alternative, the local share of the construction spending could be between \$37 million and \$39 million, assuming that the ferries are constructed at the Ketchikan shipyard. Secondary effects would be an additional \$13 million to \$19 million (see Table 2-5).

In addition, maintenance of a bridge could add about \$100,000 in additional economic activity to the local economy annually. The improved ferry alternatives would have annual operations and maintenance costs of about \$3.3 million. Historically, these costs have been paid for by a combination of tolls (about \$1.1 million in 2000), transfers from the Ketchikan Gateway Borough, and state and federal grants. Tolls paid by local residents and grants from the Borough government are a transfer from other potential spending in the community and do not represent a net gain in regional economic activity.

Considerable uncertainty exists about the potential effect of the bridge alternatives on cruise- and aviation-related spending. Alternatives C3(b) and D1 would preclude cruise ship transits of Tongass Narrows and may result in fewer or shorter port calls. Alternative F3 would require cruise ships to use West Channel, which has a higher perceived risk than East Channel. It is uncertain whether cruise lines would go around Gravina Island, or not call at Ketchikan, instead of using West Channel. The option of modifying the West Channel under Alternative F3 by dredging the channel to 750 feet wide would substantially reduce or eliminate this perceived risk. If this alternative is constructed with the channel modification, cruise ships are anticipated to use West Channel without substantive changes to their operations. Any of the bridge alternatives could affect the existing special visual flight rules (SVFR) that permit aircraft to operate in certain weather conditions, but it is uncertain what the response of the aviation community will be to the Federal Aviation Administration's (FAA) regulations regarding a bridge alternative. As a result, there is wide variation in the assumptions employed in the scenarios for potential reductions in cruise- and aviation-related spending.

The reductions in visitor spending for Alternatives C3(b) and D1, as a percentage of total visitor spending in the community, range from zero under the low scenario, to about 2 percent under the medium scenario, and to about 4 percent under the high scenario. Alternative F3 may result in reductions of about 1 percent under the medium scenario and 3 percent under the high scenario. Potential effects on local government revenues from reduced visitor spending would be about this same order of magnitude.

A few residences and businesses on Revilla Island might need to be acquired to construct some of the build alternatives. Some of the bridge alternatives might also displace the floatplane facility near the airport on Gravina Island, although this issue is presently unresolved. Otherwise, only undeveloped land would be acquired for project rights-of-way on Gravina and Pennock Islands.

All of the build alternatives will improve access to the Ketchikan International Airport and to publicly and privately owned lands on Gravina Island. Travel costs for businesses operating at the airport will be reduced with a bridge alternative, but would not decrease with a ferry alternative because the Borough is still expected to recover operating costs through passenger and vehicle tolls. It is anticipated that a bridge would result in more development on Gravina Island than improved ferry service because of the lower travel cost and the convenience offered by a bridge.

Between now and 2025, the change in the structure of the economy is difficult to foresee, and the fiscal structure of the local government is likely to change over time as well. Other factors will also change in ways we cannot foresee at this time. Given this uncertainty about the future, the results presented here should be considered a relative indicator of the economic effects of the various alternatives and not a definitive statement on such effects. Discussions regarding the findings presented in this technical memorandum should focus on the policy implications of the magnitude of change presented in this report rather than the precision and accuracy of specific numbers.

1.0 Introduction

This report provides an economic impact analysis of the Gravina Access Project (GAP) alternatives on the Ketchikan Gateway Borough and the cities of Ketchikan and Saxman. Supporting information is provided in Appendices A, B, C, and D. An economic impact analysis is one of two analyses, benefit-cost analysis being the other, often conducted to provide an economic perspective of the potential changes associated with infrastructure projects. An economic impact analysis provides a view of the distributional consequences (for example, who gains and who loses from the change) associated with this change, typically at the local level. This type of analysis generally addresses such items as changes in employment, income, government revenues, and considers the transfer payments from the state and federal government as income to the community. It can also consider the secondary or multiplier effects of monetary changes in the economy.

The benefit-cost analysis examines the positive effects (economic benefits) of an action and associated costs, including opportunity costs, from a national perspective. Benefit-cost analysis varies from an economic impact analysis in a number of ways. For example, a benefit-cost analysis can address items for which there is no direct market price, such as the value of time, as well as the monetary cost of travel. In benefit-cost analyses prepared for most transportation infrastructure projects, the monetary equivalent value of timesavings is often the most significant economic benefit. An important distinction between benefit-cost analysis and economic impact assessment is the treatment of project expenditures. In a benefit-cost analysis, these expenditures would be considered a cost because of other foregone opportunities. In economic impact analysis, the proportion of these expenditures that affect employment, income, and other measures in the local community would be regarded as a monetary gain to the local community. In addition, the multiplier effects of these direct project expenditures are also estimated in economic impact analysis.

In practice, both of these types of economic analyses are employed to provide information to decision-makers and the public to facilitate decision-making. This report provides the economic impact analysis and the technical memorandum entitled *Quantification of User Economic Benefits* for the Gravina Access Project (HLB Decision Economics, 2002) quantifies user benefits (Appendix A). These user benefits, the life-cycle cost of the GAP alternatives, time delays for air travelers on local flights (Appendix B), and the value of public lands (Appendix D), must be considered together to completely assess the total net benefits of the various alternatives.

The following subsections provide a brief description of the alternatives being considered in this economic impact analysis. Background information on direct and indirect effects and how the various changes associated with the alternatives are evaluated in this report are also included.

1.1 Proposed Alternatives

Ten alternatives are currently under evaluation for the Gravina Access Project. The No Action alternative and three of the build alternatives involve ferry service, the primary means of access between Revilla and Gravina Islands at present. The other six alternatives are bridge options to link the two islands. A brief description of the alternatives follows. All options, except the No Action, provide for additional road construction on Gravina Island. The plans include a proposed road south and west of the airport, henceforth referred to as the planned Gravina road. The proposed design of the planned Gravina road varies somewhat with the alternatives.

- No Action–There would be no change in access between Gravina and Revilla Islands. The current ferry service would continue as is.

- C3(a)–A bridge with 200 feet of vertical clearance to allow the one-way passage of large cruise ships would connect the two islands. The bridge access road would meet Signal Road on Revilla Island. The bridge would cross the Tongass Narrows to Gravina Island landing north of the airport terminal, then turn to the south, parallel to the airport runway, where it would connect with the planned Gravina road at the south end of the airport.

- C3(b)–The alignment of this bridge option is very similar to that of C3(a). The primary difference is that the maximum vertical clearance of the bridge would be 120 feet, a distance sufficient for Columbia-class ferries, but not for large cruise ships. Road access on Revilla and Gravina Islands would be similar to C3(a).

- C4–This alternative provides for a bridge with a vertical clearance of 200 feet, sufficient for large cruise ships. Near Gravina Island, this bridge has essentially the same alignment as C3(a). On Gravina Island, the bridge would connect with the planned Gravina road south of the airport. On Revilla Island, the proposed bridge access road would connect with Tongass Avenue just north of Cambria Drive.

- D1–This option calls for a bridge having a vertical clearance of 120 feet, insufficient for the passage of large cruise ships. The Gravina Island portion of this alternative would be very similar to that of the preceding bridge alternatives in that the bridge would connect to the planned Gravina road on the south side of the airport. On Revilla Island the bridge access road would intersect Tongass Avenue near Cambria Drive.

- F1–This alternative includes a bridge with a vertical clearance of 200 feet across the East Channel of the Tongass Narrows from Revilla Island to Pennock Island. This bridge would be connected by a road across Pennock Island to a 120-foot high bridge across the west channel between Pennock Island and Gravina Island. The road across Pennock Island would not provide access for Pennock Island residents. On Gravina Island, another road would be constructed from the proposed Gravina road near the airport to the West Channel bridge.

- F3–This alternative would involve construction of a bridge across the East Channel of the Tongass Narrows from South Tongass Highway to Pennock Island. This bridge would have a vertical clearance of 60 feet, thus precluding use of the East Channel by cruise ships and Alaska State Marine Highway ferries. A road across Pennock Island would connect this bridge with a bridge with 200 feet of vertical clearance, sufficient for cruise ship passage, across West Channel of the Tongass Narrows. The road across Pennock Island would not provide access for Pennock Island residents. On Gravina Island, another road would be constructed from the proposed Gravina road near the airport to the west channel bridge. An option under consideration with this alternative is to modify the West Channel by providing a 750-foot wide navigational channel. The center of the channel would be dredged to minus 40 feet water depth at mean lower low water with a minimum width of 550 feet. An additional 100 feet on each side would be dredged to minus 30 feet at mean lower low water.

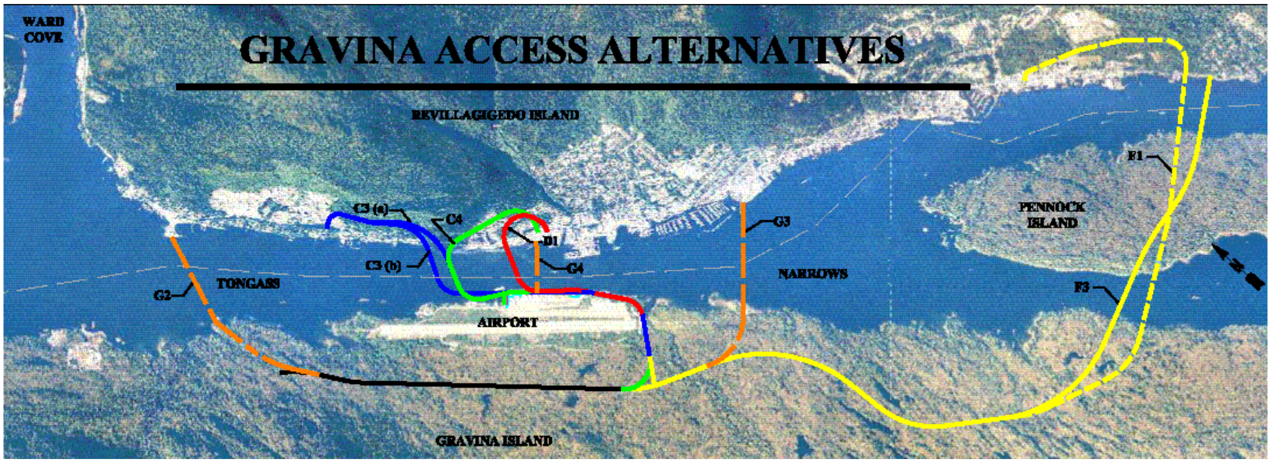
- G2–Additional ferry service for vehicles and pedestrians would be established between Peninsula Point on Revilla Island and Lewis Point on Gravina Island. New terminals would be built in both locations. A new road would be constructed to link Lewis Point on Gravina Island with the planned Gravina road. Current ferry service would continue without change.

- G3–Additional new ferry route between Ketchikan and a location just south of the airport would be established. On Revilla Island, a new terminal would be constructed between the Plaza, a mall, and Bar Harbor. On Gravina Island, this option would involve a new terminal and another road connecting the terminal to the proposed Gravina road. Current ferry service would continue without change.

- G4-Additional ferry service along the current route would be expanded with the construction of new terminals near the present terminal sites on Revilla and Gravina Islands and the addition of two ferries. A connecting road from the new terminal to the proposed Gravina road would be constructed as part of this alternative. Current ferry service would continue without change.

The proposed routes for the alternatives are shown in Figure 1.1.

Figure 1.1. Proposed Routes for the GAP Bridge and Ferry Alternatives



1.2 Background

Under the National Environmental Policy Act (NEPA), direct effects are those that "are caused by the action and occur at the same time and place."[2] The direct economic effects of the alternatives evaluated in this report include:

- Economic effects associated with construction spending
- Acquisition and relocation effects
- Operations and maintenance spending
- Effects on cruise ship operating patterns

Construction spending would increase business revenues in the community, especially retail establishments near the area of construction activity, for the duration of the construction work. Several of the bridge alternatives may reduce both the number of cruise ship dockings and the time spent in port for some of the cruise ships that continue to visit Ketchikan. Acquisition and relocation effects include the purchase of business, residential, and other property for project right-of-way (ROW) and the potential need to relocate residents or businesses elsewhere in the community. These displacement effects will begin prior to construction work.

Under NEPA, indirect effects are those that "are caused by the action and are later in time or farther removed in distance *(than direct effects)*, but are still reasonably foreseeable."[3] Indirect effects that might arise from the alternatives include:

- Economic effects of changes in cruise ship operations
- Economic effects of changes in float plane operations
- Employment effects
- Changes in income
- Regional economic development effects
- Effects on government finances, services and infrastructure provision

The potential direct and indirect economic effects of the different Gravina Access Project alternatives are described in this memorandum. Direct effects are those that are likely to be attributable to the selected alternative and which occur at the same time and place. These direct effects are grouped into four categories:

1. Direct effects from construction spending
2. Acquisition and relocation effects
3. Operations and maintenance spending
4. Effects on cruise ship operating patterns

Construction spending for any of the alternatives will increase construction-related employment and the revenues of local businesses that provide materials and equipment for the project. The greater the capital cost, the greater the short-run effect on the local economy. These additions to local employment and business revenues will then stimulate further indirect economic effects (addressed below).

Some of the bridge alternatives would require changes in current cruise ship operations, possibly leading to reductions in Ketchikan port calls and the time spent in port. The information on cruise-related changes presented in this report is summarized from the *Gravina Access Project Effects on Cruise Ships* Technical Memorandum prepared by Klugherz and Associates and Northern Economics. The bridge alternatives may also affect floatplane and general aviation operations.

Acquisition and relocation effects refer to the developed and undeveloped property that would be acquired for project rights-of-way. Under some of the alternatives, a few residences and/or businesses are likely to be acquired

[2] Federal Highway Administration, U.S. Department of Transportation. Secondary and Cumulative Effects. http://www.fhwa.dot.gov/environment/nepa/2nd_cml.htm
[3] Ibid.

for project right-of-way and the residents or businesses would need to be relocated elsewhere in the community. Except for the No Action alternative, all of the options require the acquisition of land for right-of way. Much of the undeveloped land to be acquired for the build alternatives is for roads proposed on Gravina Island and much of the undeveloped land is owned by various governmental entities.

Indirect effects happen later or at a distance, but can be foreseen and attributed to an alternative. Five indirect effects are considered in this study:

1. Economic effects of changes in cruise ship operations
2. Economic effects of changes in charter and general aviation operations
3. Employment effects
4. Changes in income
5. Regional economic development effects
6. Government service and infrastructure provision
7. Recreational activity

The focus of this technical memorandum is on the Ketchikan Gateway Borough, but discussions of the direct and indirect effects on the Cities of Ketchikan and Saxman are also provided.

Regional development plans may be affected by the alternative selected.[4] The access to Gravina Island, whether bridge or ferry, will affect residential and business location decisions. These decisions, in turn, are likely to have effects on the provision of public services and infrastructure and on access to recreational activities on Gravina Island. Furthermore, development or its absence on Gravina Island is likely to have implications for land prices on Gravina and Revilla Islands.

[4] Officials with the Ketchikan Gateway Borough Planning Office have indicated that the various options would not alter the Gravina development plans of the Borough, but the timing of development in different locations on the island could change with the alternatives.

2.0 Findings

2.1 Construction Effects

2.1.1 Direct Effects

Construction Spending

The effects from construction spending will depend on the alternative selected because the construction costs of each alternative vary substantially. Table 2-1 shows the estimated total construction spending for each alternative, and the number of direct jobs related to that spending. The spending and jobs shown in this table include jobs that may be held by local residents, as well as persons that migrate to the community on a temporary basis for employment during construction. The estimates of construction-related spending and jobs shown in Table 2-1 do not include any indirect or multiplier effects of the spending in the local area[5]. The indirect effects will be discussed in a later section. Note that in the following discussions and tables, the total number of jobs is by year. For example, if a job lasts three years, it counts as three jobs.

Table 2-1. Estimated Direct Construction Spending and Construction Jobs

Alternative	Construction Spending (Millions of 2003$)			Construction Jobs[1] (Total / Annual)
	Labor	Materials and Equipment	Total	
C3(a)	73.5	114.5	188.0	1,590/530
C3(b)	61.3	95.8	157.0	1,330/440
C4	72.2	111.8	184.0	1,560/520
D1	47.8	74.2	122.0	1,030/340
F1	84.8	134.3	219.0	1,850/620
F3	75.9	120.1	196.0	1,660/550
F3 with channel modifications	82.1	124.9	207.0	1,780/590
G2[2]	19.1	36.2	55.3	470/160
G3[2]	21.1	42.2	63.3	510/170
G4[2]	18.8	34.5	53.3	470/160
No Action[3]	0.7	1.6	2.3	30/10

[1] Annual jobs estimated by dividing total cumulative jobs created by a three-year construction period, except for the No Action alternative that has a two-year construction period. Numbers may not calculate due to rounding. Jobs can be full-time, part-time, and seasonal.

[2] Includes replacement of one ferry, and major rehabilitation of ferry terminals in year 10 of operation.

[3] Includes replacement and pending maintenance expenses that may occur between 2004 and 2006, as well as replacement of one ferry, and major rehabilitation of ferry terminals in year 10 of operation.

A substantial portion of the materials for construction will be purchased outside of the Ketchikan Gateway Borough, and a number of the skills required for construction may not be available within the local Ketchikan labor force. As a result, only a portion of the spending and jobs will accrue to local businesses and residents (see Table 2-2). As the most expensive of the project alternatives, selection of the F1 option would contribute the most to the local economy over the three-year construction period. Also, each bridge alternative would require a substantial amount of local labor, with a local payroll of at least $18.6 million during the three years of construction. Even the least expensive of the build options, ferry Alternative G4, would likely add about $11.3 million to the employment payrolls of the businesses in the Borough during the construction period, assuming the ferries are built in the Ketchikan Shipyard. If one or more of the new ferries are built outside of Ketchikan, the

[5] The numbers here are estimates and have been developed for planning purposes.

construction spending and employment shown in Table 2-2 for the ferry alternatives will decrease substantially. For example, about 46 jobs are created for every $1 million of ferry construction activities. The loss of $2.2 million in ferry construction would result in a loss of about 100 jobs. Replacement of one of the existing ferries and major rehabilitation of the ferry terminals is anticipated to occur in the 10th year of operation under the improved ferry and No Action alternatives, with about $6.3 million and $4.3 million in local spending, respectively, assuming construction of the ferry in Ketchikan.

Table 2-2. Estimated Local Construction Spending and Construction Jobs in Ketchikan Gateway Borough

Alternative	Construction Spending (Millions of 2003$)				Construction Jobs[1] (Total / Annual)
	Materials	Labor	Equipment	Total	
C3(a)	$6.4	$22.2	$9.8	$38.4	360/120
C3(b)	$5.9	$18.7	$8.1	$32.7	310/100
C4	$6.2	$23.8	$13.5	$43.5	390/130
D1	$4.8	$16.9	$10.5	$32.2	290/100
F1	$11.3	$27.3	$12.9	$51.5	470/160
F3	$9.3	$26.1	$11.4	$46.8	420/140
F3 with channel modifications	$10.5	$30.2	$13.1	$53.8	460/150
G2[2]	$4.3	$18.4	$6.4	$29.2	250/80
G3[2]	$4.8	$19.5	$7.1	$31.4	270/90
G4[2]	$4.1	$18.4	$6.5	$29.0	250/80
No Action[3]	$0.9	$0.5	$0.7	$2.1	20/10

[1] Annual jobs estimated by dividing total cumulative jobs created by a three-year construction period, except for the No Action alternative that has a two-year construction period. Numbers may not calculate due to rounding. Jobs can be full-time, part-time, and seasonal.

[2] Includes replacement of one ferry, and major rehabilitation of ferry terminals in year 10 of operation.

[3] Includes replacement and pending maintenance expenses that may occur between 2004 and 2006, as well as replacement of one ferry, and major rehabilitation of ferry terminals in year 10 of operation

Acquisition and Relocation Effects

Assessment of the acquisition and relocation effects is based on purchasing rights-of-way for the proposed routes. Slight changes in project plans and routes can occur as planning progresses and the acquisition costs described in this document should be considered as approximations. A more precise estimate of acquisition effects and costs can be made when the preferred alternative is selected and more detailed design information is available. Additional information on the amount and cost of public and private land required for the rights-of-way are presented in the *Land Use* Technical Memorandum and the *Conceptual Stage Relocation Study and Assessment of Right-of-Way Acquisition Costs* Technical Memorandum prepared by HDR. A summary of the value of land and structures identified in the latter technical memorandum is shown in Table 2-3.

Table 2-3. Estimated Acquisition Costs

Project Alternative	Total (Thousands of 2003$)
C3(a)	587
C3(b)	851
C4	1,585
D1	241
F1	565
F3	31
F3 with channel modifications	31
G2	1,016
G3	4,140
G4	422

Source: *Conceptual Stage Relocation Study and Assessment of Right-of-Way Acquisition Costs* Technical Memorandum. April 2003.

The estimated acquisition costs include the value of any private land and structures that would be acquired for right-of-way for each alternative. With the exception of lands where the Alaska Mental Health Lands Trust (The Trust) owns the surface rights, public lands are assumed available at no cost to the project.[6] The Trust has a fiduciary responsibility to maximize revenues from its resources, so a purchase of the property would be necessary. The Trust also owns the subsurface rights for several parcels that are affected by various alternatives, but it is assumed that there will be no cost to the project associated with this subsurface ownership. The airport floatplane facility is owned by the State of Alaska and leased to the Ketchikan Gateway Borough. The facility may be affected by certain of the bridge alternatives located in proximity to the airport, but this issue has not yet been resolved.

Ferry Alternative G3 has the highest acquisition costs because the new ferry terminal for this alternative would require purchasing lands that have some of the highest property values in the community, and substantial structures would be affected as well. Much of the land required for the bridge alternatives is undeveloped or owned by public entities. There is sufficient existing housing in the community to accommodate those residents whose residences would be acquired, although they may have to locate elsewhere in the community. Businesses that may be displaced by an alternative would also have to locate in a different area of the community. The cost of relocating would be covered as part of the acquisition process.

If a bridge alternative were selected, one additional effect would be the elimination of the ferry service between Gravina and Revilla Islands. Based on past performance, elimination of the ferry would represent a small net financial gain to the operator, Ketchikan Gateway Borough, since, historically, the ferry has been an unprofitable operation. However, recent toll increases may result in the ferry service being profitable. In any event, the traveling public would benefit from the reduced travel cost to Gravina Island if a bridge alternative were selected rather than a ferry alternative because of the elimination of a toll to travel to and from the island (this effect is further discussed in Section 2.2.2). In addition, the Borough may be able to garner additional revenue if it can sell the ferries and the land on which the Revilla Island ferry terminal is located. The newest ferry was built with FAA funding and it is unknown whether the Borough would be able to sell the ferry and retain the funds. The ferry terminal and land on Gravina Island may be displaced by some bridge alternatives.

There are several potential issues in the process of estimating right-of-way acquisition costs. These issues may result in the acquisition cost estimates presented here being lower or higher than the cost when the property is actually acquired.

[6] The opportunity cost of using public lands for transportation is presented in Appendix C.

