Alaska Department of Transportation & Public Facilities

TUNNEL OPERATIONS STUDY

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Prepared For:

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In June 2000, the State of Alaska Department of Transportation and Public Facilities completed construction of the Whittier Access Project by converting the existing 2.5-mile Whittier Tunnel into the world's only dual-use highway/rail tunnel with one-way reversible highway traffic. Since the tunnel was opened, there has been a significant increase in both highway and rail traffic through the tunnel, which has resulted in occasional delays to both highway and railroad traffic. The objective of this research project is to determine the current and future needs of the users of the Whittier Tunnel; evaluate current schedule and tunnel operations for regulatory compliance and efficiency; develop a visual model to illustrate problems and evaluate possible solutions. This research project concluded that access to the City of Whittier has improved since construction but the tunnel is operated below capacity when switched to highway from rail. It also concluded that the current tunnel schedule is the most efficient schedule to meet combined rail/highway demands and identified the biggest impact on operations-loaded freight trains from Whittier to Bear Valley and Railroad system failures. This research report makes recommendations to reduce delay and improve tunnel operations. This report is closely related to another research report #4000116.

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APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

TUNNEL OPERATIONS STUDY

ANTON ANDERSON MEMORIAL TUNNEL
WHITTIER, ALASKA

Project No. RI-4000(18)/61908

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LIST OF ACRONYMS

AAMT ..... Anton Anderson Memorial Tunnel
AMHS ..... Alaska Marine Highway System
AML ..... Alaska Marine Lines
ARRC ..... Alaska Railroad Corporation
BV ..... Bear Valley
CAD ..... Computer-Aided Dispatch
CN ..... Canadian National
CO ..... carbon monoxide
DOT&PF ..... State of Alaska Department of Transportation and Public Facilities
ETA ..... estimated time of arrival
FRA ..... Federal Railroad Administration
GPS ..... Global Positioning System
GVW ..... Gross Vehicle Weight
MP ..... milepost
mph ..... miles per hour
RCC ..... Remote Control Center
RV ..... Recreational Vehicles
TCC ..... Tunnel Control Center
TCS ..... Track Circuit System
TSS ..... Train Signal System
U.S. ..... United States
VMS ..... Virginia Management Systems

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Mary Brenneman, City Council, City of Whittier

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Kelly Bender, President, Whittier Chamber of Commerce

Whittier Chamber of Commerce members

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Scott Hicks, Vice President, Operations, Alaska West Express

Greg Vancil, Manager, Port Operations, Holland America - Princes Cruises

Mike Tibbles, Alaska Cruise Association

Lisa Moore, Whittier Ferry Terminal Manager, Alaska Marine Highway System

Major Marine Tours

Phillips Cruises and Tours, LLC

Whittier Boat Owners Association Members

EXECUTIVE SUMMARY

In June 2000, the State of Alaska Department of Transportation and Public Facilities completed construction of the Whittier Access Project. This project converted the existing 2.5-mile Anton Anderson Memorial Railroad Tunnel (or Whittier Tunnel) into the world's only dual-use highway/rail tunnel with one-way reversible highway traffic.

The project included construction of the tunnel invert (driving surface that can accommodate highway vehicles and trains); drainage systems; three different types of ventilation systems; two vehicle-staging areas; Tunnel Control Center; communication systems; portal buildings; a train signal system; and other safety features.

To accommodate both railroad and highway users, an operations plan and schedule were developed to provide the most effective use of the tunnel. Since the tunnel was opened, there has been a significant increase in both highway and rail traffic through the tunnel, which has resulted in occasional delays to both highway and railroad traffic. It is anticipated that there will be a continued increase in both highway and railroad needs for transiting the tunnel. This increased railroad and highway traffic is primarily due to:

1. Increased freight passing through the Whittier port. There is strong probability that additional barges with both rail and container cargo will be docking at the Whittier port in the near future, which will result in more freight trains passing through the tunnel.

2. Cruise ships have started docking in the summer at the Whittier port, which resulted in additional passenger trains and buses passing through the tunnel.

3. The Alaska Marine Highway System has increased the number of ferry dockings in the summer from one per day to two to three per day.

4. Increased recreational users and tourism during the summer months.

Objective

The objective of this research project is to:

1. Determine the current and future needs of the users of the Whittier Tunnel;

2. Evaluate current schedule and develop the most efficient schedule to accommodate future highway and railroad needs;

3. Evaluate tunnel operations to determine the most efficient way to operate and improve efficiency for both railroad and highway use in accordance with the current Whittier tunnel regulations and latest State of Alaska Department of Transportation and Public Facilities – Alaska Railroad Corporation Whittier Tunnel operating agreement;

4. Develop a visual model to illustrate problems and possible solutions.

This project did not evaluate toll schedules or operating hours. This project also did not evaluate any modifications to the tunnel regulations or to the *DOT/PF – ARRC Whittier Tunnel Operating Agreement.*

Conclusions

This project concluded:

- Access in and out of Whittier has greatly improved since the tunnel was converted to a dual-use facility and shuttle trains were discontinued in 2000. The conversion to a dual-use tunnel greatly increased the number of vehicles traveling to Whittier. Highway vehicle capacity is now approximately 3,500 equivalent cars per day with the current schedule. This compares with 240 equivalent cars per day, and people (200,000 annually) who parked their cars at Portage and used the shuttle train, prior to construction of the tunnel. Vehicles can now travel 18 hours per day during the summer and 15.5 hours during the winter.
- There have been 6 vehicle and 17 motorcycle accidents in the tunnel since it was opened in 2000.
- Although there has been a significant increase in highway traffic, the tunnel is well below highway capacity when the tunnel opens to highway traffic on schedule. When highway tunnel openings are delayed, traffic can quickly accumulate and impact highway operations.

- Alaska Railroad Corporation has modified its rail operations to accommodate highway use. Some delays regularly occur to freight-train operations, especially in the summer. Passenger-train operations have been modified with no significant delays in 2013. Alaska Railroad Corporation dispatchers and Tunnel Control regularly communicate to minimize delay impacts to both modes.

- The current tunnel schedule is the most efficient schedule for handling current and near-future combined highway/railroad traffic demands. Highway vehicles that arrive on time have been able to transit the tunnel during a scheduled opening or during the first opening after train passage.

- Passenger trains and empty freight trains traveling from Bear Valley to Whittier have relatively little impact on the highway tunnel schedule and highway operations. Passenger trains generally take only 6-8 minutes to transit the tunnel. Empty freight trains from Bear Valley to Whittier generally take 10-20 minutes. Passenger trains and empty freight trains from Bear Valley to Whittier generally do not have to be purged of emissions prior to opening for highway traffic. Generally, only one highway opening is delayed by these trains. The delay in the highway opening following train passage is usually less than 5 minutes for passenger trains and 10-15 minutes for empty freight trains.

- Loaded freight trains traveling from Whittier to Bear Valley have a significant impact on highway traffic – especially during the summer months. These trains result in delays of generally two, and sometimes up to four, highway openings. The first highway opening after one of these trains is generally delayed 25 to 35 minutes. However, the second highway opening is generally delayed only 10-15 minutes. It takes 1 to 1.5 hours for the tunnel to get back on schedule.

- Other primary causes that impact highway operations that delay highway openings are:

  Progressive failure of the Track Circuit System, which delays the transfer of the tunnel from the Alaska Railroad Corporation to the Tunnel Control Center

  Power outage, which significantly reduces the rate at which vehicles can transit the tunnel

Isolated occasions when two trains traveling in the opposite direction, or more than two trains traveling in the same direction, transit the tunnel during the same railroad window

- In general, the tunnel only needs to be purged of accumulated Carbon Monoxide after loaded freight travels from Whittier to Bear Valley and on cruise-ship days when four passenger trains and 40 to 60 buses transit the tunnel in a short period of time. It takes 10 to 25 minutes to purge the tunnel of Carbon Monoxide for the loaded freight trains.
- The time it takes to purge the tunnel is dependent upon the number of jet fans and portal fans that can be used. Due to high demand cost of power for portal fans, only one portal fan is used at a time. The State of Alaska Department of Transportation and Public Facilities has requested funding for installation of emergency backup generators. It may be economically feasible to use backup generators to run more portal fans and run those more often to reduce the time it takes to purge the tunnel.
- Time required to clear staging areas and regain schedules, after transit of a freight train from Whittier to Bear Valley, can be reduced, by increasing the rate at which vehicles are allowed into the tunnel without compromising safety.
- There has been a progressive failure of the Track Circuit System that falsely reports that a train is in the tunnel, which requires that the tunnel be shut down for both highway and rail traffic. A State of Alaska Department of Transportation and Public Facilities-funded research project, conducted by Burns Engineering, concluded that the wet environment of the tunnel is the primary cause of failure of the Track Circuit System. Based on recommendations from Burns Engineering, the State of Alaska Department of Transportation and Public Facilities has funded a project to replace the current Track Circuit System with an axle counter system.
- During a power outage, existing backup generators lack sufficient power to run the jet-fan ventilation system. During these periods, 15-car platoons are escorted by fire trucks through the tunnel. The State of Alaska Department of Transportation and Public Facilities has funded a project to install emergency backup generators.
- The most feasible ways to improve Alaska Railroad Corporation operating efficiencies in the port and tunnel are to:

Install a second parallel track from Whittier Creek to the tunnel, which will allow freight trains to transit the tunnel to the rail yard in Whittier without impacting passenger-train service.

Construct an overpass at the Whittier Street Crossing – This will eliminate the impact that rail operations have on pedestrians and cars traveling from South Whittier to the harbor and tunnel.

Increase the height of the Alaska Railroad Corporation Portage Tunnel to allow double-stacking containers on rail cars, which will allow trains with double-stack containers to travel from Whittier to Fairbanks.

- Providing a communication system (cell phone/telephone) for the public in Bear Valley will help relieve drivers' frustration during lengthy delays in highway openings.

Recommendations

To improve tunnel operations during this project, the following recommendations are made:

1. Allow Class-A vehicles (cars) to enter the tunnel without being metered in, at a rate of 1.5 seconds/vehicle, and eliminate the 15-second delay time between opening each traffic lane (except for a lane with Class-C vehicles – loaded buses) in the staging area. This will increase the capacity of the tunnel and reduce the time that it takes to clear the staging area.

2. Use new backup emergency generators to power portal fans. This will allow portal fans to be used more often and reduce the time it takes to purge the tunnel after a loaded freight train has transited the tunnel.

3. During the winter, reduce the duration of highway openings from 15 minutes to 10 minutes. This increases the duration of train windows from 8 minutes to 13 minutes and would reduce the number of times a Whittier-bound freight train has to stop in Bear Valley.

4. Provide a communication system (cell phone/telephone) for the public in Bear Valley to help relieve drivers' frustration during delays in highway openings.

5. In the winter, when cars are platooned (see Section 4.3), trucks should be allowed to transit the tunnel before cars. This will reduce the time that it takes for them to drop or pick up a trailer in Whittier.

6. Create operation instructions advising train crews to optimize arrival times at Bear Valley. These instructions can be incorporated into the Alaska Railroad Corporation timetable, operation rules, or bulletins. These would consist of running recommendations, target stations and times of arrival, and guide tables to allow train crews to adjust train speed to meet optimal times to arrive in Bear Valley for tunnel passage. This would reduce the number of trains that would have to stop for the signal at Bear Valley.

7. Conduct a follow-up ventilation study to determine the most optimal procedures for operating the ventilation system. This study would determine the most cost-effective and quickest way to purge the Tunnel of emissions after a loaded freight train has transited this Tunnel. This study would determine:

a. When the portal fans should be used, based on wind-speed and direction.

b. How many portal fans should be used.

c. Which direction to blow these portal fans.

8. Continue to support improvements in daily operational communications between Alaska Railroad Corporation Dispatchers, Tunnel Control operators, and the public.

1.0 INTRODUCTION

The Anton Anderson Memorial Tunnel (AAMT), or Whittier Tunnel, is the longest highway tunnel in North America. The AAMT is also the only tunnel in the world that is shared with one-way reversible vehicular traffic and trains. It is also the first and only toll road in Alaska.

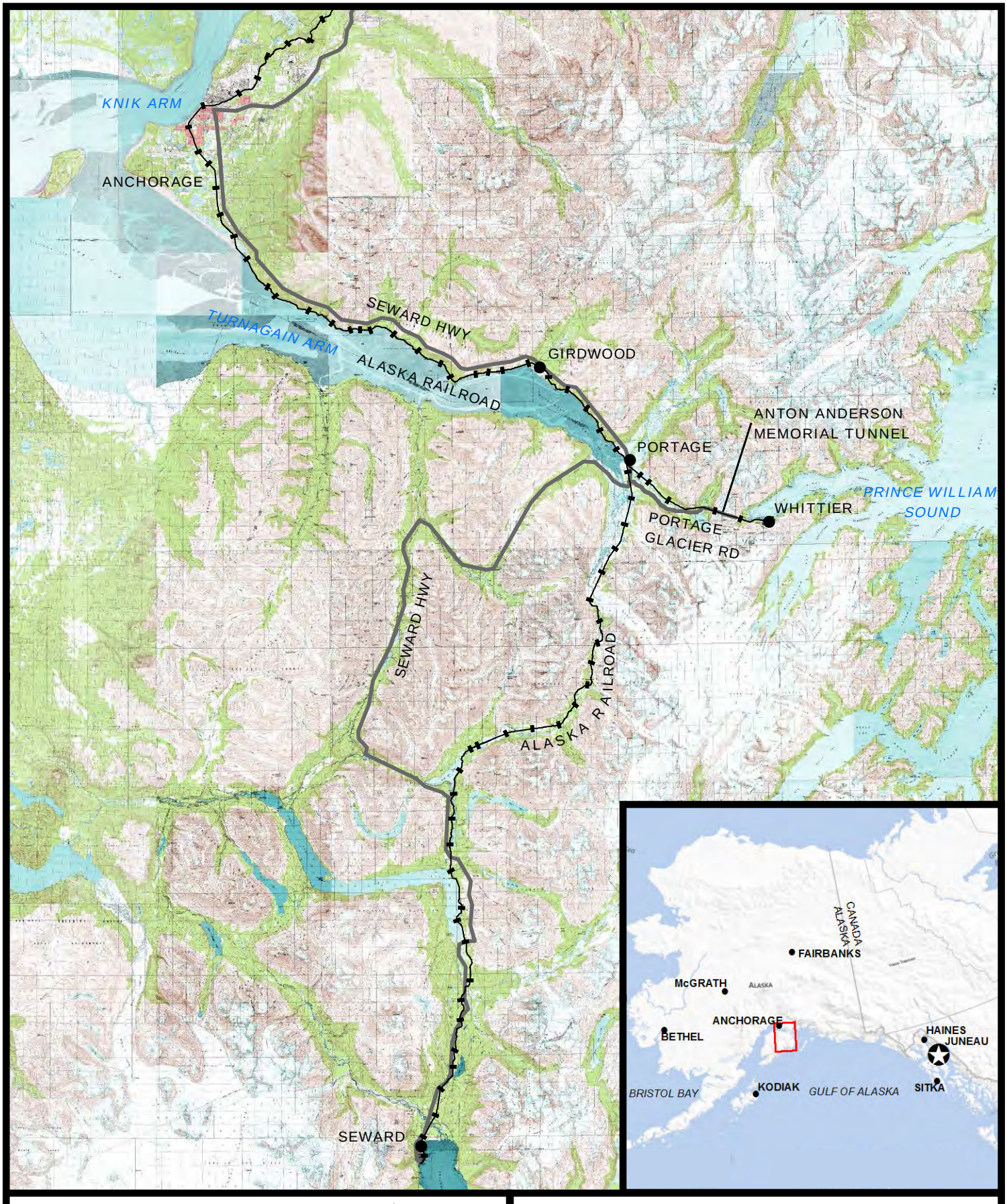
The AAMT is located 60 miles south of Anchorage, Alaska. This tunnel extends 2.52 miles (13,313 feet) through Maynard Mountain, between Bear Valley and Whittier, Alaska, and connects the Port of Whittier to the Seward Highway corridor (Figures 1 and 2).

1.1 Project Objective

The objective of this study is to analyze elements of this Tunnel that have an impact on rail and highway traffic flow and to identify potential solutions to improve traffic flow. Considerations include:

- Physical components and features of this Tunnel;
- Highway and railroad user groups;
- Schedule and regulations for this Tunnel;
- Railroad operations and highway operations;
- Incidents that affect Tunnel operations; and
- Possible methods to improve Tunnel operations.

Since traffic through this Tunnel is significantly higher during summer months, this study primarily focused on evaluating traffic from May through September. This study did not evaluate other aspects of Tunnel operations, including: toll schedule, hours of operation, modifications to Tunnel regulations, and modifications to the State of Alaska Department of Transportation and Public Facilities (DOT&PF) – Alaska Railroad Corporation (ARRC) tunnel operating agreement.



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Miles

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STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

WHITTIER TUNNEL OPERATIONS STUDY

Location Map

DATE: April 2013 | **Figure 1**

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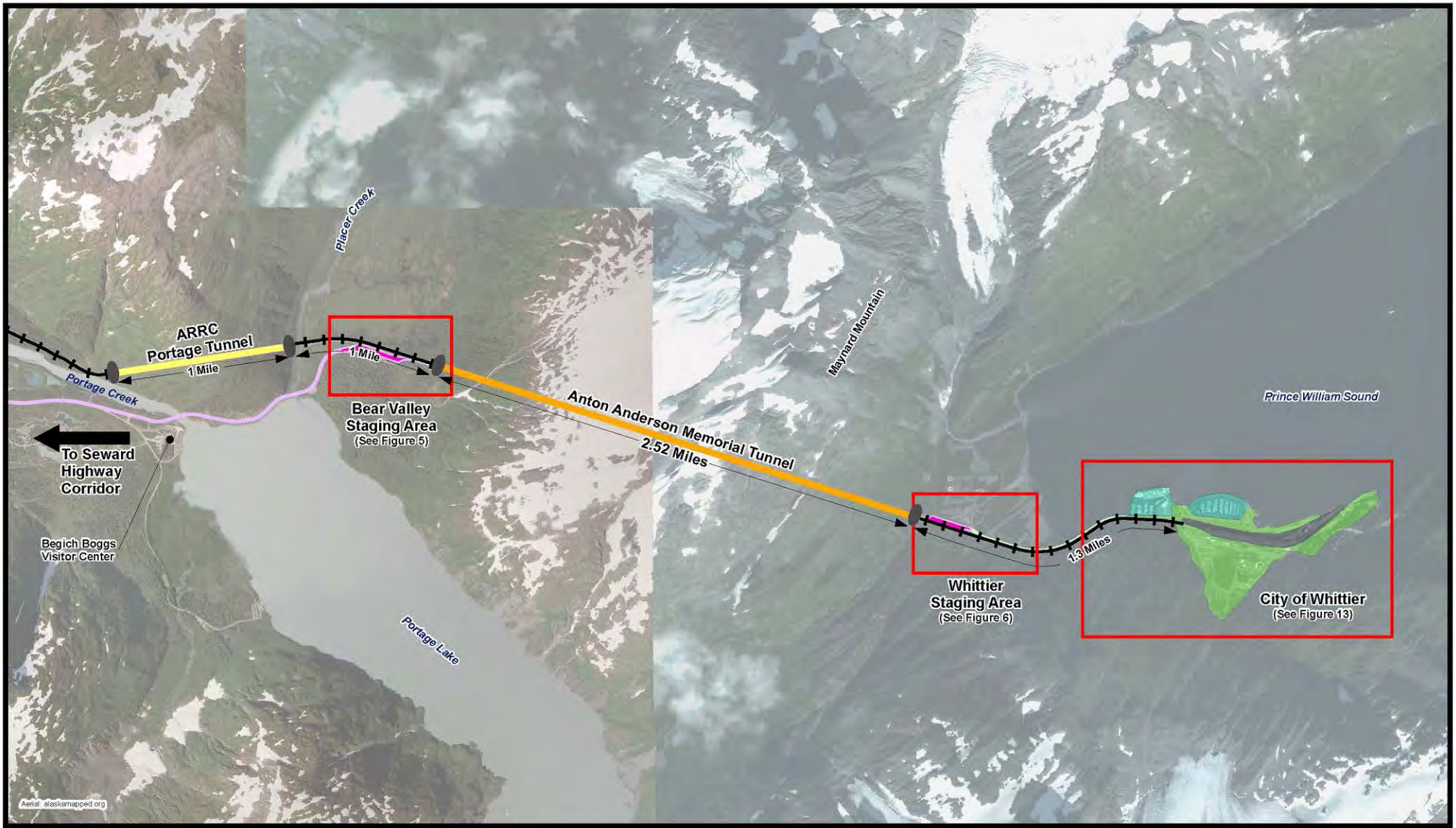

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

WHITTIER TUNNEL OPERATIONS STUDY

STUDY AREA

DATE: April 2013 | **Figure 2**

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2.0 BACKGROUND

2.1 Original Tunnel Construction

The United States Army constructed the railroad track between Whittier and Portage during World War II. As a part of this railroad construction, the AAMT was constructed and completed on April 23, 1943. This Tunnel was constructed specifically for railroad use only. Anton Anderson, for whom this tunnel is named, was an Army engineer overseeing tunnel construction.

The primary benefit of constructing this railroad was that it connected the Port of Whittier to the main railroad track between Seward and Anchorage. Whittier is the northernmost, deep-draft, ice-free port in the United States (U.S.). This helped facilitate construction of military bases during World War II.

2.2 Conversion to Dual-Use Tunnel

In the mid-1960s, the railroad began transporting vehicles and pedestrians with special shuttle train service into Whittier from Portage, which is located at Milepost (MP) 80 of the Seward Highway - 11 miles from Whittier.

These shuttle trains consisted of railroad flatcars for transporting vehicles and a passenger car. Most visitors and residents parked their cars in Portage and boarded the passenger car. To bring a vehicle into Whittier, drivers could drive vehicles onto the flatcars. Drivers and passengers remained in their vehicles, while the train traveled through this Tunnel into Whittier.

Figure 3: Vehicles on Railcars for Entry to Whittier

This shuttle service was offered daily in the summer and four days each week in the winter. Trains made six round-trips for each day that service was offered. The single shuttle train could

transport the equivalent of 40 cars and 400 passengers[1] per trip, for a total of 240 cars and 2,400 passengers per day. Longer vehicles, boats, or trailers, used more space, thus reducing the number of vehicles per train. The cost for this service was $72 for a vehicle and driver. Passengers were charged $8. A large parking lot at Portage accommodated Whittier Shuttle foot passengers.

The ARRC operated this Whittier Shuttle from 1985 to 2000. Annual ridership was about 200,000. Operations were supported solely by the ARRC (no State subsidy); annual revenues were about $2 million. There were no serious injuries during these years of Shuttle operation.

The ARRC was also experiencing a number of challenges with this Tunnel:

- Icing problems inside this Tunnel during the winter required labor to chip ice from the rail and tunnel walls prior to train passage.
- The ballast and ties were aging and required periodic maintenance.
- Rock-fall from the tunnel crown and sidewalls posed a danger to the train and crews.
- Drainage issues in some sections of this Tunnel saturated the ballast and required periodic maintenance.
- Heavy snowfall in Whittier and Bear Valley subjected the Tunnel approaches to avalanches, occasionally delaying train operations.
- Portal doors on both ends of this Tunnel had to be opened manually. In addition, ice formation at the portals occasionally interfered with operation of the doors and had to be removed.
- Dimensions of this Tunnel were only 14.5 feet wide by 20 feet high, which are not high enough to accommodate double-stacked shipping containers on railcars.
- Federal Railroad Administration regulations were changing in ways that would require extensive and expensive changes to the Whittier Shuttle operation.

[1] During Whittier cruise ship operations in the 1980s, ARRC transported up to 10 buses on the Shuttle. Combined with the 400-passenger capacity of the coaches on the Shuttle, ridership on a single train could exceed 1,000.

Providing quicker response to an oil spill in Prince William Sound was also a major factor in converting this Tunnel into a railroad/highway tunnel. During the Exxon Valdez oil spill cleanup, a majority of the material, equipment, and personnel had to travel 360 miles along the Glenn and Richardson Highways from Anchorage to Valdez, to access the oil-spill site. Providing access for supplies, equipment, and personnel through Whittier would significantly reduce response time, in case of another oil spill. A portion of the funding for the 2000 construction project (Section 2.4) was from the Exxon Valdez oil-spill lawsuit settlement.

As demand for improved access to Whittier increased, the DOT&PF considered five options to provide convenient and inexpensive access to Whittier:

1. Increase the number of weekly rail services bringing vehicles and people into Whittier.
2. Add high-speed electric trains.
3. Construct a new roadway over Maynard Mountain.
4. Expand this Tunnel, and construct a highway route adjacent to the railroad track.
5. Convert this Tunnel into a roadway/railroad dual-use facility.

