Twin Tunnels Environmental Assessment
Transportation Technical Memorandum

August 8, 2012

Table of Contents

Appendices:

List of Figures

List of Tables

Page No.

Acronyms

AADT	annual average daily traffic
AAWDT	annual average weekday traffic
ATR	Automatic Traffic Recorder
CDOT	Colorado Department of Transportation
DRCOG	Denver Regional Council of Governments
DTA	Dynamic traffic assignment (model)
DTD	Department of Transportation Development
EA	Environmental Assessment
EJMT	Eisenhower Johnson Memorial Tunnel
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
HCS	Highway Capacity Software
HPTE	High Performance Transportation Enterprise
LOS	level of service
ML	managed lane
mph	miles per hour
OD	origin-destination
PDO	property damage only crash
PEIS	I-70 Mountain Corridor Programmatic Environmental Impact Statement
RTMS	remote traffic monitoring system
RTP	regional transportation plan
SH	State Highway
SPF	safety performance function
TTI	travel time indicator
VHT	vehicle hours of travel
VMS	variable message signs
VMT	vehicle miles of travel
VOT	value of time
vpd	vehicles per day
vph	vehicles per hour
VTTS	value of travel time savings
WAC	weighted accident concentrations

1.0 Purpose of the Memorandum

The Federal Highway Administration (FHWA), in cooperation with the Colorado Department of Transportation (CDOT), is preparing an environmental assessment (EA) for proposed changes to the eastbound lanes of Interstate 70 (I-70) and the eastbound bore of the Twin Tunnels between milepost (MP) 241 and MP 244 in Clear Creek County, Colorado. The Twin Tunnels area is one of the most congested locations along the I-70 Corridor. Improvements are necessary to improve safety, operations, and travel time reliability in the eastbound direction of I-70 in the study area. The improvements will be consistent with the *I-70 Mountain Corridor Final Programmatic Environmental Impact Statement* (PEIS) Record of Decision (ROD), I-70 Mountain Corridor Context Sensitive Solutions process, and other commitments of the I-70 PEIS.

This technical memorandum (TM) discusses the regulatory setting and describes the affected environment and impacts of the Proposed Action on transportation resources within the identified study area. The TM also documents mitigation measures, including applicable measures identified in the *I-70 Mountain Corridor Final PEIS,* which would reduce any impacts during construction and operation. The I-70 PEIS identified comprehensive improvements for the Corridor. The Proposed Action would immediately address safety, mobility, and operations in the eastbound direction at the Twin Tunnels but would not address all of the needs in the Twin Tunnels area. The Proposed Action would not preclude other improvements needed and approved by the I-70 PEIS ROD.

2.0 How Does the Analysis Relate to the Tier 1 PEIS?

The *I-70 Mountain Corridor Final Programmatic Environmental Impact Statement (PEIS)* (CDOT, 2011) and the *I-70 Mountain Corridor PEIS Travel Demand Technical Report* (CDOT, 2011) provide information about existing and future transportation conditions in the study area. Some of the key findings of the PEIS that are relevant to the Twin Tunnels study area are that weekend congestion is prevalent now, 2035 congestion is expected to occur for longer periods during the day and more days of the week (with severe congestion occurring at the Twin Tunnels area for more than ten hours on a weekend), and these conditions are expected to deteriorate even more by 2050.

These key findings are generally consistent with new analysis that was conducted for this Tier 2 process, although weekday congestion is predicted to occur only occasionally, rather than on a consistent basis as it was forecast during the Tier 1 process.

2.1 What process was followed to analyze transportation conditions?

A panel of experts with backgrounds in transportation planning and the I-70 Mountain Corridor convened on December 15, 2011 to discuss and develop the methodology for forecasting future travel in the I-70 Mountain Corridor. This panel reviewed potential options for determining the rate of growth that might be used to forecast 2035 volumes and agreed that it would be appropriate to utilize two sources of base information since weekday and weekend travel patterns are significantly different.

For weekday forecasts, the panel recommended using 2035 forecasts from the Denver Regional Council of Governments (DRCOG), which is responsible for regional transportation planning efforts. DRCOG's forecasts were utilized as the basis for this Tier 2 analysis. These growth rates (growth factor of 1.41) are close to the findings of the PEIS which determined that population in the I-70 Mountain Corridor would generally double between 2000 and 2035. Recent forecasts for the period from 2010 to 2035 (which were also the basis for DRCOG's analyses) show that population in counties along the I-70 Mountain Corridor will grow between 50 and 90 percent over this period. Growth in Clear Creek County is forecast to change from approximately 10,300 in 2010 to approximately 14,450 in 2035, a growth rate of approximately 40 percent. (DRCOG, 2012)

For 2035 peak period weekend forecasts, the panel agreed to use the same traffic growth forecasts as were used in the PEIS, a traffic growth factor of 1.22. The lower weekend (compared to weekday) growth rate is reasonable since congestion currently restrains growth in weekend traffic and will in the future even if the Proposed Action is implemented.

3.0 What Agencies were Involved in This Analysis and What are Their Issues?

The agency primarily involved in the transportation analysis was DRCOG. DRCOG sent a scoping letter to CDOT on September 29, 2011 requesting that CDOT examine tolling/pricing options for the Twin Tunnels improvements and also stating that the DRCOG Metro Vision Regional Transportation Plan would need to be amended to include any additional lane capacity in the Twin Tunnels area.

The local agencies involved in the Project Leadership Team (PLT) and the Technical Team also raised questions related to transportation issues as noted below:

- Travel Demand Analysis
  - How will the model be validated and tested?
  - What is the relationship between the PEIS model and the DynusT model?
  - What are the differences in analysis procedures for weekday and weekend analyses?
- Overview of the Managed Lanes
  - How do managed lanes improve flow?
  - How do managed lanes improve reliability of travel time?
  - What is the revenue generation?
  - What infrastructure is required?
  - How does the managed lane affect or improve emergency response?
  - How does the managed lane affect the footprint?
  - Could the design speed be higher if we didn't have the managed lane?
  - What are the safety implications of the Managed Lane Option?
- How will the Managed Lane Operate?
  - When will the tolls turn on—time of day and initial day—what is the threshold?
  - How will travelers be notified?
  - What is the value of time used in the model?
  - What are the assumptions for the model in determining how much the toll should be?
  - What is the relationship between tolling and congestion?

- How will current safety problems be addressed (especially those related to headlight glare and the sharp curves)?
- Construction Phase effects
  - Will there be backups on weekdays during construction?
  - Will the chain station be available during construction for early or late season storms?

4.0 Existing Traffic Conditions

4.1 What field data were collected in the I-70 Mountain Corridor?

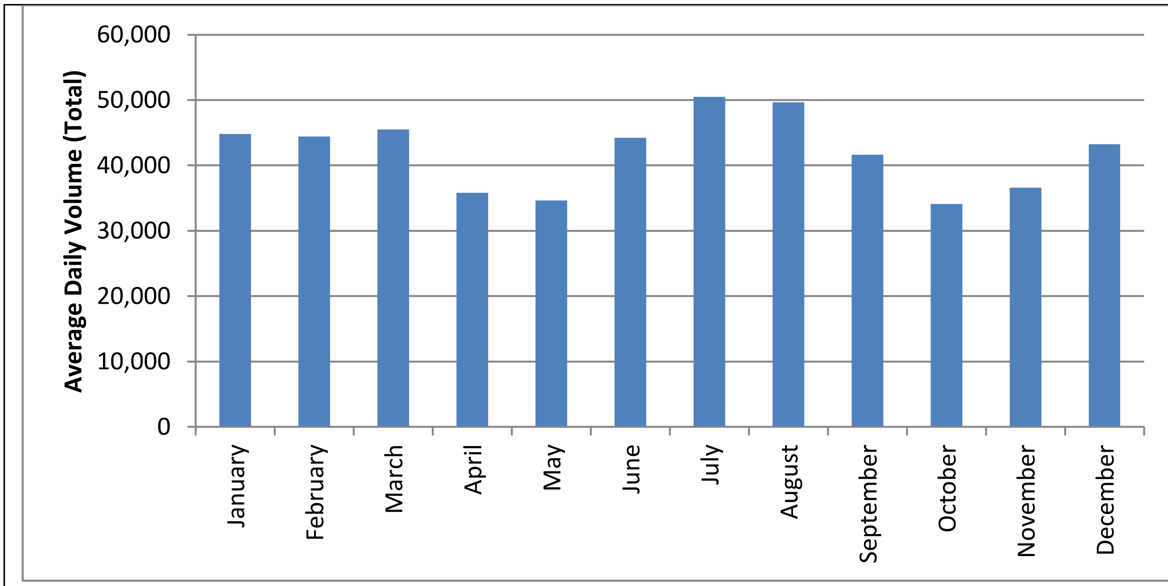
The Colorado Department of Transportation (CDOT) collects a significant amount of field data in the I-70 Mountain Corridor using electronic devices. These data are valuable in recording the hour-by hour (and often minute-by-minute) status of traffic operations in the corridor. These devices have provided the basis for the following summary of existing traffic conditions in the vicinity of the Twin Tunnels. These devices include:

- Automatic Traffic Recorders (ATR)—These devices record volumes, speeds, and vehicle classifications on an hourly basis. This information is available from the CDOT Department of Transportation Development (DTD) for each day of the year. Data is available within several days from when it was recorded. The two ATRs that are of most interest to this study effort are located at the Twin Tunnels and at the Eisenhower Johnson Memorial Tunnels (EJMT). Other nearby ATRs are located at Genesee on I-70 and at Berthoud Fall on US 40.
- Remote Traffic Monitoring Systems (RTMS)—These devices use radar to record the speed of each vehicle. They are typically located on poles along the road and can also record speed data for each lane of a multi-lane facility. Data are typically grouped into five-minute or hour averages of speed and volume for analyses. There are a number of these units already deployed along I-70, and more are being added as needs arise.
- Travel Time Indicators (TTI)—These devices record the time it takes for individual vehicles to travel between two indicators. Electronic devices are located along the road, and pick up unique identifying vehicle information from E-470 toll tags or Blue Tooth devices carried in vehicles. The time that it takes each device to travel from point to point is recorded to provide average travel times. For privacy reasons, no records from individual devices are maintained. There are a number of these units already deployed along I-70. The information gathered serves as the basis for the messages on variable message signs (VMS) indicating the travel time to major destinations ahead.

4.2 What are the seasonal patterns of traffic?

Figure 4.1 shows average total daily traffic volumes in both directions of I-70 at the Twin Tunnels on a monthly basis. These monthly volumes establish that the summer season (June through September) generates the highest average daily volumes. This is a result of the recreational opportunities that the mountains of western Colorado provide. The second highest season (December through March) is a result of the winter activities (primarily skiing) that are provided by mountain resorts. Traffic volumes during the spring (April and May) and fall (October and November) are noticeably lower.

Figure 4.1 Average Total Daily Traffic Volumes by Month (January 2009 thru December 2011)

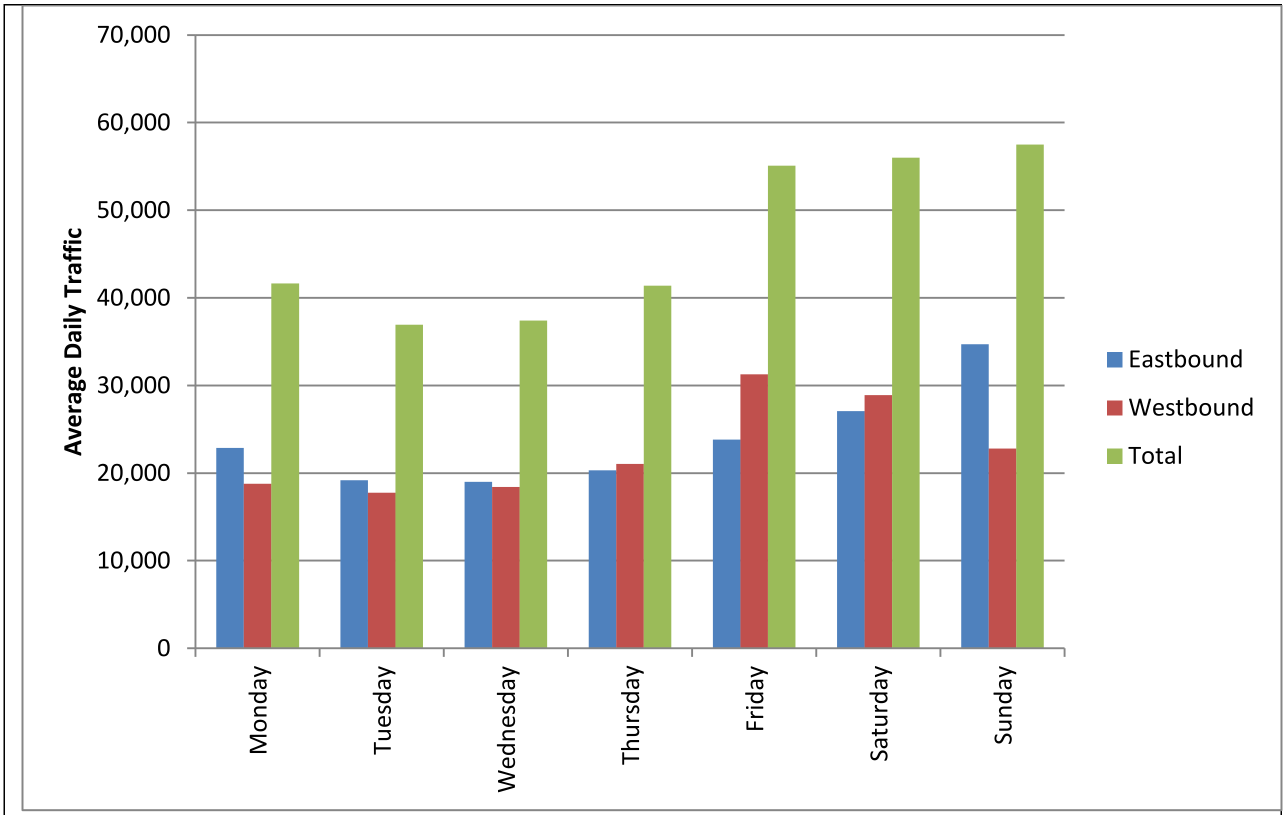


Data Source: CDOT Twin Tunnels ATR

4.3 What are the daily patterns of traffic?

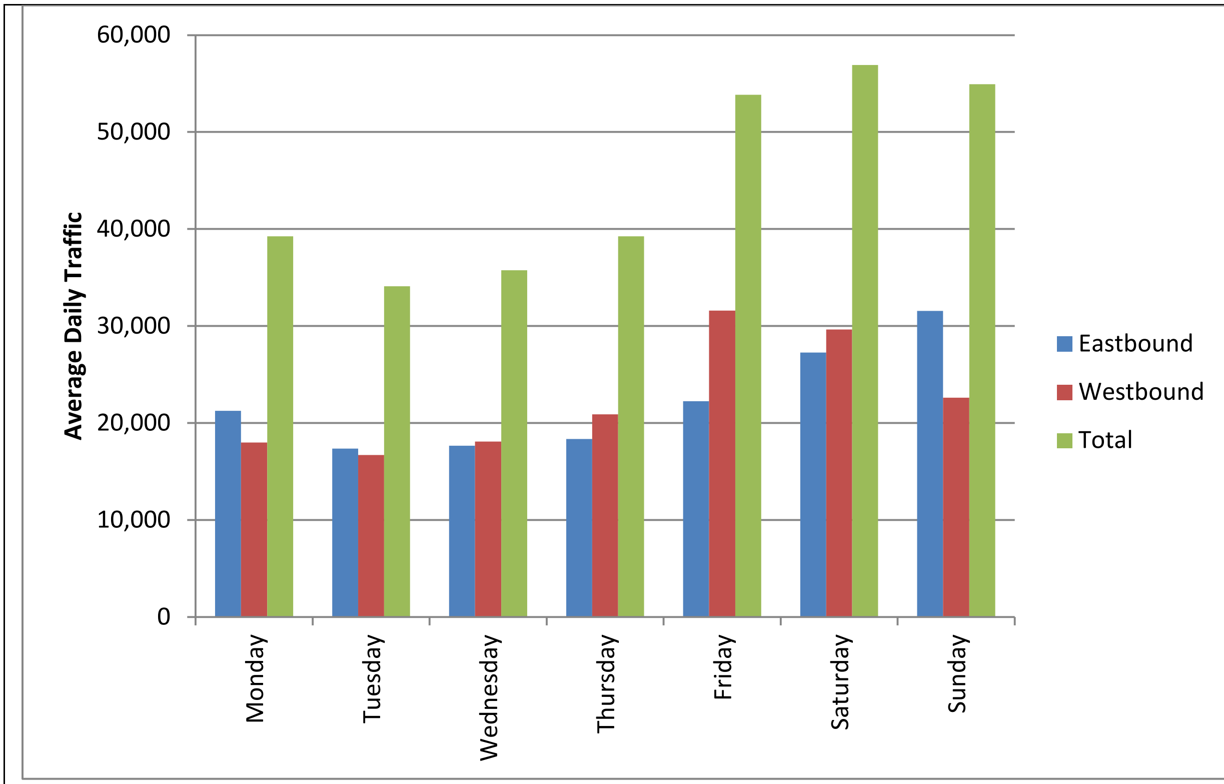
I-70 is used for different purposes on weekdays (work, shopping, medical, and social trips) and weekends (recreation). As a result, **Figure 4.2** (summer) and **Figure 4.3** (winter) show that volumes during both seasons are highest on Friday through Sunday. Volumes on these figures show westbound and eastbound volumes as well as total traffic. Westbound traffic is highest on Fridays as people drive to the mountain for recreational activities. There is slightly less westbound traffic on Saturdays. All of these vehicles add to the Sunday day volumes as they return to the Denver metropolitan area on Sundays in order to be at work on Monday morning. Thus, Sundays have the highest eastbound volumes of the week, contributing significantly to congestion on most Sundays during these two peak seasons.

