Washington
Infrastructure Services, Inc.

TOWN OF VAIL

TRANSPORTATION MASTER PLAN UPDATE

VAIL TRANSPORTATION MASTER PLAN UPDATE

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Executive Summary

Vail, Colorado attracts a large number of visitors each year because of its world-class ski area, wide array of recreational opportunities, and thriving economy with numerous restaurants, retail businesses, and services to choose from. With a high volume of visitors comes a need for an efficient transportation system to get visitors to and from Vail and to transport them within the Town as well. In 1990, the Town of Vail undertook a Transportation Master Plan to address all transportation systems and future needs for the area (see *Vail Transportation Master Plan, Felsburg Holt & Ullevig, 1993)*. That document addressed the current transportation system within Vail and also provided recommendations for improvements to the system.

Purpose of the Update to the Transportation Master Plan

The Town of Vail makes great efforts to keep its transportation system as efficient and updated as possible. This is evidenced by the many improvements and additions to the system over the years to accommodate the high volumes of visitors and traffic each year. Because ten years have passed since the production of the original Transportation Master Plan, the Town has deemed it necessary to provide an update for the continued efficiency of the transportation system. The purpose of this Transportation Master Plan Update is to review the existing conditions of the transportation system and to address and/or resolve transportation issues that have arisen since 1990. The following issues were included in the original Transportation Master Plan and will be addressed and updated in this document:

- Vail Village Deliveries
- Town Bus System (specifically, the In-Town Shuttle)

- Outlying Bus System
- Trail System Interface
- Peak Hour Traffic Volumes
- Intersection Level of Service (LOS) Analysis
- Implementation Process
- Plan Monitoring and Updating

One issue addressed in the original document has been resolved since 1990 and is no longer applicable to this update, and that is the Interstate 70 (I-70) Access.

In the original document, parking issues for the Town of Vail were also addressed. The parking issues are also being addressed at the time of publication of this update; however, the study is still underway and will be published as a separate document at a later date.

In addition to the updates in this document, new issues for the Town of Vail transportation system have come to light. These will be addressed in this document and include the following:

- Connecting fixed guideway transit systems
- Noise contour map for I-70 traffic
- I-70 capping review
- Traffic forecasting
- Programmatic Environmental Impact Statement (PEIS) issues resolution

Each of these issues will represent a different chapter in this document. In general, these issues were studied and completed individually but are brought together in this document so that all affected parties and agencies may view them as a whole system. This ensures better coordination by all agencies in making the transportation system efficient for the present as well as for the future.

Summary of Updates, Additions, and Resolved Issues

To provide ease of reference, each update and addition is summarized below with recommendations, if applicable. The issues from the original Transportation Master Plan that are either resolved or no longer applicable are also summarized below.

Updates:

Vail Village Deliveries

The Vail Village Loading and Delivery Study was researched and prepared for the purpose of analyzing and understanding all the factors surrounding people and goods movement in and out of the Vail Village Commercial Core One. The study and this summary provide options and supporting background to help minimize or eliminate motorized vehicles (primarily delivery trucks) from the Commercial Core for the purpose of enhancing visitor enjoyment and safety. Based on analysis of the present loading and delivery system and the available options for the Commercial Core, short-term and long-term recommendations include the following:

- **Short-term**

    1. Use of Variable Message Signs (VMS) at key locations could direct skiers to the parking structures and inform them of appropriate skier drop-off locations. The VMS could also be used to direct loading and delivery traffic to available access routes, loading bays, and dispersed terminals.
    2. Consideration should be given to a ticketing structure that penalizes the repeat offender of the loading zones in Vail while not affecting Village guests. First-time offenders pay the maximum hourly rate, and the rate for each subsequent offense is increased significantly.
    3. There are several access points into the Village at the present time, only one of which (Checkpoint Charlie) is able to control the entry of delivery traffic. Most delivery vehicles enter the Commercial Core through Checkpoint Charlie, and many other vehicles enter from the other three access points to the Village, frequently against traffic. In reviewing traffic patterns, traffic flow, and entry access points to the Village, it was discovered there might be some opportunity to further limit access to the Village for all types of vehicles. By guiding vehicle entry to enforceable access points throughout the Commercial Core, the overall traffic volume is dispersed over several access routes. Further, the use of on-street loading bays can be better regulated.
    4. The following planning and design function should be accomplished.
        - An operational and technology plan should be drawn up to implement a traffic management system based upon an electronic communication system that integrates real time VMS, GPS tracking, smart card, internet computer camera, and dispatch technology with operational and enforcement services.
        - A long-range plan should be developed that when implemented in phases will interconnect buildings with terminal facilities via back-of-house access routes accommodating hand or motorized carts. The plan should be implemented in conjunction with redevelopment of private property and streetscape improvements.
        - Amend loading standard in the zoning code to require enclosed (terminal) loading and delivery bays for a variety of truck types and sizes as part of large development and redevelopment projects. The excess capacity of each terminal should be integrated through developer agreements into the dispersed terminal system.
    5. One issue that is a significant contributor to the problem of truck numbers and dwell time in the Commercial Core is the time some deliveries are made. Earlier delivery of goods could remove the majority of larger delivery vehicles from the Commercial Core before “guest hours.” This approach would be most effective if instituted in conjunction with improved signage and some changes in access and traffic flow in the

Village. Stricter limitations could be put on Village access if delivery personnel could complete deliveries to all establishments before 7:00 a.m.

- **Long-term**

1. Addition of several delivery bays as part of a dispersed terminal on the Land Exchange site (the Vail Front Door project at the base of Vista Bahn/the Lodge at Vail). To effectively service at least one-third to one-half of the Commercial Core, six to ten bays for large trucks would be required.
2. Include enclosed dispersed delivery terminals in large development and redevelopment projects. The Town should also seek opportunities to require or acquire additional delivery bays in these facilities.
3. Provide strategically located, heated pedestrian walkways in the Village and adjacent commercial areas, so that push hand carts, pallet jack size pull carts, and small motorized carts can better function in the winter.
4. Where practical, construction or provision for future construction of underground delivery tunnels with street level freight elevators to facilitate loading and deliveries between buildings and dispersed delivery terminals should be done in conjunction with large development and redevelopment projects.
5. Construction of a dispersed delivery terminal with one bay for large trucks or four to eight bays for small cargo vans within an automobile parking structure on the P3&J site on Hanson Ranch Road.
6. Change current zoning code requiring additional on or off-site storage requirements per retail square foot for businesses in the Village.
7. Change current zoning code concerning required delivery space. The current zoning code requires delivery space to be ten feet by 25 feet, which is not adequate. Bars, restaurants, and hotels which require delivery of food and beverages should have one to two or more spaces, twelve feet wide and 35 to 50 feet long. This would accommodate most delivery vehicles. The code should allow for required loading bays to be located in a nearby dispersed delivery tunnel.
8. Design dispersed delivery terminals in appropriate locations so that cargo from a large truck can be transferred to a small cargo van. These would access a dispersed cargo van delivery terminal or bay located closer to the delivery destination.
9. Increase the availability of close-in restricted parking spaces within controlled access private parking structures. These would accommodate the delivery needs of residents, maintenance and construction personnel, business owners, and parcel carriers using small cargo vans and pick-ups. This will contribute to the reduced use of on-street loading bays. Restricted parking spaces could be located in existing and future parking structures built for automobiles.

Parking (summary to be provided by FHU)

To be completed as a separate document at a later date.

In-Town Shuttle Bus System

As a response to space limitations, driver shortages, and higher costs, the Town of Vail is evaluating replacing the In-Town Shuttle buses with an alternative transit system. Such a system would have to be capable of carrying 5,000 people per hour (the current peak demand is approximately 4,000 people per hour) and effectively serve a route approximately 1.5 miles in length. The route would have to be similar to the current bus system route while effectively maximizing both ridership and system operations. This update is to determine the best options, from a range of opportunities, for providing mass transit for the Town of Vail In-Town Shuttle bus route. These options are being presented to address the increased demand and other issues discussed below on the In-Town Shuttle. The bus route is roughly a three-mile loop from Vail Village to Lionshead.

The analysis of all potential options for the In-Town Shuttle system resulted in the following technologies for final consideration:

- Power Unit/Trailer Combination Units
- Low-floor Buses
- Articulated Transit Buses
- Low-floor, Articulated Buses
- Guided Busway
- Automated Guideway Transit (AGT):
    - SK
    - Cableliner DCC
    - Aeromovel

Based on analysis of the remaining technologies and input from two focus group meetings attended by residents and businesses within the Town of Vail, a set of short-term and long-term recommendations for the In-Town Shuttle bus route have been developed and include the following:

- **Short-term**

    1. Develop an Express Bus Route from Vail Village to Lionshead – Vail Transit should consider an In-Town Express Bus route between Vail Village and Lionshead. This route would run along the Frontage Road to provide for a quicker, more direct route between the two areas. The express route could also make use of a low-floor, articulated bus. In keeping with the character and space available in the Village Core area, the In-Town Shuttle is better suited for the use of 40-foot buses. However, an express route on the Frontage Road could utilize a low-floor, articulated bus to increase the capacity.

    2. Purchase Low-Emissions Vehicles - To address the problem related to smell/air quality, Vail Transit should consider selecting buses that run on compressed natural gas (CNG) and produce lower emissions.

3. Improved Information Technology and Information Displays – Electronic message boards which provide real time information should be placed at the Transportation Center, as well as other key stops along the route. Real time information along the route is extremely valuable to transit riders. Such information requires the deployment of an automatic vehicle location system (AVL) to track buses (Vail Transit already has such a system through NEXTbus). The AVL data can be converted into bus arrival times, which can be transmitted to bus stops.

4. Extend In-Town Shuttle Route to Cascade Village – If demand warrants, the In-Town Shuttle route should be extended west to serve Cascade Village. While discussion at the two focus groups held on September 21st, 2001 indicated that the existing In-Town Shuttle route should be extended to serve Cascade Village, Vail Transit should conduct an on/off survey on its West Vail Green and Red routes to determine the number of riders who currently board and/or deboard at the Cascade Village stop and where they are coming from and going to, to better determine the level of demand for a service extension.

   Extending the In-Town Shuttle route to Cascade Village will add approximately one-half of a mile to each run. This additional mileage would allow vehicles to complete their loops in 50 minutes as opposed to the current 40 minutes, and would not add any substantial cost to the service.

- **Long-term**

1. Develop Guided Busway – If the Town of Vail continues to grow as expected, and capacity on the shuttle needs to be increased to 5,000 pph, Vail Transit should consider the development of a guided busway to run between Lionshead and Main Vail/Cascade Village. The use of a guided busway would allow vehicles to run on shorter headways and therefore carry additional passengers during peak hours.

2. Install Transit-Activated Signal at High Volume Intersections along Frontage Road – At intersections such as East Lionshead Circle and Frontage Road, buses have difficulty making left-hand turns from the minor street (East Lionshead) onto the major street (Frontage). The Town of Vail could look to install a transit-activated signal system that involves detecting the presence of a bus and, depending on the system logic and the traffic situation, then give the transit vehicle special treatment. The system could give a green signal during peak periods for buses waiting to enter onto the Frontage Road. In addition, real time control technologies can consider not only the presence of a bus, but the bus adherence to schedule and the volume of other traffic.

Outlying Bus System

This update includes a West Vail route structure review based on the West Vail Red Loop and the West Vail Green Loop. Ridership, schedules, and route information are provided as well as short-term and long-term recommendations to streamline the existing route. Also included in this analysis is discussion of a potential undercrossing of I-70 to be constructed in the Simba Run area. In particular, the effects to the West Vail bus route from this undercrossing are determined.

Recommendations for the West Vail bus route include the following:

- **Short-term**

  1. Streamline Current West Vail Schedules – Vail Transit should change the current schedules, so that buses operating on the West Vail Green and West Vail Red routes depart at the same time. This would provide more balanced east-west service along the North and South Frontage roads and alleviate safety issues generated by transit users having to cross I-70 at-grade to access bus stops along the opposite frontage road. In the winter, this would mean that buses on each route make their first departure from the Transportation Center at 5:45 a.m. Streamlining these schedules would also make the system easier to understand and utilize, which could generate additional ridership.

  2. Improved Route Identification – While each of Vail Transit's routes have names and are color-coded, a number, letter, or number and letter designation should also be used to help lead passengers through a trip. The number, letter, or number and letter designation, along with the route name should be displayed on each bus and any printed maps. In addition, vehicles should have some indication of the direction they are going (e.g. West Vail Green Red – North Frontage) so that the new riders can better understand the system.

  3. Elimination of Red Sandstone School Stop on West Vail Green and Lionsridge Loop Routes – To make the routes in the West Vail area run more efficiently, two of the routes, West Vail Green and Lionsridge Loop, should eliminate stopping at Red Sandstone School. This route would continue to be served by the West Vail Red and Sandstone routes. The elimination of this stop would reduce the running time of the West Vail Green route and allow vehicles serving the Lionsridge Loop to reach their primary service area faster.

  4. Installation of Trailblazer Signs – Trailblazer signs that direct riders to the nearest stop or stops should be installed on major streets and other key strategic stops throughout West and East Vail. These signs would satisfy the need for approach information, and thus should be compatible with route guidance information with regard to location labels, directions, and route designations.

     Metal trailblazer signs with the appropriate route guidance information can cost anywhere between $500 and $1,000.

- **Long-term**

    1. Purchase of Additional Low-floor, Articulated Buses – If West Vail continues to grow over the next few years as expected, Vail Transit should consider purchasing two additional low-floor, articulated buses to handle the expected increase in demand. These vehicles should be used on the West Vail Green and Red routes. Low-floor, articulated buses have a 33 percent greater capacity than regular low-floor vehicles.

    2. Incorporation of Bus Stops at Simba Run Underpass – While the use of the Simba Run underpass to restructure the West Vail Red and/or West Vail Green routes will not provide any service enhancement or increase in ridership, additional bus stops should be located at each end of the proposed Simba Run underpass along North and South Frontage Roads to improve passenger access to the system and increase safety. These additional stops would serve the West Vail Red and West Vail Green routes, as well as the Lionsridge Loop in the winter.

    3. Incorporation of Stops at Lionshead Intermodal Facility – Following completion of the Lionshead Intermodal Facility, Vail Transit should add this location as a stop on the West Vail Green, West Vail Red, and In-Town Shuttle routes. The facility will include significant parking and should become a key transfer point for transit service, which will increase system ridership.

In addition to the West Vail bus route, a discussion of the Downvalley bus system (the ECO system) is included. A bus service review is provided and includes information on routing, schedules, and ridership as well as short-term and long-term recommendations to provide more efficient routes.

Recommendations for the Downvalley bus system include the following:

- **Short-term**

    1. Variable Lane System and GPS at Transportation Center – The transit plaza could be changed to a variable lane system rather than the current assigned lanes for each route. This would include a variable message system to direct buses into certain decks when they arrive. This would allow for staggered bus arrivals, and therefore add more capacity. The variable message system could be incorporated with a Global Positioning System (GPS), a system that allows a central control system to track the location of all buses at all times. This type of system would allow for greater capacities of buses from downvalley routes rather than the current single lane that is assigned for ECO routes.

2. Express Service on Vail to Edwards Route – To reduce the travel time for commuters and other passengers traveling from downvalley locations to Vail and generate additional ridership, express service should be provided on the Vail to Edwards route. This can be done by making some of the existing runs into an express run with limited stops, or by adding an express run, which may require additional vehicles.

- **Long-term**

1. Impact of the IMC on the Eagle Valley Transportation System – If the IMC rail line is constructed between Vail and the Eagle County Airport, two of the existing Eagle Valley Transportation routes – the Vail to Edwards and Vail to Dotsero routes – would essentially be providing redundant service. To eliminate this service redundancy and make the system function better, these routes should be converted into a feeder service, which would serve new rail stations in Edwards and Dotsero. Feeder routes would be designed to serve residential areas in each town, with runs scheduled to meet arriving and departing trains.

Trail System Interface

In the original Transportation Master Plan, the 1990 trail system is described and mapped. Recommendations are also included for new trails to be constructed that would tie in with the existing trail system and create a better-rounded system. This update provides information on trails that have been built in the Town of Vail since 1990 (from the recommendations made). Each new trail is described in terms of location and physical characteristics, and a map is included to illustrate the locations of the new trails. In addition, the recommendations made in 1990 have been re-prioritized to make a high priority of trail improvements that have not yet been implemented.

In addition to the re-prioritization of the 1990 trail recommendations, the Town has also identified additional trail links that it considers to be of high priority. These include the following:

1. Lionshead Bypass – from the skier bridge in Lionshead, bypassing Lionshead, and connecting to the existing trail system behind Tree Tops Condominiums

2. Vail Village Bypass – from Vail Road near Checkpoint Charlie, to Vista Bahn

3. Sunburst Road Bypass – from the golf course clubhouse to the west end of Katsos Ranch Path

Appendix C1 is a portion of the Eagle County Trails Master Plan. This appendix is included to illustrate how the trail system in the Town of Vail ties in with the Eagle County Trails Master Plan.

For reference, Appendix C2 includes the trail maps from the original Transportation Master Plan.

Peak Hour Traffic Volumes

In 1990, peak hour traffic volumes were collected at 26 intersections along the Frontage Roads in Vail. These counts were taken in March and July during peak weekends. This update includes counts in 2000 at the same intersections in March and July during peak weekends. The counts in 2000 differ because eight of the intersections from the 1990 counts have been reconstructed as four roundabouts; two in West Vail and two in Vail Village, all providing access to and from I-70. The results of the traffic counts are provided as Appendix A1.

Appendix A2 also provides peak hour traffic counts completed by Felzburg Holt & Ullevig in September 2000 for the Vail Village area. These counts were not conducted for the 1990 Transportation Plan but are included here for reference.

Intersection Level of Service (LOS) Analysis

The LOS Analysis update provides LOS for the intersections studied in the original Transportation Master Plan. This update also includes LOS for the newly constructed roundabouts in West Vail and Vail Village.

All intersections along the Frontage Road were found to maintain a LOS of C or better, a standard for the Town of Vail, with the exceptions of Vail Valley Drive West (LOS D), Matterhorn Circle (LOS E), and Westhaven Drive (LOS F). Recommendations for these intersections include the following:

1. Traffic signals. Although the Town of Vail has not used traffic signals in the past to maintain the character of the Town, they are still a feasible solution and could be considered.

2. Traffic directors during peak periods of travel.

3. Roundabouts at these intersections. Although the space requirements at the intersections with poor LOS would indicate that roundabouts are not a feasible solution, this possibility should be further examined, as roundabouts are effective tools in creating adequate flow conditions at an intersection.

4. An all-way stop installed at the intersection (this would bring the LOS to C).

Implementation Process

The implementation process includes a scheduled plan of action for certain elements within the Transportation Master Plan Update. Transportation system elements within the Update should be prioritized as short-term (one to five years), mid-term (six to ten years), and long-term (eleven to 20 years). Recommendations have not been made concerning priorities for the Town as priorities usually change, depending on what is most appropriate at that time. The Town of Vail should develop a flexible plan for prioritizing the recommendations included in this Update. This prioritization plan should remain open and flexible as any changes in priorities may affect other plan elements. An individual chapter is not included to address this element.

Plan Monitoring and Updating

The original Plan included continuous monitoring and periodic updates of the Transportation Plan to include actions such as periodic traffic counts and a formal plan update every five years. This update to the Transportation Master Plan serves the purpose of updating changes that have taken place in the transportation system for the Town of Vail since 1990. An individual chapter is not included to address this element.

Issue that is resolved and no longer applicable:

I-70 Access

In the original Transportation Master Plan, I-70 access was addressed because of the poor traffic flow at two of the three interchanges (West Vail and Main Vail interchanges). The report outlines the physical and operational characteristics of the interchanges, goals regarding access to I-70, additional crossing capacity of I-70 at these locations, and alternatives to solve the congestion problems at these interchanges. The issue has since been resolved with the construction of roundabouts at these interchanges – two roundabouts to replace the four intersections at West Vail, and two roundabouts to replace the four intersections at Main Vail.

Additions:

Connecting Fixed Guideway Transit Systems

Two rail systems that have been proposed are the Inter-Mountain Connection (IMC) and the Colorado Intermountain Fixed Guideway Authority (CIFGA). The IMC is a commuter rail that would primarily use existing tracks and run from Vail to the Eagle County Airport. The CIFGA system is a fixed guideway system that would run from Denver International Airport (DIA) to Vail and eventually the Eagle County Airport. This addition to the Transportation Master Plan addresses these two systems and how they would affect the transportation system in Vail.

This chapter also includes recommendations for alignments and station locations in the Vail area based on topography and proximity to activity centers. Mapping is provided in Appendix E to show potential alignments for the fixed guideway system. Potential alignments for the CIFGA system include the following:

- **Dowd Junction**

The CIFGA alignment could enter Vail by way of Dowd Canyon on the existing Union Pacific (U.P.) Railroad tracks. Just before the crossing of I-70 over Highway 6 (Dowd Junction), the alignment would curve to the east, paralleling the existing bike path. At the point where the bike path crosses under I-70, the alignment could follow one of two options. Option 1 would be a tunnel cut through the slope of the mountain north of I-70. This option would parallel I-70 until the entrance to West Vail, at which point the median opens up and the alignment would cross over to the median. This option would be most beneficial if I-70 was not capped.

Option 2 would bring the alignment into the median under the proposed capping of I-70 through Dowd Canyon, in between the eastbound and westbound lanes.

Two other options exist for the alignment in the Dowd Canyon area. Option 3 through this area involves the diversion of the alignment before Dowd Canyon. As I-70 curves to the east and back before Dowd Canyon, the alignment could continue south (instead of curving back west and into Dowd Canyon) and tunnel through into Dowd Canyon just west of West Vail. At this point the alignment could cross into the median and continue into West Vail.

Option 4 for the Dowd Junction area includes following the existing rail line into Minturn and then tunneling north back to I-70. This option would be considered because of potential grade problems at Dowd Junction. Options 1 and 2 might face difficulties in creating a rail line that could negotiate the steep grade at the intersection of I-70 and Highway 6.

- **West Vail**

For either option discussed above, the alignment would be in the median as CIFGA enters West Vail. The CIFGA alignment would remain in the median, whether or not the capping was to be constructed. A station location could also be constructed in the median for West Vail access at a location determined to be the most practical. This station would include pedestrian crossings to access areas north and/or south of I-70 and the Frontage Roads in West Vail.

- **Main Vail**

The CIFGA alignment would remain in the median through Main Vail as well, with potential station locations at the proposed North Day Lot Transportation Center in Lionshead and the Vail Transportation Center for pick-up and drop-off of riders. These stations could be constructed in the median of I-70 with pedestrian crossings to access areas north and/or south of I-70 and the Frontage Roads.

- **East Vail**

The CIFGA alignment could also remain in the median through East Vail and continue east outside of the Vail city limits.

As the IMC is proposed as an interim solution until completion of the CIFGA project, all alignment recommendations might be temporary. These sections could be removed as sections of the CIFGA project are completed. However, the IMC could also remain useful as a local service, providing more frequent stops in Vail for downvalley commuters. Any decisions regarding the temporary or permanent use of the IMC would be decided by the Town of Vail upon further studies and public involvement. Recommendations for potential IMC alignments include the following:

- **Dowd Junction and West Vail**

The IMC alignment would parallel the CIFGA alignment entering Dowd Canyon and traveling through West Vail (using Option 1 or 2). Shortly after passing by the West Vail Roundabouts and the potential station location in West Vail, the IMC alignment would leave the median, crossing over to the area between I-70 eastbound and South Frontage Road. The alignment would continue to parallel the CIFGA alignment.

- **Main Vail**

The alignment would continue to use the space between I-70 eastbound and South Frontage Road, while sharing the potential station locations at Lionshead and the Vail Transportation Center with the CIFGA for pick-up and drop-off. The IMC is proposed to end at the Vail Transportation Center, at which point the line would go back downvalley along the same route.

Noise Contour Map

This addition includes the creation of a noise contour map based on existing and future traffic volumes in the I-70 corridor. Noise measurements were taken at 50 locations throughout the Town of Vail to determine current noise levels produced primarily by I-70. These existing measurements were used for the development of a noise model. The noise model accounts for terrain features and traffic conditions. A future noise model was then developed based on known development plans and traffic forecasts. The noise model includes planning level noise abatement options.

A map of the noise contours with explanatory text will be included as a part of this section in Appendix F2.

I-70 Capping Review

The Town of Vail has expressed the desire to explore other options to reduce noise levels and bring a greater sense of community cohesion to the Town of Vail. Under consideration is the “capping” of I-70. This would involve the tunneling of I-70 under the existing alignment, using the land above for development or open space purposes. This addition to the Transportation Master Plan provides an analysis of other capping projects completed throughout the country, critical issues that the Town of Vail would face in considering such a project, and recommendations for locations and land use in constructing a cap. Appendix E provides mapping for potential capping areas along I-70 through Vail.

Traffic Model

From existing traffic counts, peak hour link volumes were documented and compared with previous 1990 link volumes. Using this information as a base, a spreadsheet-based travel demand model has been prepared for the Frontage Roads and major intersections in the Town of Vail. The model forecasts future traffic based on socio-economic data (housing, population, and employment). Eight traffic analysis zones have been used for the model and these include the following: I-70 East, I-70 West, East Vail, Vail Village, Lionshead, West Vail south of I-70, West Vail north of I-70, and Other Vail north of I-70. The model has been set up for multiple forecast years, and ten and twenty-year forecasts have been conducted. Appendices H1-H5 document the model structure and assumptions made.

Programmatic Environmental Impact Statement (PEIS) Issues Resolution

A PEIS was recently initiated by the Colorado Department of Transportation (CDOT) for I-70 between Denver and Glenwood Springs (see *I-70 Mountain Corridor PEIS, Summary of Issues, J.F. Sato & Associates, June 2000*). To prepare for this PEIS planning effort, issues that could potentially affect transportation in Vail were identified and discussed during a focus group attended by residents representing a wide array of interests and backgrounds. This addition to the Transportation Master Plan identifies these issues and potential solutions to the issues that have been recommended by the Town of Vail. The issues and solutions are also presented in the form of a matrix to indicate how different solutions can potentially address more than one issue.

Recent or Ongoing Studies

In addition to the studies described in this update, other recent or ongoing studies are taking place in the Town of Vail. Some of these are summarized below.

Transportation Center Work in Lionshead

The North Day Lot Transportation Center is proposed in the *Lionshead Redevelopment Master Plan* (Design Workshop, Inc., December 15, 1998). The Transportation Center would serve to create a major new point of entry into the pedestrian and retail core of Lionshead. It would also play a role in providing for a central transit stop in Lionshead.

The Transportation Center would consist of:

- Local/regional shuttles
- Local/regional transit and charter buses
- Short-term skier drop-off area
- Pedestrian portal
- Combination of large central service and delivery facility
- Construction under a structured parking deck
- Access to central Lionshead by freight elevators and a service tunnel
- Accommodation for a peak volume of 15-20 delivery vehicles and storage space

The Redevelopment Master Plan views the Transportation Center as a priority project as it is a prerequisite for other critical projects discussed in the Plan.

Roadway Functional Planning along South Frontage Road for Simba Run Crossing

The scope of work for this project involved conceptual design development for three elements:

1. Improvements to the South Frontage Road between Ford Park and just west of Cascade Village
2. A two-lane I-70 underpass at Simba Run
3. Related North Frontage Road improvements at the intersection of the new Simba Run Underpass

Other elements of this project:

1. Feasibility of the improvements identified in the Lionshead Redevelopment Master Plan
2. Improvements to drainage at Town Hall and access control
3. Feasibility of the South Frontage Road realignment near the VA shops
4. Space and height constraints at the pedestrian overpass

Chapter 1: Vail Village Deliveries

The following is a summary of the *Vail Village Loading and Delivery Study*, completed October 1999 by MK Centennial. The complete draft document is available through the Town of Vail, Public Works Department. Other additions have been included in the summary to reflect the evolving issues in the Town since the 1999 document.

Introduction

The Vail Village Loading and Delivery Study was researched and prepared between November 1, 1997 and November 1, 1999 for the purpose of analyzing and understanding all the factors surrounding people and goods movement in and out of the Vail Village Commercial Core One (to be referred to as "Commercial Core" for the remainder of this chapter)[1]. The study and this summary provide options and supporting background to help minimize or eliminate motorized vehicles (primarily delivery trucks) from the Commercial Core for the purpose of enhancing visitor enjoyment and safety. There are several fundamental questions that the Town of Vail must answer before determining with which of these options to proceed. These questions include:

- What is our idea of a pedestrian village and how much are we willing to spend to get there?

[1] According to the zoning district, the Commercial Core One is a mixed-use, residential and commercial core. The general boundaries of the Vail Village Commercial Core One are Gore Creek to the north, Mill Creek to the east, U.S. Forest Service to the south, and Checkpoint Charlie to the west.

A European alpine style pedestrian village where commercial and residential uses cohabitate to the mutual benefit of the economic and lifestyle expectations of the area's visitors, overnight guests, residents, businesses, and property owners. Public and private investment should be proportional and commensurate with the importance of the area to fund a significant portion of the Town of Vail government operations and provide a progressive return on investment to all property and business owners. An ongoing fund will be made available to sufficiently upgrade, embellish, and maintain the quality of the pedestrian area.

- Where does the money come from to accomplish the goal of a pedestrian village?

  Construction and maintenance funds are based on developer impact fees and public and private finance sources. Care should be taken to avoid passing on exorbitant cost through fees or increased operations taxes for businesses served by the facilities. The Town will be guided by a service and facilities plan for the Vail Village service area. The plan will specify the types of public services necessary to operate and maintain a "destination resort community" at a high level for all streetscape, loading and delivery, parking, mass transit, and traffic management systems in the service area. Some degree of on-street loading and delivery will be required in the pedestrian areas of the Commercial Core. Increased limitations will be placed upon the access and usage of on-street loading bays.

- Who has a voice in what the Town eventually does?

  The Town will be responsible for the implementation and ongoing management of the loading & delivery system and streetscape improvements as it affects the on-street staging of the loading and delivery function. On properties with the property owner and their tenants will have the voice to determine the operation and management of a close-in, decentralized (dispersed) terminal facility. The Town will establish the enforcement of operational and management requirements for the dispersed terminal systems.

- Whose interest takes priority in the process?

  In general, the interest of the resort customer, business owners, property owners, and delivery companies in the Vail Village service area take priority in the public review, operation, management, funding, and enforcement process.