The DOT&PF determined the most cost-effective option to provide the desired level of service was to convert this Tunnel into a dual-use highway/rail facility. Primary benefits of constructing a rail/highway tunnel that provided vehicle access to Whittier included:

- Increased number of vehicles that can travel into Whittier daily to approximately 3,060 to 3,825 (adjusted per Section 4.2.1).
- Expanded timeframe for vehicles to enter/leave Whittier allows people to commute to and from Whittier for work.
- 24-hour access for wheeled vehicles, which improved emergency response over the old Whittier hy-rail ambulance (ambulances made 138 trips out of Whittier in 2012).

Primary impacts to railroad operations include:

- Loss of the Whittier Shuttle reduced passenger ridership and operating revenues for the ARRC.
- ARRC freight operations have been delayed to accommodate highway use of this Tunnel. Passenger schedules have been modified to fit around scheduled highway openings.
- Increased vertical clearance in this Tunnel to 21 feet, which permitted hauling double-stacked shipping containers by rail in the future.
- Reduced rock-fall from the tunnel crown and sidewalls, due to installation of ground-support systems (rock bolts, shot-crete, and wire mesh placed throughout this entire Tunnel).
- Water- and ice-control measures to eliminate ice build-up during winter months.
- Ballast and ties were replaced with pre-cast concrete-panel invert system.
- New portal buildings with new doors that operate by remote control, by either the ARRC dispatcher in Anchorage, or by the tunnel control operator.
- Addition of lighting in this Tunnel.
- Addition of storm-drain and sub-drain systems to control surface and subsurface water.
- Enhanced security.
- Addition of ventilation features could enhance train-related emergency response.

Figure 4: Tunnel Conditions after Renovation

2.3 Port of Whittier

Whittier is the second-busiest cargo port in Alaska. This port facility provides an economical alternative to both the Seward and Anchorage ports. Advantages of the Whittier port, as compared to the Anchorage port, are:

- Dredging: The Port of Anchorage requires dredging every few years to maintain turning and docking basins. Whittier does not require dredging.
- Shorter distance: The distance at sea for cruise ships, freight ships, and barges, to travel from the continental U.S. and Canada to Whittier, is shorter than to Anchorage, which also reduces fuel consumption.
- Ice-free port: Anchorage is not an ice-free port. During winter months, ice buildup in Cook Inlet makes it more difficult for cargo ships to maneuver and dock.

The Port of Whittier also has several advantages over the Port of Seward:

- Shorter distance: The distance at sea is shorter for cruise ships, freight ships, and barges from the continental U.S. and Canada, resulting in shorter voyages that reduce fuel consumption.
- Highway/railroad distance: The highway distance from Anchorage to Whittier is 66 miles shorter than the distance from Anchorage to Seward (the railway distance is 52 miles shorter).
- Railroad grades: Steep grades through the Kenai Mountains require additional locomotives to haul less tonnage (two locomotives can pull 8,000 tons from Whittier, while four locomotives can pull just 5,000 tons from Seward to Anchorage).
- Weather: Trucks and trains have to contend with more adverse weather, including avalanches and excessive snow, on roads and tracks between Portage and Seward.
- Railroad crew logistics: Train labor crews work 12-hour shifts. The round-trip to Whittier can be accomplished in one 12-hour shift. The additional distance to Seward, however, requires two shifts with an overnight stay in Seward for one round-trip.

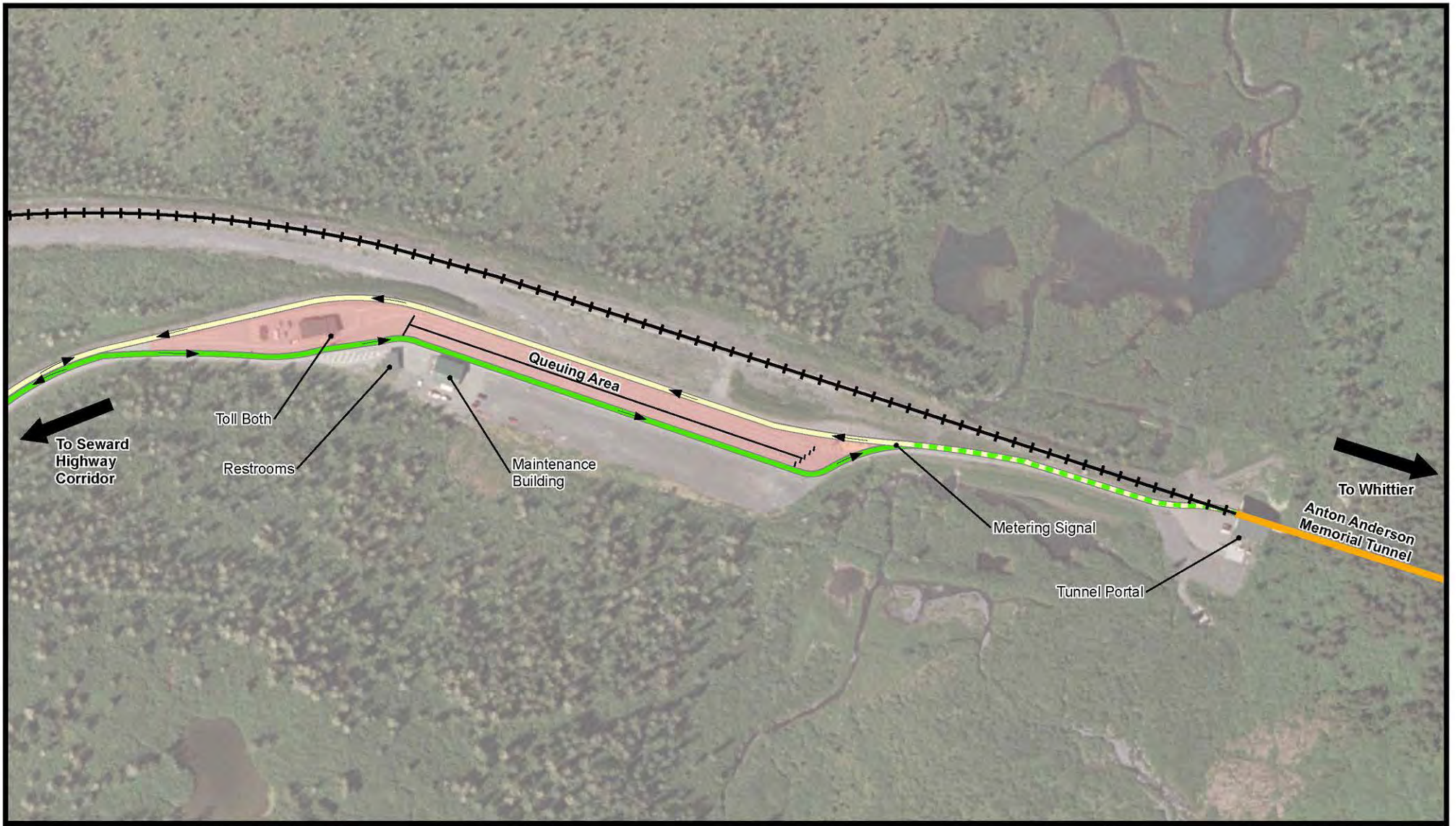
2.4 Whittier Access Project

The Whittier Access Project was constructed in three phases. The total cost of these three phases was approximately $80 million.

- Phase I – Construction of the road from the Portage Highway near the Begich-Boggs Visitor Center to the staging area in Bear Valley. This phase included construction of the 500-foot-long Portage Lake Tunnel and bridges across Portage River and Bear Creek.
- Phase II - Conversion of the existing 2.5-mile-long railroad tunnel (Whittier Tunnel) into a dual use (rail/highway) tunnel. The DOT&PF started construction of this $57.3-million tunnel project in September 1998, and it was completed on June 7, 2000. This project incorporated a number of unique components, described in the following sections.
- Phase III – Reconstruction of the road from the Whittier staging area to the town of Whittier, including construction of parking lots in Whittier, adjacent to the boat harbor.

2.4.1 Staging Areas

Vehicles wait for scheduled tunnel openings in staging areas on either side of this Tunnel. The Bear Valley staging area (Figure 5) contains six lanes, to segregate different types of vehicles as they proceed through this Tunnel. It can hold the equivalent of 240 automobiles. The Whittier staging area (Figure 6) can hold 280 equivalent automobiles, in eight different lanes. Both staging areas have changeable message signs, public restrooms, traffic signals to indicate which lane should proceed into the tunnel, and metering signals to establish the interval between vehicles. The Bear Valley staging area has two additional features: a general maintenance building and toll booths.



Portage Glacier Highway (Westbound Lanes)
Portage Glacier Highway (Eastbound Lanes)
Alaska Railroad (ARRC)
Bear Valley Queuing Area

0 100 200
Feet

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

WHITTIER TUNNEL OPERATIONS STUDY

BEAR VALLEY QUEUING AREA

DATE: April 2013 | **Figure 5**

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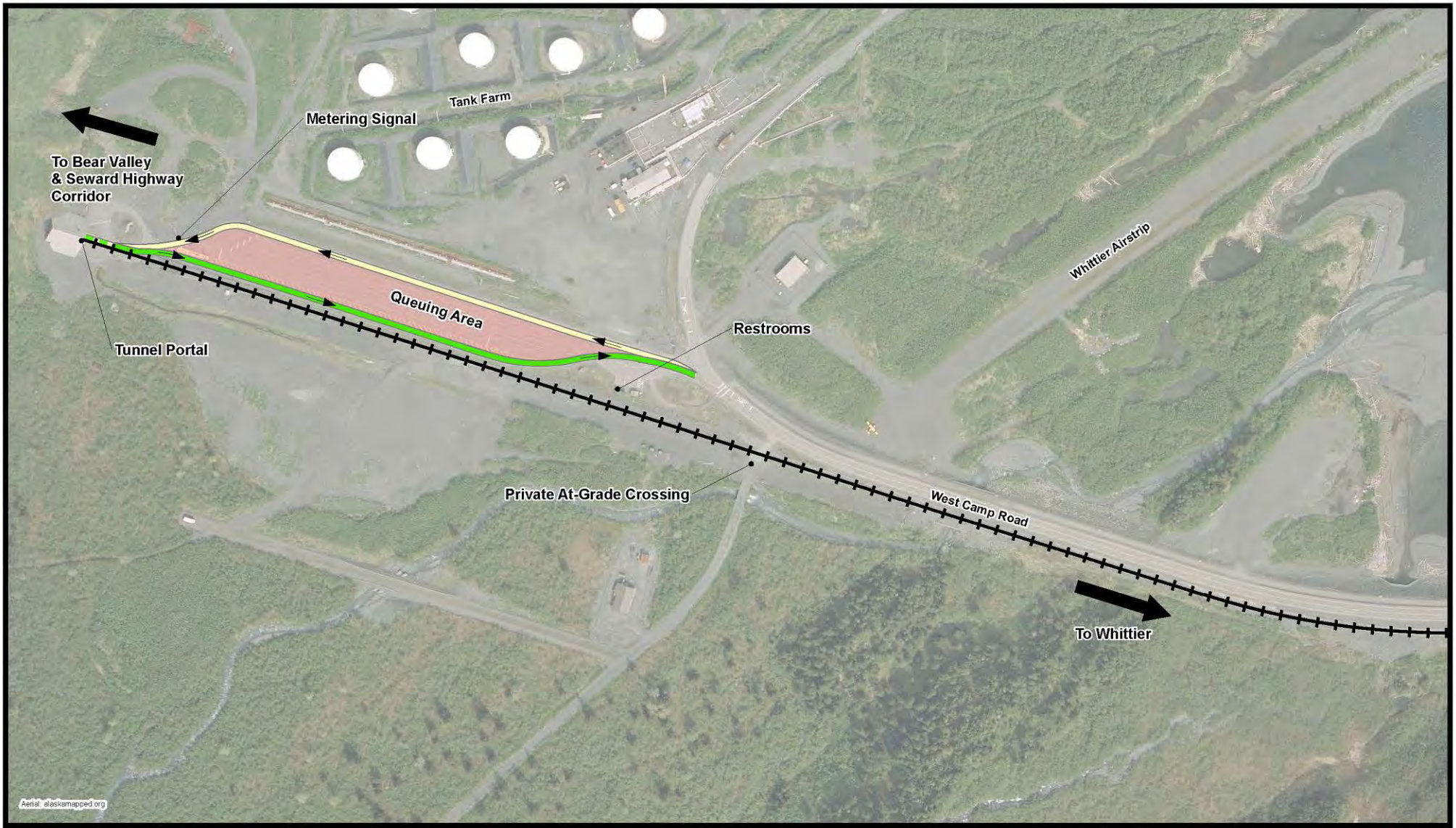

Portage Glacier Highway (Westbound Lanes)
Portage Glacier Highway (Eastbound Lanes)
Alaska Railroad (ARRC)
Queuing Staging Area

0 100 200
Feet

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

WHITTIER TUNNEL OPERATIONS STUDY

WHITTIER QUEUING AREA

DATE: April 2013 | **Figure 6**

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2.4.2 Tunnel Control Center and Remote-Control Center

The Tunnel Control Center (TCC) monitors and controls all of the operational highway systems within this Tunnel: Air-quality sensors, traffic-speed sensors, light sensors, heat detectors, communication systems, and cameras. A 10-monitor display enables tunnel operators to control traffic flow and ventilation from the TCC (Figure 7).

Figure 7: The Tunnel Control System

To provide redundancy for the TCC, the Whittier portal building houses the Remote Control Center (RCC). The RCC provides minimal services during maintenance periods and also serves to clear this Tunnel of traffic during emergencies. It has one split-screen monitor, and the computer can access the traffic, air quality, airflow, and light sensors.

2.4.3 Portal Buildings

The portal buildings in both Bear Valley and Whittier are equipped to respond to emergencies. They have been designed with 14-inch-thick concrete roofs to withstand a 1,000-pound-per-square-foot avalanche load, and the slope of each roof diverts avalanches away from the tunnel portal.

Both portal buildings are equipped with safety equipment required for safe operation of this Tunnel. They contain firefighting equipment, fire trucks, hazardous-material spill kits, an emergency water supply, emergency lighting, and two motorcycles to use during emergencies. These two motorcycles will be replaced, in the near future, with all-terrain vehicles. The Whittier portal building also houses a Case 921C front-end loader, to extract disabled vehicles and fallen rock from this Tunnel (the loader in Bear Valley is stored in the maintenance building). Two large portal fans are located in each portal building, as well.

Figure 8: Train and Cars Exiting a Portal Building

These portal buildings also contain an electrical substation and a 125-kilowatt emergency generator. When in use, these generators can provide enough power for the TCC, the closed-circuit television cameras, signal lights, traffic gates, tunnel lighting, portal doors, and safe-house ventilation. The existing generators can provide enough electricity to allow vehicles inside this Tunnel to reach the exit, but not enough power to run the jet fans needed for normal operations. Until recently, this Tunnel remained closed to all but emergency traffic while power was off line; however, tunnel fire engines may now escort a platoon of up to 15 vehicles through the Tunnel at one time during power outages.

2.4.4 Tunnel Invert

Inside the tunnel, an 11.5-foot-wide driving surface, consisting of 1,830 precast concrete panels, is level with the top of the railroad rails, which allows a single lane of automobile traffic and trains to use the same travel-way.

Figure 9: Tunnel Invert

2.4.5 Drainage- and Ice-Control Systems

Four drainage systems were installed, to handle surface and subsurface drainage in this Tunnel:

- A storm drain system was installed that collected water from the invert surface. It has the capacity to remove 250 gallons of storm water per minute.
- A sub-drain system collects water infiltrating through soil and rock in this Tunnel. The sub-drain is an 8-inch perforated pipe, below both curbs. Water collected by these sub-drains is pumped into the storm drain system at each of eight safe houses.
- Insulated water- and ice-control systems, covered by corrugated steel plates, have been installed along 610 feet of this Tunnel, where frequent drainage problems historically occurred in the winter. This water-control system minimizes ice formation and drains water into the storm drain system.
- Sheet-metal plates (pans) have been placed in some areas of the tunnel crown to divert water away from the tunnel invert. This water is diverted to the sidewalls and drains into the sub-drain system below the tunnel invert.

2.5 Tunnel Operational Systems

Several key systems maintain safety and operations of the AAMT: the TCC staff, the toll collection system, ventilation features, air-quality monitoring, communications, surveillance

cameras, train detection systems, traffic monitoring devices, the ARRC's safety features, safe houses, and emergency stations.

2.5.1 Tunnel Control Operator Responsibilities

The primary responsibility of the tunnel control operator is to safely maintain the flow of highway traffic through this Tunnel when the Tunnel is in highway mode. All of the cameras, sensors, and alarms are controlled and monitored by the tunnel control operator, who is also responsible for ensuring that all highway vehicles that entered the Tunnel have made it safely through to the opposite side before traffic is allowed to proceed in the opposite direction and before the ARRC dispatcher assumes control of the Tunnel for controlling train operations. The tunnel control operator must also manually change the interval of the metering signal for controlling vehicular traffic, based on the type of traffic exiting the staging area.

In addition to monitoring tunnel conditions and controlling traffic, the TCC staff collects tolls and responds to emergencies, as necessary. The TCC staff is not responsible for law enforcement. If a law-enforcement problem occurs, the TCC staff contacts the Whittier Police or the Alaska State Troopers.

In 2002, Virginia Management Services (VMS) was awarded the contract to operate the TCC for the DOT&PF (VMS later became Transfield Services). During the summer, the entire staff consists of 30 personnel, operating in four shifts: day and night shifts for the beginning and end of the week. The TCC is staffed by five people, from open to close. The number of staff at the TCC during the maintenance period from 11:30 p.m. to 1:30 a.m. is three, even though the last vehicle opening ends at 11:30 p.m.

In the event of a highway emergency, five staff members must be available to implement the AAMT Emergency Response Plan (including one as a "first responder" and one to be the Incident Commander). While that first responder is providing first-aid, the Incident Commander will coordinate with other firefighters, ambulances, the State Troopers, etc. Incidents may include accidents involving hazardous materials, explosions, fires, bomb threats, fallen rock, avalanches, and earthquakes. If the ARRC is in control of this Tunnel during an emergency, the dispatcher will implement the ARRC Emergency Response Plan, and the TCC staff will assist as requested. The primary concern for the ARRC is a derailment or a hazardous-material issue. The

entire staff has received State of Alaska Firefighter I certification, and the staff participates in drills that involve local emergency response agencies, twice per year. In addition, four people in Whittier are continuously on-call to respond to tunnel emergencies.

2.5.2 Toll Collection System

Credit-card machines were installed at toll booths in 2000, when this Tunnel was built. Two TCC staff members collect tolls during the summer season. Transactions initially took 45 to 60 seconds (dial-up connection), and the waiting areas immediately preceding toll booths were short. Consequently, customers using credit cards delayed customers paying with cash. Lines preceding toll booths were extended in 2001 and cash-paying customers were directed into their own lane to prevent these delays. Also, these machines were upgraded in 2008, and high-speed internet connections were added in 2010, to increase the speed to several seconds per transaction.

2.5.3 Ventilation

This Tunnel has two ventilation systems (jet fans and portal fans) to maintain air quality, to keep air flowing in the direction of travel, and to purge smoke from the Tunnel in case of fire.

Jet fans are the primary ventilation system. Three jet fans are located in the Tunnel crown at Safe Houses No. 1 and No. 8, the safe houses nearest the Tunnel openings. However, only the two jet fans farthest from the safe houses are used. The jet fan closest to a safe house does not operate efficiently, since it is recessed into the safe-house turnout and cannot maintain smooth, efficient laminar airflow. Four jet fans can generate a 6-miles-per-hour (mph) wind.

These jet fans blow air in the direction of traffic, while highway vehicles are in the Tunnel, so that in case of fire, people in vehicles behind the fire can leave their vehicles and safely proceed to the nearest safe house. Vehicles in front of the fire continue driving out of the Tunnel. Jet fans are also used to purge the Tunnel of carbon monoxide (CO) both during and after when trains are transiting this Tunnel. Heavy loads and the 0.5% uphill grade force locomotives to burn more fuel, which elevates levels of CO inside the Tunnel for freight trains leaving Whittier. Gas-powered vehicles also produce CO, but levels are significantly lower than from freight trains. Smoke and emissions must be blown in the direction of travel.

Four portal fans are housed in two portal buildings (two fans per portal). These portal fans are used primarily to supplement the jet fans in purging the Tunnel of CO, after train use, and in the case of fire. Three or four portal fans are never used simultaneously, to avoid overloading electrical transformer in Whittier. Additionally, using all four fans simultaneously could create a pressure differential, due to different airflow rates at each end of this Tunnel.

Jet fans and portal fans cannot be used at the same time. One portal fan can generate an 8-mph wind, and two portal fans can generate an 11-12-mph wind.

Due to unique climatic conditions, a significant difference in barometric pressure between Whittier and Bear Valley may occur, which causes winds through the Tunnel up to 15 mph. In these situations, jet-fan ventilation may not be able to overcome these winds, to keep air flowing in the direction of traffic. Jet fans can only overcome 4 to 5-mph winds. During these high-wind events, Tunnel operators close the portal doors on one side, after 15 cars have entered the tunnel, and portal fans are used. This only occurs 1% of the time during the summer and 3% of the time in the winter.

2.5.4 Air-Quality Monitoring System

Four CO detectors help the TCC measure CO levels. Two anemometers measure direction and speed of air flowing through the Tunnel to assist in adjusting tunnel ventilation.

2.5.5 Communications

This Tunnel contains two communication systems to improve operations, and the TCC has access to both systems.

Figure 10: Jet Fans

One system is the Alaska Land Mobile Radio, which is a state-maintained communications network linking emergency medical services, State Troopers, federal agencies (Federal Bureau of Investigation, Department of Homeland Defense, and military bases), and other state entities

with the State Incident Command Structure. Secondly, an ARRC very-high-frequency (VHF) radio system exists within the Tunnel to maintain railroad communications.

2.5.6 Surveillance Cameras

This Tunnel contains 60 closed-circuit television cameras, to allow tunnel operators to monitor traffic at tunnel plazas, traffic inside the Tunnel itself, and tollbooth transactions. At the end of 2012, the TCC began storing approximately one month of time-stamped video from all 60 cameras on several multi-terabyte hard-drives. Previous video-retention capability only allowed retention of one to two weeks of data. Additional storage will be added in 2013. Video is used for training purposes, law enforcement, validating schedule complaints from the public, and other purposes.

2.5.7 Traffic Monitoring Devices

Various sensors and detectors notify the TCC of problems that may affect traffic or public safety. This Tunnel contains nineteen Remote Traffic Microwave Sensors to communicate vehicle speeds, slow-moving vehicles, or stopped/disabled vehicles to the TCC. A photo sensor near both portal buildings detects the amount of daylight present, and tunnel lights are automatically adjusted to appropriate levels.

2.5.8 Train Signal System

The Train Signal System (TSS) is independent from the Tunnel Control System and is controlled by the ARRC dispatcher in Anchorage. The TSS can open tunnel doors and send signals to the TCC to request control of this Tunnel when a train is approaching the Tunnel. As part of the TSS, the Track Circuit System (TCS) can detect when a train is on the tracks in the Tunnel. When the ARRC dispatcher is not controlling this Tunnel, the Federal Railroad Administration (FRA) mandates that a train-limiting device must physically prevent trains from entering the Tunnel. This train-limiting device is an automatic railroad derail switch (one on each side of the Tunnel). Instead of directing trains from one track to another like a typical railroad switch, this derail switch simply directs the train to derail off the main track.

2.5.9 Safe Houses

Eight safe houses are spaced at 1,600-foot (nominal) intervals throughout this Tunnel. The intent is to ensure that tunnel users are never more than 800 feet from a safe house or tunnel opening. The doors are unlocked, but an alarm is triggered in the TCC when a safe-house door is opened. The safe houses are separated from the Tunnel by a fire-rated wall. The capacity of each safe house is 55 people (the occupants of 22 cars with 2.5 passengers per car); however, 85 people will fit standing upright. A ventilation system provides fresh air, heated to 50^{o} Fahrenheit.

Each safe house contains water, blankets, first-aid kits, fire extinguishers, emergency lights, a chemical toilet, an emergency phone, and a speaker to maintain communications with the TCC. The exterior portion of each safe house has strobe lights to aid tunnel users in finding the nearest one, and a 140-foot vehicle pullout exists immediately adjacent to each safe house.

2.5.10 Emergency Stations

Every 300 feet inside this Tunnel, an emergency station contains a telephone that is capable of contacting the TCC, a fire-alarm pull-station, portable fire extinguishers, and other emergency equipment.

2.5.11 Backup Generators

The current backup generators can be upgraded or replaced to provide adequate power for the tunnel jet fans and portal fans (see “loss of power at the tunnel” in Section 5.1) in the case of a power outage. The original purpose of the backup generators was to help vehicles inside the Tunnel move forward until they reach the exit. Recently, however, the tunnel fire engines were allowed to escort 15 vehicles at a time, while the tunnel is operating under emergency power. In this mode of operation, DOT&PF Maintenance and Operations staff cannot properly serve the volume of traffic requiring access to the Tunnel during periods of heavy traffic, especially when cruise ships are docked in Whittier. Plus, a major power outage could require the Tunnel to operate under emergency power for an extended period of time.