- In order to develop the cost estimates, it is implicitly assumed that the value per acre is constant across an entire parcel. If such is not the case, the right-of-way acquisition estimate for a parcel may understate or overstate the actual cost.
- The costs of moving the floatplane facility are not included in the analysis since it is uncertain whether the facility will be impacted. If the floatplane facility is relocated as a result of the selection of C3(a), C3(b), C4, or D1, the acquisition costs will be higher than shown in Table 2-3.

2.1.2 Indirect Effects

The potential indirect economic effects of construction activities, including right-of-way acquisition, are estimated using an input-output (I-O) model of the Ketchikan Gateway Borough economy, available from the Minnesota IMPLAN[7] Group. The company uses a large number of data sources to construct economic models of the economy of each state, county, or borough in the United States. The I-O model captures the inter-industry transactions generated by construction firms and their suppliers and the additional economic activity generated by household and government spending that will result from construction of an alternative.

When money enters an economy, it affects more than the initial recipient. When a bridge or road is built in Alaska, construction firms are the direct beneficiaries. The construction firms, in turn, buy supplies from other Alaska firms and hire workers. The shops selling the supplies make additional purchases, as do the project workers. A large share of local purchases may also be transferred out of the local economy by out-of-state purchases. The money spent locally on the project flows through the economy until it is dissipated by these out-of-region purchases. This is often called the multiplier effect. The effects of purchases from suppliers outside the state are excluded from the estimates. I-O models do not indicate the period of time when the effects of the initial spending will be felt throughout the economy. Because subsequent rounds of spending may be spread out over several years, the total effect suggested by the I-O models may not be realized in the initial year. The money that goes directly to the construction firms is part of the direct effect of the construction activities. Those effects are provided in the previous section. The additional rounds of spending caused by construction firm expenditures are part of the subsequent indirect and induced effects, which are often collectively referred to as secondary effects. It is typical that much of the secondary effect from any project occurs through expenditures by households and governments. The indirect effects shown in the following subsections were estimated using the IMPLAN I-O model for the Ketchikan Gateway Borough.

Employment

The construction and acquisition activities will result in additional jobs being created in the region (other than workers directly hired by construction contractors). The employment estimates shown here represent the potential full-time and part-time employment created because of the secondary round of spending by businesses, households (including construction workers who temporarily migrate into the community), and local governments. The indirect jobs associated with construction and acquisition activities would be spread throughout the community with most indirect employment associated with businesses located in the City of Ketchikan. A few indirect jobs may be located in Saxman, but it is more likely that jobs in the City of Ketchikan would provide a greater number of job opportunities for Saxman residents.

The estimates in Table 2-4 include the number of persons employed in activities stimulated by inter-industry transactions and the employment created by additional household and government spending. The estimates shown here do not include direct employment for laborers involved in construction activities (direct effects were presented in Section 2.1.1). The improved ferry alternatives assume that the ferries are built at the Ketchikan Shipyard, and the No Action alternative anticipates replacement of an existing ferry, also built at the Ketchikan Shipyard, in 2015. Construction of the ferries elsewhere would substantially reduce the job estimates shown here. The number of jobs created in the Ketchikan community by secondary spending of the money that individuals and

[7] IMPLAN was originally an acronym for "impact analysis for planning".

businesses receive from acquisition of land and structures for the Gravina Access Project is very small (i.e., less than three persons), except for G3, which would create eight jobs. The construction activity generates almost all of the indirect jobs in the economy.

Table 2-4. Indirect Effects of Construction and Acquisition Activities on Employment by Alternative

	Total Indirect Jobs/Annual Indirect Jobs[1]	
Alternatives	**Construction**	**Acquisition**
Bridge Alternatives		
C3(a)	250/80	<10/0
C3(b)	220/70	<10/0
C4	270/90	<10/0
D1	200/70	<10/0
F1	310/100	<10/0
F3	280/90	0/0
F3 with channel modifications	310/100	0/0
Ferry Alternatives		
G2	130/40	<10/0
G3	130/40	<10/0
G4	120/40	<10/0

[1] Annual jobs estimated by dividing total employment by three-year construction period for bridge alternatives. Improved ferry alternatives assume a three-year initial construction period and a fourth year in the 10th year of operations. If the number of total jobs is less than 10, a zero for annual jobs indicates that the number of annual jobs is closer to zero than to 10. Numbers may not calculate due to rounding.

Gross Regional Product and Labor Income

This section summarizes the estimated changes in the economic activity of the region (gross regional product) and labor income generated by the different project scenarios (see Table 2-5). The gross regional product (also called output) is a measure of the total change in economic activity, including both inputs into other industries and outputs consumed by governments and households. Labor income is a measure of the change in payments made to labor as well as proprietor's income (income received by self-employed individuals).

Much of the materials and equipment required for the bridge alternatives will be brought into the community with limited purchases from local suppliers. As a result, the large bridge construction projects have limited indirect economic effects within the community in comparison to the relatively large capital cost. Most of the indirect effects in the region will occur within the City of Ketchikan since it is the major commercial hub of southern southeast Alaska. A limited amount of transactions will occur in Saxman. Explosives that may be required for bridge construction would move through the Saxman Seaport, and trucking and warehousing companies located at the seaport could store construction equipment and materials. The Cape Fox Hotel, which is owned by the Cape Fox Corporation located in Saxman, would also be expected to benefit from increased economic activity in the Ketchikan area resulting from construction of the bridge alternatives.

The ferry alternatives have indirect effects and labor income that is lower than the bridge alternatives, but which is still relatively large compared to the total expenditures for the ferries. This is largely due to the anticipated construction of the ferries at the Ketchikan Shipyard with associated high levels of local employment, and the anticipation that local construction firms could undertake much of the related construction activity. The distribution of these indirect effects would be expected to be similar to those described for the bridge alternatives.

Table 2-5. Total Indirect Effects of Construction and Acquisition Activities by Alternative

Alternatives	Output (Millions of 2003$)	Labor Income (Millions of 2003$)
Bridge Alternatives		
C3(a)	$17.6	$6.7
C3(b)	$15.1	$5.8
C4	$18.6	$7.1
D1	$13.8	$5.3
F1	$21.8	$8.2
F3	$19.7	$7.4
F3 with channel modifications	$21.9	$8.6
Ferry Alternatives		
G2	$9.3	$3.6
G3	$10.0	$4.3
G4	$9.4	$3.4
No Action Alternative	n.a.	n.a.

n.a. Not applicable; not a result of the Gravina Access Project.

Fiscal Effects

This section reports the projected local government revenues generated from the construction and acquisition activities. The IMPLAN model uses state and borough-level data sources as well as the *Annual Survey of Government Finances* in estimating the state and local government revenues that can result from additional economic activity in the region.

Based on the social accounts of the region, construction and acquisition of the build alternatives can potentially generate additional government revenues of between $1.2 million (D1) to $2.0 million (F3) (see Table 2-6). These estimates include indirect business taxes such as excise taxes, property taxes, fees, licenses, and sales taxes paid by business. The estimates also include payments to state and local governments from the household sectors for estate and gift taxes, motor vehicle licenses, property taxes, and other taxes, fees, and charges including fishing and hunting fees. Unemployment taxes from both sectors are also included. IMPLAN does not provide a means to separate local government revenue estimates between the Ketchikan Gateway Borough, the City of Ketchikan, and the City of Saxman.

Table 2-6. Potential State and Local Government Revenues from Construction and Acquisition Activities

Alternatives	Government Revenues (Millions of 2003$)	
Bridge Alternatives	State	Local Government
C3(a)	0.6	0.8
C3(b)	0.6	0.7
C4	0.7	0.9
D1	0.5	0.7
F1	0.9	1.0
F3	0.8	0.9
F3 with channel modifications	0.9	1.1
Ferry Alternatives		
G2	0.6	0.7
G3	0.7	0.8
G4	0.6	0.7
No Action Alternative	n.a.	n.a.

n.a. Not applicable; not a result of the Gravina Access Project

2.2 Operations Effects

In addition to the local economic effects arising from construction spending, there would be further expenditures and other effects from the operations and maintenance of an access alternative. The presence of a bridge may also have direct effects on cruise ship and aviation operations, as well as indirect effects including additional economic activity occurring in Ketchikan as a result of spending on operations and maintenance, changes in visitor spending, and effects on regional economic development.

2.2.1 Direct Effects

Operations and Maintenance Effects

Selection of any of the alternatives will require annual expenditures to operate and maintain the facilities and equipment. The operating costs of the ferry alternatives result in substantially larger annualized costs over the study period. Table 2-7 provides an estimate of operations and maintenance expenditures on an annualized basis to account for the periodic nature of some maintenance activities.

Table 2-7. Annualized Operations and Maintenance Costs

Alternatives	Annual Amount (Millions of 2003$)
Bridge Alternatives	
C3(a)	0.2
C3(b)	0.2
C4	0.2
D1	0.1
F1	0.1
F3	0.1
F3 with channel modifications	0.1
Ferry Alternatives	
G2	3.3
G3	3.3
G4	3.3
No Action Alternative	2.1

Source: Gravina Access Project cost estimate received from HDR on April 25, 2003.

Note: The annualized operations and maintenance cost includes annual operating and maintenance costs, but do not include periodic replacement and major rehabilitation costs for the improved ferry alternatives since those costs are included in Table 2-5.

Changes in Cruise Ship Operations

The various ferry alternatives and the high bridge Alternatives C3(a), C4, and F1 are not anticipated to have any discernible effect on cruise ship operations. Alternative F3, which has a low bridge over East Channel, will require cruise ships to use West Channel, which they use infrequently at present because of the greater perceived risk. Alternative F3 would also require additional maneuvering time for cruise ships to enter and exit via West Channel. If the West Channel were modified as part of Alternative F3, the cruise ships would still have additional maneuvering time, but the dredging is expected to reduce the perceived risk and this alternative would not have any discernible effect on cruise ship operations. The low bridge options C3(b) and D1 will provide 120 feet of air draft (clearance) across Tongass Narrows, which will prevent the passage of large cruise ships. Alternatives C3(b), D1, and F3 without channel modifications may necessitate routing changes, additional maneuvers, and higher cruising speeds (and fuel costs) by the cruise lines to regain time involved in the routing changes and maneuvers at Ketchikan. Because cruise ships receive substantial revenues from commissions on the on-board sale of shore excursions and attractions, the potential loss of port time may reduce opportunities for shore excursions, and their operators may choose to reduce port calls in Ketchikan as a result.

The *Effects on Cruise Ship Operations* Draft Technical Memorandum prepared by Klugherz & Associates and Northern Economics for the Gravina Access Project provides a detailed explanation of the additional fuel costs that cruise ships might incur with the various alternatives, and the manner in which the alternatives may result in reduced cruise-related spending. Table 2-8 summarizes the information presented in that technical memorandum. The estimates are based on the potential effects of the alternatives on cruise activity that occurred in 2001. If no channel modification were included in Alternative F3, it is assumed that there would be a 4 percent reduction in cruise ship port calls to Ketchikan for an initial two to three year period after East Channel is closed to cruise ships. After the initial adjustment period, some cruise lines would have more experience operating in West Channel and some companies that initially sent their vessels around Gravina Island or reduced port calls in Ketchikan would begin to use West Channel and return to Ketchikan, the end result being a 2 percent reduction in cruise ship port calls to Ketchikan. This analysis uses the lesser amount because it is assumed that the cruise lines would gain their experience in operating in West Channel during the periodic closures of East Channel in the two-year construction period. It is anticipated that the periodic nature of the closures, and some ability to schedule closures, would mitigate the potential reductions in spending during the initial adjustment period. Modification of the West Channel with Alternative F3 would result in no reduction in port calls and have no effect on cruise-related spending.

Table 2-8. Effects on Annual Cruise-Related Spending

Alternatives	(Millions of 2003$)		
	Low	**Medium**	**High**
Bridge Alternatives			
C3(a)	0	0	0
C3(b)	(0.7)	(2.2)	(5.2)
C4	0	0	0
D1	(0.7)	(2.2)	(5.2)
F1			
F3	(0/0)	(3.2/1.5)	(10.9/5.5)
F3 with channel modifications	0	0	0
Ferry Alternatives			
G2	0	0	0
G3	0	0	0
G4	0	0	0
No Action Alternative	0	0	0

Source: *Gravina Access Project Effects on Cruise Ship Operations Draft*, 2002.

The effects of this potential reduction in spending are further discussed in Section 2.2.2 and the subsection entitled "Fiscal Effect on Local Governments."

Aviation Effects

The construction of a bridge alternative may lead to changes in or the elimination of the Special Visual Flight Rules (SVFR) clearance that currently governs some air traffic in the Ketchikan area.[8] Note that about 1.89 percent of the annual aircraft operations in the Ketchikan area are conducted under SVFR conditions.

The FAA anticipates that some type of change should be expected under all of the bridge alternatives, but the level of impact varies with the alternatives. Those alternatives located at the airport would have the greatest impact on aircraft operations. However, it is anticipated that air charter operators and others will seek modification of the SVFR or changes in operating procedures to offset the presence of the bridge alternatives and the potential adverse impacts on their businesses. To account for this uncertainty, there is a wide range of probabilities for the various scenarios. Table 2-9 shows the assumed reduction in the number of SVFR operations (takeoffs and landings) that might occur with changes in the SVFR clearance under the three scenario levels for the bridge alternatives. Information on the derivation and calculation of these estimates is presented in Appendix B.

[8] A decision has not yet been made regarding modification or elimination of the SVFR clearance if a bridge is constructed. Safety considerations will be the main decision factor, but it does not appear that manmade structures are associated with many aircraft accidents in Alaska. According to data from the National Transportation Safety Board, there were 9 aircraft crashes in Alaska between 1983 and 2001 that occurred when a plane or helicopter struck a building, tower, and other manmade structure. A brief synopsis of each crash is shown in Appendix B. None of those crashes involved a bridge.

Table 2-9. Reduction in Number of Operations Conducted Under SVFR Clearance With Bridge Alternatives

	(Percent)		
Alternative(s)	Low	Medium	High
C3(a), C3(b), C4, D1	0	50	100
F1	0	10	20
F3	0	5	10

The effect of these assumptions regarding the number of SVFR operations on aviation-related spending in the Ketchikan Gateway Borough is shown in Table 2-10. The estimated direct loss to the Ketchikan economy of these eliminated trips ranges up to $669,000 per year. To the extent that some passengers who might be affected by changes in the SVFR clearance would not take flightseeing charters because their cruise ship would not call at Ketchikan or would have less time in port with Alternatives C3(b), D1, and F3, this estimate may overstate the monetary effect on the community for those alternatives.

Table 2-10. Net Effects on Annual Aviation-Related Spending

	2003$		
Bridge Alternatives	Low ($)	Medium ($)	High ($)
C3(a), C3(b), C4, D1	0	(334,500)	(669,000)
Alternative F1	0	(66,900)	(133,800)
Alternative F3	0	(33,450)	(66,900)

The estimated reduction in revenue from loss of the SVFR clearance would primarily accrue to businesses located within the limits of the City of Ketchikan since the aviation businesses are located in the city. If adverse weather conditions prevent cruise ship passengers from taking flightseeing tours, they may undertake other activities such as visiting the Totem Pole Park in Saxman or shopping in the community.

2.2.2 Indirect Effects

Cruise-related Effects

The potential reductions in cruise ship port calls or time in port will have subsequent effects on spending by cruise passengers, crew, and the ships while they are in port, and will have indirect effects on the local economy. The extra fuel cost for cruise ships will not have a similar effect on the community since cruise ships do not purchase fuel in Ketchikan. Table 2-11 shows the total annual change in the local economy resulting from the reduced cruise-related spending associated with Alternatives C3(b), D1, and F3, under low, medium, and high cases.

Table 2-11. Total Estimated Annual Changes in Output, Value-Added, and Employment Effects of Cruise-Related Activities by Alternative

Scenario/Alternatives	(Millions of 2003$) Output	(Millions of 2003$) Value added	Employment
Low Case			
C3(b)	(0.9)	(0.6)	(20)
D1	(0.9)	(0.6)	(20)
F3	0.0	0.0	0
Medium Case			
C3(b)	(2.7)	(1.9)	(60)
D1	(2.7)	(1.9)	(60)
F3	(1.9)	(1.3)	(40)
High Case			
C3(b)	(6.4)	(4.4)	(140)
D1	(6.4)	(4.4)	(140)
F3	(6.9)	(4.7)	(150)

Note: Estimated impacts include direct and secondary (indirect plus induced) effects. See Appendix B for more information.

The effects of these bridges on cruise ships will begin during construction of the bridges. It is anticipated that construction activities for all of the bridge alternatives in the first few years of construction will result in periodic closure of the affected navigation channels to large cruise ship traffic in those years, and full closure of Tongass Narrows by Alternatives C3(b), D1, and F3 sometime in the second year. Construction of Alternative F3 will result in periodic closures of West Channel to cruise ship traffic in the first year of construction, and periodic closures of East Channel in the second and third year, with full closure of East Channel to large cruise ship traffic sometime in the third year.

Aviation Effects

Selection of a bridge alternative could change or eliminate the SVFR clearance that presently exists in the Ketchikan area and reduce spending in the community. Table 2-12 shows the total (direct and secondary) changes in spending potentially associated with changes in the SVFR clearance. To the extent that some passengers who might be affected by changes in the SVFR clearance would not take flightseeing charters because their cruise ship would not call at Ketchikan, or would have less time in port with Alternatives C3(b), D1, and F3, this estimate may overstate the monetary effect on the community for those alternatives.

Table 2-12. Total Annual Estimated Output, Value-added, and Employment Effects of Changes in Aviation Activities

Scenario/Alternatives	(Thousands of 2003$)		Employment
	Output	Value-added	
Low Case			
C3(a), C3(b), C4, D1	0	0	0
Alternative F1	0	0	0
Alternative F3	0	0	0
Medium Case			
C3(a), C3(b), C4, D1	(387)	(259)	(4)
Alternative F1	(77)	(52)	(1)
Alternative F3	(39)	(26)	0
High Case			
C3(a), C3(b), C4, D1	(774)	(518)	(9)
Alternative F1	(155)	(104)	(2)
Alternative F3	(77)	(52)	(1)

Note: Estimated impacts include direct and secondary (indirect plus induced) effects

Operations

Spending on operations and maintenance activities will also result in additional spending in the community. Table 2-13 shows the projected increase in output, value-added, and employment that could be generated from the annual operations and maintenance of the structures and equipment associated with the alternatives. The value-added includes labor income, other property type income, and indirect business taxes. The total output estimate includes the annual operations and maintenance expenses shown in Table 2-7.

Two numbers are presented for output, value-added, and employment for each alternative in Table 2-13. The first number represents the effects based on expected operations and maintenance spending. The second number reflects the net effect on the local economy. The negative numbers for the ferry alternatives reflect the effect of ferry tolls.

The current operations and maintenance costs of the existing ferry system are financed by tolls on passengers and vehicles. The toll paid by residents reduces the amount of disposable income available for other spending in the community. For example, if $4.1 million in operations and maintenance costs is required for the improved ferry alternatives, then $4.1 million will not be spent in other sectors of the economy. The net effect of these two actions is zero change in the economy. In contrast, the operations and maintenance costs for the bridge alternatives will be paid by the state, so this money coming into the community will create jobs and income. With a bridge alternative, expenditures by passengers for existing ferry tolls will be eliminated, thereby increasing spending elsewhere in the community. However, a bridge alternative will also result in elimination of spending for ferry operations so the net effect will also be zero. As a result, the loss of ferry operations and the gain in spending elsewhere in the community cancel each other out, leaving the benefits provided by state-sponsored operations and maintenance payments.

Table 2-13. Total Estimated Annual Output, Value-added, and Employment Effects of Operations and Maintenance by Alternative

Alternative(s)	Output (Millions of 2003$)	Value-Added (Millions of 2003$)	Employment
C3(a)	0.1/+0.1	0.1/+0.1	<10/+<10
C3(b)	0.1/+0.1	0.1/+0.1	<10/+<10
C4	0.1/+0.1	0.1/+0.1	<10/+<10
D1	0.1/+0.1	0.1/+0.1	<10/+<10
F1	0.1/+0.1	0.1/+0.1	<10/+<10
F3	0.1/+0.1	0.1/+0.1	<10/+<10
F3 with channel modifications	0.1/+0.1	0.1/+0.1	<10/+<10
G2	4.1/-4.1	2.7-2.7	50/-50
G3	4.1/-4.1	2.7/-2.7	50/-50
G4	4.1/-4.1	2.7/-2.7	50/-50
No Action	1.7/-1.7	1.1/-1.10	20/-20

Note: Estimated impacts include direct and secondary (indirect plus induced) effects for operations and toll effects (net effect is zero). Employment numbers are rounded to the nearest ten employees to avoid inferring greater precision.

Regional Economic Development

As part of the Gravina Access Project, Northern Economics has prepared a series of economic forecasts for the Ketchikan Gateway Borough; these are summarized in *Ketchikan Gateway Borough Economic Forecasts*. The mid-range forecast, termed the base case, suggests that the sectors of highest growth until 2025 are likely to be in the trade and services sector that is primarily driven by tourism. Improvements in the Alaska Marine Highway System (AMHS), development of the Inter-Island Ferry Authority, and a new ferry dock for the Metlakatla ferry are likely to attract shoppers and other visitors from parts of southeast Alaska to Ketchikan and Saxman. Increases in tourism are expected because of the anticipated growth in cruise ship visits. Population in the Ketchikan Gateway Borough is predicted to grow slightly more than 1 percent annually during this period.

Although the various alternatives may not alter the magnitude of economic activity in the Ketchikan Gateway Borough significantly, improved ferry service, and particularly a bridge, could create new growth as well as shift some economic activity from Revilla Island to Gravina Island. For example, a bridge could be a catalyst for a new harbor on Gravina Island rather than on Revilla Island, as well as associated commercial and industrial development. This growth may or may not occur in the community with ferry service. Anticipated population growth of just slightly higher than 1 percent annually suggests that some expansion of local housing will occur in the future. If additional land on Gravina Island is available for residential development, then more interest in housing on Gravina would be generated by a bridge than expanded ferry service because of the lower travel cost and increased convenience of a bridge. With expanded ferry service, it is anticipated that most of the additional housing required by a growing population would be located on Revilla Island.

In addition, a bridge along with the availability of additional land on Gravina would likely lower regional land prices and housing costs or, at least, slow their rate of increase over time in the Borough.[9] Lower land costs may stimulate some purchases of homes, or business starts, that would not otherwise have been made. This effect on land costs is certainly beneficial for potential buyers. However, each market transaction requires a seller, too, and landowners would receive lower prices with the sale of their property. With expanded ferry service rather than a

[9] The magnitude of the effect on land prices will depend, in part, on how much additional land becomes available. Although overall regional land prices are likely to fall, those on Gravina would be expected to rise, initially. At present, there are no clear indications how Gravina property owners might react to higher prices, thus there are no indications of the amount of development that might occur.

bridge and base case level of economic activity or below, only limited residential development will occur on Gravina Island in the foreseeable future. It is important to recognize that development of roads and other infrastructure by the Borough will be necessary to achieve more than very modest levels of economic development on Gravina Island by 2025. Without Borough support for expansion of the road network and utilities available on the island, development will be limited.

The availability of large tracts of industrial or commercially zoned land on Gravina Island, at lower prices than on Revilla Island, may attract firms and types of development that are presently constrained by the availability or price of such lands on Revilla Island. Firms that are not presently located in Ketchikan might be attracted to the community with the availability of such land.