- What is the time line to accomplish the goal?

  The dispersed terminal system will be phased with the redevelopment of sites and buildings throughout the service area. The rate of implementation is dependent upon the rate of redevelopment. As new terminal facilities are constructed and become operational there will also be a modification of the abandonment or usage of on-street delivery bays. Over time the noise and traffic impacts of on-street delivery will be diminished.

- Where are new loading facilities built and where are the trucks eventually going to unload?

  The dispersed loading and delivery terminal system requires that truck bays be located inside newly constructed buildings within the Vail Village service area. The loading bays will be used to serve businesses both on-site and in the service area. The number of available bays to serve the service area will be incrementally increased as new buildings are constructed and existing buildings upgraded. Different sized loading bays in each building will be specified based upon the desired service level for the volume of delivery traffic. In some cases, where the location of truck bays is impractical (e.g. existing automobile parking structures), cargo van bays can be substituted in coordination with the service plan. As dispersed terminal bays become available, on-street deliveries will be replaced by facilities provided in the dispersed terminals system.

By answering these questions, a foundation has been provided to explore options and make recommendations for the Vail Village loading and delivery system that is based upon a combination of on-street delivery and dispersed delivery bays.

Currently, the most efficient way to make deliveries in Vail is to park in front of the business and make the delivery. The distance of pushing goods and delivery truck dwell time are both at a minimum.

This method is currently allowed during the early morning hours throughout Vail Village. In general, this method works well because the trucks generally run silent (engines are turned off while idle) and drivers keep noise from doors, ramps, and pushcarts to a minimum, although they can still be heard.

Problems arise due to the sheer volume of delivery activity taking place in Vail Village, which cannot be totally accommodated between 4:00 a.m. and 8:00 a.m. Further, not all businesses participate by allowing unattended access to their businesses by drivers. Due to conflicts with pedestrians, deliveries must be off Bridge Street by 8:30 a.m.

This leaves Gore Creek Drive to take the majority of deliveries until 11:30 a.m. Many shops open by 10:00 a.m., and lunch begins by 11:00 a.m. The conflict of trucks blocking access and sight access, along with the disruption of the delivery activity, takes away from the ambience of the Village during this time.

The problem is further complicated after 11:30 a.m. The loading zones on Hanson Ranch Road, Gore Creek Drive near Hanson Ranch Chute, and Willow Bridge Road near the International Bridge are used in the morning hours. However, after 11:30 a.m., these are the only remaining delivery zones open until 6:00 p.m. This puts delivery activity in the residential and lodging neighborhoods. These areas feel burdened with the businesses impacts for the longest periods. Even if the full extent of the long-term solution of dispersed loading zones were implemented throughout the Vail Village area, there would still be loading activity on the streets of Vail Village.

The following discussion details the range of options available to the Town and their potential benefits. Short-term and long-term options are presented that are believed to be feasible and cost effective in working toward the goal of a true pedestrian village.

Recommendations

Because the 4:00 a.m. to 8:00 a.m. time period is the most service efficient, it would most likely remain in place for the Commercial Core depending upon the successes of the dispersed terminal system. Deliveries in all the existing on-street loading zones (bays) within the Commercial Core would be allowed. Depending on access requirements, on-street loading bays on Bridge Street may be used to a lesser extent. This system would be adjusted based on trial and error. The priority after 8:00 a.m. would be to allow deliveries until 10:00 a.m. on Gore Creek Drive only. After 10:00 a.m. selected on-street loading bays would be used in areas immediately adjacent to the Commercial Core not served by a dispersed terminal. Use of selected on-street loading bays would also be dependent upon the availability of loading bays in dispersed terminals.

Because the dispersed system will be phased, experience will determine how much restriction can be placed on the current delivery operation. The goals are to balance efficiency with being as restrictive as possible for the use of on-street bays to minimize disruptive impacts and to generate demand for the new bays created in dispersed terminals to ensure their maximum utilization.

The size of vehicles allowed in the existing on-street loading bays may be limited beyond a certain time frame, such as large trucks until 10:00 a.m. and smaller trucks or cargo vans after that time. Certain categories of large trucks may be prevented from having routine access and may only be limited under special circumstances and conditions.

The ultimate goal is to have the loading bays in dispersed terminals utilized to their full potential. Their design should be that when they are used to their full potential, there is appropriate mitigation of impacts on adjacent properties and the building in which they are located.

Dispersed terminals that serve off-site locations will need to address control, liability, and disruptions to their own delivery operations. Agreements will need to be prepared to ensure the owner and operator of the dispersed terminal and loading bays in conjunction with the Town are satisfied with the operation.

The Town may join in an effort with the property owner to add and acquire ownership of loading bays in a dispersed terminal. Under mutual agreement, the Town could assume control and liability of loading bays or the terminal through an access easement and operational agreement. Flexibility needs to be inherent as to how the dispersed terminal and on-street system will function exactly, as it will not be known until multiple facilities are in place and the use of on-street loading bays adjusted.

As the dispersed terminals are brought into service, the usage of on-street loading bays that once served the area now being served by the dispersed terminal will be proportionally reduced.

Short Term Recommendations

The following short-term solutions were presented to the Vail Town Council at the November 1998 Council meeting and are modified to adjust for the phasing in of the dispersed terminal system.

Variable Message Signs

One key component to vehicles in the Commercial Core is lost guests. Lost guests driving through the Village hampers the operation of Checkpoint Charlie and introduces significant automobile traffic into the pedestrian village areas. Use of Variable Message Signs (VMS) at key locations could direct skiers to the parking structures and inform them of appropriate skier drop-off locations. The VMS could also be used to direct loading and delivery traffic to available access routes, loading bays, and dispersed terminals.

Currently, VMS signs are used in the vicinity of the roundabout, on the Frontage Roads, and adjacent to the parking structure to get the attention of out-of-town guests and direct them to appropriate parking locations. These signs could be operated only during peak periods. However, many guests do become lost and find their way to Checkpoint Charlie. This is the main entry for trucks to the Village. If lost traffic to this area were minimized, more automation and smart cards could be implemented for delivery traffic.

Change in Parking Ticket Structure

Consideration should be given to a ticketing structure that penalizes the repeat offender of the loading zones in Vail while not affecting Village guests. This is an approach used in Park City, Utah. First-time offenders pay the maximum hourly rate, and the rate for each subsequent offense is increased significantly.

First-time offenders would receive a warning ticket, then the first three parking tickets a person receives would be the standard $26. The fourth and all subsequent tickets during that season (November to April) could then be $100 or more (Town of Vail Council has the authority to increase parking fines in the Village).

Access to the Village Commercial Core

There are several access points into the Village at the present time, only one of which (Checkpoint Charlie) is able to control the entry of delivery traffic. Most delivery vehicles enter the Commercial Core through Checkpoint Charlie, and many other vehicles enter from the other three access points to the Village, frequently against traffic. In reviewing traffic patterns, traffic flow, and entry access points to the Village, it was discovered there might be some opportunity to further limit access to the Village for all types of vehicles.

By guiding vehicle entry to enforceable access points throughout the Commercial Core, the overall traffic volume is dispersed over several access routes. This reduces the traffic, noise, and visual impact of delivery vehicles on the existing primary route entering at Checkpoint Charlie. Further, the use of on-street loading bays can be better regulated. Enforcement of access limitations could include either manning access gates or starting a system of "smart cards" that allow access only to card holders and only during certain times of the day. The assignment of access routes to vehicles (vendors) that make routine and scheduled delivery can be accomplished through the operational agreement of the dispersed terminal or on-street loading bay that is the point of destination.

System Planning and Design

The following planning and design function should be accomplished.

- An operational and technology plan should be drawn up to implement a traffic management system based upon an electronic communication system that integrates real time VMS, GPS tracking, smart card, internet computer camera, and dispatch technology with operational and enforcement services.
- A long-range plan should be developed that when implemented in phases will interconnect buildings with terminal facilities via back-of-house access routes accommodating hand or motorized carts. The plan should be implemented in conjunction with redevelopment of private property and streetscape improvements.
- Amend loading standard in the zoning code to require enclosed (terminal) loading and delivery bays for a variety of truck types and sizes as part of large development and redevelopment projects. The excess capacity of each terminal should be integrated through developer agreements into the dispersed terminal system.

Hours of Delivery

One issue that is a significant contributor to the problem of truck numbers and dwell time in the Commercial Core is the time some deliveries are made. While many restaurant owners in town allow delivery personnel unsupervised access to their place of business or have someone available in the early morning hours to receive goods, other restaurants/bars/hotels do not permit this. This causes some vendors to remain in Vail as late as 11:00 a.m. to 1:00 p.m. to service their customers. This equates to a significant increase in dwell time and cost as well as additional noise and visual unsightliness.

Earlier delivery of goods could remove the majority of larger delivery vehicles from the Commercial Core before "guest hours." This process would require cooperation and coordination between vendors and restaurants. This approach would be most effective if instituted in conjunction with improved signage and some changes in access and traffic flow in the Village. Stricter limitations could be put on Village access if delivery personnel could complete deliveries to all establishments before 7:00 a.m. Vendors and restaurant owners could increase the pace of delivery by providing loading and unloading assistance to truck drivers.

Once elements of the dispersed terminal system are in place, deliveries that cannot be arranged within the on-street delivery periods can be made from a nearby terminal, thus reducing the use of on-street loading bays that are currently located in residential and lodging neighborhoods adjacent to the Commercial Core. The dispersed terminal also allows for a greater efficiency of dwell time because the conditions under which deliveries are staged is less affected by weather and on-street congestion.

Before any major capital expenditure is made on long-term solutions, the appropriate short-term solutions should be implemented for at least one season. The estimated cost of implementing these suggestions ranges from $250,000 to $1,000,000. These solutions should reduce total traffic in the Village during visitor hours by 40 to 60 percent.

Other Factors

While delivery trucks do create sight and noise issues as well as an inconvenience in the Village, the ancillary issues should not be minimized as contributing factors. Some of these, which might warrant further analysis, include:

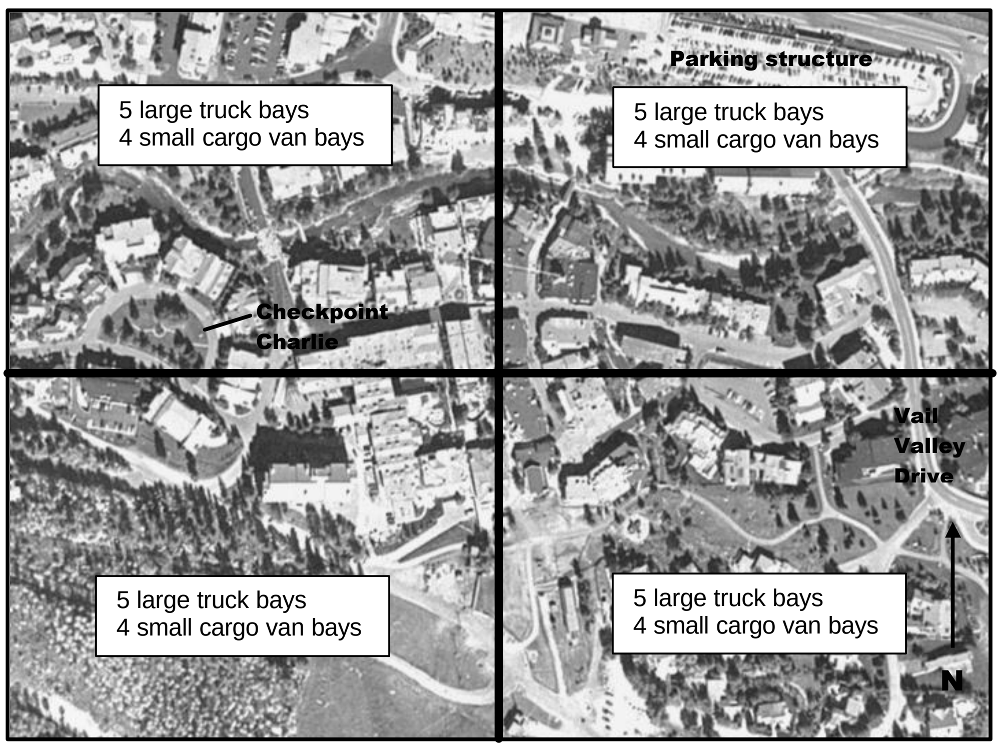
- Automobiles in the Village
- Construction (new and remodel)
- Residents
- Business owners
- Enforcement
- Snowplows
- Vans/taxis
- Small Package Delivery
    - UPS
    - USPS
    - Federal Express
    - Newspapers
    - Meal Delivery

Long Term Recommendations

Over 250 scenarios were examined to determine what combination of warehousing and delivery options might be the most feasible and productive in terms of both logistics and cost in removing vehicle traffic from the Village. While many of the scenarios had attractive traits, no one scenario was perfect. It is evident, however, that a combination of some of the features of several of the scenarios could reduce the total vehicle volume in the Village by as much as 95 percent. These include:

- Addition of several delivery bays as part of a dispersed terminal on the Land Exchange site (the Vail Front Door project at the base of Vista Bahn/the Lodge at Vail). To effectively service at least one-third to one-half of the Commercial Core, six to ten bays for large trucks would be required. This type of expansion would include approximate costs of $250,000 to $400,000 per bay. See Figure 1-1 below for potential delivery quadrants for the Commercial Core (the delivery quadrants are provided for purposes of calculating a total number of loading bays, but the actual dispersed terminal may be located in another quadrant).

Figure 1-1: Potential Delivery Quadrants for the Commercial Core



- Include enclosed dispersed delivery terminals in large development and redevelopment projects. The Town should also seek opportunities to require or acquire additional delivery bays in these facilities.
- Provide strategically located, heated pedestrian walkways in the Village and adjacent commercial areas, so that push hand carts, pallet jack size pull carts, and small motorized carts can better function in the winter.

- Where practical, construction or provision for future construction of underground delivery tunnels with street level freight elevators to facilitate loading and deliveries between buildings and dispersed delivery terminals should be done in conjunction with large development and redevelopment projects.
- Construction of a dispersed delivery terminal with one bay for large trucks or four to eight bays for small cargo vans within an automobile parking structure on the P3&J site on Hanson Ranch Road.
- Change current zoning code requiring additional on or off-site storage requirements per retail square foot for businesses in the Village.
- Change current zoning code concerning required delivery space. The current zoning code requires delivery space to be ten feet by 25 feet, which is not adequate. Bars, restaurants, and hotels which require delivery of food and beverages should have one to two or more spaces, twelve feet wide and 35 to 50 feet long. This would accommodate most delivery vehicles. The code should allow for required loading bays to be located in a nearby dispersed delivery tunnel.
- Design dispersed delivery terminals in appropriate locations so that cargo from a large truck can be transferred to a small cargo van. These would access a dispersed cargo van delivery terminal or bay located closer to the delivery destination.
- Increase the availability of close-in restricted parking spaces within controlled access private parking structures. These would accommodate the delivery needs of residents, maintenance and construction personnel, business owners, and parcel carriers using small cargo vans and pick-ups. This will contribute to the reduced use of on-street loading bays. Restricted parking spaces could be located in existing and future parking structures built for automobiles.

The number of terminals and loading and delivery bays is dependent upon several factors:

- Number of bays required by the Town's loading bay standards to serve a building and its site.
- Allocation of excess capacity of required loading bays to serve the service area.
- Site limitations and available funding will determine the increase in the number of additional on-site bays beyond standard requirements.
- Terms and conditions for bay occupancy and standard of operation for terminal facilities and enforcement.
- Vehicular size and dwell (usage) characteristics will change with twenty-four hour, seven-day week availability.

Environmental and planning factors must also be considered in the location, routing, and sizing of dispersed terminal and adjacent facilities, e.g., on-site transshipment and warehousing. These include the following:

- Truck access routes and the location and operation of on-street loading bays should equalize impacts by distributing traffic on all available access routes and in all loading bays, so that no one neighborhood or route is impacted more than another.

- Noise, lighting, and odor should have no harmful effects upon residential, lodging, and commercial properties.
- Visual and functional impacts of trucks, cargo vans, warehousing, access portals, delivery or maintenance activities, and terminal facilities upon residential, lodging and commercial properties should be minimized or eliminated and its design in keeping with the character of the surrounding neighborhood.
- The quantity of dispersed delivery terminals, bays, and specialized functions such as transshipment and warehousing.

Operations

Standard operational and enforcement guidelines for dispersed delivery terminals should be drafted. The purpose of the guidelines is to establish standards for operational easements and management agreements of facilities for which the Town is a participant or is responsible for enforcement.

Operational options could be as simple as a "first come, first served" system or as elaborate as a reservation and monitor system.

Current technology allows for reservations and check-in by cell phone, personal digital assistant (PDA), and/or smart cards. The majority of transportation logistic software programs should be adaptable to the same type of use in Vail.

A joint operational agreement could integrate dispersed terminal facilities within private developments with the same requirements as on-street loading bays. They would require a permit to park, state a maximum time limit, and have restricted hours. Enforcement could be carried out by the Vail Police Code Enforcement officers. To ensure the use of the loading bays, further restrictions should also be placed on the existing on-street spaces to limit the on-street supply and generate demand for bays in dispersed terminals.

More elaborate reservation systems could be implemented on a long-term basis as the need arises. Initially, however, a simpler operation would be the most efficient, as the operations need to be adjusted for both on-street and as dispersed delivery terminal and other support facilities are added. Some examples of more elaborate reservations systems include a centralized dispatch system or a close-in, small-vehicle or cargo van centralized or dispersed system.

A centralized dispatch system consists of changing or scheduling deliveries via a centralized dispatch. Dispatching the trucks into the Village could ensure that only a certain number of trucks would be delivering to the Village at one time. This could limit the conflicts of large trucks with guests, residents, and businesses. A centralized dispatch system would be helpful but not necessary for a dispersed terminal system. Dispatch could be handled by operational personnel at the terminal or the truck driver in direct communication with a business owner that has his or her own cargo van. Close-in, cargo van dispersed delivery terminals could reduce the need to regulate how many vehicles have access to on-street delivery bays.

The close-in, small-vehicle centralized or dispersed system consists of a receiving area at which delivery trucks would transfer products to smaller vehicles or hand-cart the goods to their final destination. The idea is to replace larger trucks currently being used in Vail Village with smaller vehicles, such as small, motorized carts or sedan-sized cargo vans. To enhance the centralized or dispersed transshipment terminal, on-site warehouse facilities are appropriate. A centralized or dispersed transshipment terminal should be within close proximity of the Village; preferably one-quarter of a mile or less, and in no instance greater than one-half of a mile. A centralized transshipment delivery terminal system would require a fleet of approximately ten to fifteen small delivery vehicles. Operators of the vehicles could either be the delivery truck driver or a third party employee. A dispersed transshipment delivery terminal system could be serviced by a similar sized fleet or business owners could acquire and operate their own small delivery vehicle. The small delivery vehicles can be housed and stage their deliveries from cargo van loading bays located in close-in parking structures sized to accommodate automobiles.

All of the recommendations outlined above could have major incremental impacts on vehicle traffic in the Commercial Core.

Chapter 2: In-Town Shuttle Bus System

Note: This chapter is based on information presented in the Town of Vail Evaluation of Mass Transit Alternatives for In-Town Shuttle Bus Route *(MK Centennial, September 7, 2000), in combination with public input from focus group meetings and conversations with Town of Vail staff.*

Introduction

The Town of Vail is a relatively young community that came into being when Vail Associates, Inc. opened Vail Mountain for alpine skiing in 1962. Since then, the local population and visitors have increased creating traffic problems during peak hours, the most serious being the evening peak as skiers leave the mountain. The efficient circulation of skiers and visitors is a priority of the Town. Currently, the Town operates two major parking garages holding 2,500 cars. A free In-Town Shuttle bus serves these garages as well as the ski portals.

As the number of visitors has increased, so has demand on Vail's transit system, including the In-Town Shuttle. Presently, the Vail transit system is having difficulty in several areas:

- The system at times has trouble meeting peak ridership demand.
- Space is an issue as the amount of buses exceeds available bus space at stations for the safe loading and unloading of passengers.
- Labor costs are an issue as adding buses to the system increases the need for more drivers, and the recruitment of drivers.
- Recruitment is an issue as Vail, like other mountain and resort areas, cannot find enough drivers to operate buses.

In response to space limitations, driver shortages, and higher costs, the Town of Vail is evaluating replacing the In-Town Shuttle buses with an alternative transit system. Such a system would have to be capable of carrying 5,000 people per hour (the current peak demand is approximately 4,000 people per hour) and effectively serve a route approximately 1.5 miles in length. The route would have to be similar to the current bus system route while effectively maximizing both ridership and system operations with stops at Lionshead, Marriott, Golden Peak, the Vail Transportation Center, and Vail Village, as well as other popular destinations. The evaluation should determine the best options, from a range of opportunities, for providing mass transit for the Town of Vail In-Town Shuttle bus route.

Town Bus System Overview

To better understand the existing In-Town Shuttle system and the need for improvements, the following overview of the system is provided including route, ridership, schedule, and cost information.

The Town of Vail operates eight free bus routes throughout the town during ski season (six operate during the remainder of the year). Seven of the eight routes serve outlying areas of Vail, while one, the In-Town Shuttle, serves Vail Village and Lionshead Village. The In-Town Shuttle provides service over a very small area, yet carried 1.6 million passengers in 1999, which accounted for more than three-quarters of the entire system ridership. During better snow years, In-Town Shuttle ridership has actually been as high as two million.

The In-Town Shuttle operates year round along a 1.5-mile route, one way (a portion of which is restricted to bus traffic only), that runs between Golden Peak and West Lionshead Circle. The route serves the high-density commercial lodging and retail core of Vail. On the busiest day in 1999 (New Years Eve), the shuttle carried 18,000 passengers. The shuttle's primary market consists of visitors, and destination and day skiers. These visitors travel between the slopes, lodging, and dining and shopping attractions within Vail and Lionshead Villages during the winter months. In addition, day visitors, residents, and employees use the shuttle as an internal circulator after having parked in either Vail or Lionshead parking structures.

The In-Town Shuttle operates between 6:30 a.m. and 1:50 a.m. Frequency of service on the route varies depending on the time of day, with 8 to 12 minute headways between 6:30 a.m. and 7:45 a.m., 5 to 7 minute headways between 7:45 a.m. and 10:45 a.m., and 8 to 12 minute headways between 10:45 p.m. and 1:50 a.m. In the winter, four buses are regularly scheduled for off-peak service, with two additional vehicles added during peak periods (on the busiest day, New Years Eve, a total of twelve vehicles are used to provide service). During summer months, three vehicles provide service all day. Each bus completes two loops per hour during peak periods and three loops during off-peak periods. Passenger loading during the peak hours slows down vehicles so they can only make two loops instead of three each hour. The actual amount of service provided during the peak and off-peak is the same, as six vehicles make twelve runs (six vehicles – two loops) during each peak hour, and four vehicles make twelve runs (four vehicles – three loops) during each off-peak hour.

The current hourly cost to provide service is between $45 and $46. The town has ten, low-floor 40' buses (with three doors), which it primarily utilizes to provide the In-Town Shuttle service. Eight of the ten vehicles are due to be replaced in 2008, while two are new.

Objectives

To provide a basis for analysis and recommendations, project objectives were established. These objectives help to determine the needs of the In-Town Shuttle system and the best alternatives to meet these needs. The objectives of the project are based upon the overall goal of the project. The goal of this project is to determine the best options from the full range of possibilities for providing mass transit for the Town of Vail In-Town Shuttle bus route.

The following objectives have been developed from the public meeting held April 19, 2000, other related studies, and previous conversations with Town of Vail staff. These are not listed in any order of priority.

Project Objectives:

- Affordability and Economic Viability
- Community-Based System
- Environmentally Sound
- Flexibility
- Visitor Use Enhancement
- Safety

Under each objective, criteria were created to further define the project objectives. Each criterion is followed by questions that should be asked to determine whether or not the alternative could be a potential option for the In-Town Shuttle system. See Appendix B1 for a full description of the project objectives and criteria.

Options for the Vail In-Town Shuttle System

Options for the Vail In-Town Shuttle system were assessed to determine their compatibility with the project objectives and criteria. Options for such a system are divided into four categories: potential technology options, potential propulsion options, potential station locations, and potential alignment options. For this report, the potential technology options were evaluated.

The screening process for these options consists of two levels – a reality check screening and a fatal flaw screening. The reality check eliminated options that are clearly unrealistic, inappropriate, or unreasonable by applying common knowledge. The fatal flaw screening eliminates options that do not meet one or more of the project objectives.

After the reality check and fatal flaw screening process, there remained several technology options to be considered for further evaluation (see Appendix B2 for a full description of the options considered and the Technology Screening Process). Based on the screening process detailed in Appendix B2, the remaining technology options are as follows: Power Unit/Trailer Combination Units, Low-floor Buses, Articulated Transit Buses, Low-floor Articulated Buses, Guided Busway, and Automated Guideway Transit (AGT). The AGT option consists of systems by several Group Rapid Transit manufacturers: SK, Cableliner DCC, and Aeromovel.

Analysis of Remaining Technologies

Two focus groups were held on September 21, 2000 to obtain public acceptance criteria and public input regarding the best options for providing mass transit for the In-Town Shuttle bus route. Discussions were based upon the remaining technology options presented in the *Town of Vail Evaluation of Mass Transit Alternatives for In-Town Shuttle Bus Route* (MK Centennial, September 7, 2000). Those present at the focus groups included Town of Vail residents and business people. The purpose of the focus groups was to discuss issues regarding the In-Town Shuttle system such as operations, maintenance, schedules, routes, bus stops, bus and other alternative technologies, overall effectiveness, and methods to improve the current system. Rail technology was also discussed as an alternative to the current bus technology used for mass transit.

Several factors were discussed during the focus group meetings regarding the In-Town Shuttle. The Comparative Screening Matrix, Figure 2-1, shows the issues raised concerning the remaining technologies and whether or not the issues are positive or negative for the Town of Vail in regard to that technology. These issues are also summarized below.

Flexibility/Alignment changes

Bus technology can easily adapt to changes in alignment. Rail/fixed guideway technology requires additional right-of-way and track. The general consensus of the focus groups was to maintain flexibility. Providing flexibility was also an objective of this study.

Flexible Station Locations

Bus technology can easily add stations/stops along the current alignment or a new alignment. Rail/fixed guideway technology is restricted to stations/stops built along the alignment. The general consensus of the focus groups was to allow for flexibility in future stop locations (i.e. Ford Park).

Noise

Bus technology would be noisier than rail as more buses would be used rather than trains. Rail/fixed guideway technology is generally quieter than buses.

Accessibility

Both technologies are ADA accessible. Bus technology typically requires time-consuming lifts for wheelchairs. Rail/fixed guideway technology is typically level with the station. Both types of technologies can provide good accessibility for sporting equipment such as skis and bikes.

Smell/Air Quality

Unless overhead power is constructed or battery power is used, bus technology will continue to emit odors/emissions from the use of diesel. New buses using natural gas or hybrid technologies could be used in the future to reduce this. Rail/fixed guideway technology does not emit excessive odors as it is typically run by electric power (overhead or in-track supply).

Use of Existing Stations

Bus technology can use existing stations/stops throughout the Town in most cases. Rail/fixed guideway technology would require new stop construction.

Employees

Bus technology requires a driver for each bus, but articulated buses and power trailer units require less labor as one driver is needed for a much higher capacity. Rail/fixed guideway technology can be automated, and therefore does not require high labor costs for operation.

Desirability

A strong majority of the participants in the focus group expressed a desire to modify the current bus system. Although the existing bus system was recognized as needing improvements, it received a passing grade from all participants. When they viewed the rail technology, comments ranged from rail being “too urban” to “not Vail.”

Congestion at Stations

The use of articulated buses might be problematic if bus congestion becomes worse at each stop. Currently, the Transportation Center is able to accommodate the space requirements for articulated buses, but at some stations more than one articulated bus would not be possible. However, since articulated buses carry higher volumes, fewer buses may be required. Improving the loading and unloading of the buses (i.e. more or wider doors) would reduce the time needed at a stop and reduce overall space needs. Rail/fixed guideway technology should reduce problems for station congestion as schedules are reliable and more than two trains or vehicles would not be in the station at the same time.

User Friendly

Bus technology requires a driver who typically acts as an ambassador and answers questions or provides assistance in case of an emergency. Rail/fixed guideway technology does not require a driver, and therefore does not provide the same feeling of personal service.

Reliability

Bus technology can be delayed by such factors as weather conditions, traffic, and rider conflicts. Rail/fixed guideway technology can run under any conditions and provides on-time, reliable service.

Aesthetics

Bus technology does not detract from the aesthetic appearance of the Town of Vail because the bus system is already a part of the fabric of the Town; rail/fixed guideway technology is viewed as too urban and inconsistent with the character of the Town.

Size of Vehicle

Bus technology requires the use of a large vehicle, but one that most people are accustomed to seeing and/or using (with the exception of an articulated bus). Rail/fixed guideway technology consists of cars that would not be larger than the size of a bus, but more than one car would not fit in with the character of Vail Village.

Figure 2-1: Comparative Screening Matrix

	Flexibility-Alignment Changes	Flexible Station Location	Noise[1]	Accessibility	Smell/Air Quality[1]	Use of Existing Stations	Employees	Desirability	Congestion at Stations	User Friendly	Reliability	Aesthetics	Size of Vehicle
Bus Technology													
Power Trailer Unit	+	+	-	+	-	+/-	+	+	+	+	-	+	-
Low-floor Bus	+	+	-	+	-	+	-	+	-	+	-	+	+
Articulated Bus	+	+	-	+	-	+	+/-	+	+/-	+	-	+	-
Low-floor Articulated Bus	+	+	-	+	-	+	+/-	+	+	+	-	+	-
Guided Busway	-	-	+	+	+		+	+	+	+	+	+	+
AGT/Rail Technology													
SK	-	-	+	+	+	-	+	-	+	-	+	-	+/-
DCC	-	-	+	+	+	-	+	-	+	-	+	-	+/-
Aeromovel	-	-	+	+	+	-	+	-	+	-	+	-	+/-

[1] Assumes standard diesel bus technology. New technologies (diesel and hybrid) are expected to produce less noise and emissions.