Figure 4.2 Summer Daily Traffic Patterns (June thru September)



Data Source: CDOT Twin Tunnels ATR

Figure 4.3 Winter Daily Traffic Patterns (December thru March)

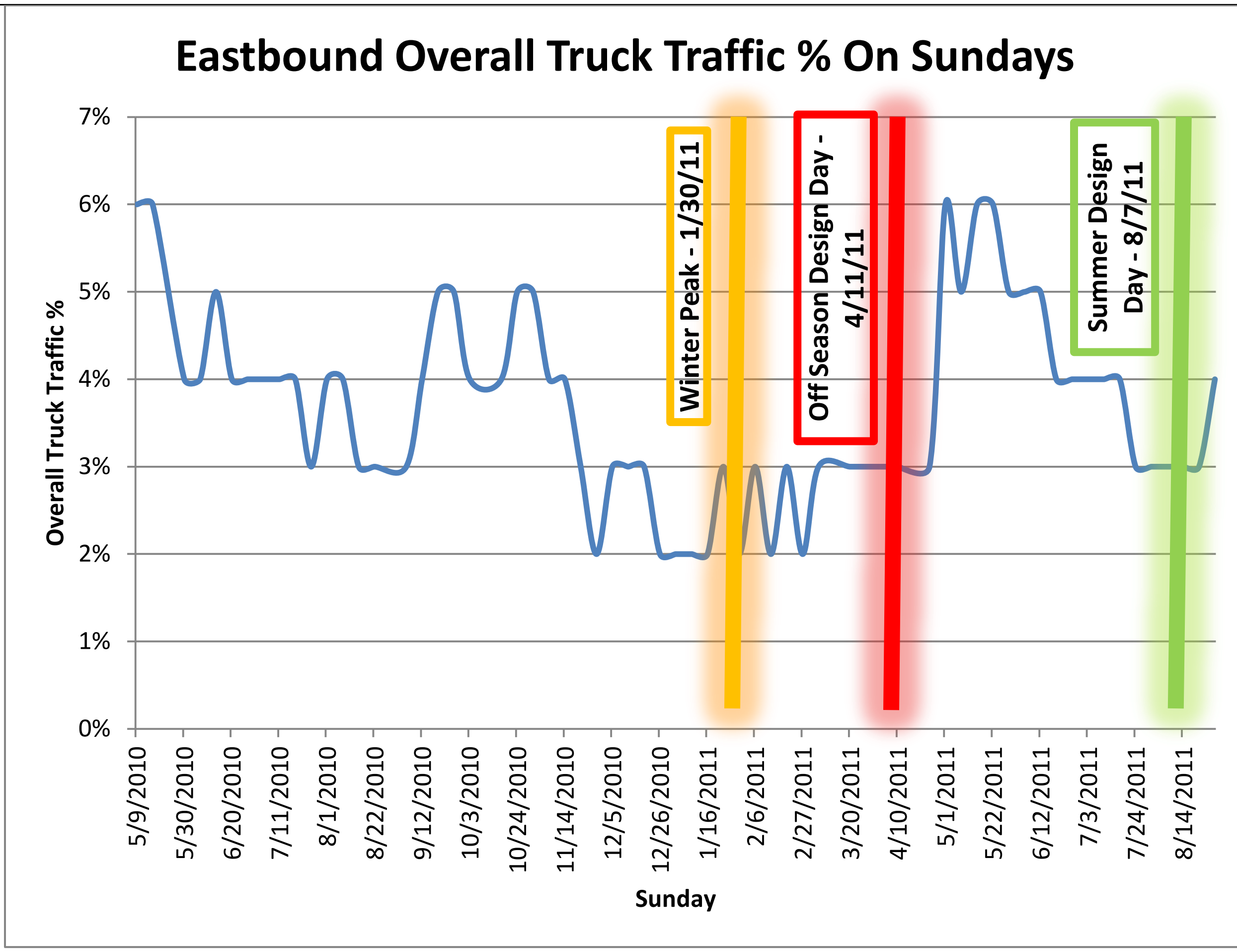


Data Source: CDOT Twin Tunnels ATR

4.4 How many trucks use the I-70 Mountain Corridor?

The ATR measured the annual average percentage of trucks traveling through the Twin Tunnels at 8.5 percent in 2010. It is higher (10.2 percent to 11.0 percent) to the west as there are fewer passenger vehicles and most of the trucks travel longer distances on I-70. The percentage gets lower to the east on I-70 closer to Denver. **Figure 4.4** illustrates the percentage of large/heavy vehicles (single and multi-unit trucks and large recreational vehicles) on Sunday afternoons during summer, winter and the off-season. Thus, Sundays are noticeably less than this average: winter is the lowest (2 percent to 3 percent), summer is next (3 percent to 4 percent) and the off-season (5 percent to 6 percent is highest). In addition, the long standing congestion problems on I-70 during Sundays afternoons are well known and businesses tend to avoid travelling during this period whenever possible. These factors more than offset the increase in recreational vehicles on weekends.

Figure 4.4 Heavy Vehicle Percentage



Data Source: CDOT Twin Tunnels ATR

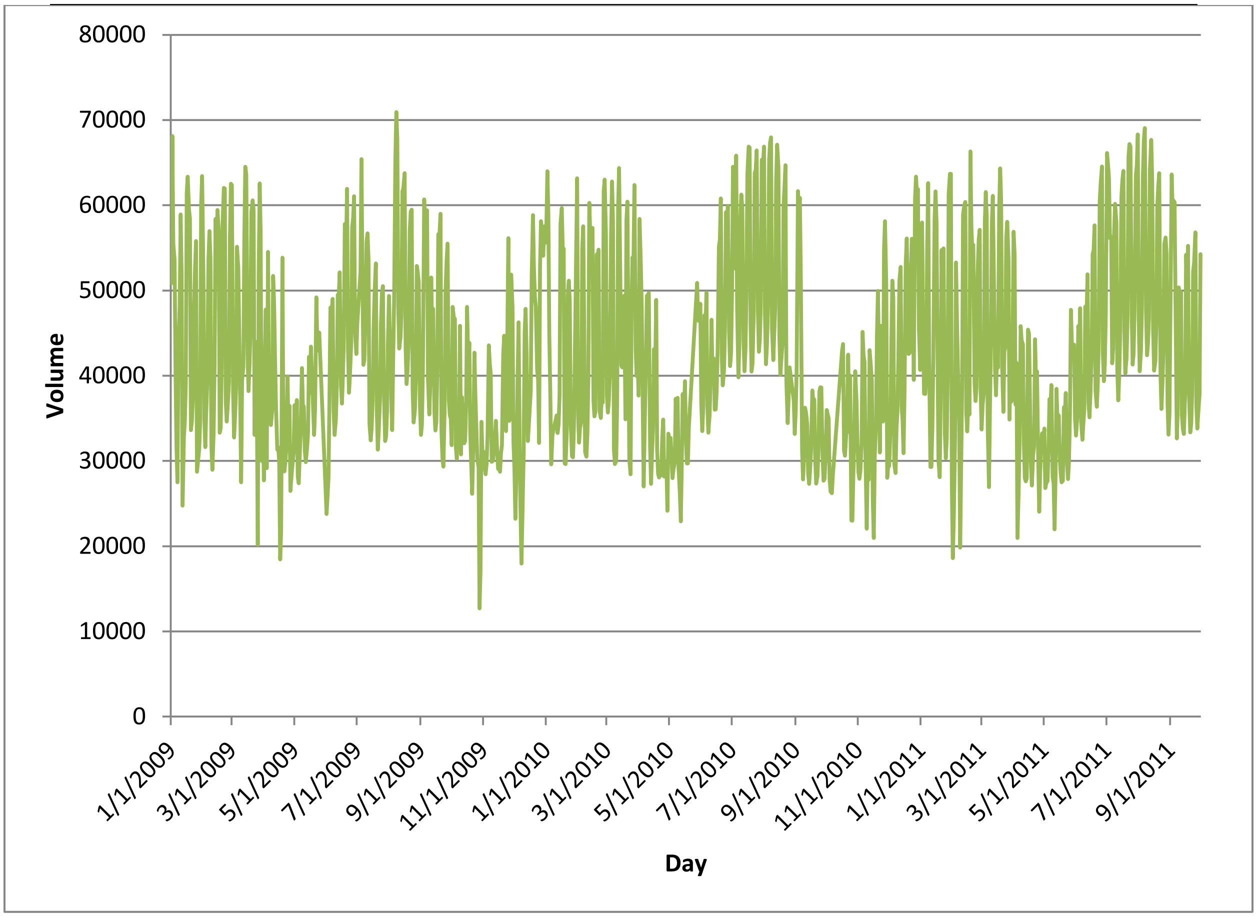
4.5 How was the peak day selected?

Peak winter and summer days were compared for 2009, 2010, and the first eight months of 2011. **Figure 4.5** shows total daily volume patterns since 2009 and **Figure 4.6** shows just the eastbound daily volumes. These figures show that peak volume days occurred during all three years during both the summer and winter seasons. **Table 4.1** compiles the highest 20 days for eastbound traffic over this most recent three year period. **Table 4.2** provides a comparison of the top ten summer days with the top ten winter days. The top 12 days occurred during the summer while two winter days are included in the highest 15 days. August 7, 2011 (the third highest) day was chosen to represent the summer peak since it is representative of the top three through seven days.

Twin Tunnels Environmental Assessment
Idaho Springs/Clear Creek County

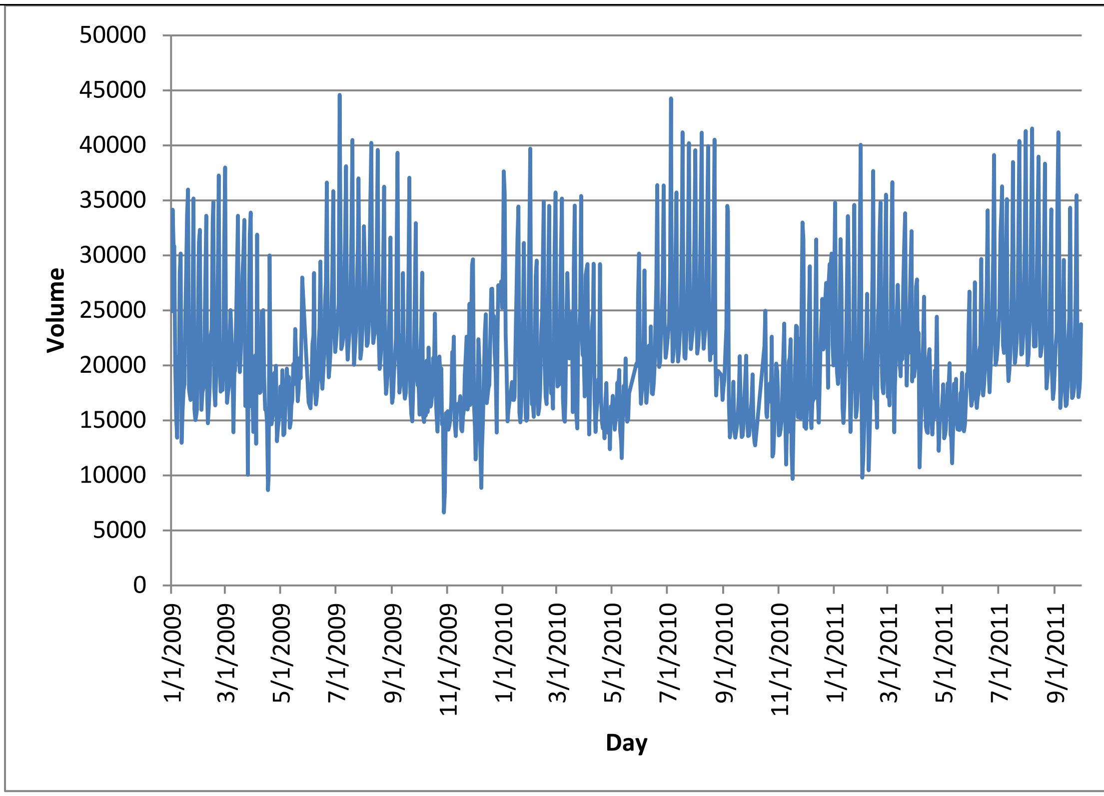
January 31, 2010 is the second highest winter day during these three years and was chosen as the winter peak day. This day was utilized in early 2010 as the basis for traffic modeling during the I-70 Reversible Lane Study. These volumes have been input into both the DynusT and VISSIM traffic models and have been utilized in the Environmental Assessment (EA) study as representative peak conditions.

Figure 4.5 Twin Tunnels Daily Traffic Trends (Total EB and WB), January 2, 2009 through August 31, 2011



Data Source: CDOT Twin Tunnels ATR

Figure 4.6 Twin Tunnels Daily Traffic Trends (EB), January 1, 2009 through September 20, 2011



Data Source: CDOT Twin Tunnels ATR

Table 4.1 Top Eastbound I-70 Daily Traffic Volumes (1/2009 thru 9/2011)

Rank	Date	Day	Daily Volume
1	7/5/2009	Sun	44,570
2	7/5/2010	Mon	44,249
3	8/7/2011	Sun	41,531
4	7/31/2011	Sun	41,284
5	7/18/2010	Sun	41,168
6	9/5/2011	Mon	41,165
7	8/8/2010	Sun	41,149
8	8/22/2010	Sun	40,509
9	7/19/2009	Sun	40,483
10	7/24/2011	Sun	40,406
11	8/9/2009	Sun	40,216
12	7/25/2010	Sun	40,187
13	1/30/2011	Sun	40,038

Table 4.1 Top Eastbound I-70 Daily Traffic Volumes (1/2009 thru 9/2011)

Rank	Date	Day	Daily Volume
14	8/15/2010	Sun	39,927
15	1/31/2010	Sun	39,700
16	8/16/2009	Sun	39,571
17	8/1/2010	Sun	39,544
18	9/7/2009	Mon	39,317
19	6/26/2011	Sun	39,128
20	8/14/2011	Sun	38,967

Data Source: CDOT Twin Tunnels ATR

Table 4.2 Highest Seasonal Eastbound I-70 Daily Traffic Volumes (1/2009—9/2011)

Highest Summer Days (2009—2011)				Highest Winter Days (2009—2011)			
Rank	Date	Day	Daily Volume	Rank	Date	Day	Daily Volume
1	7/5/2009	Sun	44,570	1	1/30/2011	Sun	40,038
2	7/5/2010	Mon	44,249	2	1/31/2010	Sun	39,700
3	8/7/2011	Sun	41,531	3	3/1/2009	Sun	37,979
4	7/31/2011	Sun	41,284	4	2/13/2011	Sun	37,665
5	7/18/2010	Sun	41,168	5	1/2/2010	Sat	37,627
6	9/5/2011	Mon	41,165	6	2/22/2009	Sun	37,262
7	8/8/2010	Sun	41,149	7	3/6/2011	Sun	36,634
8	8/22/2010	Sun	40,509	8	1/19/2009	Mon	35,986
9	7/19/2009	Sun	40,483	9	2/28/2010	Sun	35,714
10	7/24/2011	Sun	40,406	10	1/3/2010	Sun	35,690
Top 10 Average			41,651	Top 10 Average			37,430
Top 5 Average			42,560	Top 5 Average			38,602

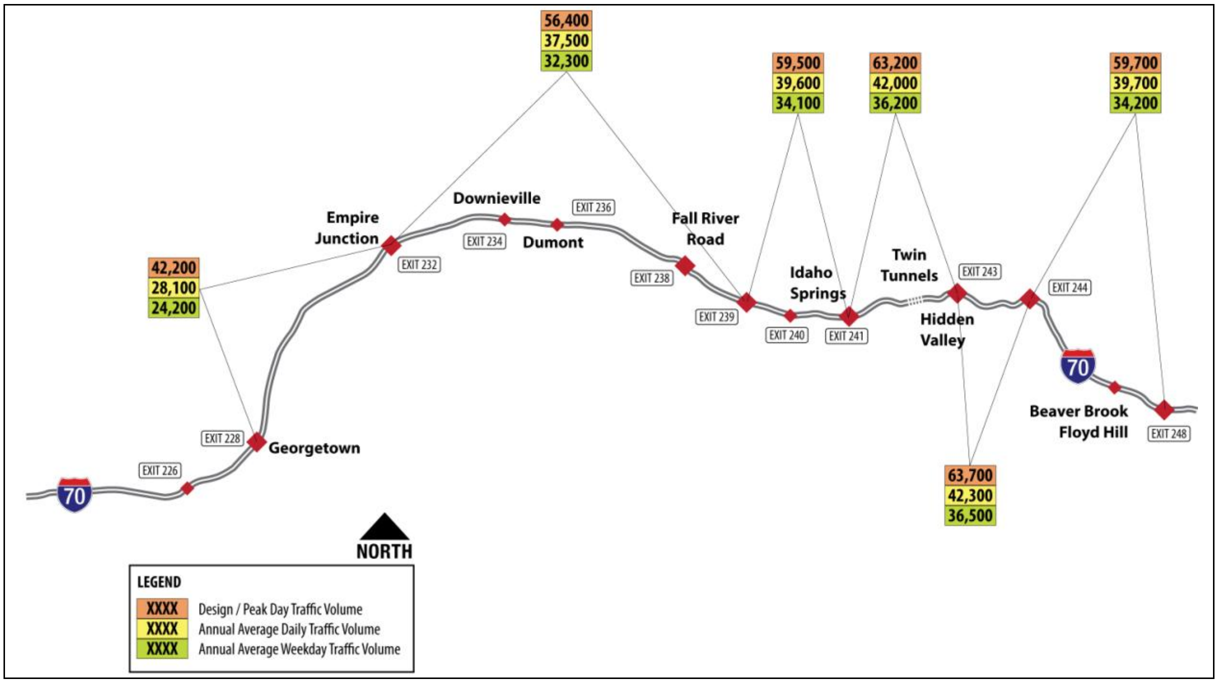
Data Source: CDOT Twin Tunnels ATR

4.6 What segments of I-70 are being analyzed for this study?

The project area for this study coincides with the two segments that will be widened from two lanes to three lanes in the eastbound direction. The widening begins at the interchange (Exit 241) at the east end of Idaho Springs, continues through the Hidden Valley/Central City Parkway interchange (Exit 243), and ends at the US 6 interchange (Exit 244) at the base of Floyd Hill.