Businesses presently operating at the Ketchikan International Airport incur several types of costs with the existing ferry service:

- Air cargo and passengers sometimes miss flights because of ferry delays.
- Deliveries of fuel, cargo, and other goods must be planned in advance, resulting in higher than necessary fuel and goods inventories.
- During extreme tides, fuel tank trucks cannot load onto the ferry and fuel tank trucks are limited on the amount of fuel that can be transported, thus requiring more trips with smaller trucks or trucks that are not loaded to capacity.
- The amount of time the driver and truck spend waiting for and traveling by the ferry could be spent on other more productive activities and improve business operations.
- Seafood products and other goods can only be transported to the airport during the ferry hours of operation, which may not be the most convenient time for seafood businesses, since at the peak of the season they may operate 24 hours per day.
- The ferry toll for delivery trucks (less than 35 feet in length) is $18.00 for a round trip.

Improved ferry service could address the first item in the list, but a bridge alternative could address all of the issues identified by airport businesses. Elimination of these business costs and improvements in efficiency and productivity would result in changes in the Ketchikan economy. Reductions in the travel time for employees could result in more time being available for other more productive endeavors, or a company could elect to reduce labor hours or employees in response to the efficiency gains. The ferry toll has already been discussed (Table 2-13) and benefits to businesses are addressed in *Quantification of User Economic Benefits for the Gravina Access Project* (Appendix A).

High levels of development on Gravina could be achieved with bridge access and high economic growth in the region. However, with high economic growth in the region, it is anticipated that improved ferry access would constrain development on Gravina Island more than a bridge. It is also expected that a bridge would result in higher levels of development on Gravina Island compared to improved ferry service under medium economic growth in the region.

Table 2-14 shows several indicators of the level of economic development on Gravina and Pennock Islands that might be achieved by 2025 with improved access and varying forecasts for economic growth in the Ketchikan Gateway Borough. The development forecasts for Gravina and Pennock Islands were created with the participation of Ketchikan Gateway Borough planning staff, but the results presented here are the responsibility of the consultant team. The indicators shown here represent the estimates of area, population, or employment that would be served by the Gravina Access Project. It is anticipated that development on Gravina and Pennock Islands would occur in areas not served by these alternatives. Access to these unserved areas would continue via private vessels and other means.

Table 2-14. Additional Development within GAP Service Area on Gravina and Pennock Islands, Given Varying Levels of Regional Economic Activity, in 2025

Category	Additional Development		
	Low-development Scenario	Medium-development Scenario	High-development Scenario
Additional Acres of Land Served			
Gravina Island			
No Action Alternative	20	n.a.	n.a.
Alternatives G2, G3, and G4	20	70	n.a.
Alternatives C3(a), C3(b), C4, and D1	20	310	680
Alternatives F1 and F3	20	410	990
Pennock Island (F1 and F3 Only)	0	80	130
Total (F1 and F3 Only)	20	490	1,120
Additional Housing Units Served			
Gravina Island			
No Action Alternative	15	n.a.	n.a.
Alternatives G2, G3, and G4	15	50	n.a.
Alternatives C3(a), C3(b), C4, and D1	15	290	600
Alternatives F1 and F3	15	380	900
Pennock Island (F1 and F3 Only)	0	80	130
Total (F1 and F3 Only)	15	460	1,030
Additional Population Served			
Gravina Island			
No Action Alternative	40	n.a.	n.a.
Alternatives G2, G3, and G4	40	130	n.a.
Alternatives C3(a), C3(b), C4, and D1	40	730	1,540
Alternatives F1 and F3	40	980	2,300
Pennock Island (F1 and F3 Only)	0	190	330
Total (F1 and F3 Only)	40	1,170	2,630
Additional Employment Served			
Gravina Island			
No Action Alternative	10	n.a.	n.a.
Alternatives G2, G3, and G4	10	50	n.a.
Alternatives C3(a), C3(b), C4, and D1	10	50	180
Alternatives F1 and F3	10	60	200
Pennock Island (F1 and F3 Only)	0	<10	10
Total (F1 and F3 Only)	10	60	210

[1] Permanent, year-round residents in 2025 that are served by the access alternatives; residents of Gravina and Pennock Islands living beyond the anticipated road network are not counted in the population numbers; with a bridge alternative a large population is expected to have seasonal or second homes on Gravina Island.

[2] Calculated as the incremental number of jobs above the No Action low case for the 2006 to 2025 time period.

n.a. Not applicable. These alternatives are not anticipated to result in this level of growth on Gravina Island.

As noted previously, much of the growth on Gravina or Pennock Island represents a transfer of development that would have occurred on Revilla Island, and not necessarily new growth to the region.

Alternatives F1 and F3 are located south of the other alternatives and will result in more development in south Ketchikan and Saxman, and on the southern portion of Gravina Island, than would otherwise occur with the other build alternatives. Over time, a portion of the workers at the Ketchikan International Airport that may not wish to move to Gravina Island could locate south of Ketchikan to avoid commuting through the center of Ketchikan, and businesses could locate south of Ketchikan in response to increased traffic volumes and population. A planned south Ketchikan school would further accelerate development in this area of Revilla Island. A portion of the growth occurring in the south part of Revilla Island would be a transfer of development that might otherwise occur near Point Higgins and other locations north of Ketchikan.

Selection of F1 or F3 will likely result in substantial growth in Saxman, even if tourism-related activities are somewhat adversely affected by reduced tourism spending associated with F3. However, the future development pattern for the community may have more retail and trade activity to support local population than the current tourism-oriented vision and, under F3, the community could experience a slight reduction in income, employment, and revenues until the population-serving activities and services were developed in the community.

Additional Infrastructure and Government Services

The Gravina Access Project is not anticipated to result in any significant long-term development in the Ketchikan area. Development on Gravina or Pennock Islands will primarily be a transfer of growth that would have otherwise occurred on Revilla Island. As a result, the location of additional infrastructure and where government services are provided will change, but the total amount of such infrastructure and services will not be significantly affected.

Development on Gravina Island would require additional infrastructure and government services. These effects depend on the nature of the development. A high-density residential development, for example, would probably require street lighting and sewage services. Low-density development would probably not. However, separate satellite facilities for police, fire, and other emergency services would almost certainly be necessary if there is substantial residential development. Similar facilities might also be necessary on Revilla Island with increased residential development at Point Higgins and other distant locations. Since the bridge alternatives would result in higher levels of development, the provision of infrastructure and government services on the island would be required sooner with the bridge alternatives. The City of Ketchikan and the Ketchikan Gateway Borough would determine when those services would be provided in the future.

With the No Action alternative or an improved ferry service alternative, a greater portion of regional economic development can be expected to occur on Revilla Island than on Gravina Island. Current development on the periphery of Ketchikan on Revilla Island would likely continue at higher levels with a ferry alternative than with a bridge alternative. Such development will also require additional government services and infrastructure.

Fiscal Effect on Local Governments

The anticipated fiscal effects on local governments from construction of a build alternative were addressed earlier. This subsection describes the fiscal effects during the operating life of an alternative. As noted above, more development on Gravina Island would be expected with a bridge than with improved ferry access or the No Action alternatives. As a result, property values on Gravina would probably increase more with a bridge, thus generating greater property tax revenue for the Borough. Offsetting this effect, to at least some extent, would be probable decreases in property values on Revilla Island as the availability of additional land on Gravina Island lessens demand for land on Revilla Island. The net effect on property tax revenue is uncertain.

Private lands and some structures would be acquired for each of the access alternatives, except for the No Action Alternative. The assessed value of the property (including structures) that might be acquired ranges from approximately $50,000 (Alternative F3) to $4.1 million (Alternative G3) (see Table 2-3). When the property is acquired, it will be taken off the tax rolls for the Ketchikan Gateway Borough, and if located within the City of Ketchikan, from the tax rolls in that government entity. None of the alternatives are anticipated to require lands located within the City of Saxman. The total assessed value of the Ketchikan Gateway Borough is approximately

$980.7 million, and the value for the City of Ketchikan is approximately $566.1 million.[10] The conversion of private lands to public rights-of-way for Alternative G3, which has the highest acquisition cost, will reduce the assessed values, and associated property taxes in the Borough by about 0.4 percent (about $15,300), and by a lesser percentage in the City of Ketchikan. Other alternatives would have lesser impacts than those calculated for Alternative G3.

Bridge Alternatives C3(b), D(1), and F3 (without channel modifications) will result in reductions in cruise-related spending, including flightseeing charters, with lower revenues to businesses in the Ketchikan Gateway Borough, the Borough government, and the Cities of Ketchikan and Saxman. Data in the *Gravina Access Project Effects on Cruise Ship Operations Draft* indicates that total cruise-related spending in the Ketchikan Gateway Borough was about $73.6 million in 2001, with passenger spending accounting for about $60.9 million of the total; the balance is spending by crew and the cruise lines for goods and services purchased in port. Total expenditures by all 2001 summer visitors (cruise and non-cruise) to Ketchikan is estimated at about $115.1 million, using ratios of cruise passenger spending to all summer visitor spending from the statewide *2001 Alaska Visitor Statistics Program Draft* (AVSP) prepared by Northern Economics for the Alaska Department of Community and Economic Development in 2002. Adding the crew and vessel expenditures suggests that total summer visitor industry (cruise passengers, crew, vessels, and other non-cruise visitors) expenditures were about $127.8 million. Other data from the 2001 AVSP suggest that visitors to Ketchikan during the non-summer months spent about $23.5 million in expenditures, for total annual visitor expenditures of about $151.3 million.

The potential cruise-related and aviation-related reductions in 2001 spending anticipated in the Ketchikan Gateway Borough with the bridge alternatives under the low, medium, and high scenarios are presented in Table 2-15. The cruise-related estimates for Alternative F3 reflect the fact that occasional closures of East Channel will occur during the construction period and this period of occasional closures will be part of the anticipated adjustment period for the cruise ship lines. If the West Channel were dredged to improve navigability for cruise ships, Alternative F3 is not anticipated to have any effect on cruise-related spending.

Reduced spending by cruise passengers will affect Saxman, but it is not anticipated that any significant portion of vessel expenditures or crew expenditures would be made in the community of Saxman. In addition, none of the reduction in aviation-related spending is expected to have an effect on the City of Saxman. The anticipated reductions in cruise passenger spending noted above for Alternatives C3(b) and D1 under the medium scenario represent about 2.2 percent of the total summer visitor expenditures of the $115.1 million made in the Ketchikan Gateway Borough in 2001. This percentage is about 1.3 percent for Alternative F3 (without channel modifications). Under the high scenario assumptions, these percentages are about 5.1 percent for Alternatives C3(b) and D1, and 4.9 percent for Alternative F3 (without channel modifications).

Tourism is estimated to account for almost $293,000, or 43 percent, of the $682,000 general fund revenues for the City of Saxman (Rubin, 2002). These tourism-dependent revenues include fees charged to tour operators for visitors they bring to the Totem Park, sales at the city-owned Native Artist Co-operative Store, and sales tax revenues (excluding non-tourism dependent businesses). A reduction of about 2.2 percent in total visitor-related revenues for the City of Saxman would result in a reduction of about $6,500 in total general fund revenues for Alternatives C3(b) and D1 under the medium scenario. The effect of Alternative F3 (without channel modifications) would be about a $3,800 reduction. Under the high scenario assumptions, the potential reduction in revenues would be $14,900 and $14,300 for Alternatives C3(b) and D1, and Alternative F3, respectively.[11]

[10] Alaska Department of Community and Economic Development. *Alaska Taxable 2001*. January 2002.

[11] The Saxman visitor industry businesses only operate during the summer season so reductions in summer expenditures are used in this calculation.

Table 2-15. Potential Spending Reductions for Bridge Alternatives ($Millions)

	Cruise-Related					
Scenario/ Alternative	Passengers	Crew	Vessel	Subtotal	Aviation-Related	Total
Low						
C3(a)	0.0	0.0	0.0	0.0	0.0	0.0
C3(b)	-0.6	0.0	-0.1	-0.7	0.0	-0.7
C4	0.0	0.0	0.0	0.0	0.0	0.0
D1	-0.6	0.0	-0.1	-0.7	0.0	-0.7
F1	0.0	0.0	0.0	0.0	0.0	0.0
F3	0/0	0/0	0/0	0/0	0.0	0/0
F3 with channel modifications	0.0	0.0	0.0	0.0	0.0	0.0
Medium						
C3(a)	0.0	0.0	0.0	0.0	-0.3	-0.3
C3(b)	-1.8	-0.1	-0.3	-2.2	-0.3	-2.5
C4	0.0	0.0	0.0	0.0	-0.3	-0.3
D1	-1.8	-0.1	-0.3	-2.2	-0.3	-2.5
F1	0.0	0.0	0.0	0.0	-0.1	-0.1
F3	-1.2	-0.1	-0.2	-1.5	-0.0	-1.5
F3 with channel modifications	0.0	0.0	0.0	0.0	-0.0	-0.0
High						
C3(a)	0.0	0.0	0.0	0.0	-0.7	-0.7
C3(b)	-4.3	-0.3	-0.6	-5.2	-0.7	-5.9
C4	0.0	0.0	0.0	0.0	-0.7	-0.7
D1	-4.3	-0.3	-0.6	-5.2	-0.7	-5.9
F1	0.0	0.0	0.0	0.0	-0.1	-0.1
F3	-4.6	-0.3	-0.6	5.5	-0.1	-5.6
F3 with channel modifications	0.0	0.0	0.0	0.0	-0.1	-0.1

The bridge alternatives would also affect businesses operating in the Ketchikan Gateway Borough, the City of Ketchikan, and the Borough government. The extent of the reduction would include reduced spending by vessel passengers, crew, ship expenditures while in port, and aviation losses. Under the medium scenario, these reductions in annual visitor expenditures would be less than 2 percent for Alternatives C3(b) and D1, about 0.2 percent for Alternatives C3(a) and C4, and about 1 percent for Alternative F3 (without channel modifications). Alternatives F1 and F3 (with channel modifications) would result in a reduction of less than 0.1 percent.

The Cape Fox Corporation estimates that after 2003, tourism-related revenues will account for 70 to 75 percent of the Corporation's gross revenues (Gigante, 2002). Applying the percentage reductions for total annual visitor expenditures in the medium scenario to the Corporation's tourism-related revenues indicates that gross revenues could decline by about 1 percent annually for Alternative F3 (without channel modifications), less than 2 percent annually for Alternatives C3(b) and D1, and less than 1 percent for the other alternatives. This reduction could affect wages paid to Saxman residents as well as the dividends paid to Cape Fox Corporation shareholders residing in Saxman and elsewhere in the Ketchikan area. The amount of such reduction is uncertain because of the responses that management might make to decreased revenues.

The Ketchikan Gateway Borough and the City of Ketchikan would also experience reduced sales tax revenues as a result of lower spending levels. A previous study (McDowell Group, 2000) indicated that about 85 percent of cruise related expenditures were taxable. Assuming this same percentage is applicable to total annual spending by other segments of the visitor industry, the medium scenario results in reductions of less than 1 percent in sales tax revenues for the City of Ketchikan and the Ketchikan Gateway Borough with Alternative F3 (without channel modifications), less than 2 percent for Alternatives C3(b) and D1, and less than 1 percent for the other alternatives.

2.3 Net Present Value of Changes in Ketchikan Economy

Net present value (NPV) is a method of comparing alternatives that have different timing of expenditures and benefits, and to incorporate the time value of such expenditures and benefits. Net present value can be presented from different perspectives. For example, life cycle costs which show the total expenditures for construction and operations and maintenance of a project, less the remaining equity or salvage value of the facilities at the end of the study period, are often summarized as a net present value in consideration of the different timing of the stream of expenditures. Table 2-16 shows the net present value of the expenditures and remaining equity for the life cycle of the alternatives. Greater net present values represent larger costs to the funding agencies over the life of the project.

Table 2-16. Life Cycle Costs

	(Millions of 2003$)		
Alternative(s)	**Expenditures**	**Remaining Equity (Salvage Value)**	**Net Present Value**
C3(a)	189.2	30.9	158.3
C3(b)	158.2	25.4	132.8
C4	185.2	27.6	157.6
D1	122.9	16.9	106.1
F1	219.9	28.6	191.4
F3	196.9	28.6	168.4
F3 with channel modifications	207.9	28.6	179.4
G2	94.7	4.7	90.0
G3	1027	4.7	98.0
G4	94.7	4.7	88.0
No Action	16.9	4.3	12.6

Source: *Gravina Access Project Cost Estimate Summary* spreadsheet provided by HDR on April 25, 2003.

Note: The discount rate used in the NPV analysis is a 4.2 percent real (excluding inflation) rate. This rate is from the *Office of Management and Budget Circular A-94* supplement issued November 2001 and is applicable to all federally funded projects until the next supplement is issued.

A net present value analysis can also be used to assess the alternatives from the perspective of the greater Ketchikan community. While expenditures by the funding agencies for construction of an access improvement represent a cost, those expenditures occurring in Ketchikan are a benefit to the community. Reductions in cruise-related or aviation-related expenditures represent a cost to the community. Operations and maintenance of the ferry alternatives contains both benefits and costs. A toll on ferry riders to support operations and maintenance of a ferry system is a transfer from other spending by local residents to the ferry system, and is a cost to other sectors of the local economy. Tolls paid by non-residents represent a benefit to the community. The ferry system has a history of obtaining federal and state grants for new construction and major refurbishments; anticipating this pattern will continue, the grants represent a benefit to the community. Table 2-17 summarizes information presented in the preceding sections and shows the net present value of these revenues and expenditures over the study period to provide another measure of the relative merits of the alternatives. The information includes the direct and indirect effects of the monetary changes as reflected with the I-O model.

Table 2-17. Net Present Value for the Ketchikan Community (Millions of 2003$)

	Alternative										
Scenario	**C3(a)**	**C3(b)**	**C4**	**D1**	**F1**	**F3**	**F3 with channel modifications**	**G2**	**G3**	**G4**	**No Action**
Low	74.6	51.4	81.6	48.9	91.2	84.1	92.9	42.8	48.9	42.0	5.3
Medium	67.9	11.6	74.9	9.1	89.8	51.9	92.3	42.8	48.9	42.0	5.3
High	61.3	(56.7)	68.3	(59.2)	88.5	(32.3)	91.6	42.8	48.9	42.0	5.3

Note: The discount rate used in the NPV analysis is a 4.2 percent real (excluding inflation) rate. This rate is from the *Office of Management and Budget Circular A-94* supplement issued November 2001 and is applicable to all federally funded projects until the next supplement is issued. Annual details for each scenario are provided in Appendix D.

The data shown for each alternative is a sum of annual construction or operations and maintenance expenditures (direct and secondary effects) that occur in Ketchikan, less any direct and secondary reductions in cruise-related or aviation-related spending or other costs to the community. Direct expenditures for materials and labor that are imported into the community for initial construction or replacement and major refurbishment are not included in this table.

3.0 References

Adler, Hans A. January 1987. *Economic Appraisal of Transport Projects*. Published for the World Bank by Johns Hopkins University Press: Baltimore.

Boyle, Melissa A. and Katherine A. Kiel. 2001. "A Survey of House Price Hedonic Studies of the Impact of Environmental Externalities," *Journal of Real Estate Literature* 9, issue 2: 117-144.

Cruise Industry News. 2001. *Cruise Industry News Annual 2001*.

Espy, Molly and Hillary Lopez. Summer 2000. "The Impact of Airport Noise and Proximity on Residential Property Values," *Growth and Change* 31: 408-419.

Federal Highway Administration, U.S. Department of Transportation. Accessed November 2001. *Secondary and Cumulative Effects*. http://www.fhwa.dot.gov/environment/nepa/2nd_cml.htm

Gigante, Peter. June 2002. Chief Executive Officer, Cape Fox Corporation. Personal communication with Northern Economics, Inc.

Glosten Associates, Inc. December 2001. *Monte Carlo Navigation Simulation Technical Memorandum (Draft)*.

Glosten Associates, Inc. December 3, 2001. *Gravina Access Project: Groundings within Natural Channel, Rev. C.*

Glosten Associates, Inc. September 2001. *Cruise Ship Traffic Projections Technical Memorandum*, Draft,

Glosten Associates, Inc. August 28, 2001. Fax to HDR Alaska, Inc. *Running Time and Other Impacts on Large Cruise Ships.*

Glosten Associates, Inc. August 2001. *Technical Memo--Reconnaissance of Vessel Navigation Requirements Report, Gravina Access Project.*

Glosten Associates, Inc. August 2002. *Real Time Navigation Simulation (STAR Center) Study, Draft – Rev. A.*

Gravina Access Project. Accessed October 2001. Website at http://www.gravina-access.com/

HDR Alaska, Inc. November 2001. *Gravina Access Project: Special Visual Flight Rules (SVFR) Analysis-Draft*.

HDR Alaska, Inc. April 2003. *Conceptual Stage Relocation Study and Assessment of Right-of-Way Acquisition Costs.*

HLB Decision Economics, Inc. November 2002. *Gravina Access Project Quantification of User Economic Benefits*.

Klugherz & Associates and the Glosten Associates. November 25, 2001. *Effects on Cruise Ship Operations and Passenger Activities*.

Klugherz & Associates. September 8, 2001. *Cruise Ship Master Interview Summary*, Memo to HDR Alaska, Inc.

Klugherz & Associates. May 31, 2001. *Interim Assessment of Cruise Industry Interviews*, memo to HDR Alaska, Inc.

Klugherz & Associates and Northern Economics, Inc. September 2002. *Effects on Cruise Ship Operations Draft*.

Ketchikan Visitors Bureau. 2001. *2001 Ketchikan Cruise Ship Calendar.*

Mastaglio, Linda. April 1997. "Bridge Bashing," *Civil Engineering* 67, issue 4: 28-41.

McDowell Group. October 2000. *The Economic Impacts of the Cruise Industry in Southeast Alaska*, report prepared for Southeast Conference.

Minnesota IMPLAN Group, Inc. 1999. *Regional Economic Model for the Ketchikan Gateway Borough*.

National Highway Traffic Safety Administration. Accessed November 2001. *Fatality Analysis Reporting System.* Available at http://www-fars.nhtsa.dot.gov/.

National Transportation Safety Board. Accessed December 2001. *Aviation Accident Data Base and Synopses.* Available at http://www.ntsb.gov/NTSB/query.asp

Northern Economics. August 2002. *Gravina Access Project Traffic Projections Technical Memorandum Draft*.

Northern Economics. July 2001. *Ketchikan Community Survey Technical Memorandum.*

Northern Economics. September 2001. *Ketchikan Gateway Borough Economic Forecasts.*

Office of Management and Budget. Accessed November 2001. *Circular No. A-94*, available on the internet at http://www.whitehouse.gov/omb/circulars/a094/a094.html#9.

Rubin, Bob. June 2002. Administrator, City of Saxman. Personal communication with Northern Economics, Inc.

Wilhelmsson, Matt. November 2000. "The Impact of Traffic Noise on the Values of Single-family Houses," *Journal of Environmental Planning and Management* 43; 799-815.