Station Locations

The focus groups also discussed optimal transit stop locations for the system. The locations were rated using a full star for stops viewed as most critical or half star for stops viewed as less critical. The following lists present: 1) those stops that received full stars from both focus groups; 2) those stops that received at least one full star from either focus group; and 3) those stops that received at least one half star from either focus group. The transit stop locations and ratings are as follows:

Full star (both groups):

- Golden Peak
- Covered bridge (Transportation Center)
- Medical Center
- Crossroads

Full star (one group):

- Ford Park
- Sonnenalp (could combine with Crossroads)
- Library/Dobson Ice Arena
- Lionshead parking structure
- Lionshead East
- Lionshead West
- Cascade
- Hub site

Half Star (either group):

- All major hotels
- Village Inn (Chateau)

The results of this discussion show that the current system already provides stops at all locations identified as full stars by both groups. Two locations identified as a full star by one group (Ford Park and Cascade) are currently served by other routes but not the In-Town Shuttle route. For the half star group, not all major hotels are served by the existing route, but further discussion revealed that this was not considered feasible or realistic. The discussion of a stop at Ford Park revolved around only providing regular service if this became a permanent parking site and providing temporary service for special events.

This shows that the current routing generally provides good service to the stations/stops considered most important. The one addition would be to extend the current system west to Cascade Village on a permanent basis. Ford Park would be considered on a temporary basis unless permanent parking was provided.

In addition to stop locations, there was also a desire to provide express service between Lionshead and Golden Peak. It was felt that during peak times the travel between these two stops was very high with less demand for intermediate stations/stops.

Recommendations

Six recommendations are presented that best meet the overall objectives and criteria for the In-Town Shuttle system, as well as issues discussed at the focus meetings. These recommendations have been divided into short-term and long-term categories. Short-term options are the most cost effective and practical for solving existing capacity and service related problems. Long-term options address capacity issues associated with future growth in the Town of Vail. It should be noted that these recommendations are based on the best available information, technology, and/or feedback from local agencies and residents. One or several recommendations may be used individually or in combination with others. The Town of Vail should consider each recommendation relative to the current traffic volumes and other traffic issues as well as looking ahead to potential traffic scenarios in the future.

Short-Term Recommendations

The following four recommendations have been identified to address existing capacity problems, as well as other issues or problems.

Develop an Express Bus Route from Vail Village to Lionshead

Based on the comparative analysis of the five feasible bus technology options (power trailer unit; low-floor bus; articulated bus; low-floor, articulated bus; and guided busway) and three AGT/rail technology options (SK, DCC, Aeromovel) versus the project goal and project objectives, it is clear that the Town of Vail should consider focusing on some type of bus technology to improve the In-Town Shuttle system. Bus technology is more flexible than rail technology, in terms of both alignment changes and station locations; can use existing stations/stops in most cases; is viewed as more user-friendly by residents; does not detract from the aesthetic appearance of the Town of Vail as would the more urban looking rail/fixed guideway; and generates less annualized costs (including capital and operating costs) than rail/fixed guideway technology.

The only areas that bus technology does not score as high as rail/guideway technology are noise, as rail/fixed guideway technology runs quieter than buses, and reliability, as rail/fixed guideway systems are not as susceptible to delays caused by traffic congestion, weather conditions, and rider conflicts. In addition, while smell/air quality could be an issue with the use of bus technology, new buses using natural gas or hybrid technologies could be used to reduce this problem.

While the existing In-Town Shuttle generally functions well during off-peak hours in the winter and during the summer season, problems occur during winter peaks when there is more intense demand for service generated by skiers departing for and from the slopes. To address the increased demand, Vail Transit typically has six buses operate during peak periods (with additional buses pressed into service on even busier days such as New Years Eve). However, since the shuttle system operates on short headways (7 minutes or less) during these hours, and such a large number of passengers are trying to board/deboard buses, the frequency between buses is often less than dwell times at major boarding points. This results in buses becoming bunched along the route, and not being uniformly spaced. The operating efficiency of the service in turn suffers as passenger loads on lead buses are greater than trailing buses, and system speed is governed by the slower bus. As the system speed slows, more passengers accumulate at stops between buses, dwell time again increases, and system speed is further reduced.

Given the above conditions, Vail Transit should consider an In-Town Express Bus route between Vail Village and Lionshead. This route would run along the Frontage Road to provide for a quicker, more direct route between the two areas. The express route could also make use of a low-floor, articulated bus. In keeping with the character and space available in the Village Core area, the In-Town Shuttle is better suited for the use of 40-foot buses. However, an express route on the Frontage Road could utilize a low-floor, articulated bus to increase the capacity.

The express route would alleviate congestion problems along the In-Town Shuttle route by diverting some of the traffic (buses and people) to the Frontage Road. One or more of the buses along the In-Town Shuttle route could be eliminated or used for another route while a low-floor, articulated bus could be used on the express route.

The express route would initially be used for service during peak winter periods, but service frequency could be increased in the future if necessary.

Purchase Low-Emissions Vehicles

To address the problem related to smell/air quality, Vail Transit should consider selecting buses that run on compressed natural gas (CNG) and produce lower emissions. The Town of Vail would need for the vehicle manufacturer to guarantee that the CNG vehicle fuel tanks would be built to handle the higher internal pressure generated on the tanks at the high altitude of the Town. This would be done when determining the vehicle specifications.

Modifications would need to be made to the System's maintenance facility if compressed natural gas vehicles are purchased instead of diesel vehicles. The typical cost to modify a maintenance facility to handle CNG vehicles is $600,000. Also, the Town would need to construct a CNG fueling station for the vehicles, which costs approximately $1.7 million.

Improve Information Technology and Information Displays

Electronic message boards which provide real time information should be placed at the Transportation Center, as well as other key stops along the route. Real time information along the route is extremely valuable to transit riders. Such information requires the deployment of an automatic vehicle location system (AVL) to track buses (Vail Transit already has such a system through NEXTbus). The AVL data can be converted into bus arrival times, which can be transmitted to bus stops. Passengers benefit because if there is sufficient time, they may decide to leave the bus stop and return closer to the arrival time of their bus. Even if they decide to wait, knowing when the bus will arrive reduces the anxiety associated with waiting.

The electronic message boards in combination with other current information technology in place for the Vail transit system will provide for a modern, easy-to-use bus system.

Extend In-Town Shuttle Route to Cascade Village

While discussion at the two focus groups held on September 21st, 2001 indicated that the existing In-Town Shuttle route should be extended to serve Cascade Village, Vail Transit should conduct a survey on its West Vail Green and Red routes to determine the number of riders who currently board or deboard at the Cascade Village stop and where they are coming from and going to, to better determine the level of demand for a service extension. If demand warrants, the In-Town Shuttle route should be extended west to serve Cascade Village.

Extending the In-Town Shuttle route to Cascade Village will add approximately one-half of a mile to each run. This additional mileage would allow vehicles to complete their loops in 50 minutes as opposed to the current 40 minutes, and would not add any substantial cost to the service.

Long-Term Recommendations

Develop Guided Busway

If the Town of Vail continues to grow as expected, and capacity on the shuttle needs to be increased to 5,000 pph, as indicated earlier, Vail Transit should consider the development of a guided busway to run between Lionshead and Main Vail/Cascade Village. The use of a guided busway would allow vehicles to run on shorter headways and therefore carry additional passengers during peak hours.

Guided busways combine the flexibility of bus transit with the permanence of rail transit at a lower cost than rail/fixed guideway technology. The technology consists of buses fitted with two small wheels projecting horizontally out of the bus, which run along two vertical rails or curbs. The main advantage of guided busways is the reduced lane width requirement, which decreases the total amount of right-of-way required. Bus steering is automated through the guide wheel mechanism, which provides a fixed-wheel position.

The total capital cost of constructing the three-mile guideway (including retrofitting the bus fleet and adding additional vehicles) would be between $15 and $20 million. The Town of Vail would, however, need to determine if there is currently enough space to construct the busway in the right-of-way along the existing roadway network, or if additional property would be required. Acquiring right-of-way would drive up the cost of the project substantially.

Install Transit-Activated Signal at High Volume Intersections along Frontage Road

At intersections such as East Lionshead Circle and Frontage Road, buses have difficulty making left-hand turns from the minor street (East Lionshead) onto the major street (Frontage). The Town of Vail could look to install a transit-activated signal system that involves detecting the presence of a bus and, depending on the system logic and the traffic situation, then give the transit vehicle special treatment. The system could give a green signal during peak periods for buses waiting to enter onto the Frontage Road. In addition, real time control technologies can detect not only the presence of a bus, but the bus adherence to schedule and the volume of other traffic.

Chapter 3: Outlying Bus System

The purpose of this update is to document a West Vail bus route structure review with recommendations to streamline the current service given the proposed roadway underpass of I-70 in the Simba Run area. The West Vail bus route currently runs along the North and South Frontage Roads, crossing Interstate 70 (I-70) at the West Vail Interchange and the Main Vail Interchange. The addition of the underpass in the Simba Run area has the potential of improving the safety for users of the West Vail route.

In addition to the West Vail bus route, an update on the downvalley bus service will be provided, as this was not in place at the time of the preparation of the 1990 Vail Transportation Master Plan.

For the West Vail bus route, seven recommendations are presented that focus on improving the operation of the West Vail service. For the downvalley bus system, three recommendations are presented. These recommendations have been grouped into short-term and long-term categories. Short-term options are the most cost effective and practical for solving existing capacity and service problems. Long-term options address capacity issues associated with future growth in West and East Vail.

West Vail Bus Route Overview

The West Vail bus route consists of two loops. The West Vail Red Loop runs from the Transportation Center to North Frontage Road using the Main Vail Interchange, runs west along North Frontage Road, crosses I-70 at the West Vail Interchange, and heads back east along South Frontage Road to the Transportation Center. The West Vail Green Loop runs from the Transportation Center west along South Frontage Road, crosses I-70 at the West Vail Interchange, heads back east along North Frontage Road, crosses I-70 again at the

Main Vail Interchange, and goes back to the Transportation Center. Each route takes approximately 40 minutes to complete.

Bus schedules for the Red and Green Loops are as follows: spring – every one to two hours (usually every hour); summer – every 40 minutes; winter – every half hour. Buses on these routes leave the Transportation Center on opposite schedules. In other words, during the winter a West Vail Red Loop bus leaves the Transportation Center on every half hour beginning at 6:00 a.m., and a West Vail Green Loop bus leaves the Transportation Center on every half hour beginning at 5:45 a.m. This provides for a West Vail bus to leave the Transportation Center every fifteen minutes. During the peak hours of holidays and peak seasons, extra buses, or "piggybacks," are sent out to accommodate increased volumes as necessary.

Because the Red route and the Green route leave the Transportation Center at different times, some transit users cross I-70 at-grade to access bus stops along the opposite frontage road. This allows them to access the timeliest bus on either route. Although this practice saves time for the transit user, it creates a serious safety issue by mixing pedestrians and high-speed traffic on I-70.

Total ridership for September 1999 through September 2000 was 472,612. Average ridership for the peak month of February is 82 passengers per hour. The total annual hourly average for the year is 37 passengers. The 40-foot vehicles can accommodate approximately 38 passengers seated with 20 people standing.

Overall costs for the current system are $38 per hour. Labor costs for the system are as follows:

- Overall average cost of drivers = $20 per hour
- Costs for seasonal drivers (two-thirds of total drivers) = $14 to $15.50 per hour, plus a seasonal bonus
- Costs for full-time drivers (one-third of total drivers) = Approximately $30,000 per year ($14.50 per hour) plus 28 percent benefits

As mentioned earlier, a crossing of I-70 in the Simba Run area is proposed. This crossing could potentially affect current headways on the existing route if this crossing was used to develop a shorter route for either the Green Loop or the Red Loop. However, using this crossing to develop a shorter route would detrimentally affect service at some of the existing stops. Other routing options using the Simba Run underpass create similar results. According to transit system staff this crossing would have little or no ridership effect on the existing system. However, an underpass would provide a route for transit users to cross I-70 to safely access the more frequent eastbound or westbound route.

Another consideration for the West Vail bus route is the incorporation of articulated buses. Articulated buses are two buses linked together, one in front of the other, with one operator. These buses would create room for 66 passengers seated and approximately 50 standing rather than the current capacity of 38 passengers seated and 20 standing. These buses also provide for a more efficient use of labor and operations, as less bus drivers are needed. Additionally, the configuration of the Transportation Center in Vail would fit this type of bus.

In addition, several units of employee housing to accommodate approximately 620 people were recently built near the City Market in West Vail (north of North Frontage Road). Additional units are planned near the Post Office (Timber Ridge) and the Mountain Bell area (Middle Creek development) to accommodate approximately 350 and 300 people, respectively. This will create a much higher demand for increased transit service in West Vail as the greatest amount of growth for the Town of Vail is occurring in West Vail. Increased service and alternative routing will be necessary to accommodate this growth.

Options Considered but Eliminated

The Town of Vail has considered several ideas for the streamlining of the West Vail bus route. One idea is to combine the East Vail route with the West Vail route. The new route would travel from the Transportation Center through the East Vail route, back to the Transportation Center and through the West Vail route. This route would still provide the same amount of buses for each individual route. However, this route has not been found to provide any real benefit to the current bus system.

The Lionsridge Loop route could also be combined with the West Vail route, creating an extra loop on the West Vail Red Loop. However, this option is not considered feasible because the winter access on this loop is marginal. The road is steep and curvy and winter conditions would make this extra loop difficult, creating inconsistent headways for the main route.

Another option is to eliminate those stops seen as inefficient on the route, but attempts to eliminate stops in the past have created public contention from those using the stops. Because of this, other options should be explored first.

Recommendations

The following recommendations were based on a review of the West Vail Route structure. The West Vail route structure review focused on an examination of existing service using the North and South Frontage roads, and the new crossing of I-70 in the Simba Run area.
The following recommendations are being made to streamline the current route:

Short-Term Recommendations

Streamline Current West Vail Schedules

Vail Transit should change the current schedules, so that buses operating on the West Vail Green and West Vail Red routes depart at the same time. This would provide more balanced east-west service along the North and South Frontage roads and alleviate safety issues generated by transit users having to cross I-70 at-grade to access bus stops along the opposite frontage road. In the winter, this would mean that buses on each route make their first departure from the Transportation Center at 5:45 a.m. Streamlining these schedules would also make the system easier to understand and utilize, which could generate additional ridership.

Improve Route Identification

While each of Vail Transit's routes have names and are color-coded, a number, letter, or number and letter designation should also be used to help lead passengers through a trip. The number, letter, or number and letter designation, along with the route name should be displayed on each bus and any printed maps. Studies have found that color should not be the only route identifier, and that passengers understand transit systems better when routes are identified by a combination of letters, numbers, names, and colors. In addition, vehicles should have some indication of the direction they are going (e.g. West Vail Green Red – North Frontage) so that the new riders can better understand the system.

Any changes to the route identification system should be done in conjunction with the recommendations to improve information technology and displays (detailed in Chapter 2: In-Town Shuttle Bus System), as maps and schedules would all have to be changed.

Eliminate Red Sandstone School Stop on West Vail Green and Lionsridge Loop Routes

To make the routes in the West Vail area run more efficiently, two of the routes, West Vail Green and Lionsridge Loop, should eliminate stops at Red Sandstone School. This route would continue to be served by the West Vail Red and Sandstone routes. The elimination of this stop would reduce the running time of the West Vail Green route and allow vehicles serving the Lionsridge Loop to reach their primary service area faster.

Install Trailblazer Signs

Trailblazer signs that direct riders to the nearest stop or stops should be installed on major streets and other key strategic stops throughout West and East Vail. These signs would satisfy the need for approach information, and thus should be compatible with route guidance information with regard to location labels, directions, and route designations.

Metal trailblazer signs with the appropriate route guidance information can cost anywhere between $500 and $1,000. A significant consideration is locating these signs in a cost-effective way to ensure access to information without additional clutter.

Long-Term Recommendations

Purchase Additional Low-floor, Articulated Buses

If West Vail continues to grow over the next few years as expected, Vail Transit should consider purchasing two additional low-floor, articulated buses to handle the expected increase in demand. These vehicles should be used on the West Vail Green and Red routes. Low-floor, articulated buses have a 33 percent greater capacity than regular low-floor vehicles, which could better handle the high volume of passengers that occur during the peak periods in the winter ski season (December through March). These buses should have three doors (with each door 32 inches in width) to allow easier access/egress for passengers, which can help reduce dwell time. The use of higher capacity, low-floor articulated buses might also save Vail Transit operating expenses, as the number of vehicles it currently utilizes during peak periods could be reduced.

In purchasing low-floor vehicles, the Town of Vail should look to vehicles with the specifications shown in Table 3-1.

Table 3-1: Low-Floor Vehicle Specifications

Vehicle Characteristic	Specification
Length	60 feet
Width	8 feet
Height	9 feet
Weight	41,000 lbs
Seating (max. capacity)	133 with skis, 160 without skis (seating configuration to be determined with manufacturer)
Turning radius	42.5 feet
Doors	3 doors each with a width of at least 32"
Motive Power	• Compressed Natural Gas • ABS Braking Control • Automatic Traction Control • Deep Mud and Snow Traction Control • Pusher type design where the rear axle provides the tractive effort
Articulated Joint	Maximum bending angle of the bus is 49 degrees

The cost of these types of buses ranges between $400,000 and $500,000. The cost of purchasing two low-floor, articulated buses for Vail's outlying bus route would be $800,000 to $1,000,000.

In addition, to address the problem related to smell/air quality, Vail Transit should consider selecting low-floor articulated buses, which run on compressed natural gas (CNG) and produce lower emissions. The Town of Vail would need for the vehicle manufacturer to guarantee that the CNG vehicle fuel tanks would be built to handle the higher internal pressure generated on the tanks at the high altitude of the Town. This would be done when determining the vehicle specifications.

Modifications would need to be made to the System's maintenance facility if compressed natural gas vehicles are purchased instead of diesel vehicles. The typical cost to modify a maintenance facility to handle CNG vehicles is $600,000. Also, the Town would need to construct a CNG fueling station for the vehicles, which costs approximately $1.7 million.

Potential disadvantages of purchasing articulated buses exist. The 60-foot buses could affect residents of local neighborhoods, as they generate a considerable amount of noise, and the overall size would not fit in with the character of the Town. Also, the modifications to some bus stops and bus storage bays mentioned earlier would be necessary to accommodate the longer buses. Bus stop locations along the route would have to be lengthened due to the increased size of the vehicle. The cost to modify a garage to handle articulated buses can range between $700,000 to $1,000,000 per bus bay.

If the Town decided not to use articulated buses for service, it would most likely be necessary to purchase additional 40-foot buses at some point to handle future capacities.

Incorporate Bus Stops at Simba Run Underpass

While the use of the Simba Run underpass to restructure the West Vail Red and/or West Vail Green routes will not provide any service enhancement or increase in ridership, additional bus stops should be located at each end of the proposed Simba Run underpass along North and South Frontage Roads to improve passenger access to the system and increase safety. These additional stops would serve the West Vail Red and West Vail Green routes, as well as the Lionsridge Loop in the winter.

Incorporate Stops at Lionshead Intermodal Facility

Following completion of the Lionshead Intermodal Facility, Vail Transit should add this location as a stop on the West Vail Green, West Vail Red, and In-Town Shuttle routes. The facility will include significant parking and should become a key transfer point for transit service, which will increase system ridership.

Downvalley Bus System

The downvalley bus system (the ECO system) has gone through substantial expansion since 1990. Although a limited service was available in 1990, the service was not capable of accommodating the increasing demand for transit service by employees that travel upvalley to work in Vail. This update describes the current downvalley bus system that was not in place at the time of the 1990 Transportation Master Plan; provides information concerning routes, schedules, and ridership; and provides recommendations for improvement of the system. Currently, seven routes run from Vail to areas downvalley. Some of these routes vary slightly from the morning hours to the evening hours and may also differ from season to season.

ECO Routes

Vail to Edwards

The Vail to Edwards route runs between the Vail Transportation Center and the Lake Creek Apartments in Edwards. The route runs every 22 to 23 minutes from 5:00 a.m. until 1:47 a.m. However, from 9:17 a.m. to 3:17 p.m. the route runs every 45 minutes. The route takes approximately 50 minutes one way.

Yearly ridership for this route (based on January 2001 through December 2001, both directions) is 570,000 passengers. The peak month is January with 73,400 passengers.

Vail to Beaver Creek

This route runs between Lionshead in Vail and the Beaver Creek Upper Village Plaza. The route runs approximately every 15 minutes from 7:55 a.m. until 11:25 a.m. and 2:55 p.m. to 6:55 p.m. The route runs approximately every 30 minutes from 11:25 a.m. until 2:55 p.m. and 6:55 p.m. to 10:25 p.m. The route takes approximately 35 minutes one way.

Yearly ridership for this route (based on January 2001 through December 2001, both directions) is 125,600 passengers. The peak month is March with 29,500 passengers.

Vail to Dotsero (including towns in between)

The Vail to Dotsero route begins in Vail, with the Transportation Center being the eastern-most connection, and ends in Dotsero in the afternoons and runs from Dotsero to Vail in the mornings. Routes from Vail to Dotsero run at 4:50 p.m. and 5:20 p.m., and a one-way trip takes approximately 70 minutes. Routes from Dotsero to Vail run at 5:55 a.m. and 6:25 a.m., and a one-way trip takes approximately 65 minutes.

Annual ridership for this route (based on January 2001 through December 2001, both directions) is 45,900 passengers. The peak month is December with 6,700 passengers.

Vail and Avon to Leadville/Red Cliff/Minturn

This route runs between the Vail Transportation Center and 5th and Letter in Leadville. The route runs at 4:30 p.m. and 4:45 p.m. and is scheduled to take 94 minutes one way. The route runs in the opposite direction at 5:40 a.m. and 6:00 a.m.

Annual ridership for this route (based on January 2001 through December 2001, both directions) is 32,600 passengers. The peak month is March with 4,900 passengers.

Vail to Minturn/Minturn to Vail

This loop runs from the Vail Transportation Center to Two Elk Estates in Minturn and back. The route runs every 90 minutes from 6:48 a.m. to 9:48 p.m. A full loop takes approximately 45 minutes.

Annual ridership for this route from January 2001 through December 2001 is 13,700 passengers. The peak month is March with 2,900 passengers.

Express Routes

Two express routes were added to the ECO Transit system in January of 2002. These include the Vail Express and the Avon Express. The Vail Express runs from Dotsero to Vail in the morning and from Vail to Dotsero in the afternoon. The Avon Express runs from Gypsum (Eagle Valley High School) to Avon in the morning and from Avon to Gypsum in the afternoon.

Because these routes were added recently, annual ridership numbers are not yet available.

Park-n-Ride Locations

In addition to the routes described above, park-n-ride lots are also available for users of the ECO transit system to park their vehicles and continue to their final destination by transit. Park-n-ride lots are available at the following locations:

- Eagle (5th and Chambers)
- Gypsum (lot under construction at Eagle Valley High School)
- Wolcott (an unofficial lot at the I-70 exit)

A park-n-ride lot is also proposed in Edwards at the Berry Creek subdivision that will likely be a partnership between ECO transit, Colorado Mountain College, and another public entity. Two additional locations that should be considered for future locations include Avon, near I-70 and Nottingham Road; and Minturn, at Dowd Junction.

Other Considerations

The addition of the InterMountain Connection (IMC) to the Eagle Valley transportation system, as described in Chapter 6: Connecting Fixed Guideway Systems, would include a local rail system that would run from Vail to the Eagle County Airport. If the IMC were to be implemented, this might change or eliminate the need for some downvalley routes. The proposed rail system would reduce emissions from diesel-engine buses and other vehicles while accommodating higher volumes of commuters within the Valley. Any future changes planned for the downvalley bus system should consider the potential influence that the IMC system could have on the bus system.

A consideration that may or may not affect future operations of the ECO regional transit service is the upcoming move of the bus barn facilities to Gypsum. As these facilities are farther away from many of the routes, the system could anticipate an increase in costs due to higher mileage and repairs on the vehicles and more driver hours.

Another consideration of the downvalley bus system is that some of the routes take too long in relation to the distance traveled and the amount of time it would take to drive the same route in a private vehicle. This decreases the incentive for people to use the transit service. One of these routes includes the Vail to Edwards route (50 minutes, one way). The time it takes for a vehicle to drive directly from Vail to Edwards is approximately ten to fifteen minutes, a savings of about 35 to 40 minutes over transit.

The capacity of the transit decks at the Transportation Center is also a consideration for the transit system. Currently, there are six lanes; five lanes accommodate Vail services and one lane accommodates all ECO routes. Most routes arrive and leave at the same times as many services leave on the hour, half-hour, etc. This is an area where changes could be considered to maximize efficiency at the Transportation Center.

Recommendations

The following recommendations were based on a review of the downvalley bus service. This review primarily examined the running time of existing Eagle Valley Transportation routes and the impact of the Intermountain Connection (IMC) on the Eagle Valley Transportation System.

Short-Term Recommendations

Establish a Variable Lane System and GPS at Transportation Center

The transit plaza should be changed to a variable lane system rather than the current assigned lanes for each route. This would include a variable message system to direct buses into certain decks when they arrive. This would allow for staggered bus arrivals, and therefore add more capacity. The variable message system could be incorporated with a Global Positioning System (GPS), a system that allows a central control system to track the location of all buses at all times. This type of system would allow for greater capacities of buses from downvalley routes rather than the current single lane that is assigned for ECO routes.

Add Express Service on Vail to Edwards Route

To reduce the travel time for commuters and other passengers traveling from downvalley locations to Vail and generate additional ridership, express service should be provided on the Vail to Edwards route in addition to the other express routes recently implemented. This can be done by making some of the existing runs into express runs with limited stops, or by adding express runs, which may require additional vehicles.

Providing express service would reduce the travel time on the Vail to Edwards (which is currently 50 minutes) to something that is similar to the driving time associated with a private vehicle – 10 to 15 minutes for Vail to Edwards. However, one disadvantage of this route is that park-and-ride locations may need to be added (such as those mentioned above) or existing locations expanded to handle potential increases in demand. More people in outlying areas may be inclined to drive to a park-and-ride facility to board the express service.

Long-term Recommendations

Plan for the Impact of the IMC on the Eagle Valley Transportation System

If the IMC rail line is constructed between Vail and the Eagle County Airport, two of the existing Eagle Valley Transportation routes – the Vail to Edwards and Vail to Dotsero routes (including all towns in between) – would essentially be providing redundant service. To eliminate this service redundancy and make the system function better, these routes should be converted into a feeder service, which would serve new rail stations in Edwards and Dotsero. Feeder routes would be designed to serve residential and business areas in each town, with runs scheduled to meet arriving and departing trains.

Chapter 4: Trail System Interface

The original Town of Vail Transportation Master Plan includes discussion about the then current (1990) Town of Vail trail system with recommendations for new trails to be constructed. These new trails would enhance the existing system by creating better mobility for bicyclists and pedestrians.

This update documents trails that have been constructed since the original Master Plan was undertaken in 1990. Figure 4-1 on pages 4-3 and 4-4 illustrate the trails constructed since 1990. Also included in this update are pedestrian opportunities that have been considered since 1990.

Appendix C1 includes for reference portions of the Eagle County Trails Master Plan that are relevant to the Town of Vail.

Recreation Trails Constructed Since 1990

(See *Vail Transportation Master Plan, Felsburg Holt & Ullevig, 1990*, for trails constructed before 1990.)

Bighorn Road Bike Path

The Bighorn Road Bike Path is approximately one and three-quarter miles long. Bighorn Road was widened to add a six-foot wide path on both sides of the road. A parking lot was also constructed at the western end of the path to provide parking for bikers riding up Vail Pass. The western end of the path begins at the south side of the East Vail Exit (I-70 Mile

Post 181). The eastern end of the path connects to the Vail Pass Recreation Path at Main Gore Drive. The trail has an asphalt surface and was constructed in 1990.

West Vail Bike Path South

The West Vail Bike Path South is approximately one-half mile in length. The path begins at the West Vail Interchange and extends east parallel to the South Frontage Road. The trail connects to a previously constructed bike path at Matterhorn Drive. The surface is asphalt, and the trail was constructed in 1996.

West Vail Bike Path North

The West Vail Bike Path North is approximately one-half mile in length. The path begins at the West Vail Interchange and extends east parallel to the North Frontage Road. It connects to the previously constructed North Frontage Road Bike Path. The path has a concrete surface and was constructed in 1997.

Dowd Junction Bike Path

The Dowd Junction Bike Path is approximately one mile long. The western trailhead is at the interchange of Highway 6 and I-70. The eastern trailhead is located at Vail Intermountain at the west end of South Frontage Road West. The trail runs parallel to and south of I-70 until it crosses under I-70 at Dowd Junction. The trail has an asphalt surface and was constructed in 1997.

Vail North Trail

The Vail North Trail is approximately seven miles in length. This is a single-track hiking and mountain biking trail that winds through the hills and runs along the north side of the Vail Valley. Work is continuing to extend the trail further east towards Spraddle Creek. The western trailhead is at the western end of Arosa Drive in West Vail. The eastern trailhead is on Buffehr Creek Drive approximately one-half mile north of the North Frontage Road. The trail has a dirt surface and was constructed in 1998-1999.

Pedestrian I-70 Undercrossings Constructed Since 1990

Since 1990, no new pedestrian I-70 undercrossings have been constructed. However, conceptual designs are being completed for a crossing at Simba Run, to be completed in conjunction with a two-lane underpass.