More powerful generators are required to operate the jet fans, which will permit operations to continue at full capacity. These generators could also be used to supply additional power, when the portal fans are used to purge the Tunnel of emissions, which will lighten the load on

Whittier's electrical infrastructure. The DOT&PF investigated generator requirements several years ago, and two diesel generators in self-contained structures that can produce 2 megawatts of electricity will cost roughly $750,000. The estimated cost for these generators and associated electrical connections is $2 million.

2.5.12 Public Communications in Bear Valley

Frequent tunnel users are accustomed to an occasional tunnel delay, but they are frustrated by the inability to communicate with others from the Bear Valley staging area. Providing a public wireless internet connection or providing incentives to develop cellular-phone service in Bear Valley will not necessarily improve tunnel operations, but it will alleviate one of the few frustrations that the public experiences with this Tunnel.

3.0 TUNNEL USERS

3.1 Railroad Operations

Approximately 56 to 68 trains a week pass through the Whittier Tunnel during the summer. During the winter, there are only 4 to 8 trains per week. A majority of the freight that is barged to Whittier is hauled out by train. During the summer, three to four cruise ships dock in Whittier per week. Eight passenger trains pass through this Tunnel to support three of the four cruise ships. In addition, the ARRC runs a daily train service (2 roundtrips) to Whittier in the summer to support the day cruises and fishing charters.

Track speed between Portage and Bear Valley is 49 mph and 59 mph for freight trains and passenger trains, respectively. Track speed for both types of trains in the Portage and Whittier Tunnels is 30 mph. If a passenger train has a DMU (oversized passenger car), track speed going through the Portage tunnel is reduced to 5 mph.

Table 1: Number of Trains per Week in Whittier Tunnel during the Summer

Types of Trains	Number of Round-Trips	Tunnel Openings*
Cruise Ship Passenger Trains	2 trains: each makes 2 round-trips per ship, 3-4 ships per week**	24-32 per week
Daily Passenger Trains	1 train makes 2 round-trips per day, 7 days per week	28 per week
Freight Trains (Alaska Marine Lines' Barges)	2-3 trains: each makes 1 round-trip per barge, 1 barge per week	4-6 per week
Freight Trains (Canadian National Barges)	1-2 trains: each makes 1 round-trip every 1.5 weeks	0-2 per week
	Total Trains:	**56-68 per week**

* Note: Two tunnel openings are required per round-trip.

** Note: Thirty-six ships docked in 2012; 58 (record high) docked in 2007.

3.1.1 Freight Trains

Alaska Marine Lines (AML), a subsidiary of Lynden Transport, and Canadian National (CN) operate barges between Whittier and Seattle (AML) and Prince Rupert (CN). ARRC operates the Whittier port facility. Thirty percent of ARRC's freight revenue is generated by freight moving through Whittier.

CN barges arrive every ten days from Prince Rupert, British Columbia, and AML barges arrive every seven days from Seattle. AML barges are scheduled to dock in Whittier on Wednesdays,

thus avoiding peak highway traffic in the Tunnel on summer weekends. It is difficult for these barges to maintain a set schedule, due to weather in the North Pacific. These barges may be delayed, due to storms encountered during transit. To maintain weekly service, AML uses up to five barges in continuous rotation between Seattle and Whittier, in the winter. In the summer season, however, AML reduces its number of barges from five to three, because inclement weather in Prince William Sound is not as frequent. Additional barges are used for unusual and large shipments (for example, hauling large fan blades for the Eva Creek Wind Farm in 2012). There is a possibility that AML will increase the number of barges per week.

Both the CN and AML barges have eight 400-foot-long tracks running parallel to one another and each track can nominally hold six fully-loaded rail cars, for a total of 48 cars per barge. The barge slip has three parallel tracks to unload railcars (Figure 12). Each barge has to be moved at least twice to offload all of the railcars.

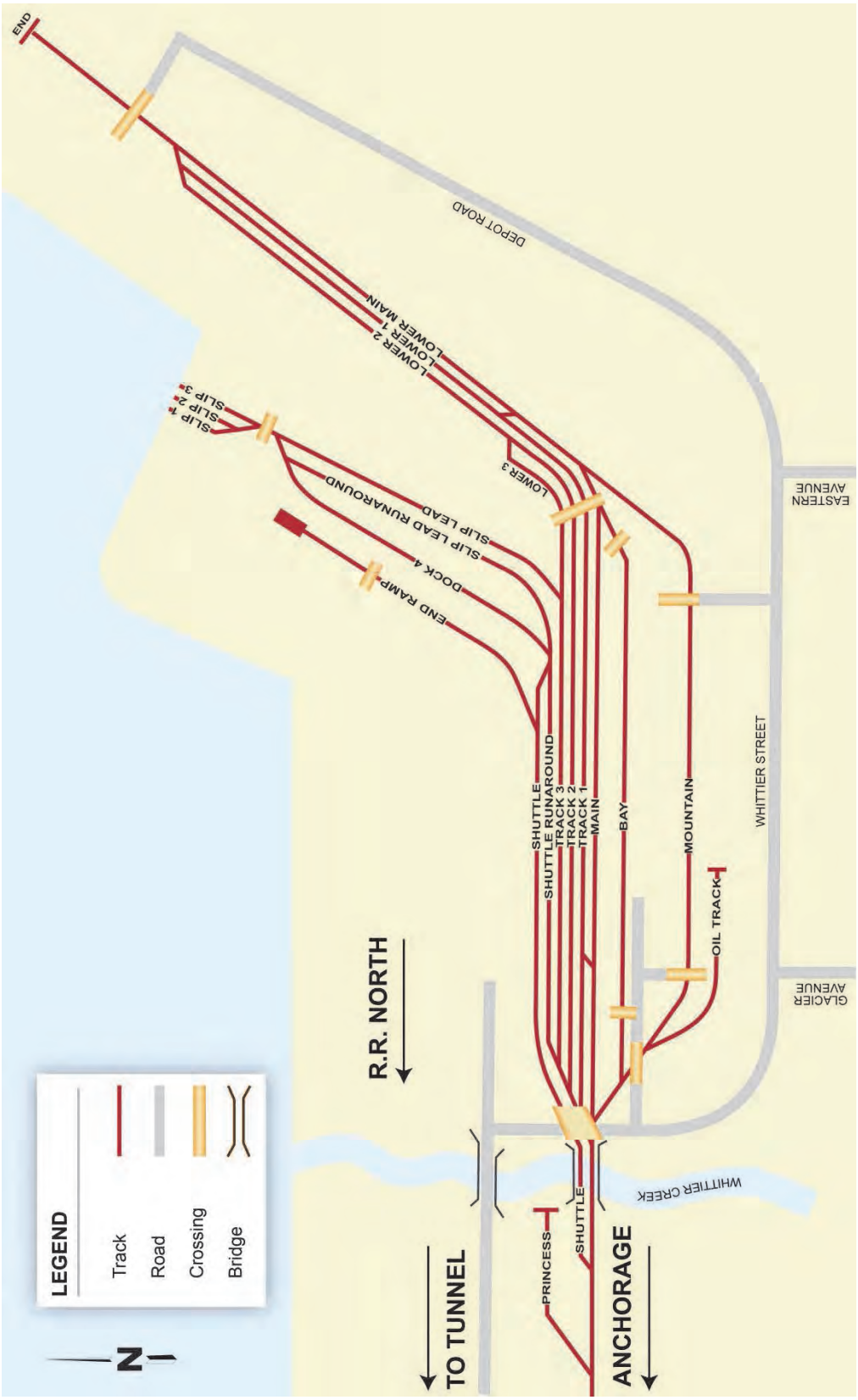

Figure 11: Whittier Yard Layout

(Note: Shipping containers are visible on the barge above the barge railroad tracks.)

Figure 12: Barge Slip for Loading/Unloading Railcars from Barges

AML barges also have specially designed racks located above the rail cars that can carry up to 192 additional shipping containers stacked in three vertical layers. In the past, higher freight volumes have resulted in each barge carrying four layers of containers. Incoming container freight volume has increased from 50 containers per week to 300 per week over 10 years, and overall freight volume has quadrupled since 2000.

One 2,400 to 2,600-foot-long train is required to haul 48 railroad cars delivered by the CN barge. Two to three trains are required to haul the 48 rail cars and containers from the AML barge to Anchorage. The first train from the AML barge is normally 7,000 to 8,500 feet long and contains rail cars and some containers. It normally departs from Whittier en-route to Anchorage within 24 hours of a barge's arrival. Due to limited space within the rail-yard, the first train has to leave the rail-yard and travel through the Whittier Tunnel to either Indian or Anchorage, to allow the second Whittier-bound freight train to pass. The second train is normally 4,000 to 5,000 feet long and consists mostly of flatcars with fully-loaded shipping containers. It normally leaves Whittier within 36 hours after a barge arrives. Containerized loads depart Whittier in the second train, because containers require additional time to be secured to flatcars. In the winter, AML barge deliveries may be divided into three trains, due to inclement weather (railcars may need to be moved from the Whittier rail-yard, during periods of heavy snow).

When freight trains return to Whittier, railcars and containers are normally empty, and these empty railcars and containers are shipped back to their point of origin. The limited amount of cargo arriving in Whittier from Anchorage normally consists of hazardous materials, which are not allowed through the Tunnel, in trucks, such as fuel from the Flint Hills Refinery near North Pole, Alaska.

3.1.2 Cruise Ship Passenger Trains

A Norwegian Line cruise ship docks every other Monday. Passengers arrive/leave Whittier via buses. Approximately 60-70 buses transit the Tunnel for each Norwegian Line cruise ship.

A Princess cruise ship docks every other Monday and Wednesday. They also dock every Saturday. Two large cruise ships have a capacity of 2,750 passengers (up to 2,900 when more than two people occupy a room), and two smaller ships can hold up to 2,100 passengers (normally 1,970 passengers). There is a possibility that an additional cruise ship, with 3,300 to 4,200 passengers, may start docking in Whittier on Sundays in 2015.

Passengers for Princess cruise ships arrive/leave Whittier by both buses and dedicated passenger trains. In the morning, when a cruise ship is docked, two empty passenger trains (Denali Express {DEX} and McKinley Express {MEX}) arrive in Whittier and depart with passengers. Approximately 900 cruise-ship passengers board passenger trains for each cruise ship. These passenger trains normally consist of 5 to 10 railcars and locomotives. Later that afternoon, a new group of passengers arrive in Whittier aboard two passenger trains. Passengers are unloaded, and the trains depart from Whittier empty. Passenger trains transporting passengers from a cruise ship in the morning normally deliver the same number of passengers in the afternoon back to the cruise ship for departure from Whittier. These trains park on the Princess track, the Mainline, and one briefly traverses the Whittier Street grade crossing as it moves into the ARRC yard (Figure 12). The first passenger train with cruise-ship passengers unloads passengers from the Princess track, and then it crosses the Whittier Street grade crossing as it moves into the ARRC yard. A second passenger train arriving in Whittier unloads passengers on the Princess track and then occupies the Mainline.

In 2010 and 2011, 130,000 cruise-ship passengers used Whittier, which is a 30% reduction over 2009. In 2012, however, traffic to Whittier increased to 155,000 passengers.

3.1.3 Daily Passenger Train

During the summer, a passenger train makes four trips per day (two round-trips) through the Tunnel to support public transportation, daytime sightseeing cruise ships, and charter boats (see Section 4.1 for more information about the Tunnel schedule). This train also provides afternoon service to the U.S. Forest Service "Whistle Stops" in Chugach National Forest, south of Portage.

3.1.4 Whittier Rail Yard Operations

Limited space in the rail-yard determines how the ARRC must operate freight trains in Whittier. The highest priority for trains entering Whittier is to ensure that the freight train is clear of the tunnel portal at the Whittier staging area, to allow vehicular traffic to transit the Tunnel. The second priority is to ensure that the Whittier Street crossing is not blocked (see Figure 13).

Empty freight trains must be separated into two or three sections, upon arrival in Whittier. This requires repeated crossing of the Whittier Street crossing by slow-moving trains. The ARRC operates the trains to open the crossing to vehicular traffic as frequently as possible. The Main track receives railcars from barges. AML loads flatcars with containers on the Mountain and Bay tracks. The combined capacity of these three tracks is 8,000 feet (roughly 110 railcars). When the three sets of railcars on the Main, Mountain, and Bay tracks are ready for departure, locomotives connect to the train on the Main track. Departure requires assembling the cars on the Main, Mountain and Bay tracks by moving over the Whittier crossing (see "Whittier Street Crossing", below).

Twice monthly, rail-yard operations are more complicated when a barge and a cruise ship are both docked in Whittier at the same time. To avoid blocking passenger train tracks, a freight train must be disassembled and moved to the rail yard before passenger trains arrive in Whittier. A freight train must arrive one and one-half hours before passenger trains arrive, to allow enough time to be disassembled and placed in the rail yard. An outbound loaded freight train cannot be completely assembled until all passenger trains have left Whittier. It takes approximately one hour to complete the assembly of a freight train after passenger trains have left. In addition, a loaded freight train must leave Whittier at least 1.5 hours prior to the scheduled arrival of another train into Whittier, to allow sufficient passing time for the train to travel from Whittier to the Coho siding at Portage and for the Whittier-bound train to travel from the Portage siding to

Whittier. These constraints limit the time that a loaded freight train can transit the Tunnel on barge/cruise-ship days to two brief periods between 9:22 a.m. – 10:22 a.m. and 1:52 p.m. – 4:22 p.m. Portions of these periods also coincide with highway openings that the DOT&PF and the ARRC have agreed will not be delayed. Figure 14 shows the periods when freight trains do not transit the Whittier Tunnel due to passenger-train operations.

Construction of a parallel track between Whittier Creek and the Tunnel would lengthen the periods that freight trains could operate on cruise-ship days by allowing those freight trains to operate without impacting passenger trains.

Whittier Street Crossing - The close proximity of the Whittier Street grade crossing to the eastern end of the rail yard is a problem for both rail operations and the traveling public. This crossing is the only vehicle[2] access from South Whittier (Begich Towers) to the Tunnel and is also the most direct access from public parking lots located south of the rail yard to most harbor areas.

Freight trains traverse the Whittier Street crossing approximately 30-40 times during the 30-36 hours it takes to unload and load each barge. During this period, pedestrians have attempted to walk between railcars while trying to access parking lots on the south side of the crossing. This stops rail operations and extends the time the train is on the crossing.

Since the railroad track between the Tunnel and Whittier Street is not long enough (5,500 feet) to accommodate a long freight train, trains are built into three segments approximately 2,000 feet to 3,000 feet long. When the train is coupled to its full length, it blocks Whittier Street up to 15 minutes for brake checks and to wait for the train opening to travel through the Tunnel. This 15-minute period is also the time that many vehicles from southern Whittier are trying to cross the railroad tracks to reach the Tunnel in time for the highway opening. The ARRC frequently delays freight trains from departing from Whittier to minimize delays of pedestrians and vehicles at this crossing.

To minimize the duration that Whittier Street is blocked when the train is ready to leave Whittier, the first two segments of the train are coupled together and pulled to the west side of

[2] The ARRC constructed a pedestrian tunnel under the Whittier Yard to improve access between the boat harbor and the Begich Towers area. Construction cost was about $2 million, and the Tunnel went into service coincidentally with the opening of the Whittier Access Project.

the crossing to wait for the Tunnel to be cleared of highway traffic and transferred to ARRC control. When the time of the train opening nears, the train is pushed back across Whittier Street and coupled with the third segment. At this point, Whittier Street is blocked for 5-10 minutes while the brakes are tested prior to leaving the rail yard (Figure 13) on the tunnel train opening.

Also, special-order freight cars (which include cars with hazardous materials), cars with mechanical problems, and improperly loaded cars may need to be removed from a train or reorganized to meet FRA regulations regarding the separation of certain types of hazardous material within a train. Removing one specific railcar from any of the three segments staged for departure requires crossing Whittier Street two to four times per railcar needing to be relocated.

Alaska Railroad (ARRC)

Parking Area

Private Boat Harbor

Public Boat Harbor

Whittier Rail Yard

0 250 500
Feet

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

WHITTIER TUNNEL OPERATIONS STUDY

CITY OF WHITTIER

DATE: April 2013 | **Figure 13**

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Highway Mode			Railroad Mode					
					Freight Trains			
					Bear Valley to Whittier		Whittier to Bear Valley	
Scheduled Highway Opening	Traffic Direction	Highway Users	Train Window	Passenger Trains	Normal Day	Cruise Ship Day	Normal Day	Cruise Ship Day
3:20 AM to 5:00 AM	Tunnel Closed To Highway Traffic		4:00 AM to 5:00 AM	Railroad Traffic Only	Yes	No (Const)	Yes	No (Pass)
5:00 AM	Safety Inspection		5:00 AM to 5:30 AM	Safety Inspection	No (M&O)	No (M&O)	No (M&O)	No (Pass)(M&O)
5:30 AM	Bear Valley to Whittier	Empty cruise ship buses (MWSat)	5:52 AM	Cruise Ship Train (Mex) into Whittier (MWSat)	No (M&O)	No (Block)(M&O)	No (M&O)	No (Block)(M&O)
6:00 AM	Whittier to Bear Valley		6:22 AM		Yes	No (Block)	Yes	No (Block)
6:30 AM	Bear Valley to Whittier	Empty cruise ship buses (MWSat)	6:52 AM	Cruise Ship Train (Dex) into Whittier (MWSat)	Yes	No (Block)	Yes	No (Block)
7:00 AM	Whittier to Bear Valley	Full cruise ship buses (MWSat)	7:22 AM	Cruise Ship Train (Mex) out of Whittier (MWSat)	Yes	No (Block)	Yes	No (Block)
7:30 AM	Bear Valley to Whittier		7:52 AM		Yes	No (Block)	Yes	No (Block)
8:00 AM	Whittier to Bear Valley	Full cruise ship buses (MWSat)	8:22 AM	Cruise Ship Train (Dex) out of Whittier (MWSat)	Yes	No (Block)	Yes	No (Block) (Cruise)
8:30 AM	Bear Valley to Whittier		8:52 AM		Yes	No (Pass)	Yes	No (Const)
9:00 AM	Whittier to Bear Valley	Full cruise ship buses (MWSat)	9:22 AM		Yes	No (Pass)	Yes	No (Cruise)
9:30 AM	Bear Valley to Whittier	AMHS passengers (M);	9:52 AM		Yes	Yes	No (Ferry)	No (Ferry)
10:00 AM	Whittier to Bear Valley	Full cruise ship buses (MWSat)	10:22 AM		Yes	Yes	Yes	Yes
10:30 AM	Bear Valley to Whittier	Day cruise passengers (Daily); AMHS passengers (Daily)	10:52 AM		No (Const)	No (Const)	No(Pass)(Ferry)	No(Pass)(Ferry)
11:00 AM	Whittier to Bear Valley	AMHS passengers (Daily)	11:22 AM		No (Const)	No (Const)	No(Pass)	No(Pass)
11:30 AM	Bear Valley to Whittier	Day cruise passengers(Daily); AMHS passengers (Daily)	11:52 AM	Passenger Train (Glacier) into Whittier (Daily)	No (Block)	No (Block)	No (Block)(Ferry)	No (Block)(Ferry)
12:00 PM	Whittier to Bear Valley		12:22 PM		No (Block)	No (Block)	No (Block)	No (Block)
12:30 PM	Bear Valley to Whittier	Day cruise passengers (Daily) ; AMHS passengers (Daily)	12:52 PM	Passenger Train (Glacier) out of Whittier (Daily)	No (Block)	No (Block)	No (Block)(Ferry)	No (Block)(Ferry)
1:00 PM	Whittier to Bear Valley	AMHS passengers (Daily)	1:22 PM		No (Pass)	No (Pass)	No (Const)	No (Const)
1:30 PM	Bear Valley to Whittier	AMHS passengers (Th)	1:52 PM		No (Pass)	No (Pass)	Yes	Yes
2:00 PM	Whittier to Bear Valley		2:22 PM		Yes	Yes	Yes	Yes
2:30 PM	Bear Valley to Whittier	AMHS passengers (Th)	2:52 PM		Yes	Yes	Yes	Yes
3:00 PM	Whittier to Bear Valley	AMHS Passengers (Th)	3:22 PM		Yes	Yes	Yes	Yes
3:30 PM	Bear Valley to Whittier	Full cruise ship buses (MWSat)	3:52 PM		Yes	Yes	Yes	Yes
4:00 PM	Whittier to Bear Valley		4:22 PM		No (Const)	No (Const)	No (Pass)(Hwy)	No (Pass)(Hwy)
4:30 PM	Bear Valley to Whittier	Full cruise ship buses (MWSat)	4:52 PM		No (Const)	No (Const)	No (Pass)	No (Pass)
5:00 PM	Whittier to Bear Valley	Day cruise passengers (Daily); Empty cruise ship buses (MWSat); Heavy Traffic (SaSu)	5:22 PM	Passenger Train (Glacier) into Whittier (Daily)	No (Block)	No (Block)	No (Pass)(Hwy)	No (Pass)(Hwy)
5:30 PM	Bear Valley to Whittier		5:52 PM	Cruise Ship Train (Dex) into Whittier (MWSat)	No (Block)	No (Block)	No (Pass)	No (Pass)
6:00 PM	Whittier to Bear Valley	Day cruise passengers (Daily); Empty cruise ship buses (MWSat); Heavy Traffic (SaSu)	6:22 PM	Cruise Ship Train (Mex) into Whittier (MWSat)	No (Block)	No (Block)	No (Pass)(Hwy)	No (Pass)(Hwy)
6:30 PM	Bear Valley to Whittier		6:52 PM	Passenger Train (Glacier) out of Whittier (Daily)	No (Block)	No (Block)	No (Pass)	No (Pass)
7:00 PM	Whittier to Bear Valley	Day cruise passengers (Daily); Empty cruise ship buses (MWSat); Heavy Traffic (SaSu)	7:22 PM	Cruise Ship Train (Mex) out of Whittier (MWSat)	No (Pass)	No (Block)	No (Const)(Hwy)	No (Block)(Hwy)
7:30 PM	Bear Valley to Whittier		7:52 PM	Cruise Ship Train (Dex) out of Whittier (MWSat)	No (Pass)	No (Block)	Yes	No (Block)
8:00 PM	Whittier to Bear Valley		8:22 PM		Yes	No (Pass)	Yes	No (Const)
8:30 PM	Bear Valley to Whittier		8:52 PM		Yes	No (Pass)	Yes	Yes
9:00 PM	Whittier to Bear Valley		9:22 PM		Yes	Yes	Yes	Yes
9:30 PM	Bear Valley to Whittier		9:52 PM		Yes	Yes	Yes	Yes
10:00 PM	Whittier to Bear Valley		10:22 PM		Yes	Yes	Yes	Yes
10:30 PM	Bear Valley to Whittier		10:52 PM		No (M&O)	No (M&O)	No (M&O)	No (M&O)
11:00 PM	Whittier to Bear Valley		11:22 PM to 1:30 AM	Tunnel Maintenance	Yes - With Advance Notice			
11:15 PM to 1:30 AM	Tunnel Maintenance							
1:30 AM to 4:00 AM	Tunnel Closed To Highway Traffic		1:30 AM to 4:00 AM	Railroad Traffic Only	Yes - With Advance Notice			

Notes: Cruise Ship day in 2013 is Saturday and every other Monday and Wednesday

Notes: Block = Freight train blocking passenger train track; Pass = Passenger and freight trains traveling to/from Whittier pass at Portage; Const = Building/breaking down freight train; M&O = Tunnel Maintenance per Operating Agreement; Ferry = Scheduled Ferry Traffic; Cruise= Cruise Ship Traffic; Hwy = Heavy Highway Traffic on Sun., Cruise Ship Days & Holiday Mon.

3.1.5 Portage and Bear Valley Operations

The configuration of the track between the ARRC mainline at Portage and Whittier is shown in Figure 15. Signals are located at MP F8.4 and F5.4. Trains receive signals at both of these locations to direct train operators to either proceed at track speed (green signal - 59 mph for passenger trains and 49 mph for freight trains), approach speed (yellow signal - 30 mph), or to stop immediately (red). Table 2 shows the impact of various signals on train operations.

In 2000, a train signal system was installed to support the Whittier Access Project. The ARRC Whittier Branch had no prior signals. One of the three train signals was installed at MP F7.0 to provide trains with advance warning of the status of the signal at MP F5.4. In 2011, the ARRC was faced with upgrading the Whittier Branch to meet new Federal standards. Because of the existing signals installed for the Whittier Access Project, the ARRC elected to signalize the remaining track from Portage to Whittier. The ARRC eliminated the advance signal at MP F7.0 and added the control signal at MP F8.4. The new signal at MP F8.4 was then integrated into both the TSS and the ARRC's dispatch system.

