The Whittier Access Project:
Anton Anderson Memorial Tunnel

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1.011 Project Evaluation
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1.0 Project Background

The town of Whittier is located in the southwestern portion of Alaska on the Prince William Sound. Whittier is not one of the largest towns in Alaska but actually one of the least populated in the state. Its placement on the Sound makes Whittier a popular spot for tourists and nearby visitors in seek of water recreation and vacationing and a utilized cargo port. Its location also made it an ideal spot when the United States government was looking for a rail port during the decline of the Second World War. In 1943 a rail port was constructed in the town of Whittier to provide a supply link from the sea to the main railway in Alaska, located at Portage. This supply link was the source of construction of the first tunnel through the Maynard Mountain. The tunnel was named after Anton Anderson, an engineer for the United States army who played a principal role in the construction of the original tunnel. The 2.5 mile tunnel was 16 feet wide and allowed one-way railcar access from Whittier into the Bear Valley.

Figure 1: A view of the new bridge and tunnel

Currently there are approximately 300 residents in Whittier, all dependent upon the trans-Maynard Mountain route. At the height of the rail port usage, the population of Whittier boomed at about 1000 inhabitants. However, that number promptly

deflated after the military pulled out of Whittier in 1950. The newly-constructed rail port quickly transitioned into a federally-run commercial port. For fifty years since its establishment as a port town, there was no vehicle access to Whittier. The town is separated from the nearest highway by five miles of mountainous terrain, glaciers, and lakes. The only means of getting in and out of the town was via the railway. Private vehicles could only be transported through use of the railroad; cars were placed on flat cars. This system was inefficient at best due to the infrequent schedule of trains and the complex staging required. The Whittier access project includes a modified tunnel through the Maynard Mountain, a new highway that feeds into the tunnel and two bridges.

Figure 2: The old railroad and a view of the old Anton Anderson Memorial Tunnel

1.1 Groups Involved

The Alaska Department of Transportation and Public Facilities (ADOT&PF) commissioned the access project due to the demand of the area. Whittier residents wanted an easier means to get into and out of the town. Tour Companies wanted an easy route for tourists to enter and exit the region. The ADOT&PF chose to follow a design-build construction method for the project, the first of its kind undertaken by the state of Alaska. There are numerous benefits of a design-build technique when applied to complex projects such as the Anton Anderson Memorial Tunnel. Design-build allows for a schedule driven project to be constructed fast

and effectively. This method also accommodates changes in the project more easily than the traditional design-bid-build method. During the reconstruction of the Anton Anderson Memorial Tunnel, one section was being constructed while another was being designed. The design-builder for the Whittier Access Project was Kiewit Construction. The lead consultant was HDR, who produced the environmental impact statement as required by the National Environmental Policy Act. The designer of the tunnel was Hatch Mott MacDonald. All of these entities: the Owner, the Design-Builder, and the Designer cooperated to construct a highly successful project.

2.0 Project Objectives

The reconstruction of the Anton Anderson Memorial Tunnel had three primary objectives. First, the project was to increase access to the town of Whittier, a town only enterable by railway. Second, the new route must guarantee the convenience and affordability of this newfound access. The last aim of the Whittier Access Project was to improve the safety measures of the tunnel in case of emergencies due to fire or winter weather.

2.1 Project Alternatives

To address the three project objectives, the ADOT&PF studied the existing tunnel and area and devised six alternatives for the rail tunnel. The first option was to do nothing and allow the town to remain isolated from the rest of the region. The more viable alternatives are the five following:

- To increase the existing rail service
- To use a high-speed electric train
- To construct a highway route over Maynard Mountain

- To construct a highway route through the tunnel
- To construct a combined roadway and railway route through Maynard Mountain and a highway leading to the tunnel

The Alaska Department of Transportation and Public Facilities chose the last option for the renovation of the Anton Anderson Tunnel. The Whittier Access Project would include a bimodal tunnel and a highway with two bridges leading to the new tunnel. This alternative was selected for cost effectiveness and practicality: the tunnel would not have to be widened to allow automobile use. The only new construction would be the roadway and bridges connecting the Anton Anderson Memorial Tunnel.

Figure 3: One side of the tunnel and a new bridge

3.0 Risks and Uncertainties

The main risks identified by the ADOT&PF before construction in 1998 were weather, the unique design-build construction method, and the availability of materials & equipment. Weather is an external, uncontrollable risk for which the management team could prepare and try to predict. This part of Alaska experiences an average snowfall of 40 feet annually and extremely high winds. A two-year construction project in these conditions retains a high risk factor and

probability of conflict. The project management team took measures to prevent delays and issues arising from the risk of extreme weather. This was the first experience of Alaska's Department of Transportation with the design-build process. Straying from the conventional method of design-bid-build was an enormous risk in itself. ADOT&PF hired HDR to produce a conceptual design and also the design specifications for the new tunnel. HDR also partnered with the ADOT&PF in managing the construction contract and sought the assistance of design/build law, tunnel engineering, ventilation, tunnel control systems, and railroad signal systems experts. The Department of Transportation and HDR managed the risk of embarking on a new construction process by combining their resources and gleaning knowledge from experts in the tunnel and railroad fields. The last risk identified by the Anton Anderson Memorial Tunnel project was the lack of availability of equipment and materials.

