Alaska Department of Transportation & Public Facilities

Evaluation of the Train Signal and Rail Systems for the Anton Anderson Memorial Tunnel

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13. ABSTRACT (Maximum 200 words)

The Whittier Access Project was completed in 2000. One phase of the project was to convert the 2.5 mile long Anton Anderson Memorial Tunnel (Whittier Tunnel) into the world's only dual-use highway/railroad tunnel with one way reversible highway traffic. This unique project incorporated many elements that had never been used before in tunnels.

The primary objective of this research project is to identify the problems affecting the train signal and the unique rail systems and drainage. The problems identified during the tunnel evaluation included: 1) progressive failure of the train signal system; 2) subsurface drainage; 3) drainage from the tunnel crown; 4) settlement of invert panels; 5) cracks in the precast concrete panels; 6) possible corrosion of the rail/panel connections, and 7) possible corrosion of the rebar in the invert panels.

This report recommends the development of three CIP projects to extend the performance life of the tunnel: 1) Replace Track Circuit System (TCS) with an axle counter system for train detection in the Whittier Tunnel; 2) Drainage Improvements to install additional water control systems in the tunnel crown and modifications to the existing water control system; and 3) Invert Panel Preservation Project to replace the asphalt in the rail insert.

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SI* (MODERN METRIC) CONVERSION FACTORS

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)

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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
CO .... carbon monoxide
DOT&PF .... State of Alaska Department of Transportation and Public Facilities
FRA .... Federal Railroad Administration
GPS .... Global Positioning System
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

Executive Summary

In June 2000, the State of Alaska Department of Transportation and Public Facilities (DOT/PF) completed construction of the Whittier Access Project. One phase of 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 construction project included construction of the tunnel invert (driving surface that can accommodate both highway vehicles and trains); drainage systems; three different types of ventilation systems; two vehicle staging areas; Tunnel Control Center (TCC); communication systems; portal buildings; train signal system and other safety features.

The primary objective of this research project is to: 1) identify the problems affecting the train signal and rail systems and 2) develop the Scope of Services for an engineering consultant contract to determine the causes of the train signal system failures and develop solutions.

The problems identified during the initial tunnel evaluation included: 1) progressive failure of the train signal system; 2) subsurface drainage; 3) drainage from the tunnel crown; 4) settlement of invert panels; 5) cracks in the precast concrete panels; 6) possible corrosion of the rail/panel connections and 7) possible corrosion of the rebar in the invert panels.

This report recommends the development of three CIP projects to extend the performance life of the tunnel:

1. <u>Replace Track Circuit System (TCS) Project</u> - This project will replace the existing Track Circuit System with an axle counter system for train detection in the Whittier Tunnel. Installation of this system would prevent future shutdowns of the Whittier Tunnel from "false occupancy" failures of the TCS. This project will also perform an as-built survey to determine the location of the key components (telephones, fire alarms, etc.) inside the tunnel and install DOT/PF furnished reflectors in the curb to establish location control for future work in the tunnel. Estimated cost of this project is $600K.

2. <u>Drainage Improvements Project</u> - This project will install additional water control systems in the tunnel crown and modifications to the existing water control system. This work will also include a LIDAR survey to determine where additional rock needs to be removed from the tunnel crown to make enough room for the additional water control systems. This project will reduce the water flowing into the subgrade, reduce panel settlement and retard corrosion of the panel rebar,

rail and rail connections (Pandral® e-clips clips). This project will extend the performance life of the concrete panel driving surface of the Whittier Tunnel and reduce the need for the ARRC to periodically relevel the invert panels. The estimated cost of this project is $2 million.

3. Invert Panel Preservation Project - This project replaces the asphalt in the rail insert that protects the rail and Pandral® e-clips clips from water and reduces corrosion. This project may also include sealing the cracks in the concrete panels which may prevent corrosion of the rebar. This project will extend the performance life of the concrete panel invert, rail, Pandral® e-clips clips and shoulders (metal inserts that hold the Pandral® e-clips clips) Estimated cost of this project is $1 million.

Safety Enhancements and other improvements that should be considered are:

1. Replacement of the eight Pan Tilt Zoom cameras with wide angle dome cameras. This will make it easier for the Tunnel Control Operator to visually scan the tunnel to verify that the tunnel is clear of vehicles prior releasing traffic or transferring the tunnel to ARRC for train passage.
2. Replace existing signs with strobe at each of the safe house turnouts with LED signs that are controlled by the Tunnel Control Operator.
3. Install rail flange way ice control at the portals. This will eliminate the need to use corrosive salt to remove ice from the flange ways.

Another AK DOT/PF research project, *Anton Anderson Memorial Tunnel Operations Study,* which evaluated the tunnel operations, was conducted at the same time as this research project.

1.0 Introduction

In 2000, the AK DOT/PF converted the existing 2.6 mile long Anton Anderson Memorial railroad tunnel (Whittier Tunnel) into the world's only dual use highway/rail with one-way reversible highway traffic. This tunnel provides the first and only highway access to the port community of Whittier – a vital cargo port, recreational harbor and tourist destination on Prince William Sound.

The planning, design and construction of the Whittier Tunnel is one of the most unique projects ever constructed in the world. It was the winner of eight national awards in engineering excellence including the ASCE Outstanding Civil Engineering Achievement for 2001.

The Whittier Tunnel has a design life of 20 years. However, there is no performance history for many of the unique systems incorporated in the tunnel to accurately predict the design life. Since any future reconstruction of the tunnel would have a severe impact to both vehicular and rail traffic to Whittier, it is essential that the performance life of the tunnel systems be extended as long as possible.

Another AK DOT/PF research project, *Anton Anderson Memorial Tunnel Operations Study,* evaluated the tunnel operations.

Figure 1 – Location Map

1.1 Problems

The four problems that affect tunnel performance are:

- Progressive failure of the Train Signal System (TSS). This failure periodically shuts down the tunnel to both highway and railroad operations.
- Settlement of the tunnel invert – rail and driving surface. One area has been re-leveled three times since 2001.
- Drainage from the tunnel crown and sidewalls may contribute to panel settlement and deterioration of the concrete panels in the tunnel invert.
- Distress of the concrete panel inverts. It is not known if cracks in the invert panel occurred during construction or has developed since construction was completed. If these cracks are developing over time, they may be an indicator of more significant long term performance problems. There is also a concern that the rebar in the concrete panels may be corroding which would reduce the performance life.

1.2 Research Objective

The primary objective of this research project is to: 1) identify the problems affecting the train signal and rail systems and 2) develop the Scope of Services for an engineering consultant contract to determine the causes of the failures and develop solutions for improving the train signal and rail systems operations.

The problems identified during the initial tunnel evaluation included: 1) progressive failure of the train signal system; 2) subsurface drainage; 3) drainage from the tunnel crown; 4) settlement of invert panels; 5) cracks in the precast concrete panels; 6) possible deterioration of the rail/panel connections and 7) possible corrosion of the rebar in the invert panels.

During the initial evaluation it became apparent that some of these problems could be solved quicker and more economically if a more thorough analysis and research is done during this initial research stage. This approach saved the cost of retaining a general design consultant and contractor to construct/repair some of these problems. It also permitted quicker implementation of the appropriate corrective action by tunnel management staff, DOT/PF maintenance staff and/or AKRR crews. Another benefit to this approach is that it was more cost effective to retain subject matter experts that require specialized expertise to analyze and design solutions to the specific unique elements of the tunnel.

1.3 Work Plan

1.3.1 Establish Location Control

The location control during construction was metric and went from west to east (Bear Valley to Whittier). The ARRC uses mile post that runs from east to west (Whittier to Bear Valley). ARRC milepost markers are located approximately every .2 mile in the tunnel.

More accurate location control was needed for the Ground Penetrating Radar (GPR) survey, TCS evaluation and field inspections. In October 2012, temporary location control was established. Each invert panel was assigned a unique number based on its location with respect to the telephones. For example, Panel # 512-6 is the sixth invert panel east of the Telephone #512. Telephones are spaced approximately every 300 feet.

Currently, survey lath was used for location control. Eventually, the lath will be destroyed and the temporary location control will be lost. This location control would have to be reestablished prior to any future inspections.

1.3.2 Evaluation of Track Circuit System

Due to their specialized expertise in railroad track circuit systems, *Burns Engineering* was contracted to research the cause and recommend solutions for the progressive train signal system failure.

On October 8, 9 and 10, 2012, *Burns Engineering* performed visual observations on the embedded track system that runs through the Whittier Tunnel. The purpose of the observations was to assess the condition of the embedded track system and to determine if its condition is a contributing factor to the problems that Alaska Railroad (ARRC) is experiencing with the track circuit based signal system. Follow-on research looked at various ways of re-establishing electrical isolation between the rails and ground. Their report and details of the field investigation are included in Appendix A.

1.3.3 Ground Penetrating Radar

An existing DOT/PF (Northern Region) term contract for Ground Penetrating Radar (GPR) with *American Engineering Testing* was modified to include conducting a GPR survey of the Whittier tunnel.

The GPR survey was performed on October 9, 2012. The primary purpose was:

1. Identify areas where voids have developed below the invert panels.
2. Determine the rock profile below the tunnel invert that may affect subsurface drainage

Distance measuring instrument (DMI) was used to determine location calibrated over a one mile interval three times on October 8, 2012. The tunnel invert surveyed was delineated using a 10-panel interval linear pattern (Staking). This linear pattern allowed the GPR data to be consistent with actual measurements. GPR scans in both traveling directions were performed with most of safe houses marked and recorded.

The GPR testing program, conducted for investigation of voids under the panel, consisted of three passes at 1.5-ft spacing over the panel – center of the panel and 1.5 feet left/right of centerline. The test program for determining the bedrock depth consisted of one pass over the CIP portion of the invert (right of the panels – see Figure 5). The scans were performed with 2 GHz and 400 MHz antennas. A scan density of 3 scans per foot was used for all four passes. The GPR system is considered by experts to be a good compromise for visualizing the voids inside and under the concrete panel to depths 18 inches with a resolution of the order of less than ½ inch. The report, test data and details of the methods used appear in Appendix B.

1.3.4 Tunnel Inspection

Field inspections were conducted between Oct. 2012 and July 2013. The scope of the field investigation was:

1. Inspect the sub-drains system
2. Document the location of the cracked panels (Appendix E)
3. Visually identify the location of invert settlement areas (Appendix E)
4. Determine locations of the tunnel crown and sidewalls that need additional drainage control. This included surveying the height of the tunnel crown at selected locations. Since the amount of water and location of drainage from the tunnel crown varies between summer and winter, the tunnel was inspected three times between Oct. 2012 and July 2013. (Appendices D)
5. Photographic survey of the wet areas in the tunnel crown and sidewalls. (Appendix C).
6. Measure voids below the panels to calibrate the GPR survey. (Appendix F & G)

1.3.5 Develop Scope for Capital Improvement Projects

Recommend Capital Improvement Projects that would enhance the performance of the Whittier Tunnel.

2.0 Background

2.1 Original Construction – 1943

During World War II, the United States Army constructed an 11 mile long railroad spur that linked the port of Whittier to the main railroad track that runs between Seward and Anchorage. As a part of this railroad spur, the Whittier Tunnel was completed on April 23, 1943. The tunnel was constructed specifically for railroad use only.

The primary reason for constructing the railroad spur to the port of Whittier during WW II was to facilitate the construction and operations of the military bases in Alaska. The primary benefits of Whittier as a port are:

1. Whittier is an ice free port so it could be used year round. (Anchorage is not an ice free port.)
2. The distance and travel time for cargo ships to travel from the U. S. ports to Whittier is significantly less than to the ports of Seward and Anchorage.
3. It is faster and more cost effective to travel by rail from Whittier to Anchorage than from Seward to Anchorage. Whittier is closer to Anchorage and trains do not have to climb steep grades to cross the Kenai Mountains.
4. Whittier is a deep water port that does not require dredging (Port of Anchorage requires annual dredging).
5. The inclement weather provided protection from bombing from enemy planes and ships could avoid enemy submarines by traveling through Prince William Sound.

2.2 Railroad Shuttle Service – 1960 to 2000

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

The 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 flatcars. Drivers and passengers remained in the vehicles while the train traveled through the tunnel into Whittier.

Figure 2 – Vehicles on Railcars for Entry to Whittier

The shuttle service was offered daily in the summer and three days per week in the week in the winter. Trains made six round trips for each day that service was offered. A single shuttle train could transport the equivalent of 40 cars per trip for a total of 240 cars 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 the vehicle and driver, plus $8 per passenger.

2.3 Tunnel Problems

The Alaska Railroad Corporation (ARRC) experienced a number of challenges with operating the tunnel:

- Frequent icing problems inside the tunnel required extensive labor to chip ice from the rail and tunnel walls prior to train passage.
- The ballast and ties were over 55 years old and had deteriorated to the point that they had to be replaced.
- Rock fall from the tunnel crown and side walls posed a danger to the train and crews. Rock falling from the tunnel crown and sidewalls had to be periodically removed from the track. An ARRC employee would have to inspect the tunnel prior to each train passing through the tunnel.
- Drainage problems caused the ballast to scour beneath the railroad ties.

- Heavy snowfall in Whittier and Bear Valley subjected the tunnel to avalanches that could bury equipment, cause derailments, and close the tunnel (on several occasions, avalanches trapped passengers and employees).
- The portal doors on both ends of the tunnel had to be opened manually. In addition, ice formation at the portals occasionally interfered with the operation of the doors and had to be removed.
- Dimensions of the tunnel are only 14.5 feet wide by 20 feet high, which are not high enough to accommodate double-stacked shipping containers on railcars.

2.4 Whittier Access Project – 2000

The Whittier project included the 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; communication systems; portal buildings; unique Train Signal System (TSS) that is integrated into the Tunnel Control System (TCS) and other safety features.

The primary benefits of this project for vehicle access to Whittier are:

- Increased number of vehicles that can travel into Whittier daily, from 240 equivalent cars (one way) to approximately 3,060 to 3,825 (adjusted per Section 4.2.1) per day.
- Expanded time frame for vehicles to enter/leave Whittier allows people to commute to and from Whittier for work.
- 24-hour access for wheeled vehicles, which improves emergency response; (ambulances made 138 trips out of Whittier in 2012).
- Improved access for supplies, equipment, and personnel to Prince William Sound in case of an oil spill from ships transporting oil from Valdez.

The primary benefits to the railroad operations include:

- Increased vertical clearance to 21 feet permitted hauling double-stacked shipping containers in the future;

- Reduced rock fall from the tunnel crown and side walls due to the installation of ground support systems (rock bolts, shotcrete, and wire mesh placed throughout the 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;
- Rail joints were removed and the rail was welded;
- New portal buildings with new doors that operate by remote control by either the ARRC dispatcher in Anchorage or the tunnel control operator
- New communication systems;
- Addition of a storm drainage and sub-drain systems to control surface and subsurface water;

Figure 3 – Tunnel Invert after Construction

2.5 Tunnel Operations (2000 – Present)

The Whittier Tunnel is operated and maintained by the Alaska Department of Transportation & Public Facilities (AK DOT&PF). The Alaska Railroad (ARRC) provides maintenance of the railroad equipment, rails and circuitry through the tunnel.

The tunnel operates on a schedule that allows for highway traffic to transit the tunnel at half hour intervals – westbound on the hour and eastbound on the half hour. Vehicles waiting to proceed through the tunnel are held at the respective staging area on either side of the tunnel. To release vehicular traffic into the tunnel, the tunnel operator ensures that the tunnel is clear of all highway and rail traffic and proceeds to call for traffic in an eastbound or westbound direction.

Both passenger and freight trains transit the tunnel between highway openings. Most freight trains that pass through the tunnel are scheduled with only a few hours' notice prior to their arrival.

3.0 Tunnel Evaluation

3.1 Track Circuit System

3.1.1 Problem

The Track Circuit System (TCS) detects when a train is in the tunnel and closes the tunnel to both highway and railroad traffic. The TCS is linked to ARRC's Train Signal System (TSS) which controls train movements through the tunnel.

A Track Circuit System (TCS) is "an electrical circuit which uses the track rails as the conductors between the transmitter and receiver devices". A track circuit sends a current along the rails, using the rails as conductors, to a track relay at the end of the block – located near Safe House #4. The track relay attached to the rails is constantly energized by a closed loop circuit unless opened by an open wire, blown fuse, etc., or by the axles of the train which allows the current to cross the rails - shunting the current away from the relay. The track circuit is considered to be "fail safe" because any failure of the circuit will cause the relay to go to its most restrictive state – train present in the tunnel and shuts the tunnel down to both highway and railroad operations.

Over the past few years, the TCS has experienced a progressive failure. When the TCS fails, it indicates that a train occupies the track in the tunnel and the tunnel automatically shuts down to both highway and railroad operations. The most likely cause of the failure is that water in the tunnel shunts the track circuit causing a "false occupancy" failure of the TCS to occur.

In 2012, the TCS has failed 40 times by falsely detecting a train in the tunnel.

- Failure occurs in railroad mode - Five of these TCS failures occurred when the tunnel was in railroad mode. This failure usually occurred when the TCS failed to detect that the train had exited the tunnel and the tunnel could not be switched to highway mode. If the TCS fails when the tunnel is in railroad mode, it may take up to several hours for the Alaska Railroad (ARRC) dispatcher to send a signal crew from Anchorage to override the TCS and reopen the tunnel up to highway traffic. In the meantime, the tunnel was shutdown to both cars and trains.

- Failure occurs in highway mode - Thirty-five of these TCS failures occurred while the tunnel was in highway mode. The tunnel control operator had to coordinate with the ARRC dispatcher to override the TCS system to allow the tunnel to continue operating in the highway mode. This normally only takes a couple of minutes.

3.1.2 Track Circuit Design

The TCS that was originally installed during construction was a very simple and singular system designed to keep rail traffic and highway traffic apart. When a train is in the circuit, the ARRC dispatcher has control of the tunnel and maintains control of the tunnel until the train leaves the block.

The tunnel TCS is divided into two track circuits – from Bear Valley to Safe House #4 and from Safe House #4 to Whittier staging area. Insulated rail joints (IJ) are installed at the end of each circuit.

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

3.1.3 Conclusions

The wet environment in the tunnel is the primary cause of the progressive deterioration of the TCS. TCS systems are not effective in areas with a wet environment. TCS systems currently are not commonly used in "wet" tunnels.

The most effective method to insure that track conditions within the tunnel do not affect the operation of the TSS is to replace the existing TCS system with an axle counter system. The recent implementation of the communication upgrade system provides spare fiber optic cable that can be used for the axle counter system.

3.1.4 Solutions

Replace the TSS with an axle counter system.

3.2 Settlement of Invert Panels

3.2.1 Problem

The tunnel invert and rails have settled in several isolated areas. Non-uniform settlement of the rail – one rail settles more than the adjacent rail – is especially critical for trains. FRA requires that the "cross-level" – difference in elevation between the two rails – shall not exceed 1.75" within 31'. A section of rail with excessive non-uniform settlement will cause the train to sway which may result in possible derailment or rail cars hitting the sides of the tunnel. ARRC inspects the track twice a week to insure that the cross level is within FRA operating criteria.

The areas with the most visual settlement of the rail are:

a. Between panels #521-34 and #521-38. Sand leveling material has pumped up into seven of the nine grout ports inspected. A void of 1" below the invert panel was measured at Panel #521-36.
b. Between panels #524-27 and #524-29. Sand leveling material has pumped up into one of the nine grout ports inspected. Voids of .25" - .5" were measured in 2 of the 9 grout ports inspected.
c. Between panels #532-09 and #534-10. This is the worst settlement area in the tunnel. This section has been re-leveled three times since the tunnel was opened in 2000. The rail had settled approximately 1.5" and was within ¼" of the FRA cross level tolerance before it was re-leveled in Feb 2013. The ground water had pumped the sand/ballast through the joints between the panels. Adjusting the sump pumps at Safe House #3 may have lowered the water table in the subgrade which may reduce further settlement.
d. Between Panels #541-5 and #541-10 - Sand leveling material has pumped up into one of the 18 grout ports inspected. Voids of .3" to 2" were measured in 3 of the 18 grout ports inspected.
e. Between Panels #581-6 and #581-8 - Sand leveling material has pumped up into 6 of the 9 grout ports inspected. Voids of .1" to .5" were measured in the other 3 of the 9 grout ports inspected.
f. Between Panels #586-26 and #586-31 - Sand leveling material has pumped up into 1 of the 18 grout ports inspected. Voids of .1" to 2.3" were measured in 12 of the 18 grout ports inspected.

The GPR survey (Appendix B) identified approximately 10-12 areas of "severe" voids below the panels. The six areas with the most significant visual settlement coincided with 6 of the areas identified with "severe" voids. (Appendix F and K) Void measurements were taken by drilling a ¼" hole thru the grout plugs and measuring the distance between the top of the invert panel and the underlying subgrade. The void measurement data is summarized in Appendix G.

As part of the railroad track maintenance, the AKRR is responsible for re-leveling the invert panels when the cross level exceeds 1.75" within 31' of track. The ARRC uses a pulley system mounted on a portable gantry to lift the rails which in turn lifts the invert panels to the proper level where the panels are flush with the adjacent CIP gutter (Figure 6). Using this process, only three panels can be lifted at one time. Sand or grout is pumped into the grout holes to fill the voids below the panels. This is a very slow and labor intensive process that can only be done during night time closures. It takes a crew of 6-10 people one shift to re-level a 75' to 100' long section of track.

The ARRC has re-leveled the track three times since the tunnel opened – all three times were at the same location (Panels #532-09 to #534-10 – near SH #3).

- For the first re-leveling effort, sand was pumped into the grout holes used to fill the voids below the panels. Within a relatively short period of time, this sand was scoured away and the invert panels settled again.
- For the second re-leveling effort, a sand/cement mix was pumped in to the voids below the panels. Due to excessive water in the ballast, the cement apparently did not set up and the cement/sand mix also scoured and the invert settled in a relatively short period of time.
- For the third re-leveling effort in Feb. 2013, a premixed commercial leveling grout was pumped into the voids below the panels. This third process appears to work since no additional visual settlement of the rail and panels have occurred.

The primary disadvantage of using the gantry/pulley system to raise the panels by lifting the rails is that it is very time consuming to move and setup the gantry system. This significantly limits the length of section of rail and panels that can be re-leveled during a single shift. In addition, some of the Pandral® e-clips clips that attach the rail to the invert panels appear to break while lifting the rail.

An alternative re-leveling process that did not use the gantry/pulley system was also tested during the third re-leveling effort. A high pressure grout pump was used to pump the grout through the grout holes into the underlying voids. This process raised the panels to be level with the adjacent gutter pans. One concern with this method is there is less control over lifting the panel to the proper elevation to match the adjacent gutter. Another concern is that grout under pressure may migrate and plug up the adjacent sub-drains.

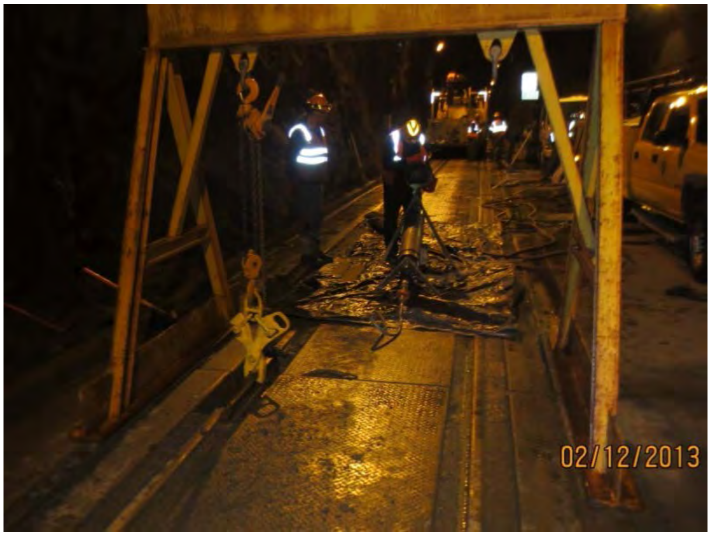


Figure 4 – Pulley/Gantry System Used for Re-leveling Panel Invert

3.2.2 Subgrade Typical Section

The subgrade below the concrete invert panels consists of (Figure 5):

- 2" of un-compacted sand that is primarily a leveling course
- 6" of granular base material compacted to 95% density
- Separation Geotextile
- Granular aggregate base or suitable exiting ballast compacted to 95% density

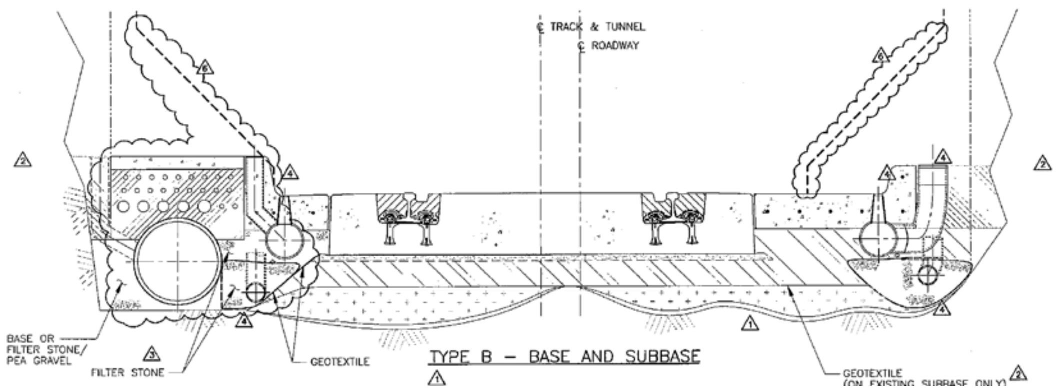


Figure 5 – Subgrade Typical Section

3.3 Subsurface Drainage

3.3.1 Problem

Poor subgrade drainage may be a significant contributing factor in panel settlement at some of the locations. If water saturates the subgrade, the un-compacted sand can erode and "pump" through the joints between invert panels. This creates voids below the invert panels which results in settlement of the invert panels and rail.

The sump pumps were not adjusted properly to pump all of the water from each sub-drain run into the storm drain. As a result, a majority of the groundwater from the Bear Valley end of the tunnel was draining to Whittier thru the sub-drain system and not in the storm drain. The water draining from the sub-drain system saturated the ballast beneath the panels. This was probably a significant contributing factor for the panel/rail settlement at Panels #532-09 to #534-10 (Safe House #3).

The sub-drain system has not been cleaned out since it was installed in 2000. The caps to the cleanouts cannot be removed to clean out the sub-drain system.

3.3.2 Subdrain Design

The subsurface drainage system consists of two 4" perforated pipes located at the bottom of the excavation below the curbs. The perforated pipe is surrounded by filter stone and filter fabric (Figure 6).

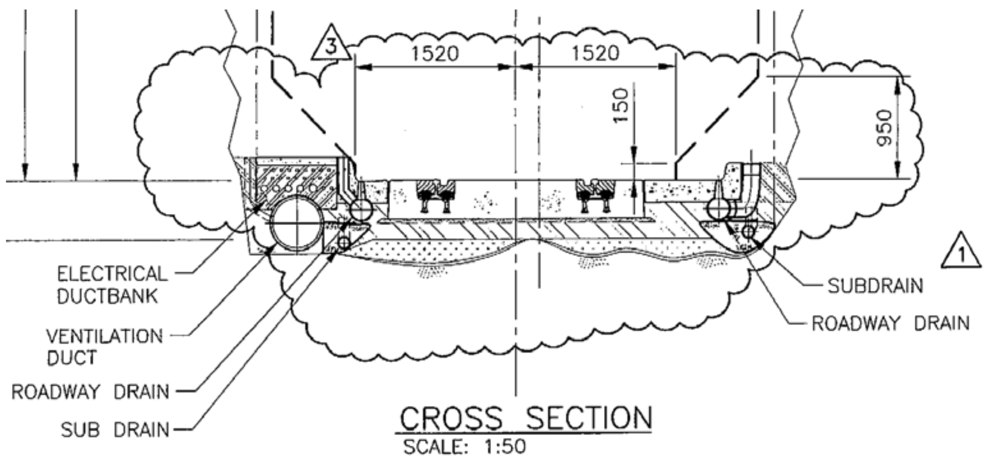


Figure 6 – Subdrain Typical

The tunnel invert and drain systems are sloped from Bear Valley to Whittier (west to east) at a .5% grade. Consequently, all water collected within the tunnel is discharged to a drainage ditch east of the Whittier Portal. Runoff from the roadway is prevented from entering the tunnel at the Bear Valley portal by a transverse slot drain.

Figure 7 – Sump Pump

Approximately every 1300 feet, adjacent to each safe house, the water drains into a sump where it is pumped into the adjacent roadway storm drain. Sub-drain cleanouts are located approximately every 300'. However, the sub-drain cleanout caps cannot be removed to permit inspection or cleaning of the sub-drain system.

3.3.3 Conclusions

The sump pumps were not adjusted properly to pump all of the water from each of the 1200' to 1400' long sub-drain pipes into the storm drain. As a result, a majority of the groundwater from the Bear Valley portal was draining to Whittier thru the sub-drain system and not in the storm drain. When the sub-drain fills with water, the water drains into the subgrade instead of removing water from the subgrade.

The water flow measured of the storm drains measured at each of the sumps. (Appendix E) was less than .1 cfs. There was no significant increase in the quantity of water flowing through the storm drain system from Bear Valley to Whittier. Further evaluation will be required if the storm drain leaks.

Slot drains for the storm drain system are spaced approximately every 300' (100' spacing near the portals). Many of these slot drains are not needed and allow a significant amount of sand into the storm drain. Therefore, the water is not flowing smoothly and efficiently through the storm drain system which may cause water to back up and leak through the pipe joints into the subgrade.

3.3.4 Solutions

1. Adjust the sub-drain sump pumps to insure that water is properly pumped from each sump to the storm drain system.
2. Clean storm drain system to allow the water to flow more efficiently through the storm drain system and possibly reduce the amount of water leaking from the storm drain pipes.
3. Replace the cleanout pipes with caps that can be easily removed.
4. Clean sub-drain system.
5. Additional analysis is needed to determine how much water is leaking from the storm drain system and if it affects panel settlement.
6. Televise storm drains and sub-drain systems, where appropriate, to identify blockages or broken pipe. Total length of both storm drain and sub-drain pipes is approximately 52,000 feet. There are approximately 180 approximately three hundred foot long sections of sub-drain/storm drain pipes.
7. Place filter geotextile in the slot drains to reduce the amount of road sand and debris from entering the storm drain system.

3.4 Drainage in Crown

3.4.1 Problem

There is a significant amount of water draining from the tunnel crown and sidewalls which accelerates the wear of the concrete panel surface and saturates the underlying ballast. This may be a factor in panel/rail settlement.

Figure 8 – Water Draining from Tunnel Crown

3.4.2 Water Control Design

Eighty five water pans (Figure 9) – approximately 340 lineal feet - were installed in some of the wet areas to divert the water from dripping on to the invert surface. The water pans were added to the contract by Change Order. The unit price for each water pan section - 46” X 100” as shown in Appendix I - was $3,100 or approximately $775 per lineal foot.

In some areas, the water drips from the edge of the pan on to the tunnel walls and splashes on to the panel surface. The water from these areas can be controlled by installing a gutter with drain pipe to the existing pans which will drain the water to the storm drain system.

The amount of water and location of the water seeping from the tunnel crown and sidewalls varies from season to season. There is significantly more water that drains from the tunnel crown and side walls during the summer – especially after periods of heavy rain.

Based on three inspection surveys (Appendix D & E) conducted in December 2012, May 2013 and July 2013, approximately 2,300 lineal feet of the tunnel crown/sidewall leaks water on to the invert. There was significantly less water dripping from the tunnel crown in December than there was in May and July. All of the tunnel crown and sidewall drainage areas identified during the December '12 and May '13 surveys were photographed. (Appendix C)

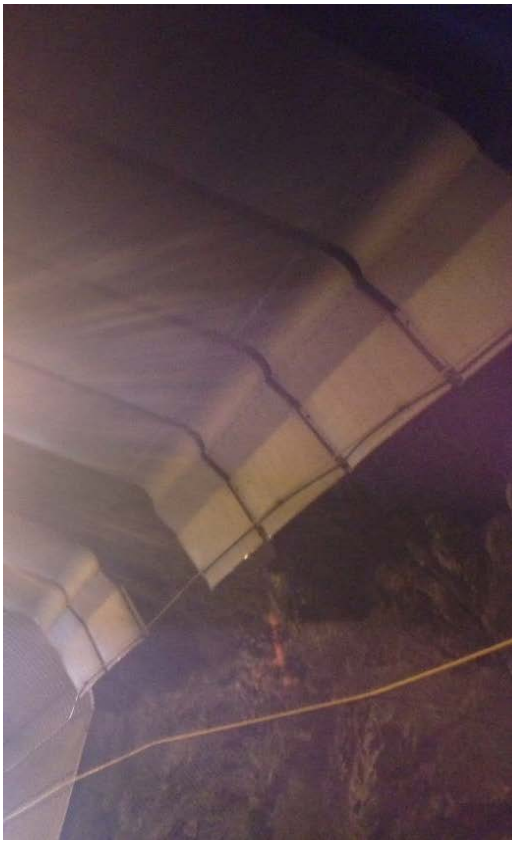
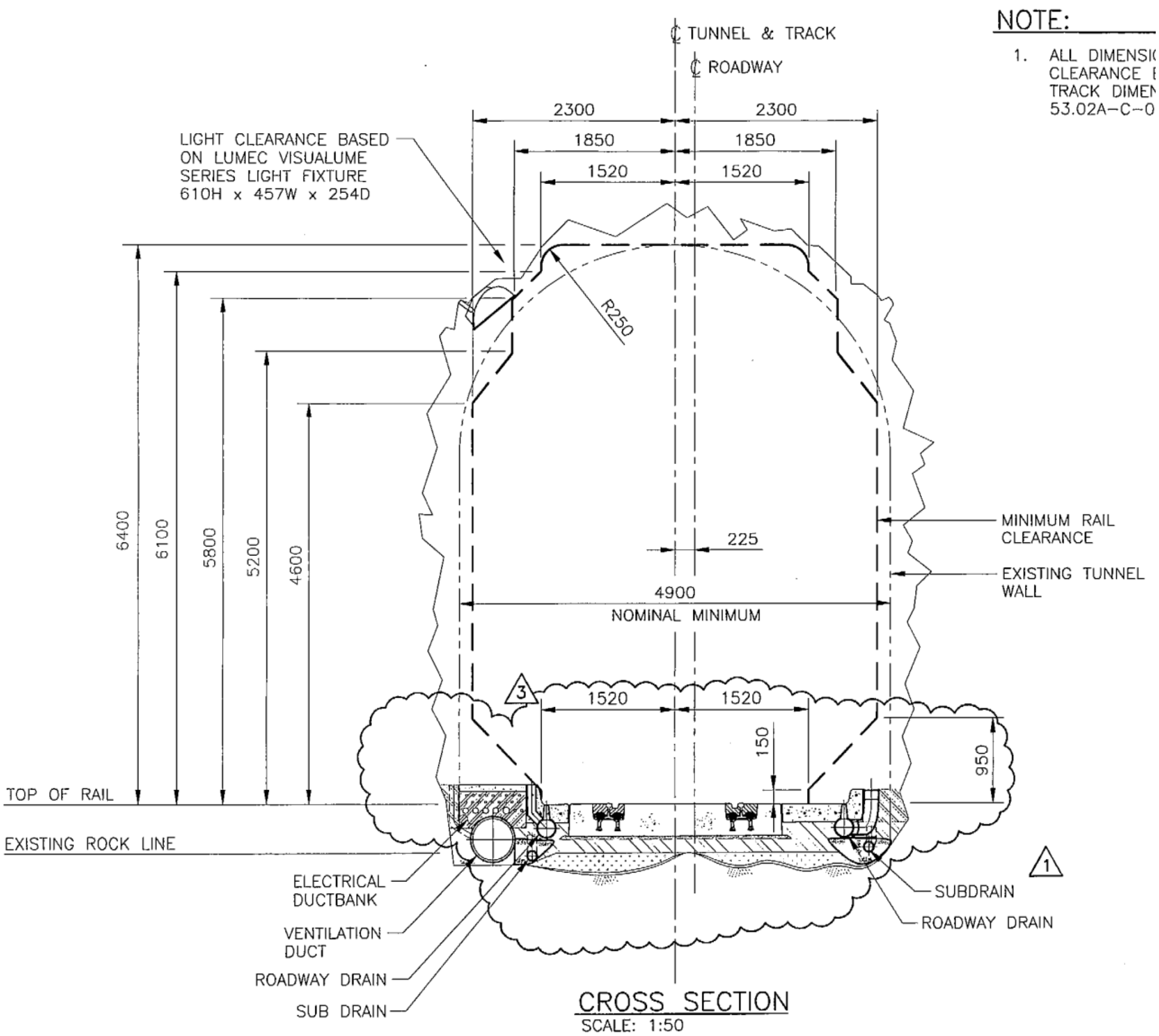


Figure 9 – Water Control System

Any future water control systems have to be at least 21' above the tunnel invert to accommodate future double stacking trains (Figure 10). The height of the tunnel crown above the tunnel invert in the wet areas needing additional water panning was generally 21' to 23' above the invert (Appendix D). A more thorough survey needs to be conducted to verify that there is sufficient room for the new water control systems.

Figure 10 – Tunnel Cross Section

Figure 10 - Tunnel Cross Section



The AKRR intends to raise the crown of the nearby Portage Tunnel to permit double stack trains to travel from Whittier to Anchorage. This project may require the same expertise in rock excavation. It may be possible to add this design and possibly construction work to the AKRR work on the Portage Tunnel. The approximate cost is $1 million to $2 million depending on how much rock has to be removed from the tunnel crown to accommodate the water control systems.

3.4.3 Solutions

1. Installation of approximately 2,300 lineal feet of water control (pans) will significantly reduce the amount of water draining on to the invert panels and into the subgrade. The water control system should also include a gutter and pipe system that collects the water from the pans and drains it directly into the storm drain system. The location of the areas that need the water control systems is listed in Appendix D.
2. Installation of gutter and pipe system to the existing 340 lineal feet of water control systems (pans) will significantly reduce the amount of water draining on to the tunnel invert.

3.5 Distress in Concrete Invert Panel

3.5.1 Problem

Approximately 15% of the panels are cracked. Most of the cracks are approximately 2 mm wide. It is not known if these cracks occurred during fabrication, installation or after installation. It is not known if these cracks are an indicator of some distress occurring to the tunnel invert or if they allow water migrate and corrode the rebar. There does not appear to be a noticeable pattern or correlation to the cracked panels with areas with visual settlement of rails and panels.

There are no visual indications on the panel surface of any rebar corrosion. However, the GPR survey identified several areas of “potential separation” which <u>may</u> be indicative of corrosion of the transverse rebar 8 inches below the panel surface.

In some areas, the asphalt between the sides of the rail and the concrete inserts has begun to deteriorate which will allow the rail and Pandral® e-clips to be exposed to water and possible corrosion.

3.5.2 Concrete Invert Panel Design

The tunnel invert consists of approximately 1600 Star Track® concrete modules (panels). Star Track®, a modular pre-cast concrete grade-crossing system produced by Oldcastle Precast, has been used to build embedded track at port facilities and numerous railroad grade crossings.

The Star Track® system used for the Whittier Tunnel is a pre-cast concrete panel that is 8 feet wide (across the track), 7.5 feet long (along the track) and 14 inches thick. The pre-cast panels are cast with two slots for running rails. Three Pandral® e-clips, hooked into shoulders cast into the bottom of the slots, attach each rail to the panel. A 3/16-inch thick continuous polyethylene pad between the base of the rail & concrete panel; and nylon insulators between the Pandral® e-clip and the flange of the rail provide electrical isolation between the rails and concrete panel.

Figure 11 – Cracks in Star Track® Panels

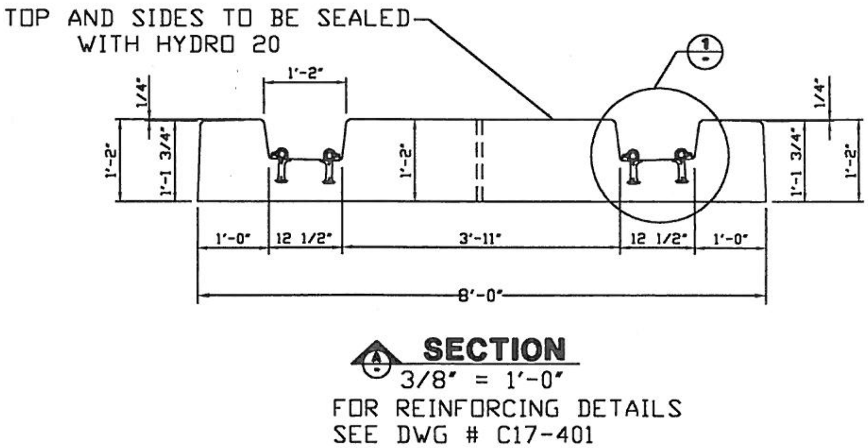


Figure 12 – Cross Section of Star Track® Panel

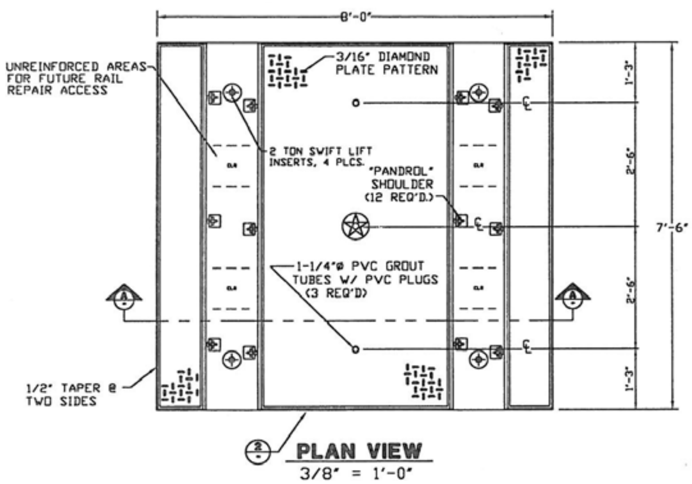


Figure 13 – Plan View of Star Track® Panel

To reduce the exposure to water and minimize corrosion of the rail and Pandral® e-clips clips, asphalt was placed between the side of the rail and the inserts of the concrete panels. At the portals, PPI Rubber Inserts® were used instead of asphalt.

3.5.3 Solutions

1. Determine if the cracks in the panels are continuing to develop and may be indicative of panel stability problems. A crack survey of the panels conducted every 2 years would determine if cracks are continuing to develop in the panels or if the existing cracks were formed during construction or fabrication. The

inspection form in Appendix E can be used to identify any new cracks in the panels that develop.

2. Perform GPR survey with the appropriate antennas necessary to identify areas where longitudinal rebar has corroded. To identify these areas, the GPR subcontractor recommends that either two 2 GHz air-coupled antennas (high speed but less sample rates) or one or two 1.6 GHz ground-coupled antennas (low speed but high sample rates) be used to identify areas of "potential separation". In the middle areas with three levels of bar, only ground coupled antenna might be able to catch the lower bars if the misalignment is greater than 2 inches. The exact same alignment of three level bars will result in the total loss of energy at the top bar. In the middle areas with three levels of bar, only ground coupled antenna might be able to catch the lower bars if the misalignment is greater than 2 inches. The exact same alignment of three level bars will result in the total loss of energy at the top bar.

3. Determine if the anomalies ("area of separation") identified in the GPR survey are caused by corrosion of the rebar with chain survey and coring. The primary benefit of this work will be to determine: 1) if the rebar is corroded; 2) if improved water control of the tunnel crown will minimize future corrosion; and 3) the performance life of the invert panels.

4. Rail Connection with Panels – Investigate the condition of the Pandral® e-clips that connect the rail to the precast concrete panels. AKRR will remove pavement form the panel inserts and expose the Pandral® e-clips for inspection. The primary benefits are: 1) to determine if the Pandral® e-clips are deteriorating due to corrosion; 2) determine if the corrosion of the Pandral® e-clips is associated with the tunnel crown drainage problems; 3) determine if additional water control system in the tunnel crown would extend the performance life of the Pandral® e-clips; and 4) determine if the AKRR needs to plan and budget for possible future replacement of the Pandral® e-clips.

3.6 Safety Enhancements and Other Improvements

3.6.1 Surveillance Cameras

There are 39 stationary surveillance cameras and 8 pan tilt zoom (PTZ) cameras mounted in the tunnel. Prior to transferring the tunnel to the ARRC dispatcher for train transit or opening the tunnel to highway traffic, the Tunnel Control Operator views each camera to verify that all people and vehicles are out of the tunnel.

The PTZ cameras are mounted opposite each of the eight safe houses. There is a small portion of each turnout that is not visible to the Tunnel Control Operator unless they rotate the PTZ camera to view the entire safe house turn outs. Rotating all eight PTZ cameras significantly increases the time to clear the tunnel. Therefore, it is not routine practice for the operator to rotate the eight PTZ cameras prior to clearing the tunnel.

Solution - Replace the eight PTZ cameras with dome cameras that would provide the Tunnel Control Operator to view the entire the safe house turnout without moving cameras. Estimated cost is $40k to $45k. Tunnel staff has expertise to install cameras.

3.6.2 Signs at Safe House Turnouts

Signs with a strobe light at each safe house instructs the motorists to proceed to the safe house when the strobe is flashing. However, motorists are not responding to the signs and strobe.

Solution - Replace the signs and strobe with a LED sign that can be controlled by the Tunnel Control Operator. Estimated cost is $180k to $200k. Tunnel staff has expertise to install the signs.

3.6.3 Flange Way Ice Control –

Ice fills the rail flange ways near the tunnel portals that requires the use of salt.

Solution - Install flange way ice control systems at both portals. The estimated cost is $200k. The tunnel staff does not have the expertise to perform this work.

4.0 Recommendations for Future Projects

The following capital improvement projects are recommended to improve and extend the performance life of the Whittier Tunnel.

4.1 Replace Track Circuit System

This project will replace the TCS with an axle counter system which will prevent future shutdowns of the Whittier Tunnel caused by “false occupancy” failures of the TCS.

The recommended scope of this project is:

- Replace the existing Track Circuit System with an axle counter system for train detection in the Whittier Tunnel. Since the axle counter system will be integrated into the train signal system, this portion of the project can be done by utility agreement with the ARRC. The recent implementation of the communication upgrade system provides spare fiber optic cable that can be used for the axle counter system. The *Evaluation of the Track Circuit System of the Whittier Tunnel* research report prepared by Burns Engineering (Appendix A) estimated the cost to replace the existing TCS with an axle counter system to be $144k. However, the ARRC estimates the cost to be approximately $431k.

- Perform as-built survey to determine the location of the key components (telephones, fire alarms, etc.). The as-built survey work may possibly be added by contract amendment to an existing survey term contract or by DOT/PF crews. The cost of this work is $50k to $60k.
- Install AK DOT/PF furnished reflectors in the curb to establish location control for future work in the tunnel. During the tunnel evaluation phase, temporary location control was established by placing survey lath approximately every 75 feet and assigning each invert panel a unique number based on the location relative to an emergency telephone. This temporary location control will be destroyed over time. The AK DOT/PF tunnel management has already purchased the reflectors but funding is needed for installation. The tunnel management staff can install the reflectors. The primary benefit of this work is that permanent location control is established before the temporary location control is destroyed. The estimated cost of this work is $40k to $50k.

The total cost of this STIP project is approximately $550k - $600k.

4.2 Drainage Improvements Project

This project will reduce the water flowing on to the concrete invert surface and into the subgrade. This will reduce panel settlement, and retard corrosion of the panel rebar, rail and rail connections (Pandral® e-clips clips and shoulders). This project will extend the performance life of the concrete panel driving surface of the Whittier Tunnel.

The recommended scope of this project is:

- Install approximately 2,300 lineal feet of water control in the tunnel crown and sidewalls. Locations are identified in Appendix D. The typical section of water control systems installed during initial construction are in Appendix I.
- Install gutter and piping system to the existing pans (340 lineal feet) installed during construction. The gutter and piping system will collect the water from the pans and drain it to the storm drain system.
- Perform LIDAR survey to determine areas where additional rock needs to be removed from the tunnel crown to make enough room for the additional water

control systems. Preferably, LIDAR survey would be conducted for the entire length of the tunnel. However, if funding is limited, only the areas requiring additional water control systems in Appendix D need to be surveyed.

- Replace the cleanout caps for the sub-drain system
- Install filter geotextile in the slot drains to prevent sand from entering the storm drain system.
- Improve the sump pump systems by increasing the depth of the sumps

The cost of this project is dependent on the amount of rock in the tunnel crown that has to be excavated from the tunnel crown to make enough room for the water control systems. Excavating the rock from the tunnel crown may be extremely expensive. The total cost for this STIP project is approximately $2 million.

4.2 Invert Panel Preservation Project

This project replaces the asphalt in the rail insert. This will retard corrosion and extend the life of the rail, Pandral® e-clips clips and shoulders. If it is determined that the cracks in the panels are allowing water to reach the rebar and cause corrosion, the cracks should be sealed.

The recommended scope of this project is:

- Replace the asphalt surrounding the rail in the rail insert.
- Replace the Pandral® e-clips clips if needed.
- Determine if the rebar in the invert panels is corroding:
    - Perform GPR survey with appropriate antennas to identify areas where corrosion may be occurring in the rebar in the concrete invert panels
    - Conduct chain survey and cores to determine if the rebar is corroding.
- Seal the cracks in panels if it is determined if water is causing the rebar to corrode.

The total cost estimate for this STIP project is $1 million.

Appendix A

Evaluation of Track Circuit Systems of the Whittier Tunnel
Final Report

By
The Burns Group

http://www.dot.state.ak.us/stwddes/research/assets/pdf/fhwa_ak_rd_13_12.pdf

Appendix B

Ground Penetrating Radar(GPR) Testing: Anton Anderson Memorial Tunnel Report

By

American Engineering Testing, Inc.

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
- ENVIRONMENTAL
- GEOTECHNICAL
- MATERIALS
- FORENSICS

REPORT OF GROUND PENETRATING RADAR (GPR) TESTING

Anton Anderson Memorial Tunnel

Whittier, Alaska

AET Project No. 28-00615

Date:

June 20, 2013

Prepared for:

Statewide Materials
Alaska DOT/PF
5800 East Tudor Road
Anchorage, Alaska 99507

www.amengtest.com

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
• ENVIRONMENTAL
• GEOTECHNICAL
• MATERIALS
• FORENSICS

June 20, 2013

Statewide Materials of Alaska DOT/PF
20506 Leprechaun
Chugiak, Alaska 99567
Attn: Tom Moses, P.E.

RE: Ground Penetrating Radar Testing and Analysis
Anton Anderson Memorial Tunnel
Whittier, Alaska
Report No. 28-00615

Dear Mr. Moses:

American Engineering Testing, Inc. (AET) is pleased to present the results of our data collection and analysis for Anton Anderson Memorial Tunnel in Whittier, Alaska. These services were performed according to our proposal to you dated September 13, 2013.

Per your request we are submitting this report to you electronically.

Sincerely,

American Engineering Testing, Inc.

Chunhua Han, Ph.D., P.E.
Principal Engineer, Geotechnical Division
Phone: (651) 603-6631
Fax: (651) 659-1347
chan@amengtest.com

SIGNATURE PAGE

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Principal Engineer, Pavement Division

Reviewed by:

David Van Deusen
Principal Engineer

TABLE OF CONTENTS

1.0 INTRODUCTION

Statewide Materials of Alaska Department of Transportation & Public Facilities (AKDOT/PF) intends to determine the cause(s) of some of the problems with the concrete panel inverts of the Anton Anderson Memorial Tunnel in Whittier, Alaska. AKDOT/PF has requested for project management, quality management, Ground Penetrating Radar (GPR) data acquisition and voids and bedrock depth analysis.

To assist you with investigation, you have authorized American Engineering Testing, Inc. (AET) to conduct Ground Penetrating Radar (GPR) testing, subsurface investigation review, and perform a voids and bedrock depth analysis for the project. With this data and voids measurements provided by AKDOT/PF, the GPR test reports will be provided so that the possible future consultant contractor can evaluate the problems with the concrete panels in the invert. This report presents the results of the above services, and provides our methodology for data collection and analysis.

2.0 SCOPE OF SERVICES

Our authorized scope of services consisted of the following:

1. Coordinate the project activities with the appropriate AKDOT/PF staff and administer the approved QC/QA plan that will assure that data is collected accurately and reflects actual pavement structure condition, within the precision specified. Perform and document regular maintenance, testing, distance and metal calibration of the GPR testing system in accordance with specific manufacturer recommendations.

2. Perform Ground Penetrating Radar (GPR) along approximately 2.6 miles (10.4 lane miles) for the determination of voids under the panel inverts and bedrock depth. Mark

and report the locations of safe houses and distance stacking encountered during data collection that affects the data collection process. Data will be collected with 1.5-foot spacing from the centerline. A scan density of 3 scans per foot is specified for this project and will determine the speed of travel of the vehicle.

3. Review voids measurements provided by the AKDOT/PF for "ground-truthing", develop the methods to relate the measurement locations to the GPR images and analysis results with linear distance and report any adjustments necessary to accurately correlate GPR data with the measurement data.

4. Provide a written report describing the GPR testing equipment and field test plan, summarizing the GPR testing data, and plotting the locations of voids and bedrock depths in stations and panel numbers. We understand pavement rehabilitation design will be completed by AKDOT/PF and does not have to be included with the report.

AKDOT/PF provided voids measurements for inclusion in our data quality check and severity calibration. Although the detailed concrete drilling is necessary to determining existing bedrock depth, the reinforced concrete drilling is too expensive to perform.

These services are intended for geotechnical purposes. The scope is not intended to explore for the presence or extent of environmental contamination.

3.0 PROJECT INFORMATION

The objective of the project is to investigate non-destructively some problems including differential movement of the pre-cast concrete panels in the tunnel invert. One of the keys for developing a better understanding of the problem is to determine if voids have developed below the concrete panels and determine the profile of the rock below the tunnel invert.

This project involves voids detection and bedrock depth data collection using ground penetrating radar (GPR) and the report of pavement thicknesses for assisting in pavement evaluation and rehabilitation design. Figures 1 shows the map of the tunnel we tested and reviewed for this report.

To enhance our understanding of the reinforced concrete panels you provided the as-built invert plan and panel shop drawing, including the typical section, layer thicknesses, and reinforcement layout.