The study area provides a broader context for traffic operations and congestion along I-70. It extends from the Georgetown interchange (Exit 228) on the west, to the Floyd Hill/Beaver Brook interchange (Exit 248) on the east. **Figure 4.7** provides a comparison of 2010 daily volumes for three typical conditions in the different segments of the study area: peak winter peak day (Sunday), annual average daily traffic volumes (AADT), and average annual weekday traffic (AAWDT). These volumes show the expected decreases between peak weekend and average weekday conditions.

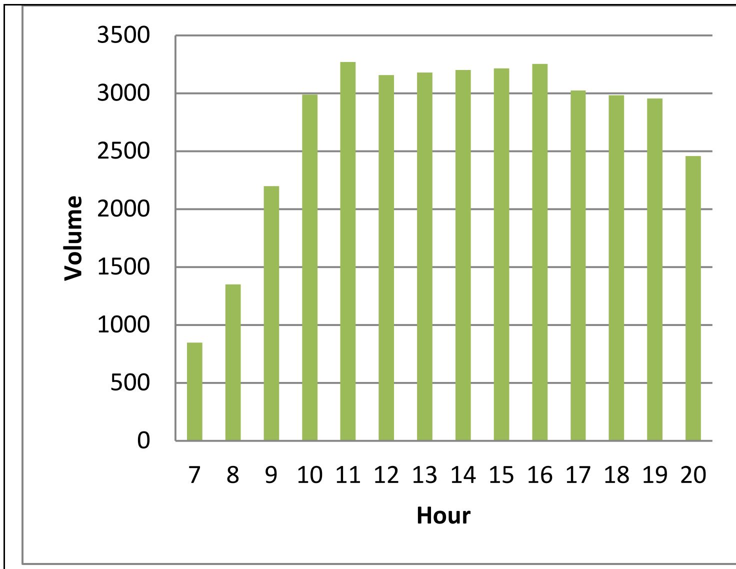
Figure 4.7 2010 Daily Volumes



4.7 What are the patterns of eastbound congestion on Sundays?

In addition to the ATR located at the Twin Tunnels, CDOT measures speeds (using RTMS units) and travel times (using TTI devices) along the I-70 Mountain Corridor to inform motorists of the projected time to reach certain destinations using the VMS along the corridor. Combining the volume and speed data provides a more complete picture of the congestion experienced on Sundays. **Figure 4.8** shows the eastbound hourly volumes from 7:00 am through 8:00 pm for the summer peak day. The graph illustrates that the maximum volume through the Twin Tunnels occurs during the 11:00 am hour at approximately 3,250 vehicles per hour (vph). The volumes fall back slightly to approximately 3,200 vph from noon to 4:00 pm. The volumes are still high at approximately 3,000 vph from 5:00 pm to 8:00 pm. This graph implies that the eastbound capacity of the Twin Tunnels is approximately 3,200 vph and that congestion (volumes more than 3,000 vph) occurs from 11:00 am to at least 5:00 pm.

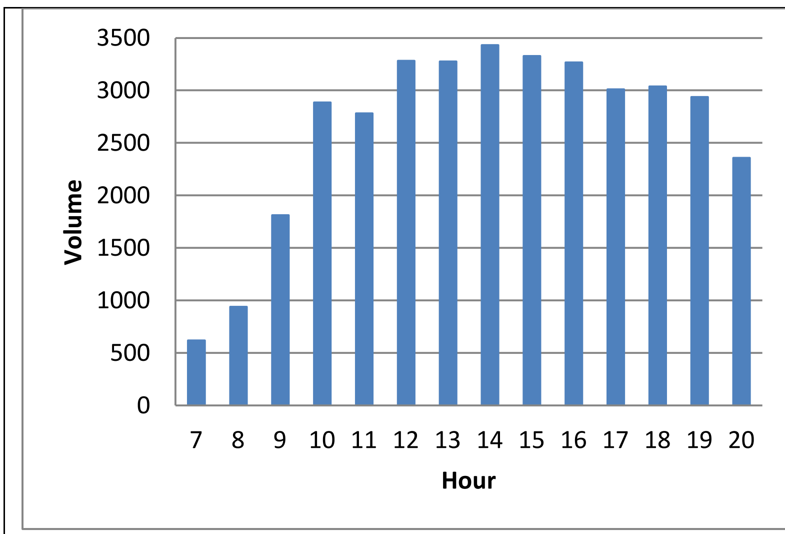
Figure 4.8 Summer Peak Day Eastbound I-70 Twin Tunnels Hourly Volumes



Data Source: CDOT Twin Tunnels ATR

Figure 4.9 shows the hourly pattern of eastbound traffic during the winter peak day. The same pattern of congestion as with summer volumes is apparent. The throughput of the eastbound tunnel increases to as much as 3,400 vph. Due to the temporal nature of ski traffic, volumes above 3,000 vph occur later in the day (starting at noon) and last later (to the 6:00 hour) than in the summer. Thus, there is generally the same number of hours above 3,000 vph as during the summer.

Figure 4.9 Winter Peak Day Eastbound I-70 Twin Tunnels Hourly Volumes



Data Source: CDOT Twin Tunnels ATR

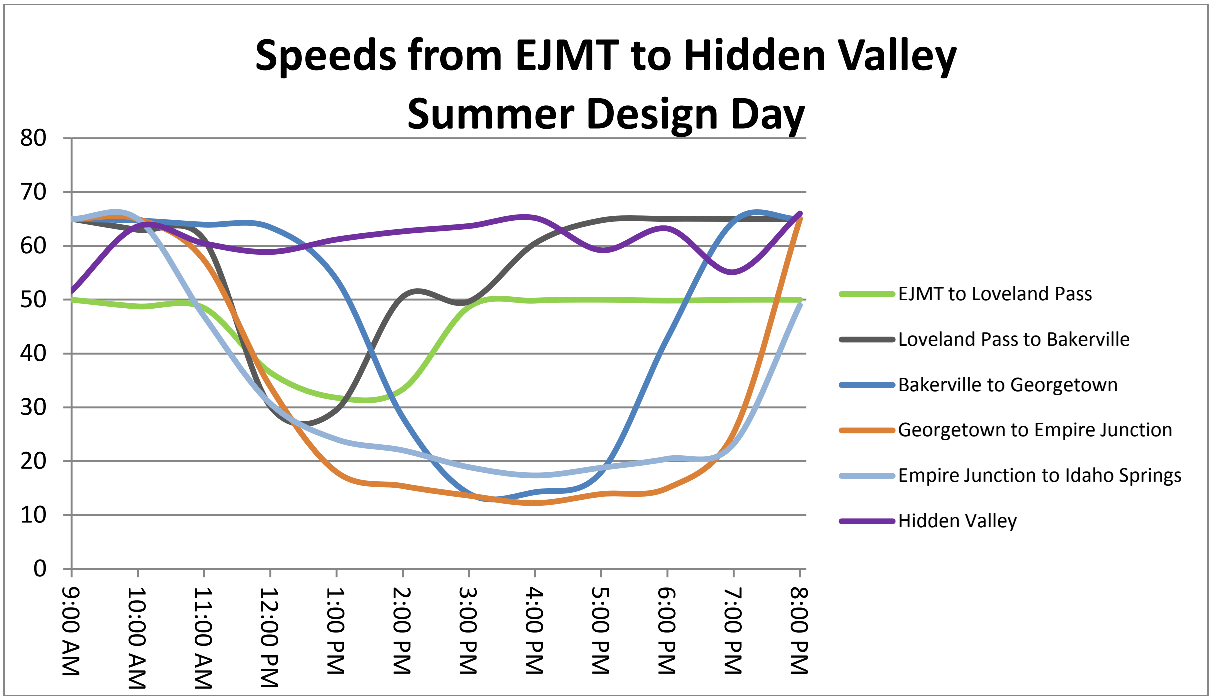
Figure 4.10 illustrates the patterns of congestion west of the Twin Tunnels on the two peak days. This figure shows average travel speeds through various segments of the corridor east of the EJMT. This shows a pattern of speeds decreasing over time through upstream segments. The segment from Empire Junction to Idaho Springs first experiences a decrease in speeds around 11:00 am. Within an hour, the speeds have fallen to the 30 mph range signifying congested speeds. The Georgetown to Empire Junction segment begins to experience a marked decrease in speeds at approximately 12:00 pm. Bakerville to Georgetown begins to experience slower speeds around 1:00 pm in the summer and 3:00 pm in the winter. Later in the day, I-70 slowly recovers from this congestion, and there is the reverse pattern of increasing speeds between Bakerville and the Twin Tunnels.

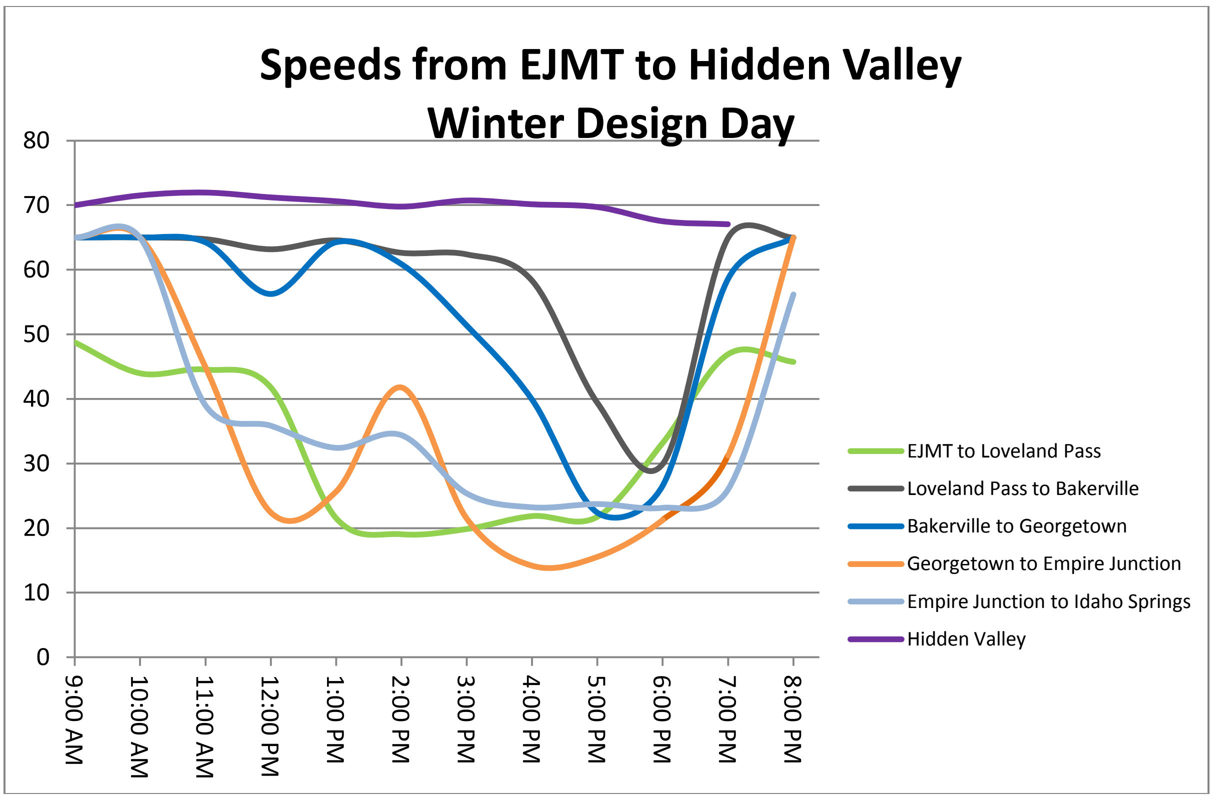
The two segments between EJMT and Bakerville have separate patterns of lower speeds. On the summer peak day, EJMT records show that to the eastbound Johnson Tunnel experienced backups from east of this tunnel that required traffic to be stopped twice west of the tunnel for a total of ten minutes between 1:00 pm and 5:00 pm. On the winter peak day, EJMT records show that the tunnel was closed eight times between 1:00 pm and 6:00 pm for a total of 102 minutes. This caused consistently low speeds for the segment just east of the EJMT.

Figure 4.11 shows the current speed profile for eastbound traffic on the two peak Sundays at two locations east of the Twin Tunnels (west and east of the Hidden Valley interchange). The red (slower speed line) was measured just west of the interchange in the vicinity of the sharp right-hand curve, and lower speed is the result of cars slowing down to negotiate this curve. The purple line (east of the interchange) shows that vehicles are back at a free flow speed (at or above 60 mph). The conclusion is that there is currently no congestion downstream of the Twin Tunnels on peak Sunday afternoons. The eastbound tunnel is the existing bottleneck that causes congestion upstream. Slower speeds downstream of the tunnel are primarily due to existing curve geometry.

The DynusT model (see page 7.1) provides a wealth of detailed output data that can be used to compare how well different scenarios for I-70 operate. The results of the model of existing conditions can be visually compared with actual data to see how well actual conditions are replicated. The following graphs and tables illustrate typical outputs from DynusT that are the basis for comparing future scenarios.

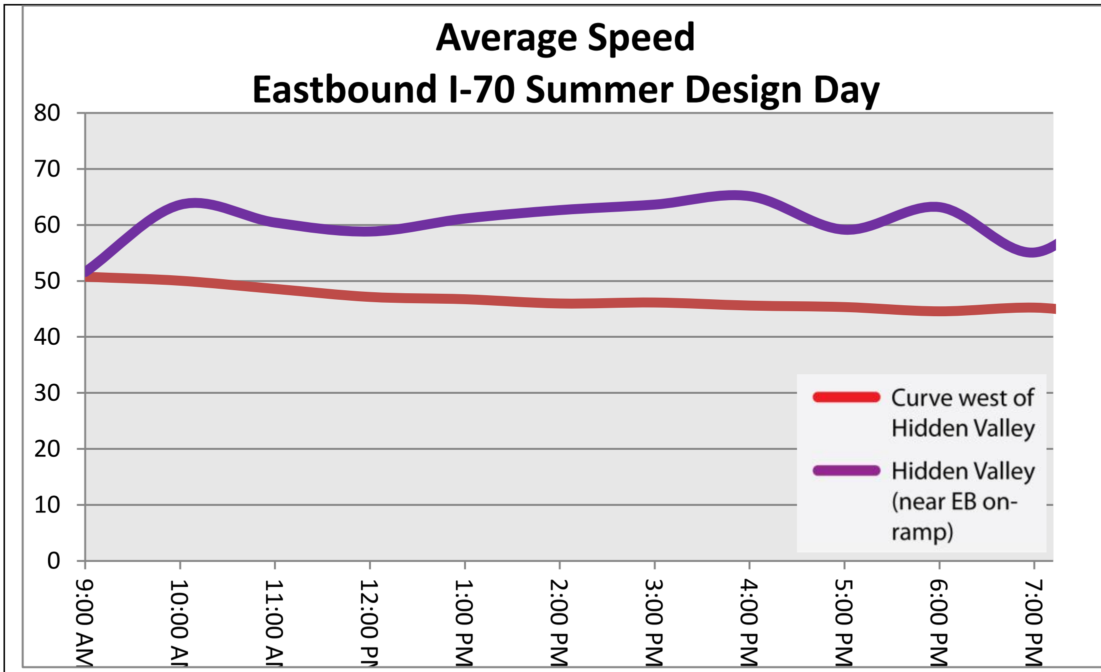
Figure 4.10 I-70 Travel Speed Trends on Peak Days