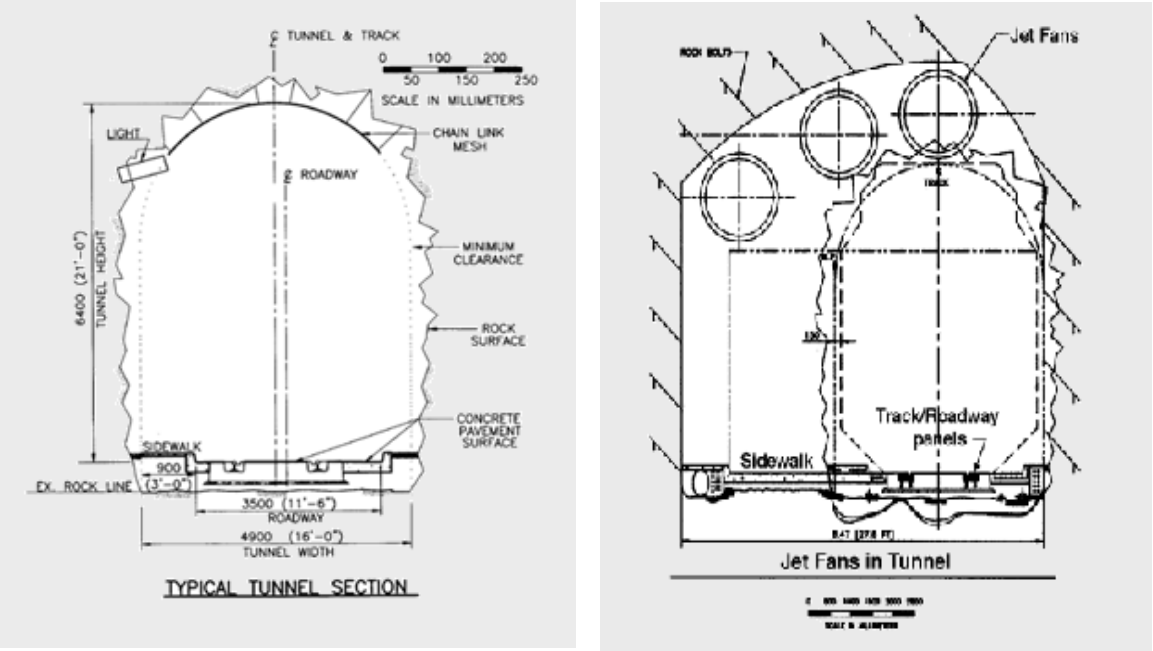


Figure 4: Construction plans for the renovation of the tunnel

4.0 Design and Implementation

The renovation of the tunnel essentially entailed the changing of the one-way railroad tracks to a one-way highway/railway. The old railway tracks were removed along with the underlying crushed rock. These elements were replaced with long concrete panels; the new railroad tracks embedded in the panels. This modification of the tunnel floor was primarily the only construction necessary for the conversion of the Anton Anderson Memorial Tunnel into a bimodal route between Portage and Whittier. However, to meet the third objective to improve the tunnel's safety measures additional rock excavation was performed. The walls of the tunnel when constructed were natural rock and exceedingly solid. The construction team decided to keep the walls natural rock, reinforcing the few weaker sections with steel plates.

Kiewit Construction excavated the rock walls of the tunnel to create room for safehouses, areas to pull off the road, and a state of the art fans system. The construction of the safehouses was aimed at providing a refuge for users of the tunnel in case of fire or extreme winter conditions. The fan system is the first of its kind to combine jet fans and portal fans. The chief purpose of the fans is to provide ventilation through the 2.5-mile tunnel. The second purpose of the reversible jet fans is to redirect wind in case of a fire emergency.

Furthermore the innovative Traffic Control System and Train Signal System monitor the complicated operation of the tunnel. A basic explanation of the tunnel operation is the following: An interval for northbound cars to enter the tunnel; a transition time for all vehicles to exit; an interval for southbound cars to enter the tunnel; a transition time; an interval for northbound trains; and the schedule continues. This complex system is regulated by the Traffic Control System and the Train Signal System and aided by staging areas at the Whittier and Bear Valley

ends of the tunnel. The construction was expected to take two years at a contract sum with the design-builder Kiewit Construction for $59.6 million.[1]

4.1 Challenges of Construction

Due to the geographical characteristics of the region, Kiewit faced several challenges during the construction of the tunnel. However, by using innovative techniques and careful planning, they managed to overcome these challenges.

Snow

On average, Whittier receives 40 feet of snow per year; thus, the problem of snow posed many difficulties for Kiewit. In addition, harsh winter weather conditions also had to be dealt with. During the 22-month construction period, the project did experience delay due to an avalanche on the Maynard Mountain. Kiewit dealt with these extreme weather problems by creating staging areas to store their equipment and machines.

Figure 5: A picture after heavy snowfall during the tunnel reconstruction

[1] Note that the entire Whittier Access Project had a total cost of $80 million: $57 million due to the Anton Anderson Memorial Tunnel renovation and $23 million due to the additional roadway and two bridges leading to the Maynard Mountain.

Tunnel Portals

Because the project was located in a mountain, Kiewit had to address the possibility of an avalanche; the potentially devastating effects of an avalanche could prove to be very costly to fix. The construction team came up with the idea of having A-shaped tunnel portals that were capable of resisting the forces of any possible avalanches. These portals were strong enough to withstand approximately 1000 pounds per square foot and were a very necessary safety precaution for the project.

Tight Working Conditions

The existing one-way tunnel was only sixteen feet in diameter, making it extremely difficult to fit a large amount of equipment and/or manpower in the tunnel at any given time. In order to deal with this problem, Kiewit utilized specialized equipment and construction methods on the job site; they also formulated a very detailed schedule of the machinery sequence for the project. Both of these measures greatly increased the project efficiency, eliminating delays caused by movement of materials, equipment, and workers.

Time Constraint

ADOT had promised several tour companies that the tunnel would be fully operational within a two-year period so that these tour companies could bring buses through to Whittier via the new tunnel. This time constraint meant that Kiewit could not afford to experience any delays in construction, either expected or unexpected. Kiewit attempted to minimize any possible delays by placing a heavy emphasis on partnering; in addition, there were overlapping shifts for the entire project duration in order to ensure that there was always continual on-site monitoring.

Keeping the Tunnel Operational

One of the most challenging limitations Kiewit had to deal with was the fact that the tunnel had to remain operational during construction because it is the only passageway into and out of Whittier. Kiewit dealt with this by practicing all installation procedures outside of the tunnel before actually performing them in the tunnel.

5.0 Project Costs

There are several costs, including both direct and indirect costs, related to this project. The main costs we uncovered were the following: construction costs, loss of full tunnel operations, and potential environmental impacts. Because the tunnel is the only road leading into and out of Whittier, its usage is very important to the community; thus, the cutback on operational use was a large cost for the people who traveled through the tunnel each day. In addition, environmental impacts are inevitable in any situation where construction is involved. Machinery and equipment on the construction site emit pollution, stir dust, and create a lot of noise, greatly disturbing the surrounding area. The costs associated with construction will be discussed in further detail.

