The Whittier Access Project - State of the Art Engineering for Alaska

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Presented by: Tom Moses, P.E.—Project Manager, ADOT&PF
Paul Witt, P.E.—Project Manager, HDR Alaska

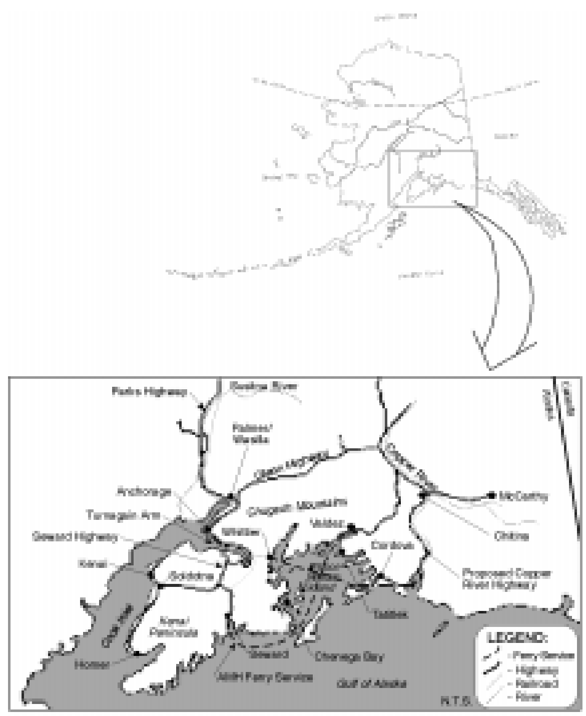
History

Whittier is a small community located on pristine Prince William Sound in Alaska. The city was originally chosen as an ice-free port by the U.S. military in the early days of WW II because of its potential as a deep water port, its proximity to central Alaska, and its severe weather conditions and geography, which minimized the chance of a successful air or sea attack.

During 1941 and 1942, the U.S. Corps of Engineers directed the blasting of the 2.6-mile hard rock tunnel through the mountains surrounding Whittier. The tunnel (named the Anton Anderson Memorial Tunnel) and a shorter 1-mile tunnel were designed to connect Whittier by rail to the mainline of the Alaska Railroad Corporation (ARRC), located eight miles away.

Whittier's importance as a port increased until the 1960s, when its military significance began to wan. This turn of events opened the opportunity for private ownership and further development that exists today.

Rising Demand for Service



Whittier's geographic location makes it a gateway to the mainland for freight ships and cruise boats as well as a window to Prince William Sound for people working in the fishing industry, for recreational boaters and for tourists coming from Anchorage and other southcentral Alaska communities. For local residents, the town is also tantalizingly close to Anchorage and the state's highway system—but not quite accessible enough.

Surrounded by the Chugach Mountains on three sides and the treacherous Gulf of Alaska on the other, Whittier has always been a port for the Alaska Marine Highway System, but has never connected directly to the land highway. Instead, the ARRC has linked the two "highways" on either side of town by shuttling automobiles on flatcars through the tunnel. Yet, the many studies that have analyzed access to Whittier since WWII have made it clear that the demand for convenient and affordable access exceeded what was supplied by the shuttle operation.

Studying the Problem

Growing demand for access to Whittier spurred the Alaska Department of Transportation and Public Facilities (ADOT&PF) to initiate a final study for the "Whittier Access Project" in 1993. ADOT&PF hired HDR Alaska to analyze access alternatives and recommend the best solution. The stated purpose of the study was to provide: (1) greater capacity to meet the demand in the tunnel corridor; (2) access that was more frequent, convenient, affordable and safer; and (3) a cost-effective contribution to Alaska's economy.

Alternatives considered in the study were:

1. Increasing conventional rail service, i.e., continue to load highway traffic onto flatcars.
2. Utilizing a high-speed electric rail service.
3. Constructing various highway routes over the mountains.
4. Constructing a highway and tunnels through the mountains.
5. Constructing a highway to Maynard Mountain and enlarging the Anton Anderson Tunnel to carry highway traffic along the existing rail bed in a dual street-railroad concept.

Each of the five alternatives and various modifications were extensively studied. A short description of each of alternative and the conclusion reached follows:

Increasing conventional rail service called for adding passenger coaches to the existing trains and having more frequent service. This alternative was eliminated due to the users' desires to have more frequent and convenient service than could be provided with this concept. This form of access would not meet the estimated traffic demand of transporting 600 vehicles per hour for the design year.