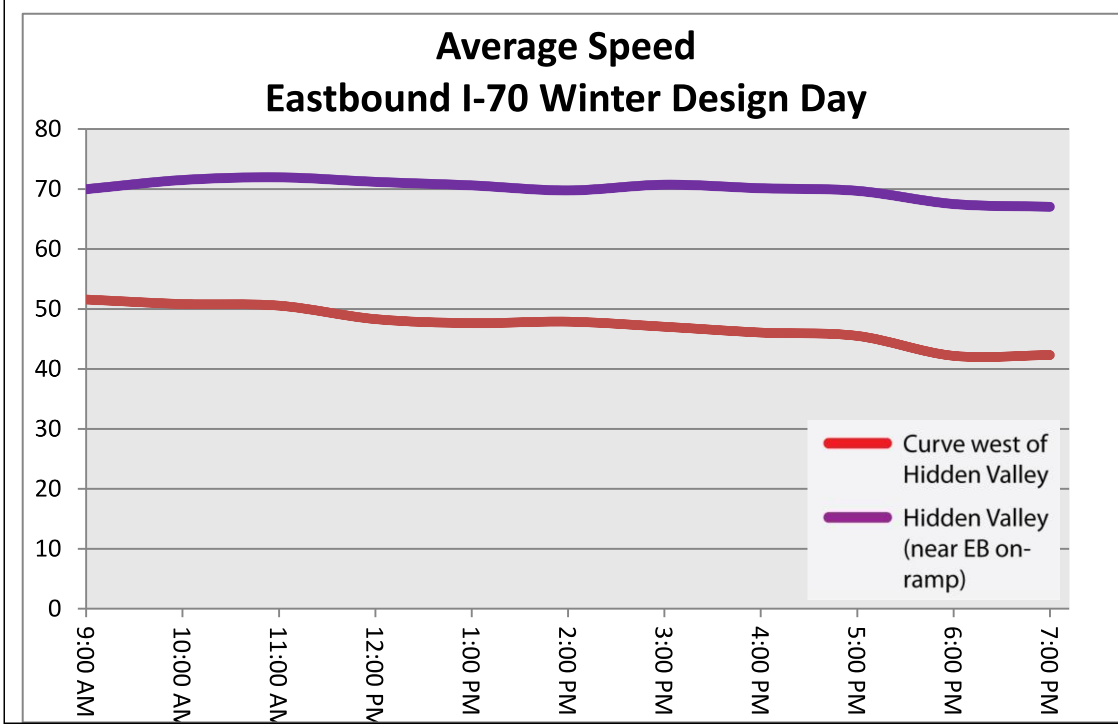


Data Source: CDOT ITS Devices

Figure 4.11 Average Peak Day Speeds east of the Twin Tunnels

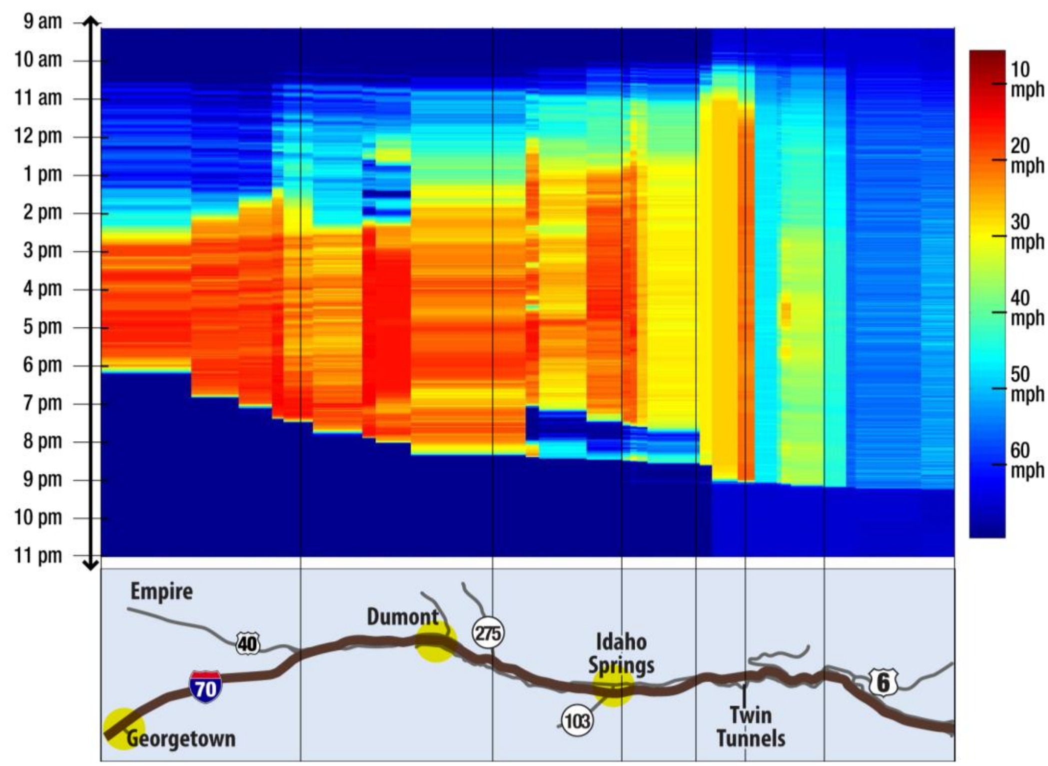


Data Source: CDOT ITS Devices



- Average Speeds—**Figure 4.12** shows the average speed of vehicles traveling eastbound on I-70 between Georgetown and the top of Floyd Hill from 9:00 am to 11:00 pm on a peak day (Sunday) based on output from the DynusT traffic modeling software. The colors vary from dark blue (high speeds) to dark red (slow speeds). The figure illustrates how traffic begins to experience slowing near the Twin Tunnels as early as 10:00 am, gradually extending back to the west eventually reaching the US 40 interchange at approximately 2:30 pm. A continuous queue of vehicles traveling under 35 mph exists between the US 40 interchange and the Twin Tunnels between 2:30 pm and 6:00 pm, with speeds operating at less than 20 mph for large portions of the corridor. As demand begins to taper off, the queue also dissipates and free flow operations are restored before 9:00 pm. The figure also shows some residual slowing east of the tunnels due to curves between Hidden Valley and US 6 and the steep uphill grades on Floyd Hill. **Figure 4.12** shows the same pattern of congestion that is found in **Figure 4.10** from actual data.

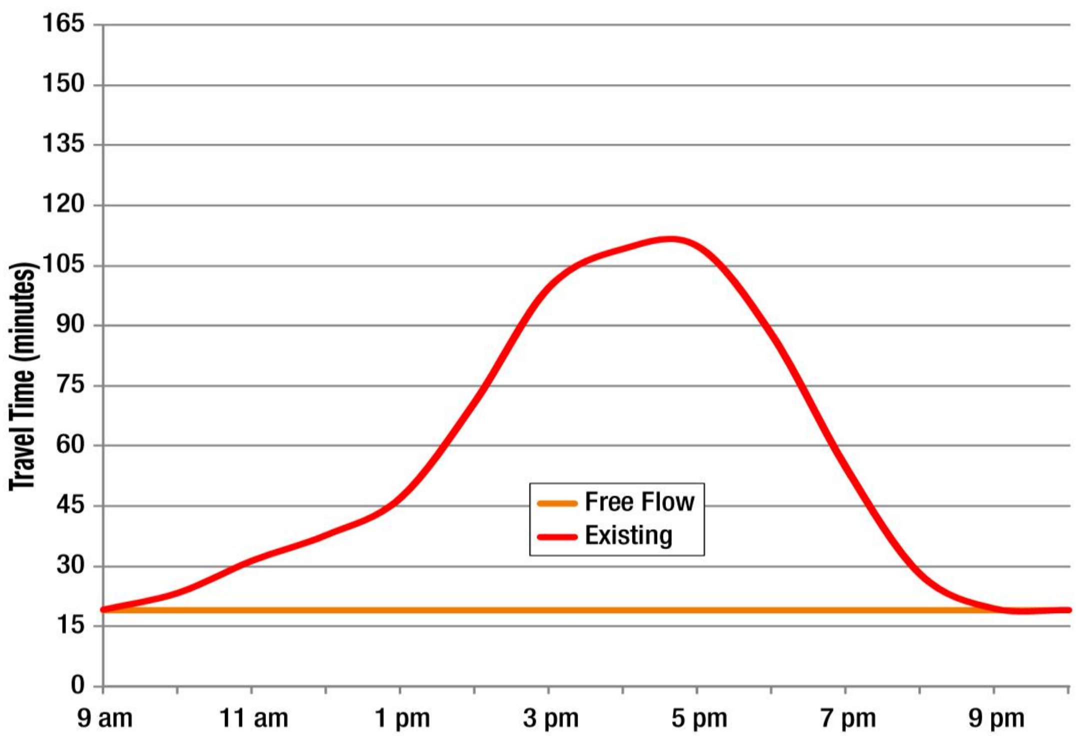
Figure 4.12 2010 Average Peak Day Eastbound Speeds by Segment between Georgetown and the top of Floyd Hill



Data Source: DynusT Model Output

- Travel Time—The result of the congestion on I-70 is an increase in the average travel time experienced by eastbound motorists. **Figure 4.13** shows the average travel time for eastbound travels on a peak day (Sunday) between Georgetown and the top of Floyd Hill. Under free flow operations, the average travel time is about 20 minutes, as this segment is slightly less than 19 miles long. Currently, the congestion in this segment extends the average travel time during the peak hours (between 2:30 pm and 6:00 pm) to nearly 120 minutes (approximately 100 minutes longer than free flow travel times). The travel times recover by 9:00 pm, consistent with the speed data shown in **Figures 4.10 and 4.12**.

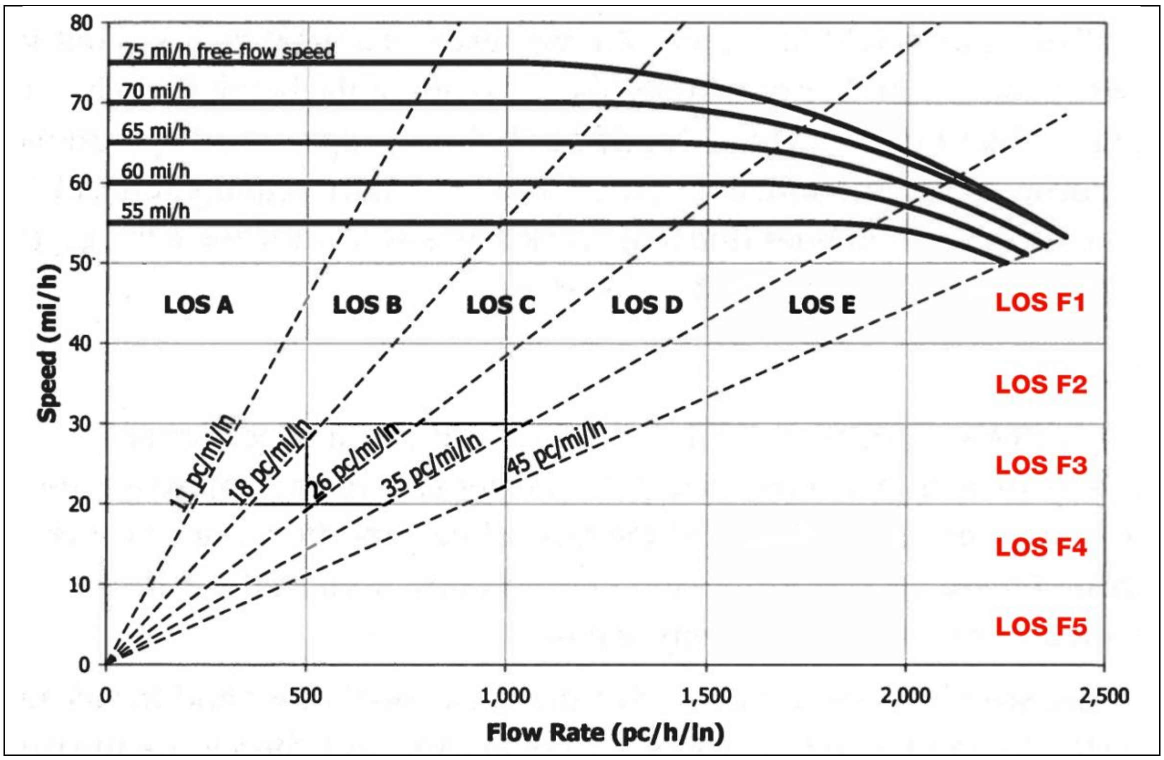
Figure 4.13 2010 Average Peak Day Travel Time Eastbound between Georgetown and the top of Floyd Hill



Data Source: DynusT Model Output

- Level of Service (LOS)—The *Highway Capacity Manual, HCM2010* (HCM) identifies level of service for freeways based on density, but LOS can also be defined using speed thresholds from basic traffic flow theory relating speed, density, and flow. Based on the *Highway Capacity Manual* (see **Figure 4.14**), freeways with a free flow speed above 55 mph (such as I-70) will typically operate at LOS A to LOS E as long as speeds remain above 50 mph. Operating speeds in excess of 50 mph are typically considered uncongested conditions and do not result in significant delay to motorists. Once the operating speed falls below 50 mph, drivers will begin to notice delays and may associate this drop in speed as the onset of congestion. As speeds continue to decrease, the degree of congestion and delay experienced by the drivers becomes more apparent. However, LOS F spans the wide range of speeds between 0 and 50 mph. For the purpose of this study, the LOS F category was further broken into five sub-categories based on 10 mph speed intervals staring at 0 mph and ending at 50 mph. Thus LOS F1 (40—50 mph) is close to free flow conditions with drivers only experiencing moderate levels of delay, while LOS F5 (0—10 mph) is near stopped conditions where drivers are experiencing significant levels of delay.

Figure 4.14 Freeway LOS from Highway Capacity Manual (Exhibit 11-6)



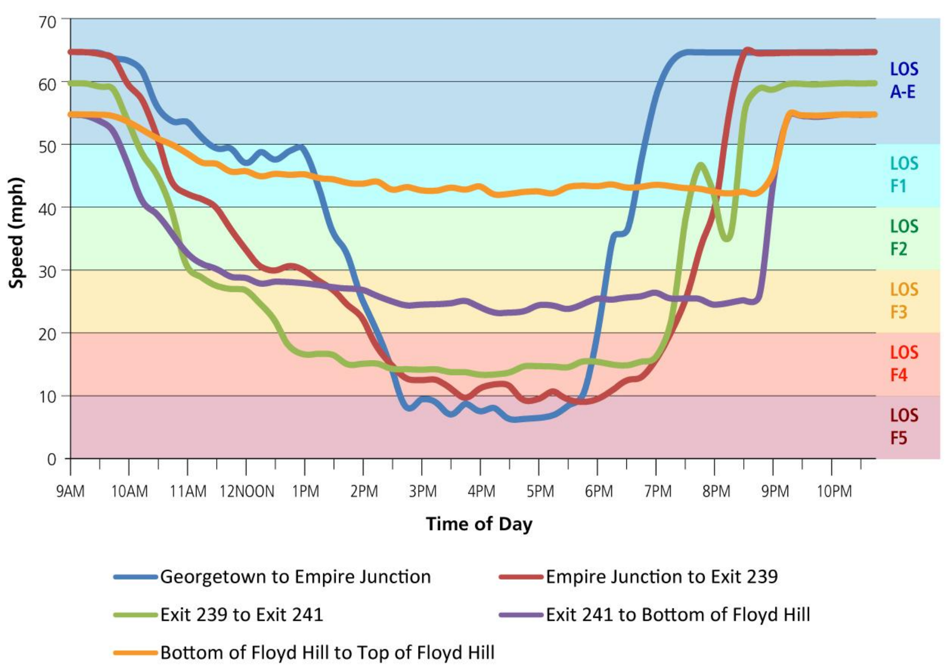
Twin Tunnels Environmental Assessment
Idaho Springs/Clear Creek County

Figure 4.15 shows the average speeds by time of day for the five major I-70 segments compared to the different LOS ranges previously identified. The segments are:

- Georgetown to Empire Junction
- Empire Junction to Exit 239 (SH 103)
- Exit 239 (SH 103) to Exit 241 (Approximate start of the proposed third lane widening)
- Exit 241 (Approximate start of the proposed third lane widening) to Bottom of Floyd Hill
- Bottom of Floyd Hill (US 6) to the top of Floyd Hill

The figure shows that I-70 operates at speeds below 50 mph, or LOS F, for a majority of the time between 9:00 am and 11:00 pm on a typical peak day (Sunday).

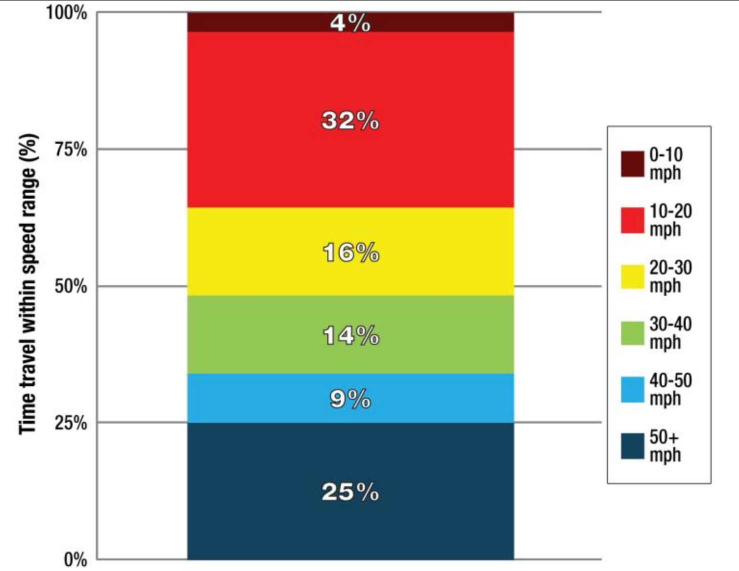
Figure 4.15 2010 Average Peak Day Speeds between Georgetown and the top of Floyd Hill



Data Source: DynusT Model Output

Figure 4.16 shows a summary of the operating LOS for the corridor based on a minute-by-minute analysis of the data presented in **Figure 1.15.** The figure shows that throughout the day drivers on I-70 experience LOS A-E operations (speeds in excess of 50 mph) about 25 percent of the time. The remaining 75 percent of time drivers will experience LOS F (speeds below 50 mph). It should be noted that the majority of the time spent at LOS A-E is during the shoulder periods (before 10:00 am and after 8:00 pm). Under existing conditions, drivers spend about 52 percent of their time traveling at speeds below 30 mph and approximately 36 percent of their time traveling at speeds that are below 20 mph.

Figure 4.16 Percent of Time Peak Day Eastbound Drivers Experience each Level of Service



Data Source: DynusT Model Output

- Travel Indicators—Vehicle Hours of Travel (VHT) and Vehicle Miles of Travel (VMT) are overall measures of traffic operations that communicate how well the highway network is operating. **Table 4.3** shows these statistics for peak day conditions in the study area as well as for the entire model area. Since DynusT can divert traffic between different routes depending of the speeds that would be encountered, it provides indications of system and corridor efficiency between different potential future scenarios.