The following cash flow diagram shows the state expenses and revenues for the first five years of the project, beginning with the first month of construction in September, 1998.

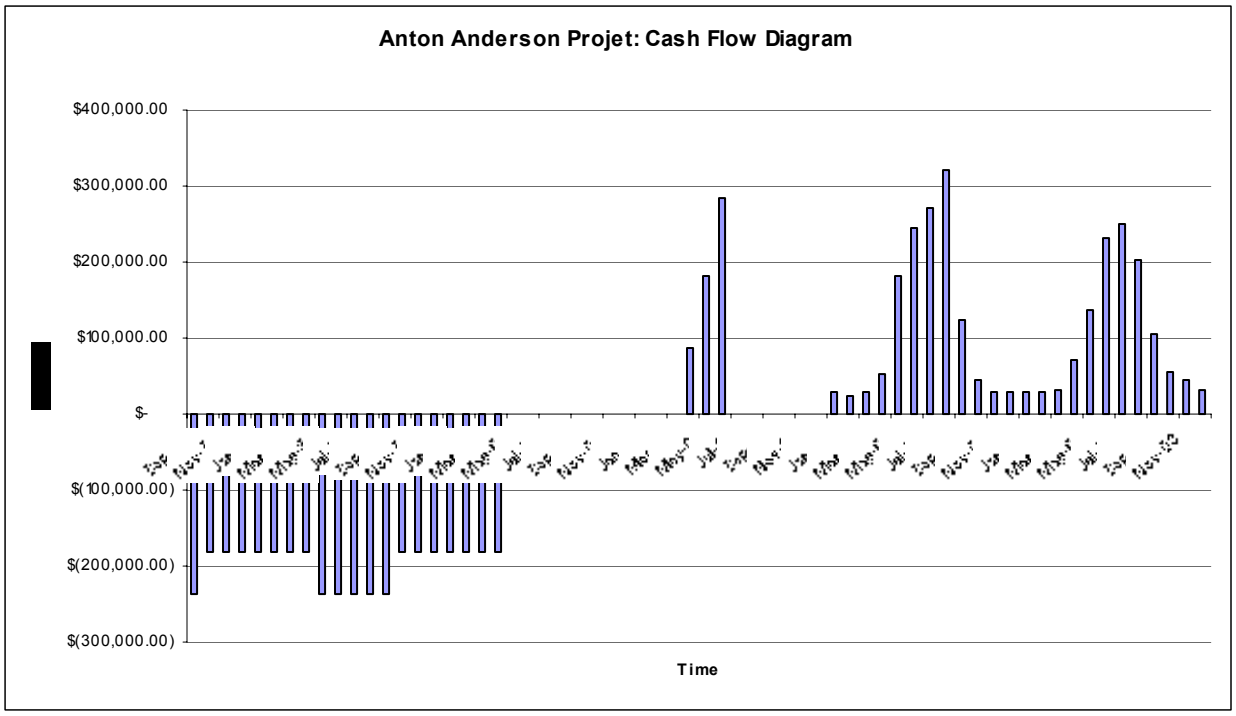


Figure 6: Cash Flow Diagram for State of Alaska

5.1 Project Benefits

The Anton Anderson Memorial Tunnel project brought many benefits to the community of Whittier as well as the state of Alaska. These include: revenue tolls, increased accessibility to Whittier as well as a shorter commute time, and an economic boost from the increase in tourism sparked by the tunnel. As mentioned earlier, the main focus of the project was not to build a toll-earning tunnel, but instead the project developers focused on addressing the problem of accessibility to the Whittier area. Below is a graph of projected toll revenue from 2001 to 2009.

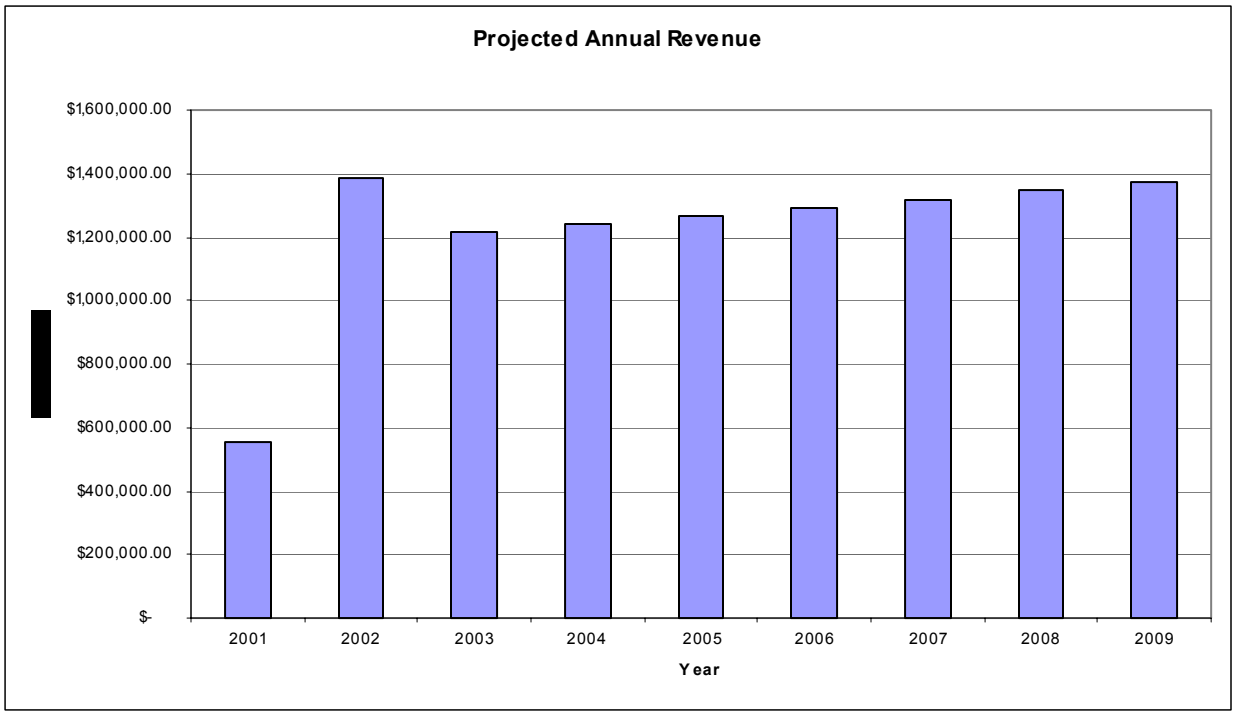


Figure 7: Projected Annual Revenue from Tolls

5.2 Cost-Benefit Analysis

The following table summarizes our cost benefit analysis in Assignment 6. It includes data provided to us by Mr. Gordon S. Burton.