Figure 1 Test Location

To create a surface that would accommodate automobiles and trains, the existing railroad track and underlying crushed rock were removed, and 1,800 pre-formed concrete panels 7.5 feet long and 8 feet wide were placed the length of the tunnel. These panels have a concrete texturized driving surface with grooves for the railroad track that allows trains to use the same surface when automobiles are not using the tunnel. Asphalt was placed adjacent to the rail to allow the removal of the rails for maintenance or replacement. Concrete also was poured adjacent to the panels to provide for an 11.5 foot wide driving surface.

Voids measurements, provided by AKDOT/PF, were performed at approximate 12 locations selected from the review of the GPR data. The approximate locations of the voids measurements on a panel are shown in Figure 2. Voids measurements and locations were provided by AKDOT/PF. Surface elevations at the measurement locations were not provided.

The above stated information represents our understanding of the project. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

4.0 SITE CONDITIONS

4.1 Panel Surface Condition

The observed panel surface condition consisted of a visual review of the panel surface and surrounding topography, by our testing technician, supplemented with a video log to document the major types of surface distress.

The age of the existing steel reinforced panel structures is about 15 years. The surface rating of the existing concrete panel is considered in fair condition under some maintenance. The major panel distress types identified include settlement/waving, seal damages in various severities, and broken rails. Wet surface is also evident in many locations. A few of panels were in poor condition and re-leveled after the field test.

Waves resulted from settlement and heave are surface defects that often result in poor ride quality, and excessive impact loading on panels, and may also make vehicle control difficult. Typical causes are voids under panels, unstable cuts, and base shear failures. This type of defect may not cause any problem at low speeds but would be objectionable or intolerable at high speeds. Corrections to the surface should be made as soon as practical when ride quality is objectionable.

4.2 Panel Base Condition

The subsurface exploration information provided by AKDOT/PF for the project consisted of voids depth measurement and material type identification. Figure 2 shows the typical locations where the measurement was taken. Table A summarizes the results of the voids depth information provided by AKDOT/PF, including the reference stations, distances from the reference station, panel number, voids depth measured at the grout port, and pavement surface condition in the surrounding area.

Table A shows the voids depths ranging from the plugged ("x") to 2.8 inches. This table is useful to identify the voids in the GPR images and to aid in final design for understanding the extensity and severity of the voids under the concrete panel.

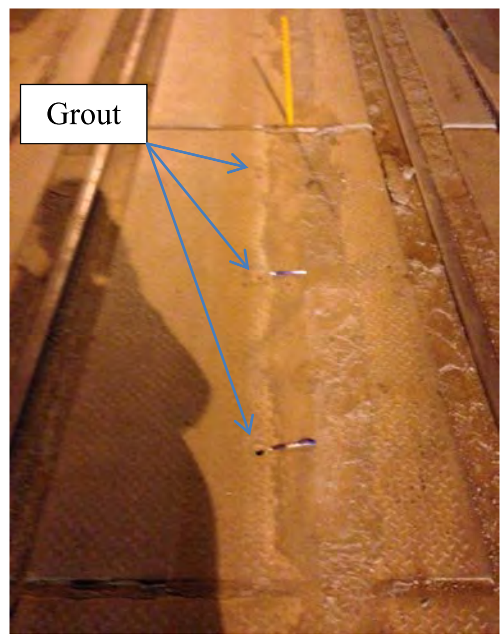

Figure 2 Measurement Locations

The "x" in Table A for the void measurements indicates that the grout plug was either plugged up or that some of the underlying leveling sand had pumped up from the bottom into the lower portion of the grout plug this would indicate that some of the panel settlement had occurred and that there may be voids in other spots below the panels.

Based upon the voids filling types, and voids depth encountered, we differentiated our analysis by defining three distinct levels of voids severity (< 1 inch, 1-2 inches, and >= 2 inches) throughout the whole length of the tunnel invert included in our review, as shown in Plot A of Appendix A.

5.0 PAVEMENT TESTING

5.1 Pavement Data Collection

5.1.1 Testing Program

The GPR testing program, conducted for investigation of voids under the panel, consisted of three passes at 1.5-ft spacing over the panel, Passes 1, 2 and 3, as shown Figure 3. The test program for determining the bedrock depth consisted of one pass (Pass 4) over the roadway concrete pavement, with 2 GHz and 400 MHz antennas. A scan density of 3 scans per foot is specified for all the four passes. The GPR system is considered by experts a good compromise for visualizing the voids inside and under the concrete panel to depths 18 inches with a resolution of the order of less than ½ inch. The test data and details of the methods used appear in Appendix A.

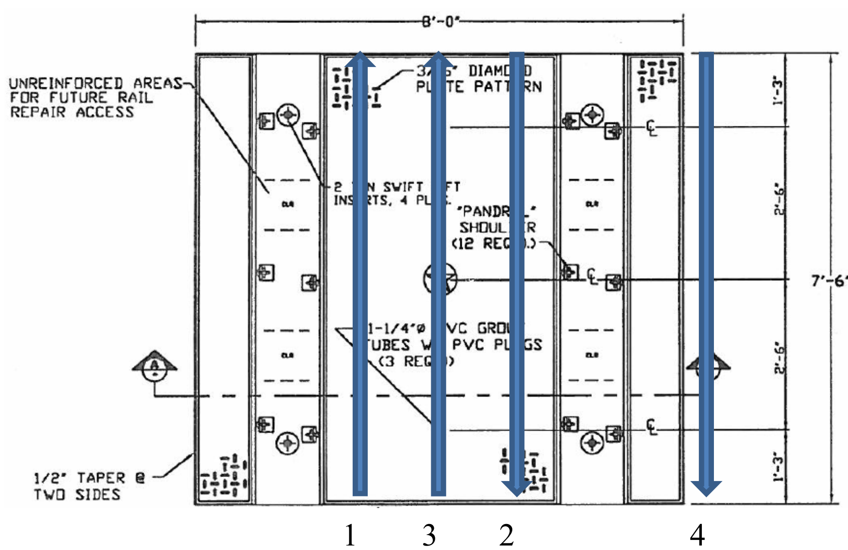

Figure 3 Testing Plan

Both AET 2 GHz air-coupled antenna and 400 MHz ground-coupled antenna were connected to AET dual channel SIR-20 controlled by the DMI mounted on the driver side rear wheel. Two antennas were designated by the channel number. More than 160,000 of GPR test points were processed and analyzed to locate and characterize the voids under the panel with the help of the void measurements.

5.1.2 Field Testing

Ground Penetrating Radar (GPR) testing was performed on October 9, 2012. Distance measuring instrument (DMI) was calibrated carefully over a one mile interval three times on October 8, 2012. The tunnel invert scanned was delineated using a 10-panel interval linear pattern (Staking). This linear pattern would allow for GPR data consistent with actual measurements. GPR scans in both raveling direction was performed with most of safe houses marked and recorded in the mark table.

The antenna mounted at the back of testing vehicle was aligned with the antenna mounted at the front of testing vehicle. The distance between two antennas is 26 feet.

Scans of the tunnel invert were collected according to SIR-20 processor settings established by GSSI Roadscan system, at a specified interval of 3 scans per lineal foot, approximately along the designated pass in the test plan. Metal plate calibration scans with the same survey setting were collected on the same day of testing. The field works were performed by a two-person crew that consisted of a designated driver and a GPR operator. The DMI connected to the SIR-20 provides for automatic display and recording distance information in both English and metric units with a 1 foot (0.3 meters) resolution and four percent accuracy when calibrated using provided procedure in the Field Program.

5.2 Pavement Data Analysis

5.2.1 Analysis Procedures

The method to relate the as-built site plan and layer layout to the GPR images and bedrock depths was developed with the distance measurement instrument based on the review of the plan and layout. A series of data processing tasks was performed prior to picking the voids locations and bedrock depths, including time zero and background noise removal, gain restore, vertical and horizontal FIR filtering, and integration of dual channels.

Voids and bedrock depths were manually picked with the identification of phase inversion and interfaces between different types of materials, which was enhanced using RADAN 6.0, a proprietary software package. A combination of data analysis and engineering judgment was implemented. The summary was completed utilizing an Excel spreadsheet because of huge amount of data. The voids locations and bedrock depths in three dimensions were extracted and calculated from the picks file (depth) and geometrics of surface scan grid (longitudinal and transverse).

The voids within or under the concrete panel change the polarity of GPR images due to change in material electromagnetic properties of concrete and air. The appropriate polarity setting was selected during voids picking process. The negative polarity was selected for air and positive polarity for steel.

5.2.2 Dielectric Constant

The depth of concrete bottom and bedrock top can be determined either by Kirchhoff migration or by coring. Since there was no coring program for comparison testing, the migration method was used for determining the dielectric constant and verified by the panel depth measurement.

Kirchhoff migration is velocity analysis that involves determining the velocity of concrete materials using steel bar within the concrete. Then, the velocity is converted to dielectric constant using the following equation:

$$\varepsilon_r = \frac{c^2}{v^2}$$

Where,
ε_r = the relative dielectric constant;
c = the speed of light or 30 cm/nanosecond (11.8 in/nanosecond);
v = the velocity of the wave through the concrete material.

5.2.3 Data Processing

A phase inversion occurs at a concrete-air interface because of the low dielectric of air. A phase inversion is a flip-flopping of the normal polarity sequence. So instead of a positive/negative/positive (white/black/white) peak, the phase inverted sequence is negative/positive/negative (black/white/black). A concrete-air reflection starts with a negative (black) peak followed by a positive (white) peak while concrete-steel reflection with a positive (white) peak followed by a negative (black) peak.

The Restore Gain function removes the gain applied to the data during acquisition. Restoring gain is an important option should you wish to export your data to a forward modeling program, or determine the dielectric permittivity, conductivity, and dispersion (approximate attenuation) of layers. The Restore Gain function uses gain information found in the file header to remove the gain function and normalize the gains.

5.2.4 Amplitude of Reflection

Amplitude of reflection was recorded for screening the air voids within and underneath the concrete panel. Since the amplitude of reflection at an interface depends on the difference between relative dielectric constants of the two materials (air, sand, aggregate, and concrete), the amplitude of reflection is proportional to the following reflection coefficient:

$$\rho_{12} = \frac{\sqrt{\varepsilon_{r1}} - \sqrt{\varepsilon_{r2}}}{\sqrt{\varepsilon_{r1}} + \sqrt{\varepsilon_{r2}}}$$

Where,

ρ_{12} = reflection coefficient;

ε_{r1} = relative dielectric constant of material 1;

ε_{r2} = relative dielectric constant of material 2.

The relative dielectric constant of non-air materials (concrete) is higher than that of air. The amplitude of reflection at the interface between the non-air materials and air is negative. The amplitude of the reinforcement bar will increase in the presence of delamination due the corrosion. The sign of amplitude was used to set the color for visualization in manual picking of voids. The manual picking of voids was verified by the actual measurements of voids at the same locations.

5.2.7 Data Analysis

From our analysis of GPR data we further defined three ranges of void depths for summarizing the voids under the panel. The mark table built in the analysis software, supplemented by the visual interpretation of the video log, was used to identify the joint location that further guided the data analysis.

The range of void depths and locations in three dimensions were extracted and calculated from the picks file (depth) and geometrics of surface scan grid (longitudinal and transverse). Three ranges of voids were resulted from coring and GPR data: < 1 inch, 1-2 inches, and >= 2 inches.

5.3 Summary

The GPR data we collected did show clear interfaces between subbase and bedrock under the roadway pavement adjacent to the panel. After the processing of the GPR data collected on the panel, the voids under the panel were visible. Voids measurements provided by AKDOT/PF were used to enhance confidence in our data analysis and improve accuracy in voids depth determination. The possible delamination at the reinforcement bar in the middle depth of the panel was noticed and analyzed for their severity and locations.

5.3.1 Voids under Panel

Voids under the concrete panel developed mainly in ten areas, one of which has been re-leveled, as shown in Plot A of Appendix A. Plot A of Appendix A shows the ranges of void depths at their locations identified by stations and panel numbers. The voids with the thickness equal and greater than 2 inches occurred more often along the right rail (17% of voids in all ranges) than that of centerline and left rail (8% of voids in all ranges). The voids with the thickness less than 1 inch were 74%, 79%, and 64% of voids in all ranges, along the left rail, centerline, and right rail, respectively.

5.3.2 Bedrock Depth

Bedrock depth under the 8-inch concrete pavement ranged from 22.8 to 45.4 inches from the top of concrete pavement, as shown in Plot B of Appendix A. Plot B of Appendix A shows the bedrock depth along the roadway pavement identified by stations and panel numbers. The thickness of subbase (from geotextile to the top of bedrock) ranged from 1.6 to 24.2 inches.

5.3.3 Middle Bar Delamination

Delamination at the reinforcement bar in the middle of the concrete panel developed widespread, as shown in Plot C of Appendix A. Plot C of Appendix A shows the severity of delamination at their locations identified by stations and panel numbers. The delamination in high severity was 10%, 17%, and 19% of all three levels of severity, along the left rail, centerline, and right rail, respectively.

6.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, our services have been conducted according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, either expressed or implied, is intended.

It should be noted that the voids under the panels change in shape and type of fillings with time due to the impact of loadings and environments, as well as to the on-going maintenance and repair acitivities.

Important information regarding risk management and proper use of this report is given in Appendix B entitled "Pavement Report Limitations and Guidelines for Use".

Appendix A

Ground Penetrating Radar Field Exploration and Testing

Plot A – Voids under Panel

Plot B – Bedrock Depth

Plot C – Middle Bar Delamination

Appendix A
Ground Penetrating Radar Field Exploration and Testing
Report No. 28-00615

A.1 FIELD EXPLORATION

The geophysical conditions at the site were evaluated nondestructively using Ground Penetrating Radar (GPR). The description of the equipment proceeds in this appendix.

A.2 EQUIPMENT DESCRIPTION

A.2.1 GSSI GPR Test Systems

The GPR test system owned by AET is a GSSI Roadscan System that consists of a bumper-mounted, 400 MHz ground-coupled antenna and a SIR-20 control and data acquisition processor, featuring dual channels. The GPR processor, including a SIR-20 data acquisition system, wheel-mounted DMI (Distance Measuring Instrument), and a tough book with the SIR-20 Field Program constitutes the newest, most sophisticated GSSI Test System, which fulfills or exceeds all requirements to meet ASTM-4748, ASTM D-6087 Standards. Figure A1 provides a view of this equipment.

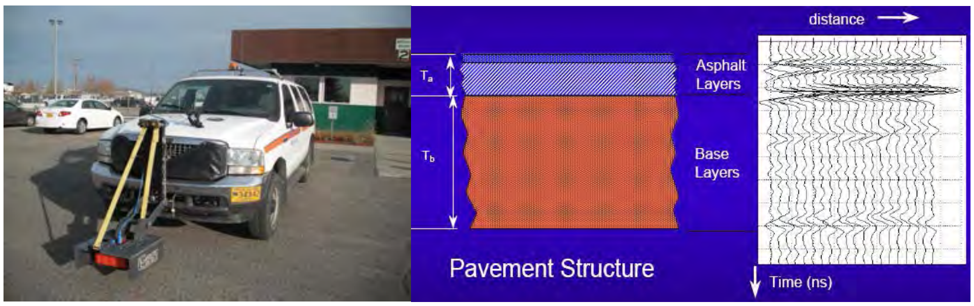

Figure A1 GSSI 400 MHz ground-coupled GPR Test System

The GPR antenna emits a high frequency electromagnetic wave into the material under investigation. The reflected energy caused by changes in the electromagnetic properties within the material is detected by a receiver antenna and recorded for subsequent analysis. The 400 MHz ground-coupled GPR is capable of collecting radar waveforms at more than 100 signals per second, allows for data to be collected at driving speeds along the longitudinal dimension of the geotechnical or bridge decks with the antennas fixed at the rear or in front of the vehicle.

The antenna used for Roadscan is the Horn antenna Model 5103 (400 MHz). The 400 MHz antenna is the current antenna of choice for site survey because it combines excellent resolution with reasonable depth penetration (8-10 feet in geotechnical materials). The data collection is performed at controlled driving speeds (5-10 mph), requiring no lane closures nor causing traffic congestion. At this peed the 400 MHz antenna is capable of collecting data at 4-inch interval (3 scans/foot).

The GPR test system owned by AET also includes a GSSI Roadscan System that consists of a bumper-mounted, 2 GHz air-coupled antenna and a SIR-20 control and data acquisition processor, featuring dual channels. With the dual channel, this antenna is integrated with the same GPR processor for the 400 MHz antenna, which fulfills or exceeds all requirements to meet ASTM-4748, ASTM D-6087 Standards. Figure A2 provides a view of this equipment.

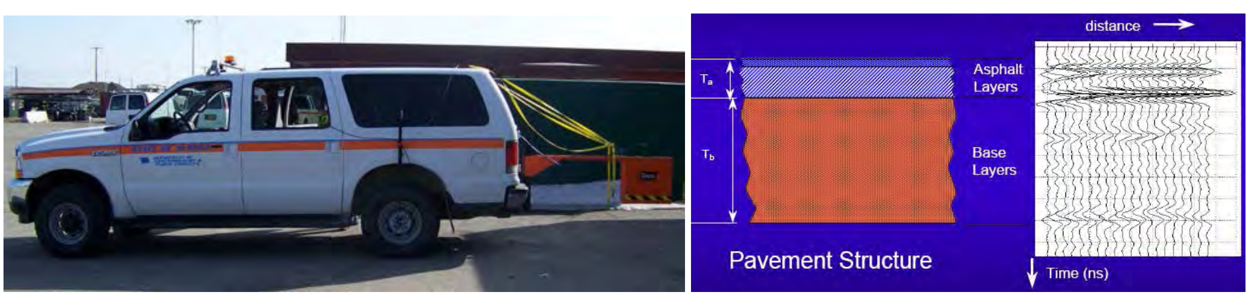

Figure A2 GSSI 2 GHz air-coupled GPR Test System

The 2 GHz air-coupled GPR is capable of collecting radar waveforms at more than 100 signals per second, allows for data to be collected at driving speeds along the longitudinal dimension of the pavements or bridge decks with the antennas fixed at the rear or in front of the vehicle.

The antenna used for Roadscan is the Horn antenna Model 4105 (2 GHz). The 2 GHz antenna is the current antenna of choice for road survey because it combines excellent resolution with reasonable depth penetration (18-24 inches in pavement materials). The data collection is performed at controlled driving speeds (5-10 mph), requiring no lane closures nor causing traffic congestion. At this peed the 2 GHz antenna is capable of collecting data at 4-inch interval (3 scans/foot).

The data were collected at a rate of about 3 vertical scans per foot. Each vertical scan consisted of 512 samples and the record length in time of each scan was 100 nanoseconds. Filters used during acquisition were 75 MHz high pass and 750 MHz low pass.

In a GPR test, the antenna is moved continuously across the test surface and the control unit collects data at a specified distance increment. In this way, the data collection rate is independent of the scan rate. Alternatively, scanning can be performed at a constant rate of time, regardless of the scan distance. Single point scans can be performed as well. Data is reviewed on-screen and in the field to identify reflections and ensure proper data collection parameters.

A.2.2 Ground Truthing

Direct depth measurement is used to get the velocity of the radar energy in the material by measuring concrete panel thickness at the grout port location. The scan obtained with the antenna is compared with the direct measurements in the synchronized stationing system.

Survey wheel is calibrated by laying out a long distance (> 50 feet) with tape measure.

A.2.3 Linear Distance and Spatial Reference System

Distance measuring instrument (DMI) is a trailer mounted two phase encoder system. When DMI is connected to the SIR-20 it provides for automatic display and recording distance information in both English and metric units with a 1 foot (0.3 meters) resolution and four percent accuracy when calibrated using provided procedure in the Field Program.

A.2.4 Camera Monitoring System

A battery operated independent DC-1908E multi-functional digital camera with a SD card is used for logging the geotechnical surface condition in the testing lane.

A.3 SAMPLING METHODS

At the project level, the testing interval is set at 24 scans per foot in the survey line spaced at 4 feet at a survey speed of approximately 5 mph. GPR tests are performed at a constant lateral offset down the survey line by using a guide bar mounted in the front bumper. The guide bar has a chain dragging on the center joint in the driver side.

At the network level, GPR tests on 6 scans per foot are set but only passes spaced at 10 feet are performed, without statistically compromising the quality of the data collected. If GPR tests are for the in situ characterization of material GPR data will be collected in more passes specified.

A.4 QUALITY CONTROL (QC) AND QUALITY ASSURANCE (QA)

Beside the annual system calibration the DMI is also calibrated monthly by driving the vehicle over a known distance to calculate the distance scale factor. The GPR will be monitored in real time in the data collection vehicle to minimize data errors. The GPR units will be identified with a unique number and that number will accompany all data reported from that unit as required in the QC/QA plan.

Scheduled preventive maintenance ensures proper equipment operation and helps identify potential problems that can be corrected to avoid poor quality or missing data that results if the equipment malfunctions while on site. The routine and major maintenance procedures established by the LTPP are adopted and any maintenance has been done at the end of the day after the testing is complete and become part of the routine performed at the end of each test/travel day and on days when no other work is scheduled.

To insure quality data, the GPR assessments only took place on dry geotechnical surfaces, and data is collected in the specified passes.

A.5 DATA ANALYSIS METHODS

A.5.1 Data Editing

Field acquisition is seldom so routine that no errors, omissions or data redundancy occur. Data editing encompasses issues such as data re-organization, data file merging, data header or background information updates, repositioning and inclusion of elevation information with the data.

A.5.2 Basic Processing

Basic data processing addresses some of the fundamental manipulations applied to data to make a more acceptable product for initial interpretation and data evaluation. In most instances this type of processing is already applied in real-time to generate the real-time display. The advantage of post survey processing is that the basic processing can be done more systematically and non-causal operators to remove or enhance certain features can be applied.

The data processing procedure is used to eliminate unwanted noise, detects significant reflections, and records the corresponding time and depth. It uses coring data and/or migration method to calculate the radar signal velocity within the geotechnical.

A.5.3 Advance Processing

Advanced data processing addresses the types of processing which require a certain amount of operator bias to be applied and which will result in data which are significantly different from the raw information which were input to the processing.

A.5.4 Data Interpretation

The EZ Tracker Target Interpretation procedure uses the output from the first step to map structural objects or anomalies and calculate the corresponding locations and depths.

A.6 TEST LIMITATIONS

A.6.1 Test Methods

The data derived through the testing program have been used to develop our opinions about the geophysical conditions at your site. However, because no testing program can reveal totally what is in the subsurface, conditions between test locations and at other times, may differ from conditions described in this report. The testing we conducted identified geophysical conditions only at those points where we measured soil layer thicknesses and observed ground surface conditions. Depending on the sampling methods and sampling frequency, every location may not be tested, and some anomalies which are present in the site may not be noted on the testing results. If conditions encountered during construction differ from those indicated by our testing, it may be necessary to alter our conclusions and recommendations, or to modify construction procedures, and the cost of construction may be affected.

A.6.2 Test Standards

Testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

A.7 SUPPORTING TEST METHODS

A.7.1 Soil Boring/Coring Field Exploration

If soil layer thicknesses, anomaly types, and subgrade soil types and conditions are desired the shallow coring/boring and sampling is used. The limited number of coring/boring is necessary to verify the GPR layer thickness data.

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Appendix B
Geotechnical Report Limitations and Guidelines for Use
Report No. 28-00615

B.1 REFERENCE

This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by ASFE[1], of which, we are a member firm.

B.2 RISK MANAGEMENT INFORMATION

B.2.1 Engineering Services Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. And no one, not even you, should apply the report for any purpose or project except the one originally contemplated.

B.2.2 Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

B.2.3 A Geotechnical Engineering Report Based on a Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typically factors include: the client's goals, objectives, and risk management preferences; road name and termini; current and future traffic loading; the general nature of the geotechnical structure involved, its type, its length, and cross section; geotechnical layer type and thicknesses; and other planned or existing geotechnical improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific geotechnical tested, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed geotechnical, as when it's changed from a minor collector to a major collector, or from a rural to a urban,
- traffic loading or traffic volume, mix, loading factors and growth rates that used to calculate traffic loading
- elevation, depth, location, width, or layer of the proposed geotechnical,
- composition of the design team, or
- project ownership.

As a general rule, always inform your geotechnical engineer of project changes, even minor ones, and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

B.2.4 Geotechnical Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. Do not rely on a geotechnical engineering report whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

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1 ASFE, 8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733: www.asfe.org

B.2.5 Most Geotechnical Findings Are Professional Opinions

Geotechnical testing identified geotechnical conditions only at those points where geotechnical tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data, analyze the data and then apply their professional judgment to render an opinion about geotechnical conditions throughout the section. Actual geotechnical conditions may differ, sometimes significantly, from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

B.2.6 A Report's Recommendations Are Not Final

Do not over rely on the construction recommendations included in your report. Those recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

B.2.7 A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

B.2.8 Do Not Redraw the Engineer's Tables and Plots

Geotechnical engineers prepare final testing and analysis tables and plots based upon their interpretation of field testing and laboratory data. To prevent errors or omissions, the tables and plots included in a geotechnical engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but it is recognized that separating tables and plots from the report can elevate risk.

B.2.9 Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In the letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

B.2.10 Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their report. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

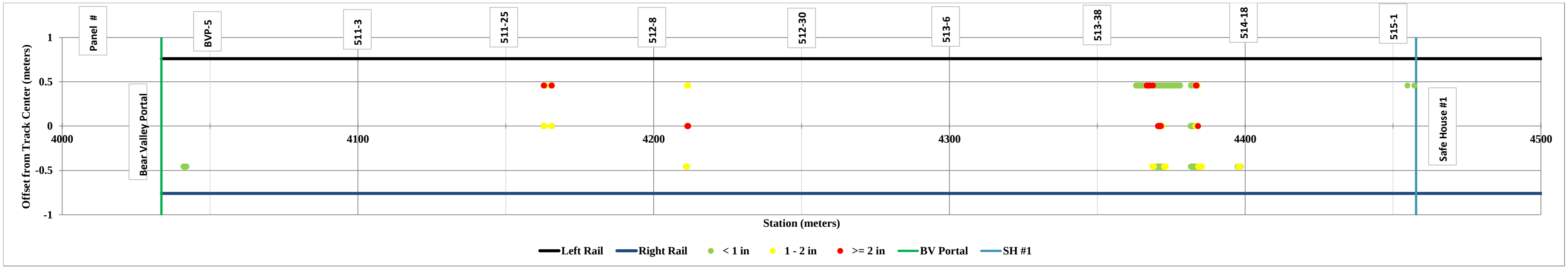
B.2.11 Geoenvironmental Concerns Are Not Covered

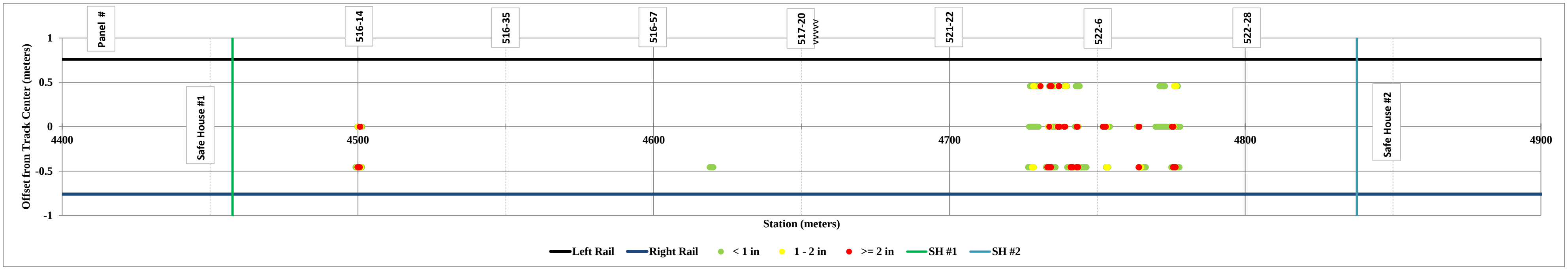
The equipment, techniques, and personnel used to perform a geoenvironmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. Do not rely on an environmental report prepared for someone else.

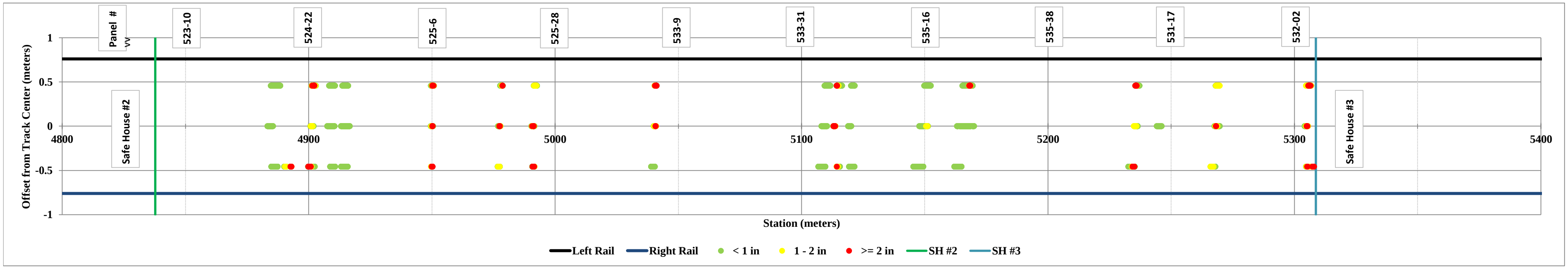
Appendix B1

Voids below Invert Panels

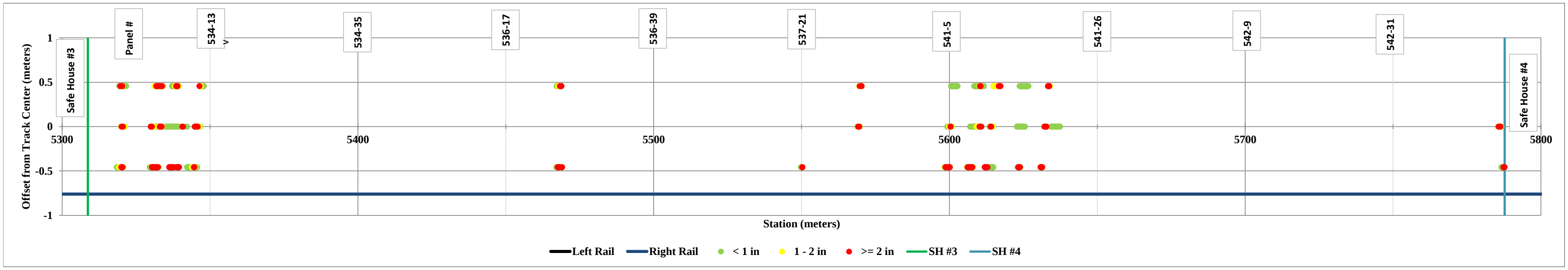
Whittier Tunnel - Voids Below the Invert Panels

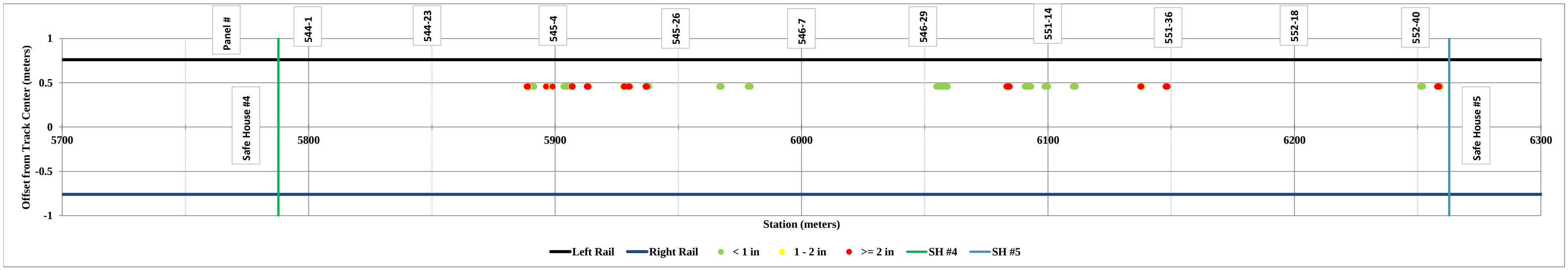


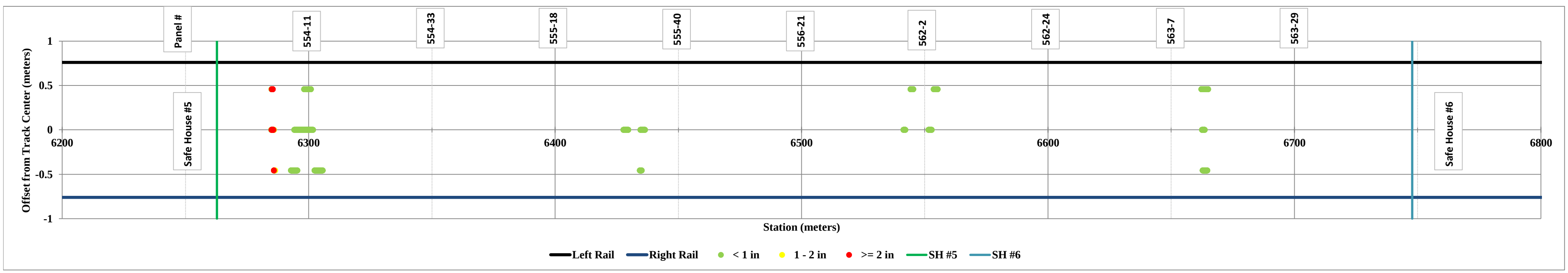




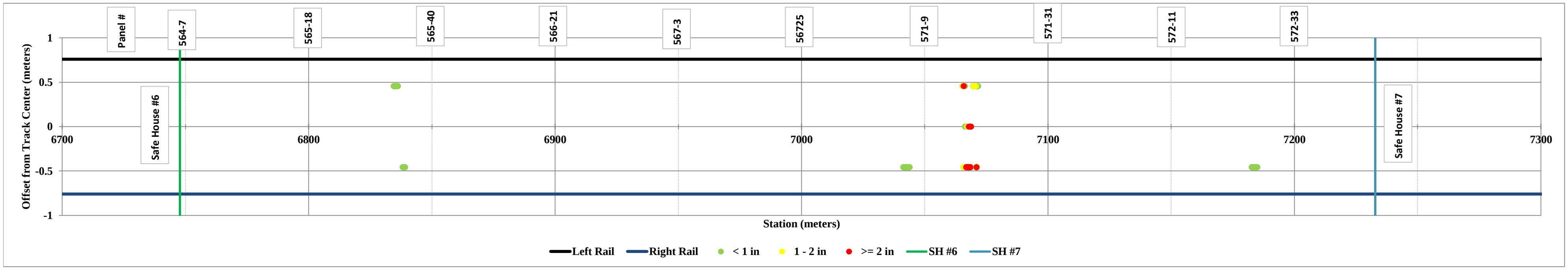
Whittier Tunnel - Voids Below the Invert Panels