Utilizing high-speed electric rail service would increase passenger service to Whittier, but was rejected because it would not increase automobile access to the marine highway system.

Constructing various highway routes over the mountains were rejected as alternatives partially because the grades needed for the new roads could not be easily met. More significantly, the location of the new roadway would require that a large portion of the road to Portage Lake (fed from Portage Glacier) would have to be filled for embankment. Further study determined that a road traversing Portage Pass through the mountains would not be safe nor could it be maintained year round.

Constructing a highway and tunnels through the mountains was rejected primarily because of cost. A new tunnel would likely have to be fully lined and be at least 2.6 miles in length. This alternative would also require additional encroachment into U.S. Forest Service lands.

Constructing a highway to Maynard Mountain and enlarging the Anton Anderson Tunnel to carry highway traffic along the existing rail bed in a dual street-railroad concept became the preferred alternative. While it was not the most conventional solution, it met all the criteria for the project, and it could be built with the funds available. The volume of rail and highway traffic were deemed to be compatible for the project corridor, and its safety issues and operating concerns were worked out in conceptual designs. The ARRC also supported this alternative as part of the railroad's charter to promote economic development of the state. The team also looked at widening the tunnel to accommodate rail and highway traffic simultaneously, but this alternative was rejected for both engineering and operating reasons.

HDR has worked hand in hand with ADOT&PF and the ARRC to create a vision of the project as described in alternative 5 and to assist ADOT&PF in managing the design and construction of the project. The landmark effort boasts several "firsts," such as:

- It is the longest highway tunnel in North America.
- It is the longest combined rail-highway use tunnel in the United States.
- It is the first U.S. tunnel to use a combination of portal and jet ventilation fans.
- The tunnel has a unique computerized traffic control system that regulates both rail and highway traffic.
- The tunnel facility is designed to operate in temperatures down to minus 40 degrees F. and in winds up to 150 mph, and its portal buildings must be able to withstand a major avalanche.
- This is the first highway or rail project in Alaska to utilize the design-build approach.

Inaugurating a Design Build Project

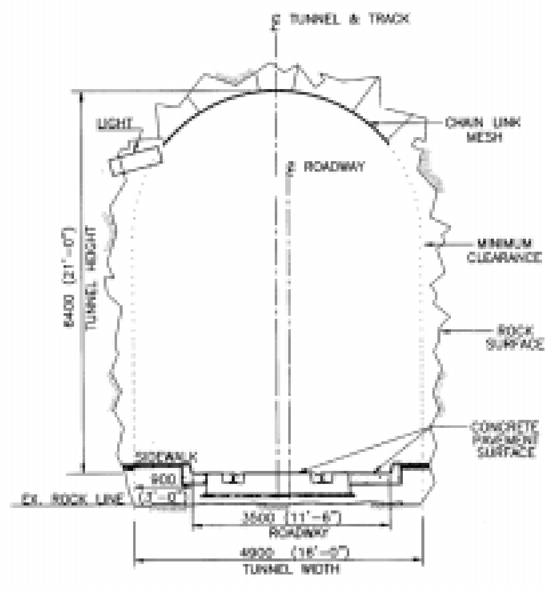
In order to write the best possible request for proposals (RFP) and performance specification to select a design/builder, the ADOT&PF/ARRC/HDR team brought together nationally recognized experts in design/build law, tunneling, ventilation, and railroad signal systems.

After a multi-stage best value selection process, a team lead by Kiewit Construction Company was selected as the design/builder and was awarded a contract in June 1998. ADOT&PF and HDR continue to coordinate through the design and construction process to ensure that the design meets the performance specification and that construction is first quality.

As part of a design/build project, the preliminary design for each component is established by the design builder, with HDR and ADOT&PF providing an "over the shoulder review." The project has been broken down into over 50 separate design/construction tasks that must be fully integrated in this state-of-the-art transportation facility. One of the advantages of the design/build process is that it allows an accelerated completion schedule. While one component of the project is being designed, another is being built, allowing the project to continually move ahead.

Meeting Design Challenges

The proposed joint use of the 2.6-mile tunnel by trains and cars has posed some difficult questions for the project's designers. The tunnel design will allow automobiles to drive directly over the track area. This approach saves tens of millions of dollars compared to widening the tunnel to allow the roadway to be separate from the track. This type of road on top of a track has been commonly used in other states on city streets, but the Whittier Access marks the first time this approach has been used in a tunnel.