Assignment 6: Cash Flow Models
Whittier Access Project, Anton Anderson Tunnel

Name: Roberta Hsu
Date: April 14, 2003

Fixed Costs			**Parameters**	
Land Acquisition	$570,000	1%	Monthly Interest Rate	0.83%
			Length of Const.	*22*
Preparation for Devel.	$2,280,000	4%	Period	*months*
			Owner's Discount	
Architect/Engineer	$17,100,000	30%	Rate	1.25%
Construction Costs	$34,200,000	60%		
Project Management	$2,850,000	5%		
Total Project Cost	***$57,000,000***			

Revenue Values				
Hours of Operation [Summer]	17	Vehicle Class	% of Total Vehicles	Fare
Hours of Operation [Winter]	11	Class A	88%	$12
Vehicles Per Hour	500	Class B1	1%	$20
Owner's Discount Rate	15.00%	Class B2	8%	$35
		Class C	1%	$125
		Class D	2%	$125
		Class E	0%	$300
		Class F	0%	$0
		Class G	0%	$10

Summary: Present Worth	
Total Fixed Cost	***$52,000,000***
Total Revenue (60 years)	***$11,000,000***

Figure 8: Summary Chart - Costs and Benefits

The total cost (costs associated with construction of tunnel) of the project was $57 million whereas the total projected revenue of the project (revenue from tolls) was approximately $11 million. This gives the calculated project a total loss of $46 million. In addition to the tolls, there are the implicit benefits that come from an increase in tourism due to the new bimodal tunnel. We do not have any information on how the tourism industry in Whittier has monetarily benefited from the new tunnel, but we can safely assume that there has been a substantial increase in tour buses and groups coming through the tunnel into Whittier. However, because this project was completely funded by federal and state money, the primary objective was not to create a profit-generating tunnel. Instead, the project objectives of increasing accessibility and decreasing the commute time were given more attention. Further charts of total revenue and cost can be found in Appendix C.

5.3 Sensitivity Analysis

In Assignment 6, we were asked to perform some sensitivity analysis for our case study project. This analysis has been summarized in several graphs which can be

found in Appendix B. For the most part, the factors that could potentially affect our project created a linear effect on the cost or revenue. The results are rather straightforward and very predictable.

6.0 Status of Project and Results

The renovations to the Anton Anderson Memorial Tunnel were completed in June, 2000. The Whittier Access Project received numerous national honors and accolades, among them the highest award given by the American Society of Civil Engineers, the Outstanding Civil Engineering Achievement Award. The project was completed two months ahead of schedule and was also under budget ($57 million versus a budgeted $59.6 million). The project is the only bimodal tunnel in the world to combine both rail and highway; in addition, it is the longest highway tunnel in North America at a length of 2.5 miles.

6.1 Tunnel Innovations

There are several notable innovations associated with this project, further contributing to its spectacular performance. A high-tech computerized control system has been created to manage the tunnel traffic and the switch between modes. This system also takes care of emergency response. In addition, the tunnel has been built to resist temperatures of up to -40 degrees, easily handling the severe snow and wind conditions common to Alaska. The Memorial tunnel is also one of the first to use both portal and jet fans for ventilation.

7.0 Discussion and Critique

From this project, we can safely establish the potential effectiveness of the design/build method. It allows for innovation in the construction process, giving the contractor leeway to make changes that could lead to many benefits.

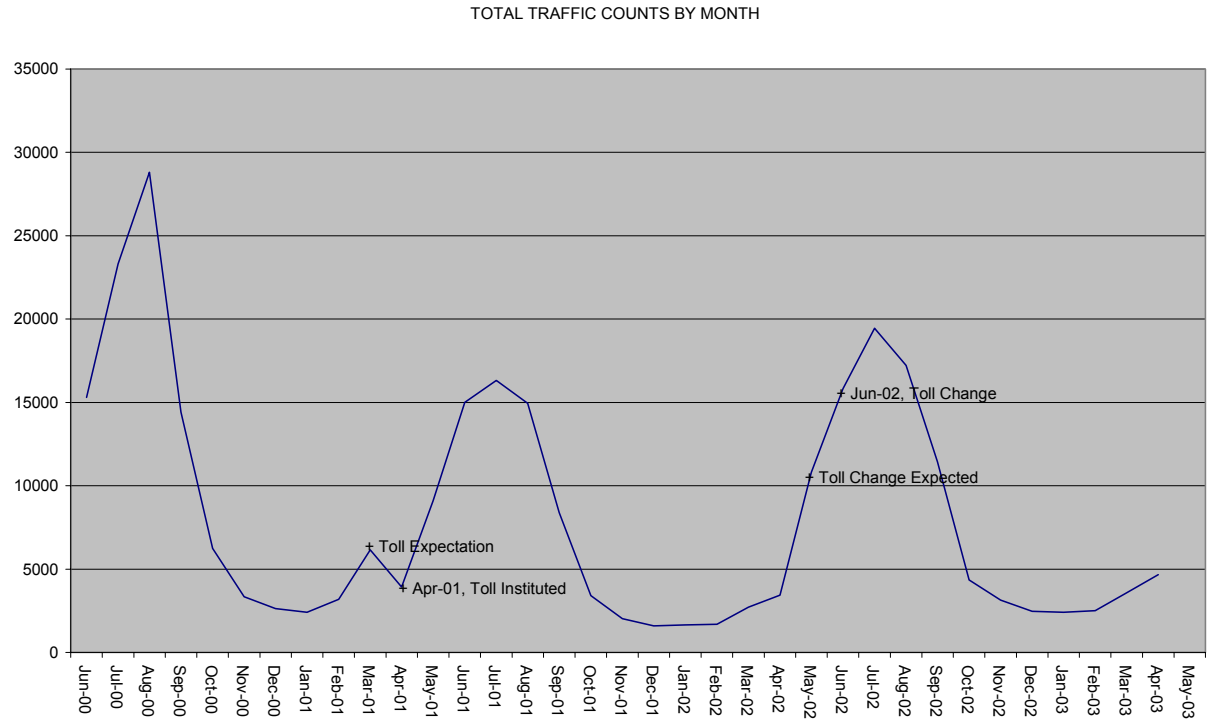
We have also seen the value of careful planning and monitoring. When there are hard time constraints and very limited working conditions, the efficiency of a project begins to heavily rely on proper scheduling as well as a reliable monitoring system. In the case of the Anton Anderson Memorial Tunnel project, the value of these two particular project aspects was priceless. Coupled together, they provided an efficient, innovative, and reliable construction process. Future construction projects have much to learn from the innovations and methods utilized on the Anton Anderson Memorial Tunnel. Construction projects that are completed ahead of schedule as well as under budget are few and far between.