Recommendations

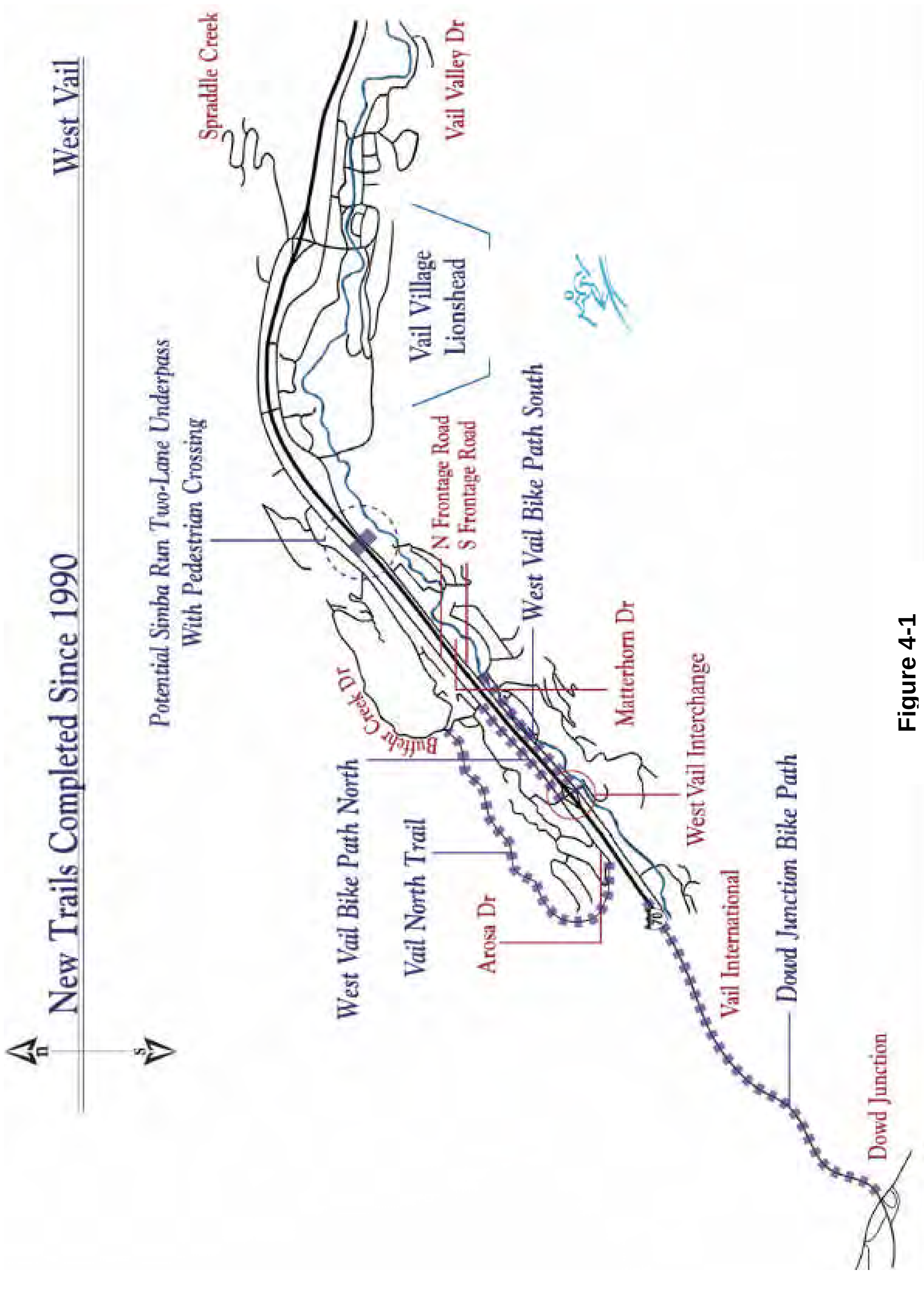
The original Master Plan identified eight trail links to complement the trail system then in place. Only one of these (Study Link 2) has since been constructed. Those that have not been constructed have now been identified by the Town as priority implementation items. See Appendix C2 for copies of the mapping of these trails as presented in the original Master Plan document.

The Town has also identified additional trail links that it considers to be of high priority. These include:

Lionshead Bypass – from the skier bridge in Lionshead, bypassing Lionshead, and connecting to existing trail system behind Tree Tops Condominiums

Vail Village Bypass – from Vail Road near Checkpoint Charlie, to Vista Bahn

Sunburst Road Bypass – from the golf course clubhouse to the west end of Katsos Ranch Path



New Trails Completed Since 1990
West Vail
n
s
Potential Simba Run Two-Lane Underpass
With Pedestrian Crossing
Spraddle Creek
Vail Valley Dr
Vail Village
Lionshead
N Frontage Road
S Frontage Road
West Vail Bike Path South
Matterhorn Dr
Buffehr Creek Dr
West Vail Interchange
West Vail Bike Path North
Vail North Trail
Arosa Dr
70
Vail International
Dowd Junction Bike Path
Dowd Junction

Figure 4-1

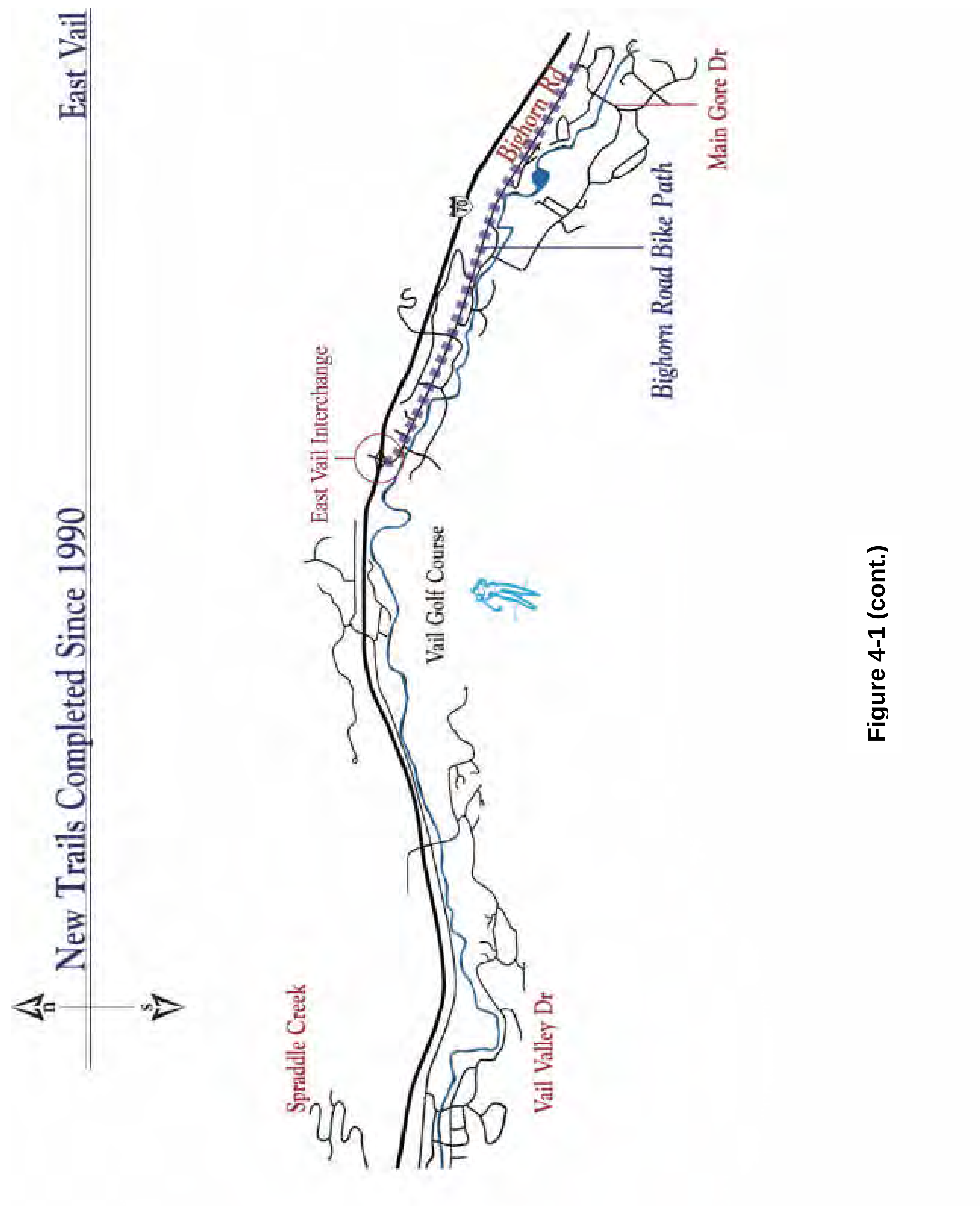


Figure 4-1 (cont.)

Chapter 5: Level of Service Analysis

Introduction

To update the intersection Level of Service (LOS) information provided in the 1990 Transportation Master Plan, traffic volume counts for the same intersections were conducted in 2000. These were completed in March and July for p.m. peak hour volumes. The p.m. peak hour typically represents the most congested period of the day in Vail. Eight intersections in Vail have been reconstructed as roundabouts (now four roundabouts total) since the 1990 counts. These roundabouts were included in the 2000 traffic counts but were counted for entering volumes only. Both entering and exiting volumes are required for roundabout LOS analysis. For the roundabouts, the counted 2000 entering volumes and previously counted exiting volumes factored for traffic growth were used in the analysis.

In addition to the intersections included in the original Plan, traffic counts were also conducted in 2002 for the Vail Village Parking structure and the Lionshead Parking structure. A LOS analysis for the two parking structures is included in this chapter as well.

Intersection Level of Service

Table 5-1 shows the LOS criteria for two-way, stop-controlled intersections, the most prevalent intersection type in Vail. The LOS is based on the average delay per vehicle. The same LOS criteria are also applicable to the roundabout analysis.

Table 5-1: Level of Service Criteria for a Two-Way, Stop-Controlled Intersection

Level of Service	Delay Range (sec/veh)
A	≤10
B	≥10 and ≤15
C	≥15 and ≤25
D	≥25 and ≤35
E	≥35 and ≤50
F	>50

The LOS calculations for each intersection and roundabout are summarized in Table 5-2. Guidelines for intersection LOS in the Town of Vail call for a minimum LOS C. All intersections and roundabouts counted in March and July fall within the range of LOS C, with the exceptions of the Frontage Road intersections with Vail Valley Drive West (LOS D), Matterhorn Circle (LOS E), and Westhaven Drive (LOS F). Because there are stop signs on the minor streets, the delay period is elevated for traffic entering the Frontage Road from the minor streets when high volumes exist on the Frontage Road.

Based on traffic forecasts provided by the traffic model (see **Chapter 9. Traffic Model**) other intersections may have poor LOS in the future. These include the Frontage Road intersections with Gore Creek Drive and West Lionshead Circle (LOS E.).

Table 5-2: Town of Vail Existing LOS Analysis

	PM Peak Hour			
	March 2000		July 2000	
Intersection	**LOS**	**Stop-Controlled Approach Delay (seconds)**	**LOS**	**Delay (seconds)**
Bighorn Rd. and Main Gore Drive North	A	9.8		
Bighorn Rd. and Streamside Circle West	B	10.3		
Bighorn Rd. and Lupine Drive	B	11.6		
Bighorn Rd. and Bridge Rd.	B	11.2		
E. Vail I-70 EB Ramps and Bighorn Rd.	B	11.0	B	10.5
E. Vail I-70 WB Ramps and Bighorn Rd.	B	12.9	B	12.8
Frontage and Booth Falls Rd.	A	9.5		
Frontage and Bald Mountain Rd.	A	9.6		
Frontage and Vail Valley Drive East	B	11.4		
Frontage and Vail Valley Drive West	D	32.3		
Frontage and Village Center Rd.	C	20.5		
Main Vail South Roundabout	C	20.8	B	9.5
Main Vail North Roundabout	B	6.7	A	2.4
Frontage and Red Sandstone Rd.	B	13.1		
Frontage and Lionsridge Loop	B	12.9		
Frontage and Buffehr Creek Rd.	C	15.9		
West Vail North Roundabout	B	9.2	A	4.0
West Vail South Roundabout	A	4.4	A	3.6
Frontage and Gore Creek Drive	C	22.6		
Frontage and Matterhorn Circle	E	44.5		
Frontage and Westhaven Drive	F	88.9		
Frontage and West Lionshead Circle (w.)	D	30.9		
Frontage and West Lionshead Circle (e.)	C	23.7		

Possible Solutions

Possible solutions exist to minimize intersection delay, especially for the intersections with LOS D or poorer (below the standard LOS C) or intersections with projected LOS of D or poorer.

- **Traffic Signals**

One solution is to install traffic signals at the intersections. Traffic signals would create an allotted time period for side street traffic to pass through the intersection uninhibited by Frontage Road traffic. This solution is not likely to be implemented, however, because the Town of Vail avoids the use of traffic signals to preserve the character of the Town.

- **Traffic Directors**

Another possible solution is the use of traffic directors. Traffic directors could be used during peak periods of traffic such as when the Vail ski area closes for the day on busy weekends or when special summertime activities are taking place in Vail.

- **Roundabouts**

Roundabouts are also used to minimize delay. However, the intersections functioning at LOS D or poorer might be not capable of supporting a roundabout because of the space requirements necessary. This possibility could be analyzed further with additional planning and engineering studies.

- **All-way Stops**

In some cases, three- or four-way stops (depending on the number of approaches at the intersection) may also minimize delay when balanced traffic volumes flow from all directions or when traffic volumes warrant the all-way stop. However, for the intersections studied for this report, all-way stops are not warranted based on *Manual on Uniform Traffic Control Devices* criteria. Despite this, Highway Capacity Software (HCS) calculations indicate that installing all-way stops at the intersections with LOS D or poorer would improve the LOS on all three intersections. For this reason, the Town of Vail might want to give further consideration to these intersections.

The worksheets prepared for the analysis discussed in this chapter are included in Appendix D1 and D2. Appendix D1 includes HCS worksheets for the unsignalized intersections and Appendix D2 includes Rodel worksheets for the roundabout analyses.

Parking Structure Level of Service

Traffic counts and LOS analysis were also conducted for the two major parking structures in Vail in the winter of 2002. These include the Vail Village Parking structure and the Lionshead Parking structure. Table 5-3 shows the parking structure LOS calculations for the a.m. and p.m. peak hour. Both the a.m. and p.m. peak hours are included in this analysis because the a.m. peak hour for the Vail Village Parking structure has a lower LOS than the p.m. peak hour. These intersections fall within the minimum LOS C. Appendix D3 includes worksheets for the parking structure LOS analysis.

Table 5-3: Town of Vail Existing Parking Structure LOS Analysis

	Winter 2002			
	AM Peak Hour		PM Peak Hour	
Intersection	**LOS**	**Parking Garage Approach Delay (seconds)**	**LOS**	**Parking Garage Approach Delay (seconds)**
Vail Village Parking and Frontage Road	C	17.0	B	10.3
Lionshead Parking and Frontage Road	A	7.8	A	7.1

Chapter 6: Connecting Fixed Guideways

Introduction

As transportation systems in Colorado are being pushed beyond their capacities, solutions to decrease congestion are being proposed by public, private, and special interest groups and individuals. One solution to the problem of overcrowded roadways is the concept of rail transit, or fixed guideways. Fixed guideways have the potential to reduce traffic volumes on roadways, utilize railroad tracks that are long since out of service, and reduce emissions of air pollutants such as carbon monoxide and ozone from automobiles.

Two separate rail systems have been proposed to intersect in the Town of Vail. Both of these fixed guideway systems were originally proposed in the ***I-70 Mountain Corridor Major Investment Study (MIS)***, *CH2MHILL, December 1998*, as a means to connect Denver International Airport (DIA) with Glenwood Springs. One of these is the InterMountain Connection (IMC), a local commuter rail and trail system designed to link communities of the Vail and Eagle Valleys. Another rail system is an elevated guideway that would run from DIA to the Eagle County Regional Airport along I-70. The proposed rail system from DIA to the Eagle County Airport is under the authority of the Colorado Intermountain Fixed Guideway Authority (CIFGA). CIFGA was created in 1998 by the Colorado Legislature as the authority responsible for resolving issues surrounding a high-speed transit service to communities along the I-70 Corridor, such as technical, financial, and public/government jurisdictional issues.

The purpose of this chapter is to describe both rail transit systems in regards to their relationship with the Town of Vail. Land and geographic limitations within the Town of Vail create a need for cooperation between these two entities – particularly for the building of rail transit stations.

I-70 Mountain Corridor Major Investment Study

The I-70 Mountain Corridor Major Investment Study (MIS) references both rail systems described above, with a brief reference to the IMC rail system and the most attention given to the DIA to Eagle Valley Airport segments. The document proposes a rail station for Vail to be located in the median of I-70, near the existing Vail parking decks, just east of Exit 176. This is also adjacent to the Vail Transportation Center. This center is serviced by all Vail bus routes, one Avon/Beaver Creek transit bus route, and all Eagle County Regional Transportation Authority bus routes, suggesting somewhat of a “transportation hub” for the Town of Vail.

As a result of the MIS, CIFGA was formed. Although the MIS document provides recommendations for a rail station location, CIFGA has adopted a policy of allowing the towns, local citizens, and local agencies to decide upon rail station locations and designs.

Colorado Intermountain Fixed Guideway Authority

After CIFGA acquired responsibility for the DIA to Eagle County Airport fixed guideway system, the agency created more detailed information regarding these systems. As mentioned previously, local citizens and agencies would ultimately decide upon the station locations and logistics for the Town of Vail. All plans for these stations would also integrate current and future transportation plans of the Town of Vail.

The system includes high-speed monorail technology, which incorporates a linear induction motor. This type of system could move a volume of travelers equivalent to as many as eight to ten additional lanes of traffic on I-70. Design speeds for this system are 125 mph for straight sections of rail line, with an average of 70 mph with stops. Annual ridership of this fixed guideway system is projected to be 125 million people.

The Vail area would be particularly difficult for determining station locations due to its limitations of land availability. A rail station would require feeder road access as well as significant parking requirements, making the task of finding available land even more difficult. Cost considerations are also a factor as costs of real estate in the area are considerably higher than many other towns along the route.

CIFGA station requirements for a basic station design in a small town would be three to five acres at a minimum. This figure includes parking, bus systems, and any facilities determined as standard for a rail station. For a town the size of Vail (a medium-sized town), station requirements would be ten to twelve acres for a basic station design – once again all-inclusive. Should the Town of Vail decide that other amenities or facilities are desirable for a rail station, such as larger stations, special facilities, etc., the Town of Vail would fund these extras.

CIFGA funding goals are as follows: one-third public funding (state/local grants); one-third private funding (equity/capital/franchising); and one-third Federal loans. As mentioned previously, the town where the station is located provides any extra spending beyond basic station requirements.

Because of the limitations of available land in the Town of Vail, CIFGA has also considered other options for a rail station to service the Town. A station could be located in a neighboring town where land availability is less of a concern. In this case, a shuttle service would be provided to service the Town of Vail.

Another possibility would be to "cap," or build a tunnel, through the Town of Vail (see **Chapter 8: I-70 Capping**). A station could be located within this cap if the CIFGA alignment were to be located within the cap as well. This option would actually create more land available for use within the Town.

The goals and objectives of CIFGA are to look beyond transportation when planning rail systems. CIFGA sees the opportunity to integrate retail businesses, employee housing, car rental services, and other amenities when planning station locations. Although the Town of Vail may be too space-limited to consider extras such as these, they are still considerations for the future that CIFGA hopes to integrate as part of the process.

InterMountain Connection

The IMC is a concept that was created to make use of the Union Pacific Railroad corridor for clean-burning diesel light rail vehicles and a trail system. The proposed project is a public-private venture sponsored by Eagle County that has partnered with CDOT to create a practical solution to the transportation problems in the Eagle Valley.

The system would be built along the existing railroad corridor. This system includes the use of diesel multiple unit (DMU) technology. Design speeds will vary from 45 to 65 mph, with an overall average speed of 57 mph between Avon and the Eagle County Airport.

Start-up stations for this system would be built at the Eagle County Airport, Eagle, Edwards, and the confluence in Avon. Expansion Phases would include extensions to Vail and Leadville. Projections for the Vail Expansion Phase show that the IMC would result in a decrease of automobiles on I-70 of approximately 19,000 vehicles per day (vpd). MIS projections for a full connection from Glenwood Springs to Vail indicate an increase in annual ridership of at least 400,000.

Proposed station locations for this project in the Vail area include West Vail (possibly in the vicinity of the West Vail interchange), Lionshead (west of Lionshead Circle, in between Frontage Road and I-70), and an intermodal center at the Vail Village Transportation Center (in between Frontage Road and I-70, just northeast of the Transportation Center).

While CIFGA and the IMC might appear to be in conflict with each other, as they are controlled by separate agencies with separate interests, they view each other as compatible services. Both have the goal of decreasing the overall number of cars on the road. The two systems would interface at Vail, creating the need for cooperation regarding station locations and rail lines.

Recommendations

Recommendations for a potential alignment of the fixed guideway system through the Town of Vail are provided on the map in Appendix E. These are schematic drawings to be used as a starting point for discussion of the alignment. These could be used as a reference for CIFGA and IMC projects. Potential alignments are also discussed below.

CIFGA

- **Dowd Junction**

The CIFGA alignment could enter Vail by way of Dowd Canyon on the existing Union Pacific (U.P.) Railroad tracks. Just before the crossing of I-70 over Highway 6 (Dowd Junction), the alignment would curve to the east, paralleling the existing bike path. At the point where the bike path crosses under I-70, the alignment could follow one of two options. Option 1 would be a tunnel cut through the slope of the mountain north of I-70. This option would parallel I-70 until the entrance to West Vail, at which point the median opens up and the alignment would cross over to the median. This option would be most beneficial if I-70 was not capped.

Option 2 would bring the alignment into the median under the proposed capping of I-70 through Dowd Canyon, in between the eastbound and westbound lanes.

Two other options exist for the alignment in the Dowd Canyon area. Option 3 through this area involves the diversion of the alignment before Dowd Canyon. As I-70 curves to the east and back before Dowd Canyon, the alignment could continue south (instead of curving back west and into Dowd Canyon) and tunnel through into Dowd Canyon just west of West Vail. At this point the alignment could cross into the median and continue into West Vail.

Option 4 for the Dowd Junction area includes following the existing rail line into Minturn and then tunneling back north to I-70. This option would be considered because of potential grade problems at Dowd Junction. Options 1 and 2 might face difficulties in creating a rail line that could negotiate the steep grade at the intersection of I-70 and Highway 6.

- **West Vail**

For either option discussed above, the alignment would be in the median as CIFGA enters West Vail. The CIFGA alignment would remain in the median, whether or not the capping was to be constructed. A station location could also be constructed in the median for West Vail access at a location determined to be the most practical. This station would include pedestrian crossings to access areas north and/or south of I-70 and the Frontage Roads in West Vail.

- **Main Vail**

The CIFGA alignment would remain in the median through Main Vail as well, with potential station locations at the proposed North Day Lot Transportation Center in Lionshead and the Vail Transportation Center for pick-up and drop-off of riders. These stations could be constructed in the median of I-70 with pedestrian crossings to access areas north and/or south of I-70 and the Frontage Roads.

- **East Vail**

The CIFGA alignment could also remain in the median through East Vail and continue east outside of the Vail city limits.

IMC

As the IMC is proposed as an interim solution until completion of the CIFGA project, all alignment recommendations might be temporary. These sections could be removed as sections of the CIFGA project are completed. However, the IMC could also remain useful as a local service, providing more frequent stops in Vail for downvalley commuters. Any decisions regarding the temporary or permanent use of the IMC would be decided by the Town of Vail upon further studies and public involvement.

- **Dowd Junction and West Vail**

The IMC alignment would parallel the CIFGA alignment entering Dowd Canyon and traveling through West Vail (using Option 1 or 2). Shortly after passing by the West Vail Roundabouts and the potential station location in West Vail, the IMC alignment would leave the median, crossing over to the area between I-70 eastbound and South Frontage Road. The alignment would continue to parallel the CIFGA alignment.

- **Main Vail**

The alignment would continue to use the space between I-70 eastbound and South Frontage Road, while sharing the potential station locations at Lionshead and the Vail Transportation Center with the CIFGA for pick-up and drop-off. The IMC is proposed to end at the Vail

Transportation Center, at which point the line would go back downvalley along the same route.

Chapter 7: Noise

As a measure of the Town of Vail Critical Strategies, a noise study was conducted to identify noise impacts created by the traffic on Interstate Highway 70 (I-70) in the Town of Vail. The study included the following tasks:

- Analyzing existing noise levels
- Determining noise impacts
- Determining future noise levels based on projected future traffic volumes
- Performing sensitivity analysis to differences in speed, variations of receiver locations, increases in truck traffic, and increases in overall traffic volume
- Determining the affect of noise barriers in various locations

The noise impacts were analyzed in accordance with the Colorado Department of Transportation's (CDOT) noise policy (*CDOT Noise Analysis and Abatement Guidelines, February 1, 1995*, See Appendix F1). Traffic noise level predictions were made for two conditions: existing 2000 and year 2020. Site conditions, including horizontal and vertical layout as well as topographical and traffic information, were used as input to the STAMINA 2.0 model. This is the approved noise model used by CDOT. General results of the traffic noise modeling effort are reported below.

The results of the noise study indicate that receivers will experience traffic noise levels in excess of CDOT's noise abatement criteria under both the existing 2000 and year 2020 traffic levels. Currently, approximately 25 percent of all the tax assessor's parcels in the Town of Vail exceed a 66-decibel noise level. This percentage represents only residential parcels that exceed the 66-decibel noise level out of the total number of parcels in the Town of Vail. Other types of land use including schools, hospitals, parks and hotels are not included in the 25 percent (these other uses represent a small percent of the total number of parcels in the Town of Vail). A description of common noise terminology, a summary of CDOT's noise policy, a description of the noise modeling process, results of the sensitivity analysis, and noise mitigation analysis are discussed below.

Noise Terminology

Noise is measured on a logarithmic scale, which is often the source of much confusion. What humans hear are pressure fluctuations in the air that are created when something vibrates, such as an engine or the cone of a loudspeaker. The range of pressure fluctuations the human ear can detect is extremely large (20 to 20,000,000 Pascals, the metric unit of pressure). This range is unwieldy to discuss, so the decibel (dB) scale is used to compress the numbers to a more manageable form. On this scale the range of human hearing is approximately 0 dB (threshold of hearing) to 140 dB (threshold of pain). Some typical noise levels are shown in Table 7-1. Note that these levels are in dB(A), not dB. The "A" denotes that the noise levels have been adjusted according to the A-weighting network. The A-weighting network adjusts noise levels to reflect the fact that the human ear is more sensitive to high frequencies than to low frequencies. A-weighted decibels are most often discussed in reference to outdoor noise situations and are used exclusively in this analysis.

Table 7-1: Typical Noise Levels

Noise Source	Noise Level (dB(A))
Amplified rock band	120
Commercial jet takeoff at 61 meters (200 ft)	110
Community warning siren at 31 meters (100 ft)	100
Busy urban street	90
Construction equipment at 15 meters (50 ft)	80
Freeway traffic at 15 meters (50 ft)	70
Normal conversation at 2 meters (6 ft)	60
Typical office interior	50
Soft radio music	40
Typical residential interior	30
Typical whisper at 2 meters (6 ft)	20
Human breathing	10
Threshold of hearing	0

Outdoor noise levels are almost constantly fluctuating, particularly near a highway. The unit called the equivalent average sound level (Leq) is used to quantify the fluctuating noise level into a single number.

The Leq has the same sound energy as the time-varying noise level over a stated time period (essentially the average noise level). The time period used in highway noise analysis is one hour. All noise levels discussed in this report are A-weighted, hourly Leqs representing the loudest hour of traffic. The loudest hour of traffic is usually represented when traffic volumes on the roadway reach Level of Service C. Levels of Service C traffic volumes are defined as traffic running at stable operations, however, the ability to maneuver and change lanes in mid-block locations may be restricted. Longer queues, adverse signal coordination or both, may contribute to lower travel speeds.

CDOT's Noise Policy

The CDOT has adopted the Federal Highway Administration's (FHWA) policy and guidance for highway traffic noise analysis and abatement (see Appendix F1). This guidance sets a standard to determine when federal and/or state funds can be used for noise mitigation related to highway traffic noise. The guidance establishes standards for noise abatement on both new construction projects (Type I projects) and for noise abatement on an existing highway (Type II projects). This noise analysis uses the noise abatement guidance for a Type II project. The standards used by FHWA and CDOT are used as representative criteria so the Town of Vail has a recognized basis for considering noise impacts.

The FHWA policy on noise mitigation states that noise mitigation must be considered for any receptor (e.g. a residence) or group of receptors (e.g. a neighborhood) where predicted traffic noise levels, using traffic volumes and roadway conditions projected 20 years into the future, approach or exceed the noise abatement criteria (NAC). The NAC establish the criteria to determine noise impacts on receivers. Relevant NAC are shown in Table 7-2. The CDOT NAC assume traffic noise is considered to "approach" a criterion at a level 1 dB(A) less than the criterion (e.g. 66 dB(A) for Category B).

Table 7-2: CDOT Noise Abatement Criteria

Activity Category	L_{eq}* (dB(A))	Description of Activity Category
B	67 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	Developed lands, properties, or activities not included in the category above (this includes retail businesses).

* Hourly A-weighted equivalent level for the noisiest hour of the day in the design year

In 1996, the FHWA released an interim final rule that revised the FHWA regulation that allows federal participation for Type II projects. The interim final rule states that for Type II projects, noise abatement measures will only be approved for projects that were approved by the state Department of Transportation (DOT) before November 28, 1995, or are proposed along lands where land development or substantial construction predated the existence of any highway. The FHWA stated that the implementation of Type II projects is a strictly voluntary decision made by a DOT and there are no special or separate federal funds to provide highway traffic noise abatement.

Currently in Colorado, the use of state transportation funds for noise abatement is only considered for highway construction on a new location or the physical alteration of an existing highway, Type I projects. However, until 1999, CDOT had a Type II project program in place. Appendix F1 shows the priority listing of projects falling under the previous Type II program. The Town of Vail had four projects on the list. One of those projects was second on the list for funding, before the Type II program was cancelled.

During the previous Type II program in Colorado, Type II projects were funded by both federal dollars as well as state transportation dollars. The amount of federal and state dollars a project was eligible for was based on the roadway classification. While FHWA dollars are no longer available for Type II noise abatement projects, the FHWA currently states that some state highway associations allow a third party to pay the difference between the actual cost of a traffic noise barrier and the cost that is deemed to be reasonable. The FHWA recognizes that this is a method that may provide abatement for traffic noise problems that might otherwise go unmitigated.

Noise Analysis

A traffic noise analysis along I-70 through the Town of Vail was conducted using the FHWA's computerized noise prediction model, STAMINA 2.0 (using Colorado emission data). This program evaluates the noise energy produced by traffic in a segment of roadway based on the traffic volume, speed, and types of vehicles using the roadway. Site-specific horizontal and vertical conditions are also input to STAMINA in addition to traffic volume and speed data.

Using existing mapping of the I-70 corridor through Vail, an XYZ-coordinate system was created. The alignment of the roadway (I-70) was translated into the XYZ-coordinate system. By inputting the alignment as XYZ-coordinates to the STAMINA noise model, the model recreates the alignment of the roadway.