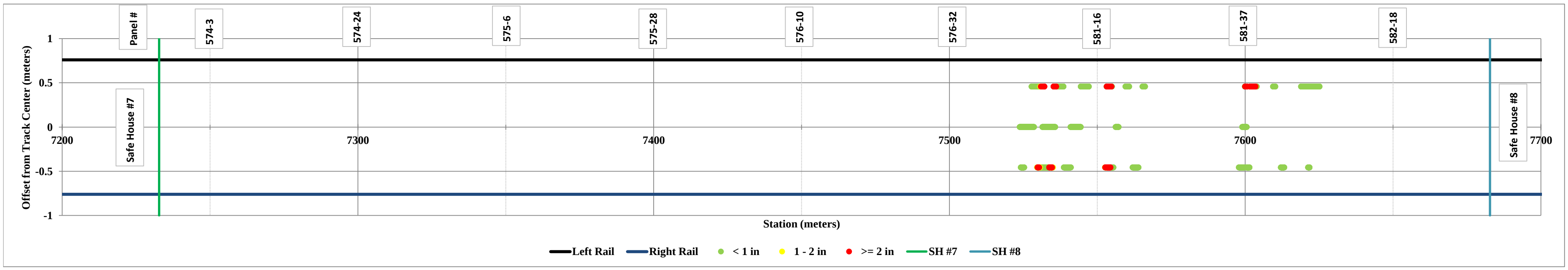


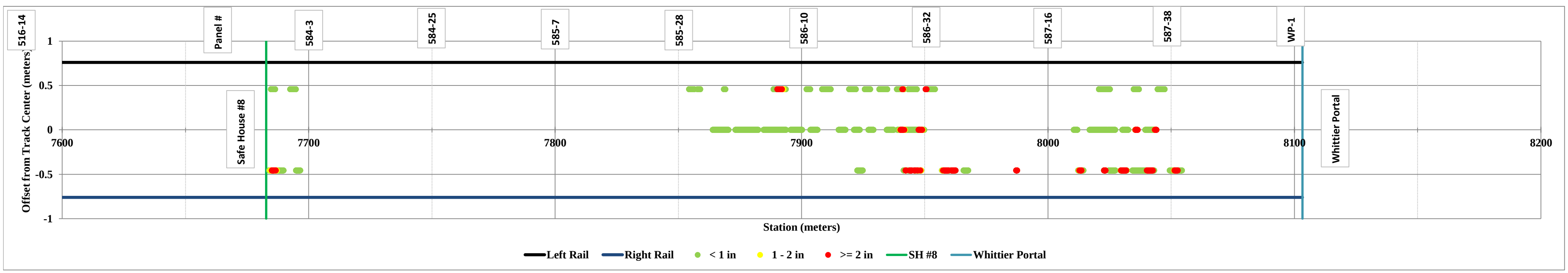




Whittier Tunnel - Voids Below the Invert Panels



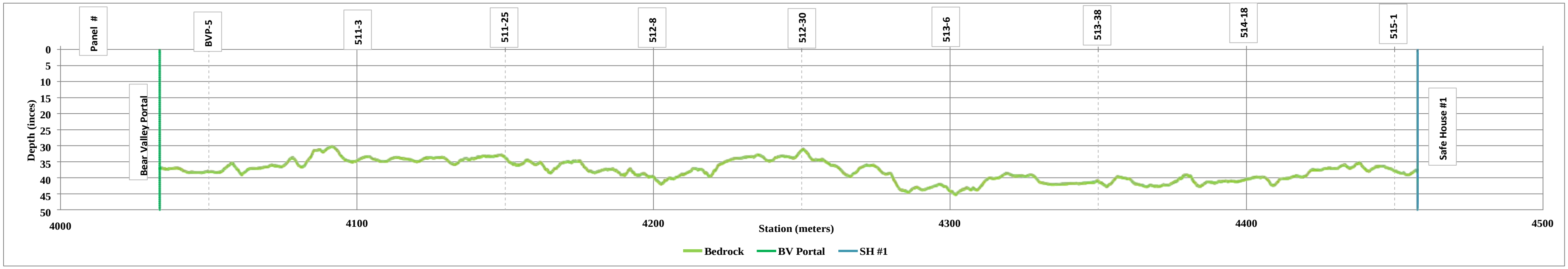


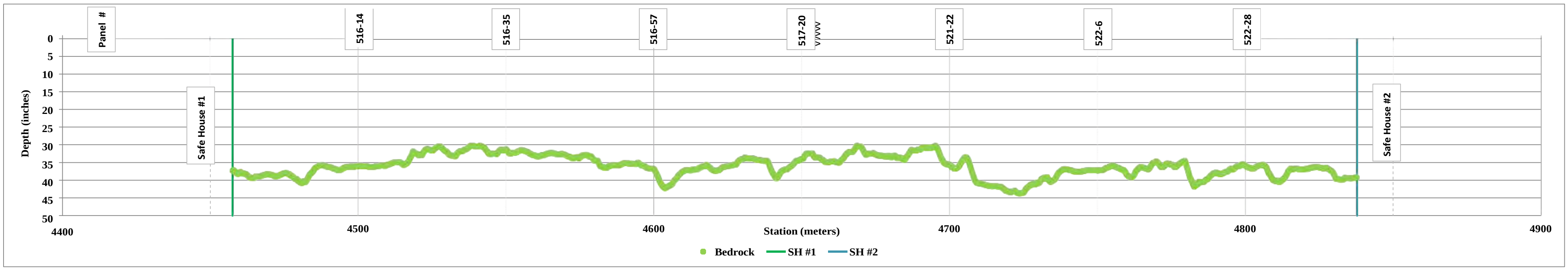


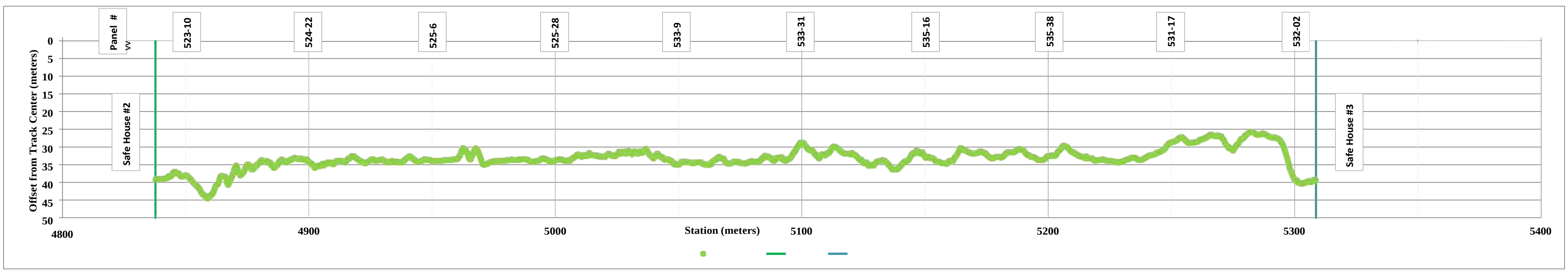
Appendix B2

Plot B Bedrock Depth

Whittier Tunnel - Bedrock Depth

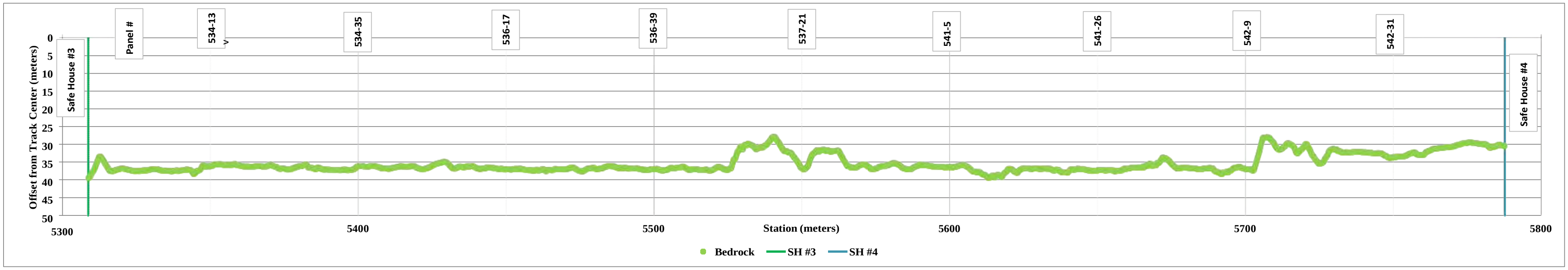


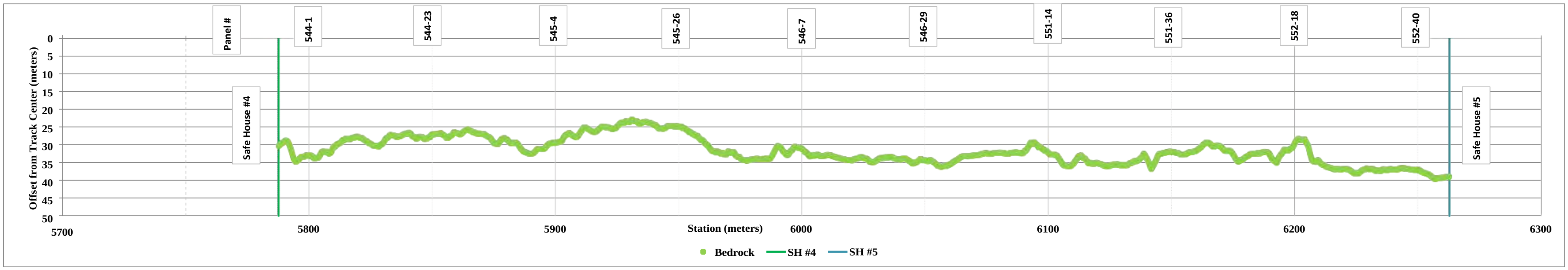


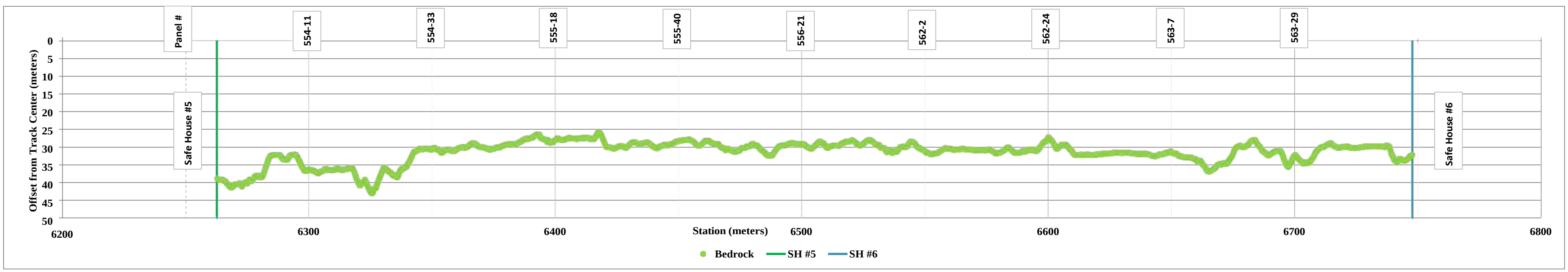


Calibrated_Voids 6-18-13

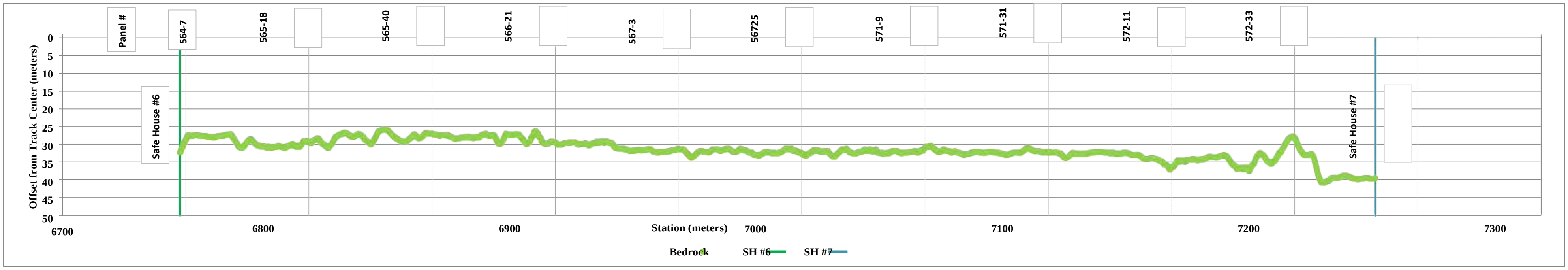
Whittier Tunnel - Bedrock Depth

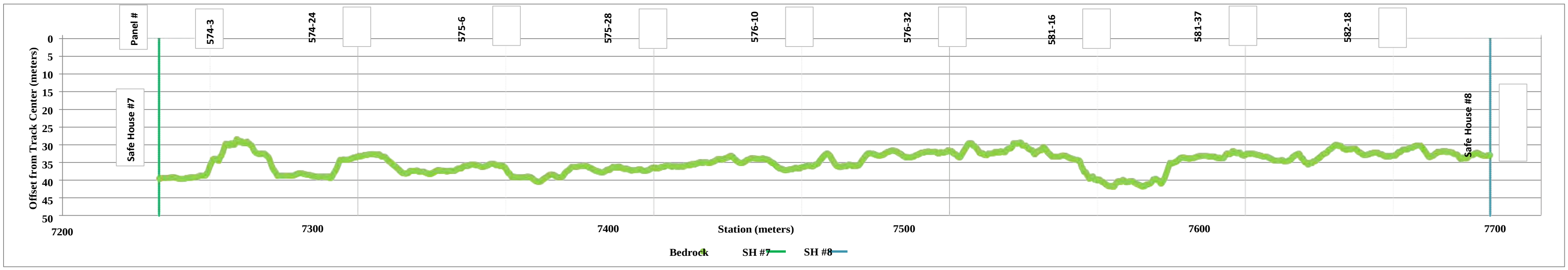


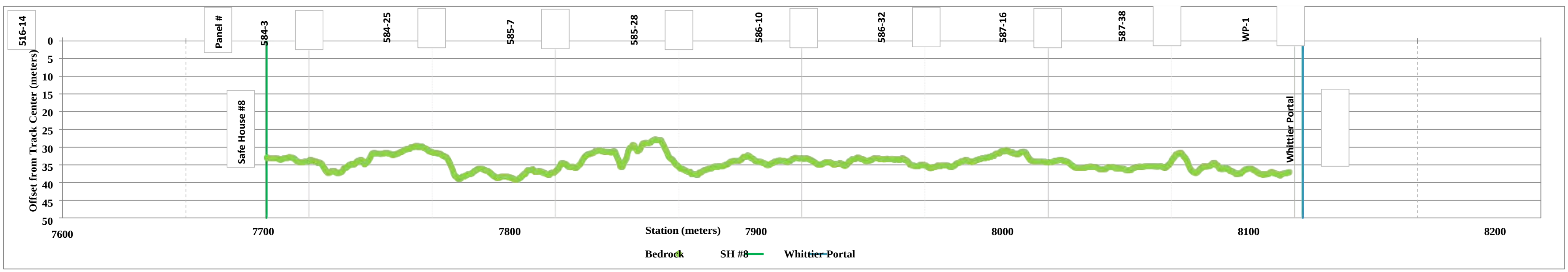




Whittier Tunnel - Bedrock Depth



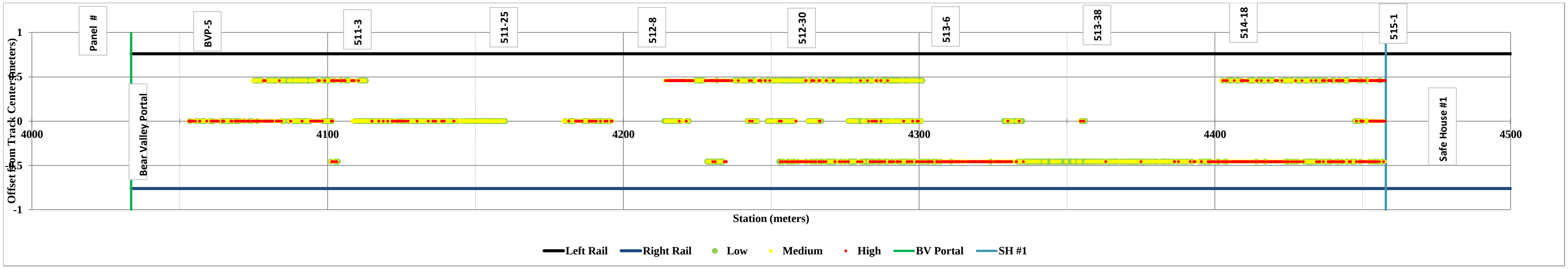


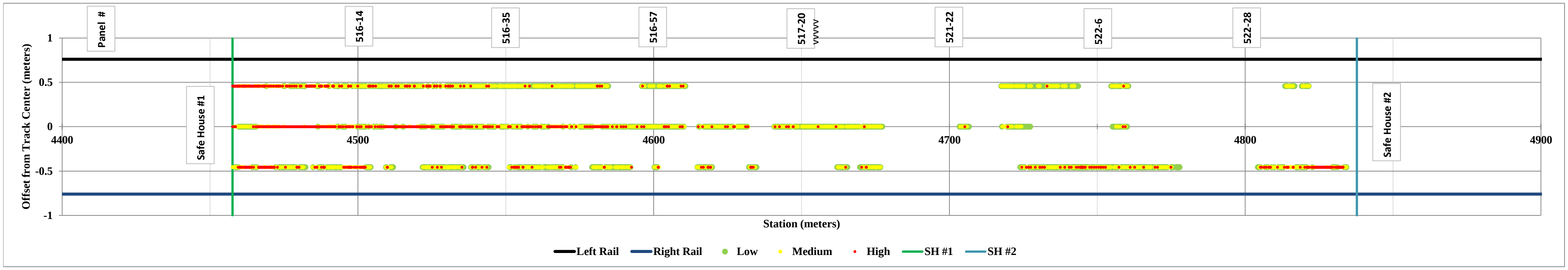


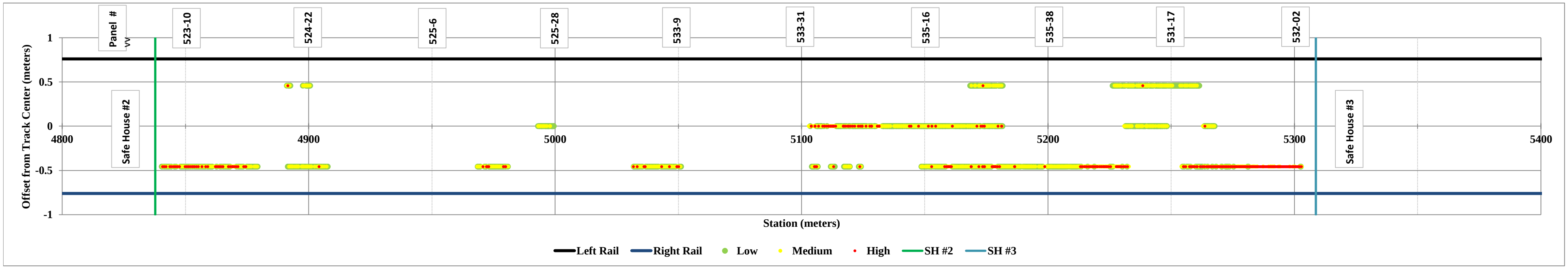
Appendix B3

Plot C Middle Bar Delamination Modified

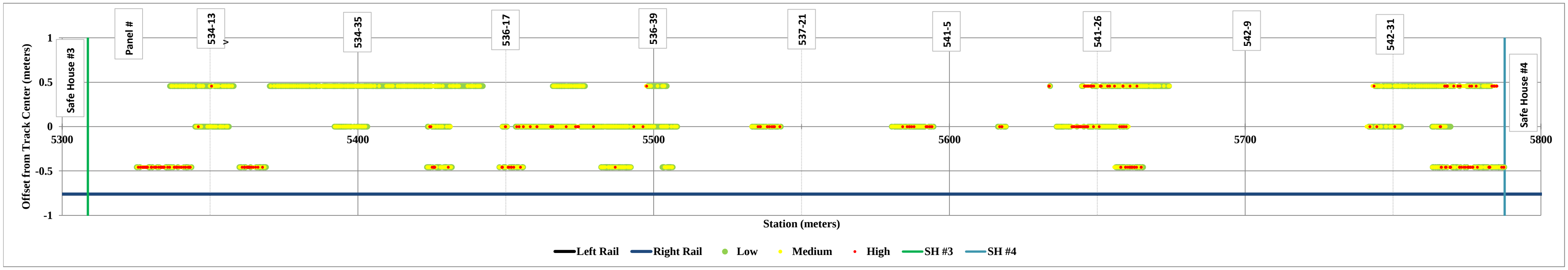
Whittier Tunnel - Potential Corrosion

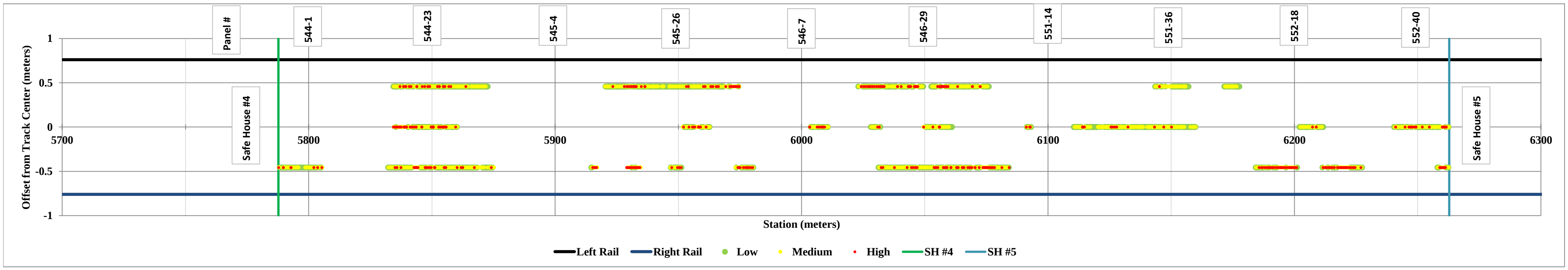


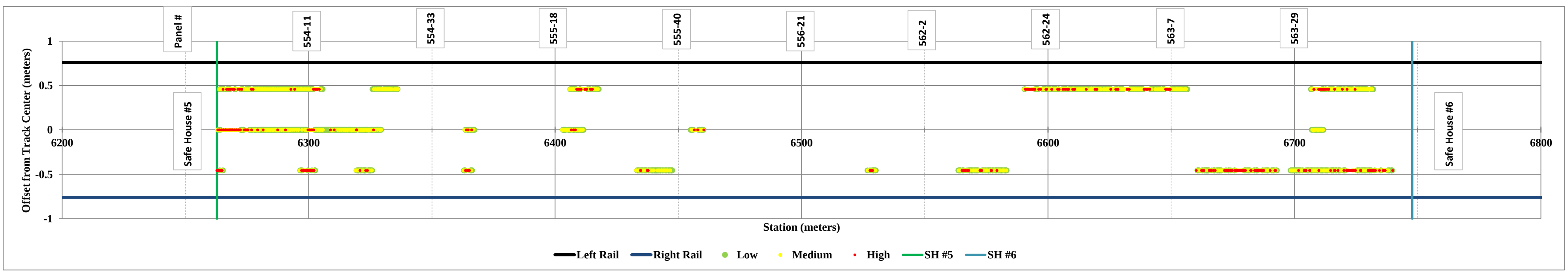




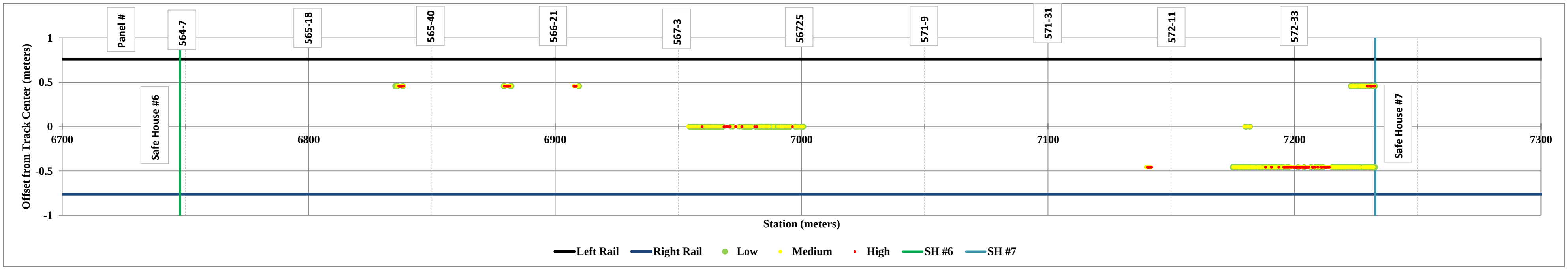
Whittier Tunnel - Potential Corrosion

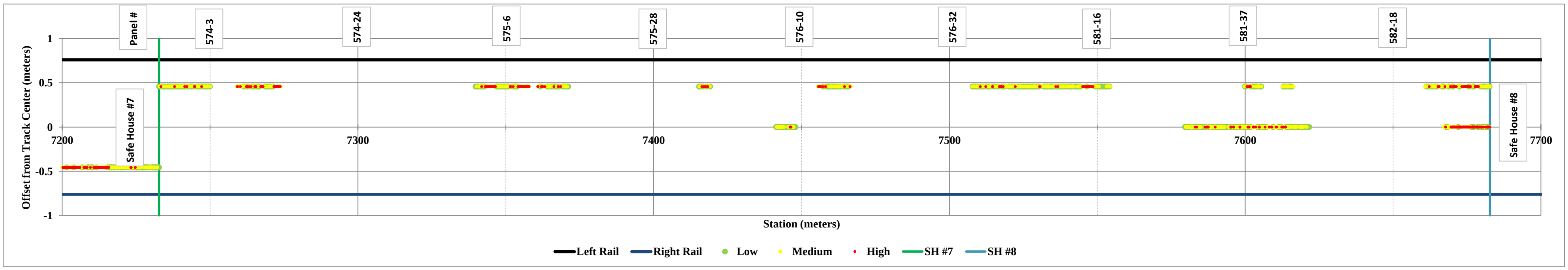


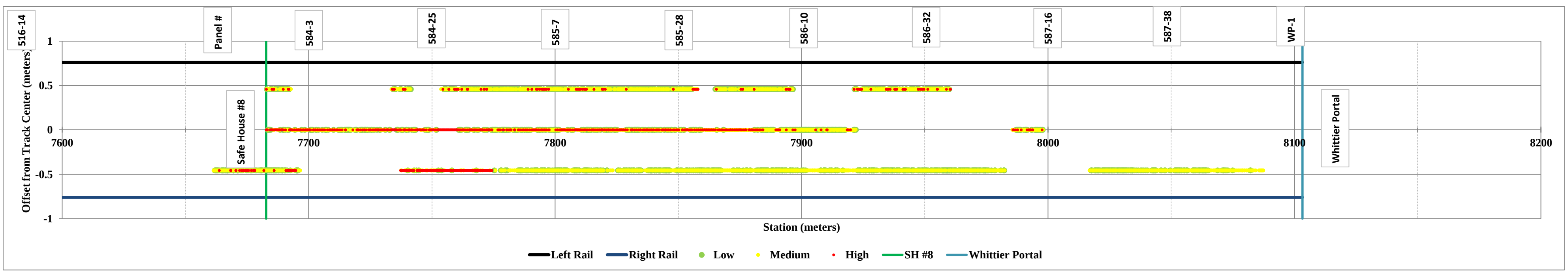




Whittier Tunnel - Potential Corrosion



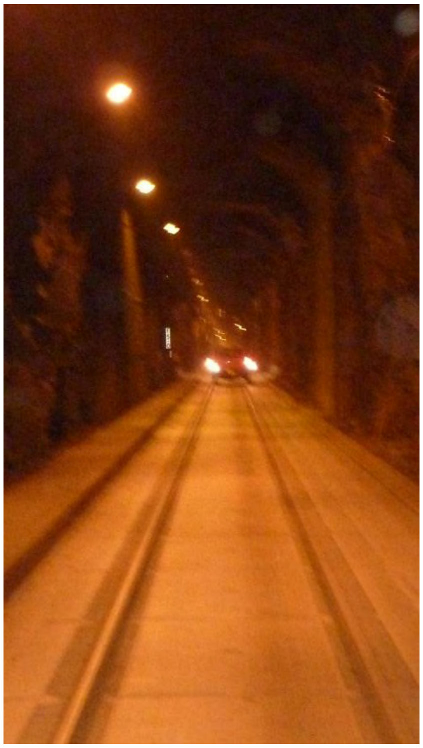




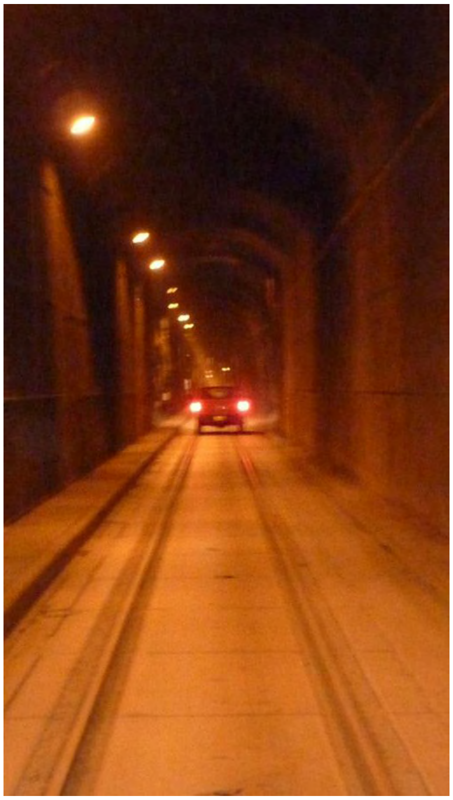
Appendix C

Photographs of Crown and Sidewalls That Require Drainage Control

BV to Tel #511 (12/5/12)

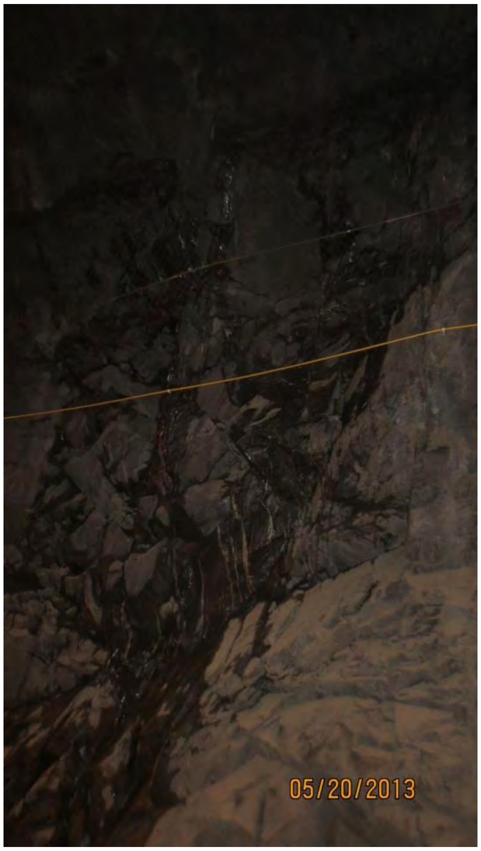


Tel #512 to Tel # 513 (12/5/12)

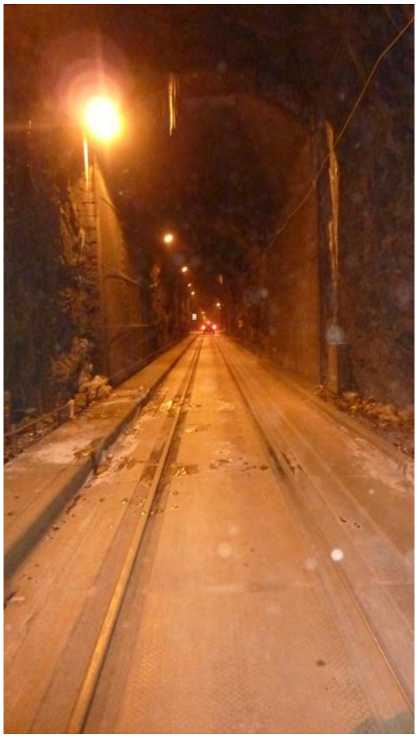


Tel #511 to Tel # 512 (12/5/12)

512-35 (5/20/13)

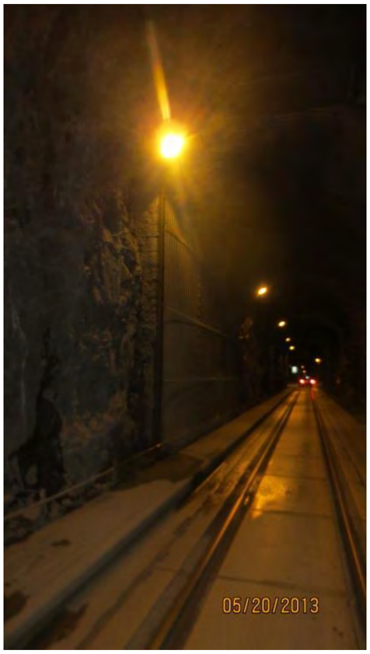


512-35 (5/20/13)

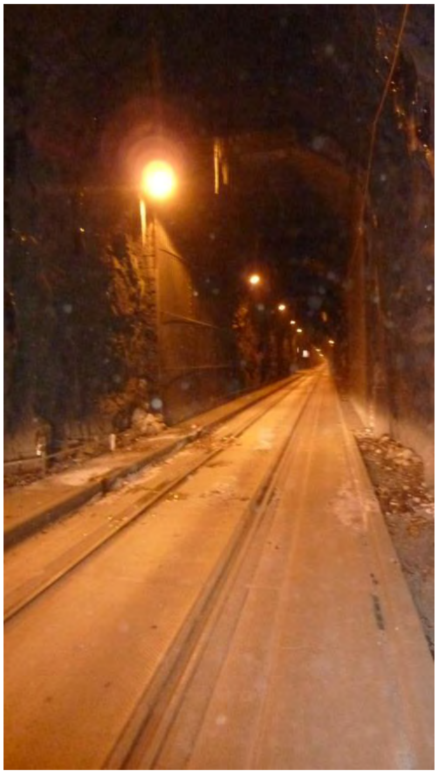


Tel #514 to Tel # 515 (12/5/12)

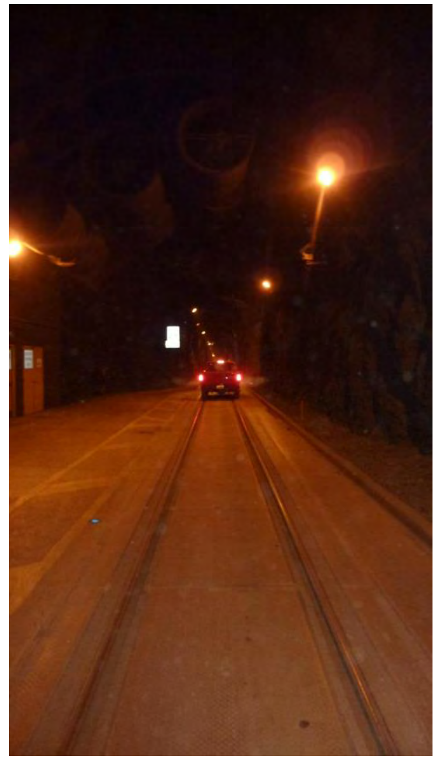
Tel #513 to Tel #514 (12/5/12)



514-03 (5/20/13)

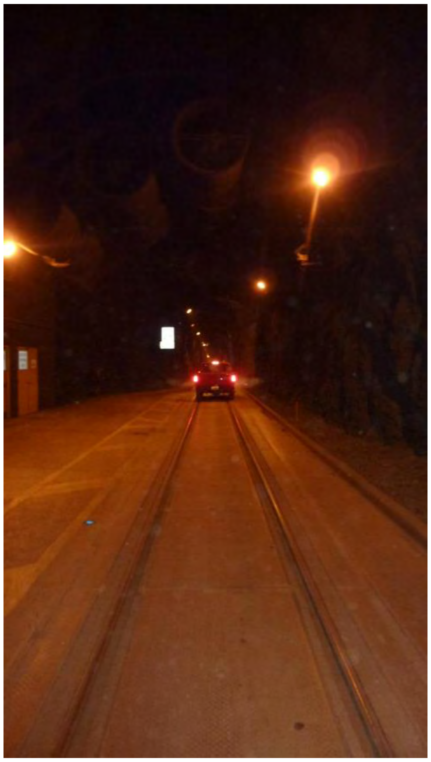


Tel #514-03 to Tel # 514-05 (12/5/12)



Tel #515 to SH #1 (12/5/12)

Tel #514-03 to Tel #524-05 (12/5/12)



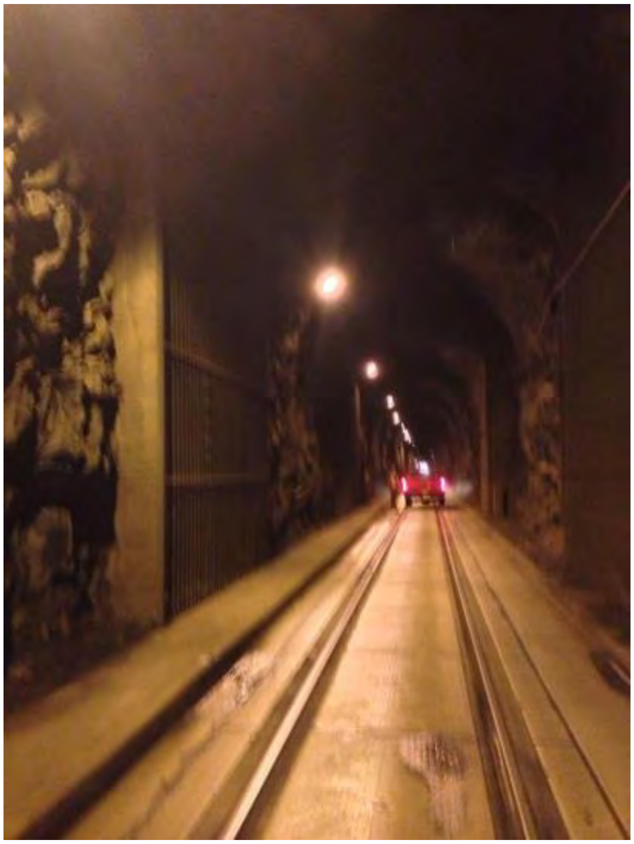
SH #1 to Tel #516 (12/12)

516-49 to 516-51 (12/12)

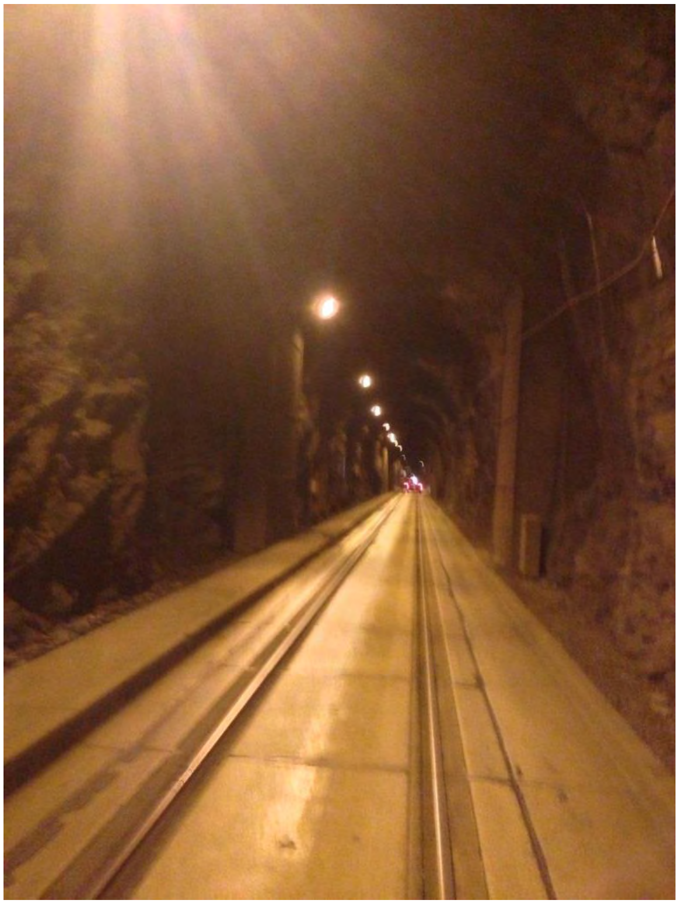
Tel # 516 to Tel #517 (12/12)

Tel #517 to Tel #521 (12/12)

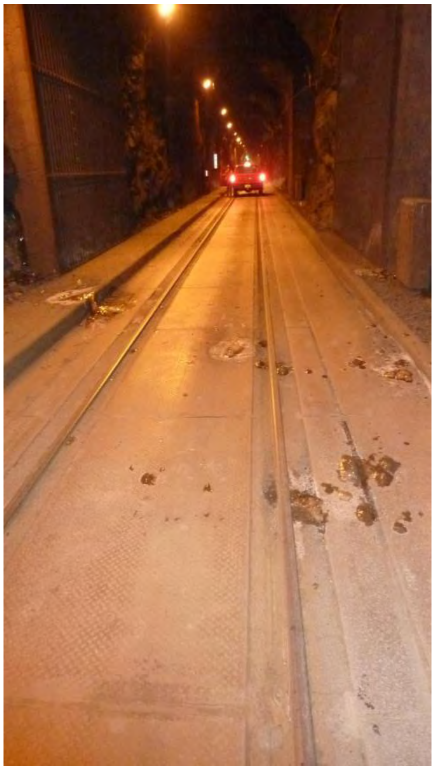
517-01 (12/12)



517-5 to 517-7 (12/12)

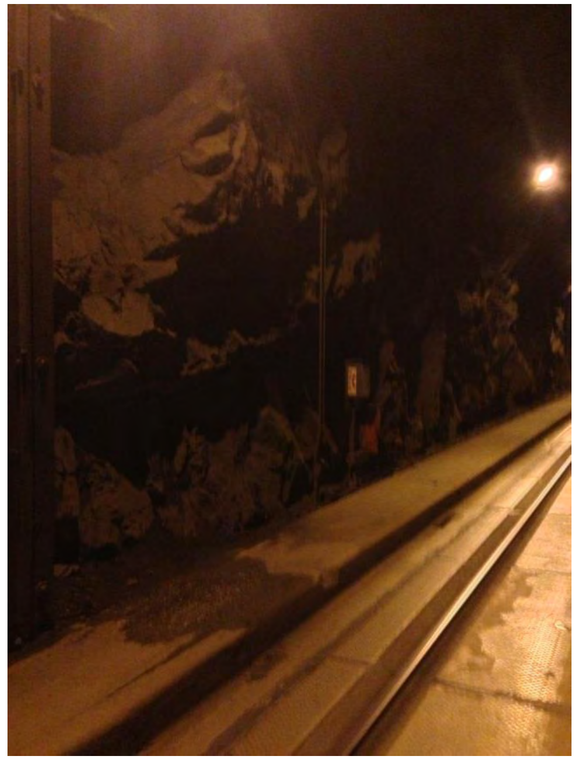


517-10 (12/12)



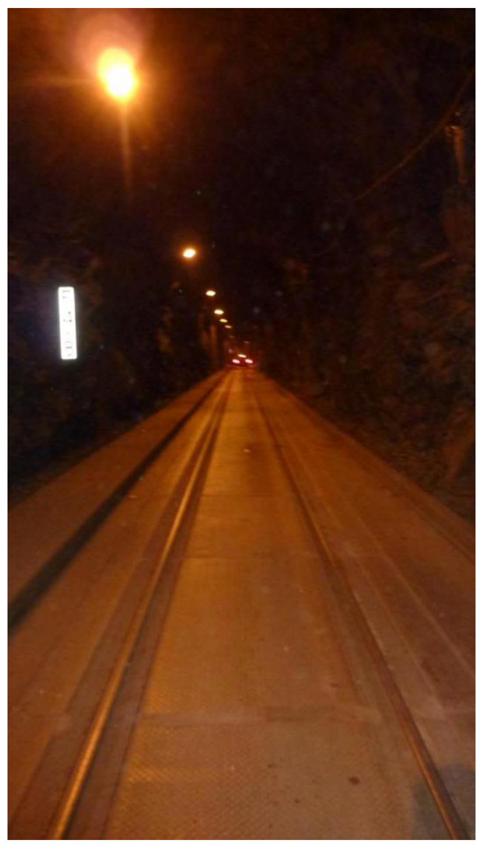
517-05 to 517-07(12/12)

517-10 (12/12)

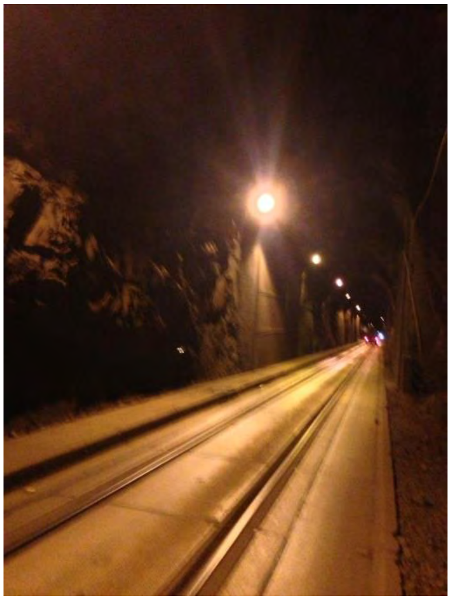


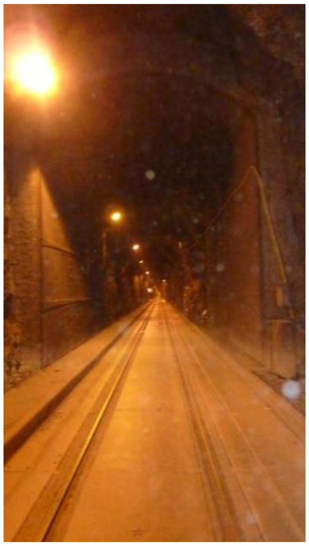
517-19 (12/12)

517-19 (12/12)



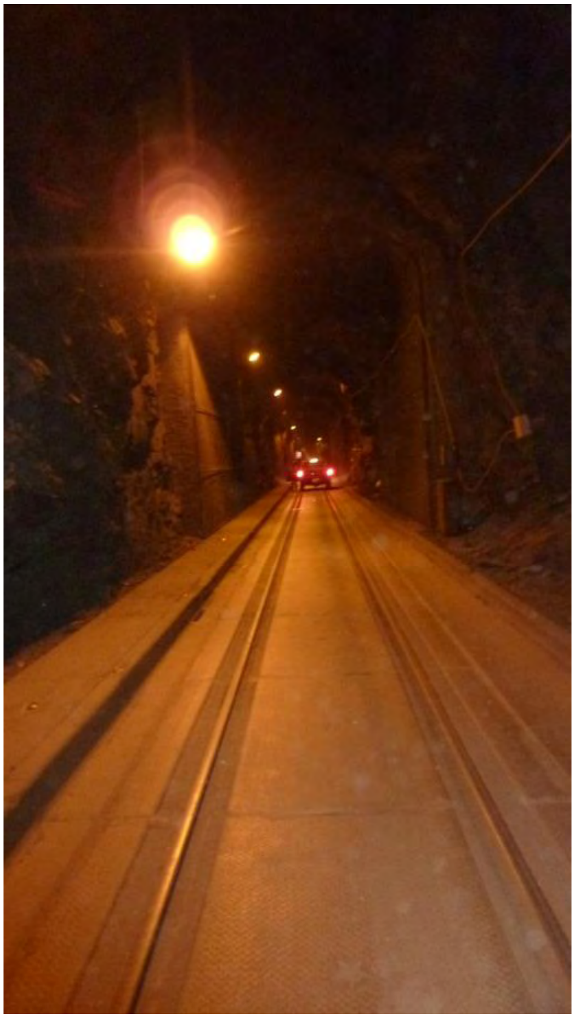
Tel #521 to Tel #522 (12/12)



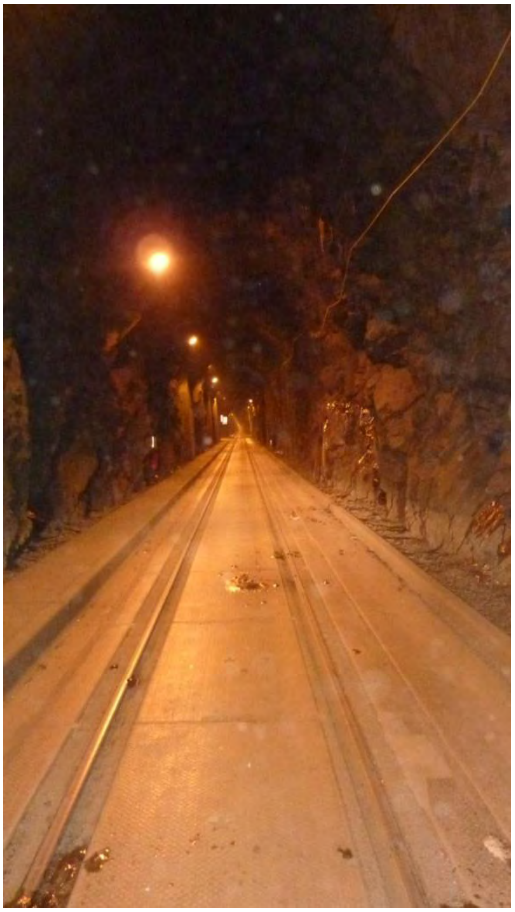


521-24 (12/12)

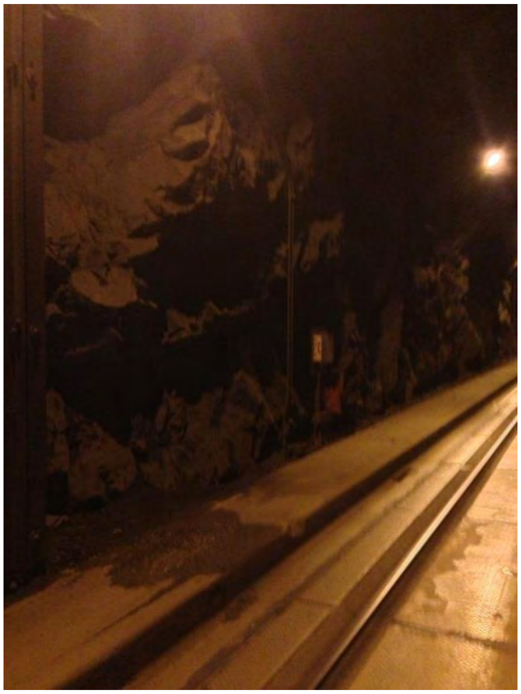
521 – 19 to 20 (5/13)



521-19 to 521-20 (12/12)

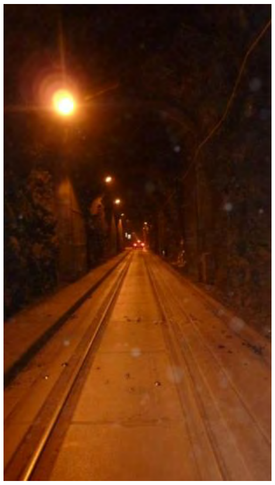


521-31 to 521-33 (12/12)



521-31 to 33 (5/13)

521-31 to 521-33 (12/12)

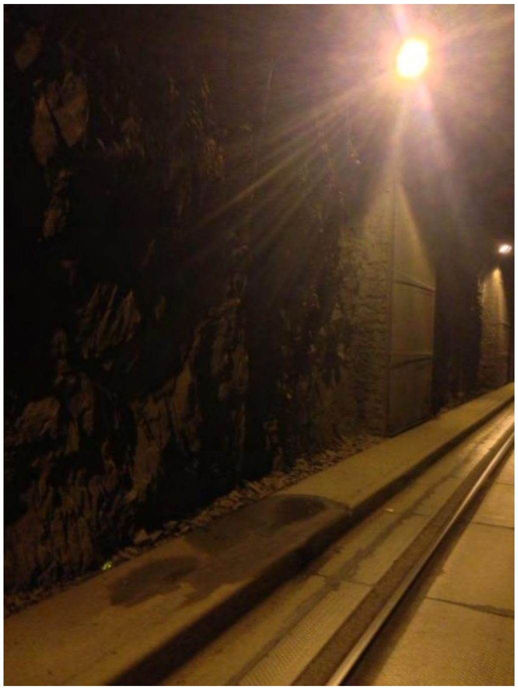


Tel #522 to Tel #523 (12/12)

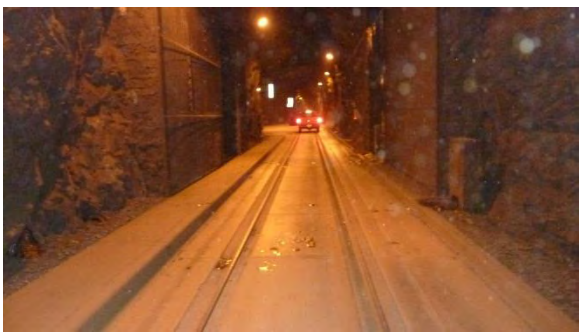
522-03 to 522-04 (12/12)

522-03 to 04 (5/13)

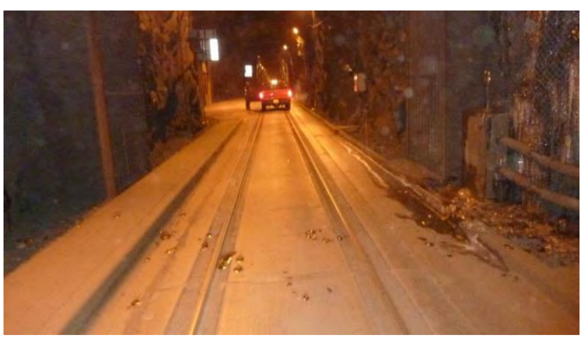
522-10 (12/12)



522-14 (5/13)



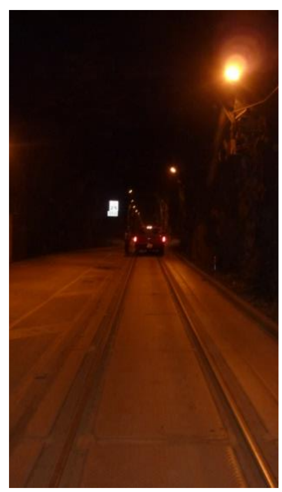
522-24 (12/12)



522-28 (12/12)

522-28 (12/12)

5-28 (5/13)



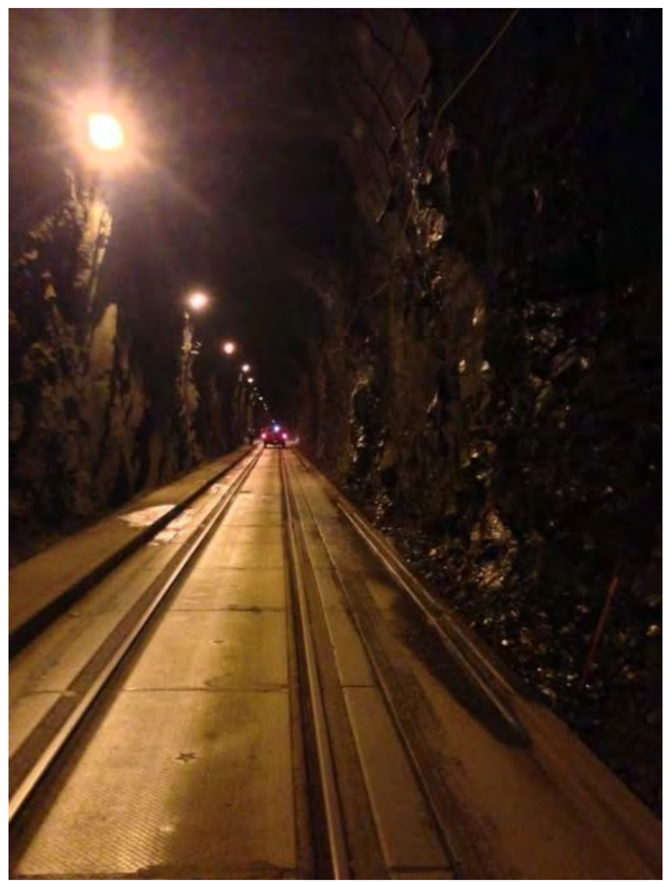
Tel #523 to SWH #2 (12/12)

SH #2 - Tel #524 (12/12)

524-10 to 524-20 (12/12)

524-10 to 524-20 (12/12)

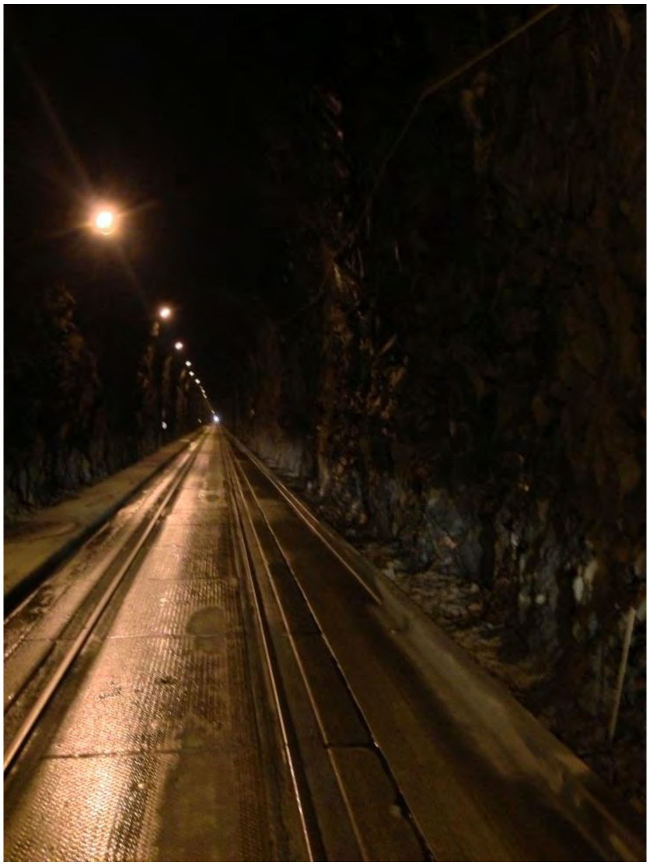
Tel #524 to Tel #525 (12/12)



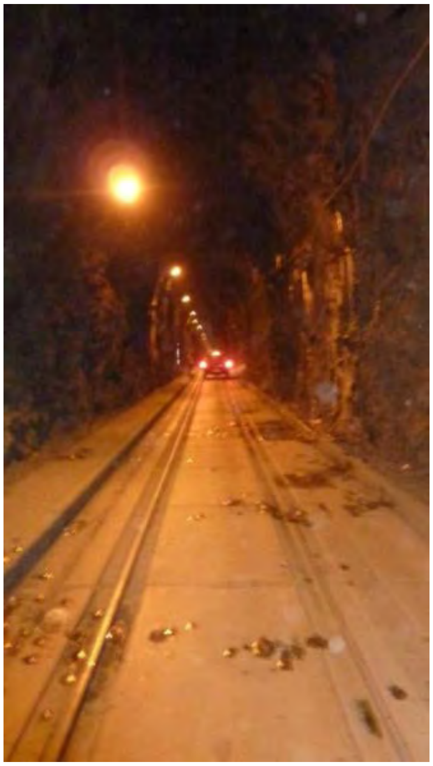
524- 10 to 28 (5/21/13)

524 – 10 to 18 (5/21/13)

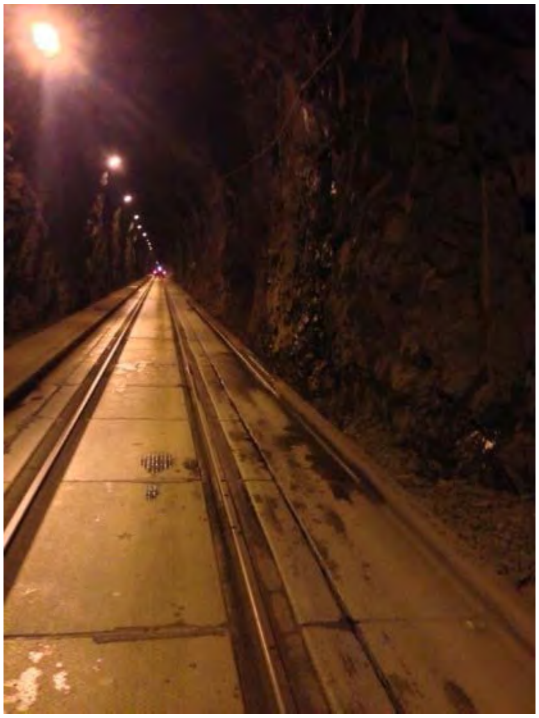
524-1-(5/21/13)



524 – 20 (5/30/13)



524-20 to 524-30 (12/12)



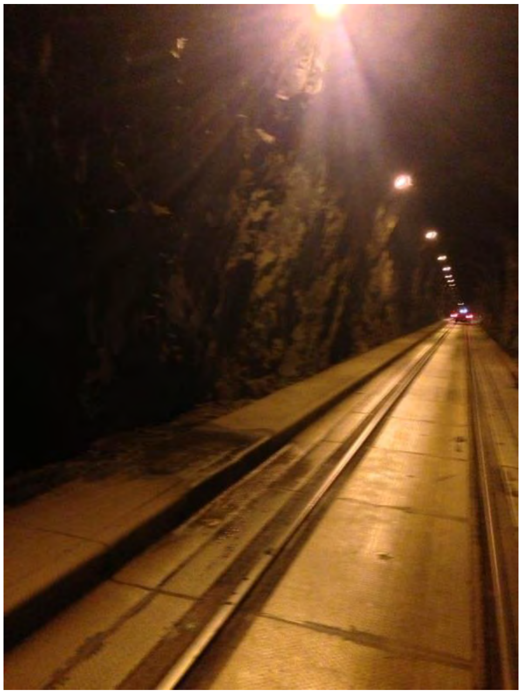
524 – 20 to 26 (5/21/13)

524-30 (5/30/13)

524-20 to 524-30 (12/12)

Tel #525 to Tel #533 (12/12)

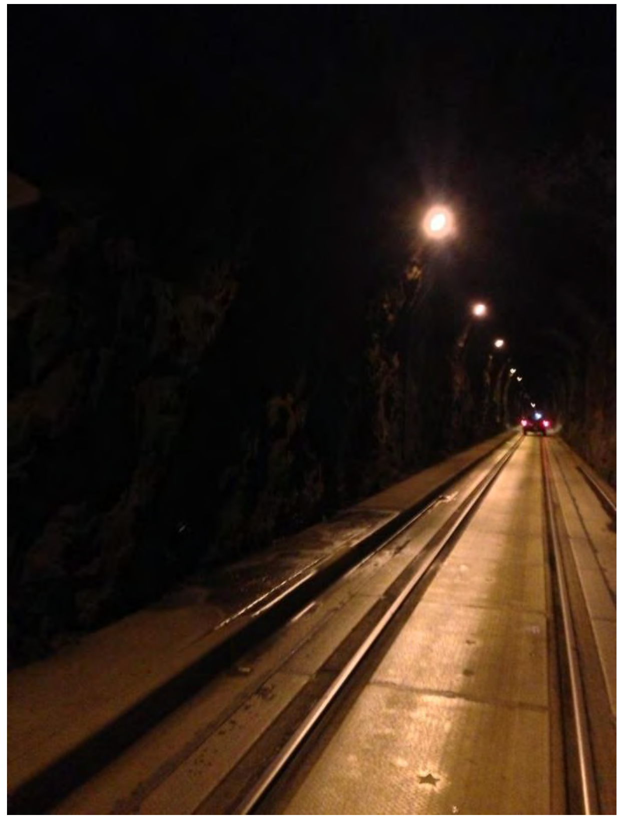
525-05 to 525-07 (12/12)



525-05 to 07 (5/21/13)

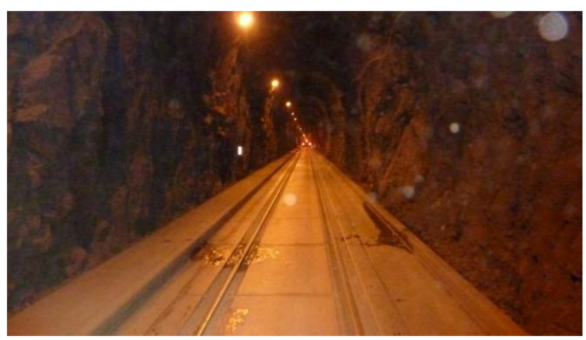
525-20 (12/12)

Tel #533 to Tel #535 (12/12)



533-15 95/21/13)

533-02 to 533-09 (12/12)



533-33 to 533-34 (12/12)

533-33 to 533-34 (12/12)

Tel #535 to Tel #531 (12/12)

535-06 (12/12)

535-19 to 535-28 (12/12)

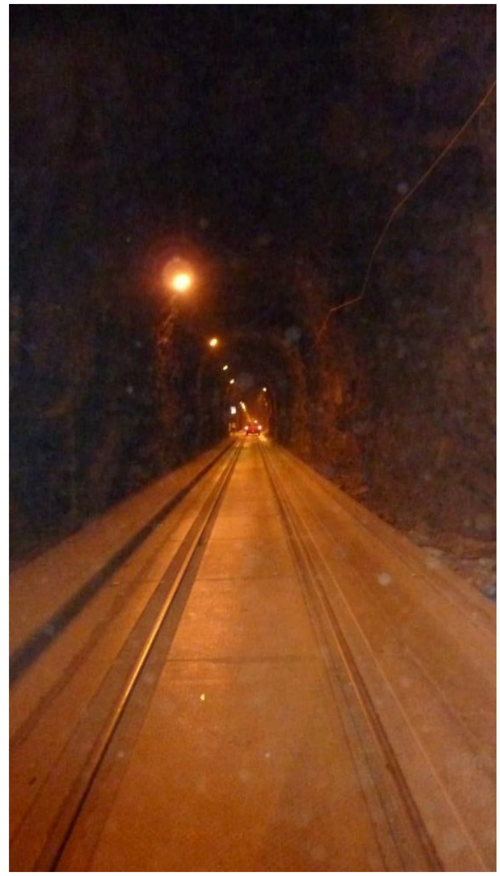
535-19 to 535-28 (12/12)

535-19 to 535-28 (12/12)

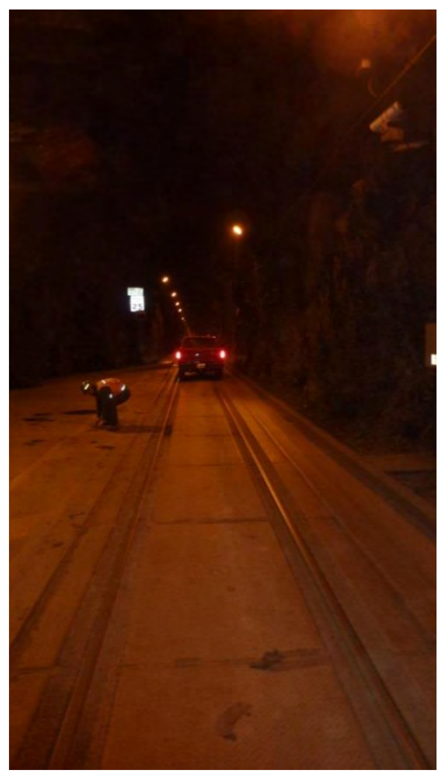
535-19 to 535-28 (12/12)

535-19 to 535-28 (12/12)

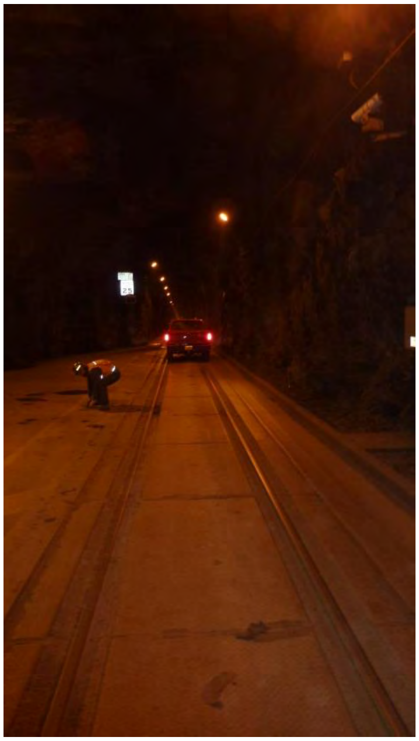
535 – 19 to 28 (5/21/13)



Tel #532 to Tel 532 (12/12)

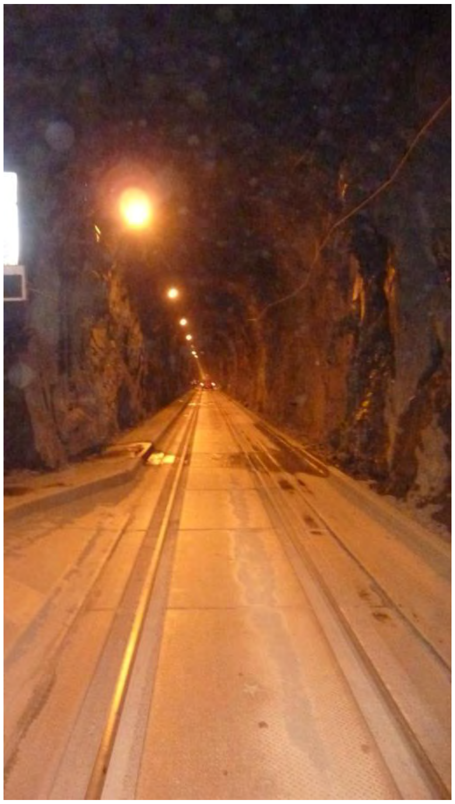


Tel #532 to SH #3 (12/12)



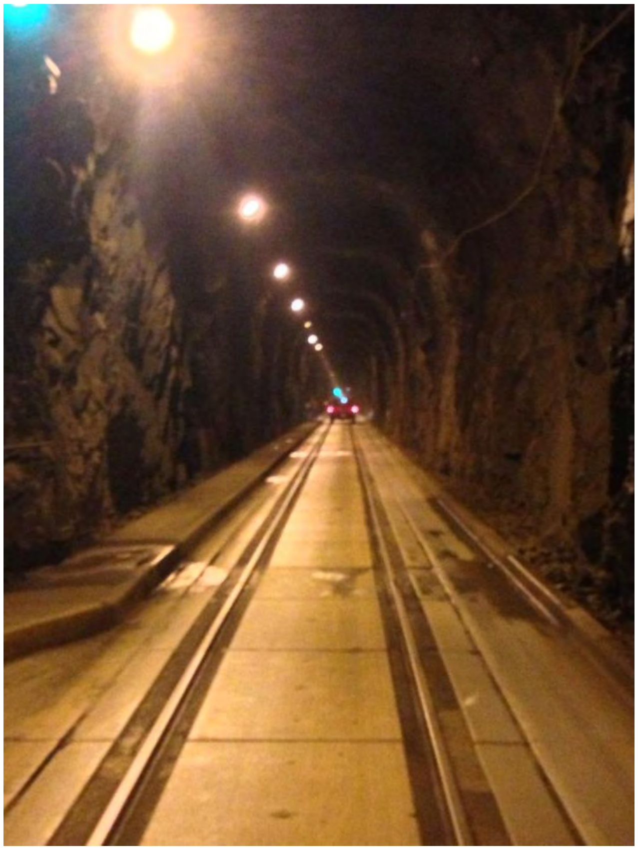
SH #3 to Tel 534 (12/12)

534-06 to 534-08 (12/12)



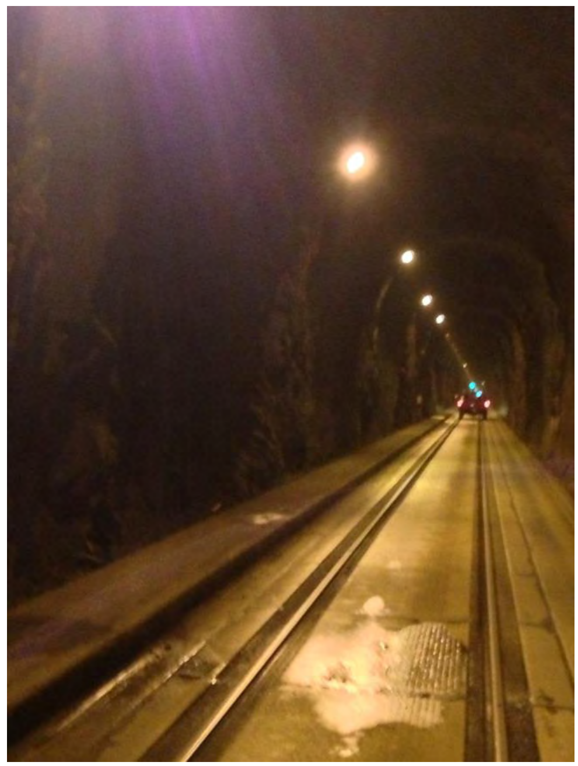
Tel #534 to Tel #536 (12/12)

534-06 to 534-08 (12/12)



534 – 06 to 08 (5/13)

534-18 to 534-20 (12/12)