Appendix A

Gravina Access Project
Quantification of User Economic Benefits

Agreement No: 36893013
DOT&PF Project No: 67698
Federal Project No: ACHP-0922(5)

Prepared for:

State of Alaska
Department of Transportation and Public Facilities
6860 Glacier Highway
Juneau, Alaska 99801

and

HDR Alaska, Inc.
712 W. 12th Street
Juneau, AK 99801

Prepared by:

HLB Decision Economics, Inc.
1525 Carling Avenue, Suite 500
Ottawa, Ontario Canada K1Z 8R9

November 2002

Table of Contents

List of Tables

List of Figures

1.0 Summary

1.1 Scope of the Study

This report presents the value of economic benefits projected to arise as a result of each of nine approaches to enhancing access to and from Gravina Island, Alaska. The options involve four airport bridge alternatives; two bridge alternatives crossing Pennock Island; and, in lieu of bridge construction, enhanced ferry services. The nine alternatives are described in Table 1-1.

Table 1-1: Alternative Approaches to Enhancing Access to Gravina Island

Alternative	Description
No-action	Existing ferry service
C3 (a)	200-foot High Bridge – Airport Area to Signal Road
C3 (b)	120-foot High Bridge – Airport Area to Signal Road
C4	200-foot High Bridge – Airport Area to Cambria Drive Area
D1	120-foot High Bridge – Airport Area
F1	Pennock Island Crossing – 200-foot High Bridge over East Channel and 120-foot High Bridge over West Channel
F3	Pennock Island Crossing – 60-foot High Bridge over East Channel & 200-foot High Bridge over West Channel
G2	Ferry Route from Peninsula Point
G3	Ferry Route from Downtown Ketchikan
G4	Ferry Route Adjacent to Existing Ferry

Source: http://www.gravina-access.com/design_center/Default.htm

1.2 Scope of Benefits Considered

All economic benefits arising from improved access to Gravina Island are considered. Benefits arise in two principal categories. The first is standard of living and productivity gains *to existing ferry users*, both autos and truck users. In addition to time savings, existing travelers can expect a change in out-of-pocket costs and, statistically, a change in accident probability rates due to a shift from one mode or level of service to another.

Benefits in the second principal category arise in the form of additional trip making to and from Gravina Island by auto and truck users for whom the costs of access prior to the improvement outweighed the value of opportunities on the other side. Such opportunities can include existing draws such as shops, work places, and social and recreational activities. As well, new opportunities can emerge in response to the new cost-to-value travel equation, leading to yet further "induced demand." This of course is what we call economic development, manifest in the form of new retail outlets, followed by or sometimes led by new residential and workplace development, so on.

The sum of all projected benefits, by category, is given in Table 1-2. As the table shows, with benefits ranging from $52 million to $70 million (in constant dollars) over the period 2003 to 2025, the airport bridge options offer the most significant economic gains. With benefits around 40 percent as much, a bridge from Pennock Island creates significantly less potential for economic gain. New ferry services offer little or no potential for material economic enrichment.

Table 1-2: Projected Economic Benefits of Alternative Approaches to Enhancing Access to Gravina Island (Present values[1] over the period 2003 – 2025, in constant dollars)

	Airport Bridge				Pennock Island Crossing		Enhanced Ferry Service		
	C3(a)	**C3(b)**	**C4**	**D1**	**F1**	**F3**	**G2**	**G3**	**G4**
Economic Benefits to Existing Travelers to Gravina Island	33.2	37.8	38.4	41.5	11.2	9.0	0.0	0.0	2.1
Other Economic Benefits (Including Residential and Commercial Development) and Environmental Effects, on Gravina Island	22.0	24.6	25.8	28.5	15.9	13.6	-0.2	-0.2	-0.2
Total Economic Benefits	55.2	62.3	64.2	70.0	27.1	22.6	-0.2	-0.2	2.0

1. Future values are discounted to the present-day equivalent at 4.2 percent compound, per annum.

The estimates given here represent the economic benefits likely to arise from the improved access to Gravina Island offered by alternative infrastructure (bridge) and service (ferry) improvements. While labor costs (employment) incurred in the construction and delivery of these options is not treated as a benefit, the reduction of any structural (long-term) unemployment in the region's construction sector due to bridge construction would justify treating a portion of the labor value as an economic benefit of the project (namely, the productive use of otherwise unproductive labor resources). The current unemployment rate in Ketchikan is 7.7 percent, approximately 2.0 percentage points above than the national average (signifying possible structural unemployment). It is possible, therefore, that bridge construction would off-set some structurally unemployed labor resources, but to what extent is unknown. As a rough judgment, approximately half of the value of the construction related jobs for residents of Ketchikan might represent economic benefits for the region.

2.0 Introduction

2.1 Proposed Alternatives

There are currently ten alternatives under evaluation for the Gravina Access Project. The no-action alternative and three of the build alternatives involve ferry service. The other six alternatives are bridge options to link the two islands. All options, except no-action, provide for additional road construction on Gravina Island, including a proposed road south and west of the airport. The proposed design of the planned Gravina road varies somewhat with the alternatives. A brief description of the alternatives is provided below.[1]

- **No-action:** Under this alternative there would be no change in access between Gravina and Revilla Islands. The current ferry service would continue without change.

- **C3(a):** A bridge with 200 feet of vertical clearance to allow the one-way passage of large cruise ships would connect the two islands. The bridge access road would meet Signal Road on Revilla Island. The bridge would cross the Tongass Narrows to Gravina Island landing north of the airport terminal, then turn to the south, parallel to the airport runway, where it would connect with the planned Gravina road at the south end of the airport.

- **C3(b):** The alignment of this bridge option is very similar to that of C3(a). The primary difference is that the maximum vertical clearance of the bridge would be 120 feet, a distance sufficient for Columbia class ferries but not for large cruise ships. Road access on Revilla and Gravina Islands would be essentially the same as C3(a).

- **C4:** This alternative provides for a bridge with a vertical clearance of 200 feet, sufficient for large cruise ships. Near Gravina Island, this bridge has essentially the same alignment as C3(a). On Gravina Island the bridge would connect with the planned Gravina road south of the airport. On Revilla Island, the proposed bridge access road would connect with Tongass Avenue just north of Cambria Drive.

- **D1:** This option calls for a bridge having a vertical clearance of 120 feet, insufficient for the passage of large cruise ships. The Gravina Island portion of this alternative would be very similar to that of the four preceding bridge alternatives in that the bridge would connect to the planned Gravina road on the south side of the airport. On Revilla Island the bridge access road would intersect Tongass Avenue near Cambria Drive.

- **F1:** This alternative entails bridge with a vertical clearance of 200 feet across the east channel of the Tongass Narrows from Revilla Island to Pennock Island. This bridge would be connected by a road across Pennock Island to a 120-foot high bridge across the west channel between Pennock Island to Gravina Island. The road across Pennock Island would not provide access for Pennock Island residents. On Gravina Island, another road would be constructed from the proposed Gravina road near the airport to the west channel bridge.

[1] Gravina Access Project Economic Impact Assessment Draft, Northern Economics Inc., September 2002

- **F3:** This alternative would involve construction of a bridge across the east channel of the Tongass Narrows from the South Tongass Highway to Pennock Island. This bridge would have a vertical clearance of 60 feet, thus precluding use of the east channel by cruise ships and Alaska State ferries. A road across Pennock Island would connect this bridge with a bridge with 200 feet of vertical clearance, sufficient for cruise ship passage, across the west channel of the Tongass Narrows. The road across Pennock Island would not provide access for Pennock Island residents. On Gravina Island, another road would be constructed from the proposed Gravina road near the airport to the west channel bridge.

- **G2:** Ferry service for vehicles and pedestrians would be established between Peninsula Point on Revilla Island and Lewis Point on Gravina Island. New terminals would be built in both locations. A new road would be constructed to link Lewis Point on Gravina Island with the planned Gravina road. Current ferry service would continue without change.

- **G3:** A new ferry route between Ketchikan and a location just south of the airport would be established. On Revilla Island a new terminal would be constructed between the Plaza, a mall, and Bar Harbor. On Gravina Island this option would involve a new terminal and another road connecting the terminal to the proposed Gravina road. Current ferry service would continue without change.

- **G4:** Ferry service along the current route would be expanded with the construction of new terminals near the present terminal sites on Revilla and Gravina Islands and the addition of two ferries. A connecting road from the new terminal to the proposed Gravina road would be constructed as part of this alternative. Current ferry service would continue without change.

These ten alternatives are summarized in the table below:

Table 2-1: Gravina Access Project Alternatives

Alternative	Description
No-action	Existing ferry service
C3 (a)	200-foot High Bridge – Airport Area to Signal Road
C3 (b)	120-foot High Bridge – Airport Area to Signal Road
C4	200-foot High Bridge – Airport Area to Cambria Drive Area
D1	120-foot High Bridge – Airport Area
F1	Pennock Island Crossing – 200-foot High Bridge over East Channel and 120-foot High Bridge over West Channel
F3	Pennock Island Crossing – 60-foot High Bridge over East Channel & 200-foot High Bridge over West Channel
G2	Ferry Route from Peninsula Point
G3	Ferry Route from Downtown Ketchikan
G4	Ferry Route Adjacent to Existing Ferry

Source: http://www.gravina-access.com/design_center/Default.htm

2.2 Background

The Alaska Department of Transportation and Public Facilities (DOT&PF), in cooperation with the Federal Highway Administration, is pursuing alternatives for improving access between Revillagigedo (commonly called Revilla) Island and Gravina Island in Southeast Alaska. This project, called the Gravina Access Project, is one of 16 high priority projects funded in the state under the Federal Transportation Equity Act for the 21st Century (TEA-21).

The project involves examining ways to link Revilla Island, home of Ketchikan, Saxman, and other communities, to Gravina Island, the location of the Ketchikan International Airport and adjoining lands that offer recreational and development potential. Currently, a small ferry across Tongass Narrows provides the only regular access to Gravina Island and it is dedicated solely to airport use. Access to the remainder of the island is not available except by watercraft. Improved transportation access to Gravina Island would provide better service to the airport and allow for development of the large tracts of land situated on the island.[2]

2.3 Approach

HDR Alaska has contracted HLB Decision Economics to evaluate the user benefits of the various access alternatives relative to the existing ferry service. The value of user benefits will be manifested in the economic development value that each of the Gravina access alternatives provide. The results of this analysis will be used to augment the Economic Impact Assessment of the Gravina Access Project conducted by Northern Economics, Inc. that considers other direct and indirect effects on the local economy of each of the Gravina access alternatives.

The modelling framework developed used by HLB in assessing user benefits in this study analyzes each of the bridge and ferry alternatives in relation to the existing ferry service between Revilla Island and Gravina Island. The following benefit categories are estimated:

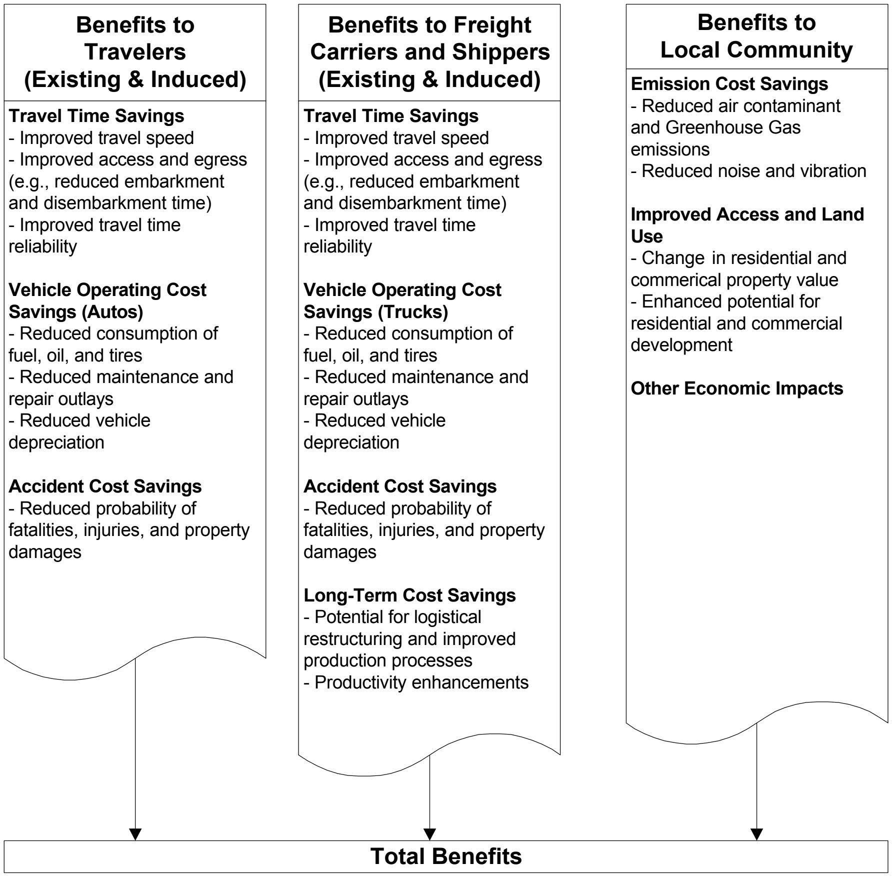
- Benefits to travelers (including travel time savings, vehicle operating cost savings, and safety benefits);
- Benefits to freight carriers and/or shippers; and
- Benefits to the local community.

Benefits such as operating and maintenance cost savings for the ferry operator were not evaluated, as these effects are already included in the Economic Impact Assessment conducted by Northern Economics, Inc.

This general modelling framework is illustrated in Figure 2-1.

[2] Project Description, The Gravina Access Project website (http://www.gravina-access.com/projdescrip.asp)

Figure 2-1: Overview of Benefit Analysis Approach



2.4 Key Assumptions

HLB utilized its StratBENCOST model to evaluate each of the Gravina access alternatives. As StratBENCOST is a strategic decision support tool for highway planning and budgeting, many of the relationships in the model were adjusted to accommodate the existing and enhanced ferry alternatives.

The following background information on data sources and assumptions utilized in the evaluation should be noted:

- For many of the model parameters such as the value of time, vehicle operating costs, etc., default StratBENCOST values were utilized. Typically these default values are sourced from Federal Highway Administration reports and databases.

- HLB did not independently estimate passenger and vehicle demand for any of the Gravina Access alternatives. Northern Economics, Inc.[3] provided the demand forecast. HLB used the "Trips G-Low" scenario to represent demand under the existing ferry service. For all other alternatives, HLB utilized the "Trips G-Med" scenario as the median demand forecast.[4]

- Travel time savings estimates, trip distances and average ferry tolls were provided to HLB by HDR Alaska.

- Traffic counts by vehicle class were not readily available. For the ferry services, truck traffic was assumed to represent 7 percent of total vehicles. For the bridge alternatives, it was assumed that truck traffic represented 9 to 10 percent of total traffic. A significant proportion of the increase in traffic for the bridge alternatives was business related.

- The alternative access arrangement is assumed to be in place by 2006. Benefits are estimated for the period 2006-2025 and are presented in 2003 $.

- A real discount rate of 4.2% is used to discount cashflows.

2.5 Organization of Report

After this introductory section, Section 3 provides the benefits estimation framework and the general economic theory behind this estimation. Section 4 provides a brief overview of the demand forecast used in the study. Sections 5 and 6 provide per trip user cost estimates and a summary of the implied price elasticity and a discussion of how it relates to that found in the literature. Finally, Section 7 provides the total user benefits for each of the access alternatives.

Appendix A summarizes the key results from using the alternative demand forecasts. Appendix B provides the detailed parameter values used in the study and Appendix C provides a discussion and review of the concept of induced demand.

[3] Gravina Traffic Model Revised.xls
[4] Alternative results obtained from using the 'Trips G-Low' and 'Trips G-High' demand forecasts are summarized in Appendix A.

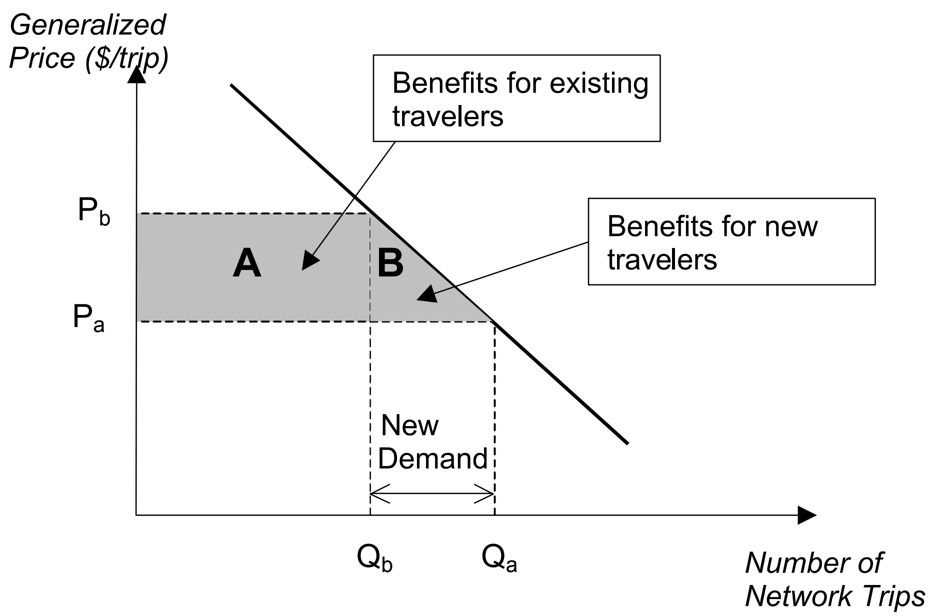
3.0 Benefit Estimation Framework

This section provides a description of the estimation techniques used to derive the benefits of the various access alternatives. For each benefit stream, structure and logic (S&L) diagrams are provided to illustrate how each benefit category is derived.

3.1 Economic Framework for Measuring User Benefits

The primary benefits of most highway and bridge infrastructure projects are benefits that infrastructure users realize through travel time savings and induced demand. The economic framework for measuring these benefits is illustrated in Figure 3-1 below. Under the status quo, users of the current ferry service demand Q_b trips between 12Gravina and Revilla at a generalized trip[5] price P_b.

Figure 3-1: Methodology for Measuring Benefits of Bridge or Ferry Alternative



where:

- P_b is the generalized trip price of the existing ferry service
- P_a is the generalized trip price after the implementation of the alternative access
- Q_b is the number of trips with the existing ferry service
- Q_a is number of trips after implementation of the alternative access

Using the assumption that a new access alternative between the islands results in a reduction in the generalized trip price P_a, we see in Figure 3-1 that the amount of trips demanded increases to Q_a creating two distinct user benefits:

[5] The generalized trip price includes vehicle operating costs, accident costs, ferry tolls, value of travel time, etc.

1. Reduced trip cost for existing travellers; and,
2. Consumer surplus from the new trips.

The reduced trip costs for existing travellers is represented by shaded area A of Figure 3-1. The consumer surplus from new trips, or the difference between what travellers are willing to pay relative to the amount travellers actually pay for new trips, is represented by shaded area B of Figure 3-1.

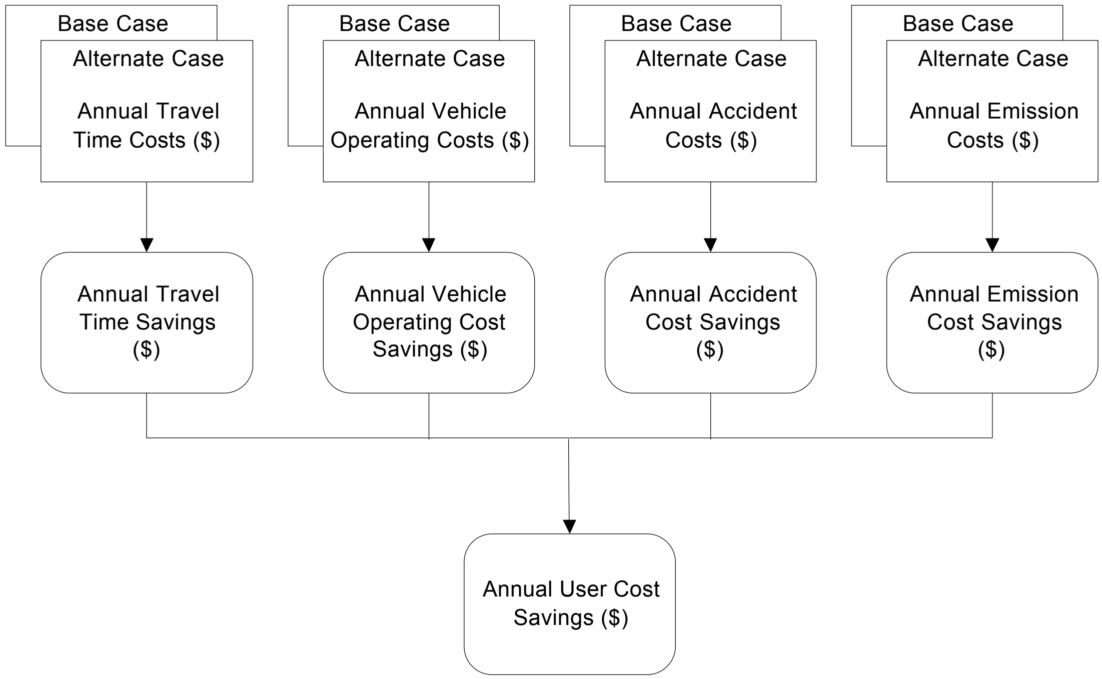
Although the economic benefits (highlighted in areas A and B of Figure 3-1) of improved access to Gravina are measured here in terms of the monetary equivalent value of the time and operating costs to be saved by users of a prospective bridge, and the consumer surplus derived from new trips, it is important to note that the final economic manifestation of such benefits will arise in other forms, including island development. Consider a big box retailer who, prior to bridge access to Gravina, viewed an island location as unlikely to attract sufficient patronage. Following construction of the bridge, the retailer calculates that a sufficient number of people in Ketchikan will find the benefits of big box shopping on Gravina to be greater than the transportation costs of getting to and from the store. A store is opened on the island accordingly. Assuming that the retailer would not have located somewhere else in the Ketchikan region in the absence of the bridge, the new retail activity is clearly an example of the bridge generating new economic value for the community. By valuing the time savings of those choosing to shop at the big box outlet (or, rather, the corresponding trips made by bridge users), we are observing this same value in another guise, the same guise in fact that prompted the retailer's location decision.

It is simply analytic convenience that leads transportation economists to measure the development value of better access through the lens of trip volumes, including new demand, and corresponding time savings. We know something of the trip generating effects of a new bridge in particular geographic circumstances. The alternative, namely to forecast the monetization of each acre of land development because of improved access, when, and so forth, requires a great deal more information and, more significantly, is a great deal less accurate.

3.2 Benefits Estimation Methodology

Figure 3-2 below illustrates a high-level structure and logic diagram describing the overall benefits framework for the access improvements highlighting the various cost elements that are considered in the analysis. For each access alternative considered, including the status quo ferry service (the base case), a generalized cost per trip is estimated including travel time costs, vehicle operating costs, accident costs and emission costs. The methodology used in estimating each of the different user cost components is described in the sections below.