Noise readings were also taken along the I-70 corridor though Vail. A total of 50 readings were selected to serve as a representative receiver sample. Each reading location (representative receiver site) was translated to the XYZ-coordinate system based on the existing mapping. The representative receiver site coordinates were also input to the STAMINA model.

The STAMINA model created an electronic schematic of the I-70 corridor through Vail, including the representative receiver site locations. By inputting the traffic volume, speed, and types of vehicles using the I-70 corridor, the model predicts the noise levels at each representative receiver site based on the receiver position from the roadway.

Since the model does not take into account any obstacles between the receiver and the roadway which may prevent sound energy from reaching the receivers (e.g., buildings, vegetation, and partial barriers), the representative receiver readings served as validation measurements to determine the amount of sound energy blocked at each representative receiver location. The amount of sound energy that is blocked by obstacles is called the shielding factor. This shielding factor was used to calibrate the noise model.

The model also does not take into account sound energy that may be reflected off surrounding terrain or structures that may increase the amount of sound energy experienced at a receiver location. The validation measurements account for this reflection.

Two noise models were created. One model produces the existing year 2000 noise levels and the other model predicts the future year 2020 noise levels, based on predicted traffic growth. Both of the models use average annual daily traffic (AADT) volumes. Analysis of the model's sensitivity to differences in speed, variations of receiver locations, and increases in truck traffic were also performed.

Noise Receptors Studied

The study area defined for the noise analysis is shown in Figure 7-1. A total of 50 representative receiver sites were selected to serve as a representative sample within the project area. The receivers are identified as receiver 1 (R1) though receiver 50 (R50).

The receivers were modeled at five feet above ground elevation (representing a standing adult) and were measured at an area of outdoor activity associated with each location. Figure 7-1 shows the approximate location of the noise receivers analyzed in the study.

Based on the modeling, a noise contour map was prepared and then the total number of affected receptors was determined using the Town of Vail Geographic Information System (GIS). The noise contour map for the existing condition is shown in Appendix F2.

Traffic Characteristics

In order to determine the traffic noise impacts associated with I-70, existing and predicted noise levels were modeled for both the 2000 existing condition and the year 2020 predicted condition.

Existing 2000 traffic volumes were determined by assuming a straight-line growth pattern between 1997 AADT counts (collected by CDOT) and 2020 predicted AADT counts (for 2020 traffic predictions, see **Chapter 9: Traffic Model**). Using hourly traffic counts collected by CDOT a peak hour factor of eight percent was determined. The hourly traffic counts collected by CDOT also provided an average of four percent medium trucks and seven percent heavy trucks on the roadway. The average speed used in the model was 70 miles per hour (mph), as validated with a speed study.

The I-70 corridor through Vail is divided into four separate segments. The segment divisions are determined by different traffic characteristics. Table 7-3 illustrates the traffic volumes, type of traffic, and average speeds that each of the four segments carries. The categories of traffic volume, type of traffic, and average speed were used as input to the STAMINA model in order to predict noise levels along the I-70 corridor through Vail.

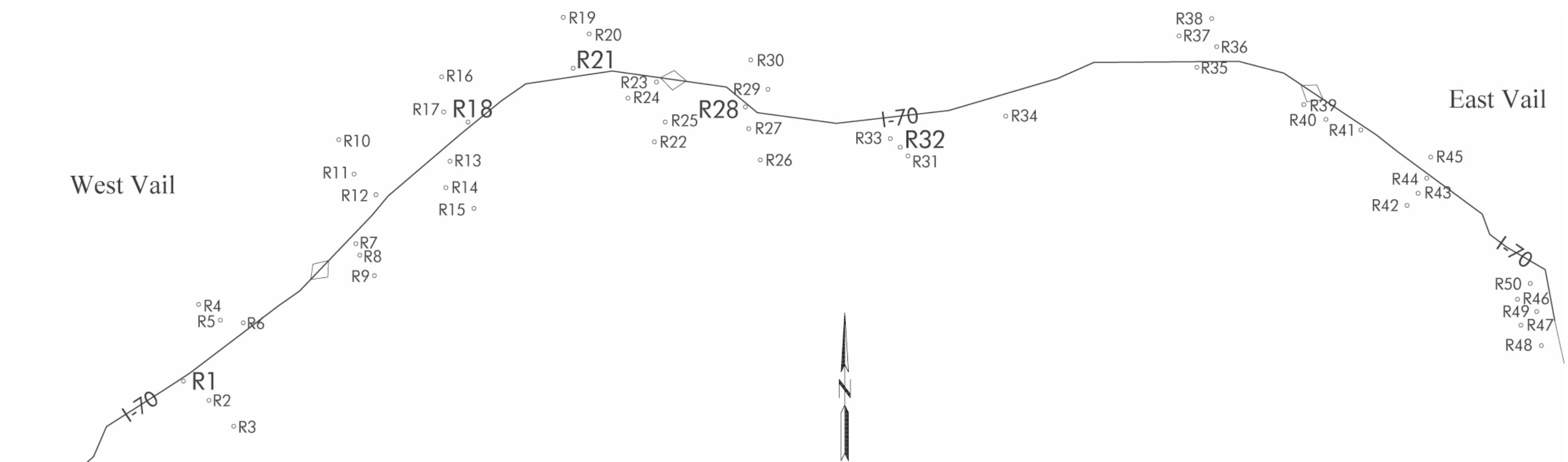
Table 7-3: I-70 Segment Characteristics

Segment Location in Vail	I-70 Segment Number (Milepost)	2000 AADT (2-Way Traffic)	2020 AADT (2-Way Traffic)	% Medium Trucks	% Heavy Trucks	% Passenger Cars	Average Speed (mph)
W. Vail	1 (171.43–173.32)	44178	68700	4.6	4.1	91.3	70
Central Vail	2 (173.32-176.03)	31048	49700	4.2	6.0	89.9	70
Central	3 (176.03-179.87)	24474	38300	4.2	7.6	88.1	70
E. Vail	4 (179.87-181.98)	20209	31600	4.0	9.0	87.0	70

Modeling Results

A total of 50 representative receiver sites were analyzed to determine the level of noise impacts associated with the different locations along the I-70 corridor. The approximate location of each receiver is illustrated schematically in Figure 7-1.

Existing noise levels were computed to be in a range from 47.2 dB(A) at a representative receiver site 1,125 feet from I-70 to 75.4 dB(A) at a representative receiver site 150 feet from I-70. Future conditions were computed to be in a range from 49.1 dB(A) at a representative receiver site 1,125 feet to 77.5 dB(A) at a representative receiver site 150 feet from I-70. Table 7-4 shows the predicted noise level reading and the difference between the existing noise level and the 2020 predicted noise level.



Receiver locations with noise levels currently in excess of 66 dB(A) are bolded

Figure 7-1: Receiver Locations

Table 7-4: Noise Model Results

Receiver	Receiver Distance from Roadway (feet)	Existing 2000 Noise Energy Levels (dB(A))	2020 Noise Energy Levels (dB(A))	Difference in dB(A) (2020-existing)
R1	150	70.0	72.0	2.0
R2	530	60.1	62.0	1.9
R3	1275	59.1	61.0	1.9
R4	1150	54.5	56.4	1.9
R5	540	57.1	59.0	1.9
R6	275	61.4	63.3	1.9
R7	320	61.0	63.0	2.0
R8	625	63.3	65.4	2.1
R9	1000	61.5	63.6	2.1
R10	2100	58.9	61.0	2.1
R11	925	60.1	62.1	2.0
R12	300	61.3	63.3	2.0
R13	310	57.8	59.8	2.0
R14	670	61.1	63.1	2.0
R15	1475	60.3	62.4	2.1
R16	1430	59.3	61.3	2.0
R17	925	65.4	67.4	2.0
R18	150	75.4	77.5	2.1
R19	1900	56.0	58.0	2.0
R20	1550	52.5	54.5	2.0
R21	300	69.2	71.2	2.0
R22	1930	58.1	60.2	2.1
R23	170	61.9	63.9	2.0
R24	750	58.3	60.3	2.0
R25	1200	54.5	56.6	2.1
R26	1450	52.4	54.4	2.0
R27	650	62.9	64.9	2.0
R28	120	68.8	70.7	1.9
R29	680	55.4	57.3	1.9
R30	1080	54.7	56.6	1.9

Receiver	Receiver Distance from Roadway (feet)	Existing 2000 Noise Energy Levels (dB(A))	2020 Noise Energy Levels (dB(A))	Difference in dB(A) (2020-existing)
R31	1470	53.5	55.4	1.9
R32	1000	66.3	68.2	1.9
R33	750	53.2	55.2	2.0
R34	860	55.9	57.8	1.9
R35	250	57.6	59.5	1.9
R36	550	61.0	62.9	1.9
R37	900	61.5	63.5	2.0
R38	1100	59.7	61.6	1.9
R39	730	53.7	55.6	1.9
R40	770	56.3	58.3	2.0
R41	175	55.2	57.1	1.9
R42	1125	47.2	49.1	1.9
R43	580	56.1	58.0	1.9
R44	180	54.8	56.8	2.0
R45	540	54.6	56.6	2.0
R46	1050	58.3	60.3	2.0
R47	1650	51.0	52.7	1.7
R48	628	55.3	57.3	2.0
R49	600	52.7	54.7	2.0
R50	450	61.3	63.2	1.9

*Shaded rows represent receivers that exceed the 66-dB(A) approach threshold in the year 2020.

Five of the representative receiver sites are found to have noise levels in excess of the noise impact criteria. These receivers, R1, R18, R21, R28, and R32 are currently above the 66-dB(A) noise level, noise abatement criteria for activity category B. Figure 7-1 shows these affected receivers in bold-faced type.

For the year 2020, six of the representative receiver sites were predicted to have noise levels in excess of the noise impact criteria. These receivers, R1, R17, R18, R21, R28, and R32 are predicted to have noise levels above 66 dB(A) in the year 2020, based on projected traffic increases.

The largest noise levels will occur for receivers located closest to I-70 or with the best line of sight of I-70. However, an increase in the distance from I-70 does not always reflect a decrease in noise level. Each receiver may have a different shielding effect based on obstacles between the receiver and the roadway, which may prevent sound energy from reaching a receiver site (e.g., buildings, vegetation, and partial barriers). Table 7-5 defines a range of noise levels for the distance from I-70 through the Vail area for both the existing and the predicted 2020 conditions. In all cases the difference between the existing noise levels and the predicted 2020 noise levels should not be detectable to the human ear (i.e., less than 3 dB(A), studies have shown a 3-dB(A) increase is barely detectable by the human ear).

Table 7-5: Noise Level Ranges Based on Distance from I-70

Distance From I-70 (ft)	Existing Noise Level Range (dB(A))	2020 Noise Level Range (dB(A))
200	53-76	57-78
400	57-70	59-72
600	53-62	55-64
800	53-64	55-66
1000	56-67	58-69
1200	47-60	49-62
1400	59*	61*
1600	52-60	54-62
1800	51*	53*
2000	56-60	58-61

*only one representative receiver located within this distance from I-70

Appendix F2 shows noise contour maps developed to estimate noise levels at any location in the Vail area. Contour maps of the existing 2000 condition as well as the predicted 2020 condition have been produced. These should be used as a guide only, due to the variability of noise levels in the Vail area caused by shielding and reflection. The maps help to identify the actual number of receiver sites in the Vail area that are affected by noise levels. Actual noise measurements should be taken in order to determine the exact noise levels at any specific location. Receiver sites may vary from single-unit structures to structures housing multiple units. The actual number of affected receivers is based on the number of units per structure.

Sensitivity Analysis

A sensitivity analysis was performed based on differences in speed, variations of receiver locations, increases in truck traffic, and increases in overall traffic volume. For the categories of speed, receiver locations, and truck traffic, two sensitivity runs were performed. Overall traffic volume sensitivity is displayed as a table.

While noise levels are predicted to increase based on the sensitivity analyses, the average increases represent levels that are not normally perceptible to the human ear. Studies have shown a 3-dB(A) increase in noise level is barely detectable by the human ear.

Speed

The existing year 2000 noise model was altered to model the existing traffic volumes at 60 mph and 55 mph. The analysis showed that on average, an increase of 0.7 dB(A) occurs with every five mph increase in speed. Noise level increases would be barely detectable over a 20 mph range (<3 dB(A)).

Receiver Locations

The existing year 2000 noise model was altered to model differing heights at the representative receiver sites. This shows how noise energy changes by level within multi-level structures. All receivers were modeled at ten feet higher than initial elevation and 20 feet higher than the initial elevation. The analysis showed that on average, an increase of 0.04 dB(A) occurred for the first ten-foot increase in elevation and an increase of 0.002 dB(A) occurred for the second ten-foot increase in elevation.

This analysis assumed that each level of a multi-level structure has the same shielding factor. In other words, each level of a multi-level structure has the same amount of sound energy blocked by obstacles (e.g., buildings, vegetation, and partial barriers). This assumption may not hold true in all cases. As the height increases for the receiver, the shielding effects realized at a lower level may have no effect on a receiver at a higher level. In areas of heavier vegetation, noise levels are often lower at ground level due to these shielding effects.

Truck Traffic Increases

The predicted year 2020 noise model was altered to model different percentages of truck traffic increase. The model analyzed an overall increase of two percent and an overall increase of four percent of trucks in the traffic mix. The analysis showed that on average, an increase of 0.3 dB(A) occurred for a two percent increase in truck traffic and an increase of 0.6 dB(A) occurred for a four percent increase in truck traffic. Noise level increases would be barely detectable up to 3 dB(A).

Traffic Volume Increases

The predicted year 2020 noise model uses an AADT volume of between 31,600 vehicles and 68,700 vehicles, depending on the segment of I-70. This AADT is an estimated increase from existing AADT. A sensitivity analysis of the relative noise level increase based on increased traffic volumes was performed. Table 7-6 demonstrates the relative noise level increase based on traffic volumes.

Table 7-6: Relative Noise Level Increases Based on Traffic Volumes

Traffic Volumes (Average Daily Traffic)	Relative Noise Level (dB(A))	Noise Level Increase (per 5000 Vehicles per day)
40000	46.0	N/A
45000	46.5	0.5
50000	46.9	0.4
55000	47.4	0.4
60000	47.7	0.3
65000	48.1	0.3
70000	48.5	0.3
75000	48.8	0.3
80000	49.0	0.2

Future traffic volumes will also have an additive effect on the existing noise contour lines. The 2020 traffic predictions show the average traffic on I-70 is to increase by 57 percent of the existing traffic on I-70. This increased traffic produces an average increase of 2 dB(A) to the existing contour lines for the 2020 condition. Again, noise level increases would be barely detectable up to 3 dB(A).

Short Duration Point Source Noise

The noise produced from engine “jake” brakes and rumble strips were measured and analyzed to determine the effect of short duration point source noise on the overall noise levels produced by the general I-70 traffic. The average increase in noise based on short duration point source noise generated from “jake” brakes and rumble strips is shown in the tables below. The tables reflect the average dB(A) increase to be added to each of the existing contour lines to reflect the presence of short duration point sources. In general, “jake” brakes add 6 dB(A) at the source and rumble strips add 9 dB(A) at the source. This incremental increase in noise becomes smaller as the distance from I-70 increases. Table 7-7 shows the effect of jake brake noise and Table 7-8 shows the effect of rumble strip noise.

Table 7-7: Decibel Increases Based on "Jake" Brake Noise

Existing Noise Contour (dB(A))	Relative Decibel Increase (dB(A))
70	2.0
66	1.0
60	0.5

Table 7-8: Decibel Increases Based on Rumble Strip Noise

Existing Noise Contour (dB(A))	Relative Decibel Increase (dB(A))
70	4.0
66	3.0
60	1.0

Noise Abatement

Identifying Noise Mitigation

Currently, representative receiver locations R1, R18, R21, R28, and R32 (representing approximately 540 receivers) were recognized as having noise levels above 66 dB(A). This is the level at which noise abatement is considered. In the year 2020, representative receiver locations R1, R17, R18, R21, R28, and R32 (representing approximately 600 receivers) were recognized as having noise levels above 66 dB(A).

While these numbers reflect the number of receivers accounted for by the representative receiver locations, the numbers do not reflect the total number of affected receivers (those receivers that experience noise levels exceeding the 66-dB(A) approach criteria) located in the Town of Vail. In order to determine the total number of affected receivers, refer to the noise contour maps presented in Appendix F1.

Mitigation Strategies

There are many possible ways to reduce the noise levels produced by the traffic on I-70. Below is a list of possible mitigation strategies.

Long Term Strategies (require construction)

Barriers
- Berms
- Concrete walls (with and without form liners)
- Wood walls
- Glass walls
- Metal walls
- Absorptive walls
- Masonry walls
- Jersey Barriers

Bury or cap I-70
White noise
Noise Cancellation
Pavement type
Insulation

Short Term Strategies (no construction)

Enforcement
Lower speed limits
No passing for trucks

Reduce volumes
Noise Ordinances
Noise Ordinances by time of day
Engine Brake ordinances
Variable message speed sign (VMS)
Static truck warning sign

In order to better understand the strategies listed above, pictures and descriptions are listed below.

Long Term Strategies (requires construction)

Barriers
Noise abatement barriers are the most common type of highway noise mitigation. The CDOT currently considers barriers only for new construction, widening, or major realignment of highways. CDOT considers noise abatement of less than 5 dB(A) unreasonable due to the negligible human perception. Barrier effectiveness is usually limited to 10 to 12 dB(A), although some special techniques can improve barrier performance by 3 to 5 dB(A).

In the Vail area, barriers are expected to be more effective on the south side of I-70 as most land use is lower than the roadway and the line of sight is easier to block. Noise barriers on the north side may not be effective for land uses located significantly above the roadway. Barrier cost varies depending upon type, style, and height. Berms may be constructed for as little as $0.5 million per mile, while structural barriers may average around $2.0 million per mile for the Vail area.

There are several different types of barriers as presented below:

- **Berms**. Noise attenuation berms have the advantage of being less expensive to construct and have the potential for landscaping. A disadvantage is that they require more space to construct. A typical noise berm in Vail is estimated to be approximately 60 feet wide.

Berm in Vail

Concrete Wall

- **Concrete walls.** Concrete noise abatement walls are becoming more common because of their longer life and ease of maintenance. Concrete walls can be simple walls or can be constructed with form liners that allow various designs (shown below).

Form liners can be used on concrete walls to create various types of designs.

Form Liners

- **Wood walls.** Previously a common type of construction in Colorado and other states, this type of noise abatement wall has fallen out of favor due to the shorter life span and higher maintenance cost.

Plywood Noise Wall

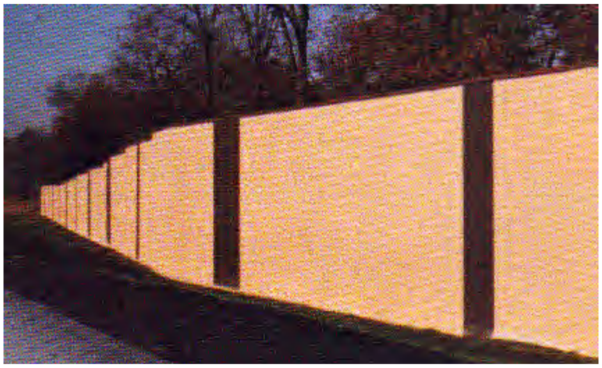
Glass Noise Wall, France

Glass Noise Wall, France

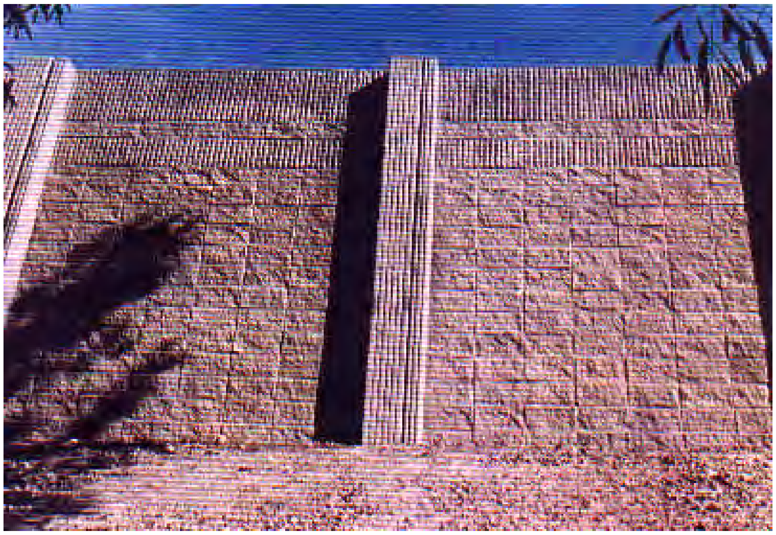
- **Glass walls.** Most of the research for glass walls has been done in Canada and Europe. Glass walls are currently not approved for use by CDOT due to concerns of highway glare, scratching, and cleaning maintenance.

- **Metal walls.** Several manufacturers produce metal walls. These are typically metal panels that are supported by posts.

- **Absorptive walls.** Absorptive noise abatement walls provide voids within the wall to "trap" noise. Absorptive walls have higher capital and maintenance costs, but can provide additional noise attenuation particularly when parallel barriers are constructed.



Absorptive Noise Wall (post and panel)



Masonry Form Liner Wall

Masonry Form Liner Wall
I-25, Colorado Springs, (neighborhood side)

- **Masonry walls.** CDOT's current focus appears to be masonry walls. These can be built on site or pre-manufactured and installed as panels. Recent variations create a masonry feel with a concrete form liner.

- **Jersey Barriers.** Also known as a Type 4 guardrail, these 32-inch high concrete guardrails are common along state highways. In recent noise measurements conducted along State Highway 82, these barriers were found to reduce noise levels by approximately 2.5 dB(A) for receivers located at the same elevation as the roadway. These barriers would appear to provide similar noise abatement for many receivers located on the south side of I-70 within Vail and some receivers located on the north side of I-70 within Vail.

Bury or cap I-70

Totally enclosing I-70 would prevent any highway noise from leaving the highway. However, both ends of the enclosure (tunnel entrances if a cut-and-cover tunnel was constructed) will produce higher levels of noise. These higher levels of noise would need to be mitigated.

White noise

This type of noise abatement is not used for highway noise. It is typically an indoor background noise generated to mask other noise.

Noise Cancellation

This is accomplished by creating an opposite and equal sound pressure wave to a known noise generator. It can be effective on very specific pieces of machinery or also equipment that is enclosed. This cannot be used for pavement noise and could only be used for engine and stack noise if each individual vehicle has a noise cancellation device installed. These devices are very specific and are not currently available for vehicles.

Pavement type

Open graded asphalt is generally considered to reduce tire noise by 2 to 4 dB (A) over dense graded asphalt. Noise reduction is due to the voids in the pavements caused by open (or uniform) grading. However, since there is no hard data or research on the subject, the FHWA's official position is that they will not allow any adjustments in noise analysis or noise abatement (or allow states to do so) until additional research is done. It is thought that the noise abatement benefits are lost as the voids get filled up with dust, sand, and other material.

Other benefits of open-graded asphalt are that it provides better drainage and therefore better traction in wet conditions. Europeans have been known to wash and vacuum their open-graded asphalt for these reasons.

Asphalt is generally considered quieter than concrete pavement although studies by the State of Washington indicate that after seven years, concrete pavement becomes quieter due to wear.

Insulation
A form of noise mitigation that is very uncommon for highway traffic noise and is somewhat common for airport noise abatement is insulation. This technique only works for enclosed buildings and its effectiveness depends greatly on the insulating materials used. This is generally considered the most expensive form of mitigation. Since Vail is in a cold climate, most buildings are typically already well insulated.

Short Term Strategies (no construction)

Enforcement
Recent speed data by the Vail Police Department indicated that average speeds on I-70 are approximately 70 mph. It is unknown if the presence of the radar trailer caused drivers to slow down. If better enforcement of speeds along I-70 resulted in a five mph reduction of average speeds, the expected noise reduction would be 0.7 dB(A). This noise level decrease is not normally perceptible to the human ear. Studies have shown a 3-dB(A) difference in noise level is barely detectable by the human ear.

Lower Speed Limits
Traffic speeds directly affect highway noise. This is primarily due to tire noise and is affected more by cars. In general, a ten mph reduction in average highway speed will reduce noise by 1.5 dB(A). If the average speed for trucks only was reduced by ten mph, the average noise would drop by about 0.7 dB(A). This noise level decrease is not normally perceptible to the human ear. Studies have shown a 3-dB(A) difference in noise level is barely detectable by the human ear.

No passing for trucks
This mitigation was suggested by a focus group of Vail property owners and residents. If restrictions on passing reduced overall speeds for trucks, noise could be reduced. This is not expected to result in any significant noise reduction.

Reduce volumes
This mitigation option was also raised by the focus group. The discussion considered that restrictions be placed on trucks such that a greater majority would take alternative east – west routes such as I-80 through Wyoming. A ten percent reduction in truck traffic is estimated to reduce noise by approximately 1.5 dB(A). This noise level decrease is not normally perceptible to the human ear. Studies have shown a 3-dB(A) difference in noise level is barely detectable by the human ear.

Noise Ordinances

Although the Town of Vail already has noise ordinances in place, additional ordinances or better enforcement could provide additional noise abatement. The current noise ordinance is 90 dB(A) at 25 feet for gross vehicle weight over 10,000 pounds. A truck conforming to the State Muffler Law traveling at 65 mph produces 86 dB(A) which conforms to the current noise ordinance. For I-70 truck traffic, noise ordinances could include reduced speeds, restrictions on engine "jake" brakes, and time restrictions. These would have to be coordinated and potentially approved by CDOT and FHWA.

Noise Ordinances by time of day

In general, most people are affected more by noise during nighttime hours than daytime hours. Federal agencies that recognize this typically penalize nighttime noise by 10 dB(A) when analyzing noise impacts. This could be recognized by incorporating restrictions on nighttime traffic.

Engine Brake Ordinances

Commonly called "jake" brakes, these compression brakes on trucks generate higher levels of noise. In general, "jake" brakes add 6 dB(A) at their source. However, since this is a point source, it dissipates more rapidly than a continuous line of traffic. At most receivers close to I-70 (at the 70 dB(A) contour), a jake brake adds about 2 dB(A) of noise. This noise generated from a jake brake has a distinctly different sound than typical traffic noise and is therefore more noticeable. At receivers farther away, the relative increase is less, 1.0 dB(A), at the 66-dB(A) contour, and 0.5 dB(A) at the 60-dB(A) contour. If engine brakes were prohibited in Vail, these point source noises could be eliminated.

Variable Message Speed Sign (VMS)

The VMS would provide a speed measurement for passing traffic, similar to the VMS in Glenwood Canyon.

Static Truck Warning Sign

A static truck warning sign would provide a warning for truckers that grades continue ahead and to maintain low speeds to prevent the necessity for using engine brakes, similar to truck warning signs at Mt. Vernon Canyon.

Modeling Mitigation

A third noise model was developed based on the results of the existing and future conditions modeled. The third model incorporates future conditions (worst case) with noise mitigation measures in place. Noise walls were modeled as abatement in various locations along the I-70 corridor through Vail. The walls were modeled per CDOT maintenance standards. The walls were positioned 20 feet from the outside lane line along I-70. This distance from the lane line provides a full twelve-foot shoulder, as well as eight feet for snow storage. The distance also prevents the wall casting shadows in the travel lanes of I-70. Typical sections for noise walls on the north and south side of I-70 are shown in Appendix F1.

The optimized height used to model the noise walls was determined by using the predicted attenuation provided by barrier nomographs. Based on variations in the height of the wall and the location of receivers through the I-70 corridor, attenuation was maximized. An Excel spreadsheet and figures representing the varying heights of noise walls and the amount of attenuation produced based on the barrier nomographs are included in Appendix F1. Table 7-9 describes the noise walls modeled.

Table 7-9: Noise Wall Descriptions

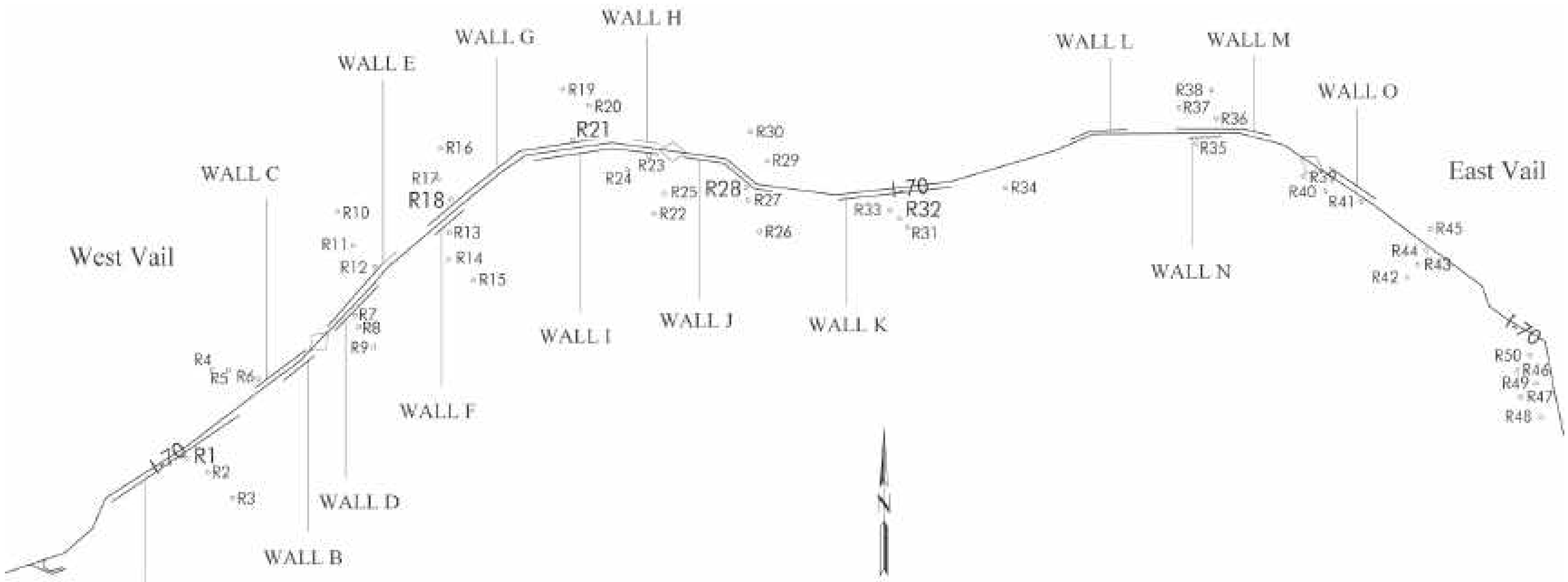
Wall	Representative Receiver Sites Protected	Approximate Length (feet)	Barrier Height (feet)
A	R1, R2, R3	4700	12
B	N/A*	1200	12
C	R4, R5, R6	2500	16
D	R7, R8, R9	3650	12
E	R10, R11, R12	3650	16
F	R13, R14, R15	2450	12
G	R16, R17, R18, R19, R20, R21	6700	16
H	N/A*	900	16
I	R23, R24	4050	12
J	R22, R25, R26, R27, R28	2750	12
K	R31,R32,R33	7000	12
L	N/A*	950	16
N	R35	2300	12
M	R36, R37, R38	550	16
O	N/A*	1400	16

*Receiver sites were not modeled at these locations. Noise walls were modeled here based on the actual land use at these locations. See Appendix F1 for more detail.