Table 4.3 2010 Peak Day VMT and VHT Summary

Scenario	VMT				VHT			
	System Wide	% Difference	I-70 Corridor	% Difference	System Wide	% Difference	I-70 Corridor	% Difference
2010 Existing	6,507,000	N/A	593,100	N/A	208,800	N/A	29,100	N/A

4.8 Is there any congestion on I-70 on weekdays?

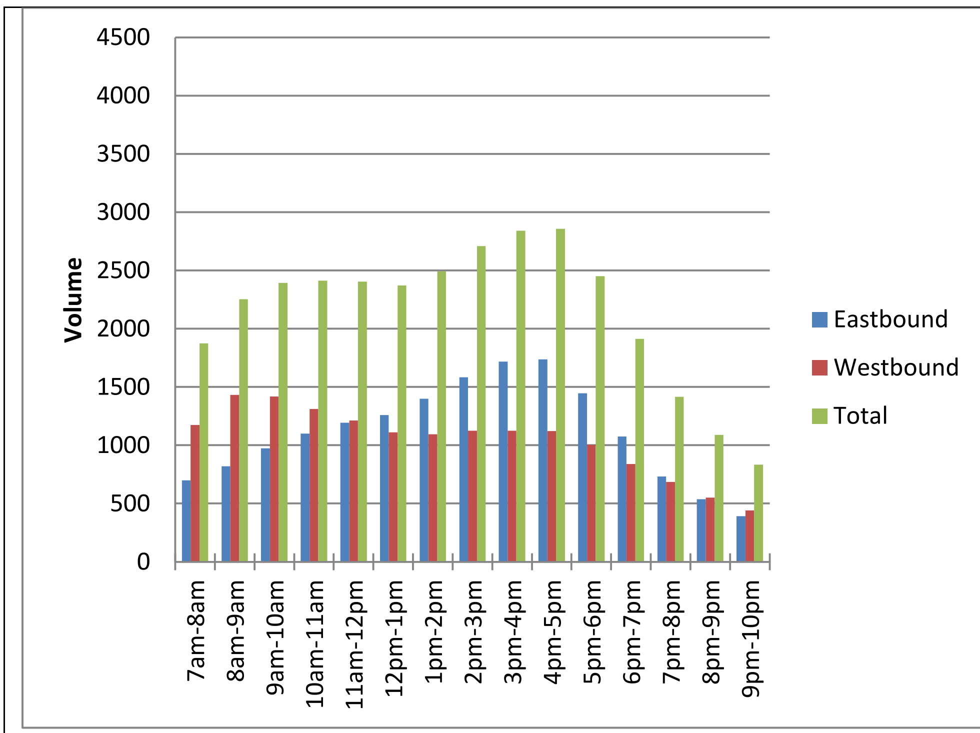
As illustrated by **Figures 4.2** and **4.3**, the volume of traffic on I-70 during weekdays (Monday through Thursday) is significantly less than weekend peak volumes. An analysis of weekday volumes is important for certain environmental factors as it represents free-flowing traffic. Hourly volumes collected by the Twin Tunnels ATR were analyzed to determine average annual weekday traffic (AAWDT) volumes for 2010. The analysis of the weekday volumes was conducted on a seasonal basis as well as an annual basis, revealing the following information:

- Winter average weekday volume (December through March): 38,025 vpd
- Summer average weekday volume (June through September): 39,418 vpd
- Spring/Fall average weekday volume (April, May, October, & November): 30,335 vpd
- Yearly Weekday Average: 36,217 vpd

The pattern of seasonal average weekday volumes duplicates the variations noted previously for weekends.

2010 AAWDT volumes for the various segments along I-70 in the study area are provided in **Figure 4.7**. Hourly volumes in both eastbound and westbound directions between 5:00 am and midnight are shown in **Figure 4.17,** based on Twin Tunnels ATR data. It is interesting to note that the Denver area's typical pattern of commuter traffic (into Denver in the morning and out of Denver in the evening) does not occur on I-70. Westbound traffic has a peak hour in the morning (less than 1,500 vph between 8:00 am and 9:00 am) when cars and trucks are traveling to the mountains, and then volumes gradually fall through the rest of the day. The return movement occurs in the afternoon as eastbound traffic gradually increases through the day and peaks (less than 1,800 vph) between 4:00 pm and 5:00 pm. Both of these directional peak hours are less than the capacity of the Twin Tunnels (approximately 3,200 vehicles per hour) and as a result, no congestion is normally experienced on average weekdays. A detailed review of hourly volumes in 2011 from the Twin Tunnels ATR revealed that the maximum non-holiday weekday (Monday through Thursday) hourly volume was 2,740 vph in the eastbound direction and 2,370 vph in the westbound direction. Non-holiday Friday traffic in the eastbound direction was also reviewed, and two winter hours were found to exceed 3,000 vph. All of these peak weekday volumes are less than the capacity of the tunnels so no delays were experienced during these hours.

Figure 4.17 Existing Average Weekday Volume by Hour of Day (I-70 at Twin Tunnels)



Data Source: CDOT Twin Tunnels ATR

The *Highway Capacity Manual* provides procedures to calculate speed, density, and levels of service (LOS) for freeway segments. **Table 4.4** shows that there is very little variation in these statistics for the AAWDT volumes over the study area segments. Uniformly good LOS is experienced throughout the average weekday. The speed data were utilized to calculate travel times between Georgetown and Floyd Hill between 9:00 am and 10:00 pm. **Figure 4.18** shows that free-flow speeds throughout the day result in uniformly good travel times. Finally, travel indicators (VMT and VHT) for the average weekday (total of both directions) are shown in **Table 4.5.**

The conclusion of these analyses is that there is currently no congestion in the study area on average weekdays.

Table 4.4 2010 (Existing) Average Annual Weekday (AAWDT) Traffic and Levels of Service

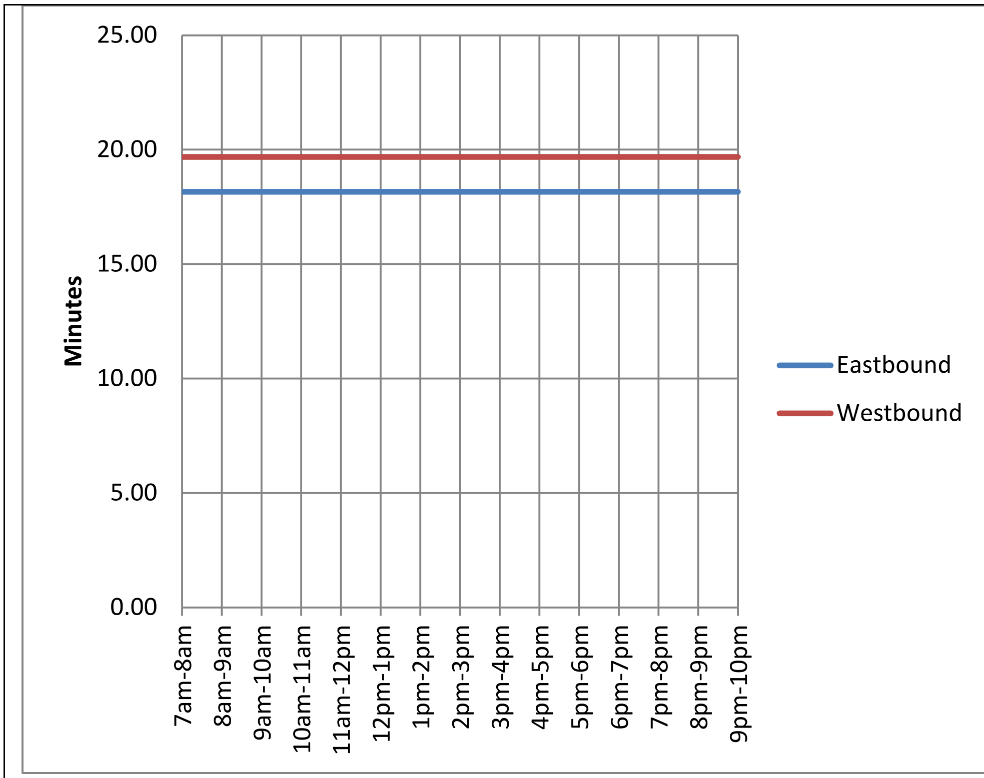
I-70 Mountain Corridor Average Annual Weekday (AAWDT) Traffic								
Direction	**Scenario**	**Daily Volume (vpd)**	**Peak Hour**	**Peak Hour Volume (vph)**	**LOS**	**Speed (mph)**	**Lanes**	**Density (pc/mi/ln)**
Floyd Hill (Exit 244 to Exit 248)								
Eastbound	Existing	17357	4-5pm	1654	A	65.0	3	10.9
Westbound	Existing	16861	8-9am	1343	B	60.0	2	14.4
Central City (Exit 244)								
Eastbound	Existing	18423	4-5pm	1755	B	65.0	2	17.4
Westbound	Existing	18109	8-9am	1442	B	60.0	2	15.5
Twin Tunnels (Exit 241 to Exit 243)								
Eastbound	Existing	18226	4-5pm	1736	B	65.0	2	17.2
Westbound	Existing	17990	8-9am	1433	C	60.0	2	18.0
Idaho Springs (Exit 239 to Exit 241)								
Eastbound	Existing	17091	4-5pm	1621	B	65.0	2	16.0
Westbound	Existing	17039	8-9am	1357	B	60.0	2	17.1
Downieville (Exit 232 to Exit 238)								
Eastbound	Existing	16228	4-5pm	1547	B	65.0	2	15.3
Westbound	Existing	16068	8-9am	1280	B	60.0	2	13.7
Georgetown (Exit 228 to Exit 232)								
Eastbound	Existing	12141	4-5pm	1156	B	65.0	2	11.4
Westbound	Existing	12040	8-9am	959	A	60.0	2	10.6

Data Source: CDOT Twin Tunnels ATR

*Base free-flow speed assumed 65 mph in eastbound direction, 60 mph in westbound direction

**LOS calculation completed using HCM 2010 freeway analysis module

Figure 4.18 Existing Weekday Travel Time by Hour of Day (Exit 228 to Exit 248)



Data Source: CDOT Twin Tunnels ATR

Table 4.5 2010 Average Weekday VMT and VHT

Scenario	VMT		VHT	
	I-70 Corridor	% Difference	I-70 Corridor	% Difference
2010 Existing	627,000	N/A	10, 050	N/A

Data Source: CDOT Twin Tunnels ATR

4.9 How much traffic uses the Frontage Road that parallels I-70?

Clear Creek County and Idaho Springs are concerned about volume of traffic using the Frontage Road (CR 314) that parallels I-70. Volumes on the Frontage Road east of Idaho Springs were counted in 2009, 2010, and 2010 by Clear Creek County. These counts show that weekday traffic volumes average between 200 vpd and 400 vpd with slightly more (52 percent to 56 percent) in the eastbound direction. The situation is markedly different on summer Sundays and holidays. Volumes range between 1,340 vpd and 1,930 vpd with more than 90 percent of the volume in the eastbound direction.

5.0 Existing Safety Conditions

5.1 What is the study area for the safety assessment?

The recent safety history for I-70 in the vicinity of the Twin Tunnels has been comprehensively analyzed in a companion document: *Safety Assessment Report – State Highway 70A Twin Tunnels Environmental Assessment (EA) – MP 240.00 to MP 247.24*, CDOT, November 23, 2011. MP 240.0 is just east of the bridge over Clear Creek east of the SH 103 interchange (Exit 240), in the center of Idaho Springs. The eastern limit of the safety assessment is at the Clear Creek County/Jefferson County line (MP 247.24). The county line is midway between the Floyd Hill and Beaver Brook half-diamond interchanges.

5.2 What are the overall crash patterns in the study area?

The crash history for the five-year period, January 1, 2006 through December 31, 2010, was examined in the study area to locate crash clusters and identify crash causes. CDOT's crash records were reconciled with the Idaho Springs Police Department, which is the primary response agency in the area.

Table 5.1 summarizes the number of crashes for I-70 over the five-year study period. There were 749 reported crashes within the study limits including mainline I-70 crashes, ramp crashes, and ramp terminal intersection crashes. There were 680 property damage only (PDO) crashes, 66 injury crashes, and three fatal crashes. The majority of the crashes (approximately 65 percent) occurred in the eastbound direction.

Table 5.1 Number of Crasher on I-70: MP 240.00—MP 247.24

Period	Number of Crashes							
	Prop. Damage Only		Injury		Fatality		Total	
	EB	WB	EB	WB	EB	WB	EB	WB
Total (01/01/2006—12/31/2010)	441	239	48	18	1	2	490	259
Overall 5-Year Average per Year	88.2	47.8	9.6	3.6	0.2	0.4	98	51.8
Eastbound/Westbound							65%	35%

5.3 What are the predominant types of crashes?

Figure 5.1 presents a graphic representation of crash types for this area. Fixed object type crashes (50 percent) were the predominant crash type, followed by rear end type crashes (19 percent) and sideswipe (same direction) (11 percent). These statistics show that approximately 61 percent of the crashes involve vehicles that left their lane and either hit a fixed object or another vehicle.

Figure 5.1 Crash Type Distribution

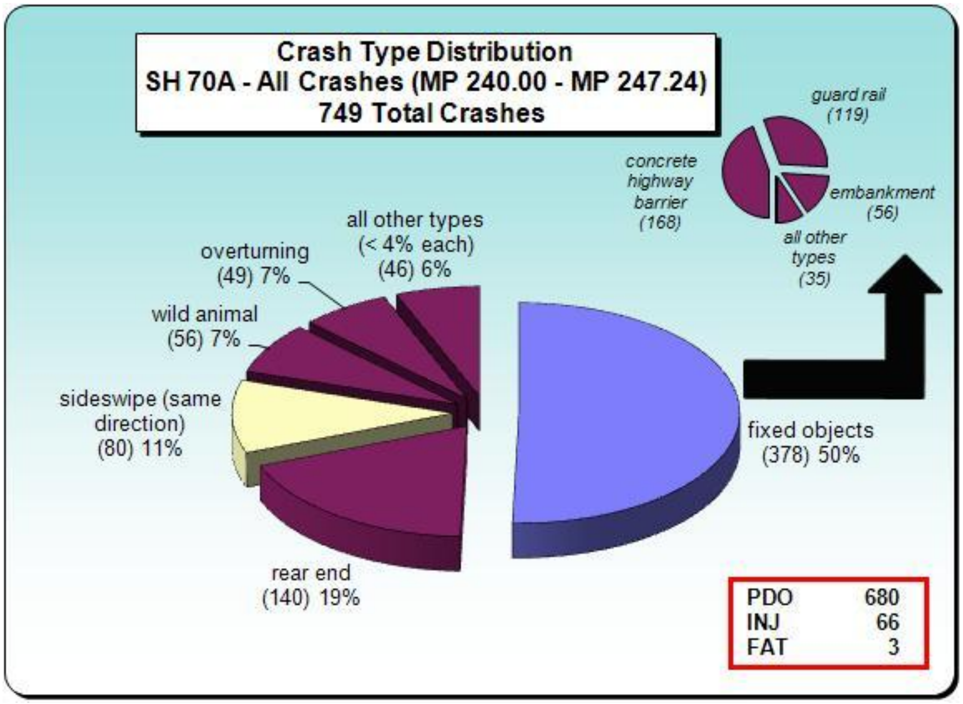


Figure 5.1 also shows that concrete highway barrier, guard rail, and embankment crashes were the most common of the fixed object type crashes along the study corridor. In general, the rail and barrier involved in the crashes typically prevented more serious crashes. The occurrence of these crashes was typically related to road conditions: the curvature in mainline I-70 throughout the corridor, vehicle speeds in the relation to road conditions or curve and/or the lighting conditions at night along I-70. Other factors that contribute to the overall crash patterns include: traffic congestion due to weekend traffic, direction of travel, and inclement weather/road conditions. More than one of these factors contributed to many of these crashes.

Table 5.2 shows a summary of the directionality of the most predominant crash types occurring along I-70. The majority of crashes (67 percent) on I-70 occurred in the eastbound direction. However, the disparity in the distribution between eastbound and westbound is most significant for the fixed object type crashes. This is not entirely unexpected as vehicles in the eastbound direction are on a downgrade, making it easier to travel at a higher rate of speed. These vehicles are more likely to lose control as they travel through the curves along I-70, leave their lane and strike a fixed object or another vehicle. The rear-end crash type, more commonly related to traffic congestion, is more evenly split between the eastbound and westbound directions.

Table 5.2 Directionality of Predominant Crash Types

Guardrail/Concrete Barrier/Embankment/Wall			Rear End			Sideswipe same direction			Totals		
EB	WB	Total	EB	WB	Total	EB	WB	Total	EB	WB	Total
251	96	347	73	62	135	49	27	76	373	185	558
72%	28%		54%	46%		64%	36%		67%	33%	

5.4 What are the locations where crashes are most likely to occur?

In order to facilitate more detailed crash analyses, the corridor was split into four segments, based on locations of each of the four interchanges. The segmentation for the corridor is presented in **Figure 5.2**.