Figure 3-2: Structure and Logic Diagram for Estimating Annual Benefits

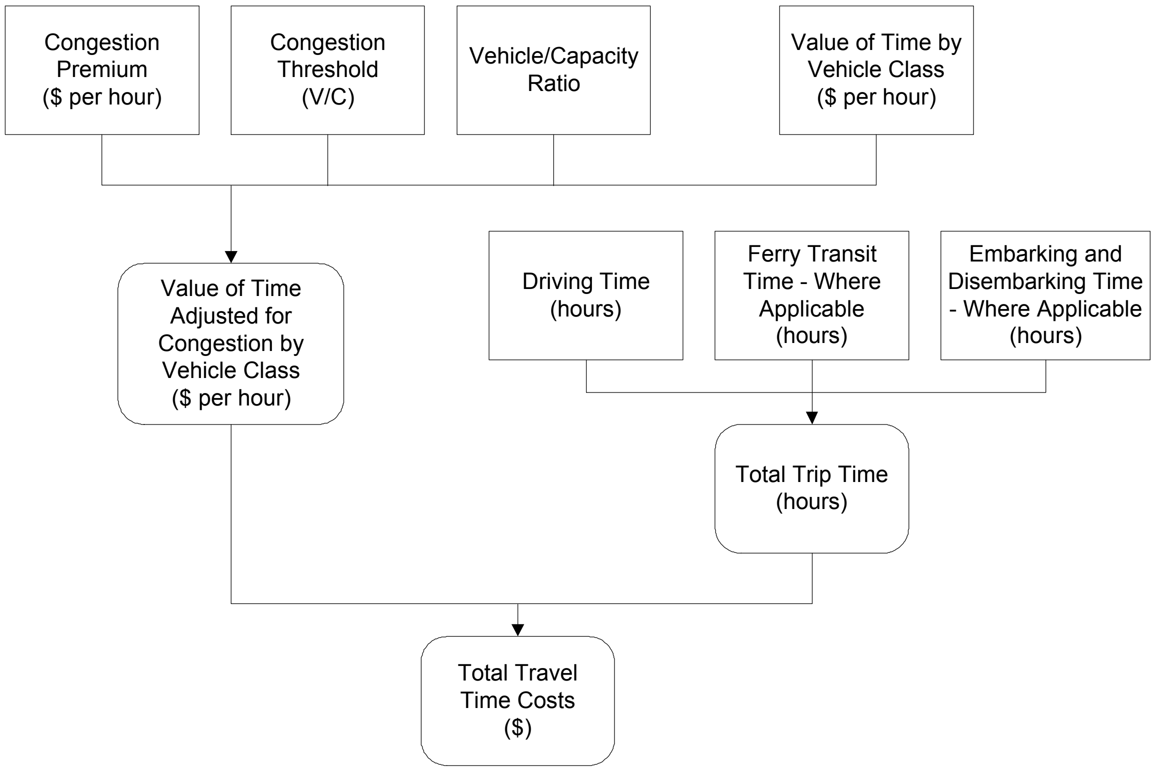


3.2.1 Travel Time Costs

Time costs figure prominently in the economic evaluation of transportation infrastructure projects. The potential time savings from even a minor improvement can translate into significant user cost savings over the life of the investment, depending on the facility type and traffic characteristics.

Travel time costs are derived by first calculating a value of time, adjusted for congestion, for passenger cars and trucks. These values of time, in dollars per hour, are then multiplied by the total trip time. These calculations are performed for both the existing ferry service and each access alternative. For the ferry alternatives, the trip length includes transit time between the islands and embarking and disembarking time.

Figure 3-3: Structure and Logic Diagram for Travel Time Costs



3.2.2 "Out of Pocket" Travel Expenses

Out of pocket travel expenses consist of vehicle operating costs for roadway traffic and ferry tolls where applicable.

Truck and passenger car operating costs are estimated for each access alternative and are multiplied by the average roadway trip length to derive a vehicle operating cost estimate per trip. Vehicle operating costs are an integral element of computing roadway user costs. They generally are the most recognized of the user costs because they typically involve the out-of-pocket expenses associated with owning, operating and maintaining a vehicle. Vehicle operating costs are calculated by multiplying the quantity of each type of resource consumed in the production of transportation services (resources necessary to drive a vehicle from one point to another) by a unit cost of consumption of the resource. The unit costs are marginal costs, net of taxes, subsidies and other transfer payments.

There are five cost components associated with operating a vehicle. They include: fuel consumption, oil consumption, maintenance and repairs, tire wear and roadway related vehicle depreciation. Each component is a unique function of vehicle class, vehicle speed, grade level and surface condition. Thus overall vehicle operating costs can vary significantly between different facility types, geographic areas and traffic patterns.

Figure 3-4: Structure and Logic Diagram for Vehicle Operating Costs

3.2.3 Accident Costs

Safety is a significant component of roadway user costs. Safety represents a principal economic factor in the planning of roads, as well as an important indicator of transportation efficiency. Outside of the economic context, safety is often the object of public concern and a leading social issue. However, since improved safety requires the use of real resources, it competes with alternative goals and aspects of transportation efficiency. The valuation of safety costs, like those of other user costs, can therefore impact the design of transportation infrastructure alternatives and influence the choice of which investments to undertake.

Accident costs are calculated by first calculating accident rates based on the facility type (roadway, bridge, etc.), travel distance and volume. Total accident costs are easily determined by multiplying the cost per accident by the corresponding number of accidents per year. These calculations are performed for each access alternative.

Figure 3-5 provides the structure and logic diagram for deriving roadway accident costs.

Figure 3-5: Structure and Logic Diagram for Roadway Accident Costs

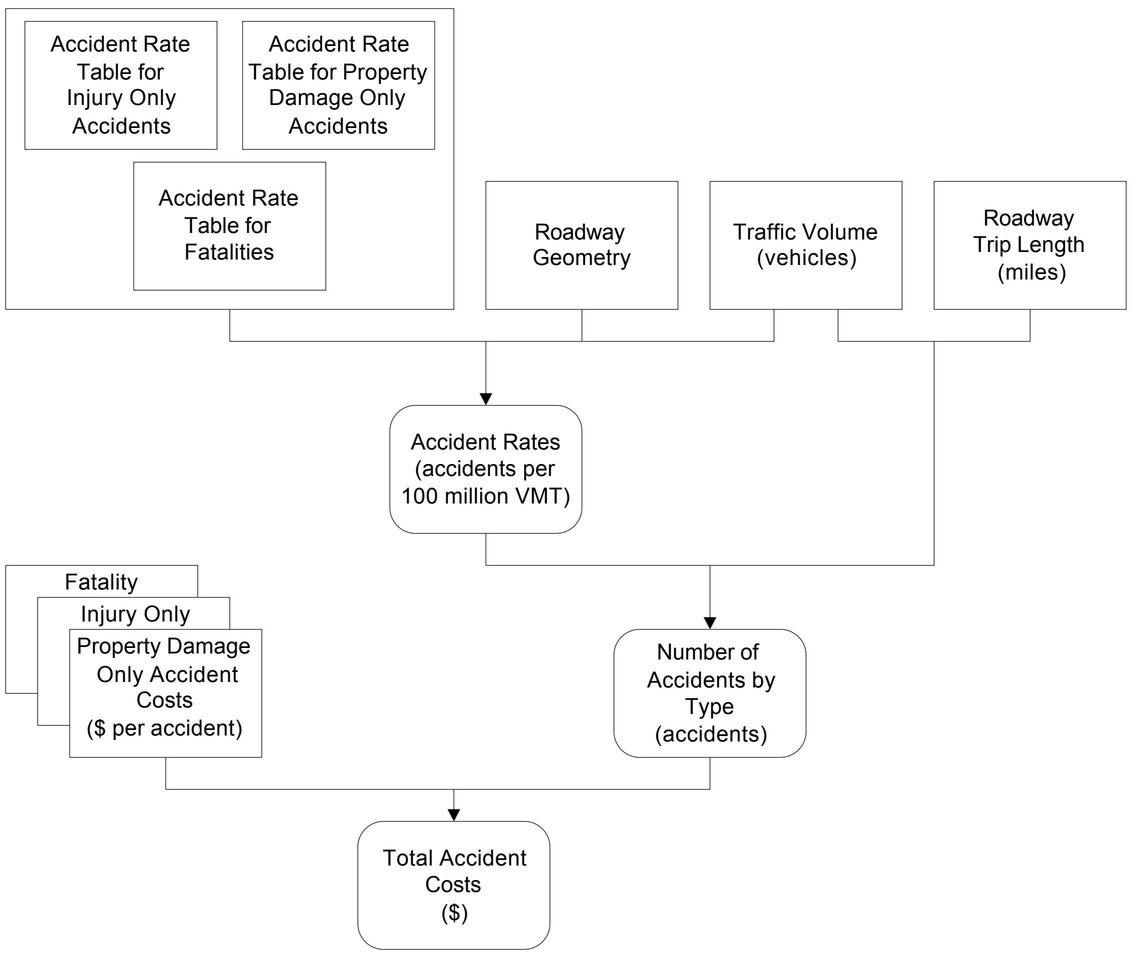
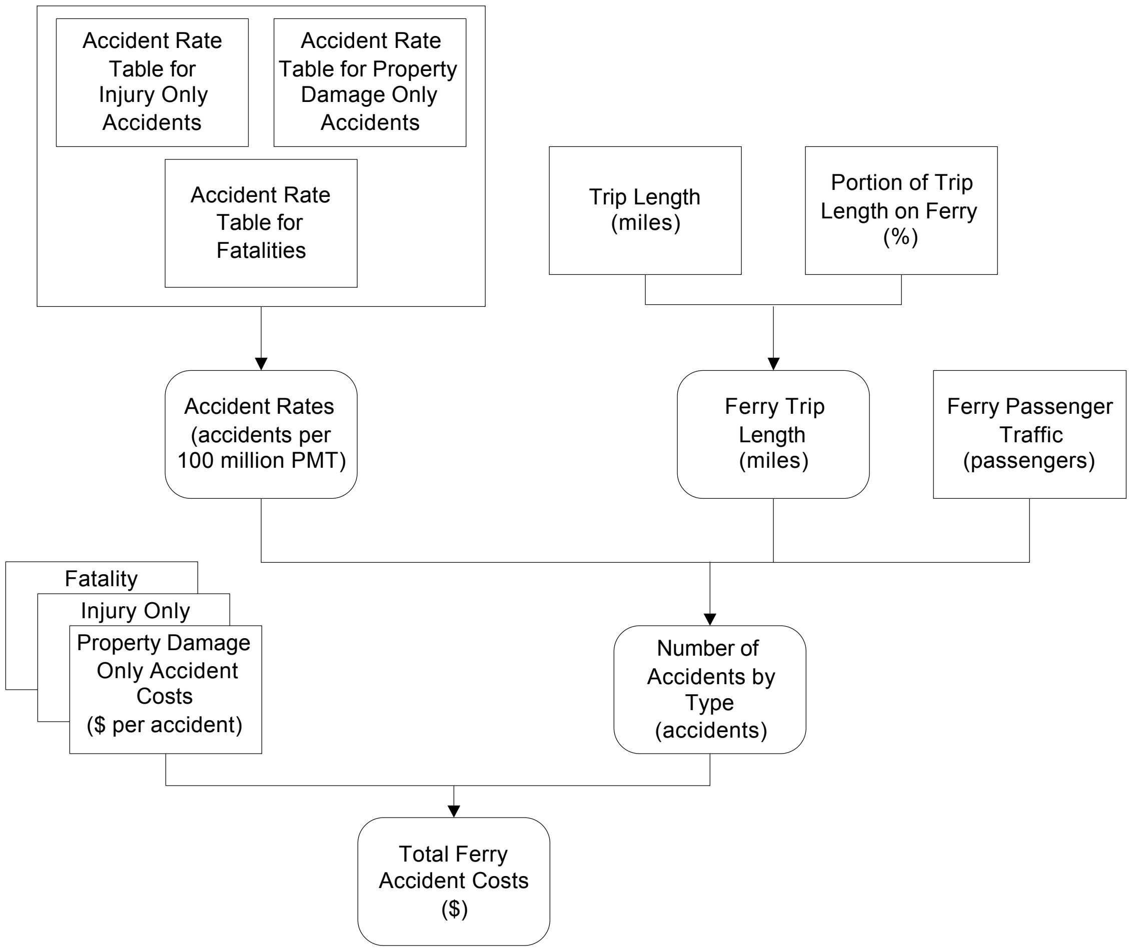


Figure 3-6 below provides the structure and logic diagram for deriving accident costs for the ferry alternatives.

Figure 3-6: Structure and Logic Diagram for Accident Costs (Ferry Alternatives)



3.2.4 Emission Costs

Environmental costs are gaining increasing acceptance as an important component in the economic evaluation of transportation and infrastructure projects. The main environmental impacts of vehicle use, exhaust emissions and vehicle-generated noise, can impose wide-ranging social costs on people, material and vegetation.

For roadway travel, annual emissions are calculated from emission data tables which are based on vehicle class and travel speed. Emissions are calculated per VMT and then multiplied by annual VMT yielding tons of emissions. For ferry travel, emissions are calculated from emissions rates by engine horsepower and load. Total environmental costs are then derived by multiplying by the cost of emissions. This calculation is performed for both the base and alternate case for every year in the analysis period. The difference between the base and alternate case yields total annual net environmental cost savings.

Figure 3-7 provides a sample Structure and Logic Diagram for emission cost estimation for roadway travel.

Figure 3-7: Structure and Logic Diagram for Emission Costs (Bridge Alternatives)

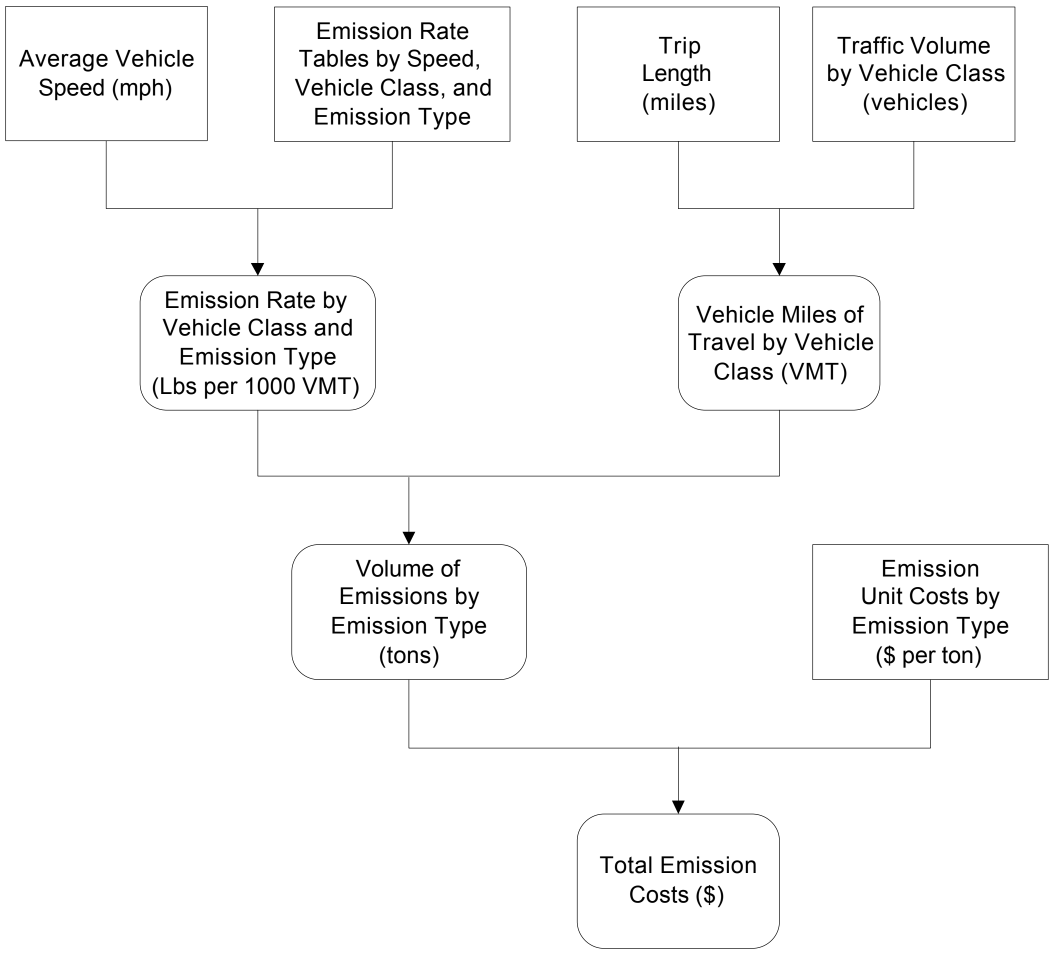
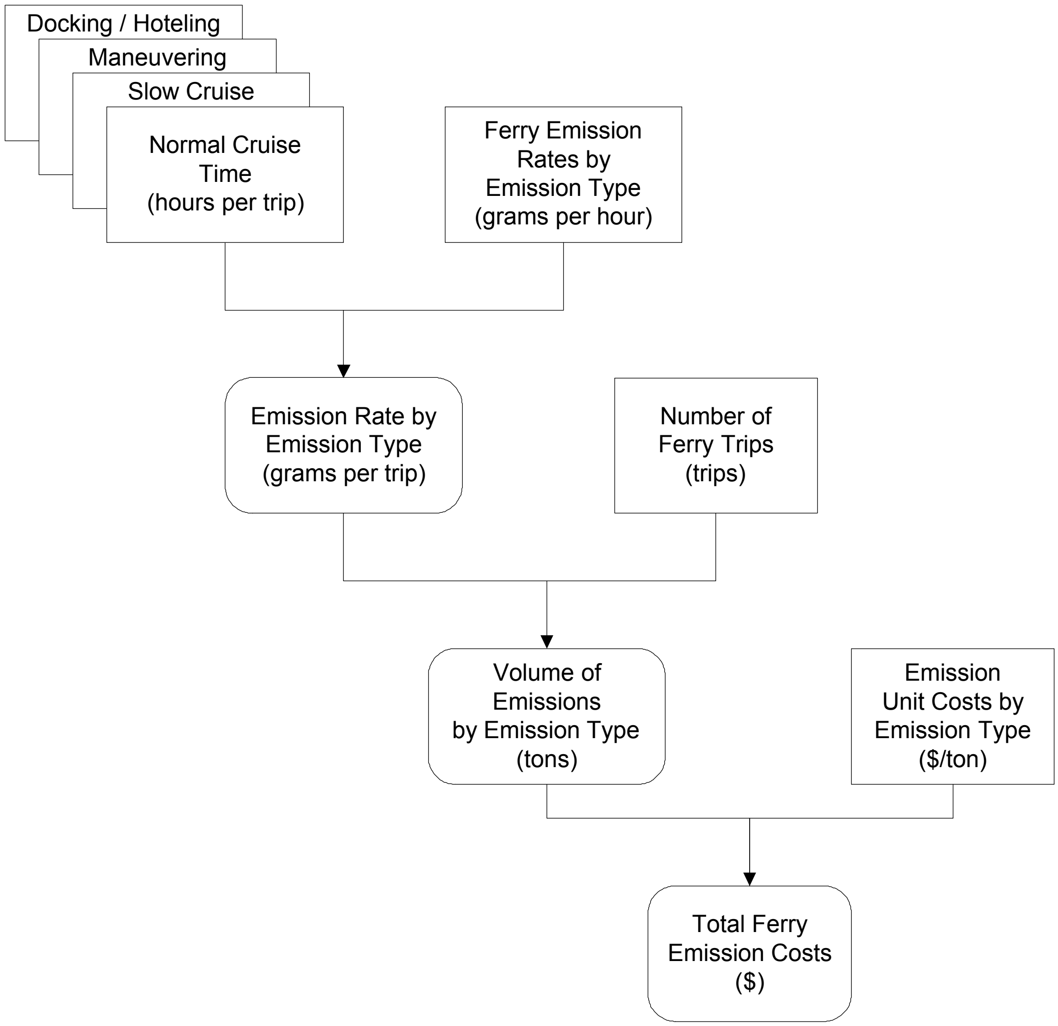


Figure 3-8: Structure and Logic Diagram for Emissions Costs (Ferry Alternatives)



4.0 Demand Forecast

This section provides a very brief overview of the demand forecasts used to derive the total user benefits. The forecast considers four broad alternatives for both passengers and vehicles:

- The existing ferry service;
- An airport bridge alternative;
- A bridge alternative with a Pennock Island crossing; and,
- An enhanced ferry service.

Table 4-1 summarizes the passenger forecasts by Gravina access alternative. Under the existing ferry service, traffic is forecast to grow at an average annual compound rate of 0.7% per year. The bridge alternatives, and in particular the bridge crossing Pennock Island, provide the greatest increase in passenger growth or new demand with demand roughly tripling that of the existing ferry service by 2025. The enhanced ferry service is forecast to increase passenger growth by 0.5% per year relative to the existing ferry service.

Table 4-1: Passenger Forecast Summary, Average One Way Trips per Day

Alternative	2006	2025	Compound Growth
Existing Ferry	1,245	1,421	0.7%
Airport Bridge	2,420	4,116	2.8%
Pennock Island Bridge	2,442	4,566	3.4%
Enhanced Ferry	1,246	1,556	1.2%

The majority of the passenger traffic on the existing ferry service relates to the Ketchikan International Airport. As shown in Figure 4-1, 89 percent of all passenger trips in 2025 are projected to be either air travel related (passenger or accompanying) or airport business related. Trips derived from residential development are forecast to represent 2% of total trips by that time.