The top elevation of the walls located on the north side of I-70 was modeled at sixteen feet above the edge of pavement. The top elevation of the walls located on the south side of I-70 was modeled at twelve feet above the edge of pavement. In some instances the walls located on the south side of I-70 may actually be taller than twelve feet if the noise wall must be built on a retaining wall. The bottom elevation of the wall may be below the elevation of the edge of pavement. The difference in the height of the barriers is due to the difference in the topography of the I-70 corridor and the maximization of attenuation. The north side of I-

70 is a steep upward slope, while the south side of I-70 is a valley. Barriers were not modeled on any bridge structure. This caused for some gaps in the walls, which reduces the effectiveness of the barrier attenuation. Figure 7-2 shows the approximate locations of the noise walls modeled. While a particular wall may not show protection of a representative receiver site, actual receivers exist behind the wall. Walls have been modeled in locations that protect impacted receivers based on the predicted contour lines for the 2020 condition. Noise contour maps reflecting the affect of the modeled noise walls is included in Appendix F2.

The year 2020 noise levels, at the modeled representative receiver sites with and without mitigation, are presented in Table 7-10. The noise levels shown in Table 7-10 do not reflect the affect of having parallel barriers in place. The STAMINA model does not produce results reflecting this condition. By having parallel barriers, especially when the heights of the parallel walls vary, the potential of noise reflecting off of the walls and back to the receivers is very likely. This parallel barrier effect could potentially increase the noise levels of certain receivers above levels currently experienced. If a more detailed analysis of the proposed noise abatement shows potential for reflection, absorptive materials should be used on the top of the wall face to reduce the parallel barrier effect.



Receiver locations with noise levels currently in excess of 66 dB(A) are bolded

Figure 7-2: Approximate Noise Wall Locations

Table 7-10: Noise Model Results with Mitigation Measures in Place

Receiver	Receiver Distance from Roadway (FT)	2020 Noise Energy Levels (dB(A))	2020 Noise Energy Levels (dB(A))	Attenuation from noise barriers modeled (dB(A))
R1	150	72.0	59.1	12.9
R2	530	62.0	51.9	10.1
R3	1275	61.0	55.4	5.6
R4	1150	56.4	52.4	4.0
R5	540	59.0	52.6	6.4
R6	275	63.3	53.0	10.3
R7	320	63.0	50.5	12.5
R8	625	65.4	56.8	8.6
R9	1000	63.6	59.4	4.2
R10	2100	61.0	55.4	5.6
R11	925	62.1	55.5	6.6
R12	300	63.3	51.9	11.4
R13	310	59.8	48.1	11.7
R14	670	63.1	55.4	7.7
R15	1475	62.4	56.2	6.2
R16	1430	61.3	57.4	3.9
R17	925	67.4	64.2	3.2
R18	150	77.5	61.0	16.5
R19	1900	58.0	50.4	7.6
R20	1550	54.5	50.8	3.7
R21	300	71.2	49.8	21.4
R22	1930	60.2	56.2	4.0
R23	170	63.9	62.0	1.9
R24	750	60.3	55.6	4.7
R25	1200	56.6	51.9	4.7
R26	1450	54.4	48.5	5.9
R27	650	64.9	56.9	8.0
R28	120	70.7	55.3	15.4
R29	680	57.3	56.0	1.3
R30	1080	56.6	55.2	1.4

Receiver	Receiver Distance from Roadway (FT)	2020 Noise Energy Levels (dB(A))	2020 Noise Energy Levels (dB(A))	Attenuation from noise barriers modeled (dB(A))
R31	1470	55.4	49.6	5.8
R32	1000	68.2	61.3	6.9
R33	750	55.2	47.6	7.6
R34	860	57.8	56.7	1.1
R35	250	59.5	58.0	1.5
R36	550	62.9	55.4	7.5
R37	900	63.5	58.5	5.0
R38	1100	61.6	56.5	5.1
R39	730	55.6	54.2	1.4
R40	770	58.3	56.8	1.5
R41	175	57.1	55.7	1.4
R42	1125	49.1	47.6	1.5
R43	580	58.0	56.5	1.5
R44	180	56.8	55.3	1.5
R45	540	56.6	55.1	1.5
R46	1050	60.3	58.8	1.5
R47	1650	52.7	51.3	1.4
R48	628	57.3	55.8	1.5
R49	600	54.7	53.2	1.5
R50	450	63.2	61.7	1.5

Cost of Mitigation

Each of the walls modeled affect different numbers of receivers. The CDOT Noise Abatement Guidelines provide a cost allowance reflecting the effectiveness of the barrier. The NAC lists a cost ceiling of $3000/decibel reduction/receiver as being a reasonable cost. The CDOT NAC realizes attenuation only for those receivers experiencing at least a 3-dB(A) reduction in noise levels. The receivers included in the cost/benefit ratio are usually limited to the first row of buildings. In built-up residential or commercial areas, the first row of buildings along a highway may provide some reduction of highway noise to areas beyond that row of buildings. In turn, additional rows of buildings may provide additional noise reduction to areas still farther beyond. The row of buildings closest to the roadway present a worst case scenario for noise levels in the area because shielding effects due to buildings are not provided for the first row of homes. However, in the area through Vail, the topography of the area allows for direct lines of sight of I-70 to not only the first row of buildings, but also to buildings further away that may be located at a higher elevation.

The walls modeled as mitigation can be constructed in various ways. Table 7-11 through Table 7-13 present the cost associated with different wall materials as well as the cost for the wall foundation based on the height of the wall.

Table 7-11: Masonry (Concrete Block) Noise Wall Cost

Noise Wall Height (FT)	Cost of Wall ($/SF)	Cost of Foundation ($/LF)	Total Cost ($/LF)
12	24-35	190	478
16	24-35	190	574

Table 7-12: Concrete Pre-Cast Panel Noise Wall Cost

Noise Wall Height (FT)	Cost of Wall ($/SF)	Cost of Foundation ($/LF)	Total Cost ($/LF)
12	20-50	190	430-690
16	20-50	190	510-990

Table 7-13: Concrete Cast in Place Noise Wall Cost

Noise Wall Height (FT)	Cost of Wall ($/SF)	Cost of Foundation ($/LF)	Total Cost ($/LF)
12	30-40	190	550-670
16	30-40	190	670-830

Additional costs may include removing/replacing traffic signs, drainage design work, absorptive noise wall paneling, retaining walls, and the potential cost for de-icing.

The cost of each of the walls modeled has been determined. The cost of the walls assumes $30 per square foot for the wall plus $190 per linear foot for the foundation. Based on the number of receivers that realize at least a 3-dB(A) decibel reduction behind each of the walls, the cost per decibel reduction was approximated. An average decibel reduction of 7 dB(A) for first row receivers (within 300 feet of I-70) was used to determine the cost per decibel reduction. The 7-dB(A) reduction is based on the average dB(A) reduction experienced by representative receiver sites modeled within 300 feet of I-70, with mitigation measures in place. The density information to determine the number of receivers realizing attenuation was provided by the Town of Vail Geographical Information System (GIS). The cost details for each wall modeled are listed in Table 7-14 below.

Table 7-14: Noise Model Results with Mitigation Measures in Place

Wall	Representative Receiver Sites Protected	Approxi-mate Length (feet)	Barrier Height (feet)	Unit Cost ($/LF)	Segment Cost ($/LF)	Cost per Decibel Reduction ($/dB(A))
A	R1, R2, R3	4700	12	550	2,585,000	3929
B	N/A	900	12	550	660,000	7857
C	R4, R5, R6	1800	16	670	1,675,000	12,594
D	R7, R8, R9	2700	12	550	2,007,500	2987
E	R10, R11, R12	3700	16	670	2,445,500	12,047
F	R13, R14, R15	1800	12	550	1,347,500	5833
G	R16, R17, R18, R19, R20, R21	6700	16	670	4,489,000	2096
H	N/A	900	16	670	603,000	86,143
I	R23, R24	4100	12	550	1,417,500	862
J	R22, R25, R26, R27, R28	2800	12	550	962,500	893
K	R31,R32,R33	7000	12	550	3,850,000	13,095
L	N/A	1000	16	670	636,500	5683
M	R36, R37, R38	2300	16	670	1,541,000	22,014
N	R35	600	12	550	82,500	2357
O	N/A	1400	16	670	210,000	1034

*Shaded rows represent walls that are reasonable under the cost/benefit ratio determined in the NAC.

Based on the cost benefit of the walls, six walls are economically reasonable according to the NAC. The NAC realizes a reasonable cost of $3,000/decibel reduction/receiver.

A more detailed model of the proposed walls, analyzing the cost/benefit ratio for each wall including all receivers in the Town of Vail that receive a minimum 3-dB(A) reduction in noise level due to noise abatement measures, may result in more of the proposed walls being economically reasonable under the NAC. Also, where space allows, walls may be built as berms to reduce costs.

Feasibility and Reasonableness of Mitigation

As part of the noise analysis and abatement guidelines set by the FHWA as well as the CDOT, the feasibility and reasonableness of mitigation must be determined. FHWA has established vague standards to perform this determination. The CDOT has used these standards and created a more concise procedure to determine the feasibility and reasonableness of proposed mitigation measures. The following questions have been answered in order to perform the feasibility and reasonableness analysis as described in the instructions for completion of the noise abatement worksheet in the CDOT Noise Analysis and Abatement Guidelines (see Appendix F1).

Feasibility

- **Can a continuous noise barrier or berm be constructed?**
  Noise barriers or berms are most effective when they are continuous and do not have any breaks for driveways, sidewalks, streets, roads, utilities, drainage facilities, irrigation ditches, etc. In the Town of Vail, continuous noise barriers can be built to achieve desired noise reduction.

- **Can a 5-dB(A) noise reduction be achieved by constructing a noise barrier or berm?**
  The noise model shows that the majority of first row receivers will realize a noise reduction of at least 5 dB(A) with the proposed mitigation measures in place.

- **Can a 5-dB(A) noise reduction be achieved by insulation of the receiver? (Normally limited to public and non-profit buildings.)**
  This question is not considered since a 5-dB(A) reduction of noise can be achieved by constructing a continuous barrier.

- **Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm?**
  Under the current proposed mitigation, no fatal flaws are apparent. However, a more detailed analysis of each of the proposed walls, should analyze details such as excessive restriction of sight distance, continuous shadows causing icing of driving lanes during the winter months, excessive glare or reflection of headlights or sunlight off the noise barrier, directing large volumes of water across the driving lanes or other severe drainage situations, to ensure no fatal flaws exist.

Reasonableness

Cost per impacted receiver per decibel. In consideration of each potential barrier or berm segment, the cost should be less than $3,000 per receiver per decibel reduction for a reasonable project, and less than $3,500 per receiver for a marginally reasonable project.

This noise analysis only took into account the front row receivers to determine the cost per decibel reduction per receiver. A more detailed analysis may prove a minimum 3-dB(A) noise reduction for more receivers and therefore warrant more noise abatement reasonable based on cost. Of the fifteen proposed noise walls, six are considered reasonable or marginally reasonable based on cost.

Impacted persons' desires. At least 60 percent of impacted people, both property owners and renters, should want the proposed noise mitigation measure for the project to be considered reasonable. An in-depth public involvement program would be necessary to determine the majority of public opinion. This public involvement would be performed during a more detailed study.

Development type. The mixture of development types plays a major part in determining the reasonableness of noise mitigation. For a project to be considered reasonable, at least 45 percent of the development should consist of Category B receivers (see Table 7-2). The Town of Vail has approximately 93 percent of the development consisting of Category B receivers. Under the CDOT Noise Abatement Criteria that makes noise mitigation within the Town of Vail very reasonable.

Development vs. Highway timing. This item compares the date of the residential or commercial development of the impacted receivers to the date of construction of the roadway improvement that contributes transportation generated noise levels. For a project to be considered reasonable, at least 50 percent of the impacted receivers should have development dates that predate the initial highway construction or last through lane addition project. The Town of Vail has approximately twelve percent of the development predating the initial interstate construction of 1969, and 53 percent predating the last phase of interstate construction in 1976 from Booth Creek east over Vail Pass. Under the CDOT Noise Abatement Criteria that makes noise mitigation within the Town of Vail reasonable.

Development existence. This item addresses the length of time impacted receivers have been exposed to transportation related noise impacts. For a project to be considered reasonable, at least 50 percent of the impacted commercial and residential receivers in a development should have been in existence for more than fifteen years. Approximately 89 percent of the residential receivers have been in existence for more than fifteen years in the Town of Vail. Under the CDOT Noise Abatement Criteria that makes noise mitigation within the Town of Vail very reasonable.

Land use controls. This item addresses the degree of land use planning which occurs in an area that attempts to minimize transportation related noise impacts on new development. For a project to be considered reasonable, local officials must either routinely coordinate new subdivision proposals with CDOT or have local land use restrictions in place that control incompatible land use adjacent to highway corridors. The Town of Vail has the following issues:

- Very stringent zoning controls.
- Very stringent design review guidelines.
- A town-wide noise ordinance. This includes the use of engine “jake” brakes.
- The use of berms for most residential areas abutting the interstate. Commercial zoning (as a buffer) on most portions of West Vail adjacent to I-70.
- Most of the land away from I-70 is constrained by geologic hazards (snow avalanche, rock fall, debris flow, 100-year floodplain). Approximately 40 percent of Vail's land area lies within a rock fall hazard zone, while no portion of the I-70 corridor through Vail lies within a rock fall zone. Therefore, there is minimal choice but to locate development adjacent to the interstate.
- The Town of Vail is constrained by the national forest.
- With very tight topographical and political boundaries, Vail averages ½ mile wide with I-70 splitting this difference. This leaves minimal space for development.
- Many parts of the residential development that lies adjacent to I-70 (Matterhorn and West Vail) that has no buffer, was developed in Eagle County and then annexed from Eagle County. Therefore, the Town of Vail did not have the benefit of reviewing development of these areas.

Under the CDOT Noise Abatement Criteria these issues make noise mitigation measures within the Town of Vail reasonable.

Summary

The following are the results of the traffic noise impacts analysis conducted for the I-70 corridor through the Town of Vail:

- FHWA/CDOT criteria were used as a guide for considering noise impacts.

- Currently, five representative receiver sites, representing a total of approximately 540 receivers, are found to have noise levels in excess of the noise impact criteria. These representative receivers, R1, R18, R21, R28, and R32 are currently above the 66-dB(A) noise level. While these numbers reflect the number of receivers accounted for by the representative receiver locations, the numbers do not reflect the total number of affected receivers (those receivers that experience noise levels exceeding the 66-dB(A) approach criteria) located in the Town of Vail. In order to determine the total number of affected receivers refer to the noise contour maps presented in Appendix F2.

- For the year 2020, six representative receiver sites, representing a total of 600 receivers, were predicted to have noise levels in excess of the noise impact criteria. These receivers, R1, R17, R18, R21, R28, and R32 are predicted to have noise levels above 66 dB(A) in the year 2020 based on projected traffic increases. While these numbers reflect the number of receivers accounted for by the representative receiver locations, the numbers do not reflect the total number of affected receivers (those receivers that experience noise levels exceeding the 66-dB(A) approach criteria) located in the Town of Vail. In order to determine the total number of affected receivers refer to the noise contour maps presented in Appendix F2.

- The largest noise levels will occur for receivers located closest to I-70 or with the best line of sight of I-70. However, an increase in the distance from I-70 does not always reflect a decrease in noise level. Each receiver may have a different shielding effect based on obstacles (e.g., buildings, vegetation, and partial barriers) between the receiver and the roadway, which may prevent sound energy from reaching the receivers.

- An average increase of 0.7 dB(A) in noise level occurs with every five mph increase in speed along I-70.

- An average increase of 0.04 dB(A) in noise level occurred for a ten-foot increase in elevation for each receiver and an increase of 0.002 dB(A) in noise level occurred for a 20-foot increase in elevation for each receiver.

- An average increase of 0.3 dB(A) in noise level occurred for an overall increase of two percent trucks in the traffic mix along I-70 and an increase of 0.6 dB(A) in noise level occurred for an overall increase of four percent trucks in the traffic mix along I-70.

- Table 7-15 below represents the average dB(A) increase based on increasing traffic volumes.

Table 7-15: Relative Noise Level Increases Based on Traffic Volumes

Traffic Volumes (Average Daily Traffic)	Relative Noise Level (dB(A))	Noise Level Increase (per 5000 Vehicles per day)
40000	46.0	N/A
45000	46.5	0.5
50000	46.9	0.4
55000	47.4	0.4
60000	47.7	0.3
65000	48.1	0.3
70000	48.5	0.3
75000	48.8	0.3
80000	49.0	0.2

- Noise produced by short duration point sources including jake brakes and rumble strips add to the overall existing noise levels. An average additive increase to the noise levels represented by the contour lines can be expected. The additive increase to the existing 60-dB(A), 66-dB(A), and 70-dB(A) contour lines due to jake brakes is 0.5 dB(A), 1.0 dB(A), and 2.0 dB(A), respectively. The additive increase to 60-dB(A), 66-dB(A), and 70-dB(A) contour lines due to rumble strips is 1.0 dB(A), 3.0 dB(A), and 4.0 dB(A), respectively.

- Noise contour maps were developed (based on noise readings taken at various representative receiver sites) to estimate noise levels at any location in the Vail area. These should be used as a guide only, due to the variability of noise levels in the Vail area caused by shielding and reflection. Receiver sites may vary from single-unit structures to structures housing multiple units. The actual number of affected receivers is based on the number of units per structure. Actual noise measurements should be taken in order to determine the exact noise levels at any specific location.

- Since this noise analysis does not include highway construction on a new location or the physical alteration of an existing highway, federal funds are not eligible for noise mitigation, under the Type I project considerations. Federal funds are eligible for this project under Type II project considerations, but the noise mitigation would have to compete against other highway projects on the Statewide Transportation Improvement Plan (STIP).

- The location and size of the proposed noise wall are analyzed strictly on a planning level analysis. The proposed walls should be optimized prior to the design stage.

- The implementation of Type II projects is a strictly voluntary decision made by a DOT and there are no special or separate federal funds to provide highway traffic noise abatement based on Type II projects.

- Based on the previous Type II priority list, if funds should become available through the reinstitution of a Type II program in Colorado, the Town of Vail should have high priority for those funds.
- The Town of Vail may compete with other transportation projects on the STIP for funds based on the traffic noise impacts due to I-70 traffic.
- Due to the outcome of the Noise Abatement Determination Worksheet, the overall noise abatement proposed for the Town of Vail is feasible and reasonable. A more detailed analysis of each individual wall should be performed before any design of the proposed mitigation is done.

Chapter 8: I-70 Capping

Introduction

The Town of Vail is conceptualizing options to utilize available land in the Vail Valley as efficiently as possible, improve overall livability and environmental sensitivity, and alleviate safety hazards on Interstate 70 (I-70). Developable land within Vail is minimal. The community is divided by the Interstate with the only connections at the three interchanges. Several extra vehicle miles are often necessary in travel between the sides of the Interstate. Furthermore, pedestrians often cross I-70 in between interchanges creating a safety hazard for themselves and motorists.

The capping of I-70 with a cut-and-cover tunnel throughout parts or all of Vail is under consideration to address all of these concerns. Cut-and-cover tunnels are generally used in place of aboveground freeways to eliminate noise and air pollution. They create more space by providing room for development, parks, recreational, cultural, and other public facilities on top of the tunnel. They also create or maintain community cohesion.

The purpose of this report is twofold. The first is to provide the issues facing Vail in capping I-70, and the other is to provide information on other cut-and-cover tunnels that have been built. The three tunnels being used for reference are located in Mercer Island, WA; Phoenix, AZ; and Duluth, MN. General information for each of these tunnels is included near the end of this report.

Opportunities

The construction of a lid over I-70 through Vail creates opportunities for new commercial, residential, and recreational development; allows for a more cohesive and livable community; and virtually eliminates the safety hazards to pedestrians and motorists that currently exist within the I-70 right-of-way. The capping of the Interstate would be at a tremendous cost but could be offset by developing the right package of real estate transactions amongst the Colorado Department of Transportation (CDOT); the Town of Vail; and commercial, residential, and recreational developers.

The capping of I-70 through Vail could create more than 550 acres of developable land in Vail, some of which could be used for new commercial and residential development, parks, open space and other uses identified by the community. The 550 acres through Vail (CDOT right-of-way) includes I-70, the Frontage Roads, and the land in between. By placing I-70 underground, the right-of-way requirements for the Interstate are dramatically reduced, even if the Interstate were expanded. The cross-section necessary to accommodate the Interstate in the tunnel would be approximately 150 feet across; representing about one-third of the total right-of-way. This accounts for three lanes in both directions of I-70 (for future growth), a two-track rail corridor, and shoulders. This, in turn, could create at least 350 acres for development. Development could then migrate closer to the Interstate and some development could occur on the lid itself. In addition to the development potential, new portals to Vail's amenities could be constructed with new interchanges along I-70, especially between the West Vail and East Vail interchanges.

The capping of the Interstate presents opportunities for creating a more cohesive and livable community. The lid would provide more opportunities for connecting the areas north and south of the Interstate. This connection would provide a more cohesive community both geographically and socially. Currently, with the Interstate dividing the community, and with only the interchanges and one pedestrian bridge connecting the two sides, pedestrians are crossing I-70 at a high risk to themselves and motorists. With careful planning of the lid, this safety hazard could be virtually eliminated.

Many environmental impacts on the community associated with traffic on the Interstate could be better mitigated, including noise, air, and water pollution, by consolidating the sources for treatment or mitigation. The current road noise along the Interstate could be dramatically reduced, as the tunnel provides for the ultimate noise wall system and noise exiting the tunnel could be muffled effectively. Similarly, air and water quality could be enhanced with similar means. The use of chemical deicers could be reduced significantly with the Interstate covered, thereby reducing the deicers effect on the environment.

Development Potential

Land use and planning will largely determine the development potential on the lid. Limitations on what can be feasibly located both physically and safely near and on the lid itself will also be a determining factor. Consideration could be given to provide the current land use breakdown percentages for the development on the lid for commercial, residential, recreational, and open space. Careful planning and consideration of the development potential must take into consideration the development rights, infrastructure impacts and mitigation, right-of-way costs, and construction costs of the lid.

The potential for development lies in four main areas: 1) commercial; 2) residential; 3) recreational; and 4) open space. Commercial development will likely provide the highest return and therefore may be the most significant factor in funding the capping. Residential and some recreational development will provide the next highest return. Some areas of the capping may be restrictive on development on or near the lid, making recreational or open space uses the primary development. Open space, while not providing actual financial assistance in the capping, would serve as a valued asset to the community. There is a potential for funding open space through alternate means of finance.

The building of a cap, in general, could provide other benefits to the community as well. The noise and pollution from I-70 has led to decreased property values in the areas adjacent to the Interstate through Vail. Capping would create potential for development as well as lessening the negative effects of I-70 on property values in the area.

Transportation Corridor Potential

Additional opportunities exist in the overall transportation system through Vail. Potential fixed guideways from Denver and the West Slope could be integrated into the capping in such a way to provide good highway interfaces, intermodal centers, and stations. Better connections to the community from the transportation systems and parking facilities could be integrated into the capping with minimal impact to the community. Additionally, better means of loading and delivery into the Town could be integrated into the capping by providing centralized docks, a concept precluded at this time due to the land constraints in Vail.

Land Value and Financial Considerations

Commercial development near or on the lid has the highest potential for paying for the construction of the capping. The key to this concept's success lies in the real estate transaction initially between CDOT and the Town of Vail. One scenario is that of a transfer or lease of the land use rights of the CDOT right-of-way near and on the lid to the Town of Vail at a nominal cost, with the construction of the capping paid for by the transfer or lease of the land use rights to commercial developers. In this scenario, consideration of the operation and maintenance costs of the additional functions necessitated by the capping would need to be included in the transfer or lease transactions. Infrastructure impacts and mitigation efforts would also be a key consideration in the development and land value.

Potential funding sources also include the Federal Highway Administration (FHWA) and CDOT. If traffic volumes continue to increase on I-70 (as they are projected to), additional highway lanes may be necessary and some mitigation measures might become necessary for noise, air quality, or other environmental issues in the future along I-70 through Vail. The costs associated with providing additional an additional lane in each direction on I-70 on the surface through Vail could be put in the $20 million to $40 million per mile. Expansion of the Interstate on the surface, given the ownership of the right-of-way and construction cost, would not near the cost of providing tunnels. However, it is possible that the FHWA and CDOT could contribute the portion of the funds for expanding the Interstate to the overall capping project. Local funding could also be used since the project would provide potentially significant improvements to noise, visual, and air quality concerns. In addition, open space funds could be used to create additional open space.

Another funding option includes the construction of the capping by CDOT with a transfer or lease of the land use rights based on fair market value. This option is unlikely though, as the risks to CDOT may not be in the best interest of the taxpayers of the State. Once the overall land use planning considerations and feasibility of uses are identified, it may be best to consider a developer(s) in the early planning stages of the capping.

In review and discussion of the information available from local realtors, it is difficult to approximate the values of the land that could be realized by capping I-70. An approximate range of values for developable land near Vail Village and Lionshead is $2.5 to $6.0 million per acre, depending on location and zoning. In areas outside Vail Village and Lionshead, an approximate range of values for developable land is $.5 to $1.8 million per acre, depending on location and zoning.

Appendix G contains a copy of a Joint Development Study produced by FHWA giving guidelines on projects eligible for the types of funding described above.

General I-70 Capping Issues

Capping Llimits

Consideration of the capping of I-70 needs to address several issues including terrain, geotechnical considerations, constructability and impact considerations, interchange locations, and planning and zoning constraints. For the purposes of conceptualization, the area from just east of the East Vail Interchange to the Dowd Junction interchange on I-70 provides the overall project limits. Due to the issues mentioned above, it may not be feasible to cap the entire length under consideration. Capping could be done in specific areas that provide the best results based upon the objectives of the project. The areas identified below are potential opportunities for capping of I-70. These areas are a “first look” for opportunity and will require additional study beyond the scope of this report. See maps in Appendix C for potential capping areas through the Town of Vail.

- **Dowd Canyon**

The Dowd Canyon area may provide an opportunity to provide an expanded transportation corridor without widening the corridor, and possible accommodations for future transit systems. In addition, with the right design, some of the geotechnical issues in the Canyon may be mitigated while providing open space and wildlife mitigation.

- **West Vail to Lionshead Area**

Some opportunities exist for additional development and open space in the area of the West Vail Interchange. Terrain transitions in this area may accommodate for transition of capping options. Consideration of a reconfigured interchange and a future transit system may be necessary to accommodate capping in this area.

- **Lionshead to Vail Village**

The area along I-70 that provides the most opportunity for development is the area between Lionshead and Vail Village. The terrain lends itself fairly well to cut-and-cover tunneling in this area. Again, consideration of future transit systems and interchange configurations will be necessary.

- **Vail Village to East Vail**

Opportunities exist in the area between Vail Village and East Vail for expansion of open space and recreational uses. Some opportunity exists for additional residential development along the perimeter of the I-70 corridor, but minimal commercial development opportunities are present.

- **East Vail to Vail Pass**

The area from East Vail to Vail Pass could also be considered for capping due to frequent inclement weather conditions and potential opportunities for residential land use in the Town’s limits. Capping areas from East Vail to Vail Pass could be used primarily for open space, wildlife corridors, and a potential additional portal to the ski area. Two potential capping areas from East Vail to Vail Pass are shown on the maps in Appendix C. For those areas that space in the median is not available, the alignment could be moved north of I-70 and tunneled.

- **Interchanges**

Four existing I-70 interchanges are within the capping limits identified above: 1) Dowd Junction; 2) West Vail; 3) Vail; and 4) East Vail. Within the scope of the capping, additional interchanges should be considered in the early planning stages, especially the potential for interchanges between West Vail and Vail interchanges and between Vail and East Vail.

The considerations for the reconfiguration of the interchanges include whether they are to remain above ground, placed within the tunnel, or relocated. The Dowd Junction and East Vail interchanges have the least necessity for any significant modification due to capping of the Interstate. However, depending upon the potential widening of the Interstate through Dowd Canyon, some modifications of the Dowd Junction interchange may be necessary. Further consideration to the West Vail and Vail interchanges should be given especially with regards to the approach of the capping. The high cost of reconfiguration of interchanges must be kept in context with the capping project as a whole.

Maintenance and Operations

Maintenance and operations of the tunnel would need to be addressed for the capping of I-70. Costs for maintaining and operating a tunnel are greater than that of the current Interstate. Costs for electricity, water, and labor may be significant. These costs and the responsibility should be resolved in the early planning stages.

Environmental Impact Considerations

With a project of this magnitude, the environmental impacts will need to be addressed, likely in the form of an Environmental Impact Statement (EIS). The process for an EIS is well defined by Federal Law and includes an encompassing analysis of the project's environmental impacts. The brief discussion included in this report will summarize some of the major issues that will require significant investigation, analysis, and mitigation plans for both the completed project and the construction of the project.

Pollution in the form of noise, air, and water will require significant analysis for the completed project. In terms of noise, I-70 traffic may experience more noise within the confined tunnel sections, whereas, outside the tunnel sections, less noise will exist. The portals of the tunnel sections, and at or near the ventilation systems, may show noise increases. Noise increases will also be expected during construction. Location of portals and ventilation systems should be analyzed with respect to noise impacts and mitigation. Air and water pollution will have the same general considerations as with noise for the I-70 traffic inside the tunnels and in the community. Mitigation of air and water issues within the tunnel involves ventilation and water handling systems. The capping of I-70 provides a good opportunity for the mitigation of noise, air, and water quality along the Interstate by consolidating the sources for mitigation techniques.