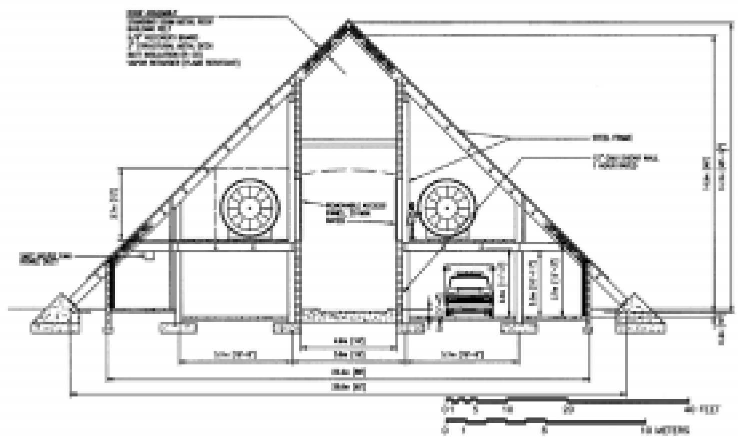


The design calls for the highway surface within the tunnel to be constructed of long-wearing concrete, which should reduce long-term maintenance costs. The entire tunnel will be lighted. The existing track structure will be removed and replaced with precast grade crossing panels. All the work will take place during short track outages that allow vital passenger and freight service to continue to Whittier.

Rock excavation along the length of the tunnel will accommodate the ventilation fans' "safe house" rooms, pull-out areas to be used for disabled vehicles, and railroad double-stack trains.

Previous examination has shown the tunnel to be stable, so only portions will need to be lined. The majority of the tunnel will have metallic mesh in the crown (roof) to catch any small loose rock that may work loose over time. The walls of the tunnel will be natural rock, as they are today. The tunnel's strength is illustrated by the minimal structural damage it experienced during the 1964 Good Friday Earthquake—the largest magnitude earthquake ever recorded in North America.

Another challenge the team is addressing is the severe weather experienced at the project location. Temperatures can reach minus 40 degrees F., with winds up to 150 mph, and 35 feet of snow. The portals of the tunnel lie in major avalanche zones. The portal structures housing the 300 hp portal fans and emergency equipment are being designed as A-frame structures to better withstand the snow loads.



<u>Installing Track/Roadway Panels</u>

Workers have completed installation of more than 1,800 of the pre-formed concrete panels necessary to “pave” the 2.6-mile tunnel to Whittier and provide road access to this western Prince William Sound port community. Each Startrack panel (manufactured by Oldcastle Corporation) is 71/2’ Long X 8’ Wide X 1.1’ Deep and has a textured concrete driving surface with the rails embedded in the panel grooves and fastened down with elastic clips.

Installing the panels in winter has been one of the most complex and challenging facets of the project. Kiewit Construction crews had to remove 2.6 miles of existing railroad track and the crushed-rock base under the track, and then install the new roadway panel system—all while maintaining limited freight and passenger train service to Whittier.

From January 1 through April 29 throughout the years of construction (1998 to 2000, the projected tunnel completion date), representatives from the ARRC, ADOT&PF, and Kiewit Construction met each week to schedule the following three weeks of work. Also involved via conference call were representatives of the City of Whittier and various freight shippers. The meetings resulted in four six-day shutdown periods and five four-day shutdown periods when train traffic halted.

During these limited shutdowns, Kiewit worked around the clock to accomplish many tasks. These tasks included:

1. Removing the track rails.

2. "Rolling out" the ties.

3. Removing the ballast and base material with bulldozers.

4. Setting up pumps to "de-water" the construction area.

5. Excavating the rock floor, as needed, for clearance.

6. Installing a geotextile fabric over the tunnel floor.

7. Installing at least 6 inches of new stone base material.

8. Compacting the base material with vibratory steel drum rollers.

9. Installing a leveling sand layer to within 1/8th-inch tolerance.

10. Setting concrete road panels with heavy equipment specifically designed for this job.

11. Installing new permanent rails into the concrete panels

As soon as each shutdown period ended, trains began using portions of the new combined road-and-track bed. During the winter shutdowns, the Kiewit crews also completed rock blasting for the roadway turnouts and safe house areas, relocated the main power lines to Whittier, and reinforced the tunnel rock structure.