Figure 4-1: Trip Distribution, Existing Ferry Service, 2025

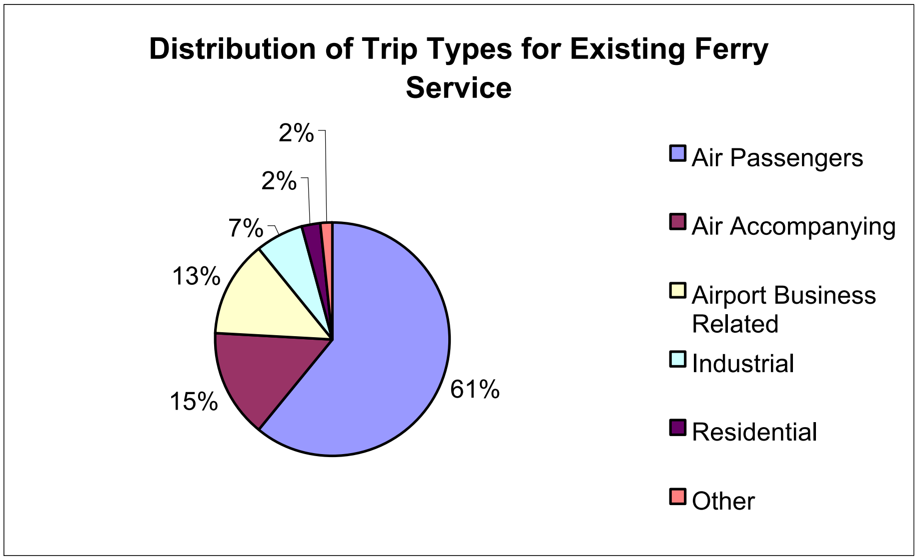
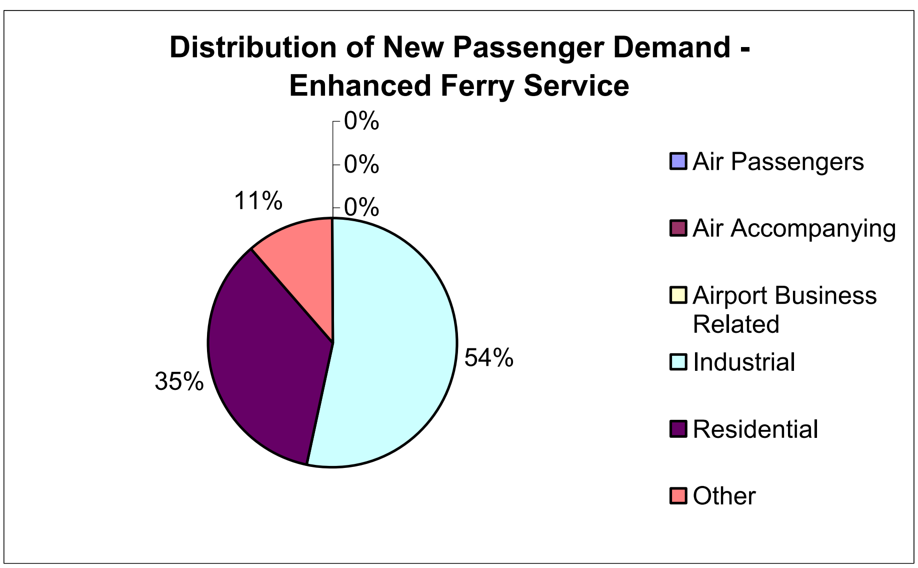


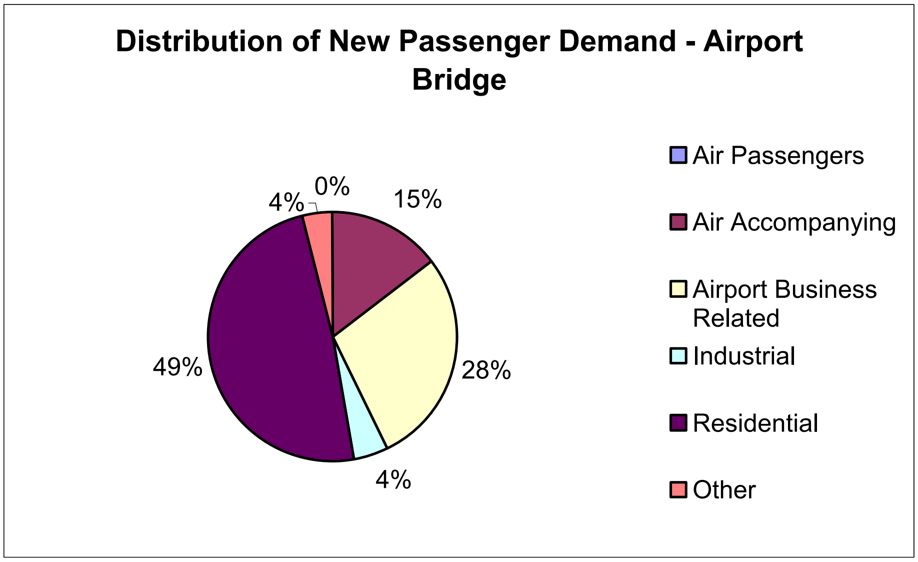
Figure 4-2 through Figure 4-4 summarize the distribution of new passenger demand from each of the Gravina access alternatives by 2025. For the enhanced ferry service, more than half of the new demand is expected from industrial uses. Residential development is forecast to account for 35 percent of new demand.

Figure 4-2: New Trip Distribution, Enhanced Ferry Service, 2025



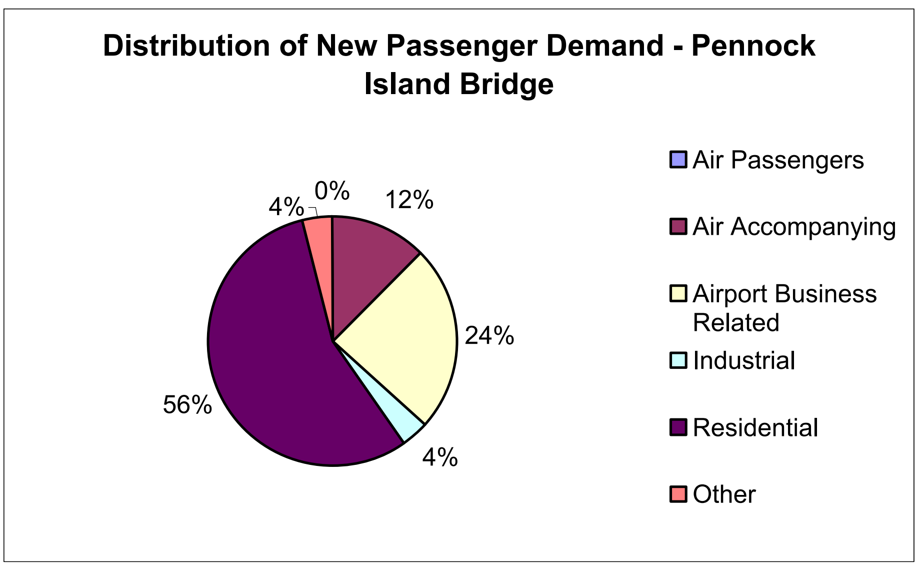
For the Airport bridge alternative, approximately half of the increased passenger flows relate to residential development, 28 percent from airport business related development and 15 percent from individuals accompanying air travellers to the airport.

Figure 4-3: New Trip Distribution, Airport Bridge, 2025



The Pennock Island bridge crossing is forecast to increase passenger demand the most due to increases in residential development. Overall, residential development represents 56 percent of the new demand by 2025 while airport related business traffic represents 24%.

Figure 4-4: New Trip Distribution, Pennock Island Bridge, 2025



5.0 Trip Costs

The following section summarizes the user cost[6] per passenger trip for each of the access alternatives. The per trip costs include travel time costs, ferry tolls, vehicle operating expenses and accident costs. The cost of each passenger trip is examined for passenger cars and trucks for both trips to existing locations on Gravina Island and trips to developable lands. In deriving the trip cost estimates, travel times and travel distances were based on estimates provided by HDR Alaska Inc[7] and Northern Economics, Inc.

5.1 Trips to Existing Locations

For trips to existing locations, the existing ferry service cost per passenger trip for cars and trucks is $10.4 and $19.0 respectively. The least expensive access alternative for existing locations is airport bridge Option D1 as it provides the most direct link to Gravina Island. User cost for cars and trucks are 64% and 61% less than the existing ferry service respectively for this option. The most expensive bridge options, in terms of user costs, are for those bridges that cross Pennock Island providing only a 15% reduction for cars and a 6% reduction for trucks.

In general, the alternative ferry solutions do not provide any user cost savings for trips to existing locations. In fact, it was assumed that the existing ferry service would be used as the primary means of accessing these locations even with the enhanced ferry service in operation.

Table 5-1: Unit Cost per Passenger for Car Trips, Existing Locations ($M 2003)

			Costs per Trip					
Option	Travel Time (hours)	Trip Length (miles)	Time	Toll	Vehicle Operating Costs	Accident	Total	Change
NB	0.42	3.8	$5.9	$4.1	$0.3	$0.1	$10.4	$0.0
C3(a)	0.19	6.1	$2.7	$0.0	$1.6	$0.8	$5.0	-$5.4
C3(b)	0.16	5.5	$2.2	$0.0	$1.4	$0.7	$4.3	-$6.1
C4	0.16	5.3	$2.2	$0.0	$1.4	$0.7	$4.2	-$6.2
D1	0.15	4.4	$2.1	$0.0	$1.1	$0.5	$3.7	-$6.7
F1	0.32	10.9	$4.4	$0.0	$2.8	$1.3	$8.5	-$1.9
F3	0.34	10.7	$4.8	$0.0	$2.8	$1.3	$8.9	-$1.6
G2	0.42	3.8	$5.9	$4.1	$0.3	$0.1	$10.4	$0.0
G3	0.42	3.8	$5.9	$4.1	$0.3	$0.1	$10.4	$0.0
G4	0.40	3.9	$5.5	$4.1	$0.3	$0.2	$10.1	-$0.3

[6] Emission costs were not considered a direct user benefit. They were considered a community benefit and are provided separately.
[7] Contained in spreadsheet: TRAV_TIME pb1.xls

Table 5-2: Unit Cost per Passenger per Passenger for Truck Trips, Existing Locations ($M 2003)

Option	Travel Time (hours)	Trip Length (miles)	Costs per Trip: Time	Toll	Vehicle Operating Costs	Accident	Total	Change
NB	0.41	3.2	$9.8	$7.0	$1.9	$0.3	$19.0	$0.0
C3(a)	0.19	5.8	$4.5	$0.0	$5.0	$0.9	$10.4	-$8.7
C3(b)	0.15	5.1	$3.7	$0.0	$4.6	$0.8	$9.1	-$10.0
C4	0.15	4.8	$3.5	$0.0	$4.3	$0.8	$8.5	-$10.5
D1	0.14	3.9	$3.4	$0.0	$3.4	$0.6	$7.4	-$11.7
F1	0.29	10.1	$7.0	$0.0	$9.0	$1.6	$17.6	-$1.4
F3	0.32	10.0	$7.7	$0.0	$8.6	$1.6	$17.9	-$1.1
G2	0.41	3.2	$9.8	$7.0	$1.9	$0.3	$19.0	$0.0
G3	0.41	3.2	$9.8	$7.0	$1.9	$0.3	$19.0	$0.0
G4	0.39	3.3	$9.2	$7.0	$1.9	$0.4	$18.5	-$0.6

5.2 Trips to Developable Lands

For trips to developable lands, the existing ferry service costs approximately $12.1 and $23.9 for cars and trucks respectively. The Pennock Island bridge option F1 provides the least user cost solution for cars with a reduction of 64%. However, in the case of trucks, all bridge access options are relatively equivalent in that they provide reductions in user cost in the range of 40-53%

The enhanced ferry alternatives provide user cost reductions for trips to developable lands of approximately 3 to 10 percent, but not near the range of the user cost reductions provided by the various bridge alternatives.

Table 5-3: Unit Cost per Passenger for Car Trips, Developable Lands ($M 2003)

Option	Travel Time (hours)	Trip Length (miles)	Costs per Trip: Time	Toll	Vehicle Operating Costs	Accident	Total	Change
NB	0.51	6.9	$7.0	$4.1	$0.7	$0.3	$12.1	$0.0
C3(a)	0.29	10.0	$4.1	$0.0	$2.5	$1.2	$7.8	-$4.3
C3(b)	0.29	10.0	$4.1	$0.0	$2.5	$1.2	$7.8	-$4.2
C4	0.27	9.2	$3.8	$0.0	$2.3	$1.1	$7.2	-$4.8
D1	0.25	8.1	$3.5	$0.0	$2.0	$1.0	$6.5	-$5.6
F1	0.21	6.3	$2.9	$0.0	$1.6	$0.8	$4.3	-$7.8
F3	0.21	6.1	$2.9	$0.0	$1.6	$0.8	$5.2	-$6.8
G2	0.51	6.9	$7.0	$4.1	$0.7	$0.3	$12.1	$0.0
G3	0.51	6.9	$7.0	$4.1	$0.7	$0.3	$12.1	$0.0
G4	0.51	6.9	$7.0	$4.1	$0.7	$0.3	$12.1	$0.0

Table 5-4: Unit Cost per Passenger per Passenger for Truck Trips, Developable Lands ($M 2003)

Option	Travel Time (hours)	Trip Length (miles)	Costs per Trip					
			Time	Toll	Vehicle Operating Costs	Accident	Total	Change
NB	0.50	6.4	$11.8	$7.0	$4.3	$0.8	$23.9	$0.0
C3(a)	0.24	8.3	$5.7	$0.0	$7.4	$1.3	$14.4	-$9.5
C3(b)	0.24	8.3	$5.7	$0.0	$7.4	$1.3	$14.4	-$9.5
C4	0.21	7.3	$5.1	$0.0	$6.5	$1.2	$12.8	-$11.1
D1	0.19	6.4	$4.6	$0.0	$5.7	$1.0	$11.3	-$12.5
F1	0.22	6.7	$5.3	$0.0	$5.8	$1.1	$12.2	-$11.7
F3	0.22	6.5	$5.3	$0.0	$5.6	$1.0	$12.0	-$11.9
G2	0.49	5.6	$11.6	$7.0	$3.8	$0.7	$23.1	-$0.8
G3	0.47	4.4	$11.2	$7.0	$3.0	$0.6	$21.8	-$2.1
G4	0.45	6.2	$10.6	$7.0	$4.2	$0.8	$22.6	-$1.3

5.3 Summary of User Cost Findings

Of all the Gravina Island access alternatives, the airport bridge option D1 provides the least cost alternative for trips to existing locations in terms of user costs. The other airport bridge options provide the next most attractive solutions for this category of trips. Neither the enhanced ferry services nor the Pennock Island crossing options provide near the users cost savings for trips to existing locations on Gravina Island as does the airport bridge solution.

However, for trips to developable lands on Gravina Island, the Pennock Island bridge alternatives provide significant user benefits along with the airport bridge options. The enhanced ferry service is also beneficial but to a much lesser degree.

6.0 Elasticity of Demand

In conducting the economic assessment, HLB Decision Economic treated the traffic forecasts for each of the access alternatives as exogenous. However, HLB did assess the implied elasticity of demand based on the traffic projections and generalized trip price reductions. This is summarized in this section.

6.1 Demand Forecast and Price Elasticity

Table 6-1 below summarizes the aggregate long run forecasts of demand and user costs for each of the access alternatives. An aggregate long run price elasticity[8] is imputed based on the passenger demand and price projections across all traffic and trip types.

Table 6-1: Implied Price Elasticity of Demand

Option	One-Way Passenger Trips Per Day in 2025	Average Price[9]	Price Change	Quantity Change	Implied Elasticity[10]
Option: NB	1,421	$10.83	N/A	N/A	N/A
Option: C3(a)	4,116	$5.71	-47%	290%	-1.7
Option: C3(b)	4,116	$5.17	-52%	290%	-1.4
Option: C4	4,116	$4.96	-54%	290%	-1.4
Option: D1	4,116	$4.42	-59%	290%	-1.2
Option: F1	4,566	$7.43	-31%	321%	-3.1
Option: F3	4,566	$7.95	-27%	321%	-3.8
Option: G2	1,556	$10.83	0%	110%	Undefined
Option: G3	1,556	$10.83	0%	110%	Undefined
Option: G4	1,556	$10.57	-2%	110%	-3.8

For the airport bridge access alternatives, the long run imputed price elasticity of demand is in the range of –1.2 to –1.7. For the Pennock Bridge alternatives, the implied elasticity is between –3.1 to –3.8, well in excess of that implied by the other bridge options. For the ferry options, the relative price is unchanged for two of the three alternatives and very small relative to the status quo service for the third, thus diminishing the significance of elasticity estimates in those cases.

6.2 Literature Review

HLB conducted a literature review of studies containing the price elasticities of travel demand. A great deal of information was found on travel demand elasticities in connection with highway investments. Most of the studies compute these elasticities with respect to highway capacity (measured as vehicle lane miles) or travel time. However, there is a group of literature focussing on the elasticity of travel demand with respect to user costs. This is briefly summarized below:

---

[8] The price elasticity of demand measures the responsiveness of quantity demanded to a change in price, with all other factors held constant.

[9] For the derivation of the average price, 25% of total trips were assumed to be to developable lands and 75% were assumed to be to existing locations. Truck traffic was assumed to be 7% of total.

[10] The elasticity was derived as follows: Elasticity = $\ln(Q_b / Q_a) \, / \, \ln(P_b / P_a)$.

- The National Highway Institute concludes that the elasticity of highway travel with respect to users' generalized cost (travel time and vehicle expenses) is typically –0.5. (*Source: National Highway Institute, 1995)*

- The U.S. Department of Transportation Highway Economic Requirements System (HERS) investment analysis model uses a travel demand elasticity factor of –1.0 for the short-term and –1.6 for the long term. (*Source: Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance Report, Department of Transportation, 1999*)

- Range of estimates of the elasticity of vehicle travel with respect to Total Price (including fuel, vehicle wear and mileage-related ownership costs, tolls, parking fees and travel time, which is equivalent to generalized costs) is –0.5 to –1.0 in the short run, and –1.0 to –2.0 over the long run. (*Source: Douglass Lee, "Demand Elasticities for Highway Travel," HERS Technical Documents, FHWA, 2000*)

One would expect that these empirical estimates based primarily on highway studies, might provide a lower bound (in magnitude) for what could be expected for a bridge replacement of an existing ferry service, especially when the bridge provides immediate access to undeveloped lands and where traffic congestion on the bridge is not expected to erode potential travel time savings.

6.3 Summary of Elasticity Findings

The implied price elasticities of demand from the traffic forecast and user price changes for the airport bridge solutions are consistent with the range of evidence found in the economic literature. However, the elasticities implied by the Pennock Island bridge alternatives are well in excess of that found in the literature and that implied for the airport alternatives.

7.0 User Benefits

This section provides a summary and interpretation of the total economic user benefits of each of the Gravina Access Alternatives relative to the status quo ferry service.

7.1 Summary of Results by Option

Table 7-1 provides a summary of the benefits for each alternative disaggregated by existing trips, new trips and net environmental benefits.

For the airport bridge options, the majority of the benefits are related to user benefits realized from existing trips as they provide for shorter trip times and ferry toll savings for users. The benefits realized from new demand are also very significant for similar reasons but are less than that from existing trips. A slight offset to these user benefits is the increased emission costs due to increased roadway vehicle use. Overall the airport bridge alternatives provide the greatest user benefits with total benefits in the range of $55-$70 million. Airport bridge option D1 provides the greatest user benefits as it provides the most direct route to Gravina Island.

Table 7-1: Economic Benefits of Gravina Access Project ($M 2003)

	Airport Bridge				Pennock Island Bridge		Enhanced Ferry Service		
	C3(a)	**C3(b)**	**C4**	**D1**	**F1**	**F3**	**G2**	**G3**	**G4**
Existing Trips									
Travel Time Savings	$19.7	$22.6	$22.9	$23.6	$9.5	$6.9	$0.0	$0.0	$2.2
Out-of-Pocket Cost Savings	$17.0	$18.2	$18.5	$20.1	$8.8	$8.9	$0.0	$0.0	-$0.1
Accident Cost Savings	-$3.5	-$3.0	-$2.9	-$2.2	-$7.0	-$6.9	$0.0	$0.0	$0.0
Existing Trip Benefits	**$33.2**	**$37.8**	**$38.4**	**$41.5**	**$11.2**	**$9.0**	**$0.0**	**$0.0**	**$2.1**
New Trip Benefits	$22.9	$25.4	$26.6	$29.1	$17.5	$15.2	$0.0	$0.0	$0.0
Total Consumer Surplus	**$56.1**	**$63.2**	**$65.0**	**$70.6**	**$28.7**	**$24.2**	**$0.0**	**$0.0**	**$2.1**
Environmental Benefits	-$0.9	-$0.8	-$0.8	-$0.6	-$1.6	-$1.6	-$0.2	-$0.2	-$0.2
Total Project Benefits	**$55.2**	**$62.3**	**$64.2**	**$70.0**	**$27.1**	**$22.6**	**-$0.2**	**-$0.2**	**$2.0**

The user benefits from the Pennock Island bridge options relate primarily from new trips to developable lands. Benefits related to existing trips are relatively small in comparison to the airport bridge option as much more roadway travel is required. In total, the user benefits of the Pennock Island crossing option are less than 40% of that provided by an airport bridge solution.

The enhanced ferry options do not provide material user benefits over the planning horizon.

Appendix A

This section provides a brief overview of the results obtained from utilizing the alternative 'Trips G-Low' and 'Trips G-High' demand forecasts used to derive the total user benefits. We compare these results to those generated by our earlier analysis based on the 'Trips G-Med' demand forecast.

Table A-1 summarizes the passenger forecasts by Gravina access alternative for the Low, Medium and High demand scenarios.

Table A-1: Passenger Forecast Summary, Average One Way Trips per Day (Low, Medium and High scenario)

Alternative	2006	2025	Compound Growth
Existing Ferry			
Low	1,245	1,421	0.7%
Medium	1,245	1,421	0.7%
High	1,245	1,421	0.7%
Airport Bridge			
Low	2,335	2,740	0.8%
Medium	2,420	4,116	2.8%
High	2,553	5,876	4.5%
Pennock Island Bridge			
Low	2,335	2,740	0.8%
Medium	2,442	4,566	3.4%
High	2,622	7,338	5.6%
Enhanced Ferry			
Low	1,245	1,421	0.7%
Medium	1,246	1,556	1.2%
High	1,345	2,538	3.4%

Table A-2 through Table A-4 below present the benefits for each alternative disaggregated by existing trips, new trips and net environmental benefits under the three different demand scenarios.

Table A-2: Economic Benefits of Gravina Access Project ($M 2003) – Low case

	Airport Bridge				Pennock Island Bridge		Enhanced Ferry Service		
	C3(a)	C3(b)	C4	D1	F1	F3	G2	G3	G4
Existing Trips									
Travel Time Savings	$19.7	$22.6	$22.9	$23.6	$9.5	$6.9	$0.0	$0.0	$2.2
Out-of-Pocket Cost Savings	$17.0	$18.2	$18.5	$20.1	$8.8	$8.9	$0.0	$0.0	-$0.1
Accident Cost Savings	-$3.5	-$3.0	-$2.9	-$2.2	-$7.0	-$6.9	$0.0	$0.0	$0.0
Existing Trip Benefits	**$33.2**	**$37.8**	**$38.4**	**$41.5**	**$11.2**	**$9.0**	**$0.0**	**$0.0**	**$2.1**
New Trip Benefits	$15.5	$17.6	$18.0	$19.5	$5.4	$4.4	$0.0	$0.0	$0.0
Total Consumer Surplus	**$48.7**	**$55.3**	**$56.5**	**$61.0**	**$16.6**	**$13.4**	**$0.0**	**$0.0**	**$2.1**
Environmental Benefits	-$0.8	-$0.7	-$0.7	-$0.5	-$1.2	-$1.2	-$0.2	-$0.2	-$0.2
Total Project Benefits	**$47.9**	**$54.6**	**$55.8**	**$60.5**	**$15.4**	**$12.2**	**-$0.2**	**-$0.2**	**$1.9**

Table A-3: Economic Benefits of Gravina Access Project ($M 2003) – Medium case

	Airport Bridge				Pennock Island Bridge		Enhanced Ferry Service		
	C3(a)	C3(b)	C4	D1	F1	F3	G2	G3	G4
Existing Trips									
Travel Time Savings	$19.7	$22.6	$22.9	$23.6	$9.5	$6.9	$0.0	$0.0	$2.2
Out-of-Pocket Cost Savings	$17.0	$18.2	$18.5	$20.1	$8.8	$8.9	$0.0	$0.0	-$0.1
Accident Cost Savings	-$3.5	-$3.0	-$2.9	-$2.2	-$7.0	-$6.9	$0.0	$0.0	$0.0
Existing Trip Benefits	**$33.2**	**$37.8**	**$38.4**	**$41.5**	**$11.2**	**$9.0**	**$0.0**	**$0.0**	**$2.1**
New Trip Benefits	$22.9	$25.4	$26.6	$29.1	$17.5	$15.2	$0.0	$0.0	$0.0
Total Consumer Surplus	**$56.1**	**$63.2**	**$65.0**	**$70.6**	**$28.7**	**$24.2**	**$0.0**	**$0.0**	**$2.1**
Environmental Benefits	-$0.9	-$0.8	-$0.8	-$0.6	-$1.6	-$1.6	-$0.2	-$0.2	-$0.2
Total Project Benefits	**$55.2**	**$62.3**	**$64.2**	**$70.0**	**$27.1**	**$22.6**	**-$0.2**	**-$0.2**	**$2.0**

Table A-4: Economic Benefits of Gravina Access Project ($M 2003) – High case

	Airport Bridge				Pennock Island Bridge		Enhanced Ferry Service		
	C3(a)	C3(b)	C4	D1	F1	F3	G2	G3	G4
Existing Trips									
Travel Time Savings	$19.7	$22.6	$22.9	$23.6	$9.5	$6.9	$0.0	$0.0	$2.2
Out-of-Pocket Cost Savings	$17.0	$18.2	$18.5	$20.1	$8.8	$8.9	$0.0	$0.0	-$0.1
Accident Cost Savings	-$3.5	-$3.0	-$2.9	-$2.2	-$7.0	-$6.9	$0.0	$0.0	$0.0
Existing Trip Benefits	**$33.2**	**$37.8**	**$38.4**	**$41.5**	**$11.2**	**$9.0**	**$0.0**	**$0.0**	**$2.1**
New Trip Benefits	$28.4	$31.2	$32.8	$36.1	$27.5	$24.1	$0.0	$0.1	$0.2
Total Consumer Surplus	**$61.6**	**$69.0**	**$71.3**	**$77.6**	**$38.7**	**$33.0**	**$0.0**	**$0.1**	**$2.3**
Environmental Benefits	-$1.1	-$1.0	-$0.9	-$0.7	-$1.9	-$1.9	-$0.2	-$0.2	-$0.2
Total Project Benefits	**$60.5**	**$68.0**	**$70.4**	**$76.9**	**$36.7**	**$31.1**	**-$0.2**	**-$0.1**	**$2.1**

Discussion of Results

Table A-3 reproduces the summary of economic benefits for each access alternative as presented in the main section of this report. These benefit values were derived on the basis of the Medium demand forecast supplied by Northern Economics Inc. Table A-2 presents the user benefits for all alternatives based on the Low demand forecast and Table A-4 provides the same for the High scenario.