When passenger trains reach MP F8.4, and the signal is amber, they must reduce speed from 59 mph (passenger) to 30 mph, resulting in reduced speeds for an additional 1.4 miles, compared to when the signal was located at MP F7.0. This increased the time for a passenger train to travel from Portage to the Tunnel entrance at Bear Valley by 1.4 minutes. In 2011, this resulted in a number of passenger trains arriving late and missing the train windows (Scenario 4 in Table 2) and having to wait 15 to 22 minutes for the next opportunity to transit the Tunnel. This was especially critical for daily passenger trains that support day cruisers. These trains must enter the Bear Valley end of the Tunnel by noon, for passengers to board day-cruise ships in time. Late trains delayed departure of day cruises.

In 2012, the ARRC changed the schedule of passenger trains, for an earlier departure from Anchorage. As a result, only one daily passenger train has missed an opportunity to transit the Tunnel on time.

3.1.6 Passing Trains

Another limitation, for railroad operations at the Whittier Tunnel, is the locations of the passing tracks. The only places that two longer trains traveling in opposite directions can pass each other are at Portage (Coho siding) and Indian. Other passing tracks between Anchorage and Portage are relatively short and can only accommodate short passenger trains. The passing track at Indian is approximately 5,000 feet long and can accommodate short freight trains and passenger trains.

With these existing track configurations, the ARRC currently operates trains as follows: Since it takes approximately one hour for a train to travel from Whittier to Portage and the train going in the opposite direction to travel from Portage to Whittier, the ARRC normally allows 1.5 hours for passing time. Therefore, a freight train must leave Whittier at least 1.5 hours before a passenger train is scheduled to arrive in Whittier. A freight train also cannot travel through the Tunnel to Whittier for at least 1.5 hours after a passenger train leaves Whittier (see Figure 14).

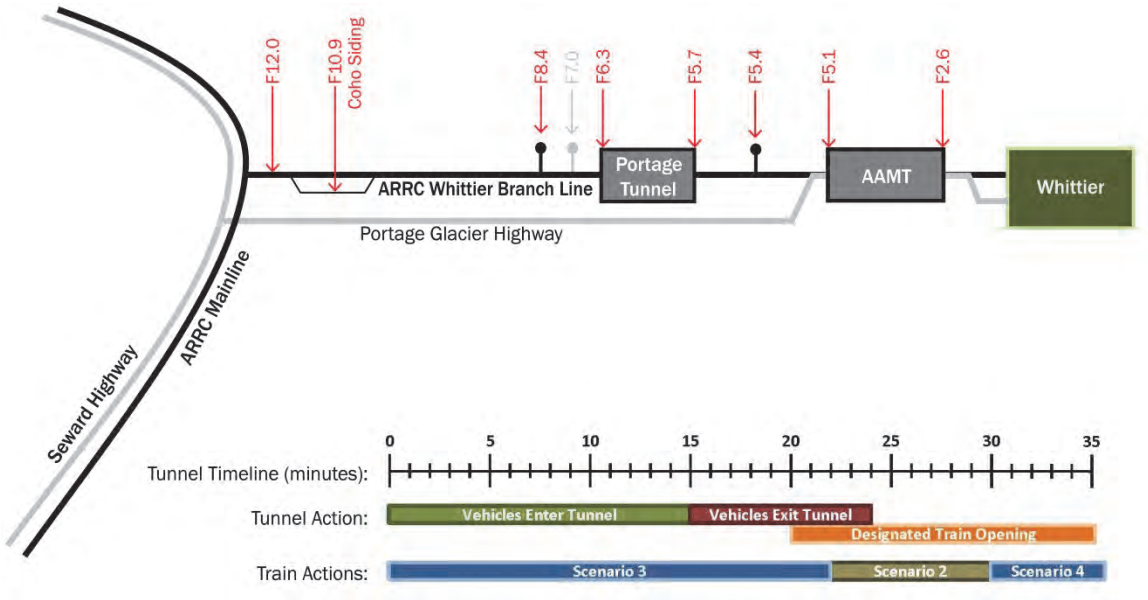


Figure 15: Bear Valley Track Schematic (see Table 2 for Scenario Description)

Table 2: Train Travel Time Scenario Descriptions for Figure 15

Scenario	Occurrence	Signal @ MP F8.4	Action @ MP F8.4	Train Speed MP F8.4 to F7.0 (mph)	Signal @ MP F5.4	Action @ MP F5.4	Travel Time MP F8.4 to F7.0	Travel Time MP F7.0 to F5.4	Travel Time MP F8.4 to F5.4
1	Night/ Maintenance Periods	Green	Maintain Track Speed	59	Green	Proceed at 30 mph	1.4 minutes	3.2 minutes	4.6 minutes
2	Train Arrives at F8.4 Prior to Scheduled Change of Traffic Direction	Amber	Reduce Speed	30	Green	Proceed at 30 mph	2.8 minutes	3.2 minutes	6 minutes
3	Early Train Arrival at F8.4	Amber	Reduce Speed	30	Red	Stop; proceed at 30 mph, when directed	2.8 minutes	3.2 minutes	6 minutes, plus wait time
4	Late Train Arrival at F8.4	Amber	Reduce Speed	30	Red	Stop; wait 15 to 22 minutes; proceed at 30 mph, when directed	2.8 minutes	3.2 minutes	6 minutes, plus 15 to 22 minutes (next train opening)

3.2 Railroad Operational and Infrastructure Improvements

3.2.1 Increase the Height of the Alaska Railroad Corporation Portage Tunnel

The tunnel crown for the AAMT was raised in 2000 during the construction project, to accommodate double-stack container cars. However, the crown of the 5,000-foot-long Portage Tunnel is too low to accommodate double-stacking containers. The clearance of the Portage Tunnel is the only restriction that precludes double-stacking containers out of Whittier, since train sizes are restricted by length, not weight. Increasing the height of the Portage Tunnel will allow double-stacked container cars to be hauled from Whittier to Fairbanks. Lynden Incorporated has successfully completed tests with the ARRC using double-stack high cube containers (9.5-foot-tall, which is standard for shipping containers). Lynden also has 10-foot-tall containers but these are likely to be unsuitable for double-stacking. The AAMT is not high enough to accommodate double stacking these taller 10-foot containers.

Typically, railroad companies use “well cars” where the bottom container sits in a depression between the wheels of the railcar, but the ARRC is currently using flatcars where shipping containers are located on a deck above the wheels of the railcar. The ARRC currently does not have well cars in its inventory, and it will need 80 (70 well cars, which will handle up to 140 containers, plus 10 cars in reserve) to sustain a long-term container double-stack operation. The cost for leasing 50 well cars is estimated to be $275,000 annually.

Increasing the vertical clearance of the ARRC Portage Tunnel could allow double-stacking two shipping containers on well cars. This will reduce train lengths, help relieve congestion in the Whittier rail yard, and reduce traffic delays to automobiles using the AAMT. Another advantage is reduced maintenance costs resulting from a lower number of rail cars using the track.

Increasing the vertical clearance can be achieved by either raising the crown of the Portage Tunnel or lowering the overall track profile. The bridge over Bear Creek was a timber trestle in 2000 when the improvements to the AAMT were in progress. This structure made it impossible to lower the track profile, but when the bridge was replaced in 2006, provisions were incorporated into the bridge to allow the track profile to be lowered. This would be a complicated project, however, because lowering the rail would disrupt rail traffic within the Portage Tunnel during construction. Raising the crown of the tunnel would have less impact on

operations during construction, but it also has its drawbacks. Rock that forms the crown of the tunnel is presently stable, and removing some of this rock could create some instability in the tunnel crown. The ARRC is currently surveying the tunnel to identify the scope of rock removal to accommodate double-stacking. This project must also consider the presence of two commercial high-capacity fiber optics cables mounted on the wall of the tunnel.

As far as the tunnel is concerned, running double-stack trains through the tunnel will reduce the length of trains, which will allow the tunnel purging by the portal fans to start sooner. On the other hand, double-stack containers may not leave enough room for jet fans to efficiently start purging the tunnel, while trains are still in the tunnel.

3.2.2 Whittier Rail-Yard Improvements

In the past, the ARRC investigated ways to expand the rail yard in Whittier. To accomplish this, the ARRC needs to either occupy space adjacent to the rail yard or increase the length of the Main, Mountain, and Bay tracks for staging outbound railcars.

Expanding the rail yard is difficult, since this requires the demolition of other infrastructure. The Delong Dock is used heavily by fish tenders, and Depot Road is heavily used by tourists (see Figure 13). Demolishing Whittier Manor, an ARRC-owned residential property, is extremely unpopular with current occupants, since Whittier has limited available housing. Leases for Whittier Manor expire in 2019, and Whittier has discussed developing more housing near Begich Towers but no definite plans have been made.

Three other improvements were considered, but they will not have a significant impact on the capacity of the yard. The ARRC has investigated increasing the length of the Main, Mountain, and Bay tracks in the past. Doing this will improve container loading/unloading operations, but the impact to the tunnel is negligible, and the blockages of the Whittier Street grade crossing will not be significantly reduced. Adding a crossover between Tracks 1 and 2 could reduce the number of blockages caused by trains at the Whittier Street grade crossing (see Figure 14). This will make it easier for locomotives to pull a train segment into the yard and move back across Whittier Street to retrieve the next train segment, but this will not have a direct effect on tunnel operations. Adding an additional track to the barge slip that bridges the gap between the rail yard

and barges will not improve operations (shifting the barge during the unloading process is not a significant problem).

3.2.3 Construct a 6,000-Foot Siding Track between Whittier and the Tunnel

An additional siding between Whittier Creek and the Whittier Tunnel Portal would permit passenger-train staging and assembly of freight trains simultaneously. Much of the required grade and culvert work has been completed, but some further widening of the rock cut, filling of grade, and track construction remains to be done. Since the mainline is used for staging passenger trains when a cruise ship is docked in Whittier, having a parallel siding track adjacent to the mainline will allow the ARRC to assemble and stage a freight train while a cruise ship is in Whittier and a passenger train is occupying the main line track. The staged freight train would not obstruct the mainline, and it could use the Tunnel to exit Whittier at a more-convenient time.

3.2.4 Grade Separation in Whittier

Parking lots are located on the south side of the Whittier Street grade crossing, but the boat harbor, tourist facilities, shops, and activities are north of this grade crossing. Constructing an overcrossing to bring Whittier Street over the track leading into the rail yard will improve access and safety for automobiles and pedestrians. Constructing this grade separation has not been studied, but it will likely be difficult and expensive.

3.3 Highway Users

The majority of highway tunnel users are recreational travelers, Alaska Marine Highway System (AMHS) users, transportation companies, commercial fishing companies, and the 220 residents of Whittier. In addition to hikers, kayakers, anglers, and boat owners, recreational travelers include cruise-ship passengers traveling by bus instead of by train.

Vehicular traffic volumes are highly variable throughout the year. There are up to 25,000 vehicle round-trips through the Whittier Tunnel in July, but this number may drop to 2,500 in January.

Holidays, cruise-ship days, and weekends tend to have higher traffic volumes. Peak traffic for the Bear Valley to Whittier openings usually occurs at 10:30 a.m., 11:30 a.m., and 12:30 p.m. Whittier to Bear Valley traffic peaks occur at 5, 6, and 7 p.m. The following tables and graphs depict changes in traffic volumes and average daily traffic in both Bear Valley and Whittier.

For the first seven months that the Tunnel was opened to automobiles, tolls were not charged, and automobiles made approximately 85,000 round-trips through the Tunnel. After implementing the toll, however, traffic volumes decreased significantly. The peak year for tunnel traffic was 2007 when there were more cruise ships docking in Whittier.

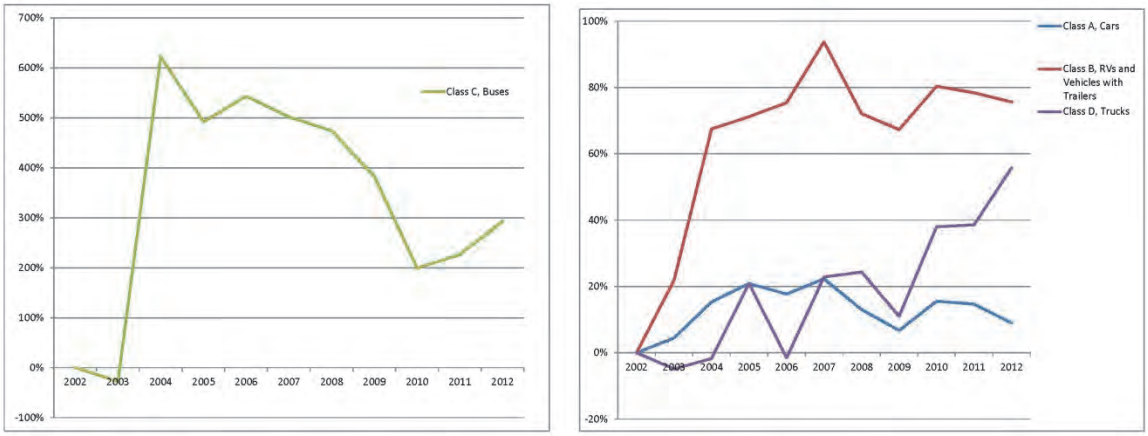


Figure 16: Percent Change in Annual Traffic in Bear Valley to Whittier Traffic Volumes

3.3.1 Alaska Marine Highway System Traffic

The AMHS also brings a significant volume of traffic through this Tunnel. Tables 3 and 4 summarize the increase in ferry traffic to Whittier since the Tunnel opened in 2000. Due to the growth in number of annual passengers, the AMHS terminal in Whittier will be elevated from a Class C terminal to a Class A terminal. This entitles the terminal to have a larger staff and a larger facility. Vehicles heading to the AMHS terminal tend to arrive in Bear Valley approximately two hours prior to ferry departures.

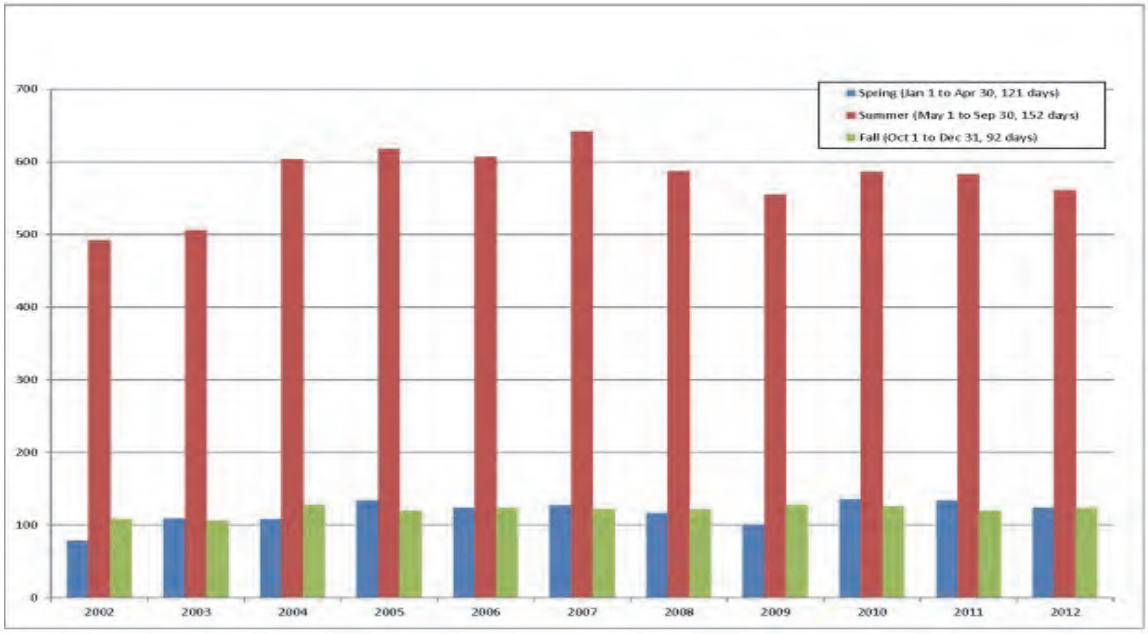


Figure 17: Bear Valley/Whittier Traffic Volumes Average Daily Volume By Season

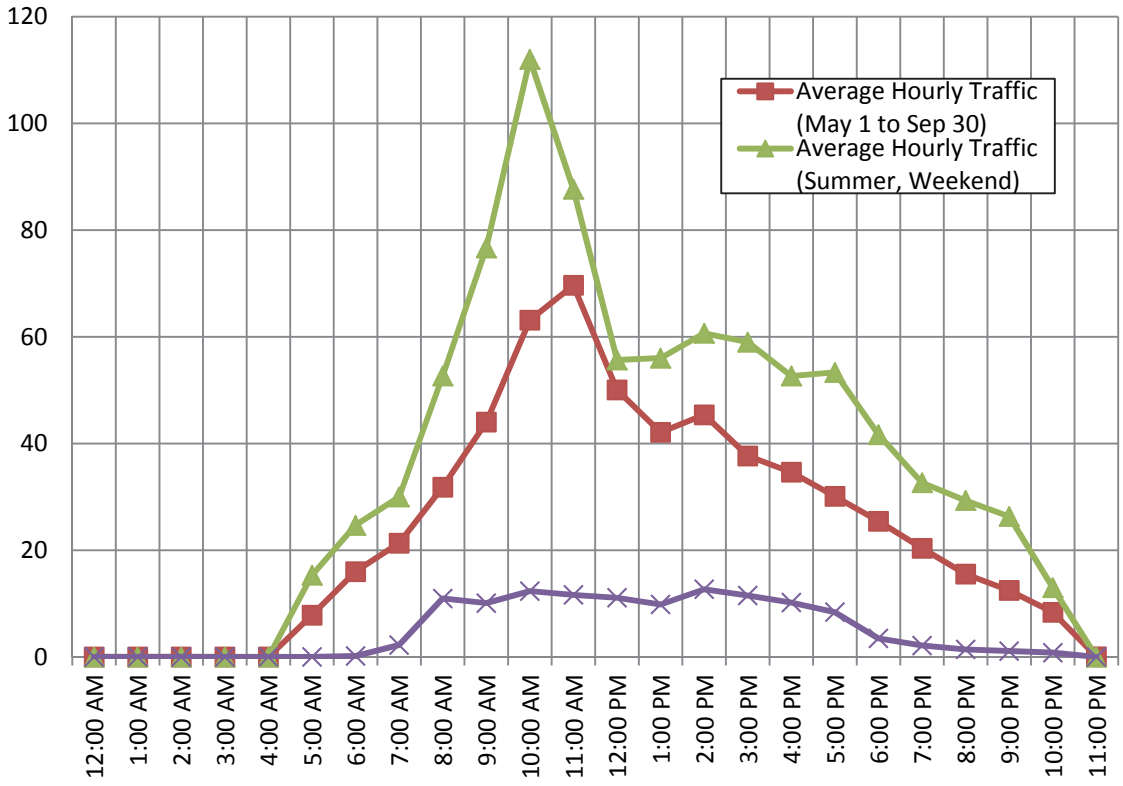


Figure 18: Bear Valley to Whittier Traffic Comparison

The current tunnel schedule can easily accommodate the volume of traffic using the AMHS ferries. Two of these AMHS ferries (*Aurora* and *Chenega*) can accommodate 34-36 vehicles. The *Kennecott* can accommodate 80 cars. However, it is critical that 10:30 a.m., 11:30 a.m., and 12:30 a.m. Bear Valley to Whittier openings not be delayed, so ferry passengers arrive in Whittier in time to catch the ferry.

Table 3: Alaska Marine Highway System Usage by Year (2002 to 2011)

Year		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Ferries		129	134	111	213	419	381	356	417	340	380
Ferries per Week		2-3	2-3	2-3	4	8	7-8	6-7	8	6-7	7-8
Embarking	Passengers	8,244	8,141	8,240	9,712	18,189	18,879	18,020	18,464	18,712	21,323
	% Change	4.5%	-1.2%	1.2%	17.9%	87.3%	3.8%	-4.6%	2.5%	1.3%	14%
	Vehicles	2,620	2,782	2,769	3,740	7,379	8,196	7,494	7,986	8,326	8,945
	% Change	1.9	6.2	-0.5	35.1	97.3	11.1	-8.6	6.6	4.3	7.4
Disembarking	Passengers	9,309	9,728	9,705	12,208	21,520	22,236	21,139	22,139	21,672	24,933
	% Change	4.2%	4.5%	0.2%	25.8%	76.3%	2.8%	-4.9%	4.7%	-2.1%	15.0%
	Vehicles	2,880	3,012	2,899	4,261	8,153	8,654	8,160	8,901	8,916	10,026
	% Change	2.5%	4.6%	-3.8%	47.0%	91.3%	6.1%	-5.7%	9.1%	0.2%	12.4%

Table 4: Alaska Marine Highway System Usage by Month (2011)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Embarking Passengers	514	543	773	899	2,495	3,482	4,762	4,167	1,873	977	498	340	21,323
Embarking Vehicles	318	238	391	576	1,135	1,343	1,664	1,526	827	477	238	212	8,945
Disembarking Passengers	594	529	790	859	2,133	4,197	6,237	5,601	2,132	959	513	389	24,933
Disembarking Vehicles	313	226	392	515	997	1,668	2,104	1,913	930	473	244	251	10,026

3.3.2 Cruise-Ship Traffic

Three of the four cruise ships use both buses and passenger trains to transport passengers. Passengers from large cruise ships require 27 buses and 7 to 8 luggage trucks for transportation out of Whittier, while small ships require 20 buses and 6 to 7 luggage trucks. The fourth cruise ship, which relies solely on buses to deliver passengers, requires 60–70 buses for passengers and 6 to 7 trucks for luggage. Since it takes a couple of hours to load and unload passengers from each cruise ship, a majority of the buses transiting the tunnel are spread over two to three

highway openings. Approximately 60 to 70 loaded buses transit the tunnel during these busy highway openings, which are well within the capacity of the Tunnel.

3.3.3 Day-Cruise Traffic

Two companies operate daytime cruises on a daily basis from mid-May to mid-September. Phillips Cruises normally has 350 passengers daily. Major Marine Cruises normally has 100 to 150 passengers per day (up to 200, a few times per month). Major Marine also hosts chartered cruises, on occasion, for up to 300 people, and these passengers normally arrive via bus. It is critical that the 10:30 a.m., 11:30 a.m., and 12:30 a.m. Bear Valley to Whittier openings not be delayed, so that passengers arrive in Whittier in time to catch their day cruises and scheduled fishing charters.

3.3.4 Freight Traffic

In addition to its rail shipments, AML frequently transports freight out of Whittier by truck. 10 to 15% (roughly 20 to 30 containers) of the shipping containers from AML barges depart from Whittier via truck, usually headed to the Kenai Peninsula. Trucks also use the AMHS to transport freight to Prince William Sound communities, and, in return, the trucks bring fresh seafood from these communities (estimates range between 17 to 30 million pounds or 340 to 600 trucks last year) through Whittier and the Tunnel into Anchorage.

4.0 TUNNEL OPERATIONS

4.1 Tunnel Schedule

The Tunnel schedule is developed to balance capacity (number of cars that transit the tunnel) with convenience. The current schedule reverses directional traffic flow every half-hour. Highway traffic enters the Tunnel during the 15-minute period at the hour and half-hour. It takes approximately 7 minutes for vehicles to transit the Tunnel. The remaining 8 minutes of "float" time (the period from 22 minutes to 30 minutes after tunnel opening) are used at the discretion of the tunnel operator to provide extra time for vehicles or trains, as possible, to maximize the efficiency of the tunnel operations. This "float" time is used: 1) to extend a highway opening during periods of heavy traffic, 2) for trains to transit the Tunnel, and 3) to allow highway schedules to be restored after train passages.

The ARRC has accommodated the highway schedule by delaying desired rail traffic times. The ARRC and the Tunnel Control Center work closely together to minimize costs of train delays, but the ARRC does absorb costs of significant delays, especially those regarding freight trains.

Establishing longer openings for vehicular traffic will allow more cars to transit the Tunnel, because less time would be spent transitioning traffic from one direction to the other. This would result in greater capacity, but with fewer tunnel openings. For example, changing the schedule so that traffic reverses directions hourly rather than every half hour would increase Tunnel capacity by 50%, but it would severely compromise convenience for regular highway tunnel users.

On the other hand, rail operations move in and out of Whittier on the relatively short train windows between highway openings. Longer highway openings would facilitate rail operations by increasing duration of train windows. The present highway schedule dictates that rail operations operate very closely to the "22" and "52" minutes of the hour. This is often difficult to achieve, especially for freight operations.

The DOT&PF held public hearings through 2004 to improve the schedule; since that time, the schedule has received only minor alterations.