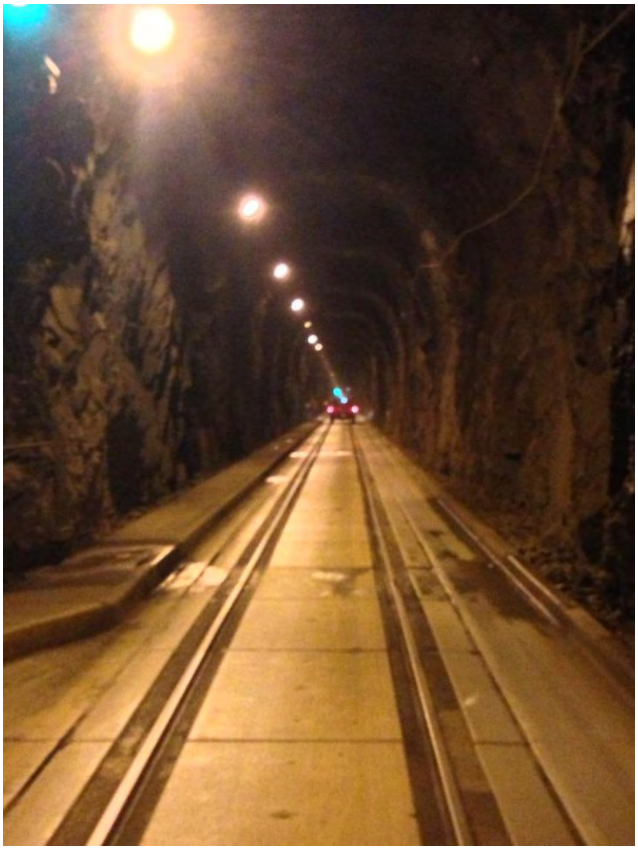


534 – 18 to 30 (5/13)

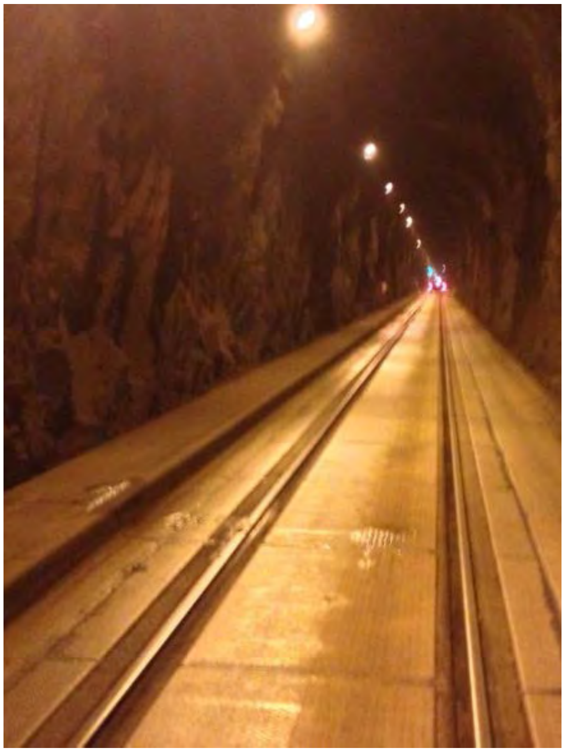
534-06 to 08 (5/13)

Tel #536 to Tel # 537 (3/5/13)

536-06 to 536-07 (12/12)



536 -06 to 07 (5/13)

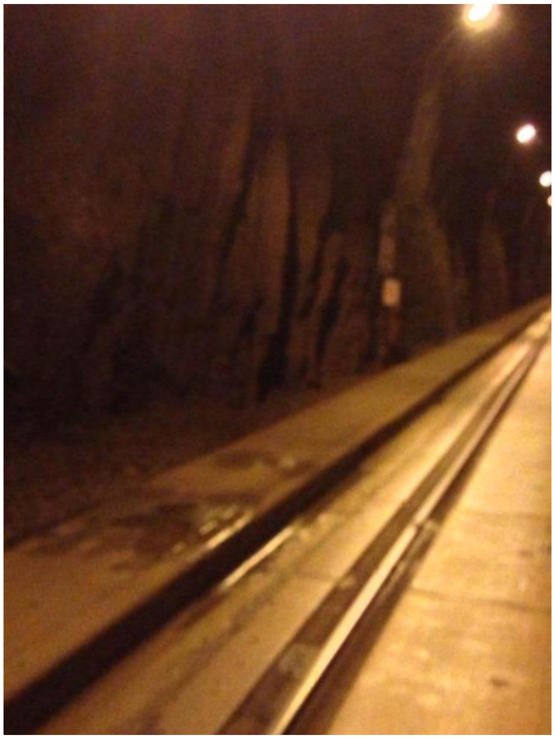


536 – 17 to 18 (12/12)

536-17 to 537-18 (12/12)

Tel #537 to Tel #541 (12/12)

537-35 (12/12)

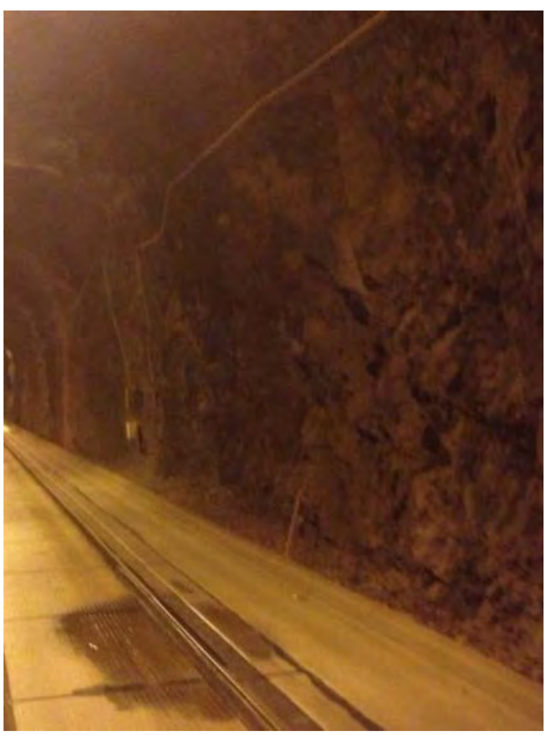


537 -35 (5/13)

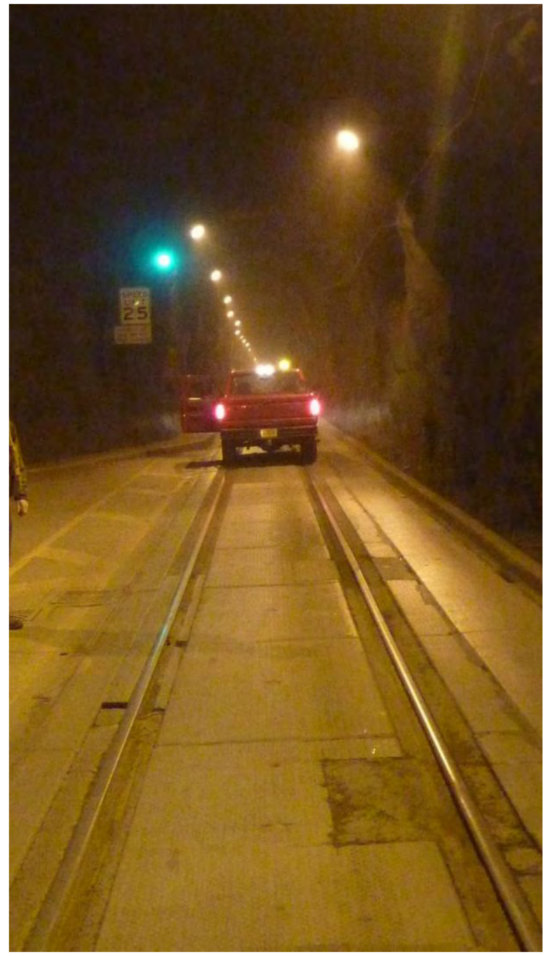
Tel #541 to Tel #542 (12/12)

Tel #542 to Tel #543(12/12)

542-10 (12/12)



542 – 09 to 10 (12/12)

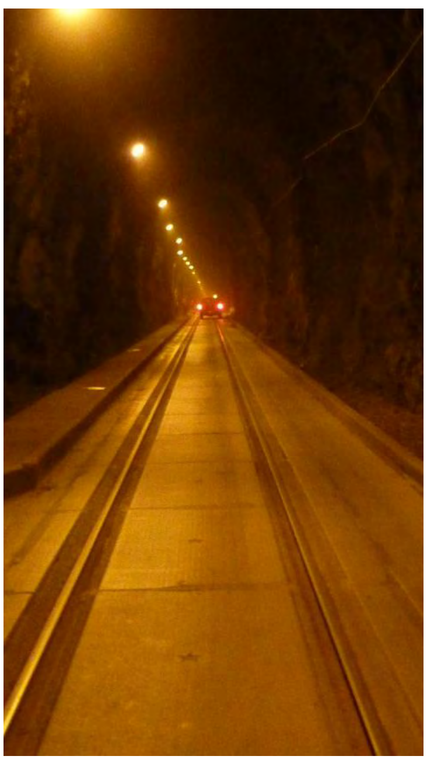


Tel #543 to SH #4 (12/12)

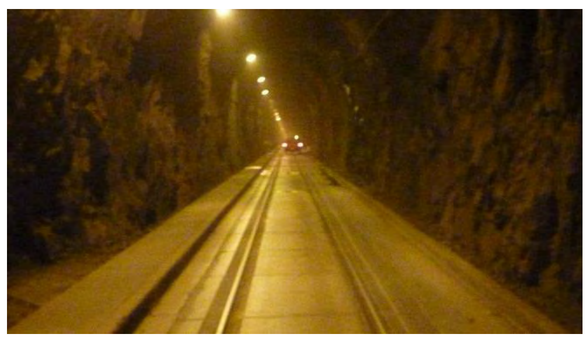
SH #4 to Tel #544 (12/12)

544-28 to 544-29 (12/12)

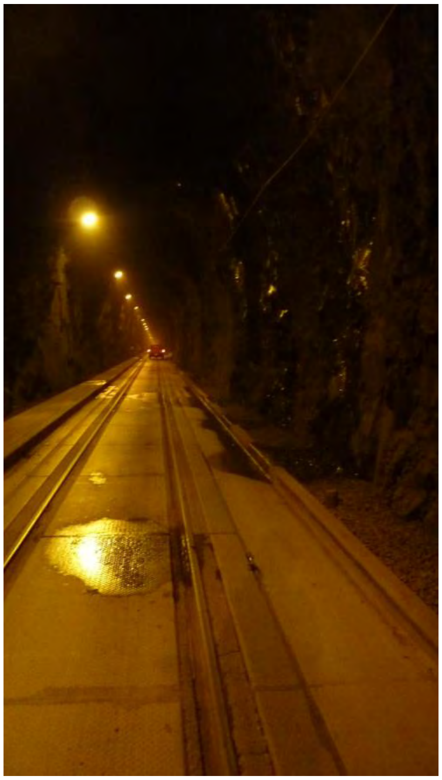
544 -28 to 29 (5/13)



Tel #544 to Tel #545 (12/12)



Tel #545 to Tel #546 (12/12)



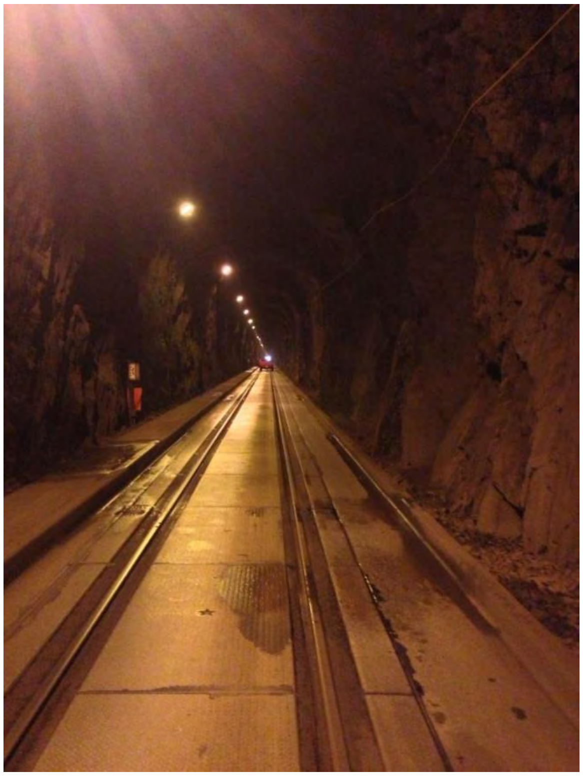
545-12 to 545-19 (12/12)

545 12 to 19 (5/13)

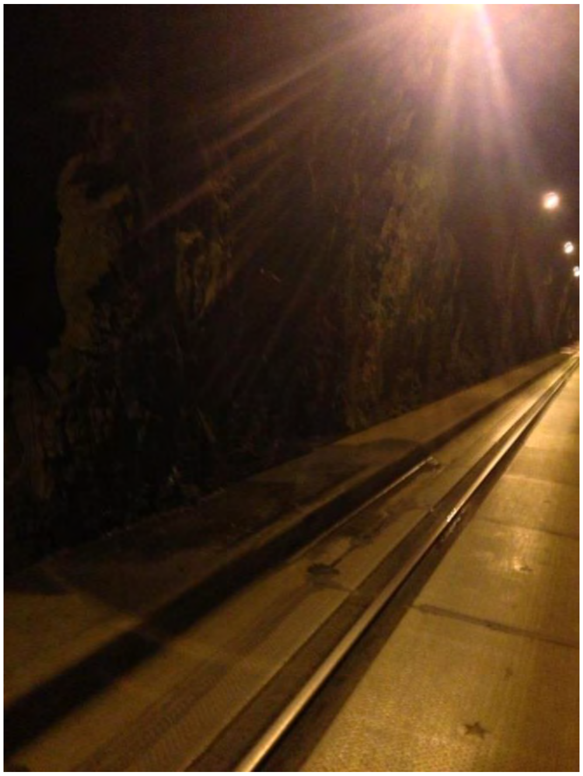
545 – 12 to 19 (5/13)

545 – 12 to 19 (5/13)

545-37 to 545-39 (12/12)

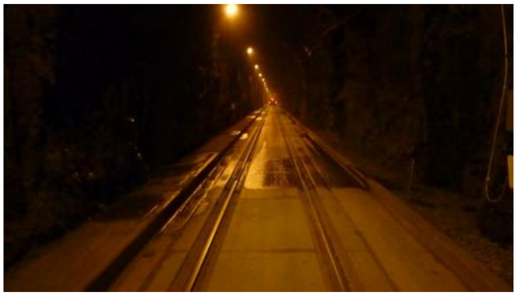


545 – 37 to 39 (5/13)



546 – 6 to 7 (12/12)

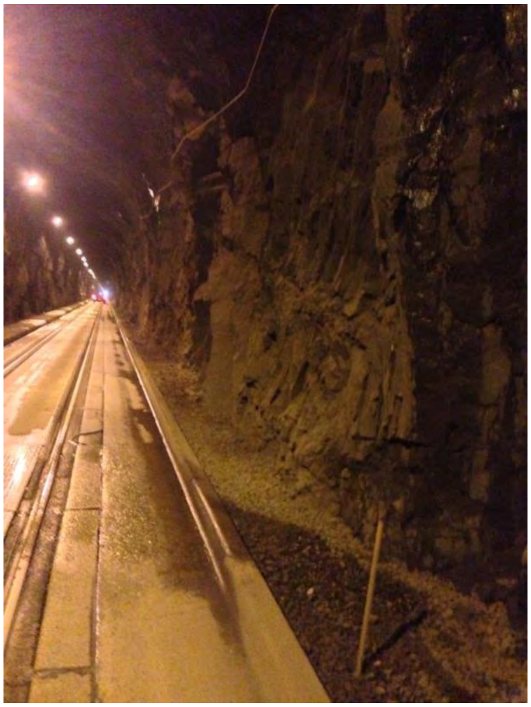
Tel #546 to Tel #551 (12/12)



546-27 to 546-33 (12/12)

546 -27 (5/13)

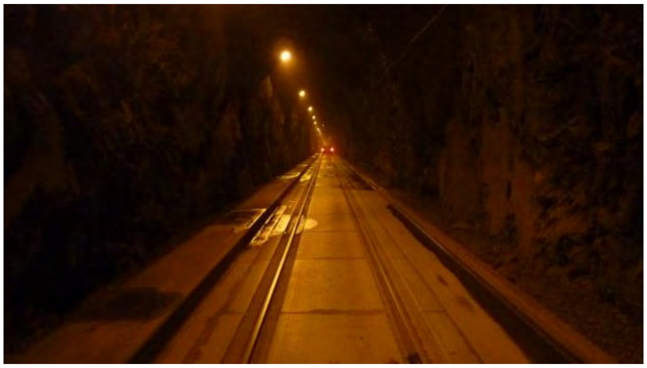
546-27 to 546-33 (12/12)



546 – 30 (5/13)

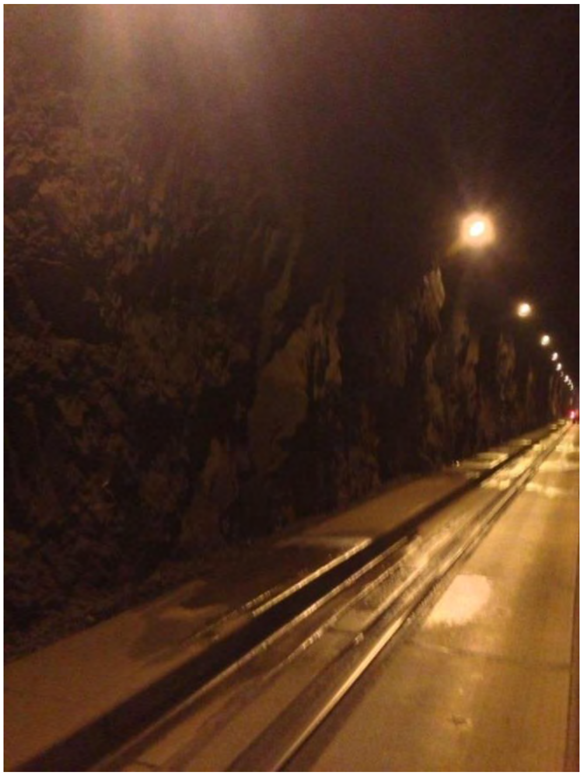
546 – 30 (5/13)

546 – 27 to 33 (5/13)



Tel #551 to Tel #552 (12/12)

551-05 to 551-07 (12/12)

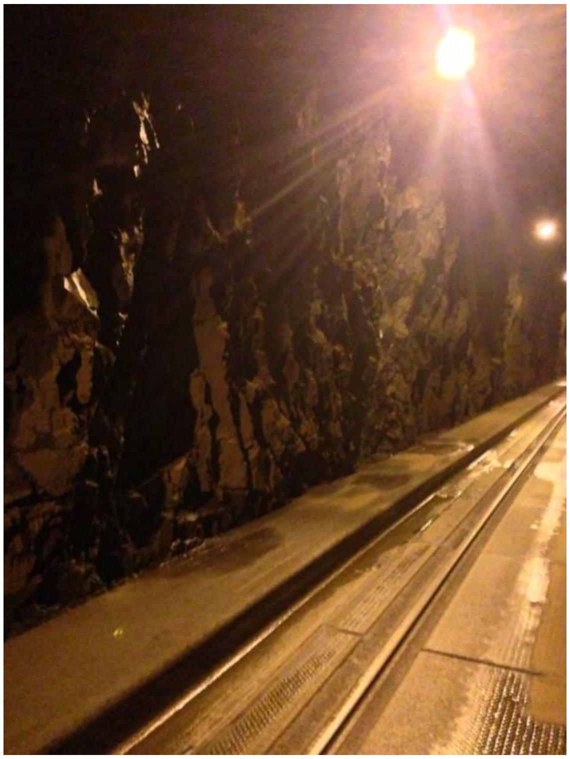


551 – 05 to 07 (5/13)

551 – 10 to 14 (5/13)

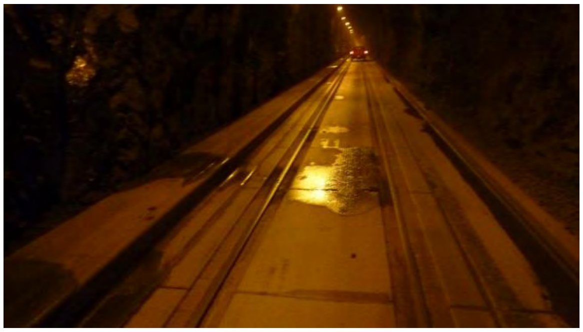
551-10 to 551-14 (12/12)

551 – 10 to 14 (5/13)

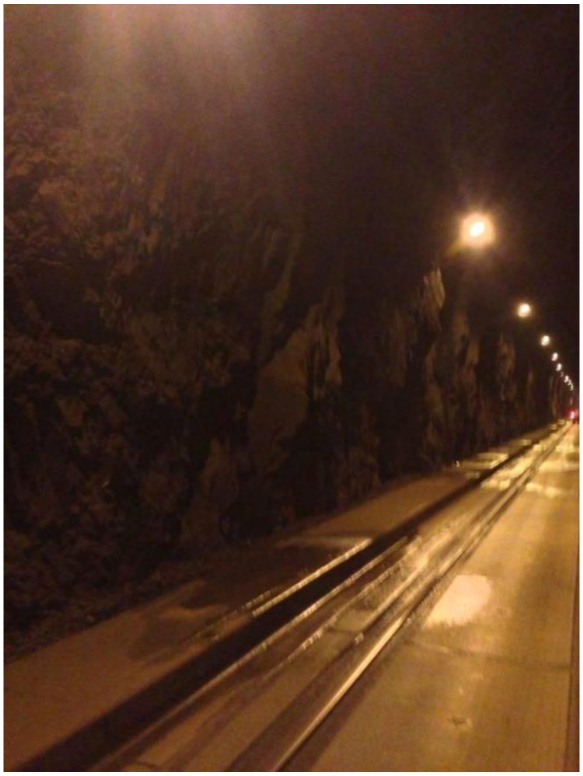


551- 10 to 14 (12/12)

551 – 18 to 24 (5/13)



551-18 to 551-24 (12/12)



551 – 18 to 24 (5/13)

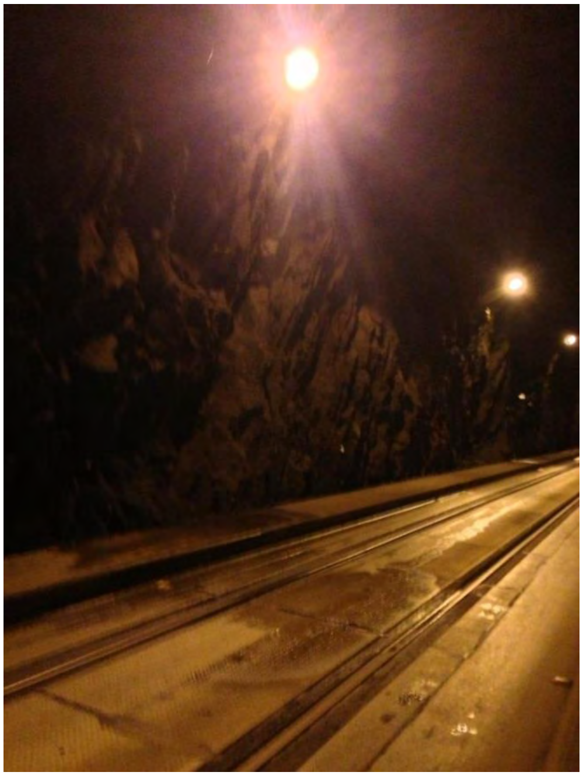
551-30 to 551-36 (3/5/13)

Tel #552 to Tel #553 (12/12)

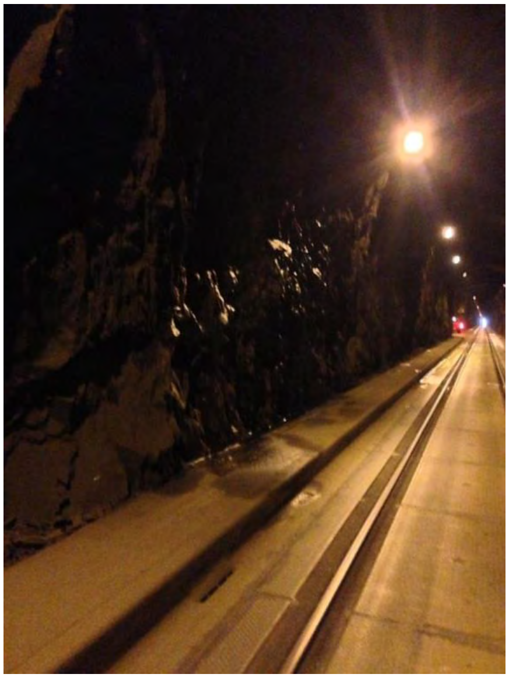
552-13 to 552-14 (12/12)

552-01 to 552-05 (12/12)

552-13 to 552-14 (12/12)

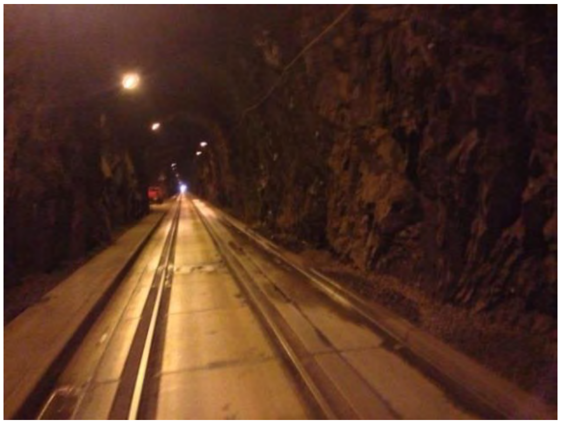


552 – 1 to 5 (5/13)



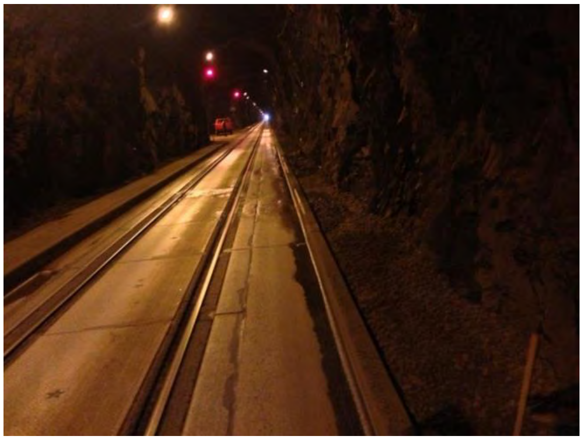
552 – 13 to 14 (12/12)

552 – 13 to 14 (12/12)



552 – 24 to 26 (5/13)

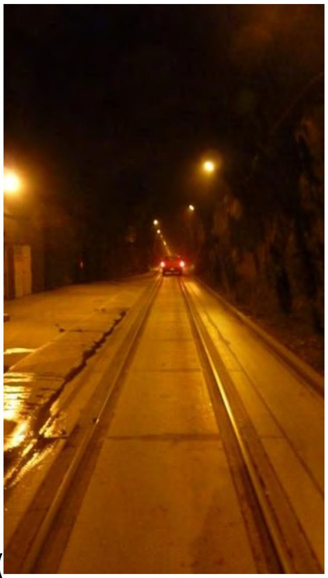
552-24 to 552-26 (12/12)



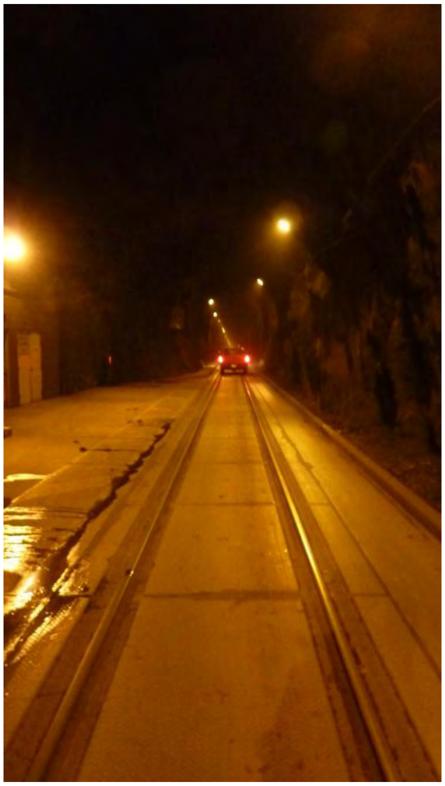
552 – 24 to 26 (12/12)

552-24 to 552-26 (12/12)

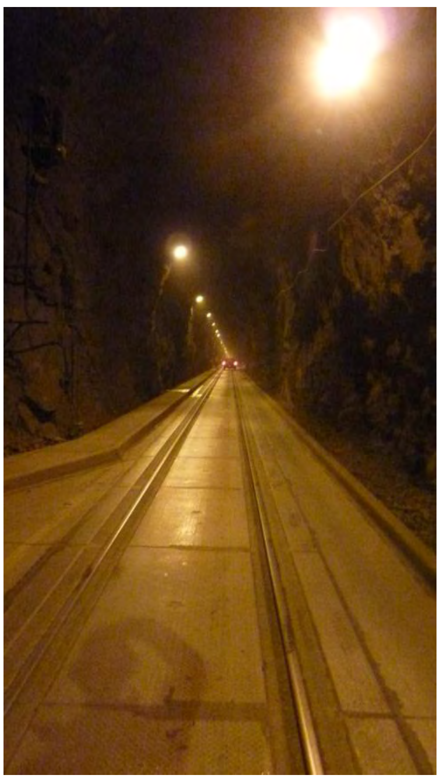
(



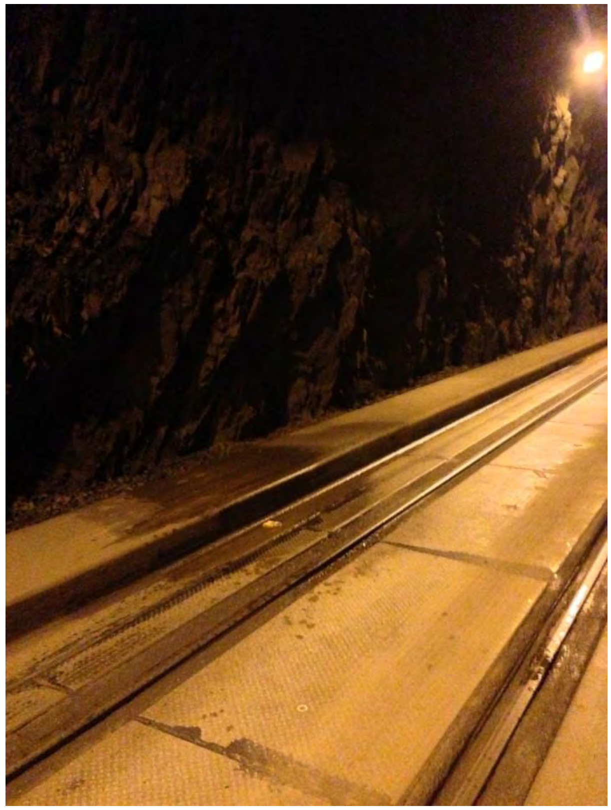
Tel #553 to SH #5 (12/12)



SH #5 to Tel #554 (12/12)



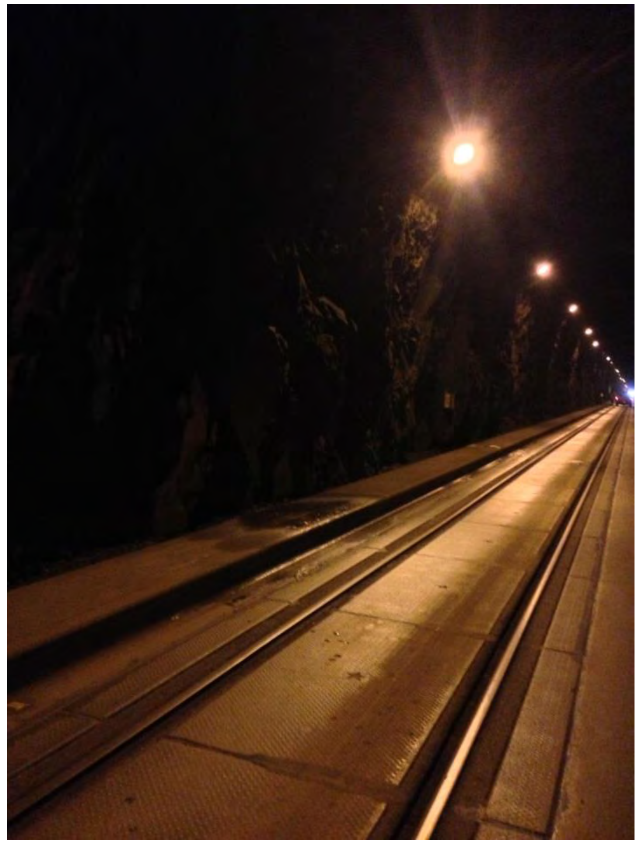
Tel # 554 to Tel #555 (12/12)



554 – 11 to 12 (5/13)

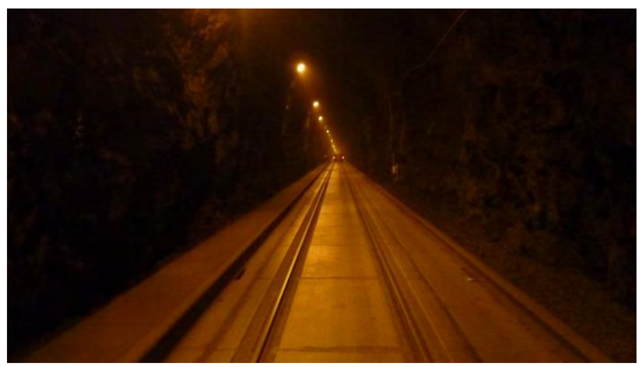
554-22 to 554-23 (12/12)

554 – 22 to 23 (12/12)



554 – 33 to 34 (12/12)

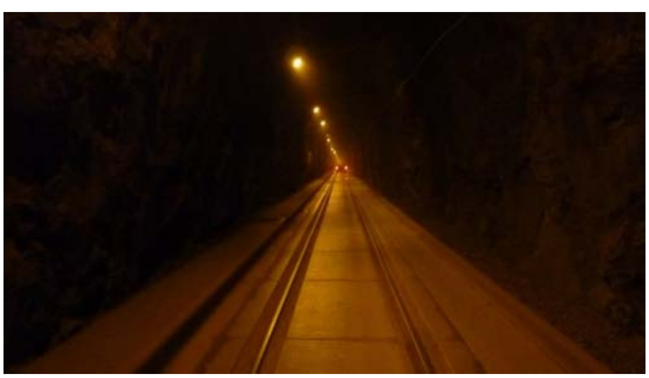
554-33 to 554-34 (12/12)



Tel #555 to Tel #556 (12/12)

555 – 07 to 09 (12/12)

555-32 to 555-33 (12/12)



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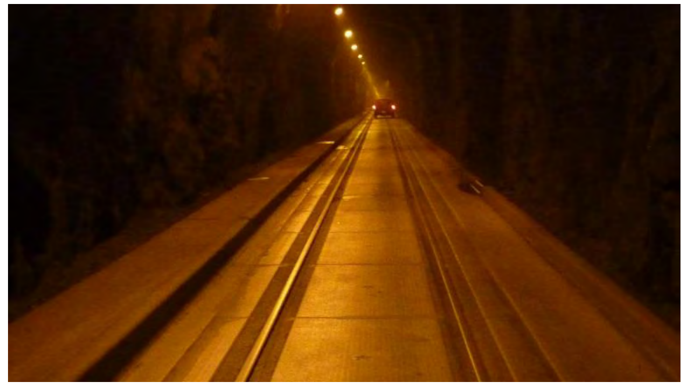
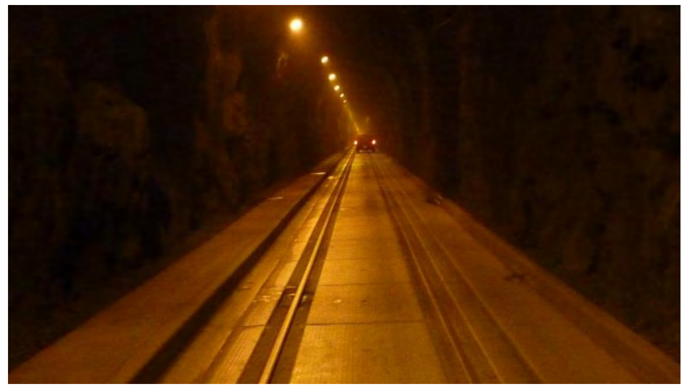
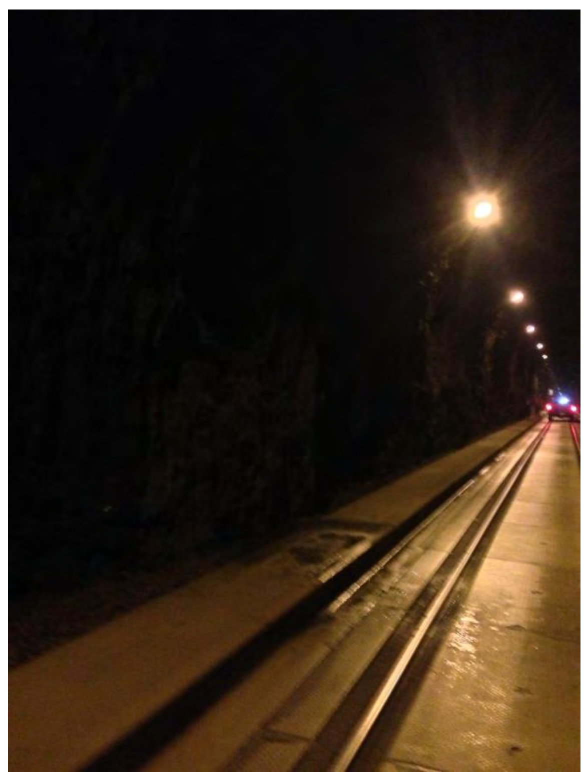


Tel #562 to Tel #563 (12/12)



562-03 (12/12)



562 – 03 (5/13)

562-08 to 562-12 (12/12)

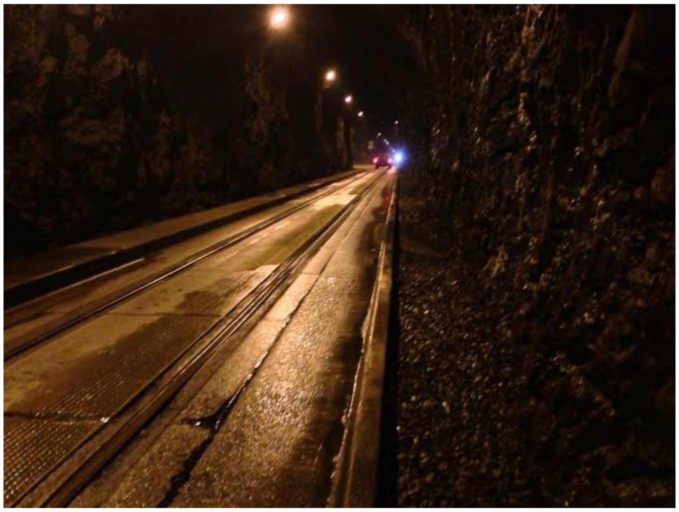
562 – 08 to 16 (5/13)

Tel #563 to Tel #564 (12/12)

563-08 to 563-14 (12/12)

563-08 to 563-14 (12/12)

563 – 08 to 14 (5/13)



563 – 08 to 14 (5/13)

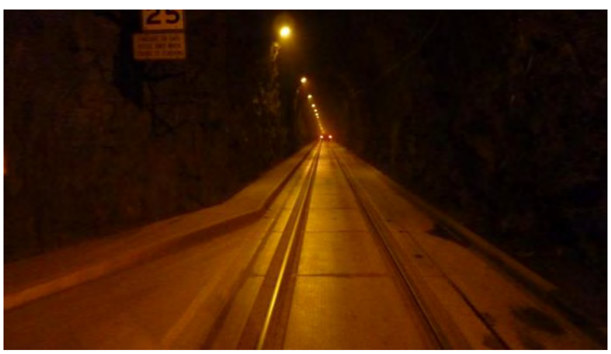
563 08 to 14 (5/13)

563-19 to 563-24 (12/12)

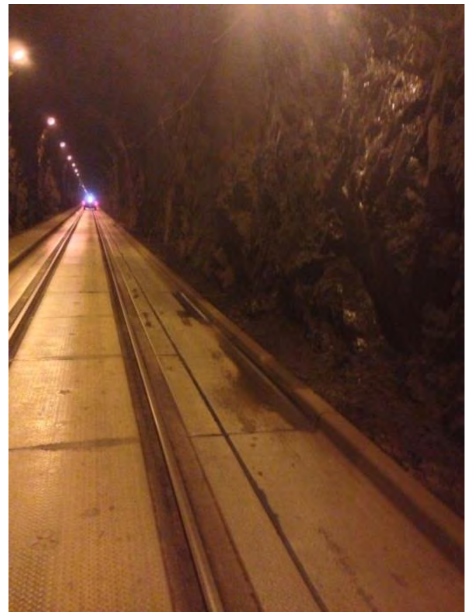
563 – 19 to 25 (5/13)

Tel #564 to SH #6 (12/12)

SH #6 to Tel #565 (12/12)

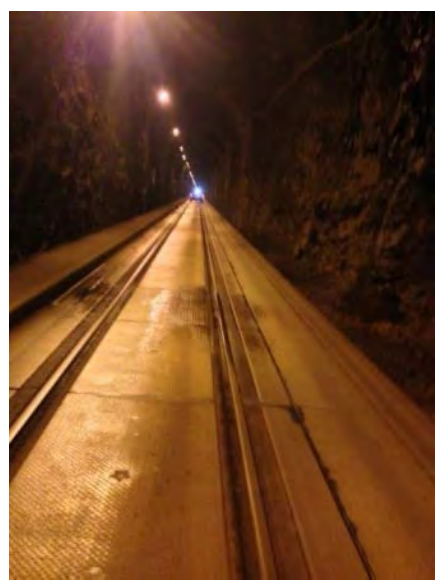


Tel #565 to Tel #566 (12/12)

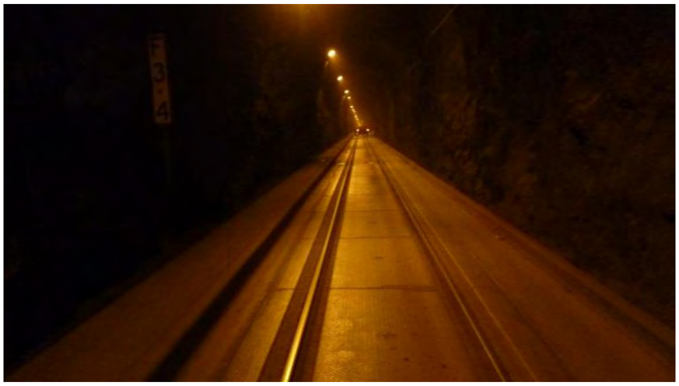


565 – 3 to 4 (5/13)

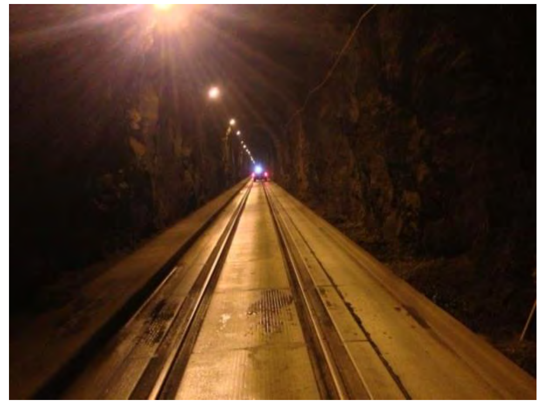
565-31 to 565-33 (12/12)



565 – 31 to 33 (5/13)



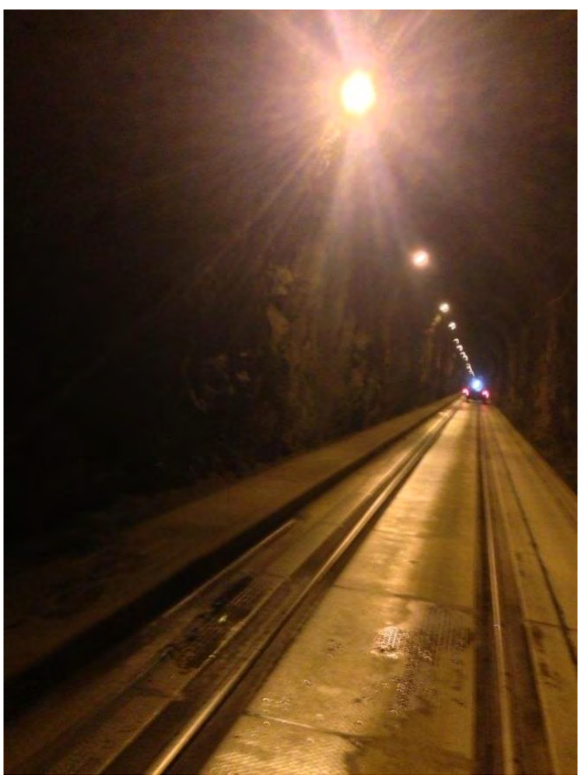
Tel #566 to Tel #567 (12/12)



566 -11 (5/15)

566-11 (12/12)

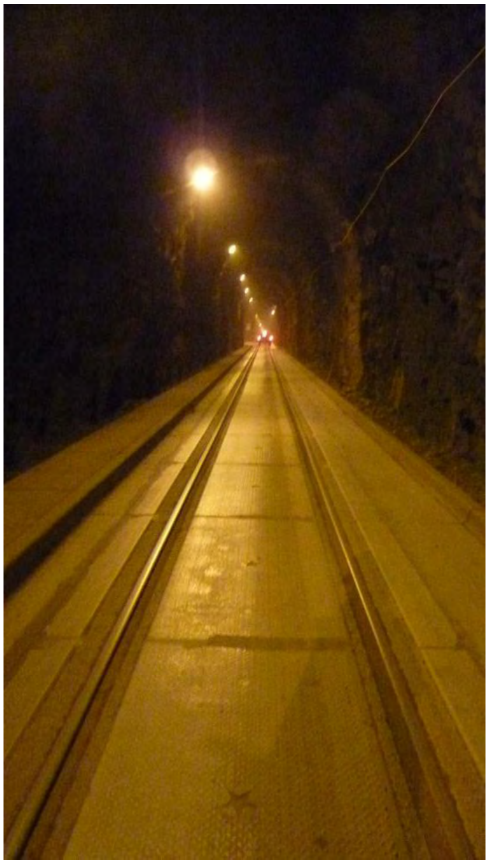
Tel #567 to Tel #571 (12/12)



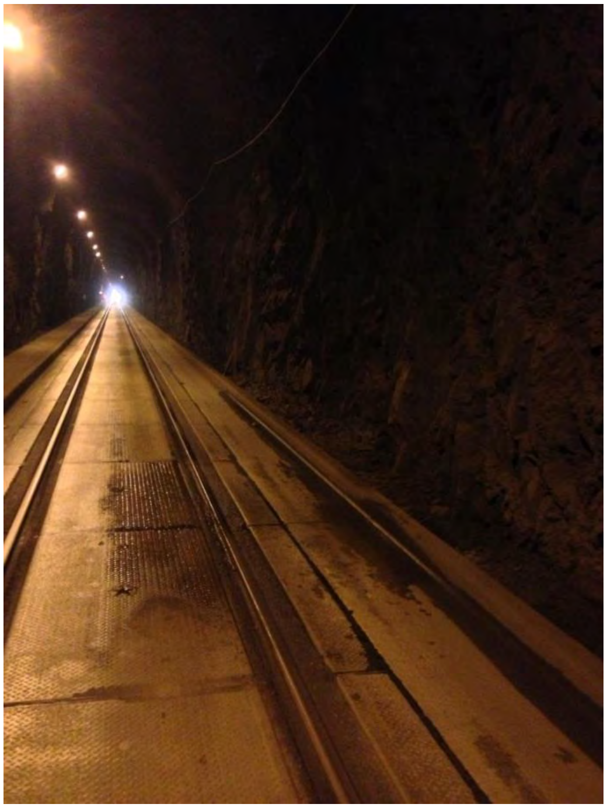
566 – 11 (5/13)

Tel #571 to Tel #572 (12/12)

571-10 (12/12)



Tel #572 to Tel #573 (12/12)

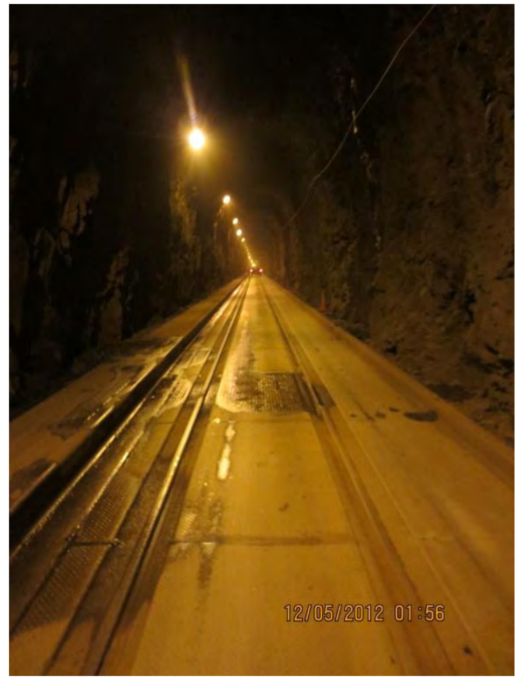


571 – 15 to 16 (12/12)

Tel #573 to SH #7 (3/5/13)

SH #7 to Tel #574 (5/3/13)

Tel #574 to Tel #575 (12/12)

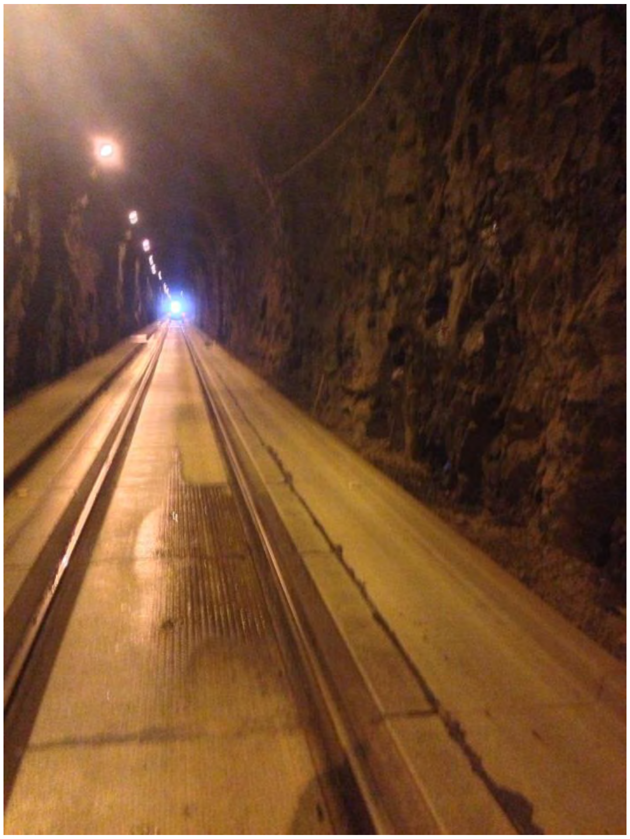


Tel #575 to Tel #576 (12/12)

575-01 to 575-05 (12/12)

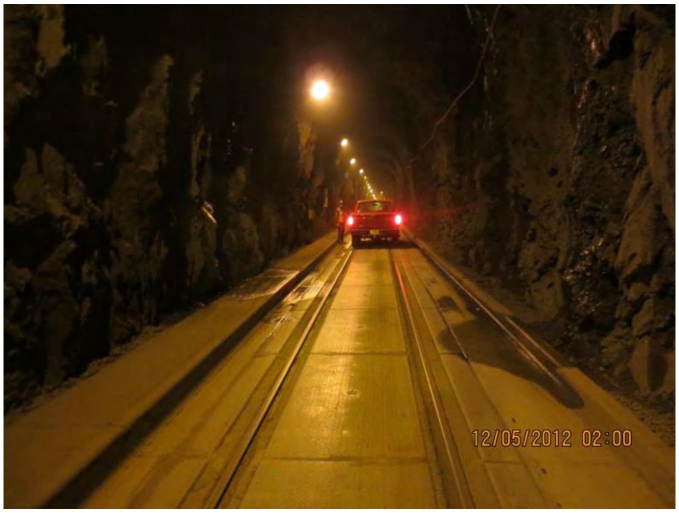
575-30 to 575-34 (12/12)

Tel # 576 to Tel #581



576 – 17 to 19 (5/13)

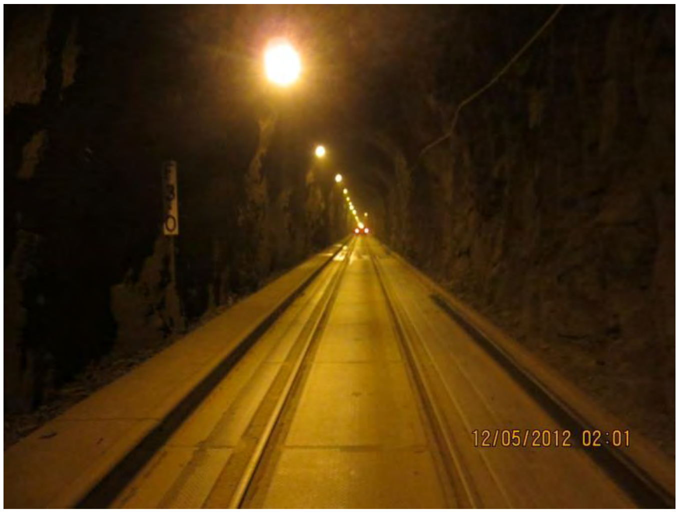
576-17 to 576-19 (12/12)