Figure 5.2 Corridor Segmentation

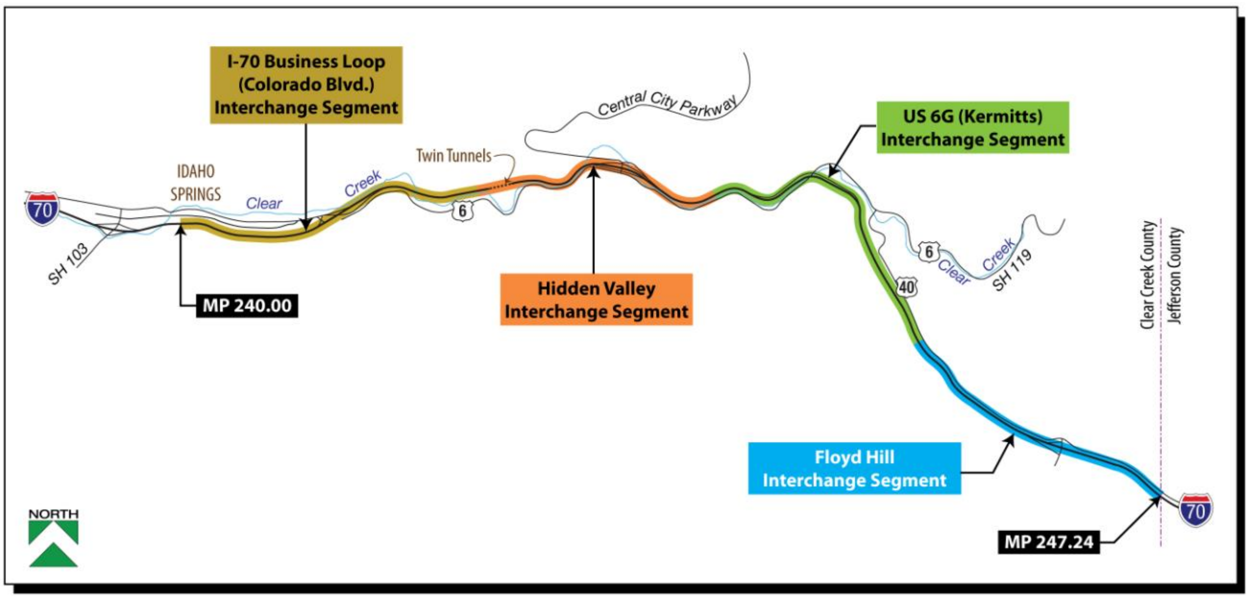
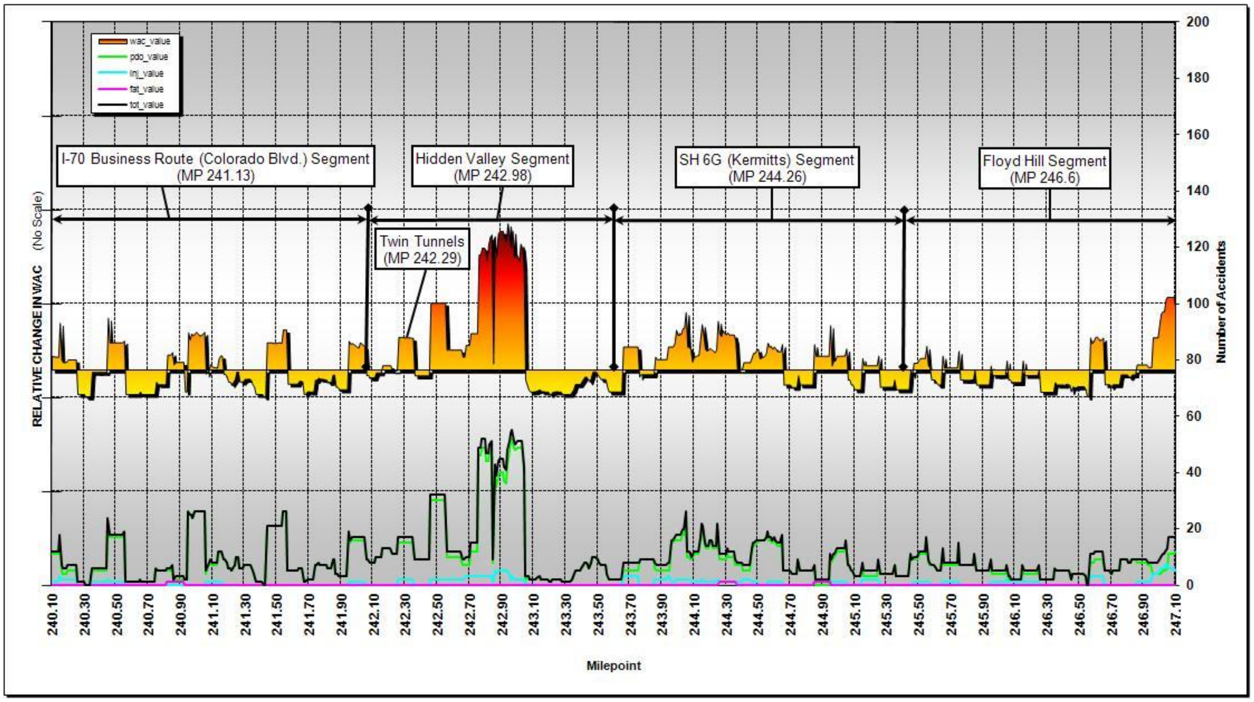


Figure 5.3 is a graphic-rendering of the change in weighted accident concentration (WAC) through the study limits, revealing the locations of crash concentration and severity along the corridor. (WAC is anon-scaled number that compares accident concentration within a stretch of highway, weighted by the severity of the accidents and traffic volume at the location where they occurred.) There are several locations of crash concentrations throughout the study corridor. In general, the largest concentrations of crashes are in the vicinity of some of the sharper horizontal curves along I-70. The largest peak on the graph coincides with the curves west of the Hidden Valley interchange. There are also several small peaks in the vicinity of the curves at the US 6 interchange (Exit 244).

Figure 5.3 Crash Locations



In addition to the examination and comparison of crash types and the WAC analysis, the assessment of the magnitude of safety problems on selected highway sections has been refined through the use of Safety Performance Functions (SPF). The SPF reflects the complex relationship between traffic exposure measured in ADT and the crash count for a unit of road section measured in crashes per mile per year. SPF models provide an estimate for the expected crash frequency for each interchange influence area (for a range of ADT) among similar facilities.

The study section of I-70 is classified as a Rural Mountainous 4-Lane Interstate. Data for five years of crash history on I-70 has been plotted for evaluation on the SPF figure shown on **Figure 5.4**. This figure shows that the majority of the SPF points for the I-70 segments are near the expected value for the given AADTs. However, the Hidden Valley segment is well above the norm, which indicates the potential for crash reduction on this segment.

Figure 5.4 Safety Performance Functions by Segment

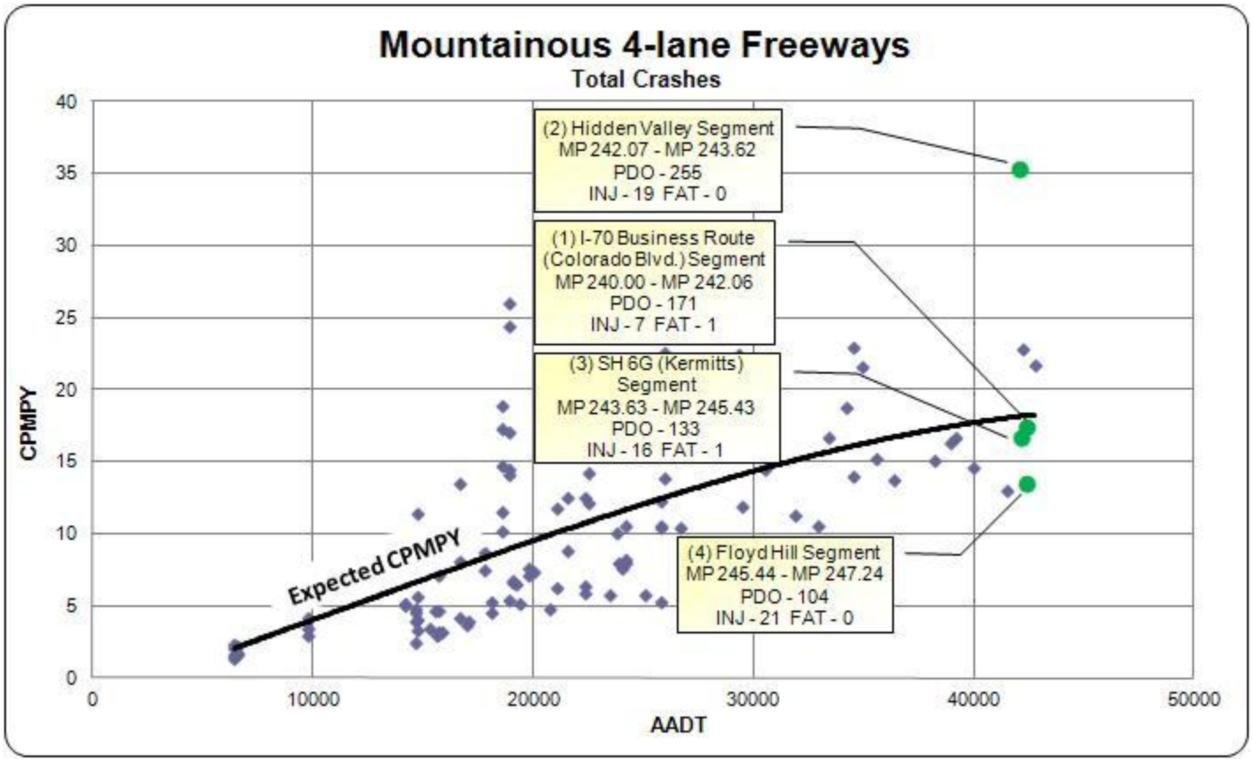


Table 5.3 provides a summary of the most predominant crash types encountered in each of the four segments. Important insights include:

- 43 percent of the most predominant crash types occur in the second segment, which includes the Twin Tunnels and Hidden Valley interchange (Exit 243).
- Of the most predominant crash types occurring in the second segment, 80 percent are fixed object type crashes, and 80 percent of these crashes occur in the eastbound direction.

These statistics show that there is a serious safety concern in the vicinity of the Hidden Valley Interchange Segment 2 for eastbound traffic.

Table 5.3 Predominant Crash Types by Segment

	Guardrail/ Concrete Barrier/ Embankment/Wall			Rear End			Sideswipe same direction			
	EB	WB	Total	EB	WB	Total	EB	WB	Total	Total
Segment 1	49	21	70	38	17	55	14	3	17	142
	70%	30%		69%	31%		82%	18%		25%
Segment 2	155	38	197	19	11	31	11	8	19	242
	80%	20%		63%	27%		58%	42%		43%
Segment 3	17	11	28	7	7	14	9	3	12	54
	61%	39%		50%	50%		75%	25%		10%
Segment 4	30	26	56	9	27	36	15	13	28	120
	54%	46%		25%	75		54%	46%		22%
Total	**251**	**96**	**347**	**73**	**62**	**135**	**49**	**27**	**76**	**558**

5.5 What are the causes of the poor safety record in Segment 2?

During the five-year study period there were 274 reported mainline crashes between MP 242.07 and MP 243.62 on I-70. There were 255 PDO crashes, and 19 injury crashes. **Figure 5.5** shows Segment 2 in relation to the other roadways in the vicinity. This figure also shows the five curves (Curves 3, 4, 5, 6, and 7) located in this segment.

Figure 5.5 Curves in Segment 2

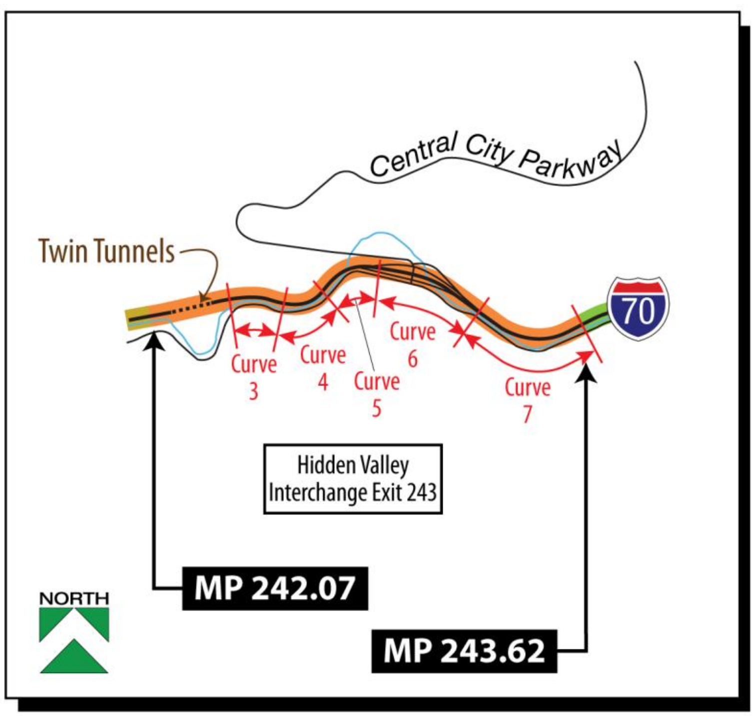
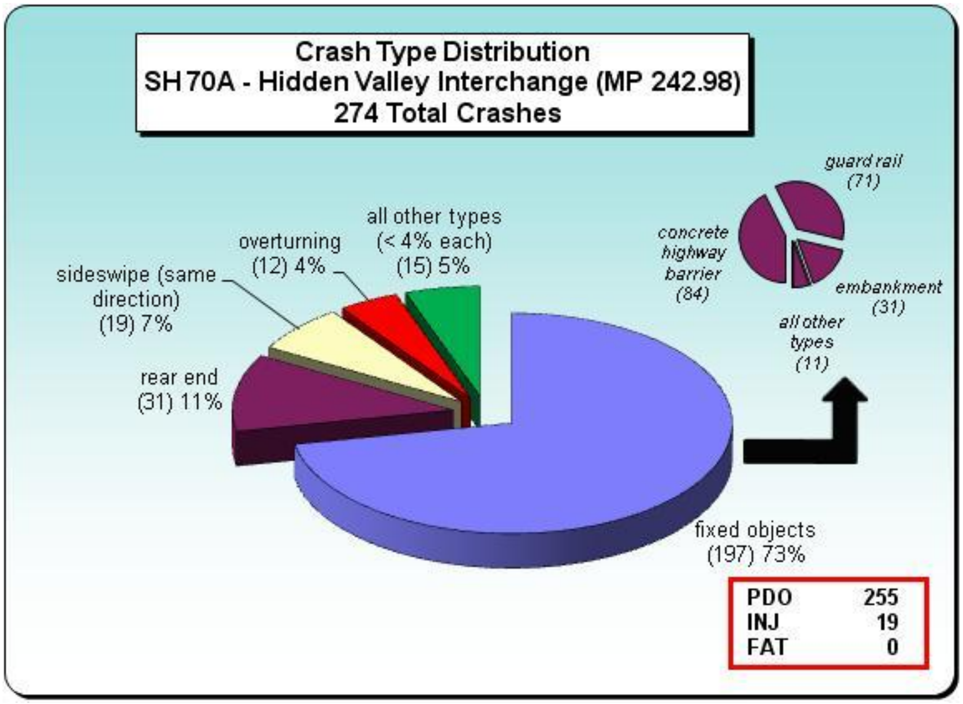


Figure 5.6 provides a graphical representation of crash types for this segment. Fixed object type crashes were predominant (73 percent) followed by rear end type crashes (11 percent).

Figure 5.6 Crash Type Distribution for Segment 2



Of the fixed object type crashes, the proportion of median barrier and guard rail type crashes were higher than expected for this portion of the study corridor. In addition, the number of embankment type crashes was also higher than expected. Of the 155 crashes in the barrier/rail categories, 126 of 155 occurred in the eastbound direction and 29 of 155 occurred in the westbound direction. Based on a review of the crash reports, many of these barrier crashes occurred at night or when a driver lost control due to the road conditions and hit the barrier or rail. However, it is worth noting that the rail and barrier involved in the crashes generally prevented a more serious crash. High speeds through these curves typically caused the crashes. The posted speed limit on I-70 is 55 mph. Of the 126 eastbound barrier/rail crashes, approximately 60 percent of the drivers (76 total crashes) were estimated to be traveling 60 mph or above at the time of the crash.

The following provides a summary of the crash patterns for the two locations that had the poorest safety record:

- **Curve 4**—During the study period there were a total of 47 crashes on this curve to the left. Of these crashes, 35 were eastbound and 12 were westbound. The most common crash types were fixed-object type crashes (28 of 47). Half of these crashes occurred on winter weekdays when both higher travel speed and/or road conditions were a common contributing factor.

- **Curves 5 and 6**—These curves are just west of and through the Hidden Valley interchange. During the study period there were a total of 163 crashes on theses curves. Of these, 131 were eastbound and 32 were westbound. The most common crash type was fixed object type crashes (108 of 163). This percentage, approximately 66 percent of the total, is a very high proportion overall. It is worth noting, that many of the fixed object crashes designated to curve 6 likely occurred when a vehicle began to lose control in curve 5 and struck a fixed object in curve 6. 102 (94 percent) of the fixed object crashes occurred in the winter and were evenly split between weekday (51) and weekend (51). As with the other curves on this segment, both travel speed and/or road conditions were a common contributing factor.

It should be noted that the Proposed Action includes the replacement of the bridge over Clear Creek that is in the center of curve 5. The new bridge will have a 55 mph design speed that is much higher than the current 45 mph design speed. It is anticipated that this improvement will significantly improve safety (see Chapter 10).

6.0 Future Growth Forecasting Methodology

6.1 What is the basis for forecasting future volumes in the I-70 Mountain Corridor?

A panel of experts with backgrounds in transportation planning and the I-70 Mountain Corridor convened on December 15, 2011 in order to confirm the acceptability of the methodology for forecasting future travel in the I-70 Mountain Corridor (see meeting minutes in Appendix A). This panel reviewed potential options (see Appendix B) for determining the rate of growth that might be used to forecast 2035 volumes, and agreed that it would be appropriate to utilize two sources of base information since weekday and weekend travel patterns are different. The panel agreed to use the following base information and procedures to forecast future volumes. In summary, the PEIS focused on analyzing peak days, and its results were used for forecasting peak day (Sunday) volumes and operations. The PEIS did not analyzed average weekday traffic and DRCOG and Colorado State Demographer forecasts and procedures were followed for this study. After the analyses were completed, it was determined that the weekday growth rate (growth factor of 1.41) is in fact close to the findings of the PEIS.