Three of the most notable changes to the Tunnel schedule, since 2000, are:

1. Increased summer operating hours to 18 hours (originally 16 hours). A 5:30 a.m. Bear Valley to Whittier Tunnel opening and an 11:30 p.m. Whittier to Bear Valley opening were added.

2. Increased operating hours during the winter from 68 hours per week to 112 hours. The current winter schedule has operating hours from 7:30 a.m. to 11 p.m. The original schedule varied daily. Operating hours were generally from 8 a.m. to 5 p.m., with extended hours to 8 p.m. three days a week.

3. Elimination of the midday 30- to 60-minute shut-down for maintenance.

These changes improved the ability of Whittier residents to make day-long trips, during the winter, to Anchorage, every day of the week, without requiring an overnight stay. The extended winter hours also allow people to commute to and from Whittier for work.

Scheduled Tunnel Opening	Scheduled Tunnel Closing	Tunnel Direction			
		2012 Summer Schedule	2012/2013 Winter Schedule	2000 Summer Schedule	2000/2001 Winter Schedule
5:00 AM	5:15 AM	Safety Inspection	Tunnel Maintenance	Tunnel Maintenance	Tunnel Maintenance
5:30 AM	5:45 AM	Bear Valley to Whittier	Tunnel Maintenance	Tunnel Maintenance	Tunnel Maintenance
6:00 AM	6:15 AM	Whittier to Bear Valley	Tunnel Maintenance	Whittier to Bear Valley	Tunnel Maintenance
6:30 AM	6:45 AM	Bear Valley to Whittier	Safety Inspection	Bear Valley to Whittier	Tunnel Maintenance
7:00 AM	7:15 AM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Tunnel Maintenance
7:30 AM	7:45 AM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Tunnel Maintenance
8:00 AM	8:15 AM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Bear Valley to Whittier -- no Sunday opening
8:30 AM	8:45 AM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Whittier to Bear Valley -- no Sunday opening
9:00 AM	9:15 AM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Bear Valley to Whittier -- no Sunday opening
9:30 AM	9:45 AM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Whittier to Bear Valley -- no Sunday opening
10:00 AM	10:15 AM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Bear Valley to Whittier
10:30 AM	10:45 AM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Whittier to Bear Valley
11:00 AM	11:15 AM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Bear Valley to Whittier
11:30 AM	11:45 AM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Whittier to Bear Valley
12:00 PM	12:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Tunnel Maintenance	Bear Valley to Whittier
12:30 PM	12:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Whittier to Bear Valley
1:00 PM	1:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Bear Valley to Whittier	Bear Valley to Whittier
1:30 PM	1:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Whittier to Bear Valley	Whittier to Bear Valley
2:00 PM	2:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Bear Valley to Whittier
2:30 PM	2:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Whittier to Bear Valley	Whittier to Bear Valley
3:00 PM	3:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Tunnel Maintenance	Bear Valley to Whittier
3:30 PM	3:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Whittier to Bear Valley
4:00 PM	4:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Bear Valley to Whittier
4:30 PM	4:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Tunnel Maintenance	Whittier to Bear Valley
5:00 PM	5:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Bear Valley to Whittier -- Tues, Fri, Sun only
5:30 PM	5:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Whittier to Bear Valley -- Tues, Fri, Sun only
6:00 PM	6:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Bear Valley to Whittier -- Tues, Fri, Sun only
6:30 PM	6:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Tunnel Maintenance	Whittier to Bear Valley -- Tues, Fri, Sun only
7:00 PM	7:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Tunnel Maintenance	Bear Valley to Whittier -- Fri only
7:30 PM	7:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Whittier to Bear Valley -- Fri only
8:00 PM	8:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Tunnel Maintenance
8:30 PM	8:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Tunnel Maintenance
9:00 PM	9:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Tunnel Maintenance
9:30 PM	9:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Tunnel Maintenance
10:00 PM	10:15 PM	Whittier to Bear Valley	Whittier to Bear Valley	Whittier to Bear Valley	Tunnel Maintenance
10:30 PM	10:45 PM	Bear Valley to Whittier	Bear Valley to Whittier	Bear Valley to Whittier	Tunnel Maintenance
11:00 PM	11:15 PM	Whittier to Bear Valley	Tunnel Maintenance	Tunnel Maintenance	Tunnel Maintenance
11:30 PM	5:00 AM	Closed to Highway Traffic		Railroad Traffic Only	

Overall, this schedule meets the goal of providing improved access to Whittier and Prince William Sound. Both the DOT&PF and the ARRC make efforts to avoid making schedule changes that will negatively impact the public. Cruise ships have an agreement with the ARRC, requiring a two-year notification of changes to passenger train schedules. This advance notification also benefits other businesses in Whittier, since many of them start planning in late summer for the following year.

4.2 Highway Openings

Highway vehicles are separated into eight different classifications. These vehicle classifications dictate the interval during which and order in which vehicles enter the Tunnel. Each vehicle classification has a different toll rate. At the established tunnel speed limit (25 mph), the typical automobile needs seven minutes to transit through the Tunnel. The tunnel operator selects the metering interval for the type of traffic. Time intervals for all classes of vehicles are shown in Table 5.

Table 5: Vehicle Classifications, Time and Spacing Intervals, and Tolls

	Vehicle Type and Description	Time (seconds)	Spacing (feet)	Tolls	
				2001	2012
A	Automobiles without trailers	1.5	90 to 100	$15	$12
	Motorcycles and motorcycles with trailers				
	Recreational vehicles (RV) up to 28 feet long without trailers				
	Trucks up to 12,000 pounds GVW without trailers*				
B1	Automobiles with trailers	7.5	500	$40	$20
	RVs up to 28 feet long with trailers				
	RVs exceeding 28 feet long without trailers				
	Trucks up to 12,000 pounds GVW with trailers*				
B2	Automobiles and RVs with boats 8.5 to 10 feet wide	7.5	500	$40	$35
	RVs exceeding 28 feet long with trailers				
	Vans/buses designed for 9 to 30 people				
	3-axle trucks 12,000+ pounds GVW without trailers*				
	Trucks (2 axles) 12,000+ pounds GVW with trailers*				
C	Buses designed for 30+ people	w/passengers: 44 Empty: 7.5	1,600	$125	$125
D	4-axle trucks 12,000+ pounds GVW without trailers*	7.5	500	$125	$125
	3-axle trucks 12,000+ pounds GVW with trailers*				

	Vehicle Type and Description	Time (seconds)	Spacing (feet)	Tolls	
				2001	2012
	Vehicles 8.5 to 10 feet wide				
	Truck-tractor and trailer combinations				
E	Vehicles 10 to 11 feet wide, 14 to 15 feet high	7.5	500	$250	$300
F	ARRC, DOT&PF, emergency, law enforcement	NA	NA	NA	NA
G	Government vehicles, school buses	Varies	Varies	NA	$10

GVW = gross vehicle weight

*The maximum weight for Class-B vehicles was 10,000 pounds (not 12,000 pounds) in 2001.

The metering signal then cycles automatically until the tunnel operator selects a different interval for the next vehicle classification. Buses (Class C) with passengers are the first class of vehicles to enter the Tunnel. Buses are followed by automobiles (Class A); vehicles with trailers, recreational vehicles (RV), and small trucks (Class B); semi-trucks (Class D); and then motorcycles. There is also a 15-second delay between each traffic lane.

Buses are spaced at 44 seconds apart, because the capacity of each safe house is equal to the number of people on one bus. By proceeding into the Tunnel at 44-second intervals, buses are spaced 1,600 feet apart, and the number of people in the Tunnel will not exceed the capacity of the safe houses. Bus drivers receive annual safety training, pertaining to spacing, lights, signals, emergency procedures, and the importance of maintaining a 25-mph speed to limit the number of buses in the Tunnel at one time. Cruise-ship companies distribute arriving buses over several tunnel openings to space out the number of passengers boarding a cruise ship.

Passenger cars enter the Tunnel after buses, because they do not receive safety training, and a slow-moving driver could easily cause a situation where there may be too many buses behind them in the Tunnel, thus exceeding the capacity of the safe houses. Empty buses are metered into the Tunnel at 7.5 seconds per bus - the same rate as semi-trucks. Motorcycles enter the Tunnel last because they are the most likely to have accidents. Oversized vehicles (Class E) are restricted to entering the Tunnel Monday through Thursday during the 7:30 to 7:45 a.m. opening in Bear Valley and the 2 to 2:45 p.m. opening in Whittier.

On occasion, intervals between vehicles that enter the Tunnel may be increased for safety reasons (e.g., if one of the Tunnel fire trucks has a mechanical problem). To reduce the time to recover the schedule during periods of heavy traffic or after a train passage, the Tunnel operator may also decrease the time intervals between vehicles.

Traffic priorities and time intervals have evolved since this Tunnel opened for automobiles. Originally, cruise-ship buses were given priority only from 12:30 to 1:15 p.m. from Bear Valley into Whittier, and from 2 to 2:45 p.m. from Whittier to Bear Valley. Additionally, empty buses initially had priority over automobiles, but this is no longer the case. The rate for automobiles (Class A) entering the Tunnel has also been reduced from 2.5 to 1.5 seconds per vehicle.

In addition to Classes A through G, a Class-H category has been used in the past. In 2010, under the authority of the DOT&PF Commissioner, contaminated soil from the abandoned tank farm in Whittier was hauled through the Tunnel for disposal in Anchorage. A special toll rate was applied to these trucks. In the summers of 2002 and 2003, only two Class-H vehicles used the Tunnel. The spring and summer of 2010 had 597 Class-H vehicles.

During cold weather in the winter, the Tunnel doors are closed as much as possible, to prevent water draining from the crown and sidewalls from freezing. During periods of cold weather, tunnel openings are deliberately delayed, to group or platoon vehicles together, which minimizes the amount of time that the Tunnel doors are open and keeps the Tunnel as warm as possible.

4.2.1 Tunnel Capacity

To estimate the actual capacity of the Tunnel, portions of seven highway openings with heavy traffic were evaluated. These included the busiest highway openings in 2013. The July 6, 2013 eastbound 6:00 p.m. opening had a total of 192 vehicles that took 18 minutes to enter the Tunnel. For most, if not all, of the busy openings, Class-A vehicles entered the Tunnel without having to stop at the metering light. There was also a 15-second delay between releasing each lane in the staging area.

Class-A vehicles entered the Tunnel at an average rate of 4.3 to 5.7 seconds per vehicle, which is significantly slower than the metered rate of 1.5 seconds per vehicle. Therefore, the goal of spacing the Class-A vehicles at a rate of 1.5 seconds per vehicle was achieved without having to meter them. Class-B, Class-C (empty buses), and Class-D vehicles entered the Tunnel at a rate of 7.6 to 14.3 seconds per vehicle, which is slower than the metered rate of 7.5 seconds per vehicle. Class-C vehicles (full buses) entered the Tunnel relatively close to their metered rate of 44 seconds per bus. The results are presented in Table 6.

Table 6: Summary of Vehicle Rate of Entry to the Tunnel

Date	Opening	Class A Vehicles	Average Entry Rate for Class A (sec.)	Class B and D Vehicles	Average Entry Rate for Class B and D (sec.)
5/29/13	1000 EB	40	4.45	5	10.4
5/27/13	1000 EB	120	5.2	26	14.3
7/4/13	1030 EB	118	5.7	19	7.6
7/4/13	1130 EB	70	5.7	27	10.0
7/4/13	1800 WB	38	4.3	N/A	N/A
7/4/13	1900 WB	23	4.5	0	N/A
7/6/13	1800 WB	93	4.7	15	9.3

East Bound (EB) and West Bound (WB)

If Class-A vehicles are allowed to proceed into the Tunnel without being metered (at a rate of 1.5 seconds per vehicle), and the 15-second delay period between opening lanes in the staging area is eliminated for Class-A vehicles, the average rate would be approximately 4 to 5 seconds per vehicle. Based on a rate of 4 to 5 seconds per Class-A vehicle, an equivalent of approximately 180 to 225 Class-A vehicles can pass through the Tunnel during each 15-minute highway opening. Therefore, during an 18-hour summer day, the daily one-way capacity of the Tunnel is approximately 3,500 equivalent Class-A vehicles. This is a significant increase over the 240 cars per day that could transit the Tunnel via the shuttle train prior to the Tunnel opening in 2000.

The following Class-A vehicle equivalent factor for each vehicle class can be used to estimate the time it will take for a group of vehicles to enter the Tunnel (Table 7):

Table 7: Class-A Equivalent Vehicles

Vehicle Class	Average Rate per Vehicle	Equivalent Class-A Vehicles
Class A	5 seconds	1
Classes B1 and B2	10 seconds	2
Class C (Full)	44 seconds	9
Class C (Empty)	10 seconds	2
Class D	10 seconds	2

Table 8 compares the estimated time based on the Equivalent Class-A vehicles with the actual time it took for the vehicles to enter the Tunnel during the seven openings evaluated.

Table 8: Comparison of Estimated Time vs. Actual Time for Vehicles Entering the Tunnel

Date	Opening	Class A	Class B, C (empty), and D	Total Vehicles	Estimated time using Equivalent Class-A Vehicle Factor (seconds)	Actual Time (seconds)	Actual Time Adjusted* (seconds)
5/29/13	1000 EB	40	7	47	4.5	4.4	4.4
5/27/13	1000 EB	120	38	158	16.3	22.2	21.2
7/4/13	1030 EB	118	25	143	14.0	14.7	14.2
7/4/13	1130 EB	70	25	95	10.0	11.2	10.9
7/4/13	1800 WB	127	0	127	10.6	8.9	8.1
7/4/13	1900 WB	23	0	23	1.9	1.7	1.7
7/6/13	1800 WB	168	24	192	18.0	18.0	16.7

*Time it would take if the 15-second delays between releases of lanes with Class "A" vehicles is eliminated

4.2.2 Tolls

Under state regulations, the DOT&PF may adjust the toll schedule one-time annually. The current toll schedule (see Table 6) was established on June 1, 2004. Tolls may not fluctuate by more than 10%, and any changes need to be implemented before April of the current year (after state-legislative appropriations have been determined). Season passes and prepaid coupon books are used heavily by buses, trucks, and Whittier residents to reduce costs. These items also help improve traffic flow through the toll plazas. However, some Whittier residents still feel that tolls are excessive and would like to see resident discounts.

4.3 Train Windows

The ARRC dispatcher works closely with the TCC. During train mode, the ARRC assumes control of the AAMT, allowing trains to proceed through the Tunnel. When trains exit the tunnel, the ARRC dispatcher relinquishes control back to the TCC, and roadway operations resume. Daily passenger trains, cruise-ship passenger trains, and freight trains transit the Whittier Tunnel during the summer. Passenger trains and empty freight trains from Bear Valley to Portage generally have minor impacts on the schedule for Highway Openings. However, Whittier to Bear Valley-bound loaded freight trains can cause significant delays to highway openings, and it may take 1 to 2 hours for the schedule to return to the scheduled half-hourly cycle.

Tunnel schedules distributed at Tunnel toll booths and posted on the AAMT website clearly indicate that train impacts have been minimized, but that an occasional 15- to 30-minute delay should be expected. However, Tunnel users frequently do not see this disclaimer.

4.3.1 Daily Passenger Trains

In the summer season, two roundtrip daily passenger trains support public rail transportation. These trains pass through the Tunnel during 11:52 a.m., 12:52 a.m., 5:52 p.m., and 6:52 p.m. railroad windows. These trains take approximately 6 to 8 minutes to transit the Tunnel and generally delay only the following/next highway opening by less than 5 minutes.

These Passenger trains sometimes miss their scheduled openings for the following reasons:

- Moving the railroad signal from F7.0 to F8.7 in 2011 increased the travel time for a passenger train traveling from Portage to Bear Valley by 1.4 minutes. This resulted in several passenger trains in 2011 arriving after the scheduled highway opening had started, and trains had to wait 20 to 30 minutes for the next opportunity to continue their trip to Whittier. In 2012, the ARRC changed the daily passenger train schedule so that the trains left Anchorage 15 minutes earlier, which alleviated this problem.
- Roughly five times each summer, the ARRC will accommodate a stop in Girdwood or Portage for special tour groups of up to 100 people. These tour groups board the regularly scheduled daily passenger train. Delays occur because the train cannot depart from Anchorage earlier to accommodate these groups, and the TCC is usually not notified of these delays.
- Some delays occur when passenger trains make unscheduled stops to allow tourists to photograph wildlife and scenery.

4.3.2 Cruise-Ship Trains

Four roundtrip passenger trains run only on days that Princess cruise ships dock in Whittier. In 2013, Princess Cruise ships docked in Whittier on Saturdays and every other Monday and Wednesday. These trains pass through the Tunnel during the 5:52 a.m., 6:52 a.m., 7:22 a.m., 8:22 a.m., 5:22 p.m., 6:22 p.m., 7:22 p.m. and 7:52 p.m. railroad openings. These trains take

approximately 6 to 8 minutes to transit the Tunnel. These trains generally delay only the following highway opening by less than 5 minutes.

On occasions when one of these cruise passenger trains is late and misses the railroad window, it transits the Tunnel during the next railroad window. This may result in two passenger trains (going in the same direction) transiting the Tunnel during the same railroad window. Since these trains are early in the morning with light highway traffic, there are relatively minor delays (less than 10-15 minutes) to the following highway opening. During the evening, if highway traffic is light, two passenger trains using the same window generally delay the following highway opening by 10 to 15 minutes, and the Tunnel schedule can recover by the second following highway opening. However, two passenger trains trying to use the same railroad window on Saturday evenings with heavy highway traffic may result in significant delays to the highway openings, which may mean that it takes more time for the schedule to recover.

The ARRC does not schedule two passenger trains traveling in the opposite direction to use the same railroad window, since they have to pass at either Portage or in the Whittier rail yard. This would take too much time and cause significant delays to the highway openings.

4.3.3 Empty Freight Trains

Approximately 3 freight trains per week haul railroad cars and containers from Anchorage to the Port of Whittier for shipment back to the U.S. and Canada. These trains generally take 10 to 20 minutes to transit the Tunnel. These trains are not scheduled and are dependent upon the arrival of barges traveling from Canada and the U.S. These trains generally only delay the following highway opening by 10-20 minutes (Figure 20). These trains usually appear (with the exception of Sunday afternoons) during periods when there is light highway traffic and generally only affect one highway opening.

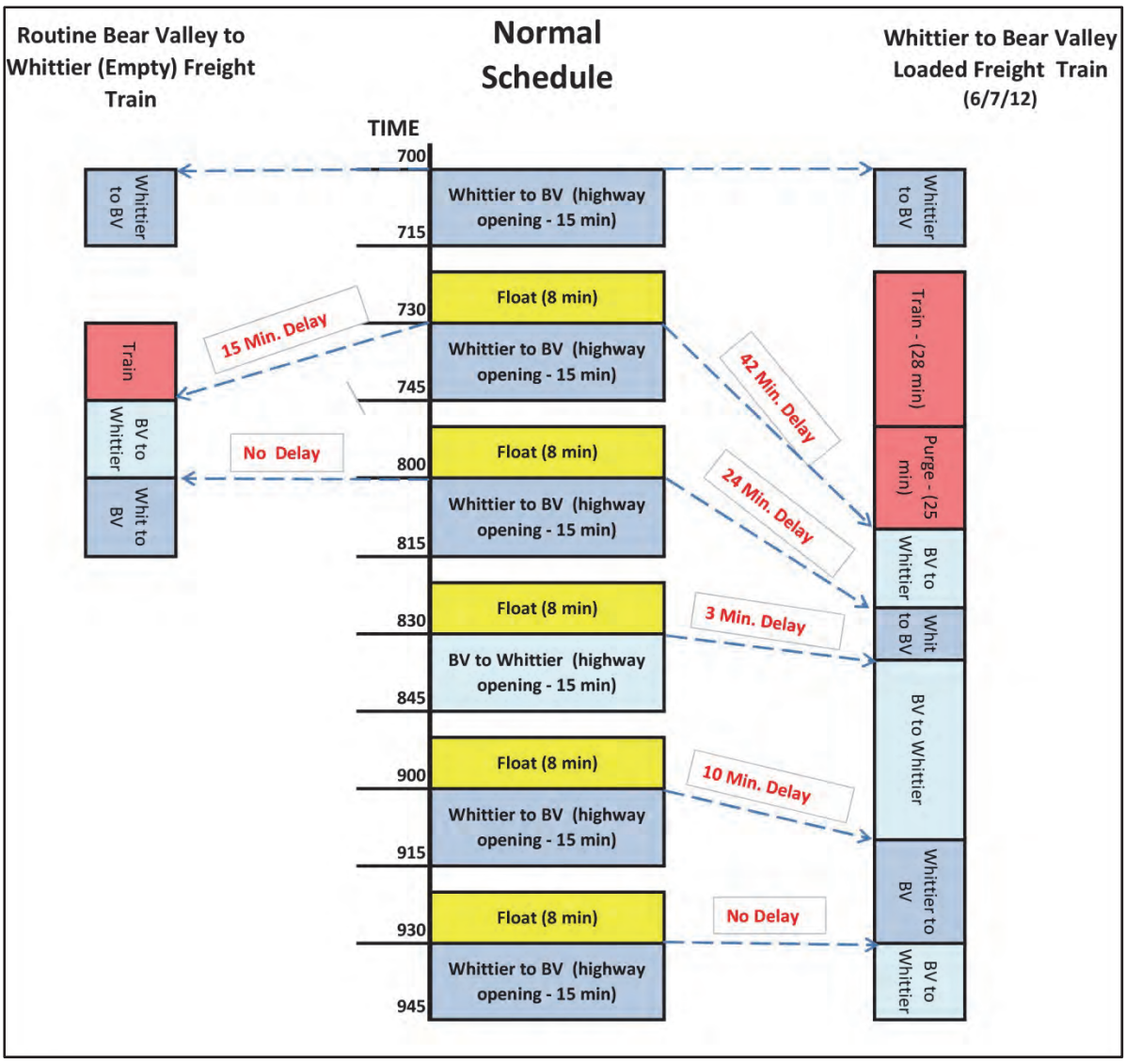
Due to the presence of daily passenger trains in the rail yard in Whittier or in the block between Whittier and Portage, these empty freight trains cannot transit the Tunnel during heavy highway traffic periods between the 10:52 a.m. to 1:52 p.m. and the 4:52 to 8:52 p.m. railroad windows. Portions of these periods coincide with highway openings with heavy traffic. On cruise-ship days, the ARRC and the Tunnel Control Center work together to schedule empty freight trains

through the Tunnel between the 8:52 to 10:22 a.m. railroad windows and the 1:22 to 3:52 p.m. railroad windows (see Figure 14).

4.3.4 Loaded Freight Trains

Approximately 3 loaded freight trains per week haul cargo through the Tunnel from the Port of Whittier to Anchorage. These trains are not scheduled and are dependent on the arrival of barges traveling from Canada and the U.S. It generally takes 30 to 50 minutes for these trains to transit and purge the Tunnel of CO. These trains cause a 20- to 40-minute delay to the first following highway opening and they may delay the subsequent two to four highway openings (Figure 20). During the period from 2011 to 2013, only 1-2% of highway openings were delayed more than 15 minutes by trains (Figure 21). The lengthiness of highway opening delays is dependent on the length of a train, the time that it takes to purge the Tunnel of CO, and the amount of highway traffic that must be cleared. Purge time is heavily dependent on the speed and direction of the wind in the Tunnel. A strong wind blowing from Bear Valley to Whittier (opposite from the direction of travel) significantly increases the time that it takes to purge the Tunnel.

With the present track configuration in Whittier, daily passenger trains block loaded freight trains during the 10:52 a.m. to 1:22 p.m. windows and 4:22 p.m. to 7:22 p.m. railroad windows. On cruise-ship days, loaded freight trains can only transit the Tunnel during the 9:22 a.m. to 10:22 a.m. railroad window and the 1:52 p.m. to 3:52 p.m. and after-8:52 p.m. railroad windows (See Figure 14). Transiting the Tunnel during the other railroad windows impacts the highway operations of the Tunnel. Figure 22 summarizes the delay of the first highway opening after a loaded freight train transited the Tunnel in 2011 and 2012. Figure 23 summarizes the number of highway openings that were delayed by loaded freight trains traveling from Whittier to Bear Valley in 2011 and 2012.



BV = Bear Valley

Figure 20: Comparison of Impacts by Empty Freight Train (Bear Valley to Whittier) and Loaded Freight Train (Whittier to Bear Valley)

However, the ARRC suffers from delay costs and other impacts when freight trains cannot depart from Whittier as soon as they are ready to do so, including:

- Barge Operation: Barges are "on-the-clock" with tug and crew while docked in Whittier. The estimated cost of the barge operation is about $6,000 per hour. The ARRC works very hard with the Tunnel Control Center to avoid situations where a train delay will result in delays to the loading, unloading, and departure of a barge.