Hazardous materials hauled on I-70 will require special consideration in the tunnels, as no feasible alternative routes are available at this time. This involves special tunnel design and procedures as included in the Hanging Lake Tunnels in Glenwood Canyon. These procedures include incident detection systems and fire and spill control systems equipment.

Other impact considerations include safety, visual quality, wildlife issues, socio-economic issues, recreation and parks issues, and historic resource issues. As with the other issues mentioned above, consideration must be given to the completed project and the construction of the project, in terms of both the I-70 driver and the community.

In addition to addressing the capping of I-70 in the form of an EIS in the future, this issue should also be addressed in other relevant studies for the area such as the I-70 Programmatic EIS (PEIS).

General Capping Considerations

The capping of I-70 through Vail most likely would be a series of tunnels rather than one large tunnel. This assumption is derived from a combination of the terrain features, land use and zoning issues, logically developable areas, the need to maintain I-70 traffic, and the relative impracticality of building a single ten to twelve-mile tunnel.

The general topography suggests that areas to be capped may be constructed in differing manners. In some areas, holding the existing grade of I-70 and covering over may be more practical than cutting the Interstate below grade and maintaining the natural topography. Consideration of the construction phasing, maintaining I-70 traffic, overall earthwork balance, and the economic implications of bringing on development early in the process for funding will all be considerations in the overall alignment and profile of the new I-70 through Vail.

Given that each of these tunnel sections would be more than 1000 feet in length, mechanical ventilation, lighting, and drainage systems would be necessary. Significant infrastructure and utility issues will require consideration with the type of development that would be needed near and on the lid to support the funding of the capping. Surface drainage will need significant consideration due to the general topography of the terrain, the proximity of the existing community, existing low-point features, and environmental concerns. It is likely, given the topography, that mechanical means for dealing with surface water may be necessary. With each of the mechanical systems mentioned above, the issue of their location and their impact on the lid development and community must be carefully considered.

In addition to the personnel requirements for operating and maintaining the tunnels, the capping of I-70 will require significant consideration of the emergency services to respond to potential incidents in the tunnel portions. This may require additional staffing and training of fire protection personnel, hazardous material response personnel, and incident control personnel.

Capping Construction Issues

The issues in the construction of capping I-70 fall under three general categories: 1) Construction Phasing; 2) Construction Techniques; and 3) Construction Impact. Issues under each of these categories are discussed.

Construction Phasing

The phasing of the I-70 capping construction requires consideration of several critical issues which all need to be addressed in the planning of the project. Given that I-70 is a major route through Colorado, it is likely that the CDOT and FHWA will require that traffic be maintained through the project area with minimal or no delay to the traveling public. This constraint will require that two-lane detours be maintained in both directions on I-70, with a design speed that will be acceptable to CDOT and FHWA. For the purposes of this planning stage, an average of 40 to 50 miles per hour may be necessary. Higher design speeds may be required or lower design speeds may be necessary for portions of the project's construction. It is likely that traffic stops may not be allowed, or if they are, stops could be limited to a few minutes for construction of special areas. Given the need to maintain I-70 traffic, careful planning of the construction phasing is mandatory from this perspective.

One possible general means of addressing this issue is to first provide two lanes of detour within the existing right-of-way, and outside the new construction footprint. Once the detour is complete, one direction of traffic can be moved to the detour. The newly vacated lanes would then be the first area for new construction. Once the newly constructed lanes are complete, one direction of traffic can be diverted onto the new lanes. Then, depending on the area, the other direction of traffic can be diverted onto the detour, allowing for the construction to continue. This concept is general in nature and would require in-depth traffic and construction analysis, however, it may provide one of the more economical means, as only one two-lane detour would be needed to maintain traffic.

Another critical issue in the construction phasing of the capping of I-70 is the need for completing sections of the cap in an expeditious manner. One of the more probable means of funding the project lies in the private development on the cap. If this becomes the case, a developer would finance the construction of the project through the revenue generation of what is constructed on the cap. With this, it is critical to begin coordination of the revenue-generating developments as soon as possible. Sections of the construction of the cap then become a driving force in the construction phasing.

An overall plan for the construction phasing of the cap also needs to consider the earthwork balance of the project. The most economical construction would include all material generated on the project to be used on the project with a minimum of extra handling. Sections of the cap that require extensive excavation should be phased during construction of other areas of the cap that require extensive fills. This task may be difficult at the startup of the project. More efficient construction can also be accomplished by setting up concrete plants in town at the time of construction to reduce haul times and maximize the recycling of materials. Minimizing the stockpiling of earthwork for later use, along with minimizing the need to import or export material, should be a priority in the overall construction phasing of the project.

Other issues in the construction phasing include those specifically related to the Town of Vail in terms of access and are equally important in the consideration of the phasing as those mentioned above. As Vail is a resort area, it derives much of its revenue through its tourism industry, and the need to preserve its access is critical. Vail is also a community, and the need to preserve its quality of life and business is critical in the construction phasing. Consideration must be given to maintaining the resort business and the community in the construction phasing by careful planning with the residents and the businesses of Vail. Perhaps the best seasons to plan extensive construction activities are during off-peak seasons, spring and fall, when traffic volumes are low and business is slow. During these seasons, significant work could be accomplished. During the remainder of the year, construction should be phased and constructed to maintain access through the Town.

Construction Techniques

The discussion of the capping of I-70 has largely been that of using a cut-and-cover type of tunneling. Cut-and-cover is a means where an open excavation is made to the final grade of the tunnel while supporting the sides of the excavation. Once the final grade is achieved, a covering, usually of steel ribs and/or concrete, is placed as the top. The top is then covered with dirt and blended into the surrounding landscape. This is the most economical means for the cap through Vail, as most of the landscape lends itself well to this technique. Another means of creating a cap may be in using the existing grade of I-70, creating a cap on it, and blending the cap into the surrounding landscape. Variations of these two means of creating the cap is likely through Vail in order to provide the best development potential and final landscape. With these techniques, earthwork balance can be addressed readily in the planning.

The geology of the area must be given careful consideration in the planning of the tunnel from a geotechnical standpoint. Construction techniques, especially in excavation and support, largely depend on the geotechnical aspects of the soils and rock. An extensive exploratory drilling program should be at the front end of the planning efforts, as construction techniques could impact construction phasing of the project.

As with the geotechnical investigations, utility investigations should also be made early in the planning efforts. Existing utilities as well as planned or potential utilities in the right-of-way should be given careful consideration in the planning stages. Utility needs for the development on the cap should also be addressed in the early planning stages to ensure a coordinated and integrated utility system is designed and installed as the construction occurs.

The staging of construction must also be considered in the early planning of the project. Staging is locating the construction facilities necessary for the project. This includes the areas for unloading of materials to be used on the project, stockpile areas, material processing areas, construction vehicle parking and maintenance areas, and office areas. A project of this magnitude will require significant acreage for these activities and addressing this issue is paramount in the planning stages.

The contract packaging of the project is also an issue that can influence the construction techniques. Contract packaging is the issuance of the individual contracts for the projects. If one developer were to assume the entire capping project, this may not be of significant concern as the developer would be driven by completion of the project in the most expeditious manner, using the appropriate contractors. If the capping project were to be a series of individual contracts, consideration should be given to the need to package the contracts for the most economical means. Careful consideration of the interface among the individual contracts is required to assure cooperation and minimization of the interfacing delays that could occur. In any contract packaging, consideration should be given to packaging the ventilation and traffic systems as separate contracts to assure that maintenance, upgrading, and warranty issues can be contracted directly with the manufacturers of those systems.

Construction Impacts

The construction impacts are far-reaching into the community and the business of the resort. Financial and quality of life impacts will be inherent in the construction of a cap over I-70. Consideration of the construction impacts must be weighed against the long-term opportunities of the finished project. A project of this magnitude will have significant impacts during construction. In general terms, the more construction impact that can be tolerated, the shorter the overall construction period. During the planning stages of the project, consideration must be given to the extent of the compromises that could be made during the construction. All parties involved, including the Town, its residents, its businesses, and affected agencies and jurisdictions must proceed into this project well informed and willing to endure the impacts of the project.

Construction impacts include those normally associated with heavy construction, especially noise and dust. Access will be hindered during construction. Careful construction phasing plans and construction documents can be developed to minimize and control the impacts. Visual impacts of the project are subjective, as there are those who enjoy the sight of construction, and with the right approach and attitude, the visual impact can provide a positive message of change to both the residents and the guests of the Town. These impacts, though, are still impacts, and need to be treated as such as the overall vitality of the Town during the construction may suffer.

The construction of the cap on I-70 would also have a workforce impact. This project would require a significant amount of construction workers in the area for a considerable amount of time. Housing and service demands will increase dramatically during the construction. Some of this impact may be mitigated through careful planning of the project and phasing. Tourism may decline during the construction. However, the needs of the construction workforce, with a proper design for mitigation, may meet the basic economic needs of the community during the construction effort.

Comparative Capping Projects

General Discussion

Capping projects already exist in several urban environments. Many were provided to increase development potential and some as mitigation of environmental and residential impacts. Three capping projects were researched to provide some comparative analysis to the capping of I-70 through Vail. These projects are in Mercer Island, Washington; Phoenix, Arizona; and Duluth, Minnesota. While the opportunities, conditions, costs, and the general dynamics might differ between the Town of Vail and these three projects, many of the same concerns and issues apply from one place to another. The information provided below highlights the research on these projects.

- **Mercer Island, WA 1987-1992**

The cut-and-cover tunnel in Mercer Island is a segment of I-90. The project originally met a lot of resistance from the public because it involved the construction of a ten-lane interstate through the city. The public did not want the air pollution and noise that an interstate would bring. Approximately 1,000 public meetings took place over the course of several years. In the end, negotiations reduced the interstate to eight lanes with a cut-and-cover tunnel in place over key sections. The tunnel is 2,800 feet long with a park and landscaping on top of the tunnel. The environmental process was also tested for this newly constructed interstate with the completion of an EIS.

- **Phoenix, AZ 1987-1990**

The cut-and-cover tunnel in Phoenix, AZ is a segment of the I-10 Papago Freeway. The tunnel is 2,700 feet (about one-half mile) long with ten lanes. Public support for this project has been strong because of the Margaret Hance Park built on top of the tunnel, creating increased green space within the city. The park includes approximately 30 acres of lawns, ponds, playgrounds, restaurants, fountains, cultural facilities, and a library; and the deck supports 13 of those acres over the freeway. Central Avenue, a major north-south connection in Phoenix, was also bridged over the park to maintain the local traffic flow.

- **Duluth, MN**

Cut-and-cover tunnel; Duluth, Minnesota

I-35 in Duluth, MN has four cut-and-cover tunnels within 13 blocks. The first tunnel (traveling east) is the Lake Place Tunnel, and it is 725 feet long. The second tunnel, the East Historic District Tunnel, is 670 feet long. The third tunnel, the West Historic District Tunnel, is 570 feet long. The last tunnel, the Leif Erickson Tunnel, is the longest tunnel at 1,480 feet. Public support was strong for these tunnels for three main reasons: they allowed several historic buildings to remain standing; they allow the main thoroughfare in the area, Superior Street, to run concurrent with the freeway; and they serve as bridges to open up physical and aesthetic access to the lakefront while providing more green space in the form of parks and landscaping.

Project Issues

- **Long-Term Agreements**

Decisions have to be made about issues such as deciding what will be constructed on top of the tunnel and responsibility for maintenance (aboveground and underground). In some cases, long-term agreements are formed between cooperating agencies. In Mercer Island, cooperation took place between local agencies and the funding agency (FHWA) to decide what to put on top of the tunnel (in this case, a park) and the responsibility for aboveground vs. underground maintenance. The Washington State Department of Transportation (WSDOT) owns the land above the tunnel and leases it back to the City of Mercer Island. Per the agreement, maintenance for the landscaped area is undertaken and funded by the city.

In Phoenix, an intergovernmental agreement was formed between the City of Phoenix and the ADOT. This agreement covers any issues that might arise concerning the tunnel such as responsibility for particular tasks or issues. The document also addresses future development of the deck area, responsibility for costs, and anticipation of any major activities that might affect the park.

In Duluth, all maintenance and further enhancements to the tunnel areas are paid for solely by the Minnesota Department of Transportation (MnDOT), eliminating the need for agreements between city and state.

- **Lid Development**

The area aboveground on the Mercer Island Tunnel consists of a park with multi-use recreational fields, tennis courts, basketball courts, and other public amenities. Mercer Island has also included a school in one section of the public area aboveground.

In Phoenix, the Margaret Hance Park is composed of much more than just a landscaped park facility. A library stands on one side of the park. Two large buildings house arts, entertainment, and theater. Elaborate statues have been placed in many areas around the park. Plans for other cultural centers are also underway.

During the development of the plans for the area above the deck, many options were presented to productively use the land. The City of Phoenix decided at that time to prohibit commercial development and use the space for public use and enjoyment. While huge commercial growth has taken place adjacent to the park, the area on the deck will be maintained for public use. The park has drawn much attention, however, and economic growth has been restored to the area as a result.

Duluth has employed several unique ideas to cover and landscape the four tunnels on I-35. They have landscaped the areas with several plantings. On Lake Place Tunnel, for example, $600,000 was spent on these plantings. They have also used culture and history in many of their designs. They have created a large mosaic “Story Floor” in the shape of Lake Superior with brass stars marking the sites of historic shipwrecks and bronze plaques around the rim of the depression describing each. They also placed a 35-foot high hexagonal clock to commemorate Duluth’s sister-city relationships with six foreign cities. On the outer wall of the tunnel, they have created a ceramic mural depicting lakefront, marine, and ship images. On top of the Leif Erickson Tunnel, an extensive English rose garden has been planted to replace a smaller, preexisting rose garden. A stairway and ramp to the newly renovated waterfront have also been installed.

- **Safety**

Safety issues must be considered for items such as flammable cargo or automobile fires. Mercer Island expressed that safety issues are of utmost importance. They have installed a foam system. If activated, foam drops to smother fires. The run-off goes to detention vaults where it is held and later removed. The material is biodegradable, so accidental leakages into the lake or other water bodies do not pose an environmental threat.

Phoenix installed expensive turbine fans, but these have not been used to date. The traffic creates a natural airflow through the tunnel, eliminating the need for these fans. However, an emergency situation in the tunnel might warrant a need for the fans in the future. They have also installed 10,000 feet of fire detection wire and 36 fire telephone cabinets every 300 feet on both sides of the tunnel (18 in each direction).

Phoenix has also installed 24 video cameras to monitor and identify traffic hazards and vandals. Electronic loops monitor traffic and send messages to an operator in a control room under Central Avenue. The operator can use cameras to evaluate the condition and use lane-control signs and message boards to guide traffic past the trouble areas.

In the City of Duluth, there is a ventilation system to control smoke in case of fire and fire sprinklers. Heat detectors mounted throughout the tunnel will trigger the fans, as well as send an automatic fire signal to Duluth's 911 emergency service. There are also 24 electronically monitored wall-mounted emergency cabinets containing manual fire alarm pull stations and emergency telephones directly connected to the Minnesota State Patrol's Duluth Headquarters. There are twelve fire hydrants within the tunnel. However, there were no regulations on fire safety systems at the time, and they are not aware of any current codes that have been enacted since then.

- **Lighting**

Lighting is an issue for tunnels, depending primarily on the length of the tunnel. Shorter tunnels allow enough daylight or streetlights (nighttime) to illuminate the interior. For the Mercer Island Tunnel, a tunnel lighting expert was hired to determine the type and amount of lighting to be used. Considerations for the lighting included start-up costs, operational costs, and replacement costs.

Phoenix has installed 3,500 amber-colored sodium lights to illuminate the interior of the tunnel. Light sensors have also been installed in the deck to adjust the amount of light in the tunnel so travelers' eyes do not have to adjust too much upon entrance and exit.

Lighting in the Duluth tunnels varies due to the lengths of the tunnels. The Historic District Tunnels do not need lighting because ample daylight illuminates the tunnels. The Lake Place Tunnel has openings in the walls to permit passage of additional sunlight. The Leif Erickson Tunnel, however, required 1,235 lights. For this extensive lighting, the monthly light bills total about $6,000 per month.

- **Eye Adjustments**

Without proper lighting and other techniques, tunnels can create problems for travelers' eyes because of the drastic differences in lighting from aboveground to belowground. In Duluth this was a particular problem as the tunnels run in succession and the distances between do not allow ample time for the eyes to adjust to lighting changes. They have employed three techniques to solve this problem. First, high-pressure sodium tiles designed for reflectivity were used inside the tunnels. Second, rustication and three different shades of brown were used to reduce reflection outside of the tunnels. Third, the concrete was dyed black with epoxy-penetrant sealer outside of the tunnels. These have all been effective methods to eliminate eye adjustment problems.

As mentioned earlier, the City of Phoenix installed light sensors to adjust the amount of light in the tunnels so the eyes do not have to adjust too much.

- **Ventilation**

Ventilation systems are generally required only for tunnels of 1,000 feet or more. Ventilation issues are important for air quality within the tunnels. An obstacle for ventilation is keeping the air pollution down in the tunnels to acceptable limits if the traffic is stopped. Mercer Island uses feed fans to extract gas, smoke, or fumes out of the tunnel. The system is fully automated by the use of monitors that continuously collect data and adjust conditions inside the tunnel.

Phoenix makes use of the turbine fans installed for fire safety. Eight, 750 horsepower fans, with blades six feet long ventilate the deck park tunnel. Phoenix has also installed five carbon monoxide sensors in the tunnel.

Duluth uses the most advanced ventilation system for the 1,480 foot long Leif Erickson Tunnel. The automated system operates from a compact ventilation building under the deck. The system includes air quality monitors in six locations. These monitors constantly test air quality and trigger fans if carbon monoxide levels go above six parts per million (ppm) (OSHA limits are 50 ppm) for more than two minutes. These fans have been triggered twice in about eight years with average daily traffic (ADT) volumes of 25,000 vehicles through the tunnels. All results are automatically reported to the district office aboveground.

- **Waterproofing**

Waterproofing is an issue for any cut-and-cover tunnel, especially those in areas of high precipitation or where large volumes of water are used for landscaping as in the case of a park over the tunnel. The Mercer Island waterproofing system includes a two part system consisting of an asphalt layer and a bentonite clay layer. The bentonite layer is placed on the outside of the tunnel and is the first layer of defense. This clay material is held in cardboard panels that are tacked to the walls and tunnel roofs. The second layer is an asphalt membrane used as a last defense should something penetrate the tunnel. This asphalt layer is applied directly to the concrete structure. The bentonite layer is activated by water, which causes the clay to swell and become a permanent waterproof seal.

In Phoenix, a thick plastic membrane was placed between the cement roof of the tunnel and a layer of soil from four to eight feet in depth for landscaping. Some leakage occurs with this system, although it is not excessive. Currently plans are underway to construct a koi pond (an authentic Japanese pond) around a Japanese teahouse. This causes concern about the pond breaking through the plastic membrane at some point. Because of this, ADOT is researching stronger membrane samples to replace the existing membrane (a major project in itself).

In Duluth, a 6.5-millimeter plastic sheet with a sticky side was wrapped around the entire tunnel. An asphalt board was used to hold the membrane in place. Four inches of low strength concrete were placed on top of that, and a granular backfill and landscaping were the final layer.

Duluth has had only one problem with leakage where the waterproofing pulled loose at the top of the Lake Place Tunnel. This was corrected and resealed.

- **Drainage**

Drainage has been a major issue for cut-and-cover tunnels in the cities referenced. In Phoenix, drainage was the greatest expense for construction. The drainage flow through the city, northeast to southwest, cut across the area where the tunnel was to be built. Consequently, a complex system of drainage tunnels under downtown Phoenix, 20 feet in diameter, was built to carry the water six and one-half miles to the Salt River (south of the project area).

- **Access**

Access for the Mercer Island project is provided through doors along the tunnel corridor, as well as through the top of the lid. Plumbing, electrical, fire abatement systems, etc., are accessed through these doors. Regulations regarding access pertain to issues such as safety and visibility, but no regulations govern maintenance access.

- **Public Support**

While all of the cut-and-cover tunnel projects have ultimately received strong public support, early and frequent communication with the public is essential when considering any project of this magnitude. Benefits of cut-and-cover tunnels such as decreased noise, better air quality, and increased green space appeal to a majority of the public. Public involvement includes actions such as public meetings and open houses, newsletters, web pages, and brochures.

Public involvement costs as a function of the total costs of the project cannot be calculated precisely, as these costs vary. In Phoenix, public involvement costs totaled one to two percent of the overall project costs. On Mercer Island, the percentage of public involvement costs was not calculated separately, but these costs totaled millions of dollars. A great deal of time and effort has been spent on public involvement by each city that has undertaken a cut-and-cover project. They all stress that a thorough public involvement process will ensure a smoother project in the long run.

Construction Issues

Construction issues must be addressed and include how to divert traffic on an interstate with high traffic volumes, schedules and timing of construction, and possible impact to local residences, structures, and businesses. In Duluth, historic structures in the area of construction were issues of much debate and concern. The cut-and-cover tunnels made it possible to preserve all historic buildings in the area. Measures used to preserve these structures included careful monitoring of blasting activities, use of small, delayed explosives, and matting of explosives to eliminate flying rock. The final resolution left good feelings between public agencies involved in the planning of the tunnels, members of the community, and historic preservation agencies.

- **Utilities Relocation**

Utilities relocation was a great obstacle for all three cities because the tunnels were not constructed within an existing roadway. Relocations are very costly and time-consuming.

- **Soil Considerations**

In areas such as Mercer Island, issues such as earthquake regions must be considered for construction of a tunnel. In Vail, however, other considerations might apply, such as depth of digging, type and density of soils present, and time of year. Digging should ideally take place during warmer seasons to avoid frozen ground.

- **Construction Details**

Construction details were not acquired from all three cities, but the ADOT provided ample information regarding the construction of the tunnel on I-10. The deck is actually 19 bridges built side by side (one-half mile long). Each bridge is approximately 150 feet wide and 250 feet long with a six-foot thick concrete floor. The bridges are covered with a specially prepared soil ranging in depth from four to eight feet.

The underground structure includes a completed bus terminal that serves two lanes. The bus terminal is still not functional to date, as efforts by the City to initiate bond opportunities have not been successful. Another attempt will be made in November.

Over 1,400 caissons support the deck units. The shafts for the 48-inch, square caissons range in depth from 35 feet to over 70 feet, which required drilling of almost 70 linear feet. The entire structure required over 100,000 cubic yards of concrete and 20 million pounds of reinforcing steel.

As mentioned earlier, the old Central Avenue was removed and replaced with a new Central Avenue Bridge. The bridge rises about 15 feet above the deck. 135,000 cubic yards of concrete was used in its construction with about 80,000 yards used in the structures and the remainder of the caissons.

Approximately 160 palm trees were removed from adjacent neighborhoods during construction. They were maintained in a nursery during the three years of construction and later returned to the same neighborhoods.

A unique feature of the Duluth tunnels includes the excavation of 236,000 cubic yards of rock. This excavated rock was used to develop the City of Duluth's new Downtown Lakewalk facility. 10,000 cubic yards of this material were also used to construct a lake trout and salmon spawning reef in Lake Superior 700 feet offshore.

The Mercer Island Tunnel required 31 million pounds of steel and 154 million cubic yards of concrete for its construction.

- **Construction Costs**

Figures for construction costs of cut-and-cover tunnels indicate that they are expensive to build. The figures in Table 1 indicate the total costs to build the tunnels in each city and the funding sources. The costs include the aboveground activities as well.

Table 8-1: Total Costs for Each Tunnel

City	Total Cost (2001 dollars) *	Funding Sources	Percentage covered by funding source
Mercer Island	$220 million	Federal (FHWA)	90%
		State (WSDOT)	8%
		Local (City)	2%
Phoenix	>$200 million	Federal (FHWA)	95%
		State (ADOT)	5%
Duluth (all 4 tunnels)	$400 million	Federal (FHWA)	90%
		State (MnDOT)	10%

*Costs have been escalated to 2001 dollars, by escalating costs by 6 % per year from 1989 to present.

In general, the FHWA primarily funded the basic structures required for the tunnels. State and local sources funded most aboveground work (landscaping, artwork, etc.).

Complete tunnel dimensions were obtained from the City of Duluth to give an average account of the costs of the four tunnels. When the work was done, the costs ranged from approximately $30,000 to $80,000 per linear foot, depending on the functions of the tunnel – ventilation, lighting, safety features, etc. These costs escalated at six percent per year over the last twelve years amount to approximately $60,000 to $160,000 per linear foot of tunnel, again dependent on the functions of the tunnel. Care should be exercised in applying these cost figures to the capping of I-70 through Vail, as the conditions, situations, and desired results are significantly different than those of the projects studied. The best way to determine a rough cost of the I-70 capping is to prepare a conceptual layout of the capping and proceed through a cost estimate based on the conceptual layout.

Funding of the tunnels in Mercer Island, Phoenix, and Duluth were built as a form of mitigation for the building of freeways through these cities. The roadways did not exist before the building of the tunnels, so noise, visual, and air quality mitigation were necessary for construction.

For comparison, construction costs were also found for the Hanging Lake Tunnels in western Colorado (approximately 50 miles west of Vail). The major difference is that these tunnels were drilled and blasted into the side of the mountain (a more expensive process). Total construction costs for this project were $90 million for two 4000 foot tunnels, each with two lanes. This equates to approximately $22,500 per linear foot in 1989 or $45,000 per linear foot escalated to 2001 at 6% per year.

- **Maintenance Costs**

Reports on maintenance costs were mixed as some city officials said these costs were much higher than projected, and others said they were as expected. Mercer Island took steps during construction to reduce long-term maintenance costs. Some measures include using stainless steel where possible because of the corrosive atmosphere in the tunnel, installing automated systems (described throughout this document), and providing easy access for maintenance. The routine maintenance costs for Mercer Island are $1,105,000 per year and are broken down as follows:

- $750,000 Area 5 Maintenance – energy bills; mechanical, electrical, electronic, utility, and fire systems; road surface; drainage; and structure
- $100,000 Signals Branch – roadway illumination, radio rebroadcast, and emergency phone and camera systems
- $175,000 Traffic Operations – traffic monitoring and systems operation
- $75,000 Mercer Island Park Department – landscape maintenance on the lid
- $5,000 Bridge Branch – structure inspection and repair

Maintenance costs for Phoenix are higher than originally anticipated. The Arizona Department of Transportation (ADOT) is responsible for the tasks and costs of maintenance underground. The routine maintenance costs for the tunnel below ground are $500,000 to $800,000 per year. The City of Phoenix is responsible for the tasks and costs of maintenance aboveground. The routine costs of aboveground maintenance are approximately $300,000 per year, and this includes tasks such as landscaping, water, personnel (a full staff just for the park), and other park and building maintenance activities.

The maintenance costs of the Duluth tunnels include costs such as wall-washing twice a year, maintenance of the concrete roadway, snowplowing (which is not excessive since the roadway is covered underground), and the use of chemicals for salt removal. Routine maintenance for the tunnels is over $200,000 per year.

Maintenance costs were also found for the Hanging Lake Tunnels, as these costs might be somewhat comparable to the maintenance costs for capping in Vail. The Hanging Lake Tunnels have two lanes in each tunnel and are three-quarters of a mile long. These tunnels have total maintenance costs of $1.4 million per year.

Chapter 9: Traffic Model

Introduction

The Vail transportation model is a simple spreadsheet model using origin and destination pairs to estimate future traffic volumes on the street network. The transportation model does not distinguish between vehicle types and trip types. The model describes the potential traffic volumes on the Vail transportation network when the existing ratio of vehicle types and trip types remains constant. The model does not assume new transit programs and services other than what would be needed to maintain the current transit mode split. The model does, however, identify the potential for congested roadways in the future that should be under consideration for new or enhanced transit and alternative transportation services.

Model Development

The spreadsheet transportation model is intended to be simple and easy to develop. In the transportation model, “nodes” represent the main origins and destinations in Vail, and “links” represent the main roadway network (including I-70) in Vail. The spreadsheet model includes sixteen nodes and eighteen links (see Figure 9-1). These nodes and links are described below.

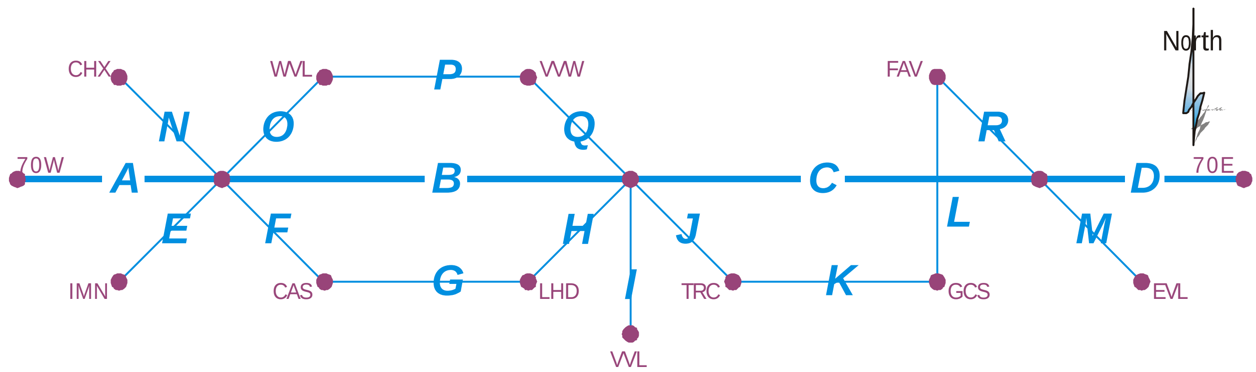


Figure 9-1: Schematic Representation of the Vail Transportation Model Network

Nodes (·)

The sixteen nodes represent specific major origins and destinations in Vail. Table 9-1 shows the name, abbreviation used in the model spreadsheet, and a description of the nodes used in the Vail transportation model.

Table 9-1: Nodes in the Vail Transportation Model

Name of Node	Abbreviation	Description
I-70 West	70W	Includes all origins and destinations west of Vail along I-70.
West Interchange	WIN	The roundabout interchange is not an origin or destination by itself, but serves as a transition point for I-70 traffic into Vail.
Intermountain	IMN	Community on the south I-70 frontage road, west of the West Vail roundabouts.
Cascade	CAS	Community on the south I-70 frontage road, east of the West Vail roundabouts.
Lionshead	LHD	Community on the south I-70 frontage road, west of the Main Vail roundabouts.