6.2 What is the basis for weekday volume forecasts?

The Denver Regional Council of Governments (DRCOG) is the regional transportation planning agency, and Clear Creek County is included in the nine-county Denver metropolitan area. DRCOG has developed 2010 base year and 2035 Regional Transportation Plan (RTP) models that forecast current and future annual average weekday traffic (AAWDT) volumes. Analyzing weekday volumes is appropriate for the Denver metropolitan area where the highest congestion is experienced during the morning and evening peak periods when drivers are commuting to work.

External stations are an essential element of all regional models because they provide information about major roads on the periphery that carry traffic into and out of the model area. For the I-70 Mountain Corridor, external stations are located on I-70 at the EJMT and on US 40 at Berthoud Pass. In 2011 when preparing the most recent generation of the RTP models, DRCOG utilized a detailed, thorough procedure to determine external station growth factors, based on projected population growth by county from the Colorado State Demographer and the distance of each external station to each county. This procedure is particularly applicable since the Twin Tunnels are near the boundary of the metropolitan modeling area, and Clear Creek, Gilpin, Summit, Grand, Park, and Lake counties were a prominent element of this analysis. In addition, the process factored in local knowledge of which counties' population would most greatly impact the number of trips passing through an external station. This process resulted in the following annual growth rates for the external stations that most affect I-70 in Clear Creek County: I-70 at EJMT (2.0 percent per year), US 40 at Berthoud Pass (1.8 percent per year), and US 6 at Loveland Pass (2.0 percent per year). DRCOG's forecasts were utilized as the basis for this Tier 2 analysis since the process was thorough, recent, and directly applicable for AAWDT volumes. It was determined that no additional analysis of population growth in mountain counties would be necessary for forecasting weekday traffic for the Twin Tunnels analyses. These growth rates are close to the findings of the PEIS which determined that population in the I-70 Mountain Corridor would generally double between 2000 and 2035. Recent Colorado State Demographer forecasts for the period from 2010 to 2035 (which were also the basis for DRCOG's analyses) show that population in counties along the I-70 Mountain Corridor will grow between 50 and 90 percent over this period. The results of this process are incorporated in the latest regional models for 2010 and 2035 which were utilized to determine growth on I-70 for weekdays (see Section 6.4).

6.3 What is the basis for weekend (Sunday) volume forecasts?

The previous description of existing traffic (Chapter 4) has shown that the I-70 Mountain Corridor has wide variations between seasons and between weekdays and weekends. Weekends (Friday through Sunday) have the highest volumes. Also, volumes on I-70 vary greatly by season: summer is the highest, followed closely by winter, and spring/fall is the lowest. These patterns are not common to the rest of the Denver area.

The I-70 Mountain Corridor PEIS conducted extensive analyses of existing traffic patterns and created a travel demand model to forecast peak period traffic along I-70 from Glenwood Springs to Denver. The PEIS compares 2000 volumes with 2035 forecasts in the *2035 Transportation Analysis Technical Report,* August 2010, Reissued March 2011. Appendix A of this PEIS report includes detailed transportation forecasts that were used to determine growth for the Twin Tunnels analyses.

6.4 What is the process for forecasting weekday volumes?

The panel determined that the existing (2010) AAWDT shown on I-70 at the Twin Tunnels by the DRCOG RTP model (43,280 vehicles per day) is too high and needs to be adjusted downward slightly. As noted in Chapter 4, the AAWDT volume as determined by CDOT's ATR is 36,217 vehicles per day (vpd). The difference between the model output and the actual count (AAWDT) is 7,063 vpd or 16.23 percent.

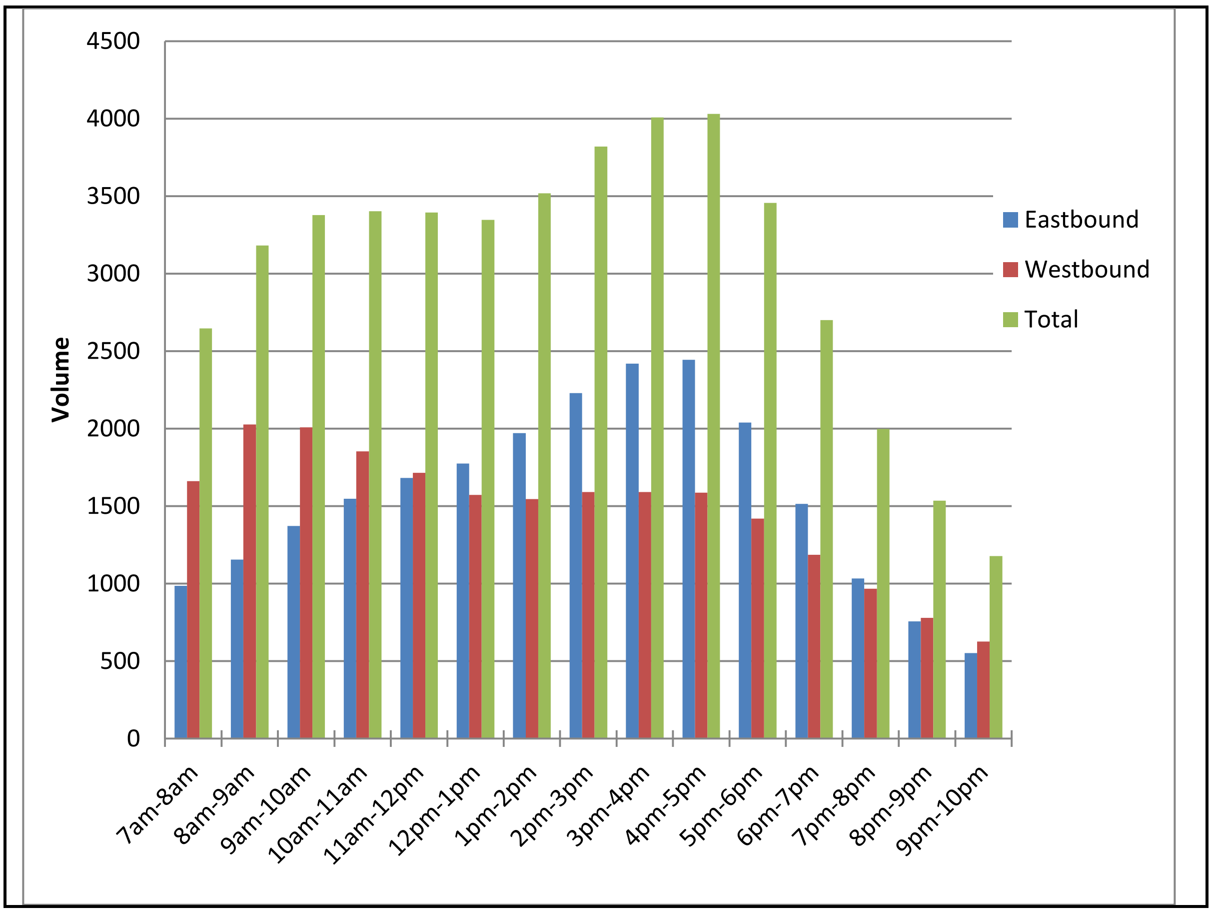
This is the basic adjustment that was applied to future weekday volumes from the RTP model. In developing the regional model, DRCOG is primarily concerned with calibrating the model based on total regional VMT and district to district distributions. They are not as concerned about screenline and individual link volumes in the model calibration process. Rather, *NCHRP 255 – Highway Traffic Data for Urbanized Area Project Planning and Design*, TRB, 1982 procedures are recommended for making the necessary link adjustments in the regional model. These procedures were followed for I-70, and the percentage (16.23 percent) used for adjusting I-70 volumes is well under the maximum desirable deviation as defined in *NCHRP 255*.

The next step involved adjusting the 2035 RTP model forecasts to reflect the determination that the model results are generally higher than actual experience:

- The raw output from the future RTP model for future traffic shows a 2035 volume of 59,485 vpd (AAWDT) at the Twin Tunnels.
- An adjustment of the 2035 volume based on the 2010 differences provides a range of future volumes between 52,422 vpd and 49,830 vpd. An average of the two potential volumes is 51,126 vpd or 51,100 vpd rounded.
- A comparison of the 2010 volume (36,200 vpd) with the 2035 volume (51,100 vpd) results in a growth factor of 1.41 (25 years—2010 to 2035) or an annual growth rate of 1.4 percent per year.

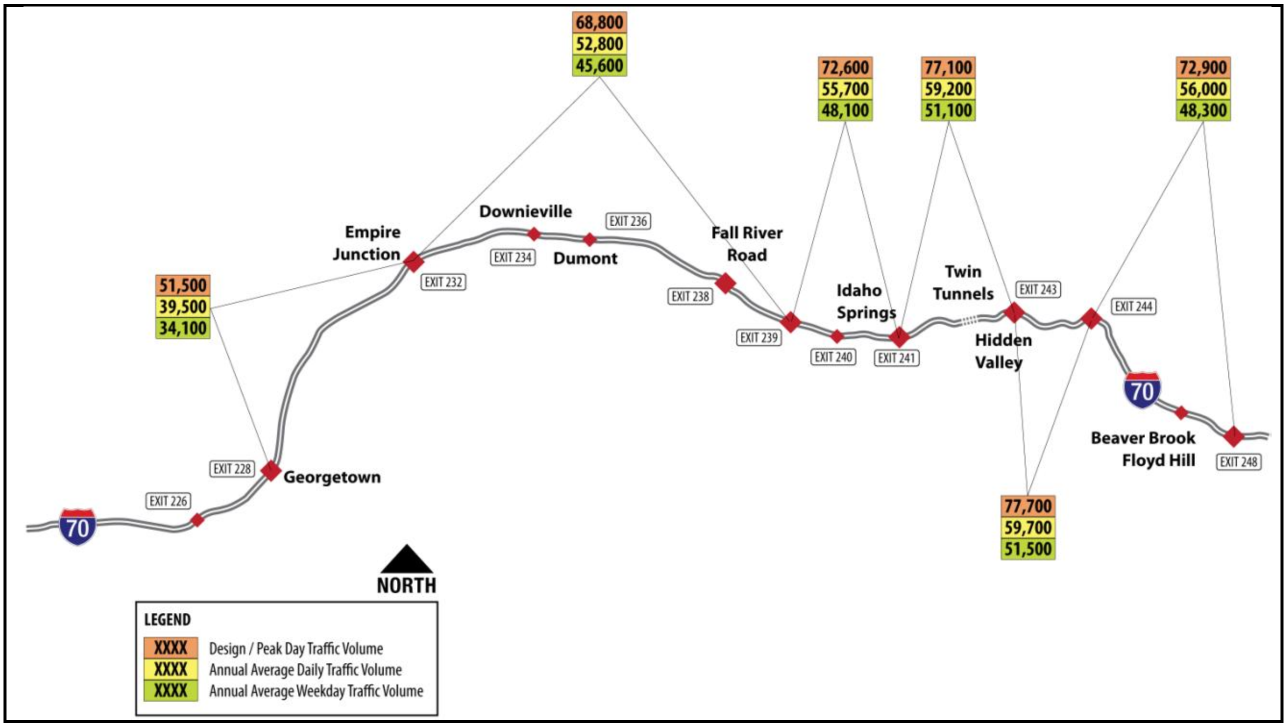
In combination with this growth factor, the directional and hourly patterns of traffic flows identified on **Figure 4.13** were then utilized as the basis for forecasting the 2035 hourly volumes for eastbound and westbound traffic that are shown on **Figure 6.1**. The spreadsheet used to create this bar graph shows that the 2035 westbound peak hour volume is 2,030 vph between 8:00 am and 9:00 am while the eastbound peak hour volume is 2,440 vph between 4:00 pm and 5:00 pm.

Figure 6.1 2035 Average Weekday Volume by Hour of Day (I-70 at Twin Tunnels)



By way of comparison to **Figure 4.7**, a summary of 2035 daily volumes forecasted to be encountered in the various segments of the study area is shown on **Figure 6.2**. The AAWDT volumes for 2035 were forecasted using the growth factor (1.41) calculated for weekday conditions. Also shown are daily forecasts for AADT and peak days (Sundays).

Figure 6.2 2035 Daily Volumes



6.5 What is the process for forecasting peak day (Sunday) volumes?

DRCOG does not forecast weekend traffic. Therefore, the panel decided that the I-70 Mountain Corridor PEIS forecasts of growth would be the best source of data for weekend (Sunday) volumes. This is an appropriate way to show consistency with previous efforts in the corridor. Future volume forecasts are found in the appendix of thePEIS *Transportation Analysis Technical Report* (March 2011). The Summer Sunday forecasts are the most applicable for eastbound peak conditions than would the Winter Saturday forecasts. The Minimal Action scenario assumes only minor provisions for future alternative transportation. It does not reduce the amount of suppressed demand by a measureable amount. The nature of the proposed Twin Tunnels improvements (one direction, three miles) is very limited, and improved transit provisions will be addressed in separate analyses and environmental documents in the future.

The growth range forecasted in the PEIS analyses (*Transportation Analysis Technical Report*) is the difference between 67,600 vpd in 2000 and 88,391 vpd in 2035 (Minimal Action). This equates to an annual growth rate of 0.79 percent and an equivalent growth factor of 1.31 (35 years—2000 to 2035) or 1.22 (25 years—2010 to 2035). This growth factor (1.22) was used for the DynusT model runs for 2035. As previously noted, 2035 daily volumes forecasted for the peak day (Sunday) in the various segments of the study area are shown on **Figure 6.2**.

In summary, the lower weekend growth rate is reasonable based on the recognition that currently, congestion restrains growth in weekend traffic. It is appropriate that this rate is lower than the AAWDT rate because there are no congestion issues to restrain weekday traffic volumes, as the following results show (see Chapters 8 and 9).

7.0 Overview of Operational Analyses Procedures

7.1 What methodologies were used to analyze traffic operations in the I-70 Mountain Corridor?

Three distinct conditions related to the construction and future operations of the Twin Tunnels were analyzed:

- Conventional analysis procedures were used since AAWDT does not normally experience congestion.
- Peak days represent the conditions frequently encountered during winter and summer Sunday afternoons. DynusT is the appropriate analysis tool to use during these times because it is designed to evaluate the effects of congestion (as well as tolling) on traffic operations.
- The construction phase of the project will last for seven to eight months during 2013. Both VISSIM and DynusT are the appropriate tools, due to the detailed operational issues to be analyzed for the detour in addition to expected congested conditions.

7.2 What methodology was used to analyze AAWDT?

As discussed in Chapters 4, 8, and 9, AAWDT traffic volumes were found to flow freely in both directions, even in the morning and afternoon peak hours. Because congestion and the resulting queuing are not normally present, the analysis procedures related to freeway operations could be utilized. These are found in Chapter 10 of the *HCM2010 Highway Capacity Manual*, Transportation Research Board, 2010. Highway Capacity Software (HCS) has been developed by McTrans at the University of Florida to facilitate the analysis procedures. The primary inputs are roadway laneage, hourly volumes, and free-flow speeds. For this application, free-flow speeds were estimated to be 65 mph in the eastbound direction and a slightly slower speed of 60 mph in the westbound direction. This is due to the steady uphill grades encountered.

7.3 What methodology was used to analyze peak day conditions?

DynusT is a dynamic traffic assignment (DTA) model that has been developed for FHWA by the University of Arizona. DTA models supplement existing travel forecasting models (such as TransCAD/Focus that is being used by DRCOG for regional analyses) and microscopic traffic simulation models (such as VISSIM—see next section). DTA models fill the gap by enabling dynamic traffic to be modeled at a range of scales from corridor (such as the I-70 Mountain Corridor) to regional areas.

According to *Dynamic Traffic Assignment—a Primer*, Transportation Research Circular, E-C153, June 2011, dynamic network analysis models (such as DynusT):

> "seek to provide another, more detailed means to represent the interaction between travel choices, traffic flows, and time and cost measures in a temporally coherent manner (e.g., further improve upon the existing time-of-day static assignment approach)… Most of these simulation methods are generally defined as mesoscopic simulation, sharing common characteristics with microscopic models: individual vehicles are represented and vehicle dynamic states are simulated through simplified car-following or traffic flow theories without describing detailed intervehicle interactions (e.g., lane changing or gap acceptance)…..In dynamic models, as in reality, explicit modeling of traffic flow dynamics ensures direct linkage between travel time and congestion. If link outflow is lower than link inflow, link density (or concentration) will increase (congestion) and speed will decrease, and therefore, link travel time will increase."

One of the explicit benefits of utilizing DynusT is its inherent capabilities to analyze the managed lane (tolled) operational option to address peak day, congested conditions. As with all computer models of traffic operation, DynusT does not account for incidents such as break-downs, crashes, geologic hazards, and others. In addition, weather and adverse road conditions which can degrade operations were not taken into account.

The DynusT modeling for the Twin Tunnel analyses included the following assumptions:

- Traffic volumes represented a peak Sunday during the winter and more specifically January 31, 2010.
- The model represents traffic conditions between the hours of 9 am and 11 pm.
- The base model and calibration process was completed by the University of Arizona.
- Calibration of the model was confined to the I-70 corridor and more specifically the I-70 mainlines.
- Most of the results of the analyses refer only to eastbound traffic operations between Georgetown and the top of Floyd Hill unless otherwise noted.
- The analysis assumed dry roadway conditions, no adverse weather, and no incidents on I-70.
- The analysis assumed all alternative routes such as frontage roads and other roadways included in the model were also free of incidents and adverse weather.
- The analysis assumed that all vehicle types (passenger vehicles and trucks) were allowed to use all roadways and all lanes.