In comparing the results for the three cases, it can be noted that there are no significant differences in the total user benefits from the enhanced ferry options. The projected growth in demand under all three scenarios is very similar, thus not impacting the results materially. For the airport bridge alternatives, user benefits range from $48-60 M in the Low case, $55-70 M in the Medium case and $60-77 M in the High case. These results reflect the wider disparity in the demand forecasts for the airport bridge options, but are still relatively tightly bunched.

However, the largest variation in results is observed for the Pennock Island bridge options. User benefits range from $12-15 M in the Low case, $22-27 M in the Medium case and $31-36 in the High case. It can be seen that benefits generated using the High demand forecast are more than 100% greater than those derived from the Low demand forecast. This can be explained by the huge difference in projected demand growth between those two states in particular.

An additional point that may be noted is that employing the alternative demand forecasts do not alter the general conclusions about the various options drawn earlier in the report. More specifically, the airport bridge access alternatives continue to provide the greatest user benefits in relation to both the Pennock Island crossings and the enhanced ferry service options under all demand scenarios.

Appendix B

The following table contains the data values for the primary variables used in the deriving the estimates of user benefits:

Table B-1: Data Values for Model Variables and Source

Variable	Median Estimate		Source
Value of time, $ per hour per passenger			
Personal cars:	13.59		Federal Highway Administration, *Highway Economic Requirement System Technical Report*, U.S. DoT, December 2000 [1]
Trucks:	23.28		
Accident costs, $ per accident			
Fatalities:	3,495,909		National Highway Traffic Safety Administration, *The Economic Impact of Motor Vehicle Crashes 2000*, U.S. DoT, May 2002.
Injuries:	30,938		
Property Damage:	2,629		
Vehicle operating costs	*Cars*	*Trucks*	
Fuel, $ per gallon	1.40	1.40	AAA Daily Fuel Gauge Report
Oil, $ per quart	4.10	1.70	[1]
Tire, $ per tire	72.60	478.20	[1]
M&R, $	118.40	412.80	[1]
Depreciable Value, $	20,774	93,071	[1]; J.P. Zaniewski, et. al. *Vehicle Operating Costs, Fuel Consumption and Pavement Type and Condition Factors*, Texas Research and Development Foundation, 1982.
Emission Costs, $ per ton			
HC	2,171		[1]
CO	68		[1]
NO_x	2,935		[1]
Truck Traffic as % of Total			
Option: Ferry	7.0%		
Increase due to Airport Bridge	3.2%		HLB Decision Economics Inc.
Increase due to Pennock Bridge	2.3%		
Average Ferry toll per Passenger, $			
Personal cars:	4.06		HDR Inc.
Trucks:	7.00		
Inflation factor, %	2.50%		HLB Decision Economics Inc.
Real Discount Rate, %	4.20%		HLB Decision Economics Inc.

Travel Time Assumptions

Table B-2: Travel Times to Existing Locations

Travel Times to Existing Locations																	
Downtown Saxman (Firestation) (Fire Station) Vehicles			Ketchikan CBD (Mile Post 0) to Airport Terminal Vehicles			Point Higgins to Airport Terminal Vehicles			Ward Cove Post Office to Airport Terminal Vehicles			Carlana Creek to Airport Terminal Vehicles			Weighted Average to Airport Terminal Cars		
	Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)
NB	5.49	32	NB	3.29	27	NB	10.54	32	NB	5.04	25	NB	0.53	19	NB	3.80	25
C3a	8.41	19	C3a	6.21	14	C3a	10.99	16	C3a	5.49	8	C3a	3.45	6	C3a	6.13	12
C3b	7.75	17	C3b	5.55	12	C3b	10.33	14	C3b	4.83	6	C3b	2.79	4	C3b	5.47	10
C4	7.00	16	C4	4.80	11	C4	12.11	16	C4	6.61	9	C4	2.10	3	C4	5.34	9
D1	6.34	16	D1	4.14	11	D1	9.98	14	D1	4.48	7	D1	1.54	3	D1	4.36	9
F1	8.69	14	F1	7.49	12	F1	19.26	31	F1	14.77	26	F1	10.26	20	F1	10.89	19
F3	6.95	12	F3	7.43	14	F3	20.21	35	F3	14.71	28	F3	10.20	22	F3	10.74	21
G2	5.49	32	G2	3.29	27	G2	10.54	32	G2	5.04	25	G2	0.53	19	G2	3.80	25
G3	5.49	32	G3	3.29	27	G3	10.54	32	G3	5.04	25	G3	0.53	19	G3	3.80	25
G4	5.60	30	G4	3.40	25	G4	10.54	32	G4	5.04	25	G4	0.64	17	G4	3.88	24

Table B-3: Travel Times to Developable Lands – Base Input (for Industrial/Commercial Development)

Travel Times to Developable Lands - Base Input (for Industrial / Commercial Development)																	
Downtown Saxman (Firestation) (Fire Station) To Developable Lands			Ketchikan CBD (Mile Post 0) to Airport Terminal To Developable Lands			Point Higgins to Airport Terminal To Developable Lands			Ward Cove Post Office to Airport Terminal To Developable Lands			Carlana Creek to Airport Terminal To Developable Lands			Weighted Average Cars To Developable Lands		
	Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)
NB	8.62	37	NB	6.42	32	NB	13.67	37	NB	8.17	30	NB	3.66	24	NB	6.93	30
C3a	10.92	22	C3a	8.72	17	C3a	13.50	19	C3a	8.00	11	C3a	5.96	9	C3a	8.64	15
C3b	10.91	22	C3b	8.71	17	C3b	13.49	19	C3b	7.99	11	C3b	5.95	9	C3b	8.63	15
C4	9.51	20	C4	7.31	15	C4	14.62	20	C4	9.12	13	C4	4.61	7	C4	7.85	13
D1	8.85	19	D1	6.65	14	D1	12.49	17	D1	6.99	10	D1	4.05	6	D1	6.87	12
F1	5.21	8	F1	4.01	6	F1	16.79	27	F1	11.29	20	F1	6.78	14	F1	7.54	13
F3	3.47	6	F3	3.95	8	F3	16.73	29	F3	11.23	22	F3	6.72	16	F3	7.26	15
G2	8.62	37	G2	6.42	32	G2	8.87	34	G2	3.37	26	G2	3.66	24	G2	5.78	30
G3	4.66	34	G3	2.44	29	G3	13.67	37	G3	8.17	30	G3	3.66	24	G3	5.22	29
G4	8.51	34	G4	6.31	29	G4	13.56	34	G4	8.06	27	G4	3.55	21	G4	6.82	27

Table B-4: Travel Times to Developable Lands - Adjusted Data (for Residential Development)

Travel Times to Developable Lands - Adjusted Data for Residential Development																	
Downtown Saxman (Firestation) (Fire Station) To Developable Lands			Ketchikan CBD (Mile Post 0) to Airport Terminal To Developable Lands			Point Higgins to Airport Terminal To Developable Lands			Ward Cove Post Office to Airport Terminal To Developable Lands			Carlana Creek to Airport Terminal To Developable Lands			Weighted Average Cars To Developable Lands		
	Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)		Distance (mi)	Time (min)
NB	8.62	37	NB	6.42	32	NB	13.67	37	NB	8.17	30	NB	3.66	24	NB	6.93	30
C3a	12.25	25	C3a	10.05	20	C3a	14.83	22	C3a	9.33	14	C3a	7.29	12	C3a	9.97	18
C3b	12.28	25	C3b	10.08	20	C3b	14.86	22	C3b	9.36	14	C3b	7.32	12	C3b	10.00	18
C4	10.82	23	C4	8.62	18	C4	15.93	23	C4	10.43	16	C4	5.92	10	C4	9.17	16
D1	10.04	22	D1	7.84	17	D1	13.68	20	D1	8.18	13	D1	5.24	9	D1	8.06	15
F1	3.97	6	F1	2.77	4	F1	15.55	25	F1	10.05	18	F1	5.54	12	F1	6.30	11
F3	2.31	4	F3	2.79	6	F3	15.57	27	F3	10.07	20	F3	5.56	14	F3	6.11	13
G2	8.62	37	G2	6.42	32	G2	9.87	36	G2	4.37	28	G2	3.66	24	G2	6.93	30
G3	5.66	36	G3	3.44	31	G3	13.67	37	G3	8.17	30	G3	3.66	24	G3	6.93	30
G4	8.62	37	G4	6.42	32	G4	13.67	37	G4	8.17	30	G4	3.66	24	G4	6.93	30

Appendix C

The theory of induced growth in vehicle travel hypothesizes that increases in the carrying capacity of a specific highway corridor or road network will result in an increased level of vehicle traffic. The increase in road capacity results in a decrease in the generalized cost of travel (especially the time costs of travel) and hence an increase in the demand for travel. While this interpretation is intuitively simple and grounded in basic economic theory, it has remained a contentious issue among traffic engineers, transportation planners, and the environmental community. A common engineering approach assumes that demand for travel is derived from exogenous growth in economic activities, and generally does not consider the inter-relationships between highway capacity, relative travel times, and overall regional accessibility.

This paper outlines the behavioural relationships underlying the theory of induced travel and reviews recent research that documents and empirically measures induced travel effects. This research has not only built a strong case for the existence of induced travel effects, but in some cases suggests that a large fraction of growth in vehicle miles of travel (VMT) is directly attributable to increases in road capacity. The paper concludes with a discussion of the additional research needs in this area and the potential implications of this line of research for EPA policies and regulations.

Induced Travel: Theory And Definitions

The underlying theory behind induced travel is based upon the generally accepted economic theory of supply and demand. Any increase in highway capacity (supply) results in a reduction in the time cost of travel. Travel time is the major component of variable costs experienced by those using private vehicles for travel. When any good (in this case travel) is reduced in cost, the quantity of the good demanded increases.

Travel supply and demand and the induced travel effect are illustrated graphically in Figure 1. The line S1 is supply before a capacity expansion or other changes that lower the cost of travel. The line S2 is supply after the change in capacity, resulting in a lower cost of travel, associated with a lower travel time cost. The quantity of travel increases from Q1 to Q2 as the change in supply lowers the cost of travel from P1 to P2. Figure 1 assumes no change in underlying demand. For example, population growth is not depicted in Figure 1. The increase in the quantity of travel from Q1 to Q2 represents the induced travel effect.

In measuring this effect there are many confounding factors that also drive growth in VMT. Population growth, increases in income, and other demographic effects, such as increased numbers of women in the workplace, are often cited (Transportation Research Board, 1997). Figure 2 shows how these effects can be graphically illustrated. The demand curve shifts outward from D1 to D2 because more travel is demanded at a given price when population increases in an area. The demand and supply curves shift simultaneously in Figure 2, and the resulting quantity of travel increases even more than in Figure 1 (to Q3). Empirically, it is difficult to isolate these two concurrent effects, and the relative contribution to VMT growth of different factors. In Figure 2, the induced travel effect is measured along the horizontal axis as the difference between Q2 and Q1, while the effect from exogenous growth is the difference between Q3 and Q2.[11]

[11] The relative scale of the effects in Figure 2 does not necessarily represent actual magnitudes.

Induced travel can be broadly defined as the increase in VMT attributable to any transportation infrastructure project that increases capacity. Hills (1996) provides a useful categorization of the various behavioural effects one can expect from highway upgrades or capacity expansions. Immediate behavioural effects include: changes in the timing of departure due to rescheduling of trips (Small, 1982); switching of routes to take advantage of new capacity; switches between transportation modes such as switching to private vehicle use from transit; longer trips; and an increase in total trips taken. The most visible of these effects (as shown by the difficulty of reducing peak period congestion) tends to be rescheduling behaviour that results in travelers returning to their preferred peak travel times. However, this effect does not necessarily result in an increase in VMT and so would not represent induced travel.[12] However, shifts to the peak that free up capacity at other times of the day can result in new trips being made at those times that are now less congested. Route switching can result in either shorter or longer distances being traveled. If the net effect is more travel this is clearly defined as induced VMT. If speeds are now faster, some additional long trips (perhaps recreational in nature or to more distant shopping centers) are likely to be taken increasing total VMT.

In addition to these short run effects, various longer run effects can have a significant impact on total VMT growth. Long run effects occur due to changes in relative accessibility within an urbanized area and can result in the spatial reallocation of activities. If speeds are higher, many residences and businesses will tend to relocate over time often resulting in longer distance trips (Gordon and Richardson, 1994).

Research Examining The Issue Of Induced Travel

Research on induced travel effects can be found going back several decades. Goodwin (1996) cites a report done for the U.K. Ministry of Transport in 1938 that evaluated a significant increase in traffic on a new road. Much of the historical literature has been based on observational traffic counts within travel corridors. These studies have generally not accounted for other exogenous effects that could also contribute to growth in VMT. Recent work by Goodwin (1996) attempted to control for exogenous factors by selecting a comparable control corridor. In general, he finds significant increases in traffic due to specific highway improvement projects within these corridors.

An early study in the U.S. by Jorgensen (1947) analyzed the traffic generating effects of the newly built Merritt and Wilbur Cross parkways in Connecticut. He found a correlation between traffic growth with gasoline sales for the state of Connecticut. Based upon this, he estimated that the parkways generated 20 to 25 percent more traffic than would have been expected from the expected trend in traffic growth.

Holder and Stover (1972) examined the traffic generating impacts of eight highway projects in Texas. This study examined trend patterns of traffic growth and concluded that there was about a 5 to 21 percent growth in traffic that was induced by the road projects.

The Transportation Research Board (1995) of the National Research Council examined the issue of induced travel and the implications for air quality and energy use. This report provides extensive

---

[12] Peak shifting that does not noticeably reduce aggregate travel times does suggest that the benefits of most projects are not accurately assessed. Rather than assessing benefits based on travel times an assessment based on the ability to travel at a preferred time should be done (Small, 1992).

detail on the behavioural impacts from expanding road capacity. The primary focus of the report was on the capability of analytical models used for forecasting regional transportation growth and emissions of criteria pollutants. The consensus was that most modeling procedures are deficient and probably do not adequately captures induced travel effects or the behavioural and economic development impacts of road projects. The report, however, was inconclusive on how induced travel may effect air quality, an issue complicated by the relationship between traffic dynamics (such as changes in acceleration characteristics) and emissions.

More recent work has attempted to separate the effects of other exogenous variables using econometric techniques. Hansen & Huang (1997) used time series data on VMT and lane miles for state highways in California, by county and metropolitan area, to estimate econometric models. They

$$\log(VMT_{it}) = a_i + b_t + \sum_k l^k \log(X_{it}^k) + \sum_{l=0}^{L} w^l \log(SHLM_{it-l}) + e_{it}$$

used a fixed effects model of the following form:

Where,

VMT_{it}	**is the VMT in region *i* in year *t*.**
a_i	**is the fixed effect for region *i*,**
b_t	**is the fixed effect for year *t*,**
X^k_{it}	**is the value of explanatory variable *k* for region *i* and year *t*,**
$SHLM_{it-l}$	**is state highway lane miles for region *i* and time *t-l*.**
l^k, w^l	**are coefficients which are estimated,**
e_{it}	**is an error term, assumed to be normally distributed.**

Other variables included in their analysis are population, personal income, population density, and gasoline prices, all of which are expected to have an effect on VMT growth. Estimates using ordinary least squares and a Prais-Winsten regression result in a statistically significant coefficient on the SHLM variable. Lane mile elasticities (with respect to VMT) of between 0.3 to 0.7 were found for models using county-level data. Elasticities of between 0.5 to 0.9 were found for models using metropolitan level data. Various lag structures were also tested and a two to four year lag structure resulted in long run elasticities that were greater than those in the unlagged models.

Noland (forthcoming) estimated a number of similar panel regression models using nationwide data at the state level. In general, Noland finds similar elasticity values ranging from 0.3 to 0.6 in the short run and from 0.7 to 1.0 in the long run. The models estimated by Noland include a disaggregation of the data by road facility type (i.e., interstates, arterials, and collector roads by urban and rural road categories). These are estimated using Zellner's seemingly unrelated regression and with a distributed lag (thereby allowing the derivation of a long run elasticity). Results for one of these models is displayed in Table 1.

An analysis of nationwide metropolitan level data by Noland & Cowart (1999) tells the same story. Long run elasticity values of 0.8 to 1.0 are derived using a distributed lag model estimated for VMT and lane miles specific to interstates and arterial road capacity. Another study by Fulton et al. (1999) used cross-sectional time series county-level data from North Carolina, Virginia, and Maryland to estimate both short run and long run elasticities. Their results are consistent with previous studies showing a short run elasticity of 0.1 to 0.4 and a long run elasticity of 0.5 to 0.8.

One issue that is not completely resolved is the issue of causality. Highway planners argue that since they have forecasted where individuals desire to travel they expect roads to fill up with travelers after they are built. However, this does not explain the fact that new highway capacity often becomes more congested more rapidly than initially planned. Goodwin (1996) compares forecast and actual rates of traffic growth (from a sampling of projects in the UK) and finds that the forecasts are generally too low. This may partially be a function of analytical forecasting tools that are not accurately capturing induced travel effects. In any case, many planners discount the work of Hansen & Huang (1997) and Noland (1999) as merely proving that a correlation has been found and that these studies show that planners are putting highways where people want to travel. These arguments, however, do not fully consider the degree to which the use of a fixed effects model minimizes simultaneity bias in the regressions.

One approach for more definitively addressing the issue of causality is to use an instrumental variable in the regression. Noland & Cowart (1999) use a two stage least squares regression using urbanized land area as an instrument for lane miles per capita. Results for a two stage least squares analysis using urbanized area are shown in Table 2. Urbanized land area is not strongly correlated with per capita VMT but is significantly related to total lane miles per capita (increasing urbanized land area results in lower lane miles per capita). Model (A) has coefficient values very similar to ordinary least squares, while model (B) shows somewhat of a reduced effect. Overall, these results tend to support the hypothesis of a causal linkage between increasing lane miles and increased VMT.
Given that the hypothesis of induced travel is supported by the results of the recent empirical studies, the next relevant question is how important is the induced travel effect compared to other drivers of VMT growth. Both Noland (forthcoming) and Noland & Cowart (1999) estimate the relative contribution of induced demand to overall VMT growth. Noland (forthcoming) applies the distributed lag model in Table 1 to forecast VMT growth out to 2010. He finds that if current trends in both lane mile increases and demographic variables continue, VMT will grow at about 2.65% annually. If lane mile growth is set to zero, this reduces VMT growth to about 1.9% annually. In other words, the induced travel effect accounts for about 28% of annualized growth in VMT. Noland & Cowart (1999) estimate this effect to average 45% of annualized VMT growth (on interstates and arterials) for metropolitan areas. This result strongly suggests that forecasting VMT growth (and the environmental impacts of that growth) needs to include some measure of transportation infrastructure as a determining factor.

Another key research question is under what circumstances might induced travel be larger or smaller. For example, one would expect induced travel effects to be larger in a congested area. Chu (1999) developed a model to try to estimate elasticity changes for different levels of underlying congestion. In deriving his theoretical model of travel demand and highway supply he determines that incremental expansion in highway capacity will have smaller effects on vehicle travel. In testing this hypothesis, he uses data from the Nationwide Personal Transportation Survey (NPTS) and estimates the following model:

$$\log(q/C) = b_0 + b_1\log(X^k) + b_2\log(C) + b_3(\log(C))^2 + e$$

where q is vehicle travel (VMT), C is a measure of capacity (lane miles), X^k refers to other variables included in the estimation, and ε is an error term. Using a cross-sectional database of metropolitan areas derived from the NPTS, Chu finds significant coefficients on both the b_2 and b_3 terms. He concludes that capacity does influence total traffic albeit with a diminishing effect as specified in his theoretical model.

Fulton et al. (1999) also attempted to determine whether population density and/or existing traffic congestion can result in different elasticity estimates. They include an interaction term for areas with low, medium, and high volumes of traffic per lane mile and also for low, medium, and high population densities. One would expect that those areas with more congestion or higher population density would have relatively larger elasticities. Fulton et al. (1999) were unable to find any statistical differences in the lane mile coefficients. Noland & Cowart (1999) also examined this issue using both the size of the metropolitan area and an index of traffic congestion as interaction terms. They found no statistical differences in the lane mile coefficients other than for medium sized metropolitan areas having a larger elasticity.

Additional research is currently being conducted to examine the development impacts of increasing highway capacity and additional attempts to statistically estimate causal linkages. The Department of Transportation is also incorporating measures of induced travel demand into their Highway Economics Requirement System which attempts to determine total financial needs for the U.S. highway system using a cost benefit analysis approach.

Future Research Needs And Potential Implications For EPA

The theoretical basis for induced travel effects and the empirical research reviewed above could have implications for how EPA undertakes its responsibilities under the National Environmental Policy Act (NEPA) and the Clean Air Act (CAA). These include, respectively, EPA's role in the review of Environmental Impact Statements and conformity determinations under the CAA.