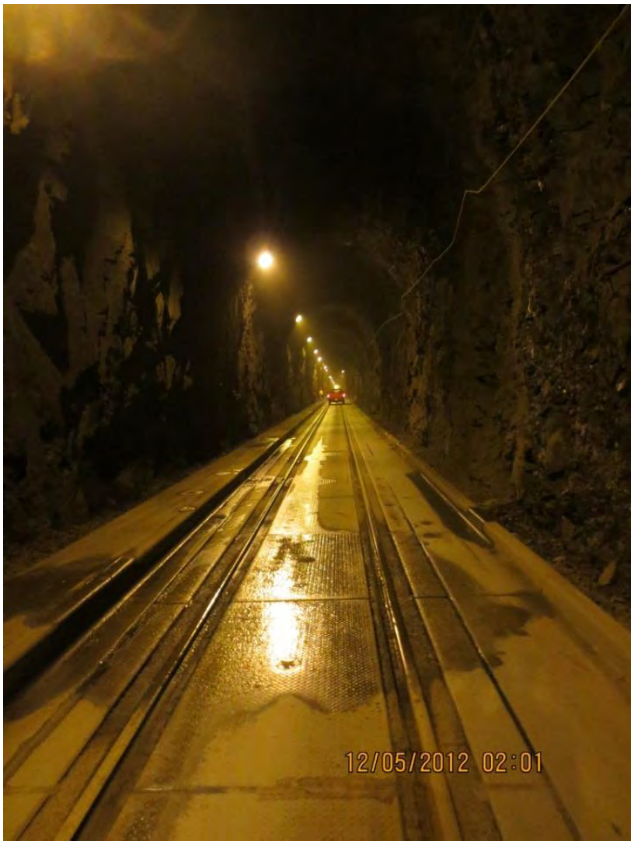
576-32 to 576-35 (12/12)

576 - 32 to 35 (5/13)

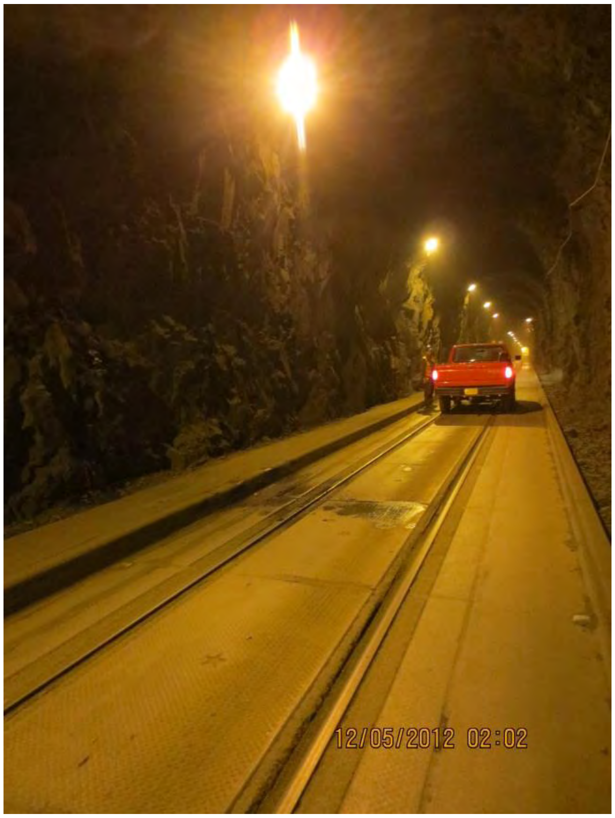
576 – 32 to 35 (5/13)



Tel #581 to Tel #582 (12/12)

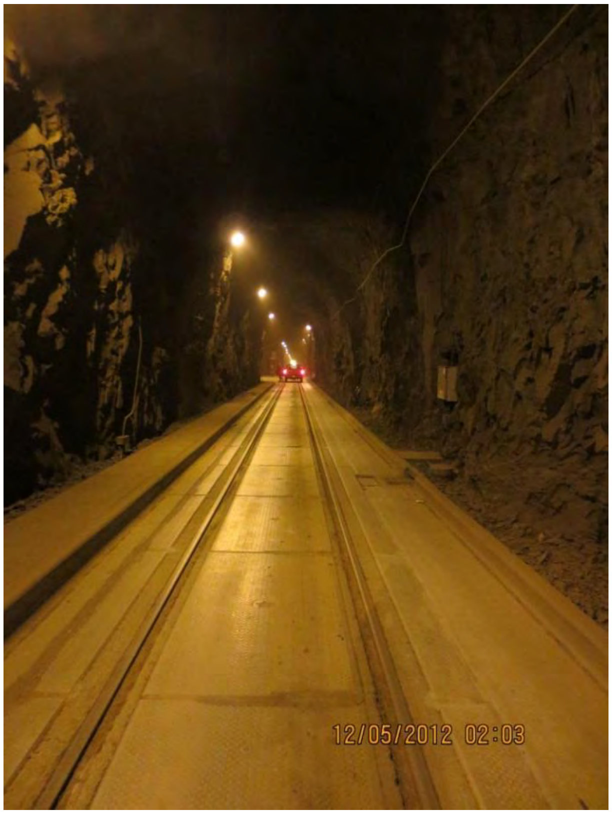


581-11 to 581-20 (12/12)

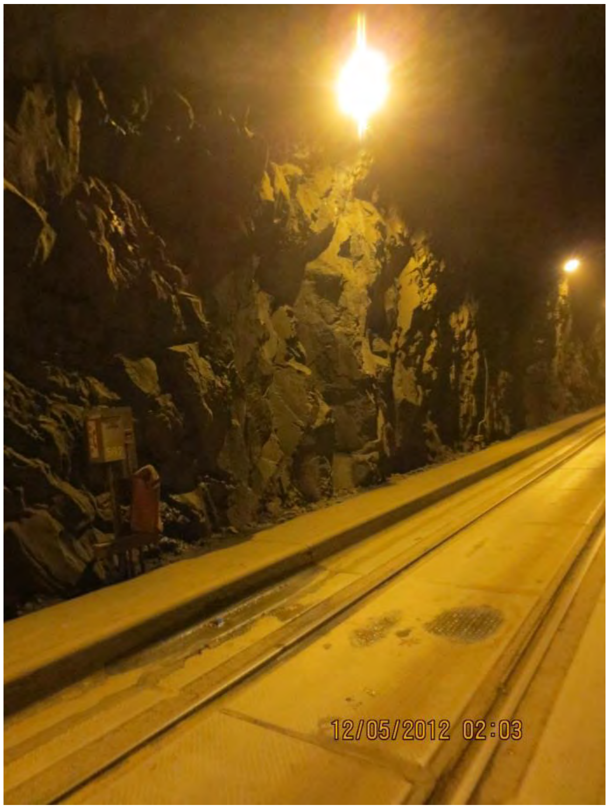


581-36 to 587-37 (12/12)

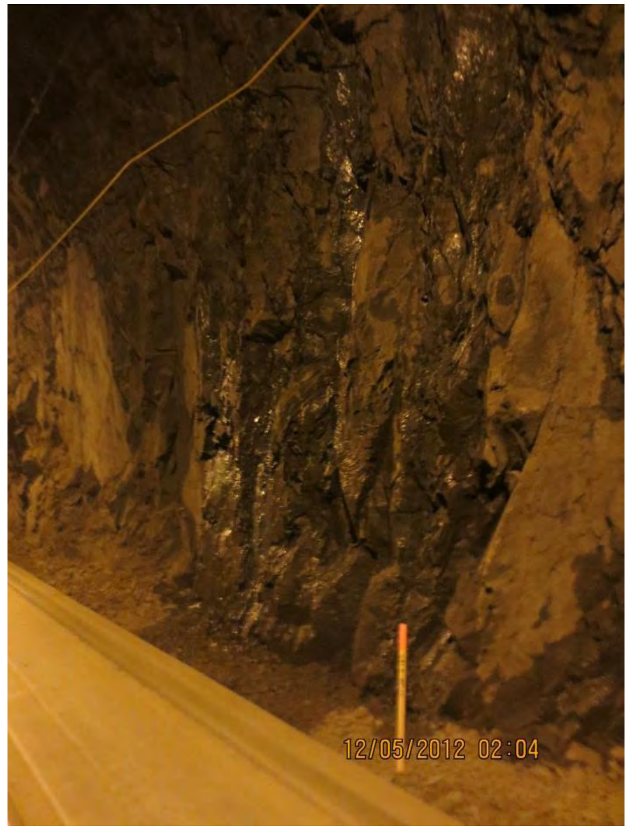
581 – 11 to 20 (5/13)



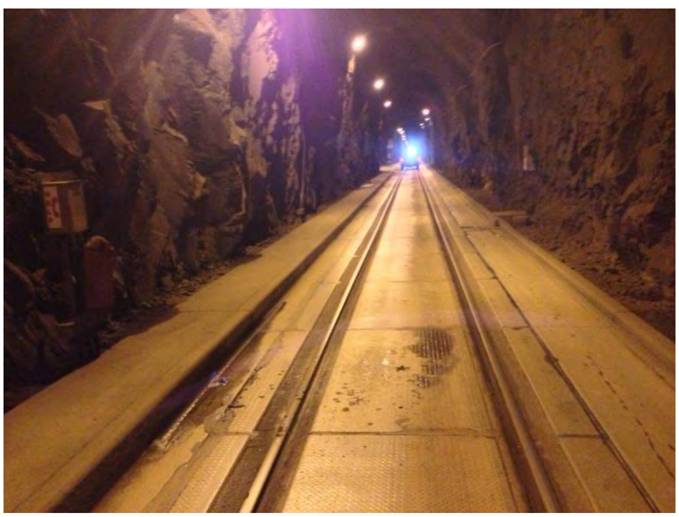
Tel #582 to Tel #583 (12/12)



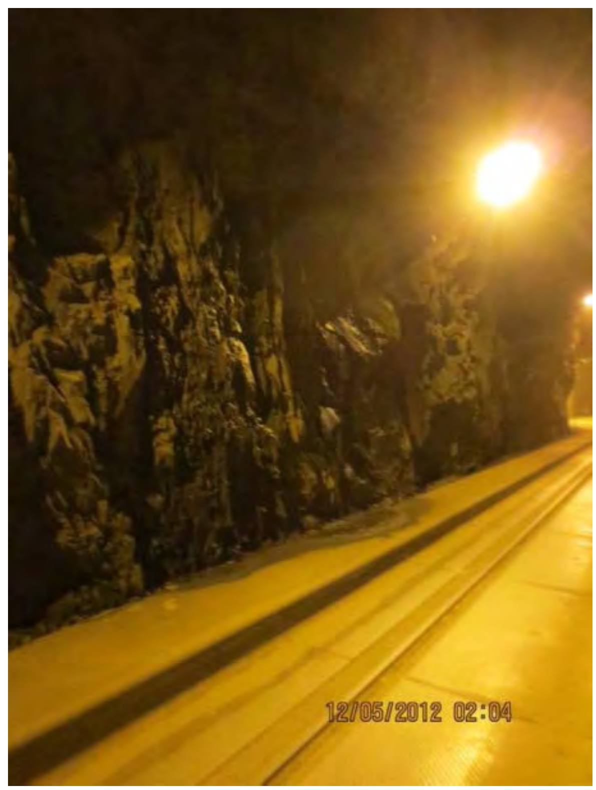
582-01 to 582-02 (12/12)



582-10 (12/12)

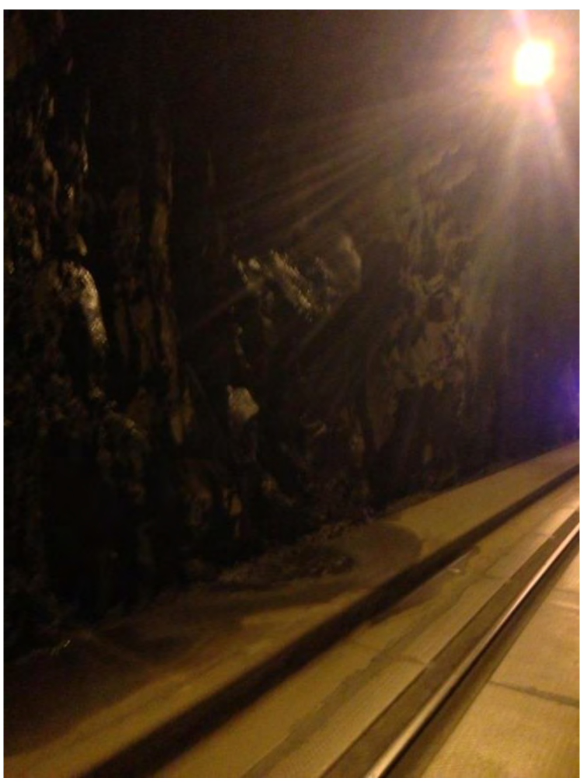


582 – 01 (5/13)

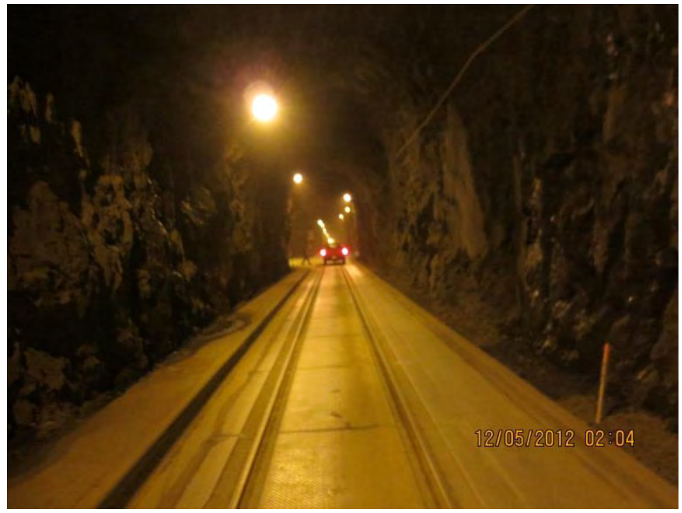


582-10 (12/12)

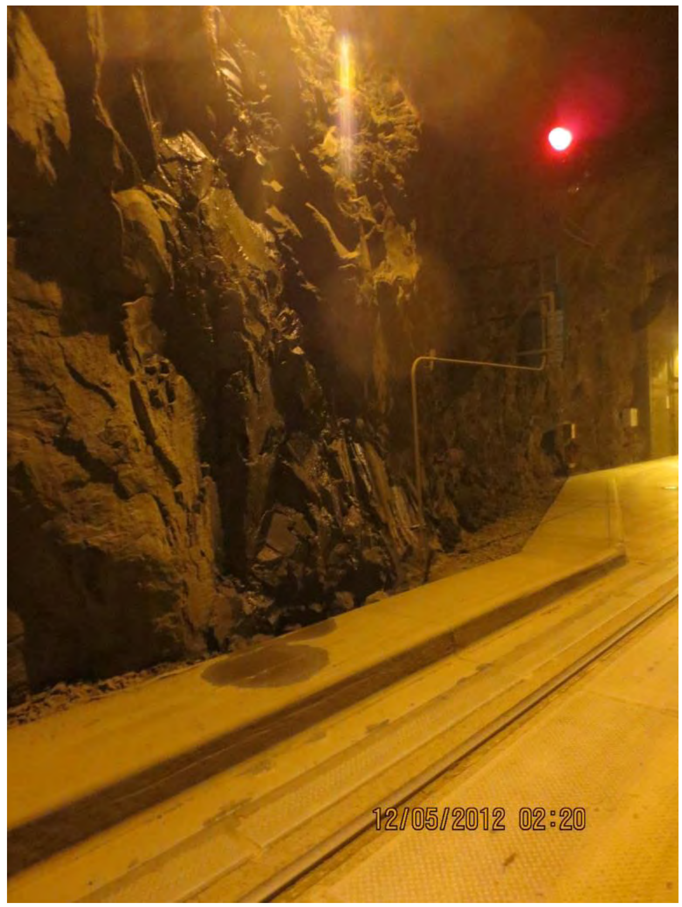
582 -13 (5/13)



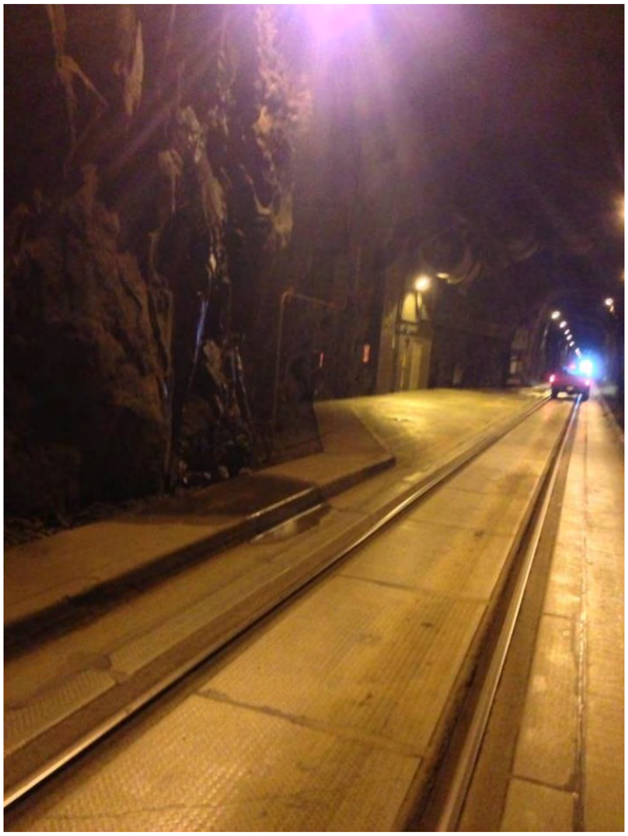
582 – 13 (12/12)



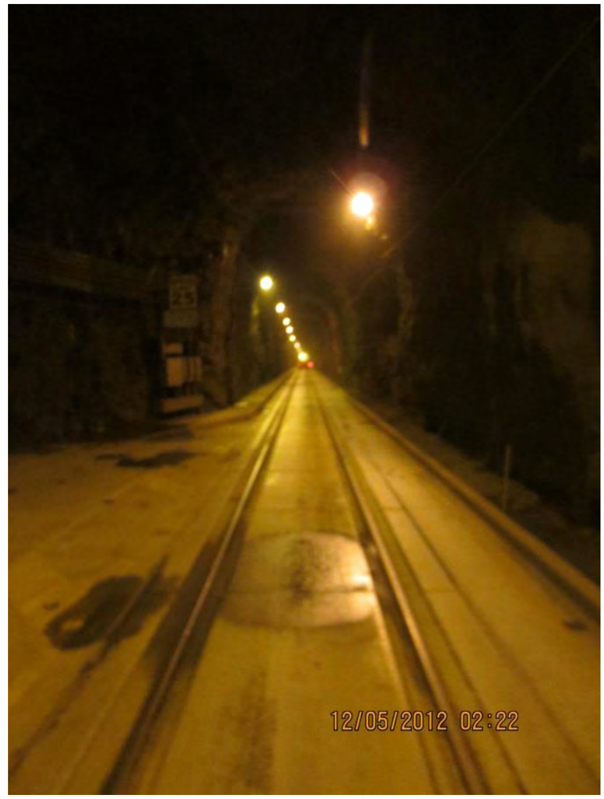
582-10 (12/12)



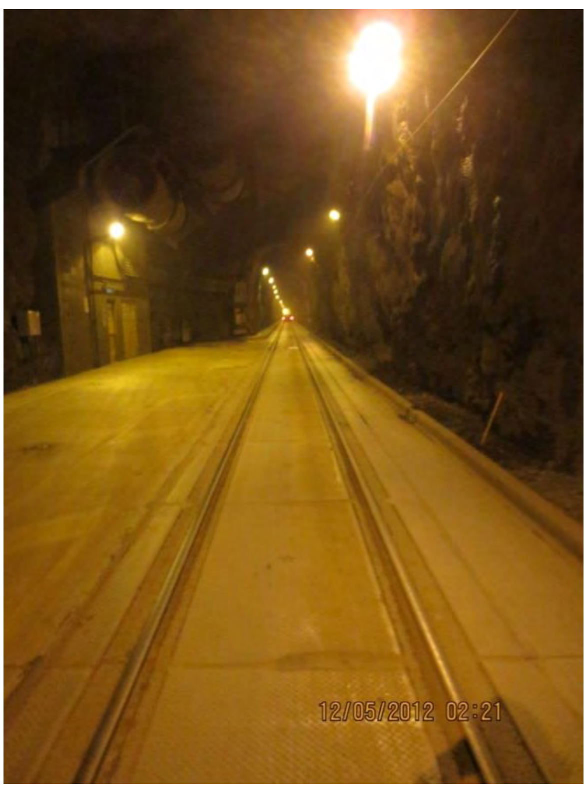
582-20 to 582-21 (12/12)



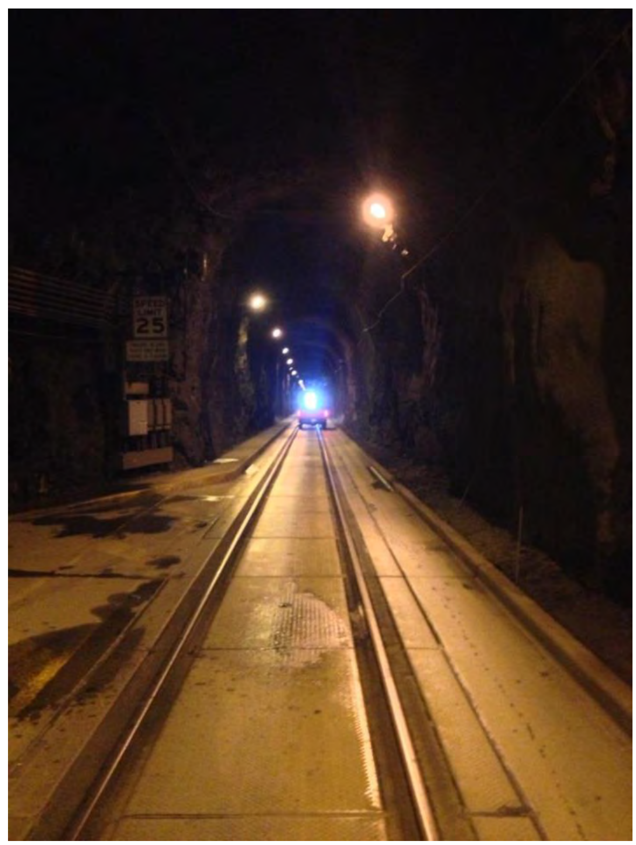
582 – 20 (5/13)



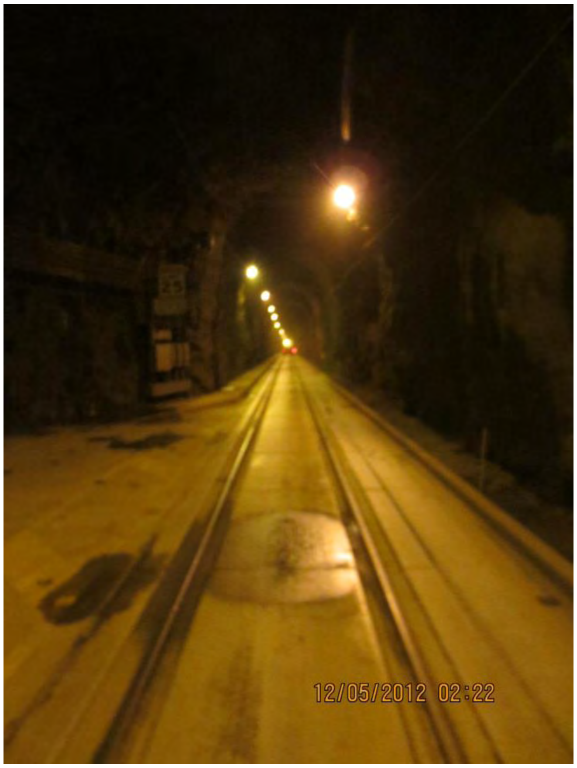
583-09 to 583-10 (12/12)



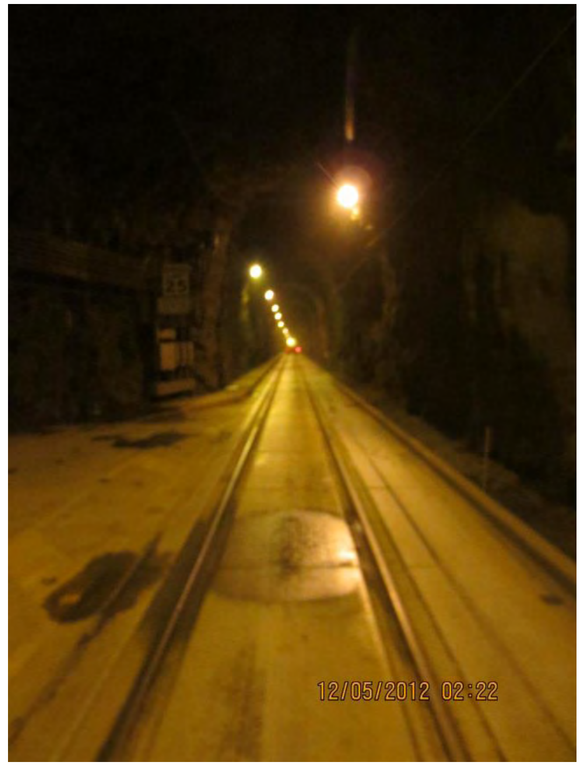
Tel # 583 to SH #8 (12/12)



583 – 09 to 10 (5/13)



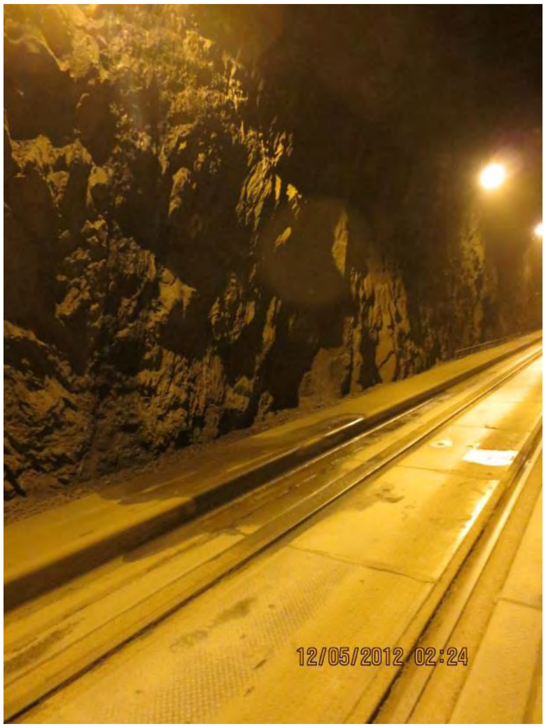
SH #8 to Tel #584 (12/12)



Tel # 584 to T3l 585 (12/12)

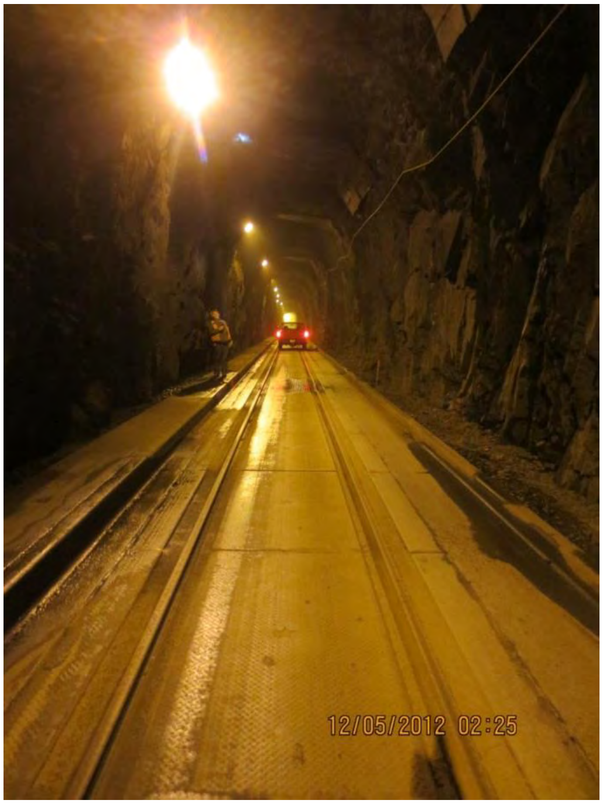
SH #8 to Tel #584 (12/12)

Tel #585 to Tel #586 (3/5/13)

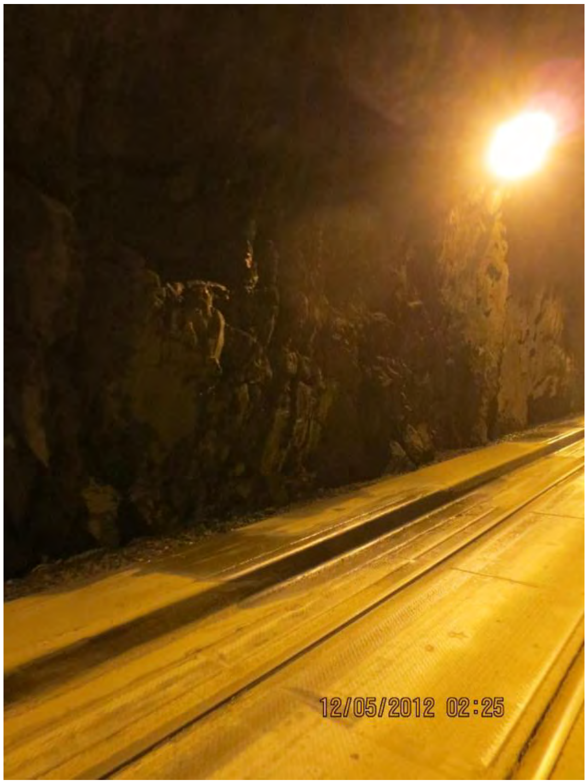


585-09 to 585-10 (12/12)

585 – 9 to 10 (5/13)

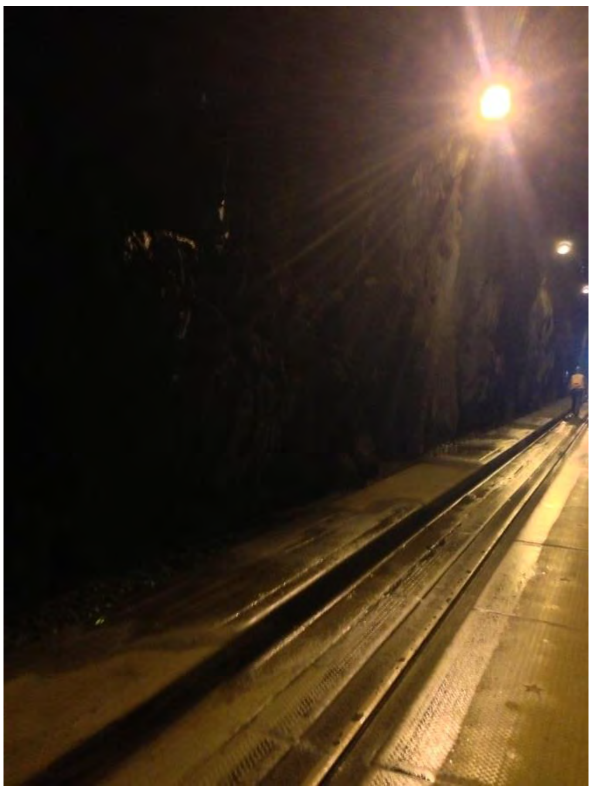


585-26 to 585-33 (12/12)

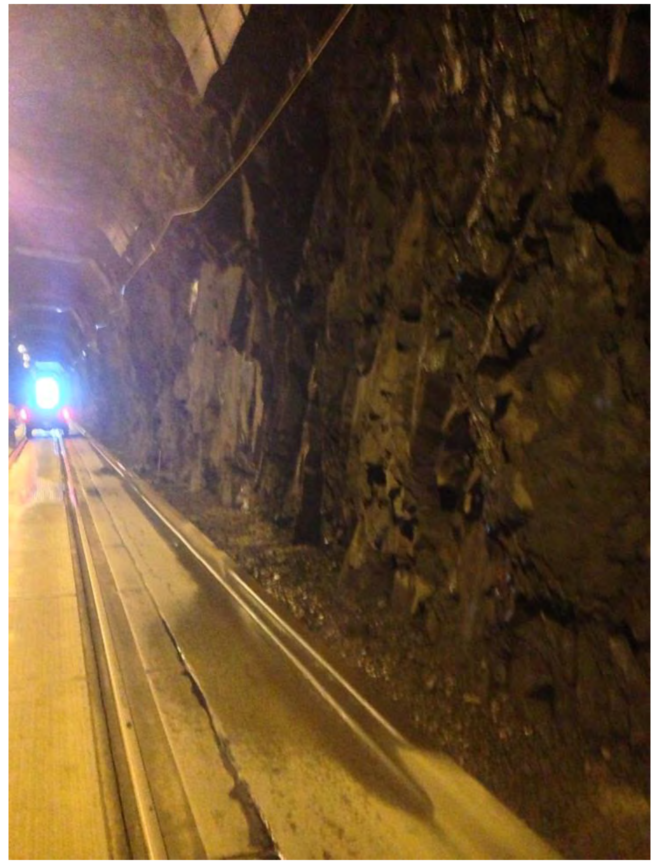


585-26 to 585-33 (12/12)

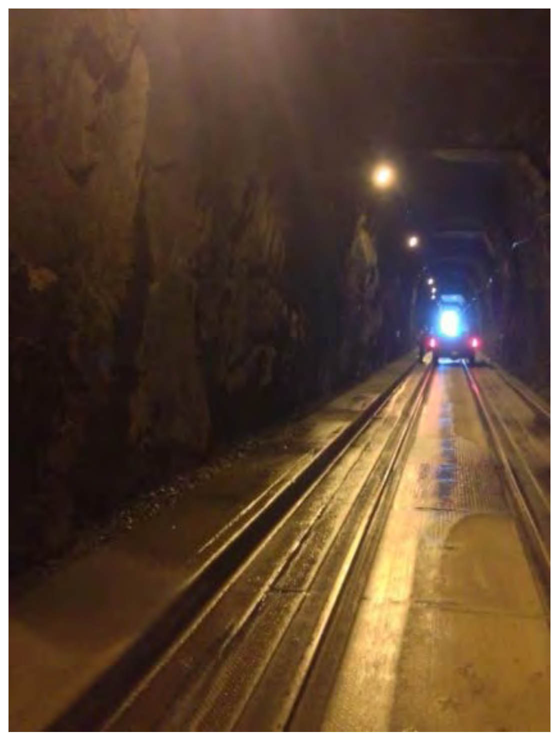
585-26 to 585-33 (12/12)



585 – 26 to 33 (5/13)



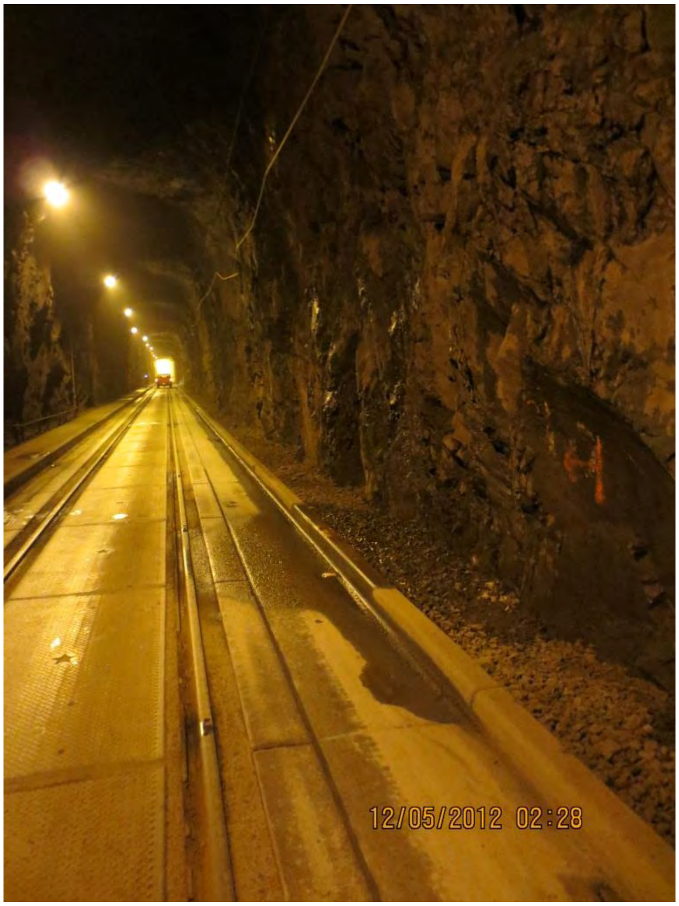
585 – 26 to 33 (5/13)



585 – 26 to 33 (5/13)

Tel #586 to Tel #587 (12/12)

585 – 40 to 586 – 10 (5/13)

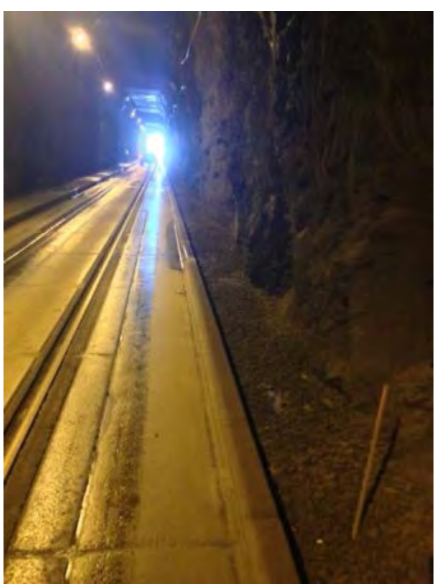


585-40 to 586-06 (12/12)

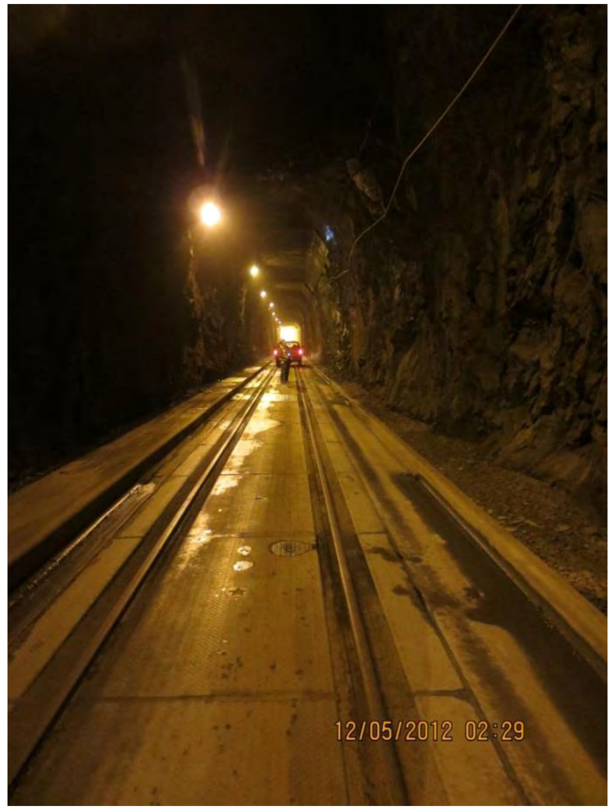
585 – 40 to 586 -06 (5/13)

586-10 (12/12)

586 -10 (5/13)



586 – 10 (5/13)



586-18 to 586-30 (12/12)

586-18 to 586-30 (12/12)

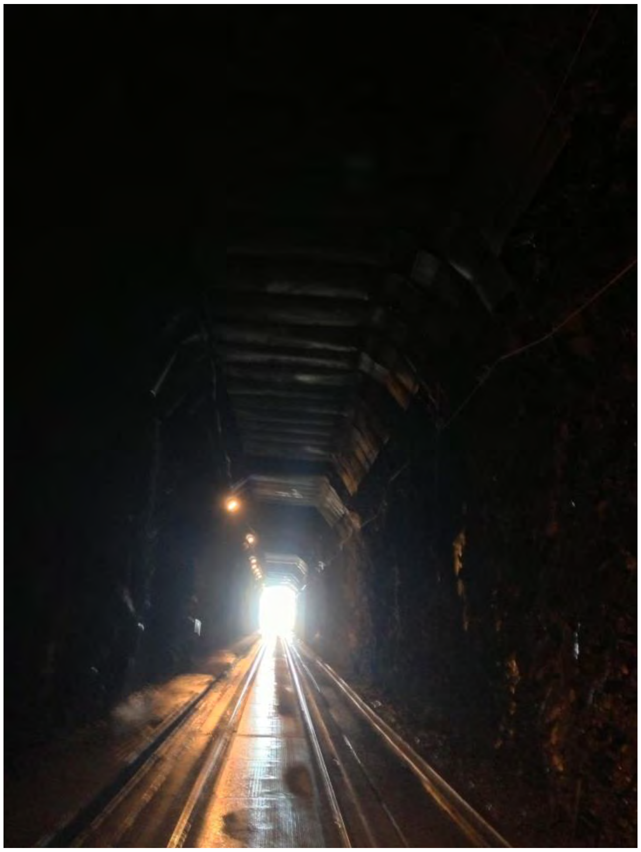
586-18 to 586-30 (12/12)

586 – 18 to 30 (5/13)

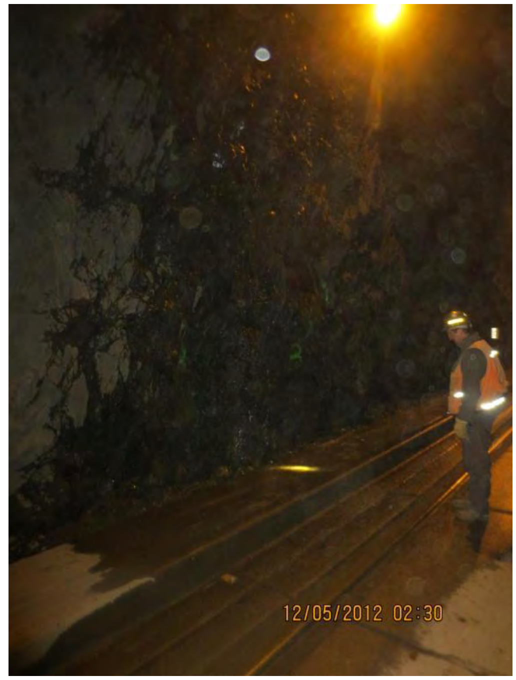
586 – 18 to 30 (5/13)

586 – 18 to 30 (5/13)

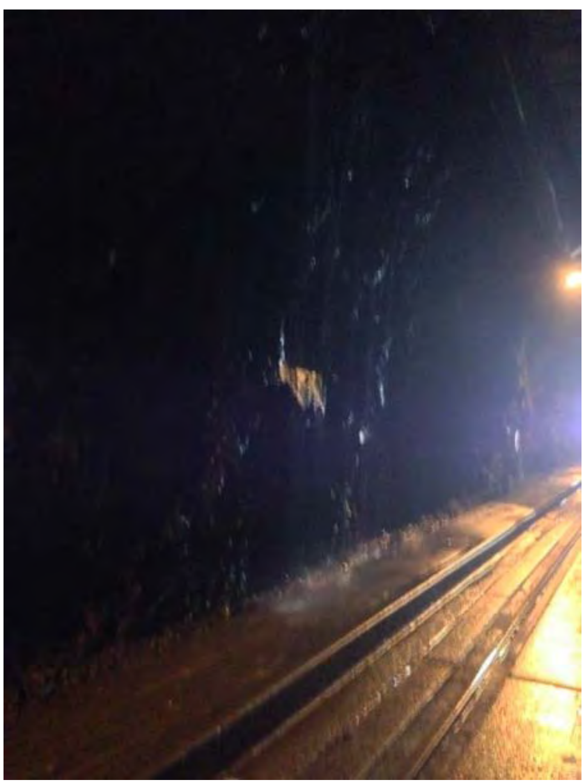
586 – 18 to 30 (5/13)



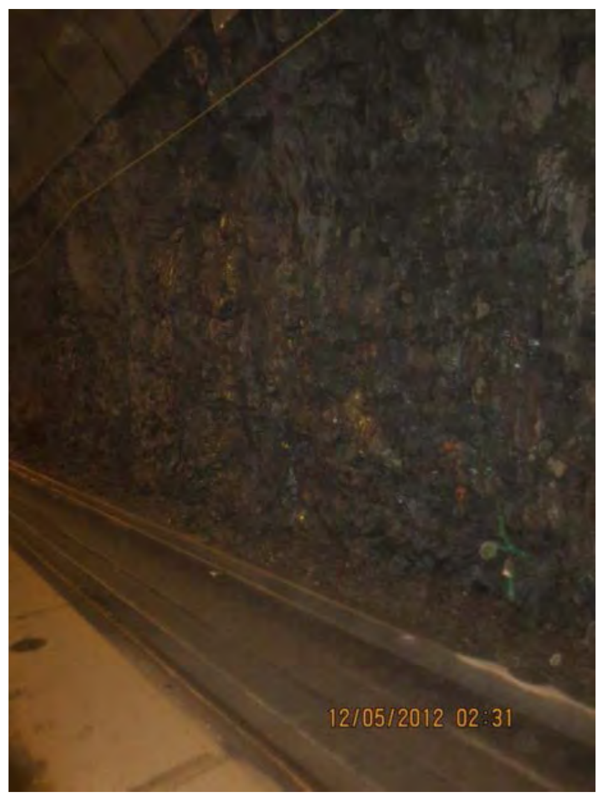
586 – end of pan (5/13)



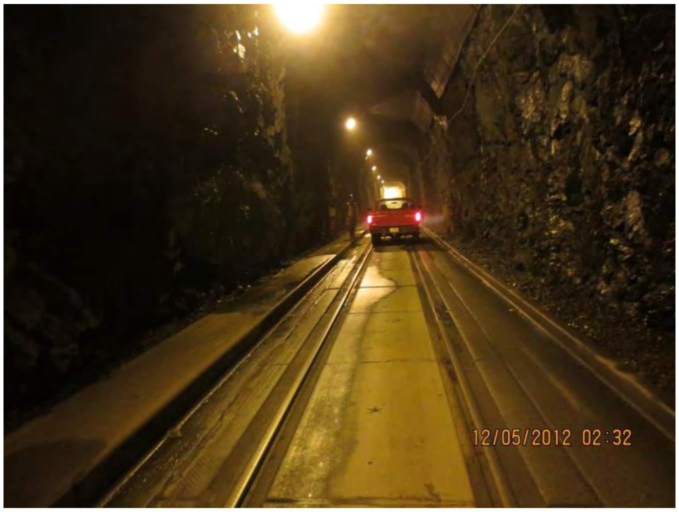
586-30 to 586-38 (12/12)



586 – 28 to 30 (12/12)



586-30 to 586-38 (12/12)



586-30 to 586-38 (12/12)

587 – 01 to 07 (5/13)

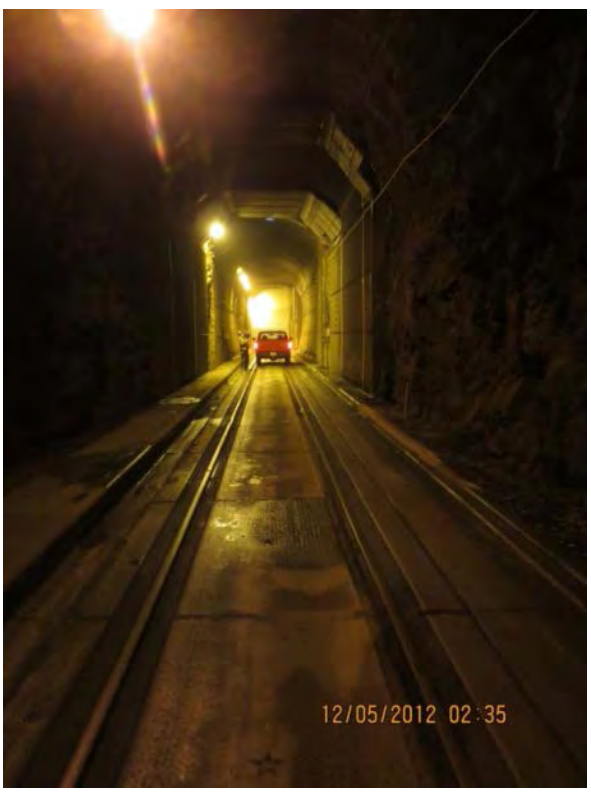
Tel #587 to Tel #588 (12/12)

587-14 to 587-20 (12/12)

587-01 to 587-06 (12/12)

587 – 14 to 20 (5/13)

587 – 14 to 20 (5/13)



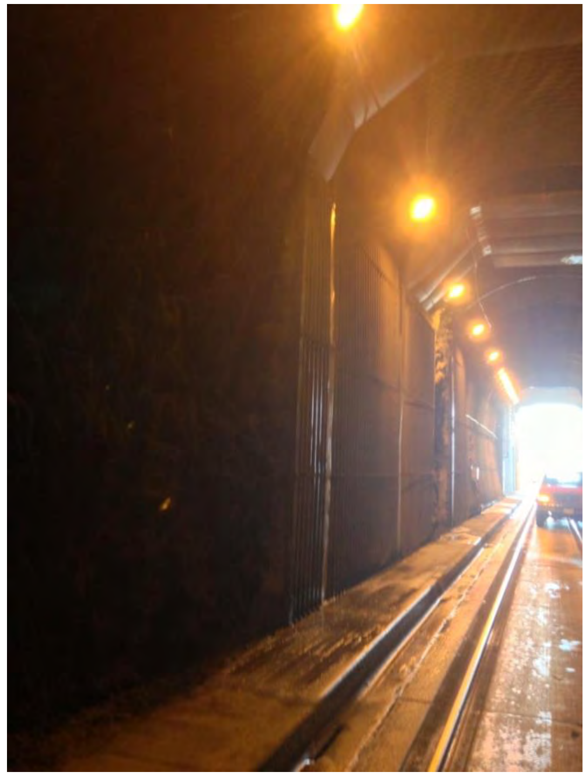
587-27 to 587-29 (12/12)

587-27 to 587-29 (12/12)

587-27 to 587-29 (12/12)

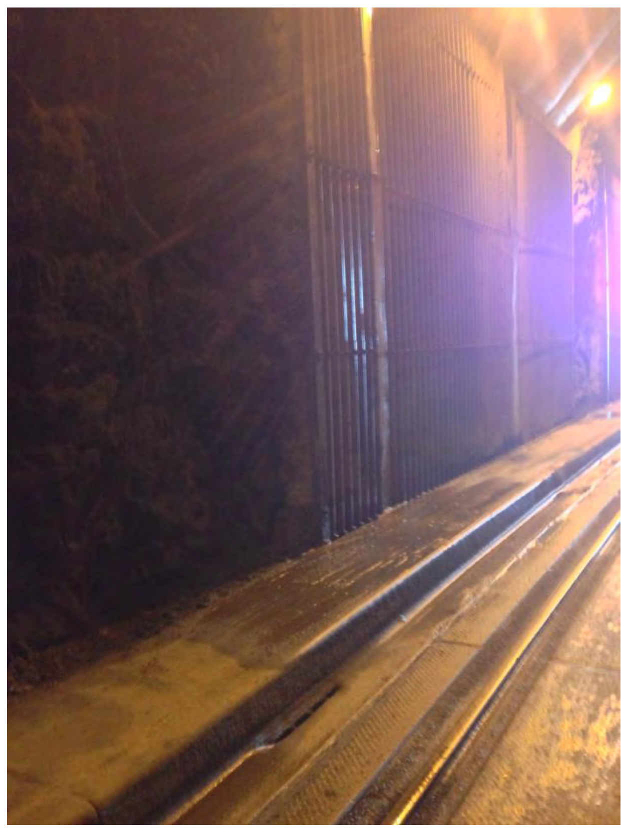
587-27 to 587-29 (12/12)

587 – 27 to 31 (5/13)

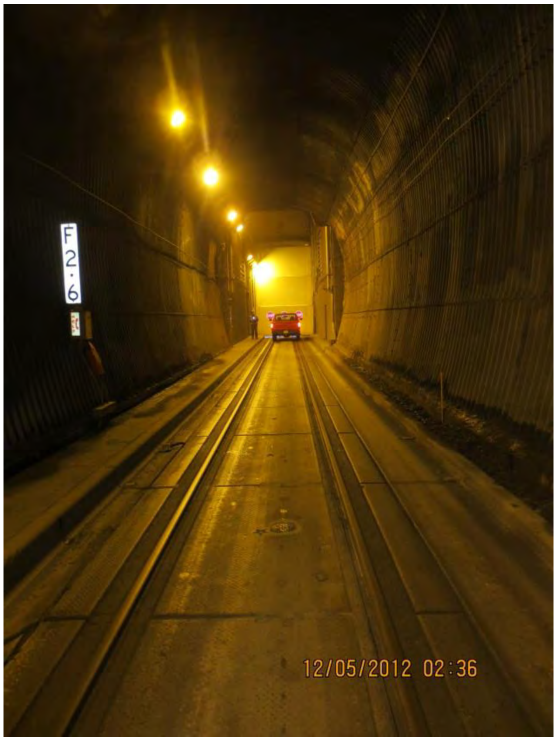


587 – 27 to 31 (5/13)

587 – 27 to 31 (5/13)

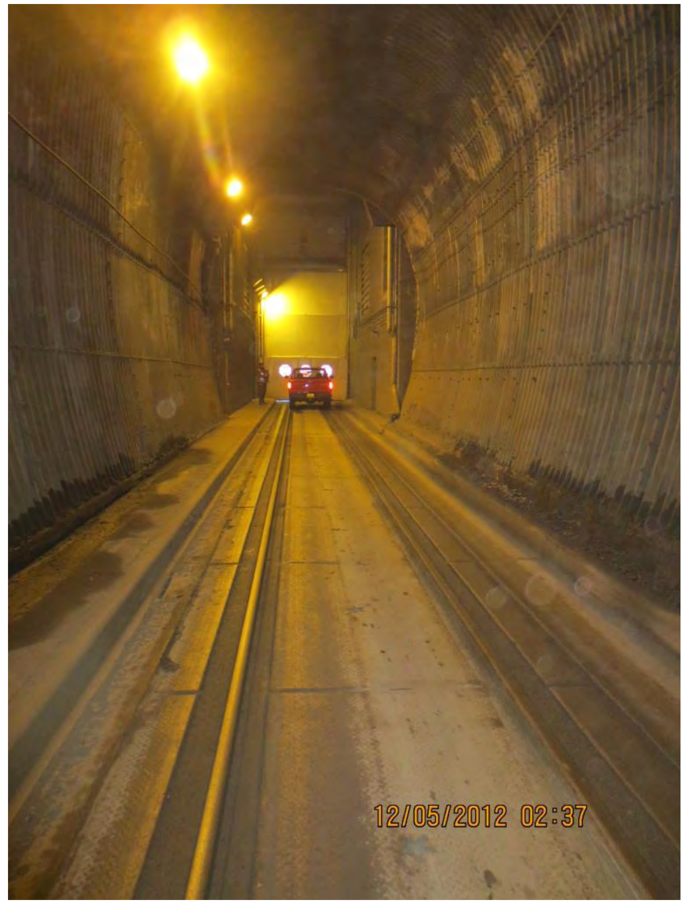


587 – 27 to 31 (5/13)