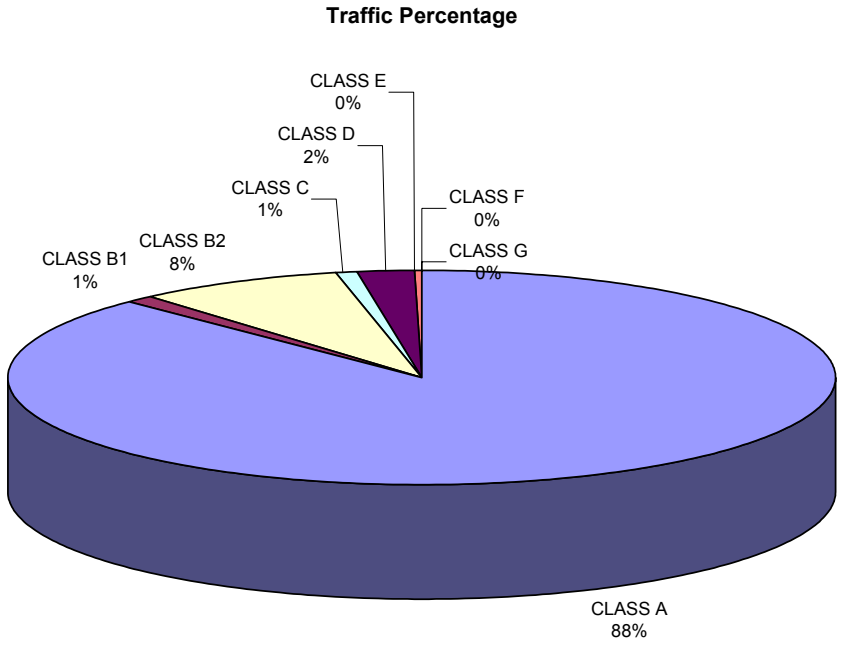
8.0 Appendix

Appendix A: Traffic Counts and Revenue Information for Anton Anderson Memorial Tunnel (Data and Information Provided by Mr. Gordon S. Burton)

MONTH	CLASS A	CLASS B1	CLASS B2	CLASS C	CLASS D	CLASS E	CLASS F	CLASS G	TOTAL	EVENT	TOTALS OF EVENT
Jun-00	12830	-	1665	221	563	20	-	-	15299		
Jul-00	19748	-	2780	415	357	9	-	-	23309		
Aug-00	19652	-	2466	350	331	10	-	-	22809		
Sep-00	12671	-	1195	86	465	6	-	-	14423		
Oct-00	5803	-	225	2	211	2	-	-	6243		
Nov-00	3085	-	78	15	147	11	-	-	3336		
Dec-00	2469	-	46	12	95	12	-	-	2634	**2000 Ends**	**88053**
Jan-01	2279	-	32	2	103	0	-	-	2416		
Feb-01	2774	-	121	75	148	67	-	-	3185		
Mar-01	5719	-	160	66	167	43	-	-	6155	**Tolls go into effect 4/1/2001**	**99809**
Apr-01	3581	-	218	12	113	1	-	-	3925		
May-01	7765	-	1030	73	227	9	-	-	9104	**1st anniversary of tunnel opening**	**112838**
Jun-01	12818	-	1703	149	316	26	-	-	15012		
Jul-01	14186	-	1736	168	227	3	-	-	16320		
Aug-01	13055	-	1573	156	167	0	-	-	14951		
Sep-01	7307	-	899	56	127	1	-	-	8390		
Oct-01	3024	-	307	0	79	0	-	-	3410		
Nov-01	1853	-	130	1	43	1	-	-	2028		
Dec-01	1470	-	84	0	42	1	-	-	1597	**2001 Ends**	**86493**
Jan-02	1579	-	60	0	20	0	-	-	1659		
Feb-02	1578	-	64	0	52	0	-	-	1694		
Mar-02	2578	-	70	1	71	0	-	-	2720	**1st anniversary of tolls**	**80810**
Apr-02	3137	-	192	13	96	0	-	-	3438		
May-02	9114	-	1288	136	264	5	-	-	10807	**New tolls go into effect June 8, 2002, 2nd anniversary of tunnel opening**	**82026**
Jun-02	13815	964	572	113	333	2	13	12	15824		

Jul-02	17175	1225	474	151	374	2	32	25	19458		
Aug-02	15182	1183	443	131	238	0	39	14	17230		
Sep-02	10255	591	213	39	301	3	17	22	11441		
Oct-02	3831	170	134	4	177	1	17	15	4349		
Nov-02	2774	84	72	0	172	0	23	18	3143		
Dec-02	2202	74	47	0	136	1	10	2	2472	**2002 Ends**	**94235**
Jan-03	2190	20	59	0	49	0	83	10	2411		
Feb-03	2328	22	40	0	74	0	30	11	2505		
Mar-03	3356	42	57	1	75	2	34	18	3585		
Apr-03	3262	24	200	14	100	0	1	1	4665		
May-03	9479	31	1340	141	275	5	1	1	11271	**3rd anniversary of tunnel opening**	**98354**
									Total traffic minus projections		**297600**