- Freight Standby, No-Crew Penalty: A freight train idling in Whittier with a crew costs about $400/hour. The ARRC regularly incurs this cost to wait on highway use of the Tunnel.

- Freight Standby, Crew Penalty: Train crews are covered by Hours-of-Service regulations. If a freight crew cannot make Anchorage during “Hours of Service”, a relief crew must be sent from Anchorage. The cost incurred by the ARRC varies but is approximately $400/hour, plus a $1,500 charge for the second crew.

- Customer Delays: Freight coming off a barge is destined for Fairbanks or Anchorage. Delays in freight departures can cause missed connections with other trains that move railcars and containers to customers.

- Ongoing Freight Delays: The ARRC experiences peak locomotive demand in the summer. If Tunnel highway operations delay locomotives, the ARRC may have to delay or cancel other trains because of lack of locomotive-power availability.

The ARRC works closely with the Tunnel Control Center to minimize combined impacts to highway and rail operations. The ARRC delays the Bear Valley-bound freight trains so that they transit the Tunnel during off-peak highway periods in the evening and at night when the tunnel is closed to highway traffic. During 2011, 2012, and part of 2013, the ARRC estimates that approximately 140 of these Bear Valley-bound freight trains transited the Tunnel during this period, 65 of which (45% to 50%) transited the Tunnel at night when the Tunnel was closed to highway traffic. Normally, only 25% of the Bear Valley-bound freight trains would transit the Tunnel during the night when the Tunnel is closed to highway traffic. Figure 21 shows the percentage of Bear Valley-bound freight trains transiting the Tunnel.

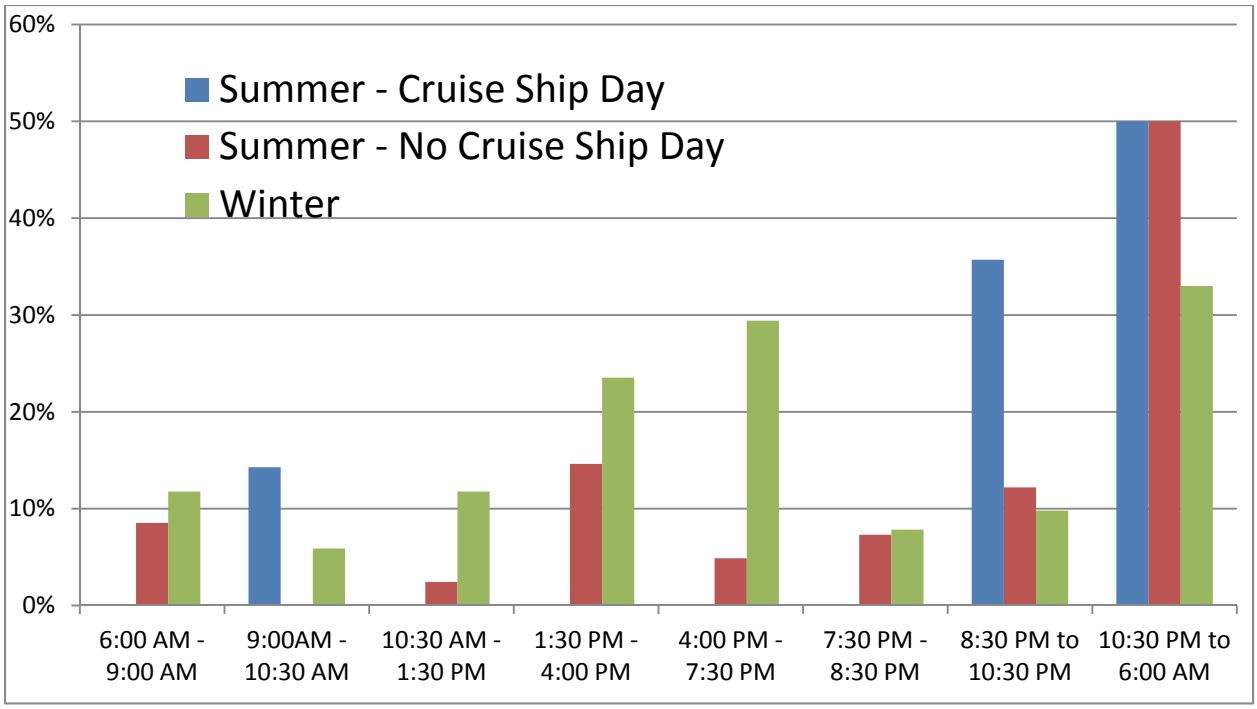


Figure 21: Percentage of Bear Valley-Bound Freight Trains Transiting the Tunnel

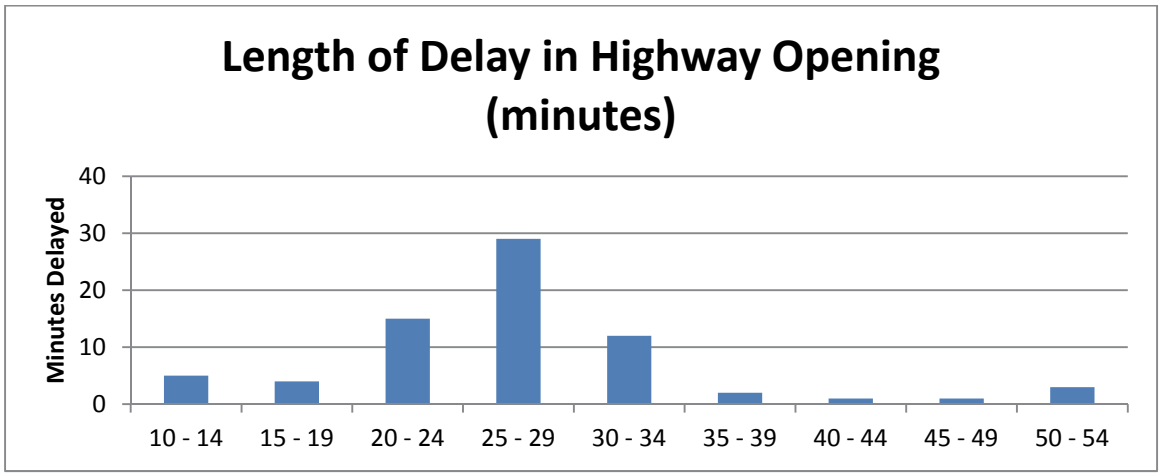


Figure 22: Delay of first Highway Opening after Loaded Freight Train travels through the Tunnel from Whittier to Bear Valley (2011 and 2012)

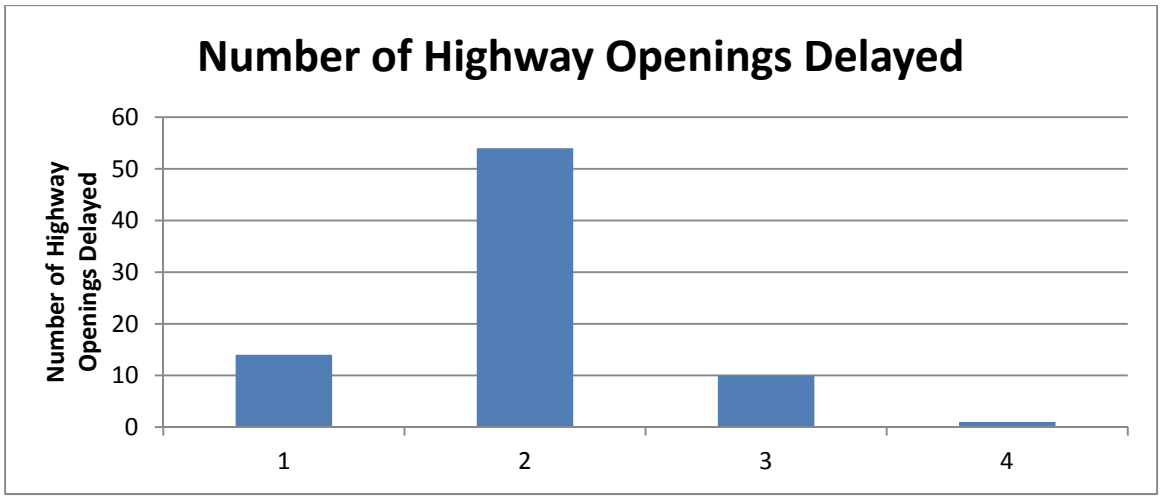


Figure 23: Number of Highway Openings delayed after each Loaded Freight Train Passes through the Tunnel from Whittier to Bear Valley (2011 and 2012)

4.3.5 Train Location

There is no reliable way for the tunnel operator to know the precise location or the arrival times of trains approaching from Portage. Therefore, tunnel operators maintain the Tunnel in highway mode until they see trains emerging from the Portage Tunnel at MP F5.7. Tunnel control operators release highway traffic at the scheduled times if they do not see a train in Bear Valley. This means that if a train is a minute later than the train window, it has to stop and wait for 22 minutes in Bear Valley until the next train window. This is especially critical for the 11:52 a.m. train window and the 12 and 12:30 p.m. highway openings, since day-cruise passengers and AMHS passengers arrive via trains and automobiles. They are depending on transiting the Tunnel during the 12:30 p.m. opening to meet their scheduled boat departures from Whittier.

The ARRC installed a Computer-Aided Dispatch (CAD) and Global Positioning System (GPS) monitors in the TCC that display the same information for train locations available to ARRC dispatchers in their Anchorage Operation Center. However, these systems do not show the location of trains in the Portage Tunnel. Since tunnel operators now know whether Whittier-bound trains are close to Bear Valley, they can determine the approximate time that a train will arrive in Bear Valley and will be on-time for the railroad window. This reduces the number of times that trains have to stop in Bear Valley to wait for the TCC operator to transfer the Tunnel to the ARRC dispatcher for train operations.

4.4 Tunnel Regulations

Title 17 Transportation *and Public Facilities – Chapter 38 Anton Anderson Memorial Tunnel* comprises the regulations that govern Tunnel operations. These regulations are the framework for the AAMT *Tunnel Segment Operations Manual* developed by the DOT&PF and VMS for the vehicle classifications (see Table 5). Vehicle size restrictions and hazardous material restrictions are included in these regulations.

4.4.1 Vehicle Size Restrictions

Normal vehicle size limits for the AAMT that appear in state regulations are 10 feet (width) by 14 feet (height) by 75 feet (length). The length restriction was changed under a Best Interest Finding from the DOT&PF Commissioner on October 9, 2007. Since standard trucks with 53-foot trailers regularly exceed the 75-foot length limitation by only 5 feet, the *Best Interest Finding* increases the maximum length to 80 feet. Regulations do not specifically prohibit long-combination vehicles (i.e., trucks with multiple trailers), but the 80-foot length limitation excludes trucks with multiple trailers. Another Best Interest Finding was approved on an interim basis on December 19, 2012, to permit vehicle heights of up to 15 feet without being classified as an oversized vehicle. Allowing 80-foot-long and 15-foot-high vehicles helps align tunnel regulations with industry standards, thus improving transportation cost-effectiveness without impacting safe operation of the Tunnel (an 80-foot-long truck can still safely fit in the pullouts adjacent to safe houses, and a 15-foot-high truck has adequate clearance inside the 21-foot-high Tunnel).

Class-E vehicles may be 11 feet wide instead of 10 feet wide. The scheduled timeframe for oversized vehicles in 2012 was from Monday through Thursday, 2:30 to 2:45 p.m. from Bear Valley to Whittier and 4 to 4:15 p.m. from Whittier to Bear Valley.

Tunnel operators are authorized to prohibit any vehicle posing an unreasonable hazard due to the condition of the vehicle, the condition of its driver, vehicle contents, or improperly secured loads.

Trucks with multiple trailers are normally excluded from using the Tunnel, because they exceed the maximum length of 80 feet. Safe-house turnouts were designed to accommodate an 80-foot-long tractor trailer, in the case of an emergency. However, in the event of a breakdown for either

single- or double-trailer trucks, the preferred recovery option is to pull the truck forward and completely out of the Tunnel. In the past, trucking companies have offered to station equipment at the Tunnel (heavy wreckers or other recovery vehicles) and provide training for Tunnel staff to use this equipment in exchange for being allowed to use double-trailer trucks in the Tunnel. Since this Tunnel was opened in 2000, semi-trucks have never had to use a safe-house turnout.

In 2005, the DOT&PF considered allowing double-trailers in the Tunnel. The draft indemnification developed by the DOT&PF required trucking companies to assume liability for the negligence of State employees and Tunnel Control Center personnel. Therefore, an agreement with trucking companies was never finalized. However, double-trailer trucks were allowed to use the Tunnel on a short-term basis under a Best Interest Finding dated January 15, 2010, to haul contaminated soil from the Whittier tank farm, with a special billing rate of $250 (Class H, compared to the $300 Class-E rate for single-trailer trucks). During this time, no accidents occurred. Indemnification requirements developed by the DOT&PF for this operation limited liability solely to the actions of trucking company employees.

The analysis to determine whether trucks with multiple trailers should be allowed to transit the Tunnel is beyond the scope of this project. Although trucks with multiple trailers are allowed in other tunnels, there is concern that:

- The rails may cause the second trailer to wander, due to off-tracking caused by the rails.
- Additional truck traffic may impact long-term performance of the precast concrete tunnel invert.

4.4.2 Hazardous Materials

Large quantities of hazardous material may only transit the Tunnel by the railroad. Under State regulations, any hazardous materials in quantities that require placards under the Code of Federal Regulations, 49 CFR 107-180 (October 1, 2003), for roadway transportation, are not allowed through the Tunnel. This does not include gasoline in the gasoline tank of a boat or vehicle (up to 400 pounds), up to 12 gallons of fuel in containers approved by Underwriters Laboratories, propane tanks with up to 100 pounds combined weight, and up to 400 cubic feet of acetylene. Fuel trucks are not allowed, and bulk fuel shipments must be hauled into Whittier by railcar.

Preventing trucks from hauling hazardous materials through the Tunnel, under tunnel regulations, results in higher shipping costs for transportation companies using the AMHS to deliver hazardous cargo (fuel, propane, acetylene, etc.) to Prince William Sound communities. Shipping quantities of hazardous cargo must be shipped into Whittier on a railcar and then loaded onto tanker trucks for delivery to communities via ferry, which adds cost. Another additional cost arises from U.S. Coast Guard requirements to provide security if hazardous cargo is stored at a port facility for multiple days while waiting for the next AMHS ferry. Consequently, hazardous-material shipments tend to occur on a limited schedule when greater volumes can be shipped simultaneously, or high costs are passed on to consumers. Other tunnels across the U.S. do not have similar restrictions regarding hazardous materials.

However, the Whittier Tunnel is unique in having only a single traffic lane, which is the sole overland access to Whittier. Accidents in the tunnel block all vehicle and rail traffic. In addition, a severe hazardous materials' incident has the potential to cut off all land-access to Whittier for an extended period of time. An analysis of this issue is beyond the scope of this study.

4.5 Operating Agreement

The Anton Anderson Memorial Tunnel Operating Agreement between the ARRC and DOT&PF existed from 2000 to 2004. Since that time, the ARRC and the DOT&PF have worked together to optimize tunnel operations for their combined use. The schedule is developed jointly by the DOT&PF Facilities Manager and the ARRC Vice-President of Transportation and Mechanical on an annual basis.

4.6 Data Collection

Two reports and two databases are maintained by the Tunnel operators at the TCC:

- The "AAMT Tunnel Operations Daily Log" is a report generated each day to list events (traffic releases, trains, etc.), times that events occur, a description, CO levels, and the staging-area status after traffic releases.
- The "ARRC Traffic Estimated Time of Arrival (ETA) and Actual Arrival Times" report is an annual report updated several times daily. It contains the date, ETA of trains, actual

arrival time of trains, when the Tunnel request was received, and when the Tunnel was released back to the TCC from the ARRC dispatcher. The Tunnel operator is also listed.

- The AAMT Toll-Monitoring System database contains toll-data vehicle classifications and vehicle counts from vehicles passing through toll plazas in Bear Valley.
- The Tunnel Control System Traffic Database contains data from traffic counters located in Whittier.

The "AAMT Tunnel Operations Daily Log" and the "ARRC Traffic ETA and Actual Arrival Times" contain manually entered data.

These databases that automatically record traffic data have limitations. Neither database can produce results that can be imported into a spreadsheet, which makes analysis of traffic data more complicated and subject to human error. Data available from the Whittier queuing area is also incomplete. The only data available is the raw number of vehicles departing from the staging area. The breakdown by vehicle classification is completely unknown.

5.0 TUNNEL INCIDENTS

5.1 Incidents that Affect Highway Operations

Highway operations are disrupted for five primary reasons:

- **The TCC receives a "false train request" (40 times in 2012).** In recent years, the TCS that detects train occupancy in the Tunnel has been experiencing a degradation of operational reliability. When the TCS fails, the default (fail-safe) state is to indicate that a train occupies the track in the Tunnel, and the Tunnel automatically shuts down both highway and railroad operations.

  Forty TCS failures occurred in 2012. Thirty-five of these TCS failures occurred while the Tunnel was in highway mode. The Tunnel control operator had to override the TCS system to allow the Tunnel to continue operating in highway mode. Five of these TCS failures occurred when the Tunnel was in train mode. This failure usually occurred when the TCS failed to detect that a train had exited the Tunnel, and the Tunnel could not be switched to highway mode. The ARRC dispatcher had to send signal crews from Anchorage to the Tunnel to correct the TCS. This required several hours. In the meantime, the Tunnel was shut down to both cars and trains.

  The ARRC attempted to solve the TCS failures by increasing power to the TCS in order to overcome power dissipation caused by current leaking from the circuit. Presently, the upper limits of the track circuit power have been reached and can no longer be increased.

  The recently completed DOT&PF research project "*Evaluation of the TCS for the AAMT*" concluded that the wet environment of the Tunnel was the cause of progressive failure of the TCS and recommended that the existing TCS be replaced with an axle-counter system.

- **ARRC dispatchers do not promptly relinquish control of the Tunnel back to the TCC.** Occasional delays occur when ARRC dispatchers do not promptly give control of the Tunnel back to the TCC after a train has left the Tunnel. Both State and FRA regulations require the ARRC to physically be in control of the Tunnel when trains pass through.

- **Loss of power at the Tunnel (seven incident reports filed in 2012):** When power failures occur, backup generators run the TCC, limited tunnel ventilation, and tunnel lights. This information is not tracked by the TCC, so the exact number of incidents is not known. The primary purpose of the backup generators is to maintain tunnel systems long enough to permit vehicles inside to exit, but they lack sufficient power to run jet fans and portal fans long-term. In 2012, the ARRC modified the TSS to connect with existing backup generators to permit continuation of highway operations in the event of a power failure. Highway traffic can continue to transit the Tunnel in a very limited capacity; tunnel fire engines may escort 15 vehicles at a time from the queuing areas, and the metering signal interval between vehicles must be increased to 15 seconds.

- **Strong winds in the tunnel:** Strong winds inside the Tunnel can cause problems purging the Tunnel or maintaining directional air flow. Extreme barometric pressure differences between both ends of the Tunnel can generate a strong-enough wind (up to 15 mph) in the Tunnel to overcome the airflow from the jet fans. The jet fans can blow air through the Tunnel at up to 8 mph. Strong winds can impede the purging of train emissions from the Tunnel and prevent maintaining airflow in the direction of travel. During these periods, the Tunnel goes into "high wind" operations, which consist of allowing 15 vehicles in the Tunnel at a time and closing the portal doors after the last car has entered the Tunnel. A high wind blowing from Bear Valley to Whittier can significantly increase the time required to purge the Tunnel after a loaded freight train has traveled through the Tunnel from Whittier to Bear Valley. This information is not tracked by the TCC, so the exact number of incidents is unknown.

- **Switch failures (0 times in 2012):** The Tunnel may not be relinquished to the TCC for vehicular traffic without using train-limiting devices to physically prevent trains from entering the Tunnel. In the past, train-limiting devices consisted of standard railroad switches and short lengths of track that diverted trains away from the Tunnel portals. On occasion, excessive ice accumulation kept these switches aligned for trains to use the Tunnel, and vehicle openings were delayed. To remedy this problem, the ARRC installed split-point derails. This new derail system is still operated by a railroad switch, but ice accumulation is less significant since they have fewer moving parts. Additionally, the

derail system was installed such that if ice accumulates, it will impede train passage and allow vehicles to continue using the Tunnel.

5.2 Incidents that Affect Railroad Operations

Automobiles rarely delay trains outside of scheduled vehicle openings, but the following incidents sporadically occur:

- **Vehicle accidents (0 times in 2012):** Since opening in 2000, six car accidents and seventeen motorcycle accidents have taken place inside the Tunnel. One reason that motorcycles have accidents more frequently is that oil from cars can accumulate on the roadway surface and precipitation cannot wash it away. To help alleviate this problem, street-sweepers clean the Tunnel twice per year. Another reason for motorcycle accidents is that the gap between the roadway surface and railroad rails can guide motorcycle tires and cause them to lose control. Motorcycles proceed through the Tunnel after all other traffic because of this. The AAMT is the only place in Alaska where helmets are required for motorcyclists.

- **Cars not turning as they exit the tunnel:** When vehicles first started using the Tunnel, some cars exited from the Tunnel and proceeded to follow the tracks rather than following the roadway as it turns outside of the Tunnel portal. This used to occur frequently (up to 30 times per year), but new signals and signage were installed in 2012. Since then, it has not been a significant problem.

- **Tunnel operators do not accommodate passenger trains that arrive late to Bear Valley (30 Times in 2011 and 1 time in 2012):** To maintain a regular vehicle schedule and reliability of the highway Tunnel schedule, the TCC is reluctant to delay highway openings of the Tunnel when trains miss their scheduled windows. Dispatchers sometimes request extensions to their scheduled arrival times, but, since dispatchers sometimes misjudge train-arrival times, Tunnel operators sometimes cannot delay highway openings when automobiles are waiting in a staging area to accommodate a late-arriving train. Instead, Tunnel operators wait to see whether a train emerges from the Portage Tunnel before delaying a vehicle opening. This problem most commonly occurs

when a daily passenger train is late arriving in Bear Valley for the 11:52 a.m. to noon train opening.

The ARRC has done the following to resolve this situation:

- Installed two systems (CAD and GPS) to help the TCC determine the location of trains as they travel from Anchorage to Whittier.
- ARRC moved the departure time of the daily Whittier passenger trains to leave Anchorage 15 minutes earlier, to more reliably hit the 11:52 train window.
- ARRC continues to foster open communications with the TCC.

Heavy highway traffic delays, passenger trains: Normally, extremely heavy highway traffic does not occur when passenger trains transit the Tunnel, usually on Sunday afternoons. However, on July 6, 2013 (Saturday), which was a cruise-ship day, 192 vehicles transited the Tunnel from Whittier during the 6:00 p.m. opening. This delayed three passenger trains leaving Whittier by 13 minutes, 5 minutes, and 5 minutes, respectively. Figure 24 illustrates impacts to passenger trains due to extremely high highway traffic that day. This is representative of conditions that may occur more frequently if a cruise ship starts coming into Whittier on Sundays. This incident shows the benefits of passenger trains regarding relieving highway traffic congestion through the Tunnel. The two passenger trains serving cruise ships typically have about 400 passengers apiece onboard, removing about 20 buses from peak-hour highway traffic.