587-37 (12/12)

587 – 37 (5/13)



Tel #588 to WP (12/12)

Appendix D

Summary of Tunnel Crown Drainage Areas

<u>Legend</u>

NM = No Water

C=Center

L = Left

R= Right

1, 2, 3 = Subjective Magnitude of Water, 3 = highest, 1= lowest

W&I = water and Ice Control

Tunnel Crown - Drainage Summary

Begin	End	Landmark			Pictures				Crown Height			Pans	Voids	Comments
			Begin	End		12/5/12	5/21/13	7/11/13	Lt.	Center	Rt			
BV	BVP													
BVP	511													
511	512													
512	513													
			512-35	512-36		no	L2,R2	L3,R3					NO	
513	514	F5.0												
514	515													
			514-3	514-5		L3,L3	L3	L3,R1					YES	End of W&I control
515	SH #1													
SH #1	516													
516	517													
			516-49	516-51		L2	L2	L2,C1,R1					NO	
517	521	F4.8												
			517-01			no	L2	L1	24.1	26	25.5		NO	
			517-05	517-07		C1	C1	L1,C2,R2					YES	
			517-10			C1	NW						NO	
			517-19			L2	L1	L3					NO	
521	522													
			521-19	521-20		NW	NW	NW					NO	
			521-22			NW	L1	L2					NO	
			521-31	521-33		R1	C1,R1						YES	
522	523													
			522-03	522-04		C1	R1						YES	
			522-14			R1	L2						YES	
			522-24			C1	?	C2,R2					NO	
			522-28			R2	R2	R1					NO	
523	SH #2	SH #2												

Tunnel Crown - Drainage Summary

Begin	End	Landmark				Pictures			Crown Height			Pans	Voids	Comments
			Begin	End		12/5/12	5/21/13	7/11/13	Lt.	Center	Rt			
SH #2	524													
524	525													
			524-08	524-18		L2,R3	L2,R2	L3	24.5	26	24.7	yes	YES	Pans start at 524-11
			524-20	524-29		C2,R3	C1,R2	L3	25.4	25.1	24.7		YES	may be dry btw 23-30
525	533	F4.6												
			525-05	525-07		R2	L2	LS,C1	21.1	23.7	23.3		YES	
			525-20			R1		L1					YES	
533	535													
			533-02	533-09		L2,C1,R2	L2,R2	L2,C3,L2	22.1	22.9	21.1		YES	
			533-15			?	L2	L2	22.3	22.2	23.1		NO	
			533-33	533-34		C1,R2	C2	L2					YES	
535	531	F4.4												
			535-06			C1,R1	C1	C1						
			535-19	535-28		C2,R2	L3,R2	L3	21	22.9	21.4	yes	YES	RT - CALCITE
531	532												YES	
532	SH #3	SH #3												
SH #3	534													
534	536													
			534-04	534-08		L3,C3,R3	L2,C1,R2	L3,C3,R3	21	21.8	22.2		YES	DAMAGED CONCRETE
			534-18	534-20		C2	L2,C2	L3,C3,R2					NO	
536	537													
			536-05	536-07		L2,C2	L2,C2	L3,C2,R1	22.1	22	21.8		NO	DAMAGED CONCRETE
			536-17	536-18		NW	C1	L2,C2					NO	
537	541													
			537-35			C1,R1	L2	L3,C2					YES	
541	542	F4.2												
542	543													
			542-08	542-10		C2	C2	C2,R2	22.3	22.9	21.9		NO	DAMAGED CONCRETE
			542-32					C2						
543	SH #4	SH #4												

Tunnel Crown - Drainage Summary

Begin	End	Landmark			Pictures				Crown Height			Pans	Voids	Comments
			Begin	End		12/5/12	5/21/13	7/11/13	Lt.	Center	Rt			
SH #4	544													
544	545	F4.0												
			544-9	544-11				L2						
			544-28	544-29		R2	R2	C2,R3					NO	
545	546													
			545-2	545-3				L2						
			545-11	524-21		L2,C2,R2	L2,C3,R3	L3,C3,R3	21.6	23.1	22		YES	
			545-36	545-40		L2,C2	L2,C2	L3,C3,R3					YES	
546	551													
			546-6	546-9		no	L2	L3					NO	
			546-27	546-33		L2,C3	L3,C3,R3	L3,C3	21.6	22.9	22.3		YES	
551	552													
			551-2	551-5				L3,C2						
			551-05	551-07		L2	L3	L3,C2					YES	
			551-10	551-14		L2,C2,R2	L3,C2,R3	L3,C3,R3	21.9	23	21.4		YES	
			551-18	551-24		L2,C2	L3,C2	L3,C1					YES	
			551-30	551-36		?	C2	L2,C2					YES	
552	553	F3.8												
			552-01	552-05		L2,C2	L2,C2	L3,C3	21.3	22.3	21.5		NO	
			552-13	552-14		L1,R2	L1,R2	L3,R2	21.7	22.7	21.8		NO	
			552-24	552-26		C2,R2	C2,R2	L2,C2,R2	21.9	22.9	21.9		NO	
553	SH #5	SH #5												

Tunnel Crown - Drainage Summary

Begin	End	Landmark			Pictures				Crown Height			Pans	Voids	Comments
			Begin	End		12/5/12	5/21/13	7/11/13	Lt.	Center	Rt			
SH #5	554													
554	555													
			554-11	554-13		no	L3	L3					YES	
			554-21	554-23		R1	R2	R3					NO	
			554-33	554-34		L2	L2	L2					NO	
555	556													
			555-32	555-33		C1	L1	L2					YES	
556	562	F3.6												
			556-7	556-9		no	L2	L2					NO	
			556-31	556-32		no	C1	NW					NO	
562	563													
			562-03	562-05		L1	L2	L2,C2					YES	
			562-08	562-17		C1,R1	R2	L3.R3					NO	
563	564													
			563-06	563-14		L2,C2,R3	L2,R4	L3,R3	22.8	23.6	21.9		YES	DAMAGED CONCRETE
			563-15	563-28		L2,C3,R4	L3,C3,R3	L3,C3,R3	21.8	22.3	21.5		NO	DAMAGED CONCRETE
564	SH #6	SH #6												
SH #6	565													
565	566													
			565-3	565-4		no	R1	R3	20.9	22.3	21.7		NO	
			565-31	565-33		C2	L2,C2	L3,C2,R1						
566	567	F3.4												
			566-11	566-12		C1	L2,C2	L3,R1	21.9	22.6	20.1		NO	
567	571													
			567-4	567-6				C2						
571	572													
			571-10			C2,R2		NW					NO	
			571-15	571-17			C2,R2	C2,R2					YES	
572	573	F3.2												
573	SH #7	SH #7												

Tunnel Crown - Drainage Summary

Begin	End	Landmark			Pictures				Crown Height			Pans	Voids	Comments
			Begin	End		12/5/12	5/21/13	7/11/13	Lt.	Center	Rt			
SH #7	574													
574	575													
575	576													
			575-01	575-05		L2,C2	L3,C2,R1	L3,C3,R1	20.9	23.1	21.9		NO	
			575-30	575-35		C1,R2	R2	C2					NO	
576	581	F3.0												
			576-17	576-19		C2	C2	L1,C3	21.4	22.4	21		NO	
			576-32	576-35		L2,R2	L2,R2	L3,R2					NO	
581	582													
			581-11	581-20		C3,R2	L2,C3,R2	L3,C3,R2	22.1	22.1	22.2		YES	
			581-36	581-37		C2	C1	C2					YES	
582	583													
			582-01	582-02		C1	C1	C1	21.5	22.1	21.6		YES	
			582-13			L1	L2,R1	L3					NO	
			582-20	582-21		L1	L2	L1					NO	
583	SH #8	SH #8												
			583-09	583-10		C2	L2,C2	L2,L3					YES	

Tunnel Crown - Drainage Summary

Begin	End	Landmark				Pictures			Crown Height			Pans	Voids	Comments
			Begin	End		12/5/12	5/21/13	7/11/13	Lt.	Center	Rt			
SH #8	584													
584	585	F2.8												
			584-4	584-6				L1,R1						
585	586													
			585-06	585-11		L2	R2	L3,R1	20.9	21.7	21.6		NO	
			585-26	585-33		L2,C3,R2	L3,C3,R3	L3,C3,R3	22	21.4	21.4	YES	YES	
586	587													
			585-40	586-06		R3	C3,R4	L2,C3,R3	21.3	21.8	21.9	YES	YES	
			586-10			C1,R2	R2	NW	22.3	22.4	20.9		YES	
			586-18	586-30		L2,C2,R3	L2,C4,R4	L3,C4,R4	21.7				YES	
			586-30	586-38		L4,R4	L3,C3,R3	L3,C4,R4	21.1	22.1	21.7	YES	YES	car wash
587	588													
			587-01	587-06		L2,R2	L3,R3	L3,R2	22.1	21.7	21.5		YES	
			587-14	587-20		R2	R2	R1	23.5	23.8	22.7	YES	YES	
			587-27	587-31		L2,C2,R3	L3,C2,R3	C1,R2	21.9	22.4	21.4	YES	YES	
			587-36	587-37			R3	R3					YES	
588	WP	F2.6												
WP	Whit													

Appendix E

Tunnel Inspection Reports

Legend

PN = Panel Number

SH = Safe House

IC = Ice Control

W(x) = Subjective Severity of Water Draining from Crown

W3 = Significant Water Draining From Crown

W1= Minor Amount of Water Draining from Crown

Whittier Tunnel Inspection Summary

Begin	End	Land mark	Length		Seals	Wet Areas (Panels)					Crack	Storm Drains		Comments			
			Panels	Feet	%	4	3	2	1	side	Pan.	N (in)	S (in)				
Bear V	BV Port		15	113	100%	0	0	0	0	0	0					3998.00	
BV Port	511		23	173	100%	0	0	0	0	0	3						
511	512		38	285		0	0	0	0	0	8						
512	513		36	270		0	0	3	0	0	7						
513	514	F5.0	41	308		0	0	2	0	0	15	0.4	1.3				
514	515		39	293		0	3	1	0	0	5	0.8	1.9		1518		
515	516	SH #1	10	75		0	0	0	0	0	3	2			462.6	4457.79	460
516	517		59	443		0	3	7	0	0	8		1.4				
517	521	F4.8	21	158		0	5	2	0	0	2						
521	522		38	285		0	7	3	0	0	5			PN# 521-37 & 38 settled			
522	523		40	300		0	4	5	2	3	5		2.4	PN# 522-01-20 settled	1262	380.00	
523	524	SH #2	10	75		0	1	0	0	0	3	1.5			384.7	4837.79	380
524	525		38	285		7	12	2	0	3	5			Broken Rail - PN# 525-16			
525	533	F4.6	40	300		0	3	2	0	0	9			Broken Rail · F4.6 PN# 525-01			
533	535		37	278		0	10	1	0	5	9						
535	531	F4.4	43	323		2	8	3	0	0	7						
531	532		37	278		0	0	0	0	2	9	2	1.3		1540	471.00	
532	534	SH #3	10	75		0	0	0	0	0	6	3	1	Rail Settlement PN#-01 to 10	469.5	5308.79	471
534	536		40	300		2	3	7	0	0	10	2	1				
536	537		40	300		0	4	1	0	0	11						
537	541		38	285		0	1	0	4	1	9						
541	542	F4.2	39	293		0	0	0	1	0	9			F4.2 2 PN# 541-01	1570		
542	543		42	315		0	2	1	0	1	8	1.8	2.4		478.6	478.21	
543	544	SH #4	10	75		0	0	0	0	0	1	2.25		Joint Bar - Pl Broken Rail		5787.00	478
544	545	F4.0	40	300		0	2	0	0	1	8	1.8	1.3				
545	546		41	308		0	10	0	2	0	8						
546	551		37	278		2	5	0	0	2	5						
551	552		39	293		3	14	5	1	0	4						
552	553	F3.8	41	308		4	6	0	0	0	6	0.9	0.8		1563	475.79	
553	554	SH #5	10	75		0	0	0	0	0	1	2.75			476.3	6262.79	476

554	555		37	278	0	4	3	0	0	7	2.25	0.9				
555	556		40	300	0	3	0	0	0	1						
556	562	F3.6	41	308	0	2	2	0	0	3						
562	563		39	293	0	2	2	0	0	3						
563	564		44	330	7	5	2	0	0	5	0.6	0.4	? # of Panels	1585	485.00	
564	565	SH #6	10	75	0	0	0	0	0	2	2.75			483.2	6747.79	485
565	566		41	308	0	1	2	0	0	10	1.3	1				
566	567	F3.4	40	300	0	1	1	0	0	5						
567	571		37	278	0	0	0	2	0	3						
571	572		42	315	0	0	3	0	3	2						
572	573	F3.2	42	315	0	0	2	0	2	3	1.6	1	South SD 10"		485.00	
573	574	SH #7	10	75	0	0	0	0	0	1	2.75			485.5	7232.79	485
574	575		40	300	0	0	0	0	0	4	1.9	1.1				
575	576		38	285	2	4	2	2	0	2						
576	581	F3.0	38	285	0	6	0	0	1	1						
581	582		41	308	7	3	2	0	2	6						
582	583		26	195	0	4	0	0	3	2	1.8	1	South SD 10"	1450	450.00	
583	584	SH #8	10	75	0	2	0	0	0	2	2.75			442	7682.79	450
584	585	F2.8	40	300	0	0	3	0	4	6						
585	586		40	300	4	6	5	2	2	1						
586	587		38	285	11	12	4	0	0	6			Car Wash - PN# 586-28-38			
587	588		40	300	0	4	10	3	1	3	1.9	2.6	1.5" drain			
588	W Portal	F2.6	19	143	0	0	0	0	0	0	1.1	1		1465	458.21	
W Portal	Whittier		18	135	0	0	0	0	0	0				446.6	8141.00	458
			1803	13523	51	162	88	19	36	267						
					2.8%	9.0%	4.9%	1.1%	2.0%	14.8%						
					383	1215	660	143	270							

Whittier Tunnel Inspection Summary

Begin	End	Land mark	Length		Seals	Wet Areas (Panels)					Crack	Storm Drains		Comments			
			Panels	Feet	%	4	3	2	1	side	Pan.	N (in)	S (in)				
Bear V	BV Port		15	113	100%	0	0	0	0	0	0					3998.00	
BV Port	511		23	173	100%	0	0	0	0	0	3						
511	512		38	285		0	0	0	0	0	8						
512	513		36	270		0	0	3	0	0	7						
513	514	F5.0	41	308		0	0	2	0	0	15	0.4	1.3				
514	515		39	293		0	3	1	0	0	5	0.8	1.9		1518		
515	516	SH #1	10	75		0	0	0	0	0	3	2			462.6	4457.79	460
516	517		59	443		0	3	7	0	0	8		1.4				
517	521	F4.8	21	158		0	5	2	0	0	2						
521	522		38	285		0	7	3	0	0	5			PN# 521-37 & 38 settled			
522	523		40	300		0	4	5	2	3	5		2.4	PN# 522-01-20 settled	1262	380.00	
523	524	SH #2	10	75		0	1	0	0	0	3	1.5			384.7	4837.79	380
524	525		38	285		7	12	2	0	3	5			Broken Rail - PN# 525-16			
525	533	F4.6	40	300		0	3	2	0	0	9			Broken Rail · F4.6 PN# 525-01			
533	535		37	278		0	10	1	0	5	9						
535	531	F4.4	43	323		2	8	3	0	0	7						
531	532		37	278		0	0	0	0	2	9	2	1.3		1540	471.00	
532	534	SH #3	10	75		0	0	0	0	0	6	3	1	Rail Settlement PN#-01 to 10	469.5	5308.79	471
534	536		40	300		2	3	7	0	0	10	2	1				
536	537		40	300		0	4	1	0	0	11						
537	541		38	285		0	1	0	4	1	9						
541	542	F4.2	39	293		0	0	0	1	0	9			F4.2 2 PN# 541-01	1570		
542	543		42	315		0	2	1	0	1	8	1.8	2.4		478.6	478.21	
543	544	SH #4	10	75		0	0	0	0	0	1	2.25		Joint Bar - Pl Broken Rail		5787.00	478
544	545	F4.0	40	300		0	2	0	0	1	8	1.8	1.3				
545	546		41	308		0	10	0	2	0	8						
546	551		37	278		2	5	0	0	2	5						
551	552		39	293		3	14	5	1	0	4						
552	553	F3.8	41	308		4	6	0	0	0	6	0.9	0.8		1563	475.79	
553	554	SH #5	10	75		0	0	0	0	0	1	2.75			476.3	6262.79	476

554	555		37	278	0	4	3	0	0	7	2.25	0.9					
555	556		40	300	0	3	0	0	0	1							
556	562	F3.6	41	308	0	2	2	0	0	3							
562	563		39	293	0	2	2	0	0	3							
563	564		44	330	7	5	2	0	0	5	0.6	0.4	? # of Panels	1585	485.00		
564	565	SH #6	10	75	0	0	0	0	0	2	2.75			483.2	6747.79	485	
565	566		41	308	0	1	2	0	0	10	1.3	1					
566	567	F3.4	40	300	0	1	1	0	0	5							
567	571		37	278	0	0	0	2	0	3							
571	572		42	315	0	0	3	0	3	2							
572	573	F3.2	42	315	0	0	2	0	2	3	1.6	1	South SD 10"		485.00		
573	574	SH #7	10	75	0	0	0	0	0	1	2.75			485.5	7232.79	485	
574	575		40	300	0	0	0	0	0	4	1.9	1.1					
575	576		38	285	2	4	2	2	0	2							
576	581	F3.0	38	285	0	6	0	0	1	1							
581	582		41	308	7	3	2	0	2	6							
582	583		26	195	0	4	0	0	3	2	1.8	1	South SD 10"	1450	450.00		
583	584	SH #8	10	75	0	2	0	0	0	2	2.75			442	7682.79	450	
584	585	F2.8	40	300	0	0	3	0	4	6							
585	586		40	300	4	6	5	2	2	1							
586	587		38	285	11	12	4	0	0	6			Car Wash - PN# 586-28-38				
587	588		40	300	0	4	10	3	1	3	1.9	2.6	1.5" drain				
588	W Portal	F2.6	19	143	0	0	0	0	0	0	1.1	1		1465	458.21		
W Portal	Whittier		18	135	0	0	0	0	0	0				446.6	8141.00	458	
			1803	13523	51	162	88	19	36	267							
					2.8%	9.0%	4.9%	1.1%	2.0%	14.8%							
					383	1215	660	143	270								

WHITTIER TUNNEL INSPECTION FORM

Tele # **516A** Sta 4,457.8 **Panel Cracks** 4,471.4

#	Sta	Seals	Drain N	Drain S	W&I	TM	BW	Dam	Other
1	4,471.4								
2	4,473.6								
3	4,475.9								
4	4,478.2					2			
5	4,480.5								
6	4,482.8				w2				
7	4,485.1								
8	4,487.4								
9	4,489.7								
10	4,492.0								
11	4,494.3								
12	4,496.5								
13	4,498.8								
14	4,501.1					2			
15	4,503.4		1.4						
16	4,505.7				w	3			
17	4,508.0								
18	4,510.3				IC-8				
19	4,512.6				IC-8	2			
20	4,514.9				IC-8				
21	4,517.2				w2				
22	4,519.4				w2				
23	4,521.7				w2				
24	4,524.0								
25	4,526.3								
26	4,528.6								
27	4,530.9					2			
28	4,533.2								
29	4,535.5								
30	4,537.8					2			
31	4,540.1								
32	4,542.3								
33	4,544.6								
34	4,546.9								
35	4,549.2					2			
36	4,551.5								
37	4,553.8								
38	4,556.1				w2				
39	4,558.4								
40	4,560.7								
41	4,563.0								
42	4,565.2				w2				
43	4,567.5								
44	4,569.8					2			
45	4,572.1								

Tele # **516B** Sta **Pa**

#	Sta	Seals	Drain N	Drain S	W&I	TM
46	4,574.4					
47	4,576.7					
48	4,579.0					
49	4,581.3				w3	
50	4,583.6				w3	
51	4,585.9				w3	
52	4,588.1				IC-9	
53	4,590.4				IC-9	
54	4,592.7					
55	4,595.0				IC-10	
56	4,597.3				IC-10	
57	4,599.6				IC-10	
58	4,601.9				IC-10	
59	4,604.2					

w4	w3	w2	w1	ws	CP
	3	7			8

WHITTIER TUNNEL INSPECTION FORM

nel Cracks | 13.4 | Tele # 517 | Sta | Panel Cracks 0.000 | Tele #

BW	Dam	Other	#	Sta	Seals	Drain N	Drain S	W&I	TM	BW	Dam	Other		#	Sta
			1	4,606.5				w2	2					1	4,652.3
			2	4,608.8				IC-11						2	4,654.6
			3	4,611.0				IC-11						3	4,656.8
			4	4,613.3				IC-11						4	4,659.1
			5	4,615.6				w3						5	4,661.4
			6	4,617.9				w3						6	4,663.7
			7	4,620.2				w3						7	4,666.0
			8	4,622.5				IC-12						8	4,668.3
			9	4,624.8				IC-12						9	4,670.6
			10	4,627.1				w3						10	4,672.9
			11	4,629.4										11	4,675.2
			12	4,631.7										12	4,677.5
			13	4,633.9										13	4,679.7
			14	4,636.2										14	4,682.0
			15	4,638.5										15	4,684.3
			16	4,640.8										16	4,686.6
			17	4,643.1				IC-13						17	4,688.9
			18	4,645.4				IC-13	2					18	4,691.2
			19	4,647.7				w3						19	4,693.5
			20	4,650.0										20	4,695.8
														21	4,698.1
														22	4,700.4
														23	4,702.6
														24	4,704.9
														25	4,707.2
														26	4,709.5
														27	4,711.8
														28	4,714.1
														29	4,716.4
														30	4,718.7
														31	4,721.0
														32	4,723.3
														33	4,725.5
														34	4,727.8
														35	4,730.1
														36	4,732.4
														37	4,734.7
														38	4,737.0
				w4	w3	w2	w1	ws	CP						w4
					5	2			2						

WHITTIER TUNNEL INSPECTION FORM

521 Sta **Panel Cracks** **0.000** Tele # **522** Sta **Panel Cracks**

Seals	Drain		W&I	TM	BW	Dam	Other	#	Sta	Seals	Drain		W&I	TM	BW	Dam
	N	S									N	S				
								1	4,739.3							
								2	4,741.6					2		
								3	4,743.9				w3			
								4	4,746.2				w3	4		
								5	4,748.4							
				2				6	4,750.7				w2			
								7	4,753.0				IC-15	2		
								8	4,755.3				IC-15			
			w3					9	4,757.6				w2			
			w3	2				10	4,759.9							
								11	4,762.2							
				2				12	4,764.5							
			w2					13	4,766.8							
			w2					14	4,769.1				ws			
								15	4,771.3				ws			
								16	4,773.6							
								17	4,775.9							
								18	4,778.2				IC-16			
				2				19	4,780.5				IC-16			
							Settlement	20	4,782.8				w2			
			w2	2			Settlement	21	4,785.1							
							Settlement	22	4,787.4							
							Settlement	23	4,789.7				w2			
			w3				Settlement	24	4,792.0				w3			
			IC-14				Settlement	25	4,794.2				IC-17			
			IC-14				Settlement	26	4,796.5				IC-17			
			IC-14				Settlement	27	4,798.8				IC-17			
			IC-14				Settlement	28	4,801.1				w3			
			IC-14				Settlement	29	4,803.4				IC -18			
			IC-14				Settlement	30	4,805.7							
			w3				Settlement	31	4,808.0							
			w3				Settlement	32	4,810.3							
			w3				Settlement	33	4,812.6			2.4	ws			
							Settlement	34	4,814.9				w1			
							Settlement	35	4,817.1				w1	2		
							Settlement	36	4,819.4							
							Settlement	37	4,821.7					2		
							Settlement	38	4,824.0							
								39	4,826.3							

Missing As-built sta. 4+660 to 5+020

w3	w2	w1	ws	CP
7	3			5

Missing As-built sta. 4+660 to 5+020

w4	w3	w2	w1	ws	CP
	4	5	2	3	5

WHITTIER TUNNEL INSPECTION FORM

0.000 | **Tele #** **523** **Sta** | **Panel Cracks** | **0.000**

Other		#	Sta	Seals	Drain N	Drain S	W&I	TM	BW	Dam	Other
Settlement		1	4,828.6					2			
Settlement		2	4,830.9								
Settlement		3	4,833.2								
Settlement		4	4,835.5					2			
Settlement		5	4,837.8		1.5						good sump
Settlement		6	4,840.0								
Settlement		7	4,842.3				w3	1			
Settlement		8	4,844.6								
Settlement		9	4,846.9								
Settlement		10	4,849.2								
Settlement											
Settlement			(0.3172)								
Settlement											
Settlement											
Settlement											
rx		Missing As-built sta. 4+660 to 5+020									
Settlement											
Settlement											
Settlement											
Settlement											
Settlement											
Settlement											
Settlement											
Settlement											
No flow water is 22" below surface											
			w4	w3	w2	w1	ws	CP			
				1				3			

WHITTIER TUNNEL INSPECTION FORM

Tele # **524** Sta 4,837.8 | 4,851.8

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	4,851.8						
2	4,854.1					2	
3	4,856.4						
4	4,858.7						
5	4,861.0						
6	4,863.3					2	
7	4,865.6						
8	4,867.8						
9	4,870.1						
10	4,872.4				w3		
11	4,874.7				w3		
12	4,877.0				Pan,w4		
13	4,879.3				Pan,w4		
14	4,881.6				Pan,w4		
15	4,883.9				w4	2	
16	4,886.2				w4		
17	4,888.5				w4		
18	4,890.7				w4		Broken Rail
19	4,893.0				w2		
20	4,895.3				w2		
21	4,897.6				w3		
22	4,899.9				w3		
23	4,902.2				w3		
24	4,904.5				w3		
25	4,906.8				w3		
26	4,909.1				w3	2	
27	4,911.4				w3		
28	4,913.6				w3	2	
29	4,915.9				w3		
30	4,918.2				w3		
31	4,920.5				ws		
32	4,922.8				ws		
33	4,925.1				ws		
34	4,927.4				ws		
35	4,929.7						
36	4,932.0						
37	4,934.3						
38	4,936.5						
Missing As-built sta. 4+660 to 5+020							
	w4	w3	w2	w1	ws	CP	
	7	12	2		3	5	

Tele # **525** Sta 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	4,938.8						
2	4,941.1						
3	4,943.4						
4	4,945.7						
5	4,948.0				w3		
6	4,950.3				w3		
7	4,952.6				w3		
8	4,954.9					2	
9	4,957.2						
10	4,959.4					2	
11	4,961.7						
12	4,964.0						
13	4,966.3						
14	4,968.6						
15	4,970.9						
16	4,973.2						Broken Rail
17	4,975.5						
18	4,977.8						
19	4,980.1						
20	4,982.3					2	
21	4,984.6						
22	4,986.9						
23	4,989.2						
24	4,991.5					2	
25	4,993.8						
26	4,996.1						
27	4,998.4					2	
28	5,000.7					3	
29	5,003.0						
30	5,005.2						
31	5,007.5						
32	5,009.8					2	
33	5,012.1					2	
34	5,014.4				w2		
35	5,016.7				w2		
36	5,019.0						
37	5,021.3						
38	5,023.6					2	
39	5,025.9						
40	5,028.1						
Missing As-built sta. 4+660 to 5+020							
	w4	w3	w2	w1	ws	CP	
		3	2			9	

WHITTIER TUNNEL INSPECTION FORM

Tele # **533** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,030.4					1	
2	5,032.7				w2		wet 5034-42
3	5,035.0				w3	2	wet 5034-42
4	5,037.3				w3		wet 5034-42
5	5,039.6				w3		wet 5034-42
6	5,041.9				w3	2	wet 5034-42
7	5,044.2				w3		
8	5,046.5				w3		
9	5,048.8				w3		
10	5,051.0						
11	5,053.3						
12	5,055.6						
13	5,057.9						
14	5,060.2				ws		
15	5,062.5				ws		
16	5,064.8				ws		
17	5,067.1				ws		w 5066
18	5,069.4				ws		
19	5,071.7						
20	5,073.9					2	
21	5,076.2						
22	5,078.5						
23	5,080.8					2	
24	5,083.1						
25	5,085.4						
26	5,087.7						
27	5,090.0					2	
28	5,092.3						
29	5,094.6						
30	5,096.8					2	
31	5,099.1						
32	5,101.4					2	
33	5,103.7				w3		bad asphalt
34	5,106.0				w3	2	
35	5,108.3						
36	5,110.6						
37	5,112.9						
	w4	w3	w2	w1	ws	CP	
		10	1		5	9	

Tele # **535** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,115.2						
2	5,117.5						
3	5,119.7					2	
4	5,122.0						
5	5,124.3					5	
6	5,126.6				w3		
7	5,128.9				w2		
8	5,131.2						
9	5,133.5						
10	5,135.8						
11	5,138.1						
12	5,140.4						
13	5,142.6						
14	5,144.9					2	
15	5,147.2						
16	5,149.5						
17	5,151.8						
18	5,154.1					2	
19	5,156.4				w3		
20	5,158.7				w3		
21	5,161.0				w3		
22	5,163.3				w3		
23	5,165.5				w3		
24	5,167.8						
25	5,170.1				w3		
26	5,172.4				w3	2	
27	5,174.7				w4		
28	5,177.0				w4		
29	5,179.3						
30	5,181.6				w2		
31	5,183.9				w2		
32	5,186.2					2	
33	5,188.4						
34	5,190.7						
35	5,193.0						
36	5,195.3						
37	5,197.6						
38	5,199.9						
39	5,202.2					2	
40	5,204.5						
41	5,206.8						
42	5,209.1						
43	5,211.3						
	w4	w3	w2	w1	ws	CP	
	2	8	3			7	

WHITTIER TUNNEL INSPECTION FORM

Tele # **531** **Sta** **0.000**

#	Sta	Seals	Drain		W&I	Panel	Other
			N	S			
1	5,213.6						F4.4
2	5,215.9					2	
3	5,218.2						rx
4	5,220.5						
5	5,222.8					2	
6	5,225.1						
7	5,227.4						
8	5,229.7						
9	5,232.0					2	
10	5,234.2						
11	5,236.5						
12	5,238.8						
13	5,241.1					2	
14	5,243.4						
15	5,245.7						
16	5,248.0						
17	5,250.3						
18	5,252.6						
19	5,254.9						
20	5,257.1						
21	5,259.4						
22	5,261.7						
23	5,264.0						
24	5,266.3					3	
25	5,268.6				ws		wet 5267
26	5,270.9				ws		
27	5,273.2						
28	5,275.5					2	
29	5,277.8		2	1.3			
30	5,280.0						
31	5,282.3					2	
32	5,284.6						wet 5284-89
33	5,286.9						wet 5284-89
34	5,289.2					2	wet 5284-89
35	5,291.5						
36	5,293.8					2	
37	5,296.1						
	w4	w3	w2	w1	ws	CP	
					2	9	

Tele # **532** **Sta** **0.000**

#	Sta	Seals	Drain		W&I	Panel	Other
			N	S			
1	5,298.4			1.1			
2	5,300.7					2	
3	5,302.9						
4	5,305.2					2	
5	5,307.5		3.3				good SP
6	5,309.8					2	
7	5,312.1						
8	5,314.4					2	
9	5,316.7					2	settle
10	5,319.0					2	settle
	(0.0260)						
	w4	w3	w2	w1	ws	CP	
						6	

WHITTIER TUNNEL INSPECTION FORM

Tele # 534 **Sta** 5,308.8 — 5,321.3

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,321.3					2	settle
2	5,323.6					2	settle
3	5,325.9						settle
4	5,328.2				w2		settle
5	5,330.4				w2	2	settle
6	5,332.7				w4		settle - wet
7	5,335.0				w4		settle
8	5,337.3				w3	2	settle
9	5,339.6				w2		settle
10	5,341.9				w2		settle
11	5,344.2		2	1			
12	5,346.5				w2		
13	5,348.8				w2		
14	5,351.1					2	
15	5,353.3						
16	5,355.6						
17	5,357.9						
18	5,360.2				w3		
19	5,362.5				w3		w - 5362
20	5,364.8				w3		
21	5,367.1				w2		
22	5,369.4						
23	5,371.7					2	
24	5,374.0						
25	5,376.2						
26	5,378.5						
27	5,380.8						
28	5,383.1					2	
29	5,385.4						
30	5,387.7					2	
31	5,390.0						
32	5,392.3						
33	5,394.6						
34	5,396.9						
35	5,399.1						
36	5,401.4						
37	5,403.7					2	
38	5,406.0						
39	5,408.3						
40	5,410.6					2	
	w4	w3	w2	w1	ws	CP	
	2.0000	3	7			10	

Tele # 536 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,412.9						
2	5,415.2						
3	5,417.5						
4	5,419.8					2	
5	5,422.0				w2		
6	5,424.3				w3		
7	5,426.6				w3	2	
8	5,428.9						
9	5,431.2						
10	5,433.5					2	
11	5,435.8						
12	5,438.1					2	
13	5,440.4						
14	5,442.7						
15	5,444.9					2	
16	5,447.2					2	
17	5,449.5				w3		
18	5,451.8				w3	2	
19	5,454.1						
20	5,456.4						
21	5,458.7						
22	5,461.0						
23	5,463.3						
24	5,465.6					2	
25	5,467.8						
26	5,470.1						
27	5,472.4						
28	5,474.7						
29	5,477.0					2	
30	5,479.3						
31	5,481.6						
32	5,483.9						
33	5,486.2					2	
34	5,488.5						
35	5,490.7						
36	5,493.0						
37	5,495.3						
38	5,497.6					2	
39	5,499.9						
40	5,502.2						
	w4	w3	w2	w1	ws	CP	
		4	1			11	

WHITTIER TUNNEL INSPECTION FORM

Tele # 537 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,504.5						
2	5,506.8					2	
3	5,509.1						
4	5,511.4						
5	5,513.6						
6	5,515.9				ws	3	
7	5,518.2						
8	5,520.5						
9	5,522.8					3	
10	5,525.1						
11	5,527.4						
12	5,529.7						
13	5,532.0						
14	5,534.3						
15	5,536.5					1	
16	5,538.8						
17	5,541.1					1	
18	5,543.4					2	
19	5,545.7					2	
20	5,548.0						
21	5,550.3						
22	5,552.6						
23	5,554.9						
24	5,557.2					1	
25	5,559.4						
26	5,561.7						
27	5,564.0						
28	5,566.3				w1		
29	5,568.6				w1	1	
30	5,570.9						
31	5,573.2						w 5573-90
32	5,575.5						w 5573-91
33	5,577.8						w 5573-92
34	5,580.1				w1		w 5573-93
35	5,582.3				w3		w 5573-94
36	5,584.6				w1		w 5573-95
37	5,586.9						w 5573-96
38	5,589.2						w 5573-97
	w4	w3	w2	w1	ws	CP	
		1		4	1	9	

Tele # 541 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,591.5					1	F4.2
2	5,593.8						
3	5,596.1						
4	5,598.4						
5	5,600.7						
6	5,603.0						
7	5,605.2						
8	5,607.5					2	
9	5,609.8						
10	5,612.1						
11	5,614.4					3	
12	5,616.7						
13	5,619.0						
14	5,621.3					2	
15	5,623.6					2	
16	5,625.9						
17	5,628.1						
18	5,630.4					1	
19	5,632.7						
20	5,635.0						
21	5,637.3						
22	5,639.6						
23	5,641.9						
24	5,644.2						
25	5,646.5						
26	5,648.8						
27	5,651.0						
28	5,653.3						
29	5,655.6						
30	5,657.9				w1		
31	5,660.2						
32	5,662.5						
33	5,664.8					2	
34	5,667.1						
35	5,669.4					2	
36	5,671.7						
37	5,673.9						
38	5,676.2					2	
39	5,678.5						
	w4	w3	w2	w1	ws	CP	
				1		9	

WHITTIER TUNNEL INSPECTION FORM

Tele # **542** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,680.8						
2	5,683.1						
3	5,685.4				ws		
4	5,687.7						
5	5,690.0						
6	5,692.3					2	
7	5,694.6						
8	5,696.8				w2		
9	5,699.1				w3		
10	5,701.4				w3		
11	5,703.7						
12	5,706.0					2	
13	5,708.3						
14	5,710.6						
15	5,712.9					1	
16	5,715.2						
17	5,717.5					1	
18	5,719.7						
19	5,722.0						
20	5,724.3						
21	5,726.6						
22	5,728.9						
23	5,731.2						
24	5,733.5					2	
25	5,735.8						
26	5,738.1		1.8	2.4		2	
27	5,740.4						
28	5,742.6						
29	5,744.9						
30	5,747.2						
31	5,749.5						
32	5,751.8						rx
33	5,754.1						
34	5,756.4						
35	5,758.7						
36	5,761.0					2	
37	5,763.3						
38	5,765.5						
39	5,767.8						wet 5766
40	5,770.1						
41	5,772.4					1	
42	5,774.7						
	w4	w3	w2	w1	ws	CP	
		2	1		1	8	

Tele # **543** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,777.0						
2	5,779.3						
3	5,781.6						Ins Joint
4	5,783.9						Ins Joint
5	5,786.2		2.6			2	Ins Joint
6	5,788.4						Ins Joint
7	5,790.7						
8	5,793.0						
9	5,795.3						
10	5,797.6						
	(0.3900)						
	w4	w3	w2	w1	ws	CP	
						1	

WHITTIER TUNNEL INSPECTION FORM

3519.6	0.2461538
	0.17
3510	

WHITTIER TUNNEL INSPECTION FORM

Tele # **544** Sta 5,787.8 5,800.3

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,800.3						
2	5,802.6						
3	5,804.9						
4	5,807.2						
5	5,809.4					1	
6	5,811.7					1	
7	5,814.0					2	
8	5,816.3				ws	2	
9	5,818.6						
10	5,820.9						
11	5,823.2						
12	5,825.5						
13	5,827.8						
14	5,830.1						
15	5,832.3						
16	5,834.6						
17	5,836.9		1.8	1.3		2	
18	5,839.2						
19	5,841.5						
20	5,843.8						
21	5,846.1					2	
22	5,848.4						
23	5,850.7						
24	5,853.0						
25	5,855.2						
26	5,857.5					2	
27	5,859.8						
28	5,862.1				w3		
29	5,864.4				w3		
30	5,866.7						
31	5,869.0						
32	5,871.3						
33	5,873.6						
34	5,875.9						
35	5,878.1						
36	5,880.4					2	
37	5,882.7						
38	5,885.0						
39	5,887.3						
40	5,889.6						
	w4	w3	w2	w1	ws	CP	
		2			1	8	

Tele # **545** Sta 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,891.9						F4.0
2	5,894.2						
3	5,896.5				w1		
4	5,898.8				w1		
5	5,901.0						
6	5,903.3						
7	5,905.6						
8	5,907.9					2	
9	5,910.2						
10	5,912.5						
11	5,914.8						
12	5,917.1				w3		
13	5,919.4				w3		wet 5919-29
14	5,921.7				w3		wet 5919-29
15	5,923.9						wet 5919-29
16	5,926.2				w3	3	wet 5919-29
17	5,928.5				w3		wet 5919-29
18	5,930.8				w3		wet 5919-29
19	5,933.1				w3	3	
20	5,935.4						
21	5,937.7						
22	5,940.0						
23	5,942.3						
24	5,944.6						
25	5,946.8						
26	5,949.1						
27	5,951.4						
28	5,953.7					2	
29	5,956.0						
30	5,958.3					2	
31	5,960.6						
32	5,962.9						
33	5,965.2						
34	5,967.5						
35	5,969.7						
36	5,972.0					2	
37	5,974.3				w3		
38	5,976.6				w3	2	
39	5,978.9				w3		
40	5,981.2						
41	5,983.5					2	
	w4	w3	w2	w1	ws	CP	
		10		2		8	

WHITTIER TUNNEL INSPECTION FORM

Tele # 546 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	5,985.8						
2	5,988.1						
3	5,990.4					2	
4	5,992.6						
5	5,994.9					2	
6	5,997.2						
7	5,999.5						
8	6,001.8						
9	6,004.1						
10	6,006.4						
11	6,008.7						
12	6,011.0						
13	6,013.3						
14	6,015.5						
15	6,017.8						
16	6,020.1					2	
17	6,022.4						
18	6,024.7					2	
19	6,027.0						
20	6,029.3						
21	6,031.6						
22	6,033.9						
23	6,036.2						
24	6,038.4						
25	6,040.7						
26	6,043.0						
27	6,045.3				w3		
28	6,047.6				w3		
29	6,049.9				w3		
30	6,052.2				w3		wet 6053-58
31	6,054.5				w4		wet 6053-58
32	6,056.8				w4		wet 6053-58
33	6,059.1				w3		wet 6053-58
34	6,061.3					3	
35	6,063.6				ws		
36	6,065.9				ws		
37	6,068.2						
	w4	w3	w2	w1	ws	CP	
	2.0000	5			2	5	

Tele # 551 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,070.5						Dip
2	6,072.8						
3	6,075.1				w1		
4	6,077.4					2	
5	6,079.7				w3		
6	6,082.0				w4		Wet-6082
7	6,084.2				w3		
8	6,086.5				w2	2	
9	6,088.8					2	Wet 6089-99
10	6,091.1				w3		Wet 6089-99
11	6,093.4				w4		Wet 6089-99
12	6,095.7				w3		Wet 6089-99
13	6,098.0				w3		Wet 6089-99
14	6,100.3				w4		Wet 6089-99
15	6,102.6						
16	6,104.9						
17	6,107.1						
18	6,109.4				w3		
19	6,111.7				w3		
20	6,114.0				w2		
21	6,116.3				w2		
22	6,118.6				w2		
23	6,120.9				w2		
24	6,123.2				w3		
25	6,125.5						
26	6,127.8						
27	6,130.0						
28	6,132.3						
29	6,134.6						
30	6,136.9				w3		
31	6,139.2				w3		
32	6,141.5				w3		
33	6,143.8				w3		
34	6,146.1				w3		
35	6,148.4				w4		
36	6,150.7				w3		
37	6,152.9					1	
38	6,155.2						
39	6,157.5						
	w4	w3	w2	w1	ws	CP	
	3.0000	14	5	1		4	

WHITTIER TUNNEL INSPECTION FORM

Tele # **552** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,159.8				w3		F3.8
2	6,162.1				w3		
3	6,164.4				w4	2	
4	6,166.7				w4		Wet 6165
5	6,169.0				w3		
6	6,171.3						
7	6,173.6						
8	6,175.8						
9	6,178.1						
10	6,180.4						
11	6,182.7						rx
12	6,185.0						wet 6186-94
13	6,187.3				w4		wet 6186-94
14	6,189.6				w4		wet 6186-94
15	6,191.9						wet 6186-94
16	6,194.2						wet 6186-94
17	6,196.5					1	
18	6,198.7						
19	6,201.0					1	wet 6202
20	6,203.3						
21	6,205.6						
22	6,207.9						
23	6,210.2						Wet- 6209-32
24	6,212.5				w3		Wet- 6209-32
25	6,214.8				w3		Wet- 6209-32
26	6,217.1				w3		Wet- 6209-32
27	6,219.4						Wet- 6209-32
28	6,221.6						Wet- 6209-32
29	6,223.9						Wet- 6209-32
30	6,226.2						Wet- 6209-32
31	6,228.5						Wet- 6209-32
32	6,230.8						Wet- 6209-32
33	6,233.1		0.9	0.8			Wet- 6209-32
34	6,235.4						
35	6,237.7						
36	6,240.0					2	
37	6,242.3						
38	6,244.5					2	
39	6,246.8						
40	6,249.1					3	
41	6,251.4						
	w4	w3	w2	w1	ws	CP	
	4.0000	6				6	

Tele # **553** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,253.7						
2	6,256.0						
3	6,258.3						
4	6,260.6		1.6				Adjust SP
5	6,262.9					1	
6	6,265.2						
7	6,267.4						
8	6,269.7						
9	6,272.0						
10	6,274.3						
	(0.0516)						
	w4	w3	w2	w1	ws	CP	
						1	

WHITTIER TUNNEL INSPECTION FORM

Tele # 554 **Sta** 6262.79 — 6,276.7

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,276.7						
2	6,278.9						
3	6,281.2					2	
4	6,283.5						
5	6,285.8					2	
6	6,288.1						
7	6,290.4						
8	6,292.7						
9	6,295.0						
10	6,297.3						
11	6,299.6				w2		
12	6,301.8				w2		wet 6302
13	6,304.1				w2		
14	6,306.4					2	
15	6,308.7						
16	6,311.0		2.3	0.9			
17	6,313.3						
18	6,315.6						
19	6,317.9						
20	6,320.2					2	
21	6,322.5						
22	6,324.7				w3		
23	6,327.0			0.6	w3		
24	6,329.3					3	
25	6,331.6						
26	6,333.9						
27	6,336.2						
28	6,338.5						
29	6,340.8						
30	6,343.1						
31	6,345.4					2	
32	6,347.6					2	
33	6,349.9				w3		
34	6,352.2				w3		
35	6,354.5						
36	6,356.8						
37	6,359.1						
	w4	w3	w2	w1	ws	CP	

Tele # 555 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,361.4						
2	6,363.7				w3	2	
3	6,366.0						
4	6,368.3						
5	6,370.5						
6	6,372.8						
7	6,375.1						
8	6,377.4						
9	6,379.7						
10	6,382.0						
11	6,384.3						
12	6,386.6						
13	6,388.9						
14	6,391.2						
15	6,393.4						
16	6,395.7						
17	6,398.0						
18	6,400.3						
19	6,402.6						
20	6,404.9						
21	6,407.2						
22	6,409.5						
23	6,411.8						
24	6,414.1						
25	6,416.3						
26	6,418.6						
27	6,420.9						
28	6,423.2						
29	6,425.5						
30	6,427.8						
31	6,430.1						
32	6,432.4				w3		
33	6,434.7				w3		
34	6,437.0						
35	6,439.2						
36	6,441.5						
37	6,443.8						
38	6,446.1						
39	6,448.4						
40	6,450.7						
	w4	w3	w2	w1	ws	CP	

WHITTIER TUNNEL INSPECTION FORM

		4	3			7	

		3				1	

WHITTIER TUNNEL INSPECTION FORM

Tele # **556** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,453.0						
2	6,455.3					2?	
3	6,457.6					2?	
4	6,459.9						
5	6,462.1						
6	6,464.4					1	
7	6,466.7				w2		
8	6,469.0				w2		
9	6,471.3						
10	6,473.6						
11	6,475.9						
12	6,478.2						
13	6,480.5						
14	6,482.8						
15	6,485.0						
16	6,487.3						
17	6,489.6						rx
18	6,491.9						rx
19	6,494.2						
20	6,496.5						
21	6,498.8					1	
22	6,501.1						
23	6,503.4						
24	6,505.7						
25	6,507.9						
26	6,510.2						
27	6,512.5						
28	6,514.8						
29	6,517.1						
30	6,519.4						
31	6,521.7						
32	6,524.0					2	
33	6,526.3				w3		
34	6,528.6				w3		
35	6,530.8						
36	6,533.1						Minor Setle
37	6,535.4						
38	6,537.7						
39	6,540.0						
40	6,542.3						
41	6,544.6						
	w4	w3	w2	w1	ws	CP	

Tele # **562** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,546.9					2	
2	6,549.2						
3	6,551.5				w3		wet 6550
4	6,553.7						
5	6,556.0						
6	6,558.3						
7	6,560.6						
8	6,562.9				w3		
9	6,565.2				w3		
10	6,567.5						
11	6,569.8						
12	6,572.1				w3		settlement
13	6,574.4						
14	6,576.6						
15	6,578.9						
16	6,581.2						
17	6,583.5						
18	6,585.8					2	
19	6,588.1						
20	6,590.4						
21	6,592.7						
22	6,595.0						
23	6,597.3						
24	6,599.5						
25	6,601.8						
26	6,604.1						
27	6,606.4						
28	6,608.7						
29	6,611.0						
30	6,613.3						
31	6,615.6						
32	6,617.9						
33	6,620.2						
34	6,622.4						
35	6,624.7						
36	6,627.0						
37	6,629.3						
38	6,631.6					3	
39	6,633.9						
	w4	w3	w2	w1	ws	CP	

WHITTIER TUNNEL INSPECTION FORM

		2	2			3	

		4				3	

WHITTIER TUNNEL INSPECTION FORM

Tele # 563 Sta 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,636.2						
2	6,638.5						
3	6,640.8					1	
4	6,643.1						
5	6,645.3					1	rx
6	6,647.6						
7	6,649.9						
8	6,652.2				w3		
9	6,654.5				w3		wet 6655-57
10	6,656.8				w3		
11	6,659.1				w4		
12	6,661.4				w4		wet 6662-68
13	6,663.7				w4		wet 6662-68
14	6,666.0				w3		wet 6662-68
15	6,668.2					2	wet 6662-68
16	6,670.5						
17	6,672.8						
18	6,675.1						wet 6675-81
19	6,677.4				w4		wet 6675-81
20	6,679.7				w4	2	wet 6675-81
21	6,682.0				w4		wet 6675-81
22	6,684.3				w3		
23	6,686.6				w2		
24	6,688.9				w2		
25	6,691.1						
26	6,693.4					2	
27	6,695.7						
28	6,698.0						
29	6,700.3						
30	6,702.6						
31	6,704.9						
32	6,707.2						
33	6,709.5						rx
34	6,711.8						
35	6,714.0						
36	6,716.3		0.6	0.4			
37	6,718.6						
38	6,720.9						
39	6,723.2						
40	6,725.5						
41	6,727.8						
42	6,730.1						
43	6,732.4						
44	6,734.7						

Tele # 564 Sta 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,736.9					2	
2	6,739.2						
3	6,741.5						
4	6,743.8						
5	6,746.1		2.1				No adjust
6	6,748.4						Water depth 24"
7	6,750.7						
8	6,753.0						
9	6,755.3						
10	6,757.6					2	
	(0.4384)						
	w4	w3	w2	w1	ws	CP	

WHITTIER TUNNEL INSPECTION FORM

	7	5	2			5	

						2	

WHITTIER TUNNEL INSPECTION FORM

Tele # 565 **Sta** 6,747.8 6,760.3

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,760.3						
2	6,762.6						
3	6,764.9						
4	6,767.2						
5	6,769.4						
6	6,771.7						
7	6,774.0						
8	6,776.3						
9	6,778.6						
10	6,780.9						
11	6,783.2					2	
12	6,785.5						
13	6,787.8					2	
14	6,790.1						
15	6,792.3						
16	6,794.6		1.3	1			23" below surf
17	6,796.9						
18	6,799.2						
19	6,801.5					2	
20	6,803.8						
21	6,806.1					2	
22	6,808.4						
23	6,810.7						
24	6,813.0						
25	6,815.2						
26	6,817.5						
27	6,819.8					1	
28	6,822.1						
29	6,824.4					2	
30	6,826.7						
31	6,829.0				w2		
32	6,831.3				w3		
33	6,833.6				w2	2	
34	6,835.9						
35	6,838.1						
36	6,840.4					2	
37	6,842.7					2	
38	6,845.0		1.4	1.4			
39	6,847.3					2	
40	6,849.6						
41	6,851.9						
	w4	w3	w2	w1	ws	CP	
		1	2			10	

Tele # 566 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,854.2						
2	6,856.5						
3	6,858.8						
4	6,861.0						F3.4
5	6,863.3						
6	6,865.6						
7	6,867.9					2	
8	6,870.2						
9	6,872.5						
10	6,874.8					2	
11	6,877.1				w3		
12	6,879.4						
13	6,881.7					2	
14	6,883.9					2	
15	6,886.2						
16	6,888.5						
17	6,890.8						
18	6,893.1						
19	6,895.4						
20	6,897.7						
21	6,900.0						
22	6,902.3						
23	6,904.6						
24	6,906.8						
25	6,909.1						
26	6,911.4						
27	6,913.7				w2		
28	6,916.0						
29	6,918.3					2	
30	6,920.6						
31	6,922.9						
32	6,925.2						
33	6,927.5						
34	6,929.7						
35	6,932.0						
36	6,934.3						
37	6,936.6						
38	6,938.9						
39	6,941.2						
40	6,943.5						
	w4	w3	w2	w1	ws	CP	
		1	1			5	

WHITTIER TUNNEL INSPECTION FORM

Tele # **567** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	6,945.8						
2	6,948.1					2	
3	6,950.4						
4	6,952.6				w1		
5	6,954.9				w1		
6	6,957.2						
7	6,959.5						
8	6,961.8						
9	6,964.1						
10	6,966.4						
11	6,968.7						
12	6,971.0						
13	6,973.3						
14	6,975.5						
15	6,977.8						
16	6,980.1						
17	6,982.4						
18	6,984.7					2	
19	6,987.0						
20	6,989.3						
21	6,991.6						
22	6,993.9						
23	6,996.2						
24	6,998.4						
25	7,000.7						
26	7,003.0						
27	7,005.3					2	
28	7,007.6						rx
29	7,009.9						
30	7,012.2						
31	7,014.5						
32	7,016.8						
33	7,019.1						
34	7,021.3						
35	7,023.6						
36	7,025.9						
37	7,028.2						
	w4	w3	w2	w1	ws	CP	
				2		3	

Tele # **571** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,030.5						
2	7,032.8						
3	7,035.1						
4	7,037.4						
5	7,039.7						
6	7,042.0						
7	7,044.2						
8	7,046.5						rx
9	7,048.8						
10	7,051.1						
11	7,053.4						
12	7,055.7				ws		
13	7,058.0				ws		
14	7,060.3				ws	2	
15	7,062.6				w2		
16	7,064.9				w2		
17	7,067.1				w2	2	
18	7,069.4						
19	7,071.7						
20	7,074.0						
21	7,076.3						
22	7,078.6						
23	7,080.9						
24	7,083.2						
25	7,085.5						
26	7,087.8						rx
27	7,090.0						
28	7,092.3						
29	7,094.6						
30	7,096.9						
31	7,099.2						
32	7,101.5						
33	7,103.8						
34	7,106.1						
35	7,108.4						
36	7,110.7						
37	7,112.9						
38	7,115.2						
39	7,117.5						
40	7,119.8						
41	7,122.1						
42	7,124.4						
	w4	w3	w2	w1	ws	CP	
			3		3	2	