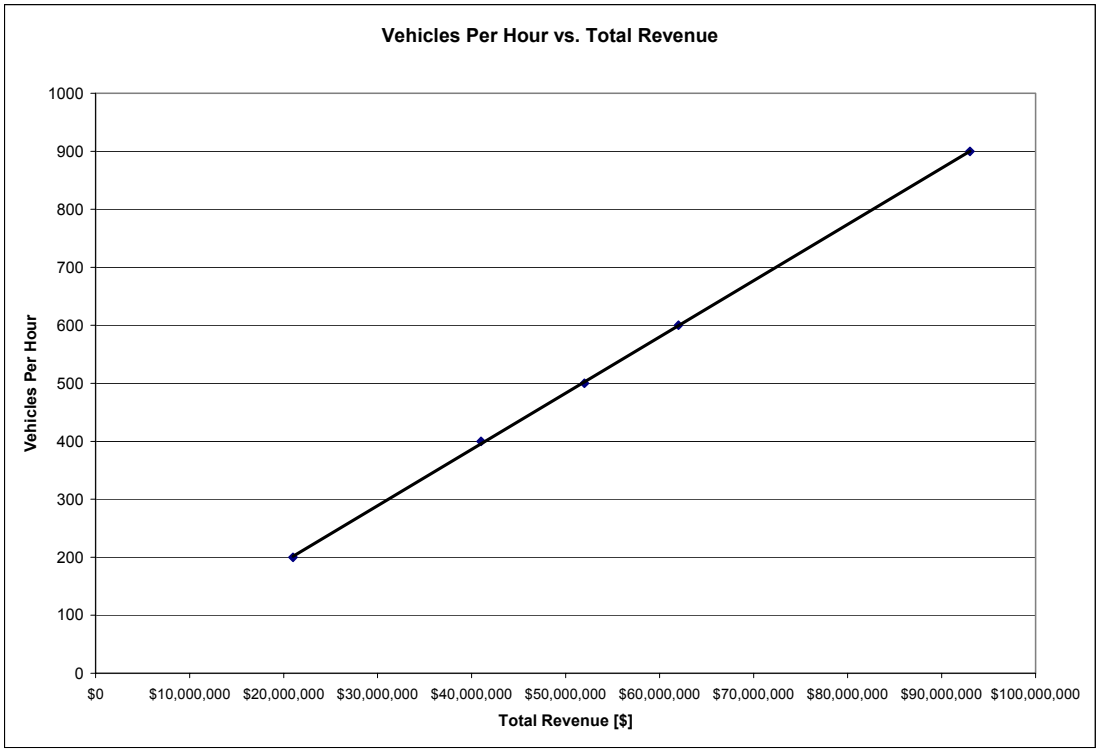


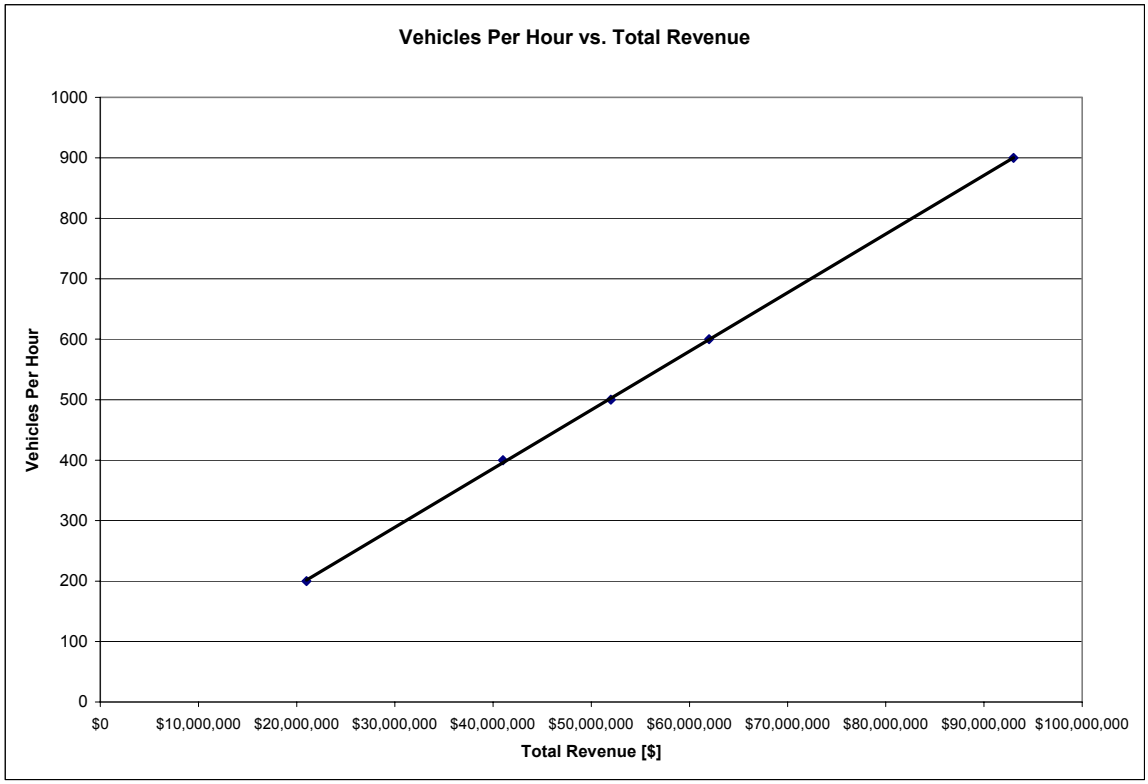
Revenue Data

Month	2000	2001	2002	2003	Average	Theoretical Revenue	Actual Revenue FY-03
January		2416	1659	2411	2162	$ 32,051.65	$ 28,549.00
February		3185	1694	2505	2461	$ 36,489.27	$ 29,226.00
March		6155	2720	3585	4153	$ 61,573.17	$ 31,090.00
April		3925	3438	4665	4009	$ 59,438.37	$ 70,000.00
May		9104	10807		9956	$ 147,590.29	$ 137,807.00
June	15299	15012	15824		15378	$ 227,983.79	$ 232,337.00
July	23309	16320	19458		19696	$ 291,988.26	$ 249,684.00
August	22809	14951	17230		18330	$ 271,742.25	$ 203,176.00
September	14423	8390	11441		11418	$ 169,271.85	$ 104,983.00
October	6243	3410	4349		4667	$ 69,193.22	$ 54,560.00
November	3336	2028	3143		2836	$	$