However, additional research is needed in order to ascertain the potential range of environmental impacts resulting from induced travel. Much of the empirical research reviewed above indicates that on a regional or national basis, additions of highway capacity are associated with increases in the total amount of vehicle miles of travel.

These increases in vehicle miles of travel have yet to be measured in terms of their impacts upon air quality (e.g., criteria air pollutant and greenhouse gas emissions).

The conversion from vehicle miles traveled to air quality impacts is not as straightforward as it may appear. For example, with the construction of a new highway, there may be more traffic "induced" onto the highway, but the flow characteristics of the traffic may be altered. Depending upon what happens to average speeds and whether the travel is "stop and go" or smooth flowing, emissions per vehicle may increase or decrease. The two effects---total travel and the characteristics of that travel---will interact to determine the emissions implications of the highway expansion. Further, additional vehicle miles of travel have impacts upon water quality, for example by affecting the amount of stormwater runoff from highways and other impervious surfaces.

Since the recent studies reviewed above rely upon aggregate analysis of vehicle miles of travel at the county, metropolitan, and state levels, the empirical results may not directly convert into specific elasticities for individual transportation corridors or individual highway projects. Additional research may be needed at the corridor-specific and project-specific level empirically measuring induced travel effects, resultant environmental impacts, and the conditions under which they occur.

National Environmental Policy Act

One of EPA's major roles[13] is to review and comment on Environmental Impact Statements for Federal projects as specified by NEPA. The role of the Environmental Impact Statement (EIS) is to provide information to decision-makers and the public about the environmental impact of projects and possible alternatives.

The stated goal of many transportation projects is to reduce congestion; however, the studies cited above suggest that forecasts of congestion reduction resulting from added highway capacity may be overestimated to the extent that they do not account for induced travel. In addition, regulations promulgated by the Council on Environmental Quality (CEQ, 1987) require the assessment of cumulative and secondary impacts of highway projects, some of which may be related to induced travel effects.

Another potential implication of the research results is that if congestion reduction forecasts of additional highway capacity are overstated, then alternative approaches to capacity additions may be more effective at reaching the goal. For example, congestion pricing on existing road capacity has been proposed as an alternative to new capacity construction (Transportation Research Board, 1994). Provision of transit services and redevelopment of existing land (e.g. brownfields and infill development) may also lead to less regional congestion.

Clean Air Act Conformity Determinations of Transportation Plans

The Clean Air Act requires transportation plans to be in conformity with State Implementation Plans for meeting the National Ambient Air Quality Standards (NAAQS). Under this law and its associated regulations, states and metropolitan planning organizations must forecast the impact of transportation plans (i.e., a collection of many different projects) on total emissions of criteria pollutants (NO_x, VOC, CO, and PM-10).

Regional transportation planning agencies (or the states) generally maintain a system of models to forecast and evaluate the impact of transportation projects and plans. These models may be deficient in accurately forecasting emissions (TRB, 1995) partly because they do not adequately account for both short run and long run induced travel effects.

Some EPA regions are working with metropolitan planning organizations to improve the state of the practice in the modeling of transportation impacts, in particular the impacts on land development. Various modeling packages are available to provide estimates of land development changes induced by transportation and accessibility changes. Improved modeling of these impacts would provide decision makers with far better information on the short-run and long-run emissions impact of alternative transportation plans and are critical for developing State Implementation Plans that will actually help bring a region into attainment of the NAAQS.

References

Chu, Xuehao, 1999, "Highway Capacity and Areawide Congestion", Working Paper accepted for presentation at the 79th Annual Meeting of the Transportation Research Board.

---

[13] EPA's role in the NEPA process is defined in Section 309 of the Clean Air Act.

Council on Environmental Quality, 1987, Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act, 40 CFR parts 1500-1508.

Fulton, Lewis M., Daniel J. Meszler, Robert B. Noland, and John V. Thomas, "A Statistical Analysis of Induced Travel Effects in the U.S. Mid-Atlantic Region", Working Paper accepted for presentation at the 79th Annual Meeting of the Transportation Research Board.

Goodwin, Phil B., 1996, Empirical evidence on induced traffic, a review and synthesis, *Transportation*, 23: 35-54.

Gordon, Peter, and Harry W. Richardson, 1994, Congestion trends in metropolitan areas. In Transportation Research Board (1994) *Curbing gridlock: Peak-period fees to relieve traffic congestion volume 2*, National Research Council, Washington, DC: National Academy Press: 1-31.

Hansen, Mark and Yuanlin Huang, 1997, Road supply and traffic in California urban areas, *Transportation Research A*, 31: 205-218.

Hills, Peter J., 1996, What is induced traffic?, *Transportation*, 23: 5-16.

Holder, R.W., and V.G. Stover, 1972*, An Evaluation of Induced Traffic on new Highway Facilities*, Texas A&M University, College Station, TX.

Jorgensen, R.E., 1947, "Influence of Expressways in Diverting Traffic from Alternate Routes and in Generating New Traffic", Highway Research Board Proceedings, 27: 322-330.

Noland, Robert B., forthcoming "Relationships Between Highway Capacity and Induced Vehicle Travel", *Transportation Research A.*

Noland, Robert B. and William A. Cowart, 1999, "Analysis of Metropolitan Highway Capacity and the Growth in Vehicle Miles of Travel", working paper accepted for presentation at the 79th Annual Meeting of the Transportation Research Board, accepted for presentation at the 1999APPAM Annual Research Conference.

SACTRA, 1994, *Trunk roads and the generation of traffic*, Department of Transport, Standing Advisory Committee on Trunk Road Assessment, London.

Small, Kenneth A., 1992, *Urban transportation economics*, Harwood Academic Publishers, Chur, Switzerland.

Transportation Research Board, 1994, *Curbing Gridlock: Peak-Period Fees to Relieve Traffic Congestion*, Special Report 242, National Research Council, National Academy Press, Washington, DC.

Transportation Research Board, 1995, *Expanding metropolitan highways: implications for air quality and energy use*, Special report 245, National Research Council, National Academy Press, Washington, DC.

Transportation Research Board, 1997, *Toward a Sustainable Future: Addressing the Long-Term Effects of Motor Vehicle Transportation on Climate and Ecology*, Special Report 251, National Research Council, National Academy Press, Washington, DC.

Appendix B

The construction of the bridge alternatives across the Tongass Narrows may result in the elimination or modification of the Special Visual Flight Rules (SVFR) clearance or changes in the manner that aircraft operate in the area. The FAA anticipates that some type of change should be expected under all of the bridge alternatives, but the level of impact varies with the alternatives.[12] The SVFR clearance is currently applicable to all aircraft, including those operating under Part 135 rules (generally air taxi operators). A more complete description of SVFR and projected air traffic operations for 2001 is contained in *Gravina Access Project Special Visual Flight Rules (SVFR) Analysis-Draft* Technical Memorandum, prepared by HDR. The aircraft operations data used in the analysis presented below are drawn or developed from that document.[13] Assumptions developed by the consultant team on percentages of flights affected by potential changes in the SVFR clearance, or aircraft operations, are based on a review of the bridge alternatives by the FAA.[12] The goal of the analysis is to describe a range of impacts in the event (1) the SVFR clearance is no longer allowed for flight operations in Tongass Narrows, or (2) if it is modified to permit some lesser level of SVFR clearance, or (3) if other operational changes are required to address the presence of a bridge in the area.

If construction of a bridge leads to the elimination of, or changes in the SVFR clearance, then some flights are likely to be cancelled while others are delayed. Since it is likely that cruise passengers and local travelers would be affected differently by the changes in the current SVFR clearance or aircraft operations, it is necessary to distinguish those flights carrying flightseeing passengers from those transporting local residents for work, commerce, and other reasons. Two major assumptions are used in this analysis.

- Cruise ship passengers have a limited amount of time available during a port call in Ketchikan and are unable to wait an extended period for better weather conditions that might permit flight. Thus if a flight is canceled because the SVFR clearance is not available or if operational changes result in a situation where a flight is canceled under certain weather conditions, it is anticipated that the cruise ship passengers will not be able to wait until the weather improves.
- Local residents of Southeast Alaska and other non-cruise passengers traveling for work, commerce, or other reasons, however, can wait but incur delay-associated costs while doing so. Consequently, it is assumed that all other trips during SVFR conditions are delayed by an average of 3 hours.[14]

Historical data on monthly flight operations, the source of the 2001 projections, do not distinguish the purpose of the flight. Thus, the number of flightseeing trips must be estimated. In order to do so, two additional assumptions are made:

- Only non-cruise passengers take flights during the October-April period.
- For flight operations subject to SVFR restrictions, the monthly average during the October-April period represents the monthly number of such flight operations affecting non-cruise passengers during the May-September period.

During the October -April period, HDR projects 669 flight operations are SVFR operations. For this seven-month period, then, the monthly average is 96 SVFR operations. For May-September 1,315 SVFR operations are

[12] Green, Mick, Principal Operations Inspector, Federal Aviation Administration, 2002. Letter to John Schommer, FAA Obstruction Evaluation Specialist. July 15.

[13] An operation is a takeoff or a landing. Thus, any plane that departs from and then returns to Ketchikan has undertaken two flight operations.

[14] Naturally, some of these other, non-flightseeing trips could have been cancelled as well. However, any local resident who planned a flight that was cancelled could arrange a flight at another time. Although there is likely to be inconvenience, and perhaps annoyance at any such cancellation, the economic losses are not as severe because these trips are probably deferred rather than eliminated. To capture the losses associated with such travel delays for local residents, the average daily duration for SVFR conditions (3 hours) calculated by HDR is used in the analysis. The value of that 3-hour delay, then, represents the loss to the passenger. Since these are assumed to be deferred rather than cancelled trips, there is no revenue loss to the flight service.

projected for a monthly average of 263. Employing the assumptions stated above, it is estimated that an average of 167 flight operations carrying cruise ship passengers occur each month under the SVFR clearance during the May-September period. Thus, of the 1,984 flight operations under SVFR conditions for 2001, 835 or 42% are attributable to flightseeing and 1,149 or 58% are attributable to non-cruise travel. These data and the projection for total operations in 2001 are shown in Table B-1.

Table B-1. Flight Operations-Total and Potentially Cancelled Operations, 2001

	Number	Percent of total	Percent of SVFR Operations
Total Operations	105,193	100	n.a.
Operations Under SVFR Clearance	1,984	1.89	n.a.
Flightseeing	835	0.79	42.1
Non-cruise Travel	1,149	1.09	57.9

n.a.: Not Applicable

Note: One take-off and one landing = two operations

The FAA anticipates that all of the bridge alternatives would require an amendment to the SVFR clearance, with those alternatives that would be constructed in the vicinity of the airport having the greatest effect on aircraft operations. The presence of Alternatives C3(a), C3(b), C4, and D1 would allow less than 10 percent of current SVFR operations. Alternatives F1 and F3 are outside of the current boundaries of the SVFR airspace, but the proximity of these bridge alternatives may require some adjustment of the exemption. The FAA believes that a high bridge in the East Channel "would create a hazard for floatplanes during all operations, VFR or SVFR," and that "Alternative F(3) would be favorable over F(1), because F(3) offers a low bridge in the East Channel (North side) of Pennock Island, and aircraft are typically lower in the East Channel." It is anticipated that the east boundaries of the SVFR airspace and possibly the altitudes would have to be adjusted for F3 "but to a lesser degree." [12]

In response to a FAA opinion that "less than 10% of the current operations conducted under Exemption 4760 would still be allowed"[15] if the bridge alternatives located near the airport were built, it is anticipated that air charter operators and others will seek modification of the SVFR or changes in operating procedures to offset the presence of those bridge alternatives and the potential adverse impacts on their businesses. Even though the FAA indicates that SVFR operations would be significantly affected by a bridge alternative located in the proximity of the airport, some aircraft operators would prefer a bridge near the airport rather than a bridge crossing at Pennock Island. The outcome of the future dialogue on the SVFR clearance and changes in operating procedures is unknown at this time.

As the FAA did not specify a percentage reduction for the Pennock Island bridge alternatives, the consultant team developed a range of assumptions from zero to complete elimination of SVFR operations that is presented in this analysis. For the high case, the assumed elimination of flight operations conducted under the SVFR clearance exceeds the FAA opinion that more than 90 percent of such operations would not be allowed. The medium case assumes that air charter operators and others would be able to negotiate with the FAA to reduce the potential reductions to 50 percent of current operations. The low case assumes that mitigation measures, including changes in operating practices, moving of the airport float plane dock, and other factors, will result in a situation similar to the existing SVFR clearance with no reduction in SVFR operations. Table B-2 shows the range of outcomes used in this analysis for the alternatives.

[15] Green, Mick, Principal Operations Inspector, Federal Aviation Administration, 2002. Letter to John Schommer, FAA Obstruction Evaluation Specialist. July 15.

Table B-2. Reduction in Number of Operations Conducted Under SVFR Clearance With Bridge Alternatives

	(Percent)		
Alternative(s)	Low	Medium	High
C3(a), C3(b), C4, D1	0	50	100
F1	0	10	20
F3	0	5	10

In the worst-case situation (the high case), the bridge alternatives located near the airport would result in the cancellation of all flights conducted under the present SVFR clearance. The medium case assumes half of these flights would be canceled, and the low case assumes that adjustments would be made that would not result in the cancellation of any flights presently conducted under the SVFR clearance. The range of potential reductions in SVFR operations for F1 and F3 are based on the information presented by the FAA.[12]

In order to estimate the potential losses arising from delayed and cancelled flights, some additional assumptions about travel cost, trip prices, and spending patterns are needed to complete the analysis:

- Internet advertisements for flightseeing tours in Ketchikan have a wide range of prices depending on the characteristics of the trip. These prices vary from $79 to $379 per person. An average price of $250 per passenger is used for a flightseeing trip.
- Similarly, a wide variety of aircraft are employed for flightseeing. Passenger capacity ranges from a low of three or four on small aircraft to fifteen passengers on larger planes. An average of eight passengers per trip on flightseeing excursions is assumed in this analysis.
- For trips made by local residents and other non-cruise passengers, each flight carries 5.5 passengers during the May-September period and three passengers during the remainder of the year.

Since each trip involves two operations, a takeoff and a landing, the estimated 835 flightseeing operations under SVFR conditions during 2001, implies 417.5 flightseeing trips. Thus the removal of the SVFR clearance under the worst-case situation for the bridge alternatives located near the airport might have caused the cancellation of a about 418 flights carrying cruise ship tourists in 2001. With an estimated eight passengers each paying a price of $250, the revenue loss per cancelled trip would be $2,000 or a total annual revenue loss of $836,000. Lesser amounts of revenue losses would be associated with the other bridge alternatives and for the low and medium cases.

Cruise ship passengers whose flightseeing tour is cancelled will have additional time for other activities. Thus the revenue losses incurred by the flight services are likely to be offset, in part, by more spending on other activities and goods in Ketchikan. In order to capture this effect, this analysis assumes that each passenger who had booked a cancelled flight spends an additional $50 on other goods and services such as souvenirs and food. This extra spending amounts to $167,000 annually under the high case. Thus, the direct net revenue losses to the community under the high or worst-case situation amount to $669,000 for the year. In terms of net indirect losses to the community, the input-output analysis estimated the following additional effects: a $21,000 reduction in local government revenues for the year, and a $161,000 reduction in production of goods and services, and employment in the region for the year.

Out of the 1,984 SVFR operations projected for 2001, an estimated 835 operations, or 417.5 excursions, are attributable to cruise ship activity. Therefore, the remaining 1,149 SVFR operations, or 574.5 excursions, affect local travelers. Based on the average daily duration of SVFR conditions calculated by HDR, the elimination of the SVFR clearance is anticipated to cause an average 3-hour delay for each of these trips. For each passenger, the purpose of the trip determines the value placed on the delay. In transportation analysis, the value of time for a person traveling on business is normally estimated at the average wage in the community. This wage in Ketchikan is estimated at $16.23.[16] Thus someone traveling for work, who incurs a 3-hour delay, places a value of $48.69 on the delay. It is assumed that a person traveling for other reasons values time at a third of the average wage, or $5.41 per hour.[17] Thus, such a traveler incurs a cost of $16.23 during a 3-hour delay. Each flight carrying local residents and other non-cruise travelers will transport some passengers for work-related activities and others who are traveling for other reasons. No data were available regarding the percentage of passengers traveling by trip purpose. Arbitrarily, a 50-50 split is assumed; with each flight operation being 50% travelers for work-related reasons and 50% travelers for other reasons.

A flight originating in Ketchikan and carrying residents of the region will have one operation, a takeoff, in Ketchikan and the landing elsewhere. As mentioned earlier, 5.5 passengers are assumed to be on each such flight between May and September. If this flight is delayed, the 5.5 passengers leaving Ketchikan would incur a loss of valued time. But, the assumed 5.5 passengers on the return trip to Ketchikan are also affected by the delay since their plane arrived 3 hours later than scheduled.[18] Since these passengers also incur the delay eleven passengers are affected; half are assumed to be traveling for work-related matters and the other half for other reasons. The value of the time for the example eleven passengers during the May-September period who incur the delay is estimated at $357.06.

For the remainder of the year, when there are fewer local residents and non-cruise travelers (three per trip is assumed), a delay due to elimination of SVFR operations affects six passengers. The three affected passengers traveling for work reasons incur delay costs of $146.07. The delay imposes costs of $48.69 on the other three.

Applying these per flight figures to the projected SVFR operations that would not be undertaken in 2001 without the clearance, suggests that the total value of time delays incurred in 2001 due to flight delays under a worst-case situation would be $151,135 (see Table A-2). Summing the costs of cancelled and delayed flights and adding the extra cruise passengers spending on other items expected when flights are cancelled yields a total impact of $820,135 for 2001 if the SVFR clearance had not been in effect. Table B-3 presents the results of the above described analysis for the various bridge alternatives with a range of potential impacts for changes in the SVFR clearance and operating procedures.

[16] This hourly wage estimate is developed from Alaska Department of Labor and Workforce Development figures for average monthly earnings by industry in the Ketchikan Gateway Borough in 1999. The wage rate is then increased by 3.9% to reflect inflation occurring since 1999. The Consumer Price Index for Anchorage was used to determine the rate of inflation since 1999.

[17] There is no general consensus on this valuation. The one-third or 33% assumption falls within the range suggested by Adler (1987).

[18] For simplicity it is assumed that a 3-hour delay on takeoff affects only the next departure of that plane and not any subsequent departures. To illustrate, imagine a plane makes three daily round trips between Ketchikan and another location with just a short period for refueling and loading between the landing and the next takeoff. If the first departure is delayed by 3 hours, every one of the five subsequent departures could also be delayed by 3 hours. Such a possibility is ruled out by assumption.

Table B-3. Potential Effects of Flight Operations Cancellations and Delays Due to Changes in SVFR Clearance and Operating Procedures, 2001

Airport Bridge Alternatives C3(a), C3(b), C4, D1	Low ($)	Medium ($)	High ($)
a) Potential Reductions in Flightseeing Revenue		(418,000)	(836,000)
b) Cruise Passenger Spending after Cancelled Flights		83,500	167,000
Subtotal (a-b)		(334,500)	(669,000)
c) Value of Time Delay for Local Flights			
Passengers Flying for Work		(56,676)	(113,351)
Passengers Flying for Other Reasons		(18,892)	(37,784)
Subtotal		(75,568)	(151,135)
Total Costs of SVFR Clearance Change (a - b + c)		(410,068)	(820,135)

Pennock Bridge Alternative F1	Low ($)	Medium ($)	High ($)
a) Potential Reductions in Flightseeing Revenue		(83,600)	(167,200)
b) Cruise Passenger Spending after Cancelled Flights		16,700	33,400
Subtotal (a-b)		(66,900)	(133,800)
c) Value of Time Delay for Local Flights			
Passengers Flying for Work		(11,335)	(22,670)
Passengers Flying for Other Reasons		(3,778)	(7,557)
Subtotal		(15,114)	(30,227)
Total Costs of SVFR Clearance Change (a - b + c)		(82,014)	(164,027)

Pennock Bridge Alternatives F3	Low ($)	Medium ($)	High ($)
a) Potential Reduction in Flightseeing Revenue		(41,800)	(83,600)
b) Cruise Passenger Spending after Cancelled Flights		8,350	16,700
Subtotal (a-b)		(33,450)	(66,900)
c) Value of Time Delay for Local Flights			
Passengers Flying for Work		(5,668)	(11,335)
Passengers Flying for Other Reasons		(1,889)	(3,778)
Subtotal		(7,557)	(15,114)
Total Costs of SVFR Clearance Change (a - b + c)		(41,007)	(82,014)

Appendix C

Table C-1. Aircraft Accidents Involving Manmade Structures in Alaska January 1, 1983-December 6, 2001

NTSB ID Number	Location	Date	Type of Aircraft	Incident
ANC84LA012	Kodiak	October 30, 1983	Helicopter, Bell 206-B	Hit transmission tower
ANC84LA086	Deadhorse	June 8, 1984	Douglas C-118A	Struck radio beacon tower
ANC85LA034	Mt. Village	January 9, 1985	Cessna 207	Hit roof of abandoned building on takeoff
ANC88LA081	Naknek	July 2, 1988	Cessna 206	Hit radio tower
ANC93LA043	Ketchikan	March 12, 1993	De Havilland DHC-2	Struck one story building on takeoff
ANC95LA120	Kenai	July 28, 1995	Cessna 182	Struck small wooden building (duck shack) on takeoff
ANC97FA092	Nome	June 27, 1997	Cessna 207A	Struck radio tower while under SVFR conditions
ANC00FA110	Juneau	August 31, 2000	Cessna 172G	Shortly after takeoff hit spruce tree then hangar.
ANC01FA106	Kotzebue	August 13, 2001	Maule M-6-235	Collided with radio antenna tower.

Note: Includes only aircraft in the air at or just before the time of impact. Does not include taxiing aircraft or aircraft that had just landed.

Appendix D

The following information presents the total estimated value of the land and structures present in the right-of-way (ROW) required for the Gravina Access Project Alternatives. Table C-1 presents the value of the land and structures, including those that are owned by public entities, in the ROW. The value incorporates the cost to acquire private land and structures in the ROW, plus the value of public lands required for the project. The value attributed to the public lands represents the opportunity cost of the land being used for transportation in place of an alternate use. The total value measure is used in a benefit-cost analysis. The acquisition cost represents the cost to the funding agency for acquiring the private land and structures or, conversely, the income to residents and others from the sale of their land and structures for the project. This measure is analyzed in the previous economic impact analysis. The data presented here are based on information from the Ketchikan Gateway Borough Assessor's office as analyzed by HDR Alaska, Inc.

Table D-1. Estimated Value and Acquisition Cost for Right-of-Way

Alternative	Total Square Feet Taken	Affected Value ($)
C3(a)[a]	2,012,990	$ 1,420,539
C3(b)[a]	1,977,512	$ 1,472,554
C4[a]	1,434,536	$ 1,303,898
D1[a]	1,756,764	$ 1,080,709
F1	3,864,548	$ 1,536,990
F3	3,182,232	$ 1,239,554
G2	1,913,844	$ 2,512,736
G3	1,099,626	$ 6,160,956
G4	1,591,875	$ 1,465,060

Source: Conceptual Stage Relocation Study and Assessment of Right-of-Way Acquisition Costs, April 2003.

[a] Cost estimates do not include the cost of moving the publicly owned floatplane facility.