WHITTIER TUNNEL INSPECTION FORM

Tele # **572** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,126.7						rx
2	7,129.0						
3	7,131.3						
4	7,133.6						
5	7,135.8						
6	7,138.1					2	
7	7,140.4						
8	7,142.7						
9	7,145.0						
10	7,147.3						
11	7,149.6						
12	7,151.9						
13	7,154.2						
14	7,156.5						
15	7,158.7						
16	7,161.0						
17	7,163.3						wet 7163-67
18	7,165.6						
19	7,167.9						
20	7,170.2						
21	7,172.5						
22	7,174.8						
23	7,177.1						
24	7,179.4						
25	7,181.6						
26	7,183.9						
27	7,186.2						
28	7,188.5		1.6				
29	7,190.8			1			adjust sump
30	7,193.1						25" below surf
31	7,195.4						
32	7,197.7						
33	7,200.0					2	
34	7,202.3						
35	7,204.5						
36	7,206.8				w2s		wet 7207-11
37	7,209.1				w2s		wet 7207-11
38	7,211.4					2	
39	7,213.7						
40	7,216.0						
41	7,218.3						
42	7,220.6						
	w4	w3	w2	w1	ws	CP	
			2		2	3	

Tele # **573** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,222.9						
2	7,225.2						
3	7,227.4						
4	7,229.7					2	
5	7,232.0		2.6				
6	7,234.3						
7	7,236.6						
8	7,238.9						
9	7,241.2						
10	7,243.5						
	(0.5868)						
	w4	w3	w2	w1	ws	CP	
						1	

WHITTIER TUNNEL INSPECTION FORM

Tele # 574 **Sta** 7,232.8 | 7,246.4

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,246.4					2	
2	7,248.6						
3	7,250.9						
4	7,253.2						
5	7,255.5						
6	7,257.8						
7	7,260.1						rx
8	7,262.4						
9	7,264.7						
10	7,267.0						
11	7,269.3						
12	7,271.5						
13	7,273.8						
14	7,276.1						
15	7,278.4						
16	7,280.7						
17	7,283.0		1.9	1.1			
18	7,285.3						
19	7,287.6						
20	7,289.9						
21	7,292.2						
22	7,294.4					2	
23	7,296.7						
24	7,299.0						
25	7,301.3						
26	7,303.6						
27	7,305.9						
28	7,308.2						rx
29	7,310.5						
30	7,312.8					2	
31	7,315.1					2	
32	7,317.3						
33	7,319.6						
34	7,321.9						
35	7,324.2						
36	7,326.5						
37	7,328.8						
38	7,331.1						
39	7,333.4						
40	7,335.7						
	w4	w3	w2	w1	ws	CP	
						4	

Tele # 575 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,338.0				w2		
2	7,340.2				w3		
3	7,342.5				w4		wet 7342
4	7,344.8				w4		
5	7,347.1				w2		wet 7347
6	7,349.4						
7	7,351.7						
8	7,354.0						
9	7,356.3						
10	7,358.6						
11	7,360.9						
12	7,363.1				w1		
13	7,365.4				w1		
14	7,367.7						
15	7,370.0						
16	7,372.3						
17	7,374.6					2	rx
18	7,376.9						
19	7,379.2						
20	7,381.5						
21	7,383.8						
22	7,386.0						
23	7,388.3						
24	7,390.6						
25	7,392.9						
26	7,395.2						
27	7,397.5						
28	7,399.8						
29	7,402.1						
30	7,404.4				w3		
31	7,406.7						
32	7,408.9						
33	7,411.2				w3		
34	7,413.5				w3		
35	7,415.8						
36	7,418.1					2	
37	7,420.4						
38	7,422.7						
39	7,425.0						
40	7,427.3						
	w4	w3	w2	w1	ws	CP	
	2	4	2	2		2	

WHITTIER TUNNEL INSPECTION FORM

Tele # 576 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,429.6						
2	7,431.8						
3	7,434.1						
4	7,436.4						
5	7,438.7						
6	7,441.0						
7	7,443.3						
8	7,445.6						
9	7,447.9						
10	7,450.2						
11	7,452.5						
12	7,454.7						
13	7,457.0						
14	7,459.3						
15	7,461.6						
16	7,463.9						
17	7,466.2				w3		
18	7,468.5				w3		
19	7,470.8				w3		
20	7,473.1						
21	7,475.4						Wet 7369
22	7,477.6						
23	7,479.9						
24	7,482.2						
25	7,484.5						
26	7,486.8						
27	7,489.1						
28	7,491.4						
29	7,493.7						
30	7,496.0						
31	7,498.3					2	
32	7,500.5				ws		
33	7,502.8				w3		wet 7499-09
34	7,505.1				w3		wet 7499-09
35	7,507.4				w3		wet 7499-09
36	7,509.7						wet 7499-09
37	7,512.0						wet 7499-09
38	7,514.3						wet 7499-09
	w4	w3	w2	w1	ws	CP	
		6			1	1	

Tele # 581 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,516.6						
2	7,518.9						
3	7,521.2						
4	7,523.4					2	
5	7,525.7						
6	7,528.0						
7	7,530.3						
8	7,532.6					1	
9	7,534.9						
10	7,537.2						
11	7,539.5				w3		settle
12	7,541.8				w4	2	
13	7,544.1				w4		
14	7,546.3				w4		Wet 7541-51
15	7,548.6				w4		dip
16	7,550.9				w4		Wet 7541-51
17	7,553.2				w4		Wet 7541-51
18	7,555.5				w4	2	Wet 7541-51
19	7,557.8				w2		
20	7,560.1				w2	2	wet 7555
21	7,562.4					1	
22	7,564.7						wet 7558
23	7,567.0						
24	7,569.2						
25	7,571.5						
26	7,573.8						
27	7,576.1						
28	7,578.4		1.6	1			
29	7,580.7				ws		
30	7,583.0				ws		
31	7,585.3						
32	7,587.6						
33	7,589.9						
34	7,592.1						
35	7,594.4						
36	7,596.7				w3		
37	7,599.0				w3		
38	7,601.3						
39	7,603.6						
40	7,605.9						
41	7,608.2						
	w4	w3	w2	w1	ws	CP	
	7.0000	3	2		2	6	

WHITTIER TUNNEL INSPECTION FORM

Tele # **582** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,610.5				w3		
2	7,612.8				w3		
3	7,615.0						Wet 7611
4	7,617.3						
5	7,619.6		1.8	1			26" below surf
6	7,621.9						
7	7,624.2						
8	7,626.5						
9	7,628.8						
10	7,631.1						
11	7,633.4				ws		
12	7,635.7				ws		
13	7,637.9				ws		
14	7,640.2						
15	7,642.5						wet 7637
16	7,644.8						
17	7,647.1						
18	7,649.4						
19	7,651.7					2	
20	7,654.0				w3		
21	7,656.3				w3		
22	7,658.6						
23	7,660.8						
24	7,663.1						
25	7,665.4						
26	7,667.7					2	
27	7,670.0						
	w4	w3	w2	w1	ws	CP	
		4			3	2	

Tele # **583** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,672.3						
2	7,674.6					2	
3	7,676.9						
4	7,679.2						
5	7,681.5		3.4				
6	7,683.7						
7	7,686.0						
8	7,688.3						
9	7,690.6				w3	3	
10	7,692.9				w3		
	(0.0932)						
	w4	w3	w2	w1	ws	CP	
		2				2	

WHITTIER TUNNEL INSPECTION FORM

Tele # 584 **Sta** 7,682.8 — 7,695.3

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,695.3				w2		
2	7,697.6				w2		
3	7,699.9				w2		
4	7,702.2				ws		
5	7,704.4				ws		
6	7,706.7				ws		
7	7,709.0				ws	2	
8	7,711.3						
9	7,713.6						
10	7,715.9						
11	7,718.2					2	
12	7,720.5						
13	7,722.8						
14	7,725.1						
15	7,727.3						
16	7,729.6						
17	7,731.9						
18	7,734.2					2	
19	7,736.5						
20	7,738.8						
21	7,741.1					2	
22	7,743.4						
23	7,745.7						
24	7,748.0						
25	7,750.2					2	
26	7,752.5						
27	7,754.8						
28	7,757.1						
29	7,759.4						
30	7,761.7						
31	7,764.0						
32	7,766.3						
33	7,768.6						
34	7,770.9						
35	7,773.1						Wet 7772
36	7,775.4						
37	7,777.7						
38	7,780.0						
39	7,782.3					2	
40	7,784.6						
	w4	w3	w2	w1	ws	CP	
			3		4	6	

Tele # 585 **Sta** 0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,786.9						F2.8
2	7,789.2						
3	7,791.5						
4	7,793.8						
5	7,796.0				ws		
6	7,798.3				ws		
7	7,800.6						
8	7,802.9						
9	7,805.2				w3		
10	7,807.5				w3		
11	7,809.8				w2		Wet 7808
12	7,812.1				w2		
13	7,814.4				w2		
14	7,816.7						
15	7,818.9						
16	7,821.2						
17	7,823.5						
18	7,825.8						
19	7,828.1						
20	7,830.4				w1		
21	7,832.7				w1		
22	7,835.0						
23	7,837.3						
24	7,839.6				ws		
25	7,841.8				ws		Wet 7742-47
26	7,844.1				w3		Wet 7742-47
27	7,846.4				w2	2	Wet 7742-47
28	7,848.7				w3		Wet 7742-47
29	7,851.0				w4		
30	7,853.3				w4		
31	7,855.6				w4		wet 7855
32	7,857.9				w4		
33	7,860.2				w3		
34	7,862.5				w2		
35	7,864.7						
36	7,867.0						
37	7,869.3						
38	7,871.6						
39	7,873.9						
40	7,876.2				w3		
	w4	w3	w2	w1	ws	CP	
	4.0000	6	5	2	2	1	

WHITTIER TUNNEL INSPECTION FORM

Tele #	586	Sta	0.000

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,878.5				w3		
2	7,880.8				w3		
3	7,883.1						
4	7,885.4				w4		
5	7,887.6				w4	2	Wet 7886
6	7,889.9				w3		
7	7,892.2						
8	7,894.5						
9	7,896.8						
10	7,899.1				w3		wet 7891
11	7,901.4						
12	7,903.7						
13	7,906.0						
14	7,908.3						
15	7,910.5						
16	7,912.8						
17	7,915.1					2	
18	7,917.4				w2	2	
19	7,919.7				w2		
20	7,922.0				w2	2	Wet 7920
21	7,924.3				w3		
22	7,926.6				w3		
23	7,928.9				w2		
24	7,931.2				w3	2	wet 7929-57
25	7,933.4				w3	2	wet 7929-57
26	7,935.7				w3		wet 7929-57
27	7,938.0				w3		wet 7929-57
28	7,940.3				w4		wet 7929-57
29	7,942.6				w4		begin pan
30	7,944.9				w4		wet 7929-57
31	7,947.2				w4		wet 7929-57
32	7,949.5				w4		wet 7929-57
33	7,951.8				w5		wet 7929-57
34	7,954.1				w5		Carwash
35	7,956.3				w5		wet 7929-57
36	7,958.6				w5		wet 7929-57
37	7,960.9				w3		wet 7960-72
38	7,963.2				w3		wet 7960-72
	w4	w3	w2	w1	ws	CP	
	11	12	4			6	

Tele #	587	Sta	-

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	7,965.5				w2		wet 7960-72
2	7,967.8				w3		wet 7960-72
3	7,970.1				w3		wet 7960-72
4	7,972.4				w2		end pan
5	7,974.7				w2		
6	7,977.0				w3		
7	7,979.2						
8	7,981.5				ws		
9	7,983.8						
10	7,986.1						
11	7,988.4						
12	7,990.7						
13	7,993.0						wet 7991-11
14	7,995.3				w2		wet 7991-11
15	7,997.6				w2		wet 7991-11
16	7,999.9				w2		wet 7991-11
17	8,002.1				w1		wet 7991-11
18	8,004.4				w1		wet 7991-11
19	8,006.7		1.9	2.6	w1	2	wet 7991-11
20	8,009.0				IC-21		
21	8,011.3				IC-21		
22	8,013.6				IC-21		
23	8,015.9				IC-21	2	
24	8,018.2				IC-21		
25	8,020.5				IC-21		
26	8,022.8				w2		
27	8,025.0				w2		
28	8,027.3				w2		
29	8,029.6				w2		
30	8,031.9						
31	8,034.2						
32	8,036.5				IC-22		
33	8,038.8				IC-22		
34	8,041.1				IC-22		
35	8,043.4				IC-22		
36	8,045.7				IC-22		
37	8,047.9				w3		
38	8,050.2				IC-23	1	
39	8,052.5				old port		
40	8,054.8				old port		
	w4	w3	w2	w1	ws	CP	
		4	10	3	1	3	

WHITTIER TUNNEL INSPECTION FORM

Tele # **588** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	8,057.1						F2.6
2	8,059.4						
3	8,061.7						
4	8,064.0						
5	8,066.3						
6	8,068.6						
7	8,070.8						
8	8,073.1		1.1	1			
9	8,075.4						
10	8,077.7						
11	8,080.0						
12	8,082.3						
13	8,084.6						
14	8,086.9						
15	8,089.2						
16	8,091.5						
17	8,093.7						
18	8,096.0						
19	8,098.3						
	w4	w3	w2	w1	ws	CP	
						0	

Tele # **WP** **Sta** **0.000**

#	Sta	Seals	Drain N	Drain S	W&I	Panel	Other
1	8,100.6						
2	8,102.9						
3	8,105.2						
4	8,107.5						
5	8,109.8						
6	8,112.1						
7	8,114.4						
8	8,116.6						
9	8,118.9						
10	8,121.2						
11	8,123.5						
12	8,125.8						
13	8,128.1						
14	8,130.4						
15	8,132.7						
16	8,135.0						
17	8,137.3						
18	8,139.5						
ep	8,141.8						
	w4	w3	w2	w1	ws	CP	
						0	

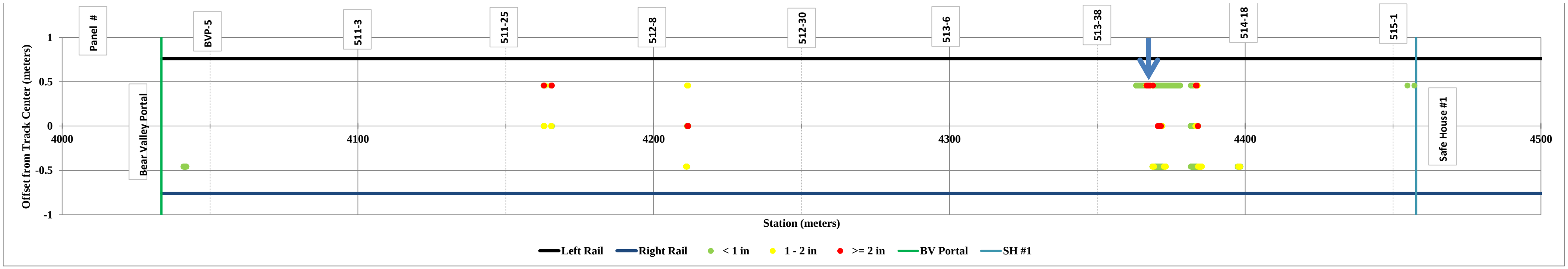
Appendix F

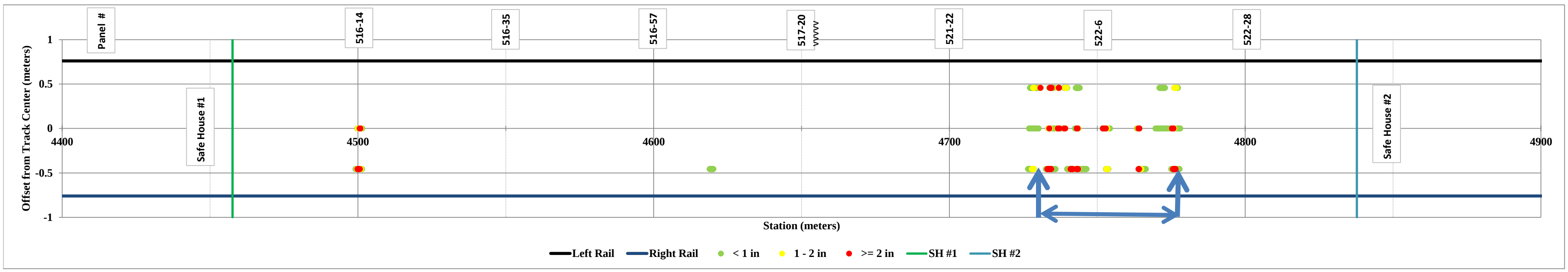
GPR Survey of Void Areas below the Invert Panels

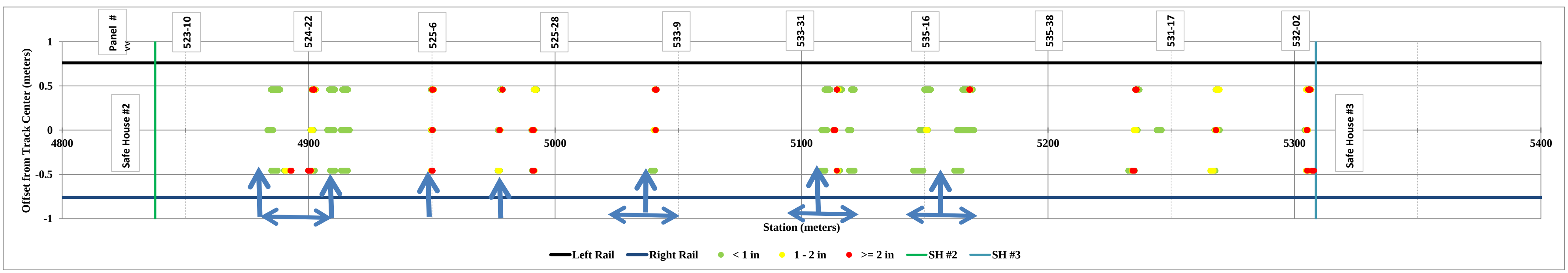
Legend

Water Draining from Crown

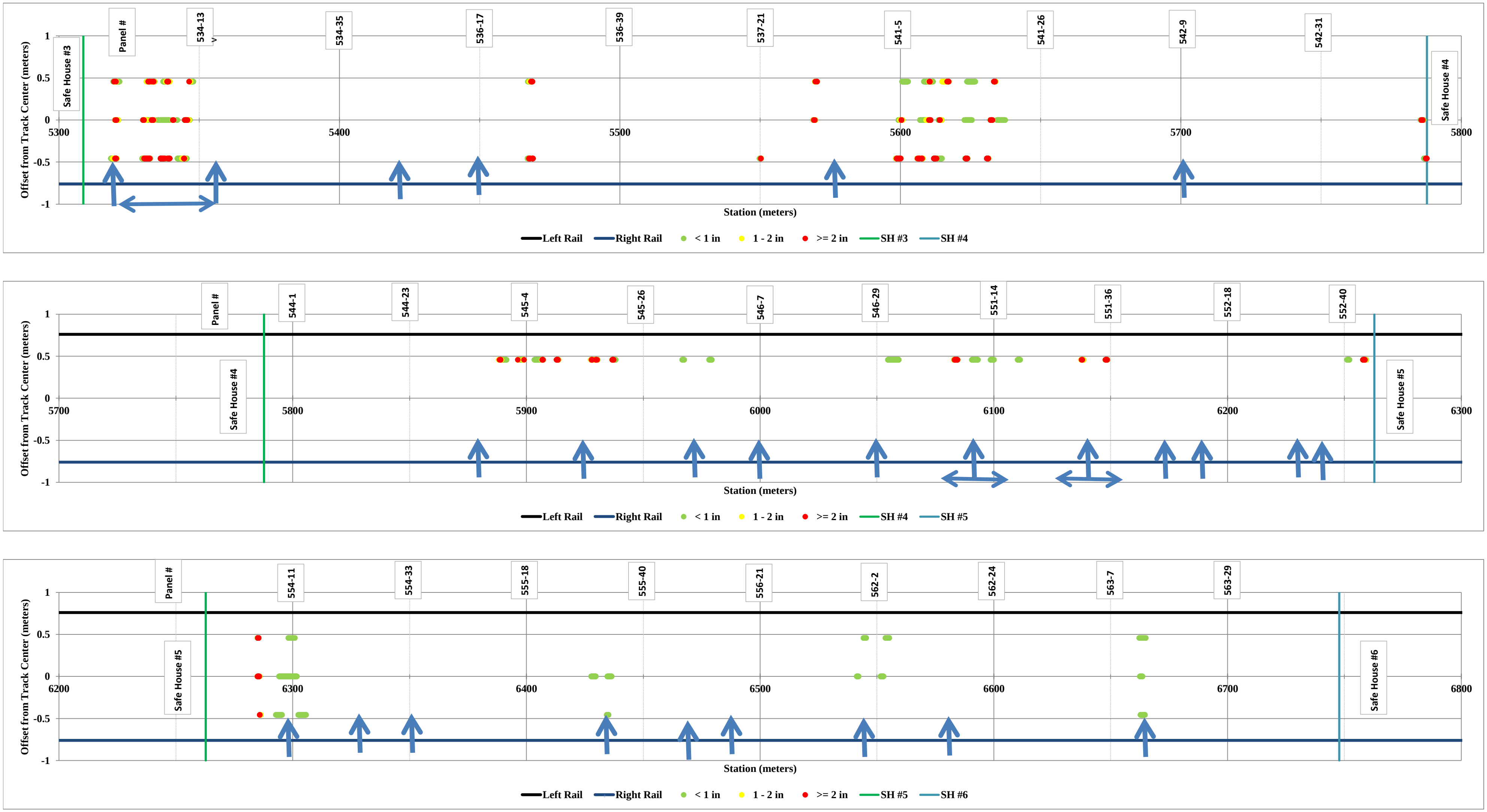
Whittier Tunnel - Voids below the Invert Panels





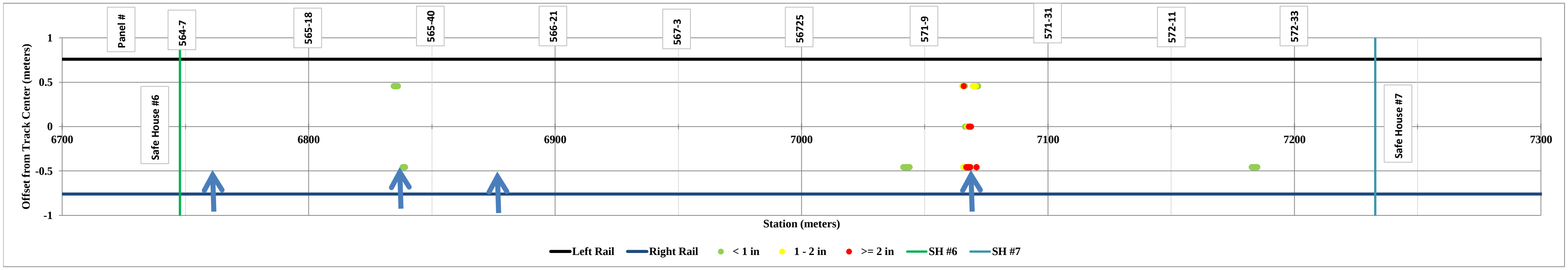


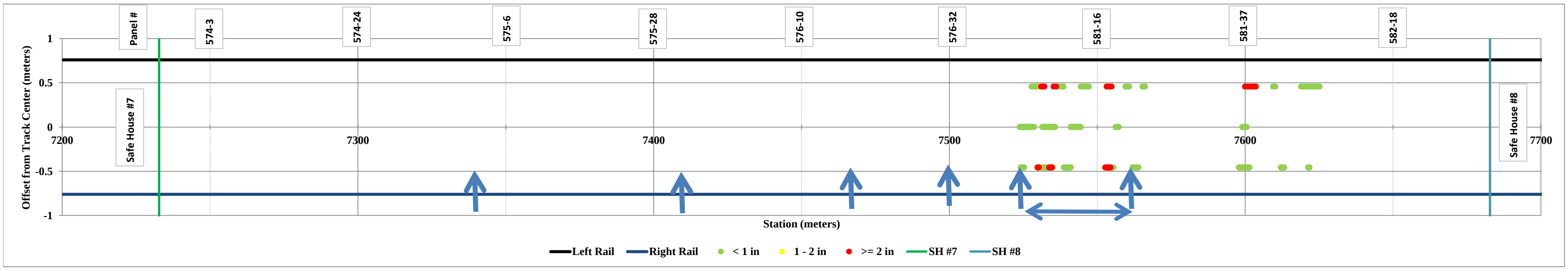
Whittier Tunnel - Voids below the Invert Panels

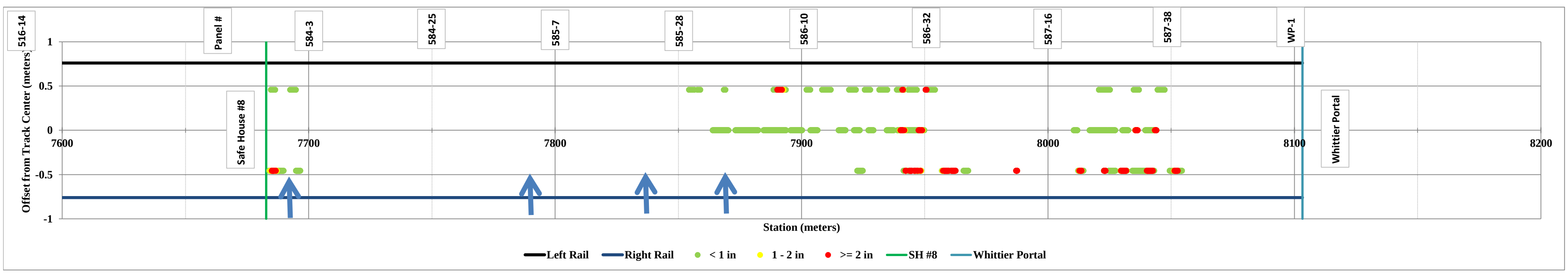


Calibrated_Voids 6-18-13

Whittier Tunnel - Voids below the Invert Panels







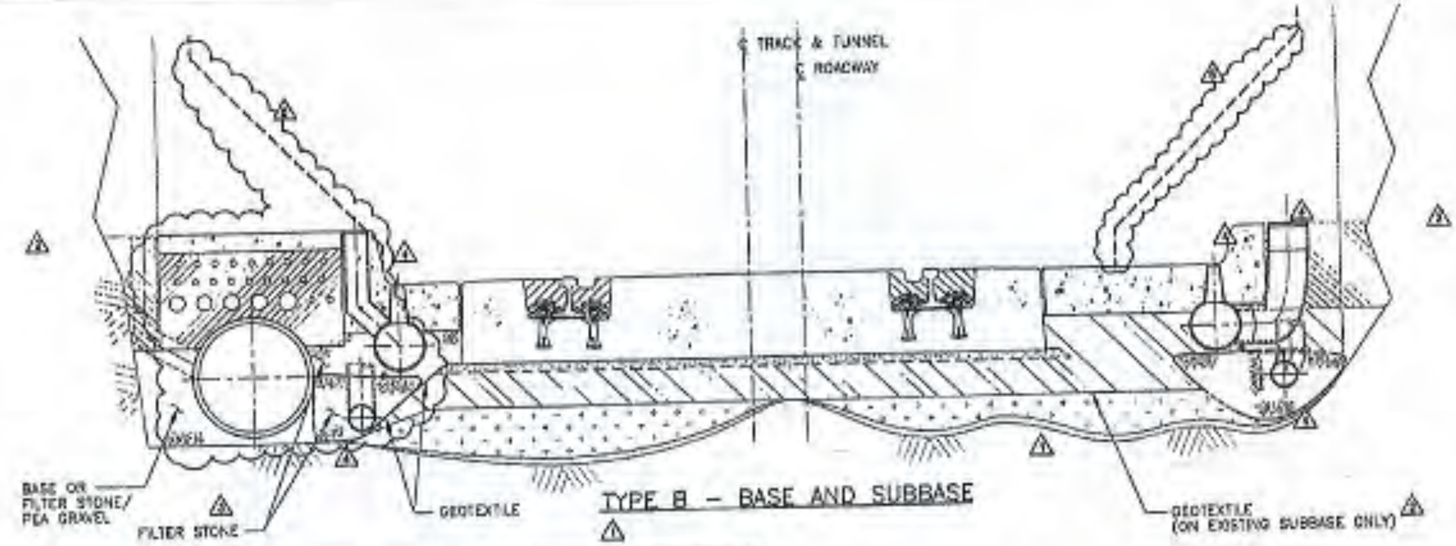
Appendix G

Summary of Void Measurements

Voids Measurements Locations																							
Distance from the reference (m)					Distance from the reference (ft)													Comments			Settlement		
Void Area	Ref.	Begin Panel (m)	Approx. Sta	End Panel (m)	Begin Panel (ft)	Dist from east (ft)	Actual Begin Panel (ft)	Approx. Panel #	Panel #	Proj Sta. (m)	West Grout Port (ft)	Void (in)	Middle Grout Port (ft)	Void (in)	East Grout Port (ft)	Void (in)	End Panel (ft)	Wet	Seals	Comments	Dr. Han	G Burton	
1	BV Port																						
		334.53	4367.88	336.82	1097.5		1091.7	514-4	**514-4**	4366.8	1093.6	x	1095.5	x	1097.3	x	1099.2		blown	Broken rail			minor
		336.82	4370.17	339.11	1099.2		1099.2	514-5	**514-5**	4369.1	1101.1	x	1103.0	x	1104.8	1.3	1106.7	dry	seal		8		settl on rt.
							1106.7	514-6	**514-6**	4371.4	1108.6	0.8	1110.5	x	1112.3	x	1114.2						Rail
							1114.2		**514-7**	4373.7	1116.1		1118.0		1119.8		1121.7						
							1121.7		**514-8**	4376.0	1123.6		1125.5		1127.3		1129.2						
2	SH#1																						
		271.35	4729.14	273.64	890.2	356.6	885.6	521-35	**521-34**	4727.8	887.5	x	889.4	x	891.2	x	893.1						1" to
		275.92	4733.71	278.21	905.2	341.6	893.1	521-37	**521-35**	4730.1	895.0	x	896.9	x	898.7	x	900.6	wet	bad		9		1.25" sett
							900.6		**521-36**	4732.4	902.5	x	904.4	1.0	906.2	0.0	908.1						
3	SH#2		4863.30				83.6	524-6	**524-6**	4863.3	85.5	0.0	87.4	0.0	89.3	0.0	91.1	wet		wet to the			?
							91.1	524-7	**524-7**	4865.6	93.0	0.0	94.9	0.0	96.8	0.0	98.6			east			
3	SH#2																						
		74.42	4912.21	76.71	244.2		241.1	524-27	**524-27**	4911.4	243.0	0.0	244.9	x	246.7	0.5	248.6		blown	Panel is higher			Rt. Rail -
		76.71	4914.50	79.00	248.6		248.6	524-28	**524-28**	4913.7	250.5	0.3	252.4	0.0	254.2	0.0	256.1	wet	seal	than CIP	6	4	.25" settle
							256.1		**524-29**	4916.0	258.0	0.0	259.9	0.0	261.7	0.0	263.6						
4	SH#2																						
		328.03	5165.82	330.32	1076.2	468.7	1076.2	535-23	**535-23**	5165.5	1078.1	0.0	1080.0	0.4	1081.8	0.3	1083.7	wet	Blown		7	5	.25" sett
		330.32	5168.11	332.61	1083.7	461.2	1083.7	535-24	**535-24**	5167.8	1085.6	0.3	1087.5	0.0	1089.3	0.0	1091.2		Seal				
7	SH#3																						
		298.31	5607.10	300.60	978.7		957.4		**541-5**	5600.7		0.0		0.0		0.0							
		300.60	5609.39	302.89	986.2		964.9		**541-6**	5603.0		0.0		0.0		0.0							
		302.89	5611.68	305.18	993.7		972.4		**541-7**	5605.3		0.0		0.0		0.0			Blown		3	3	.5" to .75"
		305.18	5613.97	307.47	1001.2		979.9		**541-8**	5607.6		0.3		x		0.3		dry	Seal				sett.
		307.47	5616.26	309.76	1008.7		987.4		**541-9**	5609.9		2.0		0.0		0.0							
		309.76	5618.55	312.05	1016.2		994.9		**541-10**	5612.2		0.0		0.0		0.0							
		314.80	5623.59	317.09	1032.5		1025.0	541-5	**541-14**	5621.3	1026.9	0.0	1028.8	0.0	1030.6	0.0	1032.5						
		317.09	5625.88	319.38	1040.0		1032.5	541-6	**541-15**	5623.6	1034.4	0.3	1036.3	0.3	1038.1	0.1	1040.0	dry	?				?
		319.38	5628.17	321.67	1047.5		1040.0		**541-16**	5625.9	1041.9	0.0	1043.8	0.0	1045.6	0.0	1047.5						
A1	SH#5																						
		33.76	6296.55	36.05	110.7		106.0	554-9	**554-9**	6295.0	107.9	0.3	109.8	0.0	111.6	0.3	113.5						
		36.05	6298.84	38.34	113.5		113.5	554-10	**554-10**	6297.3	115.4	0.0	117.3	0.0	119.1	0.0	121.0	dry	?				?
							121.0		**554-11**	6299.6	122.9	0.0	124.8	0.0	126.6	0.0	128.5						
A2	SH#6																						
		319.09	7066.88	321.38	1046.9		1042.0	571-17	**571-16**	7064.9	1043.9	0.0	1045.8	x	1047.6	0.0	1049.5						
		321.38	7069.17	323.67	1049.5		1049.5	571-18	**571-17**	7067.2	1051.4	0.3	1053.3	2.3	1055.1	2.8	1057.0	wet	?				?
							1057.0		**571-18**	7069.5	1058.9	0.0	1060.8	0.0	1062.6	0.5	1064.5						
8	SH#7																						
		295.05	7527.84	297.34	968.0		968.2	581-8	**581-6**	7528.0	970.1	x	972.0	x	973.8	x	975.7						
		297.34	7530.13	299.63	975.7		975.7	581-9	**581-7**	7530.3	977.6	x	979.5	x	981.3	x	983.2	wet	Blown seal		5		.5" sett
							983.2		**581-8**	7532.6	985.1	0.3	987.0	0.1	988.8	0.5	990.7						
9	SH#8																						
		253.67	7936.46	255.96	832.3		831.3	586-26	**586-26**	7935.7	833.2	0.0	835.1	0.0	836.9	0.5	838.8						
		255.96	7938.75	258.25	838.8		838.8	586-27	**586-27**	7938.0	840.7	1.0	842.6	0.1	844.4	0.0	846.3						
		258.25	7941.04	260.54			846.3		**586-28**	7940.3	848.2	2.3	850.1	x	851.9	0.6	853.8	wet	?		1	2	?
		260.54	7943.33	262.83			853.8		**586-29**	7942.6	855.7	0.5	857.6	0.3	859.4	1.0	861.3						
		262.83	7945.62	265.12			861.3		**586-30**	7944.9	863.2	0.8	865.1	0.3	866.9	0.3	868.8						
		265.12	7947.91	267.41			868.8		**586-31**	7947.2	870.7	2.3	872.6	0.0	874.4	0.0	876.3						
10	SH#8																						
		341.58	8024.37	343.87	1120.7		1116.8	587-27	**587-26**	8022.8	1118.7	0.0	1120.6	0.0	1122.4	0.0	1124.3						
		343.87	8026.66	346.16	1124.3		1124.3	587-28	**587-27**	8025.7	1126.2	0.3	1128.1	0.0	1129.9	0.0	1131.8	wet	?		10		?

Appendix H

Plan Sheets for Tunnel Invert



TYPE B – BASE AND SUBBASE

	NAME	MATERIAL	COMPACTION
	LEVELING COURSE	3/8" MINUS, NFS	NOT COMPACTED
	BASE	150 MIN. THICK AGGREGATE BASE	PER SPECIFICATION, MIN. 95% M.D.D. (AASHTO T-180)
	SUBBASE	SUITABLE EXISTING MATERIAL (SEE NOTE 5.) OR AGGREGATE BASE	PROOF ROLL EXISTING 95% M.D.D. (AASHTO T-180)
	EXISTING MATERIAL	MAX. DEPTH = "TOOTH DEPTH"	NOT COMPACTED
	COARSE FILL	BALLAST	NOT COMPACTED
	LEAN CONCRETE	10 MPa MINIMUM	N/A
	FILTER STONE OR PEA GRAVEL	SEE DESIGN PKG 53.02B	SEE DESIGN PKG 53.02B

SUBBASE PREPARATION PROCEDURE:

1) REMOVE EXISTING MATERIAL TO TOP OF SUBBASE.
2) REMOVE ANY UNSUITABLE MATERIAL TO EXCAVATOR "TOOTH DEPTH" AS DEFINED BELOW.
3) PROOF ROLL SUBBASE WITH VIBRATORY COMPACTOR OR EQUIVALENT COMPACTIVE EFFORT BY CONSTRUCTION EQUIPMENT.
4) REMOVE ANY UNSUITABLE MATERIAL IDENTIFIED DURING THE PROOF ROLLING.
5) UNSUITABLE MATERIAL IS DEFINED AS:
   A) FROST SUSCEPTIBLE MATERIAL.
   B) FINE TO MEDIUM SAND POCKETS.
   C) MATERIAL CONTAINING DELETERIOUS MATTER (e.g. ORGANIC MATTER, WASTE, DEBRIS)
   D) FROZEN MATERIAL.
   E) MATERIAL THAT IS NOT FIRM AND UNYIELDING.
6) REMOVE ALL EXISTING MATERIAL TO EXCAVATOR "TOOTH DEPTH" FOR A DISTANCE OF 300 m FROM EXISTING PORTAL DOORS.
7) FILL UNDRAINED POCKETS WITH SUBBASE MATERIAL TO ABOVE STATIC WATER LEVEL PRIOR TO PROOF ROLLING.

NOTE:

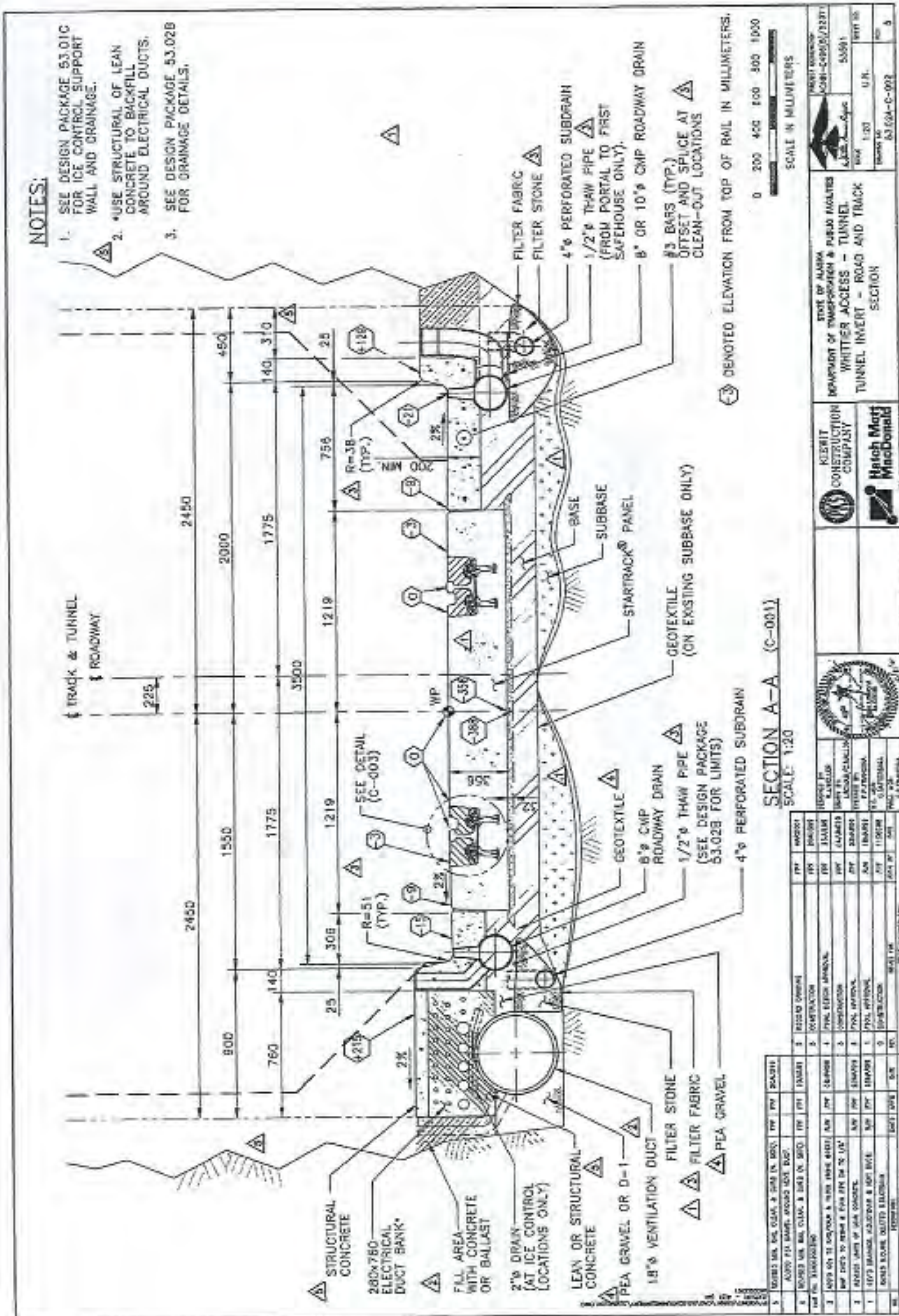
STRUCTURAL CONCRETE CAN BE USED IN PLACE OF LEAN CONCRETE AROUND THE ELECTRICAL CONDUIT.

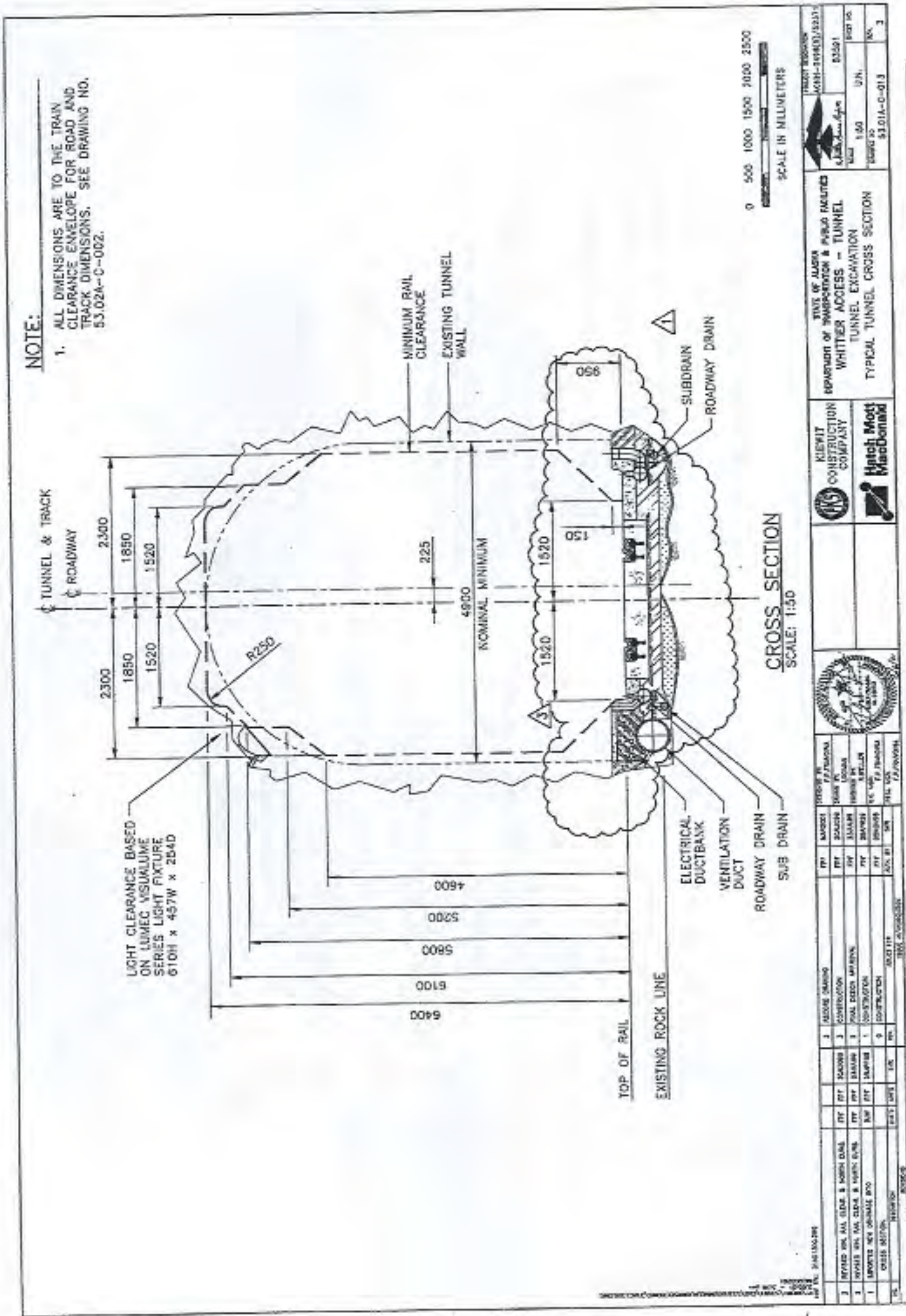
0 200 400 600 800 1000
SCALE IN MILLIMETERS

KIEWIT CONSTRUCTION COMPANY
Hatch Mott MacDonald

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION & PUBLIC FACILITIES
WHITTIER ACCESS – TUNNEL
TUNNEL INVERT – ROAD AND TRACK
TYPE B – BASE AND SUB-BASE

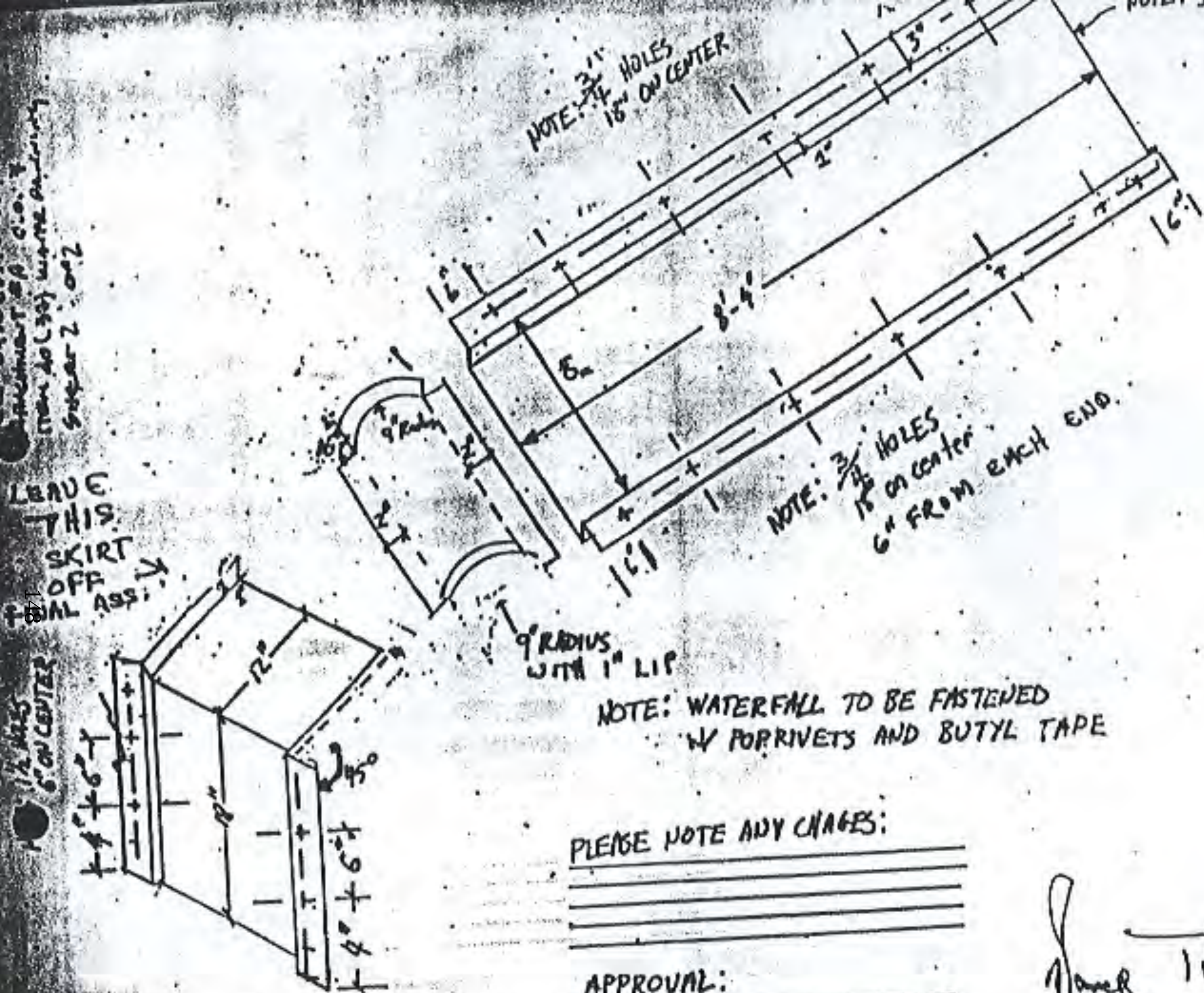
SCALE 1:50 U.N.
53001
53.02A-C-005


NOTES:
1. SEE DESIGN PACKAGE 53.01C FOR ICE CONTROL SUPPORT WALL AND DRAINAGE.
2. *USE STRUCTURAL OF LEAN CONCRETE TO BACKFILL AROUND ELECTRICAL DUCTS.
3. SEE DESIGN PACKAGE 53.02B FOR DRAINAGE DETAILS.
℄ TRACK & TUNNEL
℄ ROADWAY
STRUCTURAL CONCRETE
280x760 ELECTRICAL DUCT BANK*
FILL AREA WITH CONCRETE OR BALLAST
2"φ DRAIN (AT ICE CONTROL LOCATIONS ONLY)
LEAN OR STRUCTURAL CONCRETE
PEA GRAVEL OR D-1
1.8"φ VENTILATION DUCT
FILTER STONE
FILTER FABRIC
PEA GRAVEL
8"φ CMP ROADWAY DRAIN
1/2"φ THAW PIPE (SEE DESIGN PACKAGE 53.02B FOR LIMITS)
4"φ PERFORATED SUBDRAIN
GEOTEXTILE
SEE DETAIL (C-003)
GEOTEXTILE (ON EXISTING SUBBASE ONLY)
STARTRACK® PANEL
SUBBASE
BASE
FILTER FABRIC
FILTER STONE
4"φ PERFORATED SUBDRAIN
1/2"φ THAW PIPE (FROM PORTAL TO FIRST SAFEHOUSE ONLY)
8" OR 10"φ CMP ROADWAY DRAIN
#3 BARS (TYP.) OFFSET AND SPLICE AT CLEAN-OUT LOCATIONS
DENOTED ELEVATION FROM TOP OF RAIL IN MILLIMETERS.
SECTION A-A (C-001)
SCALE: 1:20
SCALE IN MILLIMETERS
KIEWIT CONSTRUCTION COMPANY
Hatch Mott MacDonald
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION & PUBLIC FACILITIES
WHITTIER ACCESS - TUNNEL
TUNNEL INVERT - ROAD AND TRACK SECTION


NOTE:
1. ALL DIMENSIONS ARE TO THE TRAIN CLEARANCE ENVELOPE FOR ROAD AND TRACK DIMENSIONS. SEE DRAWING NO. 53.02A-C-002.
℄ TUNNEL & TRACK
℄ ROADWAY
2300
1850
1520
225
R250
4900
NOMINAL MINIMUM
MINIMUM RAIL CLEARANCE
EXISTING TUNNEL WALL
950
150
SUBDRAIN
ROADWAY DRAIN
LIGHT CLEARANCE BASED ON LUMEC VISUALUME SERIES LIGHT FIXTURE 610H x 457W x 254D
4600
5200
5800
6100
6400
TOP OF RAIL
EXISTING ROCK LINE
ELECTRICAL DUCTBANK
VENTILATION DUCT
ROADWAY DRAIN
SUB DRAIN
CROSS SECTION
SCALE: 1:50
0 500 1000 1500 2000 2500
SCALE IN MILLIMETERS
KIEWIT CONSTRUCTION COMPANY
Hatch Mott MacDonald
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION & PUBLIC FACILITIES
WHITTIER ACCESS - TUNNEL
TUNNEL EXCAVATION
TYPICAL TUNNEL CROSS SECTION
53501
53.01A-C-013

Appendix I

Plan Sheets for Tunnel Drainage



NOTE: WATERFALL TO BE FASTENED W/ POPRIVETS AND BUTYL TAPE

PLEASE NOTE ANY CHAGES:

APPROVAL: Lee-Frail Kavit CS
Authorized Signature Required

2-10-00

WORK SHEET

Sheet 1 of 2

(1)

Project
Type of Work

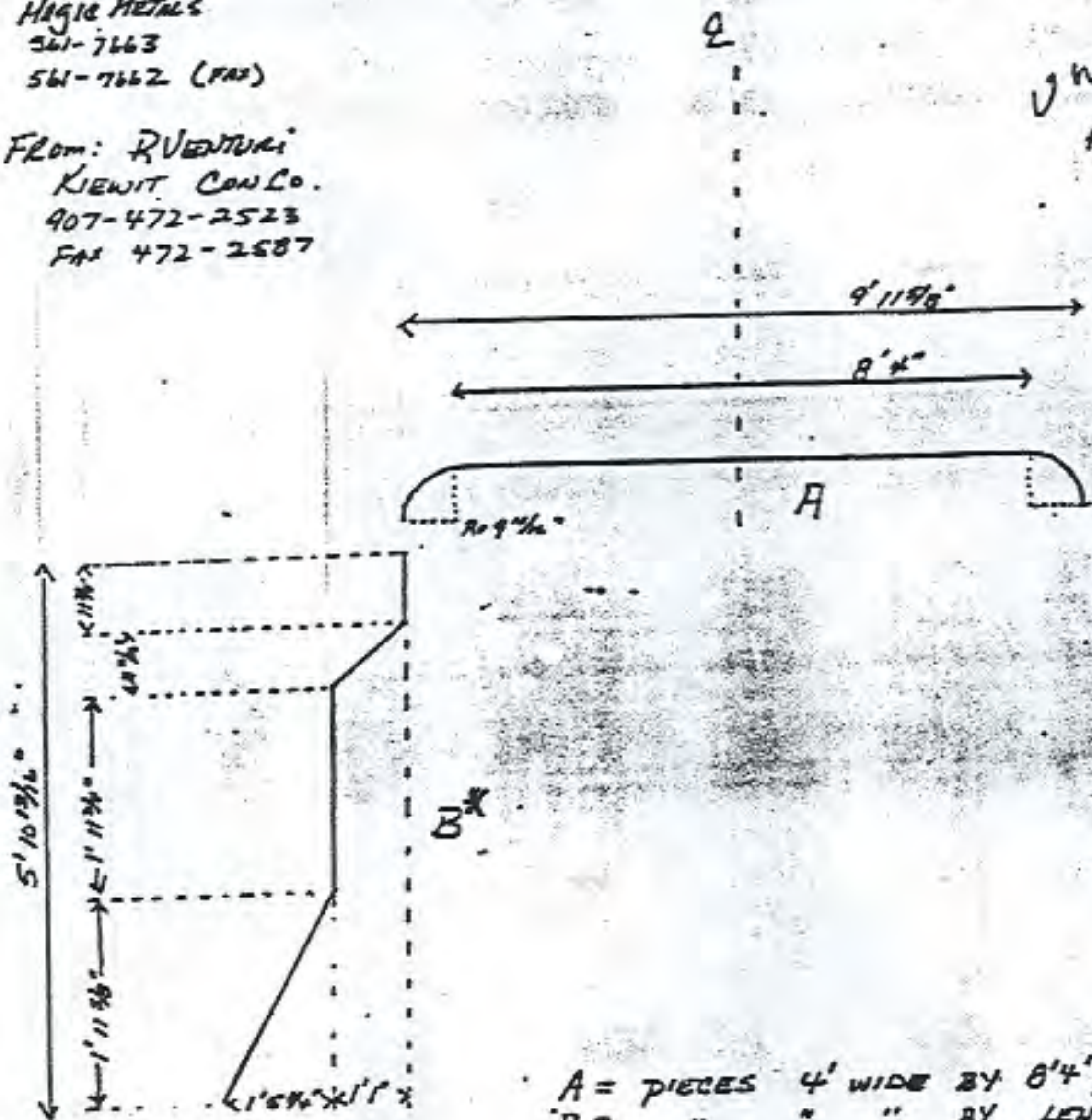
Estimator
Date

Item No.
Sheet No.