<u>Building a Tunnel Ventilation System Unique to the United States</u>

Energy efficient jet fans attached to the tunnel ceiling will work in conjunction with more traditional portal fans to ventilate the 2.6-mile tunnel to Whittier. This is the first time in the United States that jet fans will be used in conjunction with portal fans that sit in the tunnel entrances. Normal train operations will not require the use of fans, but the fans will reduce concentrations of carbon monoxide during automobile operation and can quickly purge the tunnel of fumes after train operations.

European tunnels often use jet fans, but they have not been used in the United States. The design for the Whittier tunnel will use six 75-hp jet fans for normal operations and four 300-hp portal fans for emergencies. During emergencies, the powerful portal fans will blow smoke and fumes away from any vehicles stopped in the tunnel. During normal operations, the more efficient jet fans will keep the tunnel air healthy at a lower operating cost, saving money for the state of Alaska and keeping tunnel tolls to a minimum. Installation of the ventilation system is projected to occur in the fall of 1999.

Designing Tunnel Portals to Withstand Avalanche

The portal buildings, which will be built of structural steel and concrete, will safely absorb the shock of any potential avalanche, and their A-frames shape will split any snow slides and reduce the snow loads. Engineers have designed the portal roof on the Whittier side, where there is the greatest avalanche potential, to withstand forces of 1,000 pounds per square foot. On the Portage side, the roof is designed to withstand forces of 220 pounds per square foot. For comparison, in Anchorage, 40 miles away, the roof building code for withstanding a typical snow load is 40 pounds per square foot.

Each portal structure will contain two large portal fans, which will be used for tunnel ventilation. The buildings will also house emergency vehicles and equipment, power distribution equipment, furnaces to heat ice control panels within the tunnel, and remote operations consoles (the main operations center will be in a separate toll building). Each portal building will also have a train-sized “garage” door that will roll up and down to let automobiles and trains in and out.

Train Signal System and Tunnel Control Systems

One of the most complicated aspects of the project is the design of the tunnel control system (TCS) and its interaction/interlocking with the proposed train signal system (TSS).

The TCS is responsible for all tunnel operations and vehicle movement within the tunnel. The TCS functions include vehicle detection, surveillance, illumination, ventilation, driver information, highway signals, and gates. It has interlocking functions that will only permit vehicle traffic movement in one direction at a time. The TSS is responsible for train movement through the tunnel and is interlocking with respect to opposing train movements, switches, track conditions, and signals.

The two systems are vitally interfaced and interlocked so that train movements and vehicle movements in the tunnel cannot occur at the same time, and that one move cannot succeed the other until the move in progress has been fully completed and the tunnel has been released.

The operation of the tunnel is such that it must be in a mode for either highway or railroad operation. The initial use would basically be on a first-come, first-serve basis, as required.

The TSS is a Harmon designed automatic block signal system. When the tunnel is in the railroad mode, the TSS controls the trains and locks out the operation of the TCS system. All the highway gates are closed and the highway signals are set to red.

When the tunnel is in the highway mode, the TCS locks out the TSS until highway vehicles are cleared from the tunnel. The TCS is an intelligent traffic system that tracks each vehicle and meters traffic through the tunnel. Since the tunnel can only accommodate traffic in one direction, traffic is held at staging areas at both ends of the tunnel. Traffic will alternately proceed in one direction and then the other. It is anticipated that traffic will move in one direction for half an hour and then the other direction for half an hour. The operator will select an operating sequence maximizing highway traffic flows, and control the proper sequence of traffic lights, driver information signs, and ventilation.

The ARRC requires that trains always have preference in the system so that if the tunnel is in highway vehicle mode, the TCS will be prompted to clear all vehicles form the tunnel and surrender control to the TSS.

Since this will be the ARRC's first signal system, the project will not need a FRA application, but will require that the system be inspected for compliance prior to use.

Conclusion

The majority of the site work will be completed by the winter of 1999. ADOT&PF's goal of opening the tunnel to highway traffic in May 2000 is on schedule. The exceptional teamwork between all the parties involved makes this complex project both viable and enjoyable. While hurdles and scheduling conflicts need to be resolved before the tunnel is opened to the public, the positive attitude between the entire project team has been instrumental in keeping it on budget and on schedule.

While this is not a standard system, all parties are convinced that it will meet the requirements of a safe workable installation. It is designed and being constructed to benefit all constituencies of the State of Alaska, and to provide the long sought efficient affordable access to Whittier.