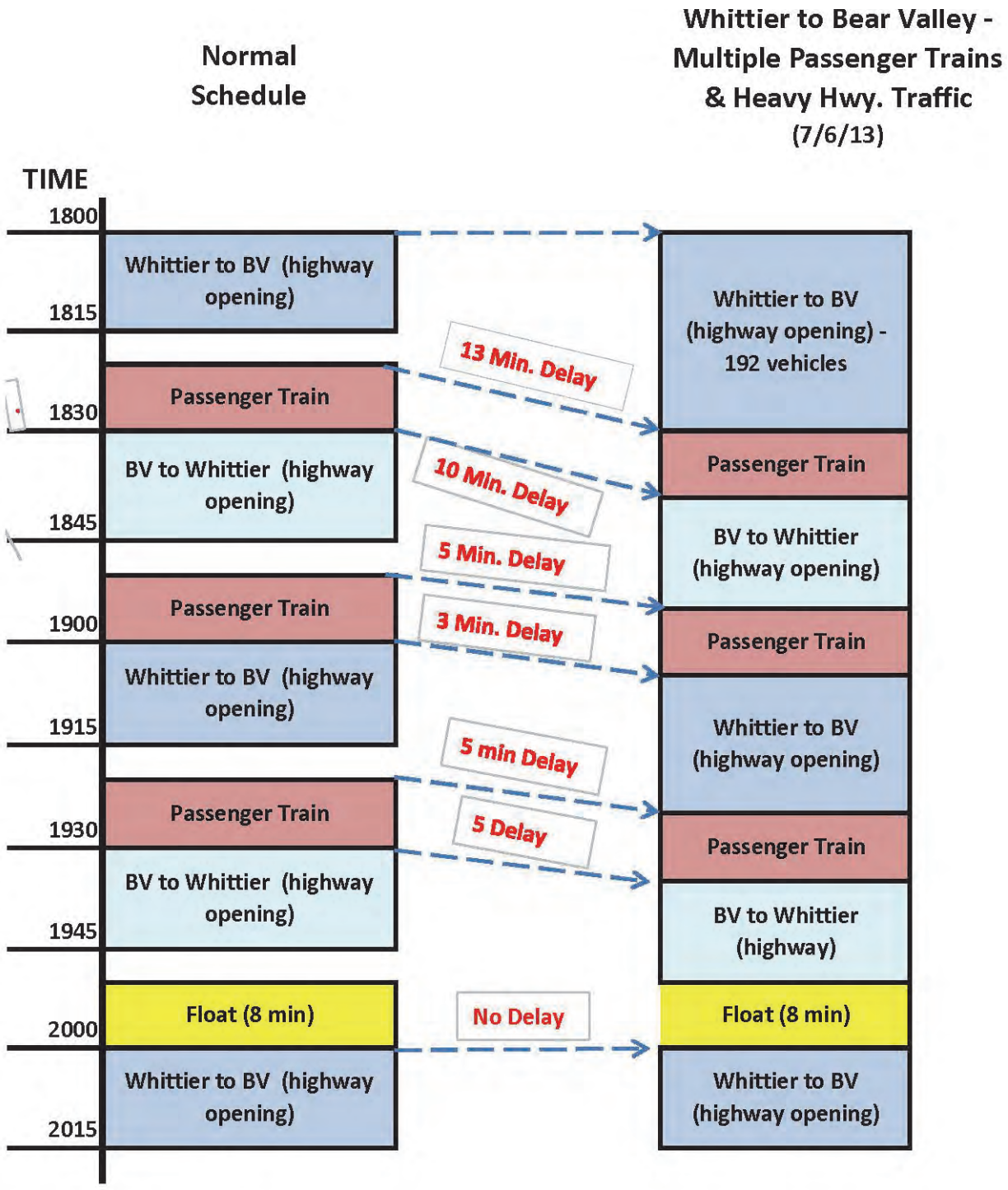


Figure 24: Heavy Highway Traffic Impacts on Passenger Trains (7/6/13)

BV = Bear Valley

6.0 CONCLUSIONS

- Access in and out of Whittier has greatly improved since the Tunnel was converted to a dual-use facility and shuttle trains were discontinued. The conversion to a dual-use Tunnel greatly increased the number of vehicles traveling to Whittier. With the current schedule, highway capacity is now approximately 3,500–4,000 equivalent cars per day. This compares with 240 equivalent cars per day and with people (200,000 annually) who parked their cars at Portage and used the shuttle train prior to construction of the Tunnel. Vehicles can now travel 18 hours per day during the summer and 15.5 hours during the winter.

- There have been six vehicle and seventeen motorcycle accidents in the Tunnel, since it was opened in 2000.

- Although there has been a significant increase in highway traffic, the Tunnel is well below highway capacity when the Tunnel opens to highway traffic on schedule. When highway Tunnel openings are delayed, traffic can quickly accumulate and impact highway operations.

- ARRC has modified its rail operations to accommodate highway use. Some delays regularly occur within freight-train operations, especially in the summer. Passenger-train operations have been modified with no significant delays in 2013. ARRC dispatchers and the Tunnel Control Center regularly communicate to minimize delay impacts to both modes.

- The current Tunnel schedule is the most efficient schedule for handling current and near-future combined highway/railroad traffic demands. Highway vehicles that arrive on-time have been able to transit the Tunnel during a scheduled opening or during the first opening after train passage. However, if a highway opening is delayed, vehicles may accumulate in staging areas that may take 1-2 hours to return to scheduled openings. When a Tunnel opening is delayed, the Tunnel Control Operator, at his or her discretion, may adjust the duration of each highway opening to clear as many vehicles as possible, to reestablish scheduled highway openings.

- Passenger trains and empty freight trains traveling from Bear Valley to Whittier have relatively little impact on the highway Tunnel schedule and highway operations.

Passenger trains generally take only 6-8 minutes to transit the Tunnel. Empty freight trains from Bear Valley to Whittier generally take 10-20 minutes. Passenger trains and empty freight trains from Bear Valley to Whittier generally do not have to be purged of emissions prior to opening for highway traffic. Generally, only one highway opening is delayed by these trains. The delay in the following highway opening is usually less than 5 minutes for passenger trains and 10-15 minutes for empty freight trains.

- Loaded freight trains traveling from Whittier to Bear Valley have a significant impact on highway traffic during the summer months. These trains result in delays of 3 to 4 highway openings. It generally takes 1 to 1.5 hours for the Tunnel to get back on schedule. The time it takes to get back on schedule is dependent on the length of the freight train, the amount of fumes from the engine that have to be purged from the Tunnel, the volume of highway traffic that needs to pass through the Tunnel during each opening, and the time it takes to purge the Tunnel.

- Primary causes of Tunnel problems that impact highway operations that delay highway openings are:

  - Progressive failure of the Track Circuit System (TCS), which delays the transfer of the Tunnel from the ARRC to the Tunnel Control Center. The TCS falsely reports that a train is in the Tunnel, which requires that the Tunnel be shut down for both highway and rail traffic. A DOT&PF-funded research project conducted by Burns Engineering concluded that the wet environment of the Tunnel is the primary cause of the failure of the Track Circuit System. Based on recommendations from Burns Engineering, the DOT&PF has funded a project to replace the current TCS with an axle-counter system

  - Power Outages, which significantly reduce the rate at which vehicles can transit the Tunnel. During a power outage, existing backup generators lack sufficient power to run the jet-fan ventilation system. During these periods, 15-car platoons are escorted by fire truck through the Tunnel. The DOT&PF has funded a project to install emergency backup generators.

  - Isolated occasions when two trains traveling in the opposite direction or more than two trains traveling in the same direction transit the Tunnel during the same railroad window.

- The most feasible ways to improve ARRC operating efficiencies in the port and Tunnel are to:
  - Install a second parallel track from Whittier Creek to the Tunnel, which will allow freight trains to transit the Tunnel to the rail yard in Whittier without impacting the passenger train service.
  - Construct an overpass at the Whittier Street Crossing – This will eliminate the impact that rail operations have on pedestrians and cars traveling from the harbor to South Whittier.
  - Increase the height of the Alaska Railroad Corporation Portage Tunnel to allow double-stacking containers on railcars, which will allow trains with double-stack containers to travel from Whittier to Fairbanks.
- Passenger train operations have accommodated the highway openings by adjusting their departure times and schedules to use one of the two train windows in each hour. When passenger trains have been unable to meet a scheduled window, the ARRC and the TCC are generally able to work out an acceptable resolution.
- The ARRC has worked to delay freight departures from Whittier, to avoid peak highway-use periods. The ARRC incurs delay costs and operating problems because of this. Delay costs vary, with impacts to barge service, ARRC train-crews' duties' timing, and impacts to freight customers' deliveries. ARRC and TCC personnel are satisfied that a workable relationship exists to balance these issues.
- In general, the Tunnel only needs to be purged after a loaded freight train travels from Whittier to Bear Valley and during cruise-ship days, after four passenger trains and 40 to 60 buses have transited the Tunnel. It takes 10 to 25 minutes to purge the Tunnel of CO from these trains and buses. The speed and direction of wind in the Tunnel is the primary factor in how long it takes to purge the Tunnel and reopen to highway traffic. A strong wind (up to 15 mph) blowing from Bear Valley to Whittier significantly increases the

time to purge the Tunnel, since the air needs to be blown back toward Bear Valley, which is the direction of travel for a loaded freight train. This wind is caused by barometric-pressure differential between Whittier and Portage Valley.

- The time it takes to purge the Tunnel is also dependent on the number of jet fans and portal fans that can be turned on. Due to limited availability of economic power, only one portal fan can be turned on. The DOT&PF has requested funding for installation of emergency backup generators. It may be feasible to use backup generators to run more than one fan at a time and to run portal fans more often. This will reduce the time it takes to purge the Tunnel, once new backup generators are installed.
- The time required to clear staging areas and for schedule recovery, from the transit of a freight train from Whittier to Bear Valley, can be reduced by increasing the frequency that vehicles are allowed into the Tunnel without compromising safety.
- A communication system (cell phone/telephone) for the public in Bear Valley will help relieve drivers' frustration during delays in highway openings.

7.0 RECOMMENDATIONS FOR IMPROVING TUNNEL OPERATIONS

To improve Tunnel operations, the following recommendations are made:

1. Reduce the time that vehicles are metered into the Tunnel by allowing Class-A vehicles (cars) to enter the Tunnel without being metered in, at a rate of 1.5 seconds/vehicle, and eliminate the 15-second delay time between opening the traffic lanes (except for a lane with Class-C vehicles: loaded buses) in the staging area.

2. During the winter, reduce the duration of highway openings from 15 minutes to 10 minutes. This increases the duration of train windows from 8 minutes to 13 minutes and would reduce the number of times a Whittier-bound freight train has to stop in Bear Valley.

3. Create operation instructions advising train crews to optimize arrival times at Bear Valley. These instructions can be incorporated into the ARRC timetable, operation rules, or bulletins. These would consist of running recommendations, target stations and times of arrival, and guide tables to allow train crews to adjust train speed to meet the optimum time for Tunnel passage. This would reduce the number of trains that would have to stop for the signal at Bear Valley. For example, to arrive in Bear Valley in time for a 10:52 to 11:00 railroad window, a freight train should pass the Coho siding between 10:43 to 10:51 and the signal at F 8.4 between 10:46 and 10:54. (These times are approximate and should be verified based on actual train operations. These times are based on a track speed of 49 mph between the Coho siding and F 8.4 and 30 mph between F 8.4 and Bear Valley. These times are also based on an instantaneous reduction in speed from 49 mph to 30 mph at F 8.4.)

4. Provide a communication system (cell phone/telephone) for the public in Bear Valley to help relieve drivers' frustration during delays in highway openings.

5. When the new backup emergency generators are installed, they can also be used to economically power the portal fans. This would result in the portal fans being used more often to purge the Tunnel after a loaded freight train has transited the Tunnel.

6. Conduct a follow-up ventilation study to determine the most optimal procedures for operating the ventilation system. This study would determine the most cost-effective and

quickest way to purge the Tunnel of emissions after a loaded freight train has transited the Tunnel. This study would determine:

a. When the portal fans should be used, based on wind-speed and direction

b. How many portal fans should be used

c. In which direction the portal fans should be blown

7. In the winter when cars are platooned (see Section 4.3), trucks could be given priority. When trucks deliver freight to Whittier, they have 30 minutes to enter Whittier, disconnect their trailers, reconnect to new trailers, and return to the Whittier queuing area. Trucks are successful at meeting this timeline approximately 85% of the time in the summer, but only 75% of the time in the winter. By giving trucks priority through the Tunnel in winter, they will have up to 10 additional minutes to drop their trailers and return to the Tunnel, which will improve their ability to meet this timeline.

8. The operators' reports could be improved by:

a. Merging both spreadsheets into one document.

b. Adding columns to record the time to purge the Tunnel of emissions, the direction in which trains are travelling, train types (passenger or freight), the time that the Tunnel is in train mode, and train delay time.

c. Formatting the "Train ETA," "Train Arrival Time," "Request Time," and "Release Time" columns for a 24-hour time period to simplify calculations and spreadsheet analysis. There will be no costs associated with this recommendation.

d. Modifying the database system to import data into spreadsheets for analysis.

e. Installing traffic counters in each lane of the Whittier staging area and tabulating the number of vehicles per class per hour, since vehicles are queued according to their classifications.

f. Improving the accuracy of the Whittier traffic counts. The database is missing significant portions of data for days at a time, leading to significant inaccuracies, when determining average daily traffic levels.

g. Recording the type and direction of travel of each train transiting the Tunnel.

h. Recording the wind speed and direction of the wind in the Tunnel when the loaded freight trains transit the Tunnel.

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APPENDIX A

Highway Traffic

Bear Valley to Whittier Traffic Volumes by Vehicle Classification

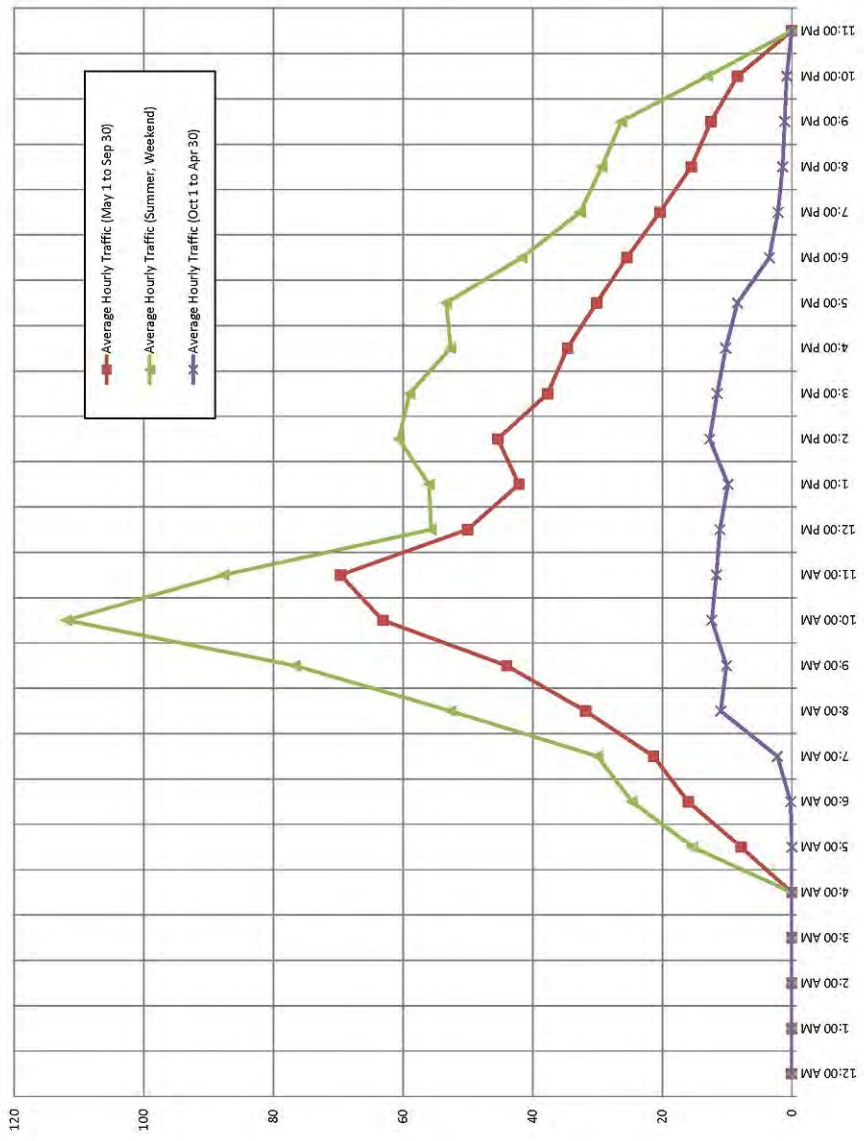
	A	B1	B2	C	D	E	F	G	H	Total	Daily Average
2002	83,203	4,290	3,627	588	2,233	14	151	107	1	94,214	258
2003	86,913	7,309	2,339	428	2,124	29	245	348	1	99,736	273
2004	95,946	8,505	4,752	4,247	2,194	57	557	382	0	116,640	320
2005	100,554	9,268	4,283	3,482	2,699	37	277	419	0	121,019	332
2006	97,932	9,179	4,705	3,783	2,199	35	277	453	0	118,563	325
2007	101,750	10,088	5,249	3,539	2,743	48	218	459	0	124,094	340
2008	94,040	8,366	5,258	3,378	2,776	44	191	409	0	114,462	314
2009	88,801	8,169	5,075	2,839	2,478	41	305	402	0	108,110	296
2010	96,137	9,571	4,705	1,759	3,081	76	580	466	597	116,972	320
2011	95,421	9,092	5,031	1,920	3,094	97	678	497	0	115,830	317
2012	90,704	8,468	5,435	2,312	3,478	95	786	378	0	111,656	306

Total	1,031,401	92,305	50,459	28,275	29,099	573	4,265	4,320	599
%	83.09%	7.44%	4.07%	2.28%	2.34%	0.05%	0.34%	0.35%	0.05%

Whittier to Bear Valley Average Daily Traffic by Hour

	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
2006	9	23	32	52	71	88	106	86	86	98	94	93	93	113	79	54	28	32	10
2007	9	24	30	50	68	91	104	93	83	99	94	90	91	123	83	57	31	34	10
2008	8	21	27	45	64	83	94	88	78	94	91	82	86	108	73	49	24	37	10
2009	12	24	28	46	61	86	94	91	79	100	91	88	90	107	76	54	37	27	8
2010	9	19	24	37	57	75	90	95	81	91	95	88	87	100	86	53	40	26	11
2011	8	16	24	32	52	75	89	86	82	87	95	88	85	93	90	62	43	31	16
2012	9	11	23	28	42	70	86	88	82	87	80	77	76	92	92	55	43	32	20
Overall	9	20	27	41	59	81	95	90	81	94	91	87	87	105	83	55	35	31	12

*Traffic data from the Whittier staging area is not complete; therefore, annual totals are not available. Additionally, no vehicle classifications are available in Whittier.


Average Hourly Traffic (May 1 to Sep 30)
Average Hourly Traffic (Summer, Weekend)
Average Hourly Traffic (Oct 1 to Apr 30)
120
100
80
60
40
20
0
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
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9:00 PM
10:00 PM
11:00 PM

Bear Valley to Whittier Traffic Volumes by Vehicle Classification (Seasonal Traffic)

		A	B1	B2	C	D	E	F	G	H	Seasonal Total	Daily Average	Annual Total
2002	Spring	8,872	0	386	14	239	0	0	0	0	9,511	79	94,214
	Summer	65,527	3,962	2,988	570	1,509	12	101	72	1	74,742	492	
	Fall	8,804	328	253	4	485	2	50	35	0	9,961	108	
2003	Spring	11,944	386	250	6	339	2	179	53	0	13,159	109	99,736
	Summer	66,351	6,528	1,842	419	1,414	24	36	241	1	76,856	506	
	Fall	8,618	395	247	3	371	3	30	54	0	9,721	106	
2004	Spring	11,806	382	311	3	490	11	14	31	0	13,048	108	116,640
	Summer	74,019	7,745	3,756	4,240	1,242	37	429	324	0	91,792	604	
	Fall	10,121	378	685	4	462	9	114	27	0	11,800	128	
2005	Spring	13,690	666	438	3	1,245	8	26	55	0	16,131	133	121,019
	Summer	76,923	8,192	3,534	3,476	1,217	29	202	316	0	93,889	618	
	Fall	9,941	410	311	3	237	0	49	48	0	10,999	120	
2006	Spring	13,529	528	445	7	317	5	53	108	0	14,992	124	118,563
	Summer	74,704	8,235	3,532	3,774	1,483	25	186	273	0	92,212	607	
	Fall	9,699	416	728	2	399	5	38	72	0	11,359	123	
2007	Spring	13,520	608	589	3	496	8	48	116	0	15,388	127	124,094
	Summer	78,525	9,066	4,140	3,535	1,766	31	121	288	0	97,472	641	
	Fall	9,705	414	520	1	481	9	49	55	0	11,234	122	
2008	Spring	12,253	369	675	8	631	8	48	70	0	14,062	116	114,462
	Summer	72,037	7,642	4,136	3,370	1,661	30	110	280	0	89,266	587	
	Fall	9,750	355	447	0	484	6	33	59	0	11,134	121	
2009	Spring	10,852	165	490	0	460	3	40	101	0	12,111	100	108,110
	Summer	67,683	7,613	4,121	2,835	1,558	33	198	231	0	84,272	554	
	Fall	10,266	391	464	4	460	5	67	70	0	11,727	127	
2010	Spring	13,655	591	692	39	576	9	77	125	595	16,359	135	116,972
	Summer	72,602	8,614	3,492	1,720	1,993	59	360	269	2	89,111	586	
	Fall	9,880	366	521	0	512	8	143	72	0	11,502	125	
2011	Spring	14,029	621	690	6	604	26	88	145	0	16,209	134	115,830
	Summer	72,062	8,069	3,750	1,913	1,998	66	467	296	0	88,621	583	
	Fall	9,330	402	591	1	492	5	123	56	0	11,000	120	
2012	Spring	12,551	631	898	26	651	16	171	61	0	15,005	124	111,656
	Summer	68,452	7,504	3,930	2,279	2,314	71	476	260	0	85,286	561	
	Fall	9,701	333	607	7	513	8	139	57	0	11,365	124	

Total	1,031,401	92,305	50,459	28,275	29,099	573	4,265	4,320	599
Summer Total	788,885	83,170	39,221	28,131	18,155	417	2,686	2,850	4
Annual Average	93,764	8,391	4,587	2,570	2,645	52	388	393	54
Annual Summer Average	71,717	7,561	3,566	2,557	1,650	38	244	259	0
Annual Daily Average	257	23	13	7	7	0	1	1	0
Summer Daily Average	472	50	23	17	11	0	2	2	0
Percentage	83.09%	7.44%	4.07%	2.28%	2.34%	0.05%	0.34%	0.35%	0.05%
2012 Percentage	81.24%	7.58%	4.87%	2.07%	3.11%	0.09%	0.70%	0.34%	0.00%

Bear Valley to Whittier Traffic Volumes by Hour (Seasonal Traffic)