TO:
Hagie Metals
561-7663
561-7662 (FAX)

FROM: RVenturi
Kiewit Con Co.
907-472-2523
FAX 472-2587

Unit Price
A - Top
B - Side piece



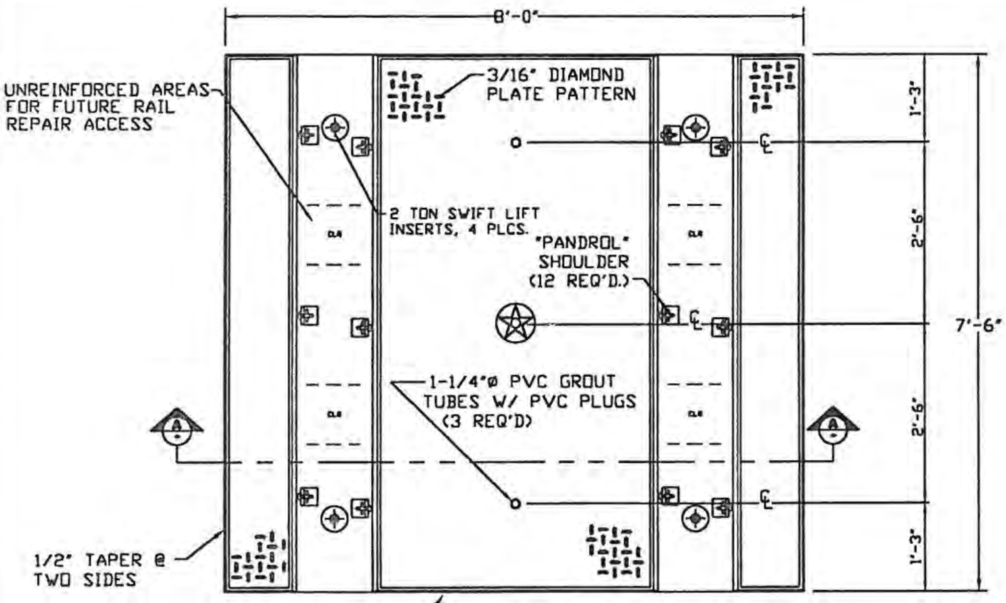
A = PIECES 4' WIDE BY 8'4" plus RADIUS
B = " " " BY LENGTH of bent sec

20ga sheet metal galvanized

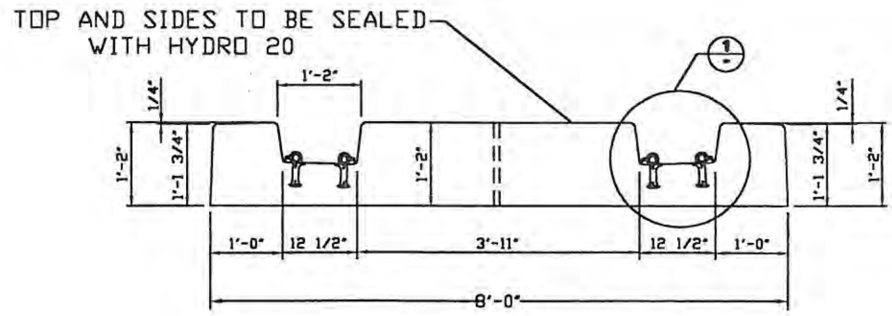
* SEE ATTACHED SHEET FOR PIECE 'B'

Appendix J

Plan Sheets for Concrete Invert Panels



PLAN VIEW
3/8" = 1'-0"

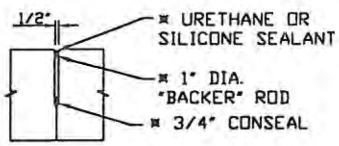


SECTION
3/8" = 1'-0"

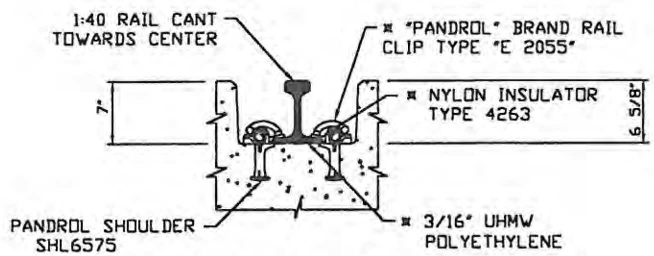
FOR REINFORCING DETAILS SEE DWG # C17-401

STAR TRACK RAILROAD CROSSINGS

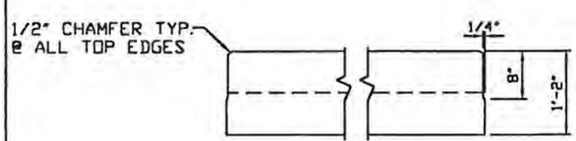
* THESE ITEMS ARE SUPPLIED BY AMCOR PRECAST CO. AND INSTALLED BY OTHERS.



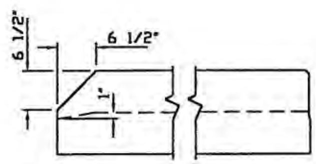
JOINT DETAIL
N.T.S.



DETAIL W/ 115# AREA RAIL
N.T.S.



TYPICAL END DETAIL
THIS DETAIL IS USED ON ALL STANDARD PIECES
QUANTITY = 1828 PCS.



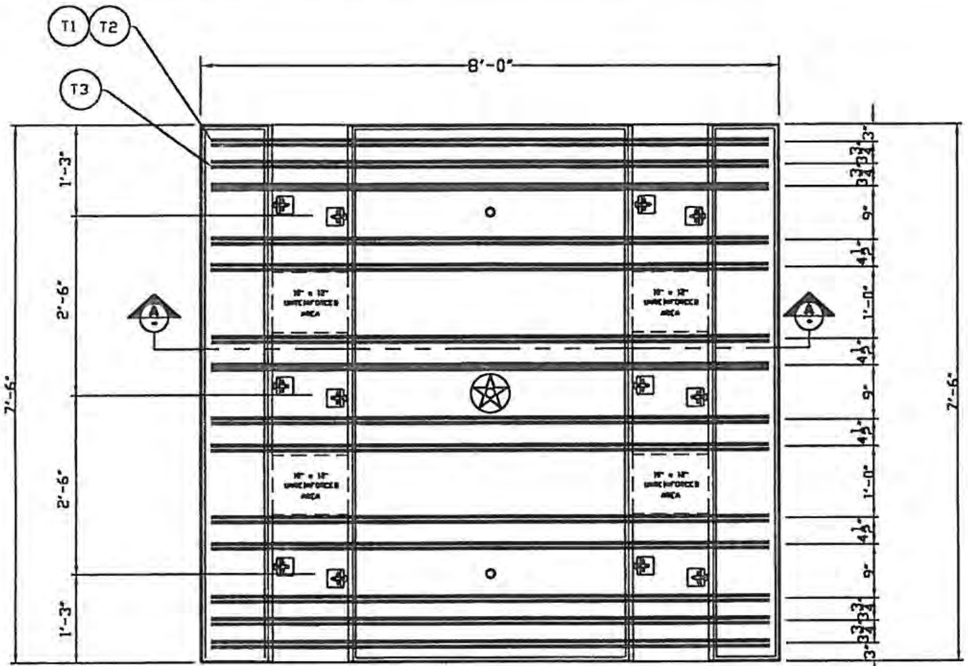
SLOPED END DETAIL
THE SLOPE DETAIL IS USED ON ONE END OF AN END PIECE ONLY
QUANTITY = 2 PCS.

DESIGN NOTES:

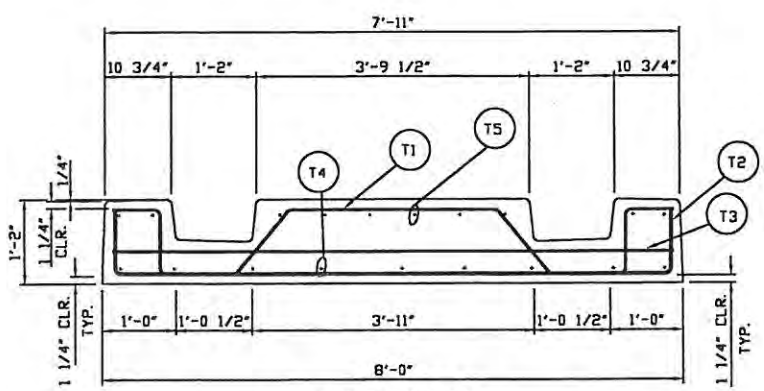
1) DESIGN LOADINGS:
   - A. AASHTO HS-20-44, W/ IMPACT
   - B. SOIL WEIGHT = 120 PSF
   - C. EQUIVALENT FLUID PRESSURE = 45 PCF
   - D. 80 PSF LATERAL LIVE LOAD SURCHARGE
   - D. COPPER E-TRACK LOAD
2) CONCRETE 28 DAY COMPRESSIVE STRENGTH SHALL BE 6000 PSI (MIN.)
3) STEEL REINFORCEMENT: REBAR, ASTM A-615 GRADE 60
4) TYPE III CEMENT

DRAWN BY: JS	DATE: 05/25/99	PAGE 1 OF 1
SOLD BY: JIM BAKER	DWG NAME: C19-406	SCALE: 3/8" = 1'-0"
STARTRACK 9,074 LBS TOTAL 9,074 LBS	**STARTRACK II - 7'-6"** **PRODUCT DETAILS**	
THIS DRAWING IS THE PROPERTY OF AMCOR PRECAST. IT IS SUBMITTED FOR REFERENCE PURPOSES ONLY AND SHALL NOT BE USED IN ANY WAY INJURIOUS TO THE INTERESTS OF SAID COMPANY.	CHECKED BY:	DATE
	REVISION DATE:	ORDER#

AMCOR Precast COLORADO DIVISION
8392 RIVERVIEW PARKWAY LITTLETON, CO 80125 PHONE: (303) 791-1100
DIVISION OF Oldcastle® Precast, Inc.



PLAN VIEW
3/8" = 1'-0"



SECTION (A)
3/8" = 1'-0"

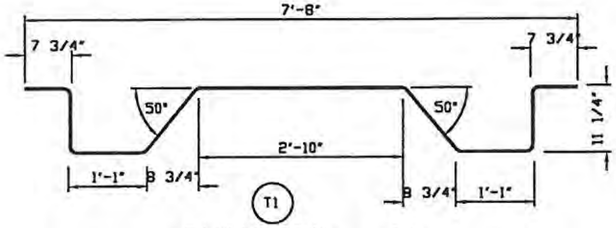
FOR PRODUCT DETAILS
SEE DWG # C19-406

DESIGN NOTES:

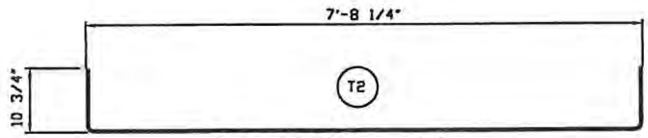
1) DESIGN LOADINGS:
   A. AASHTO HS-20-44, W/ IMPACT
   B. SOIL WEIGHT = 120 PSF
   C. EQUIVALENT FLUID PRESSURE = 45 PCF
   D. 80 PSF LATERAL LIVE LOAD SURCHARGE
   D. COPPER E-TRACK LOAD
2) CONCRETE 28 DAY COMPRESSIVE STRENGTH SHALL BE 6000 PSI (MIN.)
3) STEEL REINFORCEMENT: REBAR, ASTM A-615 GRADE 60
4) TYPE III CEMENT

DRAWN BY: JS	DATE: 05/14/99	PAGE 1 OF 2
SOLD BY: JIM BAKER	DWG NAME: C17-401	SCALE: 3/8" = 1'-0"
STARTRACK 9,074 LBS TOTAL 9,074 LBS	**STARTRACK II - 7'-6"** **REINFORCEMENT DETAILS**	
THIS DRAWING IS THE PROPERTY OF AMCOR PRECAST. IT IS SUBMITTED FOR REFERENCE PURPOSES ONLY AND SHALL NOT BE USED IN ANY WAY INJURIOUS TO THE INTERESTS OF SAID COMPANY.	CHECKED BY:	DATE
	REVISION DATE: 05/21/JS	ORDER#

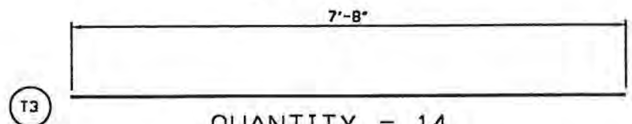
AMCOR Precast COLORADO DIVISION
8392 RIVERVIEW PARKWAY LITTLETON, CO 80125 PHONE:(303) 791-1100
DIVISION OF Oldcastle® Precast, Inc.



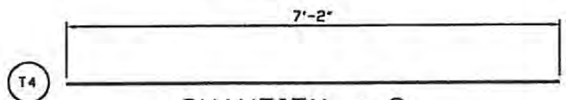
QUANTITY = 14
#4 BAR



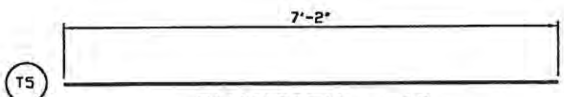
QUANTITY = 14
#5 BAR



QUANTITY = 14
#4 BAR



QUANTITY = 9
#4 BAR @ 10 1/2" O.C.



QUANTITY = 10
#5 BAR @ 7 1/2" O.C.

STEEL DETAILS
3/8" = 1'-0"

STAR TRACK RAILROAD CROSSINGS

DRAWN BY: JS	DATE: 05/14/99	PAGE 2 OF 2
SOLD BY: JIM BAKER	DWG NAME: C17-401	SCALE: 3/8" = 1'-0"
STARTRACK 9,074 LBS TOTAL 9,074 LBS	**STARTRACK II - 7'-6"** **REINFORCEMENT DETAILS**	
THIS DRAWING IS THE PROPERTY OF AMCOR PRECAST. IT IS SUBMITTED FOR REFERENCE PURPOSES ONLY AND SHALL NOT BE USED IN ANY WAY INJURIOUS TO THE INTERESTS OF SAID COMPANY.	CHECKED BY: REVISION DATE: 05/21/JS	DATE ORDER#

AMCOR Precast COLORADO DIVISION
8392 RIVERVIEW PARKWAY LITTLETON, CO 80125 PHONE:(303) 791-1100
DIVISION OF Oldcastle® Precast, Inc.

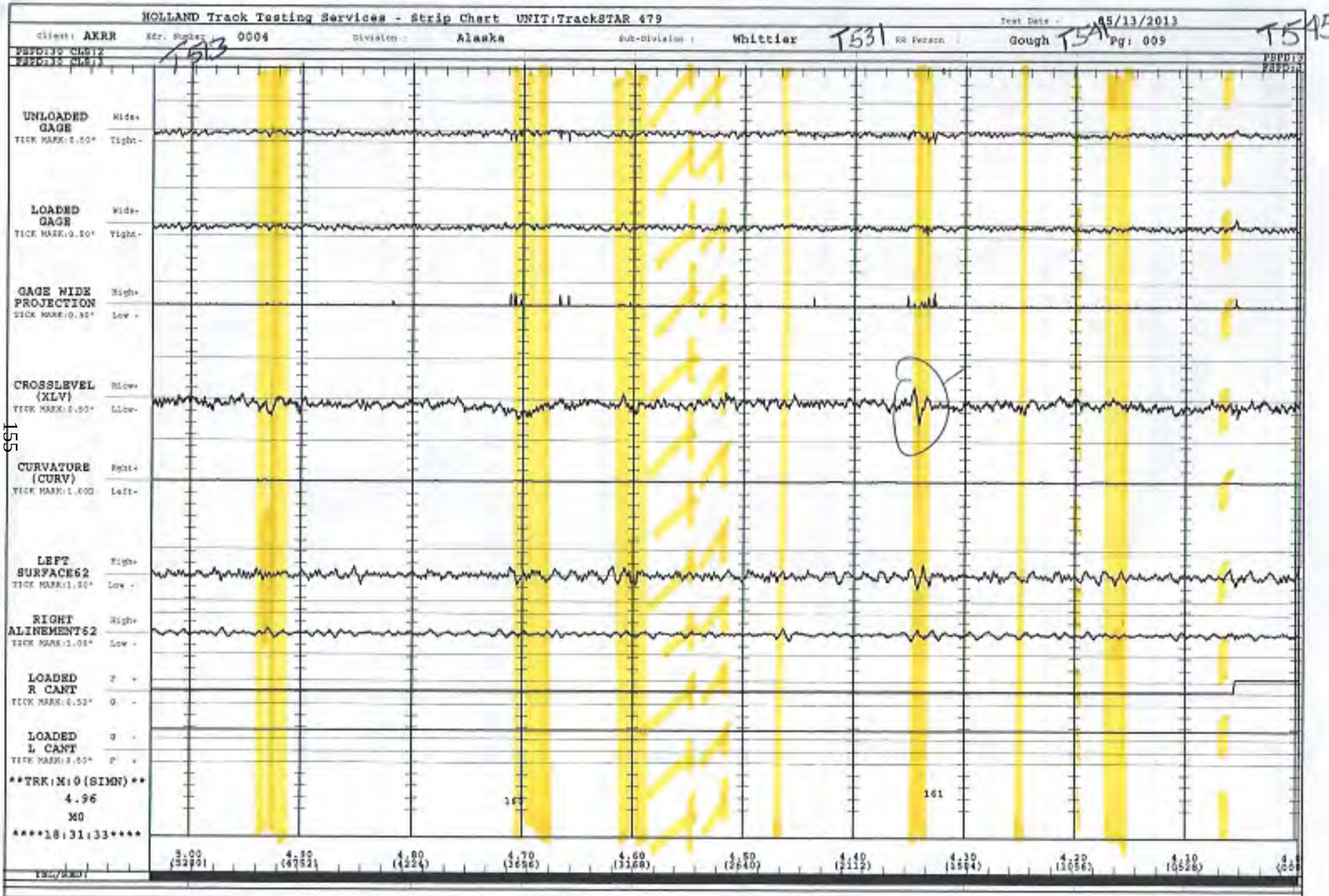
Appendix K

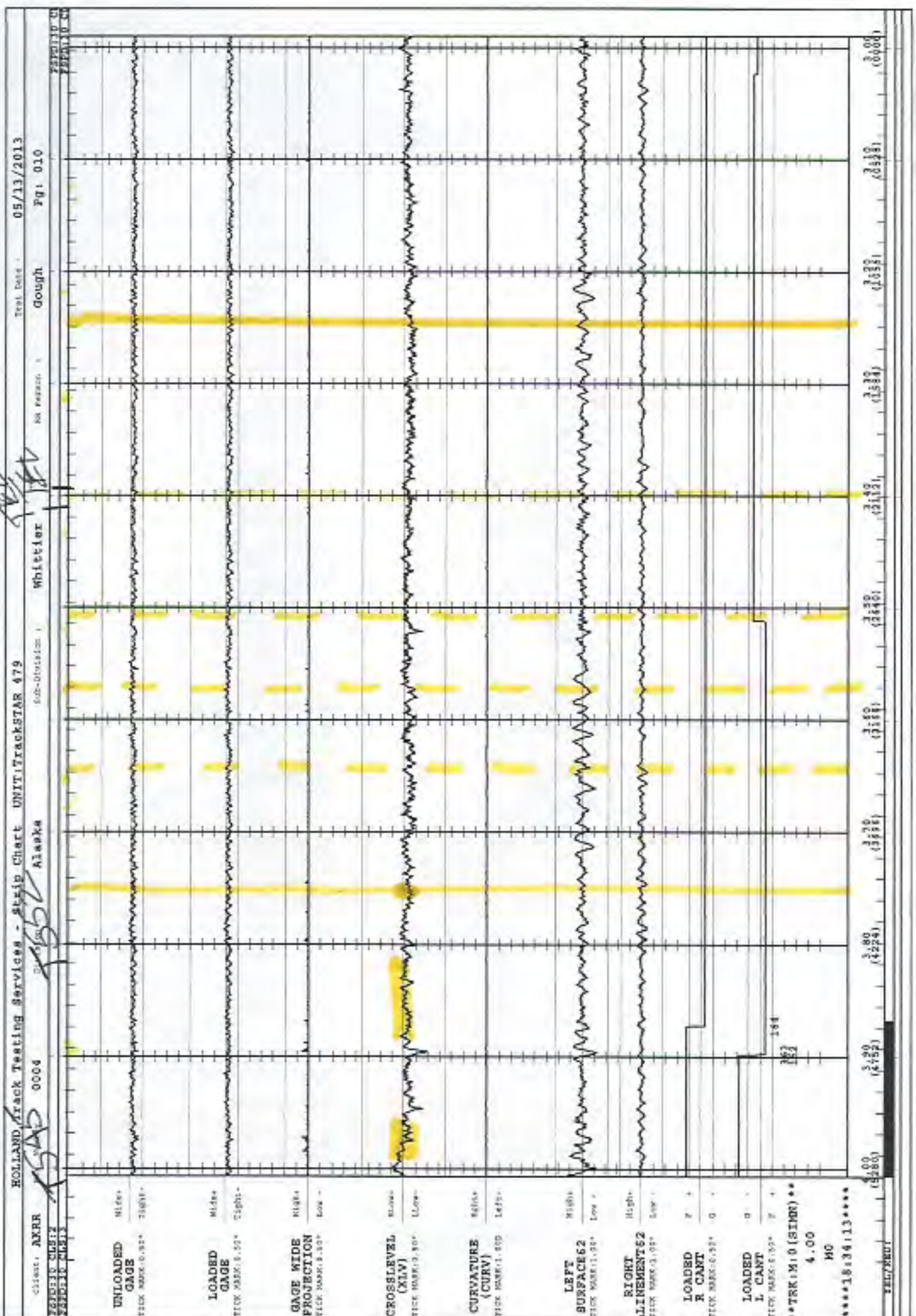
Track geometry with Void Areas

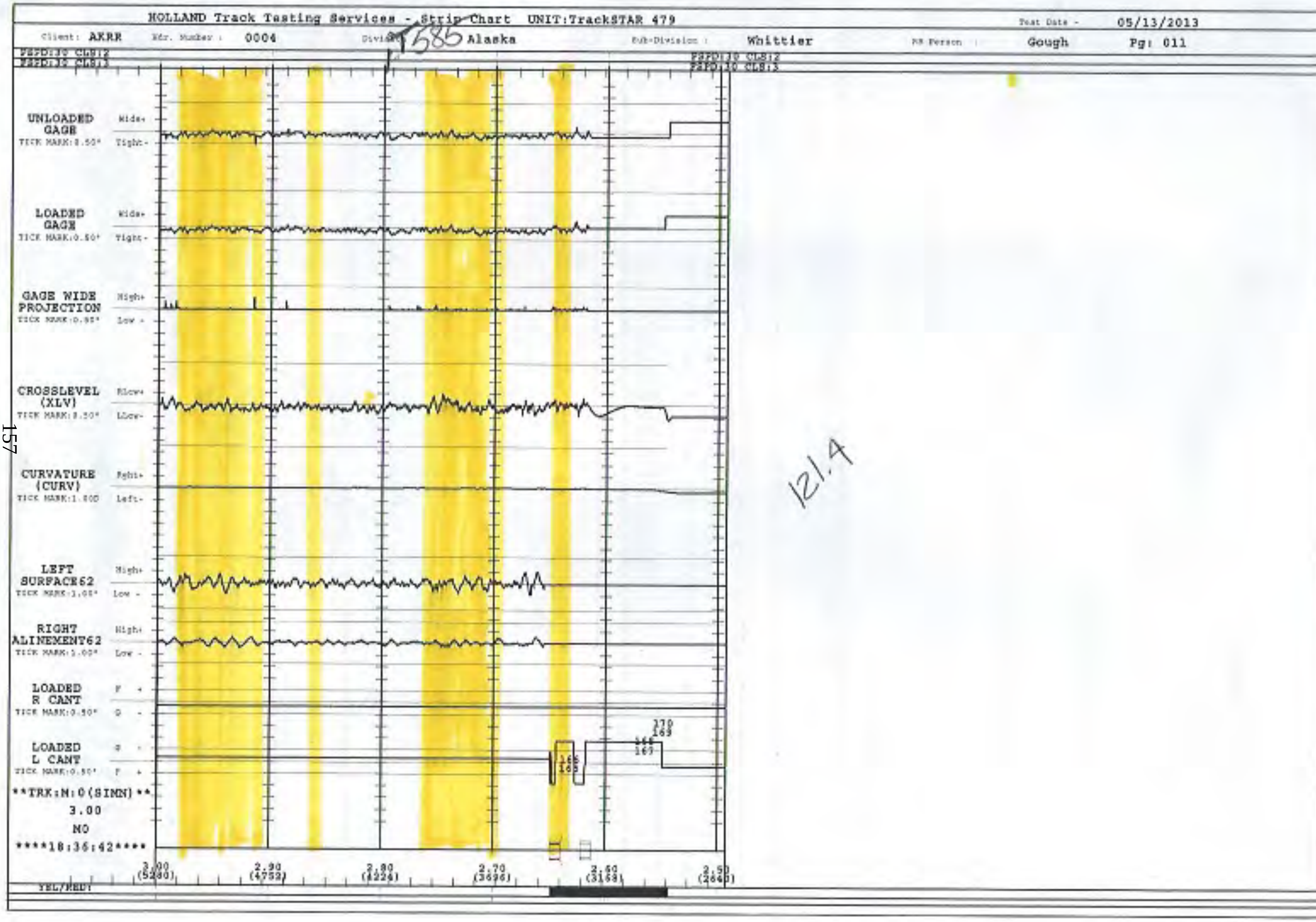
<u>Legend</u>

Yellow Highlight = GPR identified Void Area below Panel

3.28


HOLLAND Track Testing Services - Strip Chart UNIT:TrackSTAR 479
Test Date - 05/13/2013
Client: AKRR
0004
Division : Alaska
Sub-Division : Whittier
RR Person : Gough
Pg: 009
T513
T531
T541
T545
UNLOADED GAGE
TICK MARK:0.50"
Wide+
Tight-
LOADED GAGE
TICK MARK:0.50"
Wide-
Tight-
GAGE WIDE PROJECTION
High+
Low +
CROSSLEVEL (XLV)
TICK MARK:0.50"
CURVATURE (CURV)
TICK MARK:1.00D
Left-
LEFT SURFACE62
TICK MARK:1.00"
High+
Low -
RIGHT ALINEMENT62
TICK MARK:1.00"
High+
Low -
LOADED R CANT
TICK MARK:0.50"
LOADED L CANT
TRK:M:0(SIMN)
4.96
M0
****18:31:33****
161
5.00 (5280)
4.90 (4752)
4.80 (4224)
4.70 (3696)
4.60 (3168)
4.50 (2640)
4.40 (2112)
4.30 (1584)
4.20 (1056)
4.10 (0528)


HOLLAND Track Testing Services - Strip Chart UNIT:TrackSTAR 479
Client: AKRR
0004
Alaska
Whittier
Gough
05/13/2013
Pg: 010
UNLOADED GAGE
LOADED GAGE
GAGE WIDE PROJECTION
CROSSLEVEL (XLVL)
CURVATURE (CURV)
LEFT SURFACE62
RIGHT ALINEMENT62
LOADED R CANT
LOADED L CANT
4.00
MO
3.00
3.10
3.20
3.30
3.40
3.50
3.60
3.70
3.80
3.90
4.00


HOLLAND Track Testing Services - Strip Chart UNIT:TrackSTAR 479
Test Date - 05/13/2013
Client: AKRR
Hdr. Number: 0004
Division: Alaska
Sub-Division: Whittier
RR Person: Gough
Pg: 011
FSPD:10 CLS:2
FSPD:10 CLS:3
UNLOADED GAGE
TICK MARK:0.50"
Wide+
Tight-
LOADED GAGE
TICK MARK:0.50"
Wide+
Tight-
GAGE WIDE PROJECTION
High+
Low -
CROSSLEVEL (XLV)
TICK MARK:0.50"
RLow+
LLow-
CURVATURE (CURV)
TICK MARK:1.00D
Rght+
Left-
LEFT SURFACE62
TICK MARK:1.00"
High+
Low -
RIGHT ALINEMENT62
TICK MARK:1.00"
High+
Low -
LOADED R CANT
TICK MARK:0.50"
LOADED L CANT
TICK MARK:0.50"
TRK:M:0(SIMN)
3.00
NO
****18:36:42****
3.00 (5280)
2.90 (4752)
2.80 (4224)
2.70 (3696)
2.60 (3168)
2.50 (2640)
170
169
166
167
YEL/RED!
585
121.4

Appendix L

Inspection Summary

Tunnel Inspection Summary

Bear Valley to SH #1

Telephone	BV - BVP																		
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Water																			
Settlement																			
Voids																			
Seals	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cracks																			

Telephone	BVP - 511																						
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Water																							
Settlement																							
Voids																							
Seals	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Cracks												X	X						X				

Telephone	511 - 12																																						
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Water																																							
Settlement																																							
Voids																																							
Seals																																							
Cracks	X			X			X		X																	X			X			X						X	

Telephone	512 - 513																																			
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Water																																			X	X
Settlement																																				
Voids																																				
Seals																																				
Cracks	X		X																X		X					X		X					X			

Telephone	513 - 514																																								
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Water																																									
Settlement																																									
Voids																																									
Seals																																									X
Cracks	X		X				X		X					X	X			X		X			X	X			X	X		X											X

Telephone	514 - 515																																						
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Water			X	X	X																																		
Settlement			X	X	X																																		
Voids				X	X	X	X	X																															
Seals	X					X																																	
Cracks											X				X							X						X	X										

Telephone	515 - 516									
Panel #	1	2	3	4	5	6	7	8	9	10
Water										
Settlement										
Voids										
Seals										
Cracks	X					X			X	

Tunnel Inspection Summary

SH #1 to SH #2

Telephone	516-517																																																									
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
Water																																																											
Settlement																																																											
Voids																																																											
Seals																																																											
Cracks					X									X		X			X								X			X					X									X															

Telephone	517-521																				521-522																																					
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Water	X				X	X	X			X									X																				X	X		X									X	X	X					
Settlement																																																			X	X	X	X	X	X	X	X
Voids																																																						X	X	X		
Seals																																																						X		X		
Cracks	X																	X								X				X		X							X		X									X								

Telephone	522-523																																						523 - 524									
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	1	2	3	4	5	6	7	8	9	10
Water			X	X										X										X				X																					
Settlement																																																	
Voids																																																	
Seals																																																	
Cracks		X		X			X																												X		X			X			X			X			

Tunnel Inspection Summary

SH #2 to SH #3

Telephone	524 - 525																																					
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Water								X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X									
Settlement															X	X	X							X	X	X	X	X	X									
Voids						X	X																				X	X	X									
Seals														X				X								X	X	X	X			X						
Cracks		X				X									X											X		X										

Telephone	525 - 533																																							
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water					X	X	X													X																				
Settlement																																								
Voids																																								
Seals																																								
Cracks								X		X										X				X			X	X				X	X					X		

Telephone	533 - 535																																				
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Water		X	X	X	X	X	X	X	XX	X					X																		X	X			
Settlement																																					
Voids																																					
Seals																																					
Cracks	X		X			X														X			X				X			X		X		X			

Telephone	535 - 531																																										
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Water						X													X	X	X	X	X	X	X	X	X	X															
Settlement																					X	X	X	X																			
Voids																							X	X																			
Seals	X																													X													
Cracks			X		X									X				X								X						X							X				

Telephone	531 - 532																																				
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Water																																					
Settlement																																					
Voids																																					
Seals																																					
Cracks		X			X				X				X											X				X			X			X		X	

Telephone	532 - 534									
Panel #	1	2	3	4	5	6	7	8	9	10
Water										
Settlement									X	X
Voids									X	X
Seals										
Cracks		X		X		X		X	X	X

Tunnel Inspection Summary

SH #3 to SH #4

Telephone	534 - 536																																							
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water				X	X	X	X	X										X	X	X																				
Settlement	X	X	X	X	X	X	X	X	X	X																														
Voids	X	X	X	X	X	X	X	X	X	X																														
Seals	X	X	X	X	X	X	X	X																																
Cracks	X	X			X			X						X									X					X		X							X			X

Telephone	536 - 537																																							
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water					X	X	X										X	X																						
Settlement																																								
Voids																																								
Seals																											X													
Cracks				X			X			X		X			X	X		X						X					X				X					X		

Telephone	537 - 541																																					
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Water																																						
Settlement																																						
Voids																																						
Seals																																						
Cracks		X				X			X						X		X	X						X					X		X							

Telephone	541 - 542																																						
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Water																																							
Settlement							X	X	X	X	X	X	X	X																									
Voids					X	X	X	X	X	X				X	X	X																							
Seals																																							
Cracks	X							X			X			X	X			X															X		X			X	

Telephone	542 - 543																																									
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Water								X	X	X																						X										
Settlement																																										
Voids																																										
Seals																																										
Cracks						X						X			X		X							X		X										X					X	

Telephone	543 - 544									
Panel #	1	2	3	4	5	6	7	8	9	10
Water										
Settlement										
Voids										
Seals										
Cracks					X					

Tunnel Inspection Summary

SH #4 to SH #5

Telephone 544 - 545

Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water									X	X	X																	X	X											
Settlement																																								
Voids																																								
Seals																																								
Cracks					X	X	X	X									X				X					X			X							X				

Telephone 545 - 546

Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Water		X	X								X	X	X	X	X	X	X	X	X	X	X															X	X	X	X	X	
Settlement	X	X	X	X	X	X	X	X							X	X	X	X	X	X																					
Voids										X					X	X	X	X																							
Seals																	X	X																							
Cracks								X								X		X		X								X		X						X		X			X

Telephone 546 - 551

Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Water						X	XX	X	X																		X	X	X	X	X	X	X				
Settlement																																					
Voids																																					
Seals																																					
Cracks			X		X											X			X															X			

Telephone 551 - 552

Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Water		X	X	X	X	X	X			X	X	X	X	X				X	X	X	X	X	X	X						X	X	X	X	X	X	X			
Settlement																																							
Voids																																							
Seals																																							
Cracks				X				X	X				X		X																								

Telephone 552 - 553

Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Water	X	X	X	X	X								X	X										X	X	X															
Settlement																																									
Voids																																									
Seals																																									
Cracks			X														X		X							X			X							X		X		X	

Telephone 553 - 554

Panel #	1	2	3	4	5	6	7	8	9	10
Water										
Settlement										
Voids										
Seals										
Cracks					X					

Tunnel Inspection Summary

SH #5 to SH #6

Telephone	554 - 555																																				
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Water											X	X	X								X	X	X										X	X			
Settlement										X	X	X	X																								
Voids									X	X	X																										
Seals																																					
Cracks			X		X									X						X				X							X	X					

Telephone	555- 556																																							
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water																																X	X							
Settlement																																								
Voids																																								
Seals																																								
Cracks		X																																						

Telephone	556 - 562																																								
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Water							X	X	X																						X	X									
Settlement																																									
Voids																																									
Seals																																									
Cracks						X															X											X									

Telephone	562 - 563																																						
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Water			X	X	X			X	X	X	X	X	X	X	X	X	X																						
Settlement																																							
Voids																																							
Seals																																							
Cracks	X																	X																				X	

Telephone	563 - 564																																											
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
Water						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																
Settlement																																												
Voids																																												
Seals																																												
Cracks			X	X				X							X											X																		

Telephone	564 - 565									
Panel #	1	2	3	4	5	6	7	8	9	10
Water										
Settlement										
Voids										
Seals										
Cracks	X									X

Tunnel Inspection Summary

SH #6 to SH #7

Telephone	565 - 566																																								
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Water			X	X																											X	X	X								
Settlement																																									
Voids																																									
Seals																																									
Cracks											X		X						X		X						X		X			X		X		X	X		X		

Telephone	566 - 567																																							
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water											X	X																												
Settlement																																								
Voids																																								
Seals																																								
Cracks							X			X			X	X															X											

Telephone	567 - 571																																			
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Water				X	X	X																															
Settlement																																					
Voids																																					
Seals																																					
Cracks		X																X									X										

Telephone	571 - 572																																									
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Water										X			X	X	X	X	X																									
Settlement														X	X	X																										
Voids																X	X	X																								
Seals																																										
Cracks														X			X																									

Telephone	572 - 573																																									
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Water																																										
Settlement																																										
Voids																																										
Seals																							X	X																		
Cracks						X				X																							X					X				

Telephone	573 - 574									
Panel #	1	2	3	4	5	6	7	8	9	10
Water										
Settlement										
Voids										
Seals										
Cracks				X						

Tunnel Inspection Summary

SH #7 to SH #8

Telephone	574 - 575																																						
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water																																								
Settlement																																								
Voids																																								
Seals																																								
Cracks	X																					X								X	X									

Telephone	575 - 576																																						
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water	X	X	X	X	X																									X	X	X	X	X	X					
Settlement																																								
Voids																																								
Seals																																								
Cracks																	X																			X				

Telephone	576 - 581																																				
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Water																	X	X	X													X	X	X	X			
Settlement																																						
Voids																																						
Seals																																						
Cracks																															X							

Telephone	581 - 582																																							
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Water											X	X	X	X	X	X	X	X	X	X																X	X				
Settlement						X	X	X			X	X	X	X	X	X	X	X	X	X	X																				
Voids						X	X	X																																	
Seals												X	X	X	X	X	X	X	X																						
Cracks				X				X				X						X		X	X																				

Telephone	582 - 583																									
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Water	X	X											X							X	X						
Settlement																											
Voids																											
Seals																											
Cracks																			X							X	

Telephone	583 - 584									
Panel #	1	2	3	4	5	6	7	8	9	10
Water										
Settlement										
Voids										
Seals										
Cracks		X								

Tunnel Inspection Summary

SH # 8 to Whittier

Telephone	584 - 585																																							
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water				X	X	X																																		
Settlement																																								
Voids																																								
Seals							X																																	
Cracks							X				X							X			X				X														X	

Telephone	585-586																																							
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water						X	X	X	X	X	X															X	X	X	X	X	X	X	X							X
Settlement																																								
Voids																																								
Seals																						X					X													
Cracks																											X													

Telephone	586 - 587																																					
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Water	X	X	X	X	X	X				X								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Settlement																		X	X	X	X	X	X	X	X	X	X	X	X	X	X							
Voids																										X	X	X	X	X	X							
Seals																									X	X	X	X	X									
Cracks					X												X	X		X					X													

Telephone	587 - 588																																							
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Water	X	X	X	X	X	X								X	X	X	X	X	X	X							X	X	X	X	X					X	X			
Settlement																																								
Voids																										X	X													
Seals					X												X																							
Cracks														X					X				X									X		X			X			

Telephone	588 - WP																		
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Water																			
Settlement																			
Voids																			
Seals							X	X	X	X	X	X	X	X	X				
Cracks																			

Telephone	WP - Whittier																	
Panel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Water																		
Settlement																		
Voids																		
Seals	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cracks																		

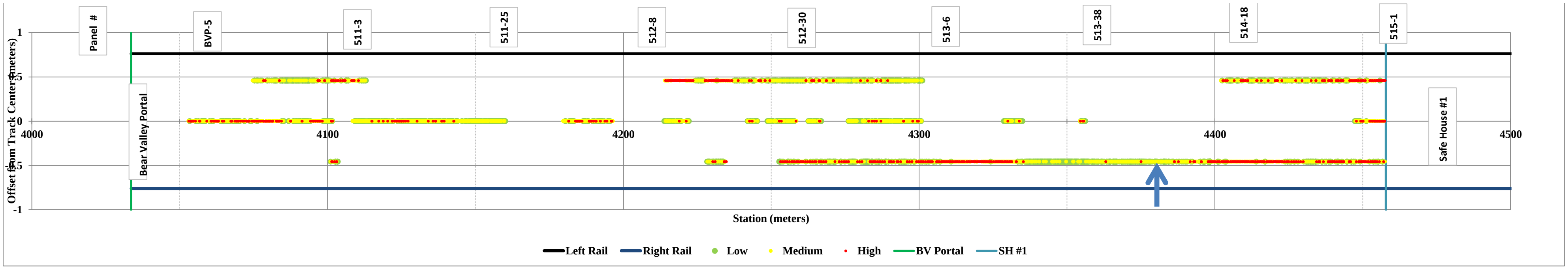
Appendix M

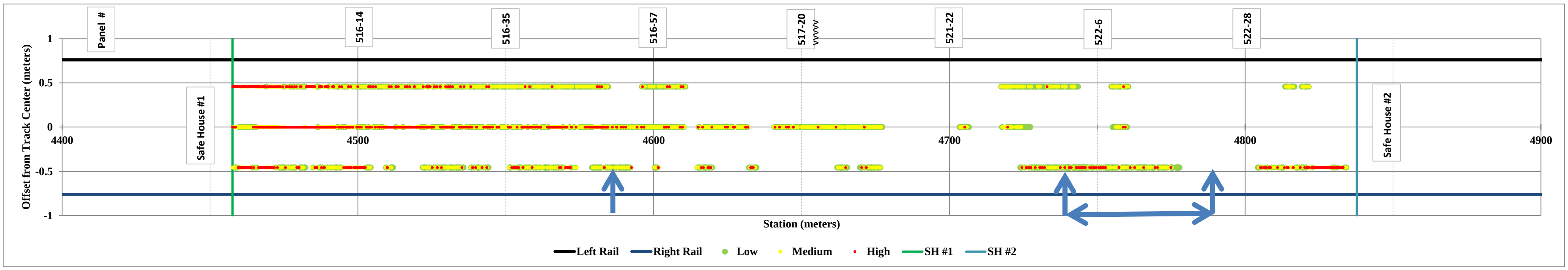
Potential Corrosion in Invert Panel Rebar

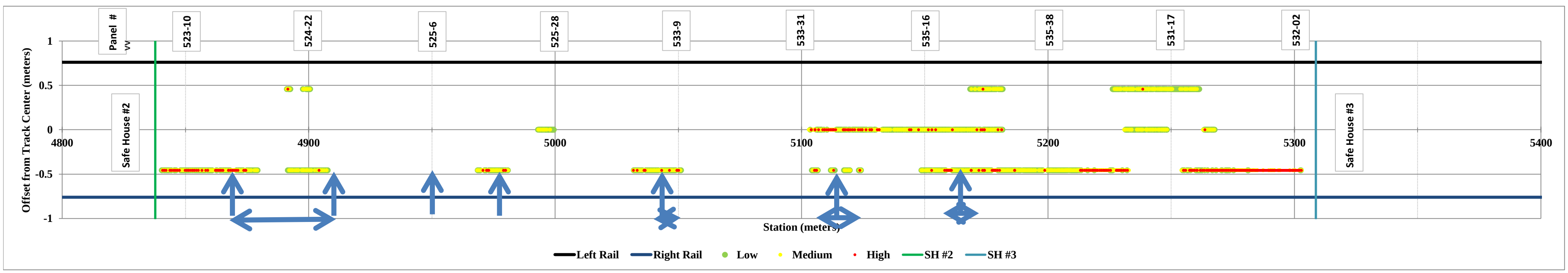
Legend

Water Draining from Crown

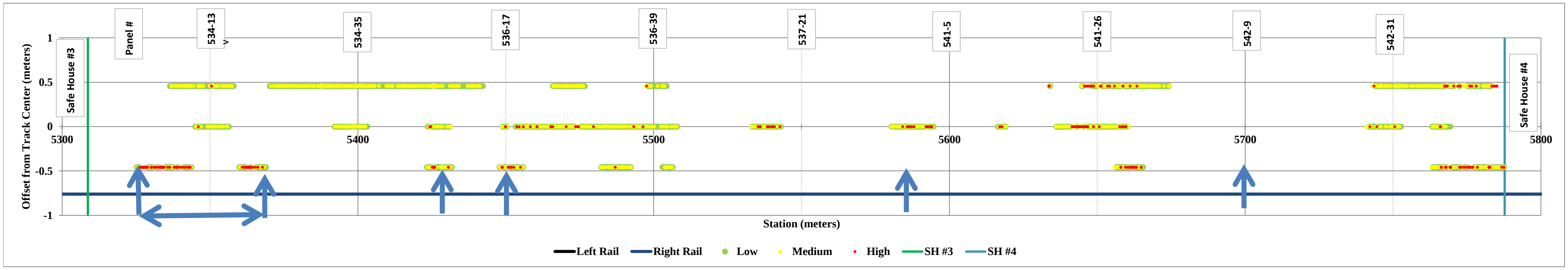
Whittier Tunnel - Potential Corrosion

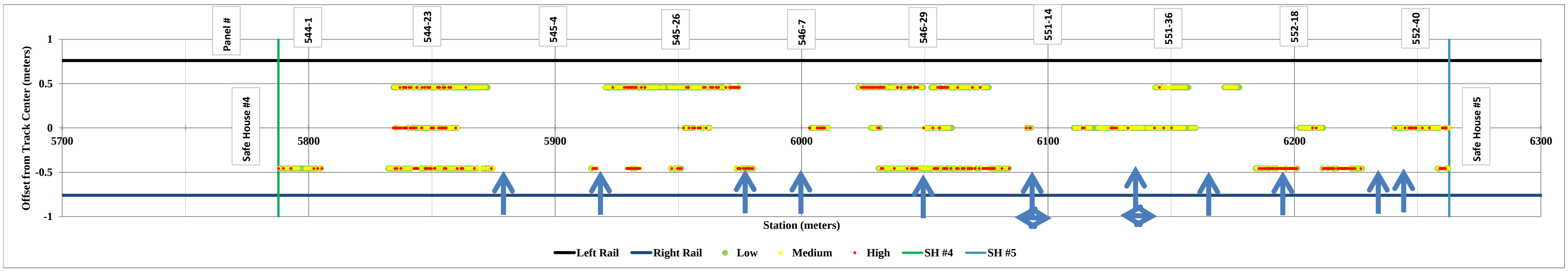


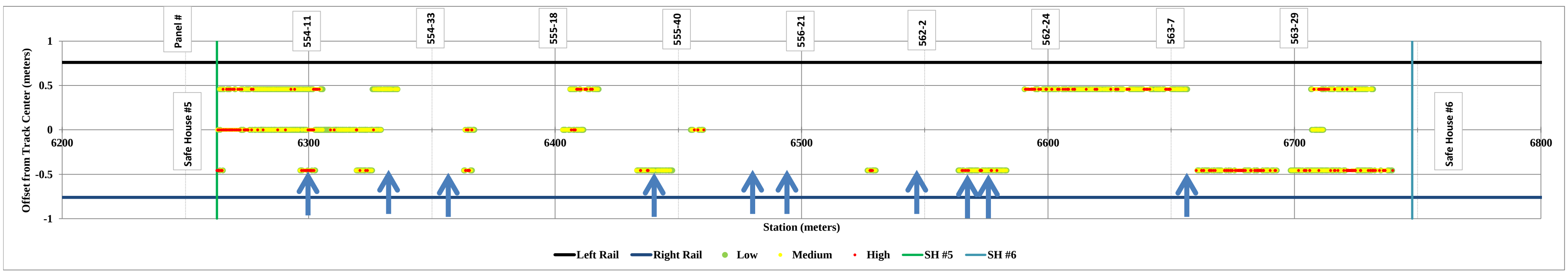




Whittier Tunnel - Potential Corrosion







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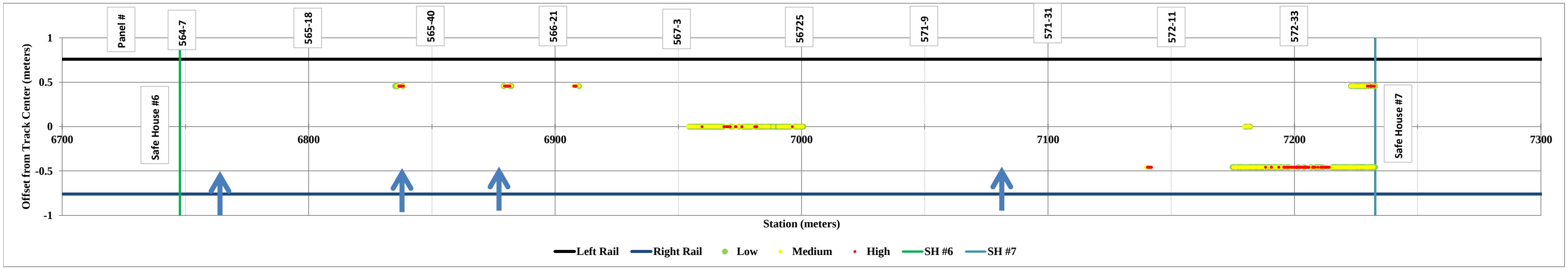
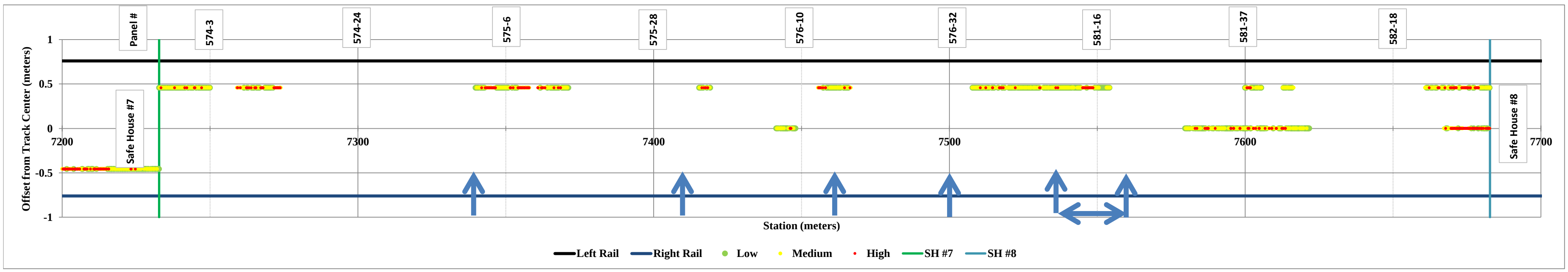
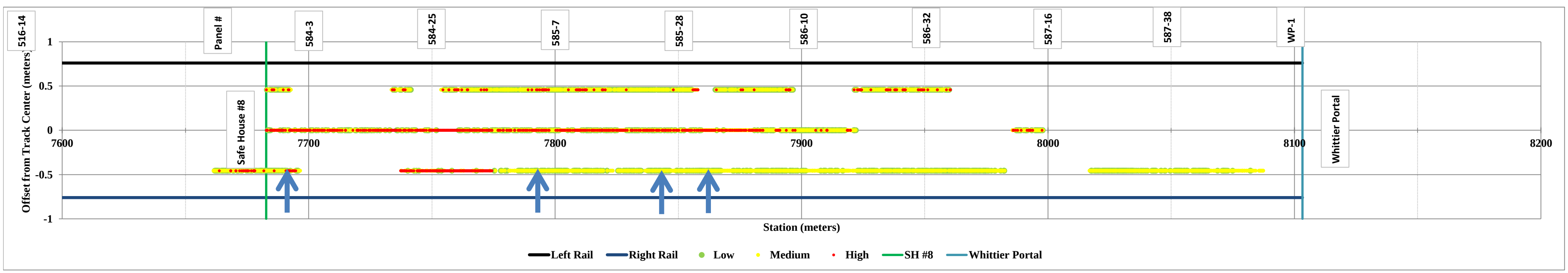
Whittier Tunnel - Potential Corrosion







Calibrated_Voids 6-18-13

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Brian Lindamood, P.E., Director of Project Management, Alaska Railroad Corporation

Jon Garner, Superintendent of Southern Terminals, Operations, Alaska Railroad Corporation

Clark Hoppe, Vice President of Engineering, Alaska Railroad Corporation