						42,038.76	44,743.00
December	2634	1597	2472		2234	$ 33,123.99	$ 32,667.00
Total	**88053**	**86493**	**94235**	**13166**	**89594**	**$ 1,442,484.85**	**$ 1,218,822.00**
Year-To-Date-Total				**281947**			

Appendix B: Charts of Sensitivity Analysis on Anton Anderson Memorial Tunnel




Vehicles Per Hour vs. Total Revenue
Vehicles Per Hour
1000
900
800
700
600
500
400
300
200
100
0
$0
$10,000,000
$20,000,000
$30,000,000
$40,000,000
$50,000,000
$60,000,000
$70,000,000
$80,000,000
$90,000,000
$100,000,000
Total Revenue [$]


Construction Costs vs. Total Cost
Construction Costs [$]
$70,000,000
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
$0
$10,000,000
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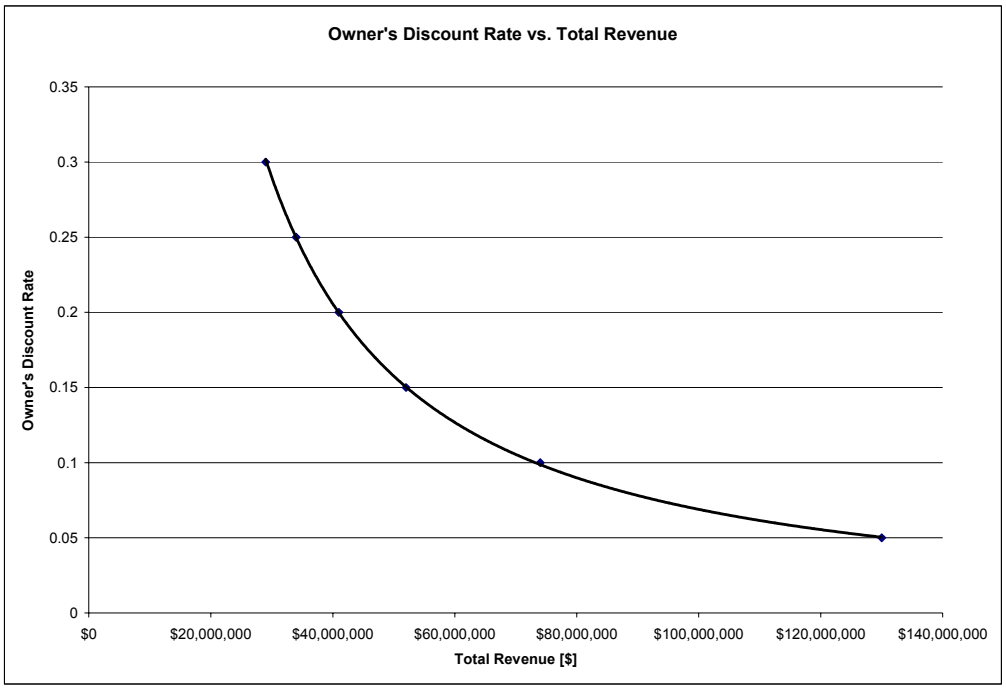
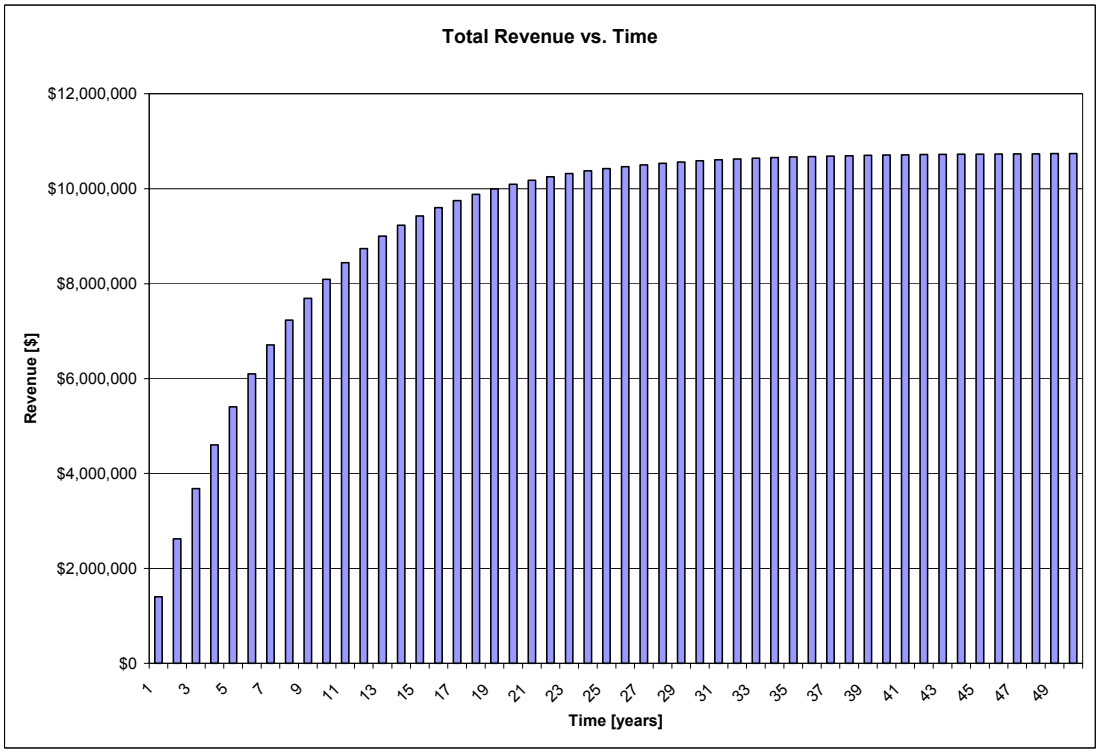
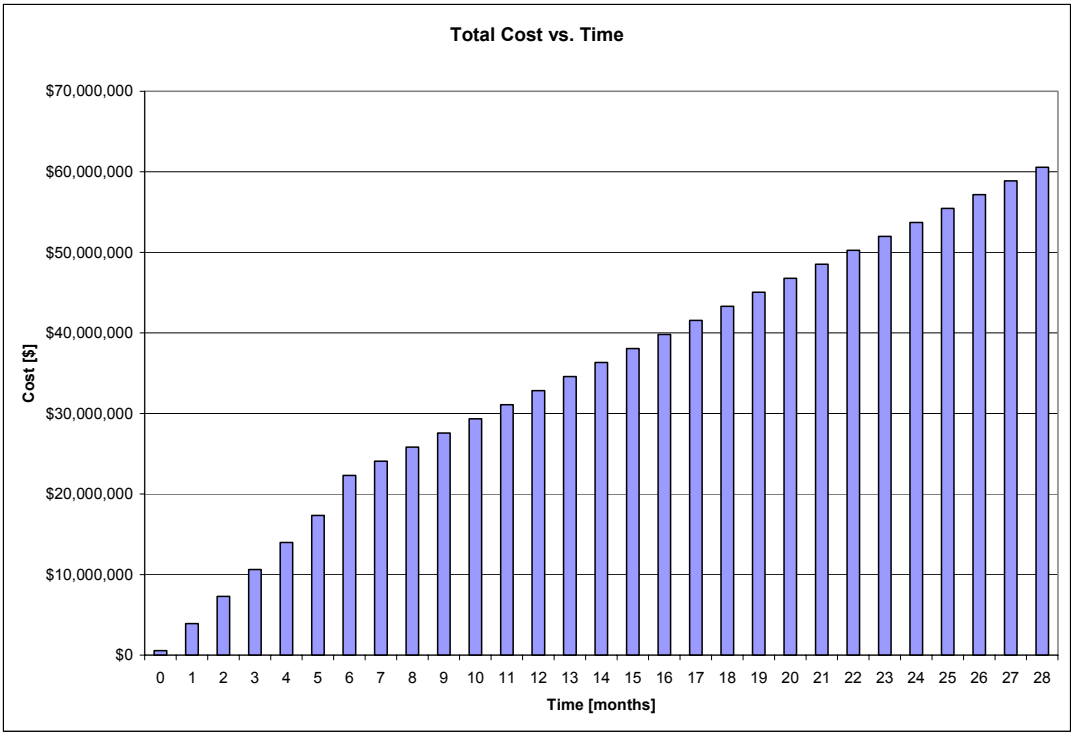
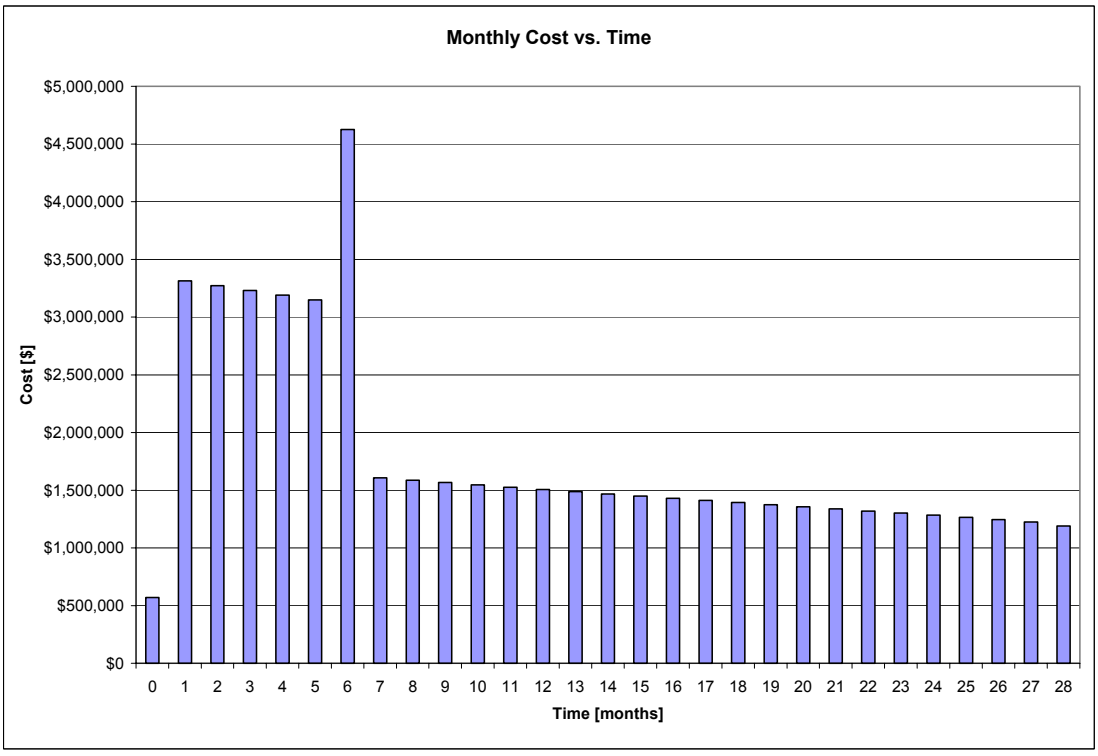
$60,000,000
$70,000,000
$80,000,000
Total Cost [$]



Appendix C: Cost and Revenue Charts




Total Cost vs. Time
$70,000,000
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
Cost [$]
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Time [months]


Monthly Cost vs. Time
$5,000,000
$4,500,000
$4,000,000
$3,500,000
$3,000,000
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$0
Cost [$]
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Time [months]

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