Middle Interchange	MIN	The roundabout interchange is not an origin or destination by itself, but serves as a transition point for I-70 traffic into Vail.
Vail Village	VVL	The main village of Vail, south of the Main Vail roundabouts.
Transportation Center	TRC	Transportation intermodal facility on the south I-70 frontage road, east of the Main Vail roundabouts.
Golf Course	GCS	The public golf course in Vail on the south I-70 frontage road.
Falls at Vail	FAV	Community on the north I-70 frontage road, west of the East Vail interchange.
East Interchange	EIN	The interchange is not an origin or destination by itself, but serves as a transition point for I-70 traffic into Vail.
East Vail	EVL	Community south of I-70 and east of the East Vail interchange.
I-70 East	70E	Includes all origins and destinations west of Vail along I-70.
Chamonix	CHX	Community on the north I-70 frontage road, west of the West Vail roundabouts.
West Vail	WVL	Community on the north I-70 frontage road, east of the West Vail roundabouts.
Vail View	VVW	Community on the north I-70 frontage road, west of the Main Vail roundabouts.

Links (——)

The eighteen links represent the major roadway network in Vail. Table 9-2 shows the name and description of the links used in the Vail transportation model.

Table 9-2: Links in the Vail Transportation Model

Name of Link	Description
A	I-70 west of the West Vail roundabouts
B	I-70 between the West Vail roundabouts and the Main Vail roundabouts
C	I-70 between the Main Vail roundabouts and the East Vail interchange
D	I-70 east of the East Vail interchange
E	South frontage road west of the West Vail roundabouts
F	South frontage road from the West Vail roundabouts to the center of the Cascade area development
G	South frontage road from the center of the Cascade area development to the center of the Lionshead development
H	South frontage road from the Main Vail roundabouts to the center of the Lionshead development
I	Main access to Vail Village
J	South frontage road from the Main Vail roundabouts to the transportation center
K	South frontage road from the transportation center to the golf course
L	From the golf course to the Falls at Vail on the opposite side of I-70
M	Bighorn Road from the East Vail interchange to East Vail
N	North frontage road from the West Vail roundabouts to the center of the Chamonix development
O	North frontage road from the West Vail roundabouts to the center of the West Vail development

P	North frontage road from the center of the West Vail development to the center of the Vail View area development
Q	North frontage road from the center of the Vail View area development to the Main Vail roundabouts
R	From the Falls at Vail to the East Vail interchange

Model Matrix

The main origins and destinations (the nodes) in Vail were arranged to create the following origin (rows) and destination (columns) matrix shown in Table 9-3.

Table 9-3: Origins and Destinations Matrix (Existing)

DESTINATIONS

ORIGINS

	70W	WIN	IMN	CAS	LHD	MIN	VVL	TRC	GCS	FAV	EIN	EVL	70E	CHX	WVL	VVW
70W	0	0	653	1182	2694	0	1912	3323	2869	641	0	684	4038	1058	2135	2478
WIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IMN	457	0	0	36	126	0	70	161	178	26	0	31	151	24	49	105
CAS	1182	0	56	0	165	0	583	982	824	49	0	62	344	38	81	233
LHD	1924	0	128	119	0	0	553	990	890	188	0	201	1176	167	339	687
MIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VVL	509	0	27	152	203	0	0	103	148	5	0	10	53	25	52	33
TRC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GCS	1145	0	98	331	497	0	222	168	0	86	0	97	603	221	427	349
FAV	706	0	32	55	286	0	22	143	257	0	0	11	60	36	74	47
EIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EVL	1369	0	82	120	555	0	75	307	498	22	0	0	177	87	180	121
70E	4375	0	242	373	1782	0	214	957	1620	59	0	98	0	265	548	367
CHX	1058	0	39	38	232	0	94	333	525	33	0	45	245	0	15	175
WVL	1200	0	41	46	265	0	110	380	608	38	0	50	284	8	0	184
VVW	2826	0	165	265	1104	0	136	594	1027	47	0	70	386	199	368	0

Each cell contains a value that represents a number of trips being made between two nodes (the process of developing the trip numbers is discussed in the following section). All trips are assumed to be one-way and originating from home (home-based). For example, in Table 9-3 the number of existing trips made between CAS and TRC is 982. However, the number of existing trips made between TRC and CAS is zero because the TRC does not produce an original trip (i.e., a home-based trip). All trips from the TRC were originally produced from somewhere else.

The origin and destination table is used to determine the volume of trips made between nodes. The volume of traffic on an individual roadway (link) can be obtained by adding up specific trips between nodes (origin and destination pairs). Appendix H2 contains the roadway link volumes and associated origin and destination pairs.

Existing Network

Population and Employment Estimates

Assumptions were made about the population and employment of each node with respect to every other node. Data from the U.S. Census Bureau was used to estimate relative population densities for each node. Land use and zoning maps were used to estimate relative employment densities for each node. Appendix H1 contains the population and employment data used for developing the model. Existing traffic volume information and the population and employment estimates were used to allocate existing trips for the model. The **Calibration** section below discusses the calibration procedure in more detail.

Volumes

Existing traffic information was used to develop a baseline of existing traffic volumes for the existing model matrix. The model uses the most recent data available for the Town of Vail from counts taken in the summer of 2000 and verified through conversations with the Town of Vail. The model also uses the most recent available traffic volume information for I-70 through Vail. Appendix H2 contains the traffic volume information used for the model.

Calibration

The existing volumes for the Vail area were used to calibrate the model. Trips were assigned to specific origin and destination (O-D) pairs in an iterative process. The trips were assigned to O-D pairs based on the respective weight of the population and employment densities. The greater the population or employment density, the more trips were assigned to that O-D pair. The iterative process included adjustments to original population and employment estimates to create model volumes that matched existing volumes.

The iterative process yielded a model that reports existing traffic volumes on the network to within two percent, with thirteen out of eighteen links within a one percent tolerance. The largest margin of error was twelve percent. Appendix H3 contains the results of the model calibration.

Future Network

Growth Factors

Estimates of growth for each node were developed in consultation with the Town of Vail, except for nodes east and west of Vail on I-70. The growth in nodes east and west of Vail on I-70 were developed using the *I-70 Mountain Corridor MIS*. The following table shows the estimated growth over a 20-year period for each node:

Table 9-4: Estimated Growth for Nodes in the Vail Model

	Population			**Employment**		
Node	**Annual Growth**	**20-Year Growth**	**Growth Factor**	**Annual Growth**	**20-Year Growth**	**Growth Factor**
70W	3.50%	70.0%	1.700	3.50%	70.0%	1.700
WIN	0.00%	0.00%	1.000	0.00%	0.00%	1.000
IMN	0.13%	2.50%	1.025	0.00%	0.00%	1.000
CAS	0.13%	2.50%	1.025	0.15%	3.00%	1.030
LHD	1.00%	20.0%	1.200	1.25%	25.0%	1.250
MIN	0.00%	0.00%	1.000	0.00%	0.00%	1.000
VVL	0.65%	13.0%	1.130	0.20%	10.0%	1.100
TRC	0.10%	2.00%	1.020	0.10%	2.00%	1.020
GCS	0.03%	0.50%	1.005	0.03%	0.50%	1.005
FAV	0.03%	0.50%	1.005	0.00%	0.00%	1.000

EIN	0.00%	0.00%	1.000	0.00%	0.00%	1.000
EVL	0.03%	0.50%	1.005	0.03%	0.50%	1.005
70E	3.50%	70.0%	1.700	3.50%	70.0%	1.700
CHX	0.13%	2.50%	1.025	0.00%	0.00%	1.000
WVL	0.15%	3.00%	1.030	0.40%	8.00%	1.080
VVW	0.00%	0.00%	1.000	0.03%	0.50%	1.005

The growth estimates assume very little population growth in the Vail area with the exception of some in-fill development in Lionshead and Vail Village. Employment growth is expected to out-pace the population growth in these same areas, including the commercial growth in the West Vail development.

The existing traffic volumes are multiplied by the growth factors to estimate future traffic conditions. The relative weight of the growth factors provides an estimate of the trip distribution between origins and destinations. This type of model is commonly referred to as a Fratar trip model. In a Fratar model, the trip growth on a link is related to the growth rate of the associated origin and destination nodes and the relative size of the growth compared to other nodes. An iterative process of balancing origins and destinations yields the future 2020 transportation model. Appendix H4 contains the growth model.

Trip Assignment and Adjustments

The simple spreadsheet model assumes that the O-D pairs only have one route. In reality, there are several different routes (links) between O-D pairs. In the Vail model, the route chosen for the origin and destination pair is assumed to be the most likely route. For instance, the model assigns all trips between Cascade (CAS) and Vail View (VVW) along links F, O, and P. However, a certain percentage of the actual trips being made will use another route along links G, H, and Q. In the Vail model, these trips are reassigned based on the forecasted traffic volumes and capacity of the individual links.

Before adjustments, some links showed decreases in forecasted traffic volume as a result of the “all or nothing” trip assignment discussed in the previous paragraph. Reassigning trips from overloaded links solves this problem. Trips were reassigned if the link volumes exceeded a level of service D (LOS D). Typically, LOS D represents a congested condition that may be unacceptable to some drivers. Drivers that are discouraged by the congested condition will seek other routes to their destination. Appendix H5 shows the trip assignment and reassignment worktable for the model.

Final Model – Adjusted 2020 Traffic Volumes

The final, adjusted model is shown in Figure 9-2 representing the Vail Valley/I-70 corridor. Table 9-5 represents the 2020 adjusted model traffic volumes for the Vail model.

Table 9-5: 2020 Adjusted Volumes for the Vail Model

Link		Existing Volumes	% increase to 2020	2020 Model Volumes Adjusted
I-70	A	40,500	74%	70,600
I-70	B	28,250	77%	50,000
I-70	C	22,400	76%	39,400
I-70	D	18,500	74%	32,200
Intermountain	E	3,000	3%	3,100
South Frontage Road	F	10,000	26%	12,600
South Frontage Road	G	9,000	39%	12,500
South Frontage Road	H	12,000	17%	14,000
Vail Village	I	5,130	21%	6,200
South Frontage Road	J	16,000	5%	16,800
South Frontage Road	K	8,000	23%	9,800
Underpass	L	7,000	6%	7,400
Bighorn Road	M	5,000	2%	5,100

Chamonix	N	4,500	16%	5,200
North Frontage Road	O	12,000	18%	14,200
North Frontage Road	P	7,000	31%	9,200
North Frontage Road	Q	5,000	16%	5,800
Falls at Vail	R	7,000	29%	9,000

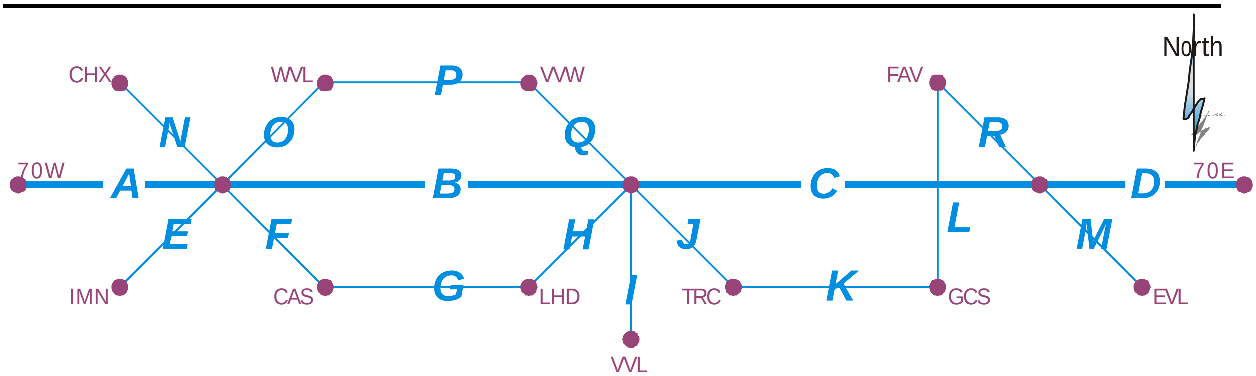


Figure 9-2: Final Adjusted Schematic Representation of the Vail Transportation Model Network

Summary

Given the assumptions about the growth potential in Vail, the model identifies several roadways that have the potential for significant increases in traffic volume; specifically, the North and South Frontage Roads near the West Vail interchange.

The model indicates that the North Frontage Road (links O and P) will see a substantial growth in traffic over the next 20 years with an approximately 30 percent increase. This is due to the assumed employment growth of the West Vail development north of I-70. Increased development in the Lionshead area results in increased traffic volumes on the South Frontage Road between the West Vail roundabouts and the Main Vail roundabouts.

Note that the South Frontage Road link to the Transportation Center (TRC) has only a moderate increase (five percent) in traffic volume. This is because the Transportation Center is not expected to attract any more traffic volume than it currently does now. Enhanced transit services or additional incentives to use the Transportation Center could be implemented to counteract the increase in traffic volumes in other parts of the town. If such strategies are implemented, the traffic volumes in and out of the Transportation Center would increase.

The Town of Vail has set a limit of acceptable congestion of LOS C or less on town streets. Several of the roadways modeled for the existing condition do not meet this criterion. These roads include the South Frontage Road between the West Vail roundabouts and the Transportation Center (links F, G, H and J) and between East Vail and the Transportation Center (K), the main road into Vail Village (link I), and the North Frontage Road into West Vail (links O and P). In addition, the South Frontage Road into the Transportation Center is in excess of LOS D. The model estimates that these roads will continue to be over LOS C, with links F, H, J, and O being at LOS D.

Chapter 10: PEIS Issues

The Colorado Department of Transportation (CDOT) recently initiated a Programmatic Environmental Impact Statement (PEIS) for Interstate 70 (I-70) between Denver and Glenwood Springs. Several I-70 issues have been identified that affect the Town of Vail and are relevant to the PEIS process. These issues were developed by the Town of Vail from a citizen focus group. The purpose of this chapter is to document the issues identified, discuss real and potential problems caused by these issues, make recommendations for these issues, and provide input into the PEIS process.

Issues

Issues relevant to the Town of Vail that were raised from staff involvement and from the focus group held September 28, 2000 included the following: noise, air quality, water quality, fixed guideway opportunities, accessibility, congestion, safety, the East Vail Interchange design, and transportation options. For each of these issues, comments were raised to address the associated causes and/or problems. Potential threats to the Town of Vail were then identified for each issue. Finally, solutions were proposed to address these issues. Table 10-1 at the end of this chapter also shows these issues in the form of a matrix. The matrix includes each issue and the solutions that might address that issue. Most of the solutions pertain to more than one issue.

Noise

Noise has become a concern for many Vail residents, due primarily to increasing traffic on I-70. Comments raised through the input process include the following:

- **Speeding**. Many vehicles on I-70 exceed the posted speed limit through the Town of Vail, creating higher levels of noise.

- **High traffic volumes** – a high volume of vehicles creates overall noise levels that are unacceptable to the residents of Vail.

- **Type of pavement** – rough pavement on I-70 and rumble strips along the sides of I-70 create higher noise levels through this area.

- **Topography** – the steep valley slopes keep more noise in the valley and result in increased noise levels from I-70.

- **Compression brakes on large trucks** – Commonly referred to as "Jake-brakes," these are used to reduce speed on downgrades. These brakes create high levels of noise and are used by trucks traveling west on I-70 on the downgrade of Vail Pass.

These factors may result in potential threats to the Town of Vail and its residents. Property values may begin to decline if noise levels continue to increase, especially near I-70. This may also result in lower development potential of the area in general. Quality of life for residents may decrease if high levels of noise become constant from I-70. The visitor experience may be negatively altered as well if the area is perceived as too noisy and congested. Finally, health risks such as loss of hearing and increased stress may also be associated with high noise levels.

Ways were discussed to solve noise problems along I-70 through the Town of Vail. Some methods met unanimous approval while others were discussed only briefly. The solutions discussed that met unanimous approval are as follows:

- **Better enforcement of speed limits** using techniques such as an increase in enforcement personnel or issuing speeding tickets using photo radar.

- **Lower the speed limit** for trucks through the Vail area.

- **No passing for trucks** through Vail.

- A smoother, **low noise pavement** could be used on I-70 through the Vail area. This would reduce tire noise.

- **Sound barriers** to block I-70 noise from the Town of Vail, if they are feasible.

- **Enforce the noise ordinance** that is currently in place for the Town of Vail. This could involve better coordination between the Town of Vail and the local or state law enforcement agencies.

Some other opportunities to address noise issues were also mentioned but not unanimously supported including the following:

- **Alternative transportation routes for trucks and freight** through the area to diffuse the noise.

- **Bury or "cap" I-70** through Vail. This would involve tunneling I-70 underground and using the land above for development, open space, or other uses.

- **White noise** is a low-level noise used to mask louder noises. Residents or businesses could use white noise to muffle the noise from I-70.

- **Noise cancellation** creates opposite and equal noise waves to cancel the noise from automobile engines, based on the characteristics of each individual engine.

Some solutions for noise that will be described in further detail below include the use of Intelligent Transportation Systems (ITS), better construction management, and providing incentives for using alternative transportation use.

Air Quality

Air quality has also become an important issue for residents of the Town of Vail due to increased traffic volumes through the area. The Town of Vail raised comments specific to air quality including the following:

- **Burning brakes** cause greater emissions of particulates and odor into the air, causing a decline in air quality in the Vail Valley.

- **Dust** in the form of PM_{10} results from gravel used on the road for snowy/icy conditions on I-70.

Problems with air quality create potential threats to the Town of Vail and its residents. The threats addressed were found to be the same as those listed resulting from noise, with the addition of several issues specific to air quality. In addition to the health of residents of the Town of Vail, wildlife in the area could be adversely affected. The threat of hazardous material spills by trucks transporting these materials could also create potential air quality problems. Other hidden threats could exist as well, which are not always apparent in the short term; rather, they have the potential to affect the long-term health of the community.

Opportunities to address air quality issues were also unanimous in some cases, with only a few comments on others. Opportunities to address air quality issues that met unanimous approval include the following:

- **Diligent carbon monoxide (CO) monitoring**. By constantly monitoring CO levels, the Town of Vail will be better informed as to when levels are unacceptable.

- **Decreased sanding of I-70** in snowy or icy conditions. Sanding the roads to increase traction for vehicles traveling I-70 in these conditions creates high amounts of dust. Alternative types of traction could be considered such as hard aggregate that gets swept away instead of creating dust. Other types of deicers could also be used that are more environmentally sound to decrease sanding while still providing a safe roadway in snowy or icy conditions.

- **Alternative transportation modes for people** such as a fixed guideway system would decrease the amount of vehicles on the road and therefore could reduce the amounts of pollutants in the air.

- **Alternative transportation routes for freight** could be used to disperse the emissions in the air. Instead of all vehicles on I-70 traveling the same route, trucks and other freight vehicles could take an alternative route to reduce concentrated levels of emissions in the corridor.

Other ideas mentioned to address air quality issues include fans or mechanical devices to diffuse vehicle emissions in the Vail Valley along I-70 and the installation of a heated roadway to reduce the amount of sanding necessary.

In addition to these solutions, some others that would address air quality described under solutions for noise include speed enforcement, lowering the speed limits for trucks and other vehicles, and capping I-70.

Some solutions for air quality that will be described in further detail below include ITS and providing incentives for alternative transportation use.

Water Quality

Water quality is another concern for the Town of Vail because of increased traffic volumes. Comments were raised by the Town of Vail about I-70 and the effect that high traffic volumes are having on water quality. These include the following:

- **The source of the pollution into the waterways**. Point source pollution is easier to diagnose and control; but non-point sources, which can originate from I-70 and travel to distant waterways, can often be difficult to diagnose and treat.

- **Sanding** of I-70. Once the snow and ice melts, the sand is blown into ditches or runs off into waterways near I-70, creating sediment problems.

- **Polluted run-off** is a problem resulting from storm drainage, animal carcasses or road kill, magnesium chloride used for deicing, oil and other hazardous materials from vehicles traveling I-70, and litter.

Threats caused by these issues are once again the same as those common to noise and air quality, with the addition of some specific to water quality. Polluted waters adversely affect fish and plant habitat. This can be seen in declining numbers of certain species of fish and plant life. Another threat is that the water flows to downvalley communities, putting the health of the residents, wildlife, and plant life in those areas at risk as well.

Some opportunities to address these issues were raised briefly during the process, and these include the following:

- **A water treatment program** for local waterways.

- **An Adopt a Highway program** to clean up litter and spills before they have a chance to enter the waterways.

- **Better maintenance** of the area to keep the corridor free of litter, hazardous materials, and/or other obstacles that might lead to the polluting of the local waterways.

In addition to these solutions, other solutions already addressed that would apply to water quality include capping I-70, less sanding, alternative routes for freight, and heating the roadway.

Some solutions for water quality that will be described in further detail include ITS, better construction management, and providing incentives for alternative transportation use.

Fixed Guideway

The PEIS also addresses the idea of a fixed guideway (monorail) that would eventually run from Denver International Airport (DIA) to the Eagle County Airport, under the authority of the Colorado Intermountain Fixed Guideway Authority (CIFGA). Because the guideway would travel through parts or all of Vail, the Town of Vail addressed the issue. The main comment raised was that the fixed guideway would provide for a greater capacity of people to travel to and from the area. The higher volume of people using a monorail and therefore not driving in their vehicles could lessen the threats to the community mentioned for the preceding issues.

Some opportunities to address this issue and encourage people to use the monorail were discussed, and these include the following:

- **Provide services in the median** for travelers using the fixed guideway system (in those areas where the system runs in the median).

- **Provide incentives to use the monorail** such as discounted rates for certain groups or periods of travel or a frequent users card that offers special discounts or free miles after a specified amount of use.

- **Coordinate with parking strategies in Vail**. This could be achieved by locating stations near existing public parking garages or lots in Vail.

- **Make compatible with the types of uses for the community**. For example, because skiing is a primary industry in the Vail Valley, ski racks and luggage compartments should be installed on the cars of any rail system. All types of use for the area should be considered to encourage riders to use this type of transportation.

- **Find alternatives to the addition of traffic lanes on I-70 through Vail**. The Town of Vail feels that widening I-70 is not the answer to congestion problems, and alternative transportation solutions such as a monorail are necessary. Additional lanes of traffic on I-70 could potentially limit opportunities for other transportation solutions in the corridor in the future.

In addition to these opportunities, other solutions already mentioned that would apply to the fixed guideway include capping I-70, alternative transportation modes for people, and alternative transportation routes for freight.

Some solutions that would apply to the use of a fixed guideway system that will be described in further detail include better driver education and ITS.

Other Issues

Other issues were discussed by the Town of Vail in less detail, while still retaining the same level of importance. These are discussed below.

Access

Access is not always consistent on I-70 from Denver to Vail (and vice versa) because of construction delays, weather, congestion, and other unforeseen conditions. The Town of Vail raised some comments concerning access. One of these is the economy of Vail. Inclement weather, closures, or other conditions may create poor or no accessibility for the Town of Vail. This may prevent people from visiting the area, and therefore, reduce benefits to the economy.

Poor accessibility may also result in a poor guest experience. High travel times can create frustration and a feeling of dissatisfaction with the overall experience. Consequently, some of these guests may not make repeat visits.

Another comment concerning access involves the dependability of travel times along I-70 in the corridor. Travel times are generally inconsistent, depending on the time of day and other unforeseeable conditions on I-70.

The Town of Vail discussed opportunities to address access. One solution was unanimous while others were mentioned briefly. The unanimous solution discussed is Intelligent Transportation Systems (ITS). ITS is a way of managing transportation from a broader perspective, stressing the fact that transportation involves more than just widening highways. For a growing population, alternative methods of improving transportation should be considered such as rail systems, improved bicycle and pedestrian facilities, better management of existing systems, better management of vehicles, and better management of transportation users. Some of these systems such as fixed guideway systems can be run in almost all weather conditions and would not be hindered by delays such as road construction or road closures.

Another solution is better communication. This includes better communication with residents of the Town of Vail, travelers on I-70, and within agencies such as the Colorado Department of Transportation (CDOT). Improved information for travelers such as road closures and congestion delays may alert a driver to make the trip at another time or use another route, if possible. The various regional branches of CDOT may also benefit by keeping all information consistent and updated through constant communication, electronically and/or verbally. This can be done with centrally managed message signs, radio, websites, and phone systems.

Better construction management during construction activities can also minimize delays for improved access. By practicing efficient construction management techniques such as performing the majority of the work during off hours or days, traffic congestion can be minimized.

Other solutions already mentioned that also apply to access include capping I-70, alternative transportation modes for people, alternative transportation routes for freight, providing services in the median, providing incentives for alternative transportation use, and coordination with parking strategies in Vail.

Congestion

Congestion along I-70 is another concern for the Town of Vail. Congestion occurs under many circumstances including peak hour periods such as post-ski area closure, accidents, inclement weather, and construction delays. Congestion and traffic delays can reduce the quality of life for residents and quality of experience for guests.

One solution that met unanimous approval for the Town of Vail is an Incident Management Plan, a subset of ITS, to be managed by CDOT. Incident management involves the anticipation and prevention of problems by assigning jurisdictional responsibility for problems or incidents that may occur on I-70. This would require coordination between several different agencies such as fire, emergency services, and CDOT; all of which may be under different jurisdictions. In the event of an accident, the Plan would designate a responsible party for that type or location of accident. Specific procedures would be laid out for that party to follow in order to respond quickly and clear out the accident to maintain adequate traffic flow.

Other solutions that have been mentioned previously that would address congestion include alternative transportation modes for people, alternative transportation routes for freight, other ITS, traveler communication, construction management, better CDOT communication, providing services in the median, providing incentives for using alternative transportation, and coordinating alternative transportation with parking strategies in Vail.

Safety

Safety has also become a concern for the Town of Vail. As an increasing number of vehicles are traveling I-70 at high speeds, more accidents are occurring. In addition to some of the solutions discussed above, another solution to this problem includes installing guard barriers on I-70. These would prevent vehicles from crossing over into the other lanes or driving over a steep drop during an accident.

Better driver education is a unanimous solution to create safer driving conditions. Many drivers are unaware of the potential hazards that may exist on a roadway such as I-70. By educating drivers about these hazards and how to avoid them, many accidents could be avoided.

Other solutions already mentioned that would also apply to safety include speed enforcement, lower speed limits, no passing for trucks through Vail, capping I-70, alternative transportation modes for people, alternative transportation routes for freight, heating the roadway, incident management, other ITS, and providing incentives for using alternative transportation.

East Vail Interchange Design

The Town of Vail also discussed the East Vail Interchange design. They feel that the design needs to be reviewed in relation to the traffic volumes at that interchange.

One solution that was discussed is a redesign of the intersection. A more efficient design could alleviate traffic problems by creating a better flow for the high traffic volumes.

Another solution for this issue that has already been mentioned is better CDOT communication. Intersections such as this one with poor functionality should be made a priority for local and state agencies.

Transportation Options

Transportation options involve creating or providing other modes or options to I-70 travelers. Some specific options include finding sources of funding for the CIFGA. CIFGA would provide an alternate mode to private vehicles. Funding for this agency has not yet been established for the creation of a mass transit alternative to I-70. Another option includes giving the CDOT responsibility for finding an alternative route for freight carriers. One example is the use of I-80 as an alternative route to I-70.

Solutions suggested for this issue that have already been mentioned include other alternative transportation modes for people, alternative transportation routes for freight, driver education on the benefits of alternate modes, ITS, traveler communication, better CDOT communication, services in the median, providing incentives for using alternative transportation, coordination with parking strategies, catering to types of uses for those using alternate modes such as the CIFGA, and prohibiting the addition of traffic lanes to I-70.

Conclusion

While the Town of Vail is not a large community in terms of population and area, the community is an important part of the economy of Colorado. The ski area, recreation, and retail industries are substantial contributors to the state. The issues discussed by the Town of Vail are not necessarily specific to their community. These are issues that affect many towns along I-70. With rising local and visitor populations, I-70 has been a source of conflict and debate over solutions to relieve environmental, safety, and congestion concerns that will only become worse with time if no action is taken. Alternative transportation solutions seem to be the most promising remedies for many of the problems on I-70. The Town of Vail presents these issues with the hopes of creating lasting solutions for the future of the community and other communities along I-70.

Table 10-1: PEIS Issues and Possible Solutions

Issues	**Speed Enforcement	**Lower speed limit for trucks	Lower speed limit for all vehicles	**No passing for trucks	Reroute trucks	**Low noise pavement	Bury/cap I-70	White noise	Noise cancellation	**Sound barriers	Enforce Noise Ordinance	**Monitor CO	**Less sanding	**Alt. transp. Modes for people	**Alt. transp. routes for freight	Fans/mechanical removal of air	Heat roadway	Water treatment	Adopt a Highway	Maintenance	**Driver education	**Incident Management	**Other ITS	Guard barrier	Traveler communication	Construction Management (during construction)	Better CDOT comm.	Redesign	Services in median	Provide incentives for using alt. transp.	Coordinate with parking strategies	Cater to types of use	**No more traffic lanes
Noise	X	X	X	X	X	X	X	X		X	X												X			X				X			
Air Quality	X	X	X		X		X					X	X	X	X	X	X						X							X			
Water Quality					X		X						X				X	X	X	X			X			X				X			
Fixed Guideway							X							X	X						X		X				X		X	X	X	X	X
Accessibility					X		X							X	X								X		X	X	X		X	X	X		
Congestion					X									X	X							X	X		X	X	X		X	X	X		
Safety	X	X	X	X	X		X							X	X		X				X	X	X	X						X			
E. Vail Interchange Design																											X	X					
Transportation Options							X							X	X						X		X		X		X		X	X	X	X	X

Solutions

* Indicates unanimous support for these solutions by the Town of Vail.

APPENDICES

A1 Peak Hour Traffic Volumes, March 2000 and July 2000
A2 FHU Vail Village Peak Hour Traffic Volumes, September 2000
B1 Project Objectives and Criteria
B2 Technology Screening Process
C1 Portions of the Eagle County Trails Master Plan
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D1 Intersection Level of Service
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E I-70 Capping and Fixed Guideway Mapping
F1 CDOT Noise Analysis and Abatement Guidelines
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