		12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
2002	Spring	0	0	0	0	0	0	0	3	657	511	958	795	863	1258	1059	1021	1016	735	355	129	93	58	0	0
	Summer	0	0	0	0	0	0	2152	2775	3776	5455	7987	9906	7311	4994	6344	4836	4510	4022	3374	2658	2117	1577	944	4
	Fall	0	0	0	0	0	0	0	2	1224	860	886	1000	1086	1070	1061	936	882	792	140	22	0	0	0	0
	TOTAL	0	0	0	0	0	0	2152	2780	5657	6826	9831	11701	9260	7322	8464	6793	6408	5549	3869	2809	2210	1635	944	4
2003	Spring	5	5	5	11	5	3	9	1	1439	1044	1158	1431	1532	1443	1386	1305	1203	961	163	27	10	4	6	3
	Summer	2	0	0	0	0	0	2402	2689	3719	5602	8288	11104	7982	4881	6553	4909	4460	3805	3351	2572	2099	1524	908	6
	Fall	0	0	0	0	0	0	0	0	1362	835	878	1020	1002	991	992	902	804	785	125	25	0	0	0	0
	TOTAL	7	5	5	11	5	3	2411	2690	6520	7481	10324	13555	10516	7315	8931	7116	6467	5551	3639	2624	2109	1528	914	9
2004	Spring	0	0	0	0	0	0	0	1	1683	1167	1158	1285	1327	1223	1396	1254	1177	1192	152	33	0	0	0	0
	Summer	28	19	17	22	20	1204	2950	4075	5067	6844	9619	11689	8377	5563	8011	5668	5375	4522	3873	3091	2398	1934	1398	28
	Fall	7	10	8	4	0	0	0	1	1719	1031	1118	1220	1124	771	1590	1093	1080	805	154	30	10	9	7	9
	TOTAL	35	29	25	26	20	1204	2950	4077	8469	9042	11895	14194	10828	7557	10997	8015	7632	6519	4179	3154	2408	1943	1405	37
2005	Spring	0	0	0	0	0	0	0	1	1942	1624	1487	1440	1536	1195	2196	1466	1389	1202	410	243	0	0	0	0
	Summer	0	0	0	0	0	1450	2726	4084	5306	6836	9415	11360	8192	6727	6538	6627	6148	4972	4123	3250	2577	2123	1433	2
	Fall	0	0	0	0	0	0	0	6	1335	980	1093	1089	1043	758	1518	1117	1112	846	102	0	0	0	0	0
	TOTAL	0	0	0	0	0	1450	2726	4091	8583	9440	11995	13889	10771	8680	10252	9210	8649	7020	4635	3493	2577	2123	1433	2
2006	Spring	0	0	0	0	0	0	0	1	1493	1324	1463	1423	1402	999	1851	1624	1551	1272	389	197	3	0	0	0
	Summer	2	3	3	2	0	1392	2583	3626	5302	7015	9711	11436	7792	7100	7296	5805	5402	4704	3953	3338	2358	1954	1411	24
	Fall	0	0	0	0	0	0	0	0	1227	1036	1346	1211	1138	708	1431	1162	1093	888	112	6	1	0	0	0
	TOTAL	2	3	3	2	0	1392	2583	3627	8022	9375	12520	14070	10332	8807	10578	8591	8046	6864	4454	3541	2362	1954	1411	24
2007	Spring	0	0	0	0	0	0	0	26	1352	1440	1811	1501	1403	1127	1840	1559	1545	1210	402	172	0	0	0	0
	Summer	1	0	0	0	0	1607	2570	3597	5706	7295	10632	11996	8188	7334	7428	6377	5881	5133	4377	3219	2563	2129	1429	10
	Fall	0	0	0	0	0	0	0	17	1388	1037	1175	1201	1187	768	1394	1110	962	878	115	1	1	0	0	0
	TOTAL	1	0	0	0	0	1607	2570	3640	8446	9772	13618	14698	10778	9229	10662	9046	8388	7221	4894	3392	2564	2129	1429	10
2008	Spring	0	0	0	0	0	0	0	1	1486	1352	1537	1386	1448	894	1596	1388	1310	1152	335	175	2	0	0	0
	Summer	4	0	0	0	0	1338	2269	3016	5240	6947	9487	10815	7770	6904	7298	5792	5294	4576	3907	3146	2271	1903	1276	13
	Fall	0	0	0	0	0	3	23	382	610	832	1166	932	857	950	961	1149	827	713	480	399	353	283	214	0
	TOTAL	4	0	0	0	0	1341	2292	3399	7336	9131	12190	13133	10075	8748	9855	8329	7431	6441	4722	3720	2626	2186	1490	13
2009	Spring	0	0	0	0	0	0	21	609	674	923	1364	937	889	927	973	1201	963	767	612	404	326	291	230	0
	Summer	0	0	15	0	0	1742	2368	3023	4930	6255	8317	9776	6967	6396	6757	5503	5050	4361	3899	3411	2371	1786	1342	3
	Fall	0	0	0	0	0	0	16	726	581	831	1164	1144	975	938	1040	1155	849	666	433	383	321	296	204	5
	TOTAL	0	0	15	0	0	1742	2405	4358	6185	8009	10845	11857	8831	8261	8770	7859	6862	5794	4944	4198	3018	2373	1776	8
2010	Spring	0	0	0	0	0	3	91	745	953	1234	1594	1675	1295	1354	1475	1573	1220	924	741	535	410	310	224	3
	Summer	0	0	0	0	0	1553	2383	2949	4952	7037	10179	9742	7296	7150	6802	6018	5412	4831	4006	3198	2305	1983	1315	0
	Fall	0	0	0	0	0	0	52	446	860	959	1307	1103	1026	957	989	1009	808	623	422	347	241	203	150	0
	TOTAL	0	0	0	0	0	1556	2526	4140	6765	9230	13080	12520	9617	9461	9266	8600	7440	6378	5169	4080	2956	2496	1689	3
2011	Spring	0	0	0	0	0	0	58	583	990	1356	1684	1460	1526	1373	1387	1458	1115	969	800	529	370	305	246	0
	Summer	2	0	0	0	0	1414	2288	3056	4638	7181	10854	9747	7194	7008	7042	5710	5213	4650	3795	3107	2502	1935	1279	6
	Fall	0	0	0	0	0	0	24	559	789	916	1349	1029	878	926	889	897	726	583	412	329	318	221	155	0
	TOTAL	2	0	0	0	0	1414	2370	4198	6417	9453	13887	12236	9598	9307	9318	8065	7054	6202	5007	3965	3190	2461	1680	6
2012	Spring	2	0	0	0	0	0	117	580	886	1164	1645	1336	1217	1196	1306	1295	1107	854	734	580	460	302	224	0
	Summer	3	0	0	0	0	1428	2070	2806	4585	7147	11085	8904	6627	6348	5826	5766	5178	4784	3898	3079	2432	2032	1285	3
	Fall	0	0	0	0	0	0	32	482	674	867	1195	1291	898	915	995	959	825	582	454	394	348	263	191	0
	TOTAL	5	0	0	0	0	1428	2219	3868	6145	9178	13925	11531	8742	8459	8127	8020	7110	6220	5086	4053	3240	2597	1700	3
Total		112	74	96	78	50	26,274	52,256	78,956	151,433	187,048	258,389	275,067	209,436	178,970	201,976	172,495	156,566	133,969	97,327	75,249	56,310	45,215	30,798	234
Summer Total		42	22	35	24	20	13,128	26,761	35,696	53,221	73,614	105,574	116,475	83,696	70,405	75,895	63,011	57,923	50,360	42,556	34,069	25,993	20,880	14,020	99
Annual Average		10	7	9	7	5	2,389	4,751	7,178	13,767	17,004	23,490	25,006	19,040	16,270	18,361	15,681	14,233	12,179	8,848	6,841	5,119	4,110	2,800	21
Annual Summer Average		4	2	3	2	2	1,193	2,433	3,245	4,838	6,692	9,598	10,589	7,609	6,400	6,900	5,728	5,266	4,578	3,869	3,097	2,363	1,898	1,275	9
Annual Daily Average		0	0	0	0	0	7	13	20	38	47	64	69	52	45	50	43	39	33	24	19	14	11	8	0
Summer Daily Average		0	0	0	0	0	8	16	21	32	44	63	70	50	42	45	38	35	30	25	20	16	12	8	0
Percentage		0.00%	0.00%	0.00%	0.00%	0.00%	1.10%	2.19%	3.31%	6.34%	7.83%	10.82%	11.52%	8.77%	7.49%	8.46%	7.22%	6.56%	5.61%	4.08%	3.15%	2.36%	1.89%	1.29%	0.01%
2012 Percentage		0.00%	0.00%	0.00%	0.00%	0.00%	1.28%	1.99%	3.46%	5.50%	8.22%	12.47%	10.33%	7.83%	7.58%	7.28%	7.18%	6.37%	5.57%	4.56%	3.63%	2.90%	2.33%	1.52%	0.00%

Bear Valley to Whittier Typical Summer Weekend Traffic by Hour

	12:00 AM to 4:59 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
Friday, 8/10/2012	0	11	20	14	40	60	94	82	37	32	54	45	60	62	42	43	44	36	18	0
Saturday, 8/11/2012	0	24	39	54	75	95	137	105	71	90	88	71	65	56	63	30	23	20	11	0
Sunday, 8/12/2012	0	11	15	22	43	75	105	76	59	46	40	61	33	42	20	25	21	23	10	0
Weekend Total	0	46	74	90	158	230	336	263	167	168	182	177	158	160	125	98	88	79	39	0
Daily Average	0	15	25	30	53	77	112	88	56	56	61	59	53	53	42	33	29	26	13	0

APPENDIX B

Freight Train Schedule

Railroad Mode - Cruise Ship Day - Bear Valley to Whittier

RR Windows		Cruise Ship Days	2011									2012									2013				
		Bear Valley to Whittier	25-May	8-Jun	22-Jun	6-Jul	20-Jul	3-Aug	17-Aug	31-Aug	14-Sep	30-May	13-Jun	27-Jun	11-Jul	25-Jul	8-Aug	22-Aug	5-Sep	19-Sep	29-May	12-Jun	26-Jun	10-Jul	24-Jul
4:00 AM to 5:00 AM	Railroad Traffic Only	No (Const)																							
5:00 AM to 5:30 AM	Safety Inspection	No (T1)																		BV-W					
5:52 AM	Cruise Ship Train (Mex) into Whittier (MWSat)	No (Block)(T1)																							
6:22 AM		No (Block)																							
6:52 AM	Cruise Ship Train (Dex) into Whittier (MWSat)	No (Block)																							
7:22 AM	Cruise Ship Train (Mex) out of Whittier (MWSat)	No (Block)																							
7:52 AM		No (Block)																							
8:22 AM	Cruise Ship Train (Dex) out of Whittier (MWSat)	No (Block)																							
8:52 AM		No (Pass)																							
9:22 AM		No (Pass)																							
9:52 AM		Yes																							
10:22 AM		Yes																							
10:52 AM		No (Const)																							
11:22 AM		No (Const)																							
11:52 AM	Passenger Train (Glacier) into Whittier (Daily)	No (Block)																							
12:22 PM		No (Block)																							
12:52 PM	Passenger Train (Glacier) out of Whittier (Daily)	No (Block)																							
1:22 PM		No (Pass)																							
1:52 PM		No (Pass)															BV-W							BV-W	
2:22 PM		Yes																???							
2:52 PM		Yes																							
3:22 PM		Yes																	BV-W						BV-W
3:52 PM		Yes		BV-W			BW-w		BV-W							BV-W									
4:22 PM		No (Const)																							
4:52 PM		No (Const)																							
5:22 PM	Passenger Train (Glacier) into Whittier (Daily)	No (Block)																							
5:52 PM	Cruise Ship Train (Dex) into Whittier (MWSat)	No (Block)																							
6:22 PM	Cruise Ship Train (Mex) into Whittier (MWSat)	No (Block)																							
6:52 PM	Passenger Train (Glacier) out of Whittier (Daily)	No (Block)																							
7:22 PM	Cruise Ship Train (Mex) out of Whittier (MWSat)	No (Block)																							
7:52 PM	Cruise Ship Train (Dex) out of Whittier (MWSat)	No (Block)																							
8:22 PM		No (Pass)																							
8:52 PM		No (Pass)																							
9:22 PM		Yes																							
9:52 PM		Yes																							
10:22 PM		Yes																							
10:52 PM		No (T1)																							
11:22 PM to 1:30 AM	Tunnel Maintenance																								
1:30 AM to 4:00 AM	Railroad Traffic Only																								

Notes: Block = Freight train blocking passenger train track; Pass = Passenger and freight trains traveling to/from Whittier and passing track at Portage; Build = Building freight train; T1 = Operating Agreement; T2 = Heavy Tunnel Traffic;

Railroad Mode Cruise Ship Days - Whittier to Bear Valley

RR Windows		Whittier to Bear Valley	2011									2012									2013				
			25-May	8-Jun	22-Jun	6-Jul	20-Jul	3-Aug	17-Aug	31-Aug	14-Sep	30-May	13-Jun	27-Jun	11-Jul	25-Jul	8-Aug	22-Aug	5-Sep	19-Sep	25-May	12-Jun	26-Jun	10-Jul	24-Jul
4:00 AM to 5:00 AM	Railroad Traffic Only	No (Pass)																							
5:00 AM to 5:30 AM	Safety Inspection	No (Pass)(T1)																							
5:52 AM	Cruise Ship Train (Mex) into Whittier (MWSat)	No (Block)(T1)																							
6:22 AM		No (Block)																							
6:52 AM	Cruise Ship Train (Dex) into Whittier (MWSat)	No (Block)																							
7:22 AM	Cruise Ship Train (Mex) out of Whittier (MWSat)	No (Block)																							
7:52 AM		No (Block)																							
8:22 AM	Cruise Ship Train (Dex) out of Whittier (MWSat)	No (Block)																							
8:52 AM		No (Const)																			W-BV				
9:22 AM		Yes																							
9:52 AM		No (T2)																							
10:22 AM		No(T2)																					W-BV		
10:52 AM		No(Pass)(T2)																							
11:22 AM		No(Pass)(T2)																							
11:52 AM	Passenger Train (Glacier) into Whittier (Daily)	No (Block)(T2)																							
12:22 PM		No (Block)(T2)																							
12:52 PM	Passenger Train (Glacier) out of Whittier (Daily)	No (Block)(T2)																							
1:22 PM		No (Const)																							
1:52 PM		Yes																							
2:22 PM		Yes																							
2:52 PM		Yes																							
3:22 PM		Yes																							
3:52 PM		Yes																							
4:22 PM		No (Pass)(T2)																							
4:52 PM		No (Pass)(T2)																							
5:22 PM	Passenger Train (Glacier) into Whittier (Daily)	No (Block)(T2)																							
5:52 PM	Cruise Ship Train (Dex) into Whittier (MWSat)	No (Block)(T2)																							
6:22 PM	Cruise Ship Train (Mex) into Whittier (MWSat)	No (Block)(T2)																							
6:52 PM	Passenger Train (Glacier) out of Whittier (Daily)	No (Block)(T2)																							
7:22 PM	Cruise Ship Train (Mex) out of Whittier (MWSat)	No (Block)(T2)																							
7:52 PM	Cruise Ship Train (Dex) out of Whittier (MWSat)	No (Block)																							
8:22 PM		No (Const)																							
8:52 PM		Yes																				W-BV			
9:22 PM		Yes							W-BV							W-BV									
9:52 PM		Yes				W-BV																			
10:22 PM		Yes																							W-BV
10:52 PM		No (T1)																							
11:22 PM to 1:30 AM	Tunnel Maintenance																								
1:30 AM to 4:00 AM	Railroad Traffic Only																								

Notes: Block = **Freight train blocking passenger train track;** Pass = **Passenger and freight trains traveling to/from Whittier and passing track at Portage; Const = Building freight train; T1 = Operating Agreement; T2 = Heavy Tunnel Traffic**

Railroad Mode - Non Cruise Day - Bear Valley - Whitier

RR Windows	Highway Traffic in Precedding Opening	Bear Valley to Whittier	2011									2012										2013					
			18-May	1-Jun	15-Jun	29-Jun	13-Jul	27-Jul	10-Aug	24-Aug	7-Sep	23-May	6-Jun	20-Jun	4-Jul	18-Jul	1-Aug	15-Aug	29-Aug	12-Sep	26-Sep	22-May	5-Jun	19-Jun	3-Jul	17-Jul	
4:00 AM to 5:00 AM	Railroad Traffic Only	Yes																									
5:00 AM to 5:30 AM	Safety Inspection	No (T1)																									
5:52 AM		No (T1)																									
6:22 AM		Yes																		BV- W							
6:52 AM		Yes																				BV- W			BV- W		
7:22 AM		Yes						BV- W															BV- W				
7:52 AM		Yes																									
8:22 AM		Yes								BV-W																	
8:52 AM		Yes																									
9:22 AM		Yes			BV- W									BV- W													
9:52 AM		Yes																									
10:22 AM		Yes	BV-W																								
10:52 AM		No (Const)				BV-W						BV- W						BV- W	BV- W								
11:22 AM		No (Const)																									
11:52 AM	Passenger Train into Whittier (Daily)	No (Block)																									
12:22 PM		No (Block)																									
12:52 PM	Passenger Train out of Whittier (Daily)	No (Block)																									
1:22 PM		No (Pass)										BV- W								BV- W							
1:52 PM		No (Pass)															BV- W										
2:22 PM		Yes		BV-W											BV- W												
2:52 PM		Yes																									
3:22 PM		Yes																									
3:52 PM		Yes																									
4:22 PM		No (Const)											BV- W														
4:52 PM		No (Const)																						BV-W			
5:22 PM	Passenger Train into Whittier (Daily)	No (Block)																									
5:52 PM		No (Block)																									
6:22 PM		No (Block)																									
6:52 PM	Passenger Train out of Whittier (Daily)	No (Block)																									
7:22 PM		No (Pass)																									
7:52 PM		No (Pass)																									
8:22 PM		Yes																				BV-W				BV-W	
8:52 PM		Yes														BV- W											
9:22 PM		Yes							BV-W																		
9:52 PM		Yes																									
10:22 PM		Yes																									
10:52 PM		No (T1)																									
11:22 PM to 1:30 AM	Tunnel Maintenance																										
1:30 AM to 4:00 AM	Railroad Traffic Only																										

Notes: 1A = Freight train blocking passenger train track; 1B = Passenger and freight trains traveling to/from Whittier and passing track at Portage; 1C = Building freight train; 2A = Heavy Tunnel Traffic; 2B = Operating Agreement

Railroad Mode - Non Cruise Day - Whittier to Bear Valley

RR Windows		Whittier to Bear Valley	2012 1-Jun	15-Jun	29-Jun	13-Jul	27-Jul	10-Aug	24-Aug	7-Sep	23-May	6-Jun	20-Jun	4-Jul	18-Jul	1-Aug	15-Aug	29-Aug	12-Sep	26-Sep	2013 22-May	5-Jun	19-Jun	3-Jul	17-Jul	
4:00 AM to 5:00 AM	Railroad Traffic Only	Yes																								
5:00 AM to 5:30 AM	Safety Inspection	No (T1)																								
5:52 AM		No (T1)																								
6:22 AM		Yes																								
6:52 AM		Yes																								
7:22 AM		Yes																								
7:52 AM		Yes																								
8:22 AM		Yes																								
8:52 AM		Yes																								
9:22 AM		Yes																								
9:52 AM		No (T2)																								
10:22 AM		No(T2)																								
10:52 AM		No(Pass)(T2)																								
11:22 AM		No(Pass)(T2)																								
11:52 AM	Passenger Train into Whittier (Daily)	No (Block)(T2)																								
12:22 PM		No (Block)(T2)																								
12:52 PM	Passenger Train out of Whittier (Daily)	No (Block)(T2)																								
1:22 PM		No (Const)																						W-BV	W-BV	
1:52 PM		Yes																								
2:22 PM		Yes																								
2:52 PM		Yes											W-BV													
3:22 PM		Yes																								
3:52 PM		Yes																								
4:22 PM		No (Pass)(T2)																								
4:52 PM		No (Pass)(T2)															W-BV									
5:22 PM	Passenger Train into Whittier (Daily)	No (Block)(T2)																								
5:52 PM		No (Block)(T2)																								
6:22 PM		No (Block)(T2)																								
6:52 PM	Passenger Train out of Whittier (Daily)	No (Block)(T2)																								
7:22 PM		No (Const)(T2)																								
7:52 PM		Yes											W-BV	W-BV		W-BV										
8:22 PM		Yes																							W-BV	
8:52 PM		Yes																								
9:22 PM		Yes																								
9:52 PM		Yes																								
10:22 PM		Yes																								
10:52 PM		No (T1)																								
11:22 PM to 1:30 AM	Tunnel Maintenance																									
1:30 AM to 4:00 AM	Railroad Traffic Only																									

Notes: Block = Freight train blocking passenger train track; Pass = Passenger and freight trains traveling to/from Whittier and passing track at Portage; Const = Building freight train; T1 = Operating Agreement; T2 = Heavy Tunnel Traffic;

APPENDIX C

Freight Train Traffic – 2010 to 2012

Whittier to Bear Valley Freight Trains

2011, 2012 & 2013 (May - July)

				All Whittier to BV Trains				Loaded Freight Trains					Hwy. Opening Delay			
Date	Day	Time	Cruise Ship Days	TSS Time (min)	Transit Time (min)	Purge Time (min)	TOTAL (min)	TSS Time (min)	Transit Time (min)	Purge Time (min)	TOTAL (min)	Portal Fans	1st	2nd	3rd	4th
5/5/2011		1535	no	2	10	14	**26**					yes	27	10		
5/12/2011		1850	no	4	10	18	**32**					no	28	12		
5/18/11		1017	no	2	9	15	**26**	2	9	15	**26**	no	14	8		
5/19/11		649	no	3	14	15	**32**					no	18			
6/2/11	Thur	1453	no	3	10	15	**28**					no	23	4		
6/9/11	Thur	2030	no	4	15	15	**34**					no	28	10		
6/10/11	Fri	1902	no	4	20	2	**26**					no	20	4		
6/15/11	Wed	1415	yes	18	22	9	**49**					no	34	20		
6/17/11	Fri	2155	no	3	26	1	**30**					no	25	10		
6/23/11	Thur	2120	no	2	21	5	**28**					no	28	11		
6/24/11	Fri	2155	no	3	26	1	**30**					no	25	10		
6/27/11	Mon	1930	no	3	12	17	**32**					no	25	13		
6/29/11	Wed	1054	yes	1	15	15	**31**					no	25	8		
6/30/11	Thur	1325	no	5	15	10	**30**					no	30	17	5	
7/6/11		2131	yes	2	19	12	**33**	2	19	12	**33**	yes	24	8		
7/14/11	Thur	2000	no	5	20	10	**35**					no	25	7		
7/19/11	Tues	1426	no	2	18	7	**27**					yes	21	5		
7/21/11	Thur	1946	no	7	14	7	**28**					no	14			
7/22/11	Fri	1924	no	2	14	10	**26**					no	20	5		
7/28/11	Thur	1321	no	7	14	10	**31**					no	22	7		
8/11/11	Thur	2122	no	6	39	14	**59**					no	51	32	10	
8/17/11	Wed	2117	yes	11	16	16	**43**	11	16	16	**43**	yes (2)	31	11		
8/18/11	Thur	1355	no	4	12	19	**35**					no	31	29	11	
8/25/11	Thur	1822	no	3	25	6	**34**					no	26	7		
9/1/11	Thur	2147	no	3	24	6	**33**					no	20			
9/10/11	Sat	2120	yes	6	18	12	**36**					no	26			
9/11/11	Sun	620	no	3	11	20	**34**					no	24	3		
9/15/11	Thur	2046	no	6	56	1	**63**					no	43	22		
9/18/11	Sun	1321	no	2	9	22	**33**					yes	24	11		
9/24/11	Sat	1952	no	5	27	1	**33**					no	25	5		
9/25/11	Sun	1625	no	2	14	17	**33**					yes	28	10		
9/26/11	Mon	1324	no	5	14	18	**37**					yes	31	13		
9/28/11	Wed	1523	no	2	32	9	**43**					yes	36	19	2	
9/28/11	Wed	2155	no	3	9	18	**30**					yes	25	3		
5/3/11	Thur	753	no	5	16	14	**35**					no	28	6		
5/3/12	Thur	1821	no	4	15	20	**39**					no	30	10		
5/7/12	Mon	1720	no	3	13	23	**39**					yes	29	10		
5/17/12	Thur	825	no	6	22	12	**40**					no	25	10		
5/17/12	Thur	2154	no	2	16	16	**34**					no	28	8		
5/25/12	Fri	1653	no	3	16	12	**31**					no	23			
5/31/12	Thur	1950	no	1	11	13	**25**					no	15			
6/7/12	Thur	711	no	3	25	25	**53**	3	25	25	**53**	no	42	24	3	10
6/18/12	Mon	1349	yes	3	17	19	**39**					yes	25	13		
6/20/12	Wed	1452	no	5	17	10	**32**	5	17	10	**32**	yes	24	11		
6/20/12	Wed	1752	no	2	10	19	**31**	2	10	19	**31**	yes	24	7		
6/28/12	Thur	1354	no	2	14	15	**31**					no	25	14		
6/28/12	Thur	2147	no	1	16	15	**32**					no	24	4		
7/4/12	Wed	1751	no	6	20	14	**40**	6	20	14	**40**	yes	31	22		
7/9/12	Mon	2151	no	4	11	19	**34**					no	25	12		
7/13/12	Thur	1951	no	4	12	15	**31**					yes	22	4		
7/19/12	Thur	1929	no	3	12	13	**28**					yes	29	10		
7/20/12	Fri	618	no	5	15	15	**35**					no	23	5		
7/25/12	Wed	2121	yes	6	47	8	**61**	6	47	8	**61**	yes	54	50	closed	
7/26/12	Thur	1424	no	4	24	2	**30**					no	24	22	9	
8/1/12	Wed	1949	no	8	16	11	**35**	8	16	11	**35**	yes	25	11		
8/2/12	Thur	820	no	12	12	18	**42**					no	32	18		
8/3/12	Fri	2056	no	2	8	18	**28**					yes	24	8		
8/9/12	thur	854	no	9	21	8	**38**					no	32	21		
8/15/12	wed	1648	yes	3	16	13	**32**	3	16	13	**32**	yes	20	8		
8/16/12	Thur	623	no	4	46	8	**58**					no	51	30	7	
8/25/12	Sat	2138	yes	4	10	27	**41**					yes	49	29	12	
8/30/12	Thur	616	no	3	17	14	**34**					no	20			
8/30/12	Thur	1622	no	4	10	19	**33**					yes	25	6		
9/4/12	Tues	2050	no	3	16	16	**35**					no	28	3		
9/6/12	Thur	750	no	11	18	13	**42**					no	32	14		
9/6/12	Thur	2002	no	3	23	16	**42**					yes	32	12		
9/13/01	Thur	1419	no	3	8	20	**31**					no	20	5		
9/21/12	Fri	1450	no	3	20	11	**34**					yes	25	6		
9/21/12	Fri	1951	no	5	9	25	**39**					yes	60	1		
9/28/12	fri	1153	no	1	7	2	**10**					no	8	5		
5/29/13	Wed	853	yes	3	14	16	**33**	3	14	16	**33**	no	26	23	7	
6/12/13	Wed	2048	yes	5	13	18	**36**	5	13	18	**36**	yes	24	7		
6/19/13	Wed	2340	no	4	16	23	**43**	4	16	23	**43**	yes	Tunnel closed			
6/26/13	Wed	1025	yes	4	11	24	**39**	4	11	24	**39**	no	34	24	9	
7/3/13	Wed	1324	no	5	18	14	**37**	5	18	14	**37**	yes	31	19	4	
7/17/13	Wed	1329	no	0	18	18	**36**	0	18	18	**36**	yes	35	11	4	
7/17/13	Wed	2022	no	1	10	0	**11**					no				
7/24/13	Wed	2224	yes	2	20	14	**36**	2	20	14	**36**	yes	28	6		
				4.1	17.6	13.4	**35.1**	4.2	17.9	15.9	**38.0**		27.7			