7.3.1 What is the operational objective for the Managed Lane analysis?

CDOT wants the combination of the value of travel time savings (VTTS) and toll rates to create a ML facility that provides reliable travel to drivers that chose to use it. Revenue generation is by far a secondary concern. While the High Performance Transportation Enterprise (HPTE) does not need to sell bonds to pay for the project, they would like to see that the VTTS/toll rate be high enough that the revenue generated can cover reasonable expenses in collecting the tolls. DRCOG will want to make sure that the VTTS used for the managed lane (ML) analyses is within a general range of reasonableness. Additionally, local stakeholders will need to be satisfied with the analysis approach and assumptions. The VTTS should be low enough that the attractiveness of the ML will not be overestimated.

DynusT has the capability to utilize a congestion pricing approach where the actual toll charged varies with traffic demand in order to maintain traffic speeds at level of a preset minimum (45 mph). The results of the preliminary DynusT analyses are reasonable and show that the differences between the various VTTS are predictable and logical.

7.3.2 Why is DynusT appropriate for I-70 analyses?

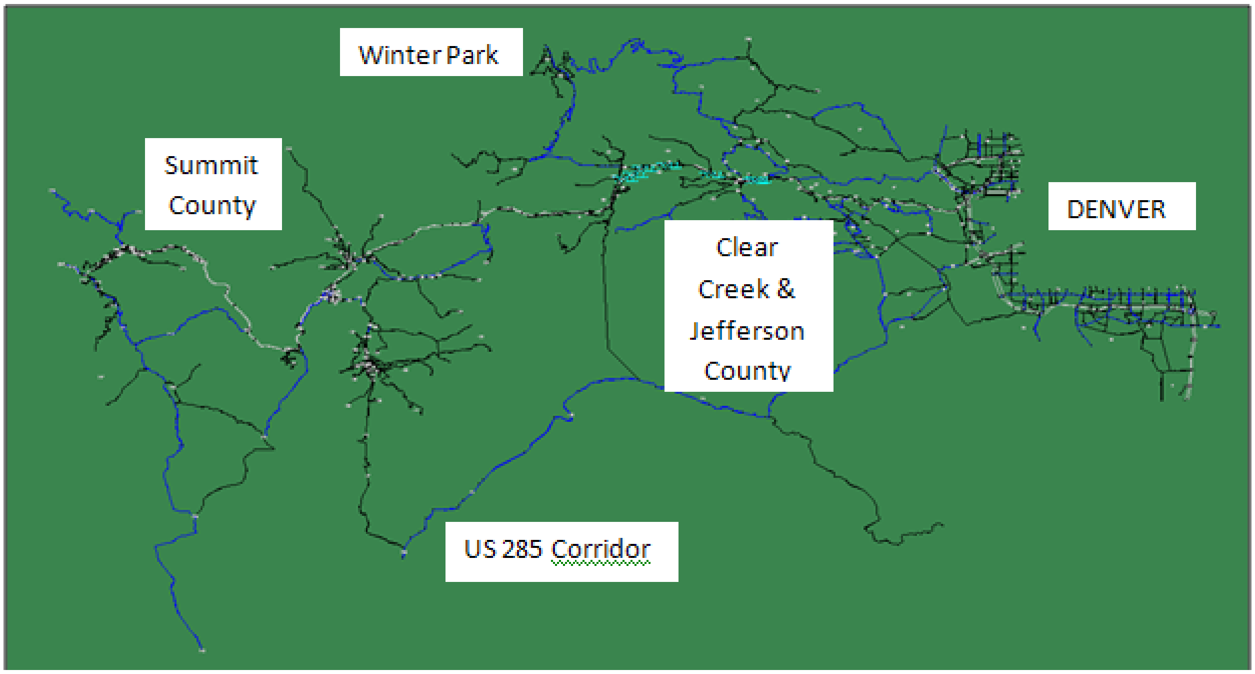
DynusT is the modeling software used to evaluate managed lane volumes, pricing, and diversion to local roads, as well as various measures of effectiveness. The model of the I-70 Mountain Corridor was initially prepared by the University of Arizona, but was subsequently transferred to Atkins to run the managed lane and three general purpose lane (3GPL) options for the EA documentation. The model is based on the I-70 Mountain Corridor PEIS traffic model. Origin-Destination (OD) information was taken from the PEIS model and input to the DynusT model. The DynusT model and OD data was then calibrated against actual 2010 traffic count data collected on multiple highways within the model. Planning year forecasts for 2035 were made by growing the DynusT volumes by 0.8 percent per year from 2010 to 2035.

Figure 7.1 shows the boundaries of DynusT model used for completing the analysis of the Twin Tunnels widening. From this model, regional travel indicators, such as vehicle miles traveled and vehicle hours of travel, were obtained for both the entire model area network and for the I-70 corridor study area (Georgetown to the top of Floyd Hill).

7.3.3 What is the operational strategy for the Managed Lane analysis?

The managed lane will be operational when expected volumes exceed capacity for three hours or more. On this basis, most Sundays during the winter and summer will be managed by 2035, as well as approximately 12 Saturdays during a typical year. In off-peak periods, the lane would be operated as a non-priced general purpose lane. The expected hours of operation during peak periods were determined by DynusT modeling. Other potential days of the week for managed lane operations and the year of initial implementation will be determined both by DynusT models and by more conventional analytical tools.

Figure 7.1 DynusT Model Boundaries



7.3.4 What value of travel time savings was used to analyze the Managed Lane?

One of the inputs that the DynusT traffic modeling software requires is the assumed value of travel time savings (VTTS) in order to determine the volume of traffic that will use the managed lane. DynusT has the ability to assign separate VTTS for single occupant vehicles, high occupant vehicles, and trucks. The current model does not contain high occupant vehicle data, thus the VTTS for this class was assigned no value. For all model runs the VTTS for trucks was assigned to a value of $75, and this value was maintained throughout the analysis.

To better understand the variability of traffic that might use the ML, the DynusT model has been run initially with a range of VTTS (2010 Dollars) for single occupant vehicles (basically all non-truck vehicles in the model), as follows:

- $9.23—as derived from the I-70 West PEIS
- $24—PEIS value multiplied by an average occupancy of 2.6 passengers/vehicle
- $32.20—PEIS value inflated from 2000 to 2011, which compares to the Consumer Price Index increase from 169.9 to 226.4, or 34 percent
- $43.40—FHWA guidance (see following discussion)
- $48—doubling of the $24 value and used by the University of Arizona to conduct other preliminary analyses

- $75—artificially high value to test sensitivity of the model

Recent research concerning VTTS is described in *Departmental Guidance on Valuation of Travel Time in Economic Analysis*, FHWA, September 28, 2011. Following are the highlights of this document:

- The document evaluated both personal and business trips
- All travelers' (any age) value of time are independent and additive
- Detailed justification is required for the use of lower than reported values for recreational trips
- The scale of income levels developed is applicable nationwide, and analysts should not attempt to substitute incomes for particular modes or locations.
- The document recommends that a VTTS of $16.70 per person is appropriate for intercity personal travel (which includes recreational trips)
- The range of acceptable VTTS for this category is between $14.30 and $21.50

Using a VTTS of $16.70 for I-70 would equate to a value of $43.40 (based on 2.6 occupants per vehicle).

7.3.5 What range of tolls was used to analyze the Managed Lane?

For this preliminary analysis a congestion pricing approach to tolling was used to analyze the impact of the ML. The following inputs (2010 Dollars) were applied to the ML using the DynusT congestion pricing approach:

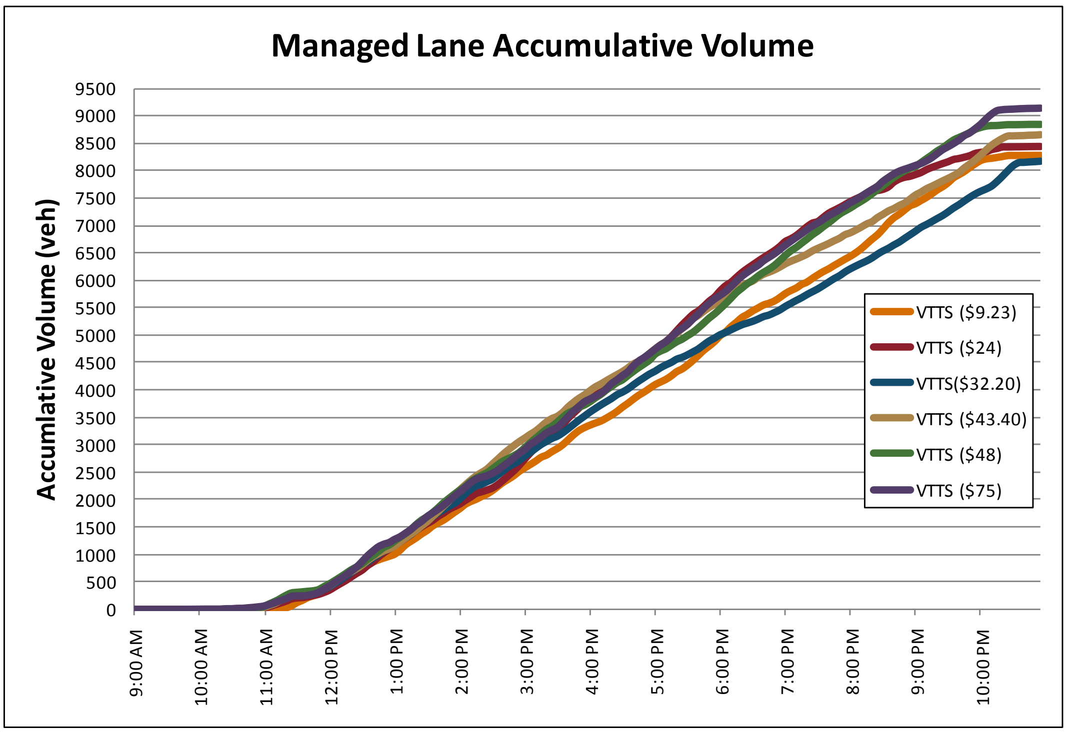
- Minimum toll for passenger vehicles = $0.25
- Minimum toll for trucks = $18.25 (As with the I-25 HOT lane, HPTE charges trucks an $18 surcharge on top of the regular toll)
- Maximum toll for passenger vehicles = $50
- Maximum toll for trucks = $68
- Minimum preferred operating speed of the ML = 45 mph

7.3.6 What impact does VTTS have on the project fees for a Managed Lane?

The DynusT model for the future peak day (2035) was evaluated for a Managed Lane Option by holding all variables constant with the exception of varying the VTTS. The DTA capabilities of DynusT, combined with the congestion pricing function, resulted in eastbound I-70 traffic being assigned between the two general purpose lanes and the single managed lane. DynusT assigns traffic based on a defined VTTS value , DTA principles, and managed lane principles that attempt to balance out travel times between all lanes. In keeping with the congestion pricing criteria that the managed lane should operate at or above 45 mph, DynusT results show the volumes that choose to enter a managed lane gradually increasing as the operations of the general purpose lanes begins to deteriorate. A total of six different VTTS values were evaluated as previously discussed.

Figure 7.2 shows the projected cumulative volume that would use the managed lane throughout a 2035 peak day (Sunday) at each VTTS value. As expected, this figure shows that as VTTS increases the overall number of vehicles choosing to use the managed throughout the day increases. As road users put more value on their time, more will choose to use a managed facility in an effort to save time. The total cumulative volumes using the managed lane range between 8,200 and 9,200 vehicles across the full range of VTTS values modeled, or a difference of about 70 vehicles per hour during the 14 hours of the day included in the analysis period. The VTTS values of $43.40 shows approximately 8,700 vehicles using the managed lane, which is near the middle of the overall range of volumes.

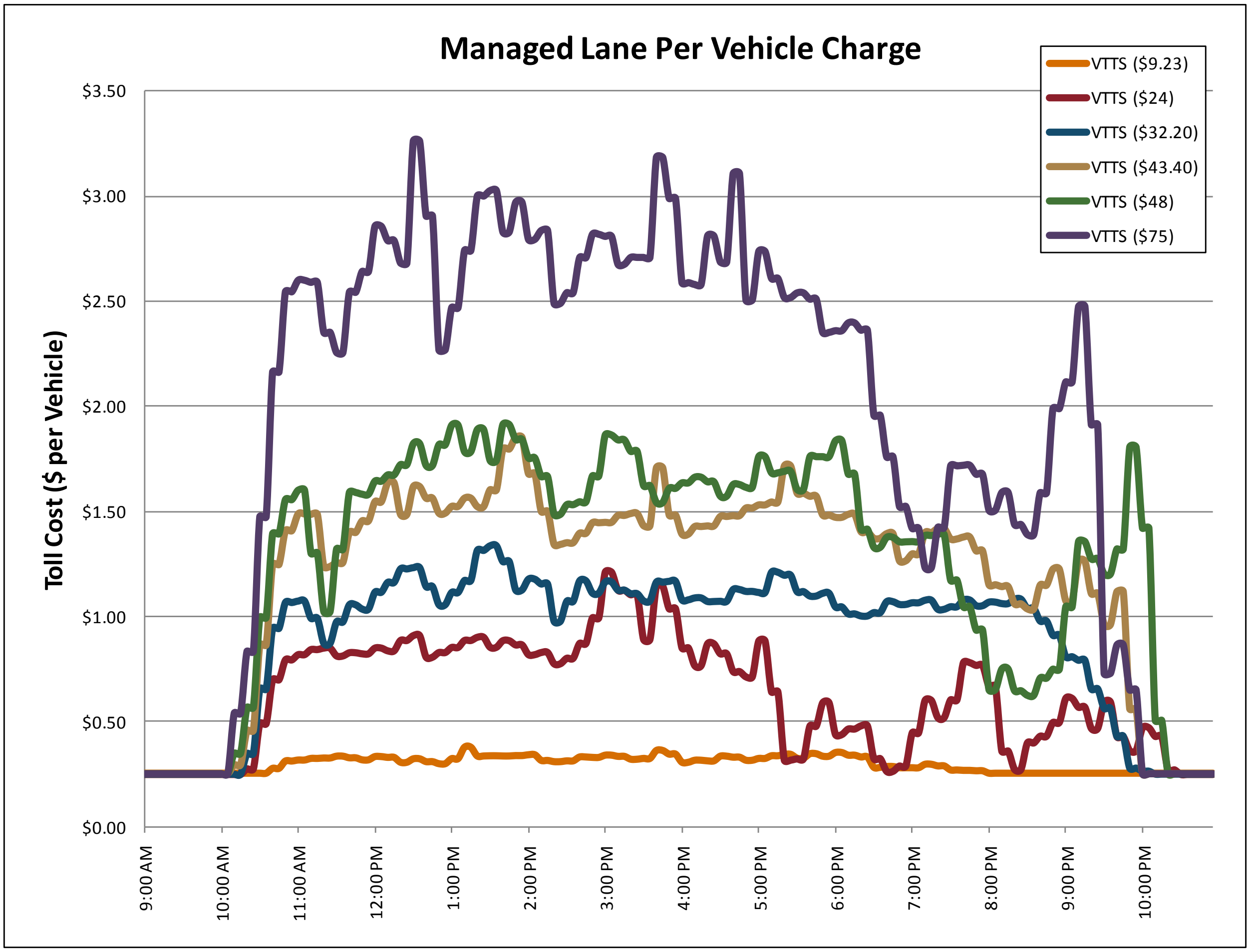
Figure 7.2 Cumulative Projected Peak Day 2035 Volumes in Managed Lane with Differing VTTS



Data Source: DynusT Model Output

Figure 7.3 shows the output from DynusT's congestion pricing scheme based on 15-minute intervals throughout the modeled time period in 2035. In other words, the figure shows the projected charge per vehicle that would be necessary for the managed lane to operate at a speed at or above 45 mph based on differing VTTS values. The figure is consistent with expected results with charges increasing with increasing VTTS. The lowest charges are associated with the lowest VTTS and the highest charges are associated with the highest VTTS. The per-vehicle managed charge ranges between $1.00 and $3.00 (2010 Dollars) overall for VTTS values greater than $10. Again, the VTTS of $43.40 occurs near the middle of the ranges of charges and is typically about $1.50 for the majority of the day. The results of the analysis show that this VTTS value will not overstate or understate the performance of the managed lane. All final analyses of the managed lane on I-70 were completed using a VTTS value of $43.40 for all passenger vehicles.

Figure 7.3 Charge per Vehicle in Managed Lane with differing VTTS (2035 Volumes)



Data Source: DynusT Model Output

7.3.7 How likely are snowsports enthusiasts to use the Managed Lane?

The I-70 Coalition commissioned a recent survey of I-70 users to gain more knowledge about how they use the *I-70 Mountain Corridor (I-70 Coalition – 2012 Dinosaur Lots Winter Survey, Overview of Findings*, RRC Associates, Inc., February 2012). As part of the study, a series of customized questions about traffic issues on I-70 were posed to a random sampling of Front Range skiers/riders. This included questions to determine their likely behavior in relation to potential tolling along I-70. Couples with no children and empty nesters are most likely (70%)

to pay a toll during peak travel times to save time. Singles with no children and households were inclined (70%) to continue to use the existing free lanes with more congestion. Similarly households with incomes between $75k and $149k were most likely (61%) to pay a toll. This decrease to 39% for households making more than $150k and 21% for those making less than $75k. With regard to age of the respondent, individuals over 55 were most likely (67%) to pay a toll, those age 35 to 54 were in the middle (51%), and individuals under 34 were least likely (31%) to pay a toll.

7.4 What methodologies were used to analyze construction phase traffic conditions?

VISSIM is a traffic simulation model on a microscopic level. It simulates the movement of individual vehicles based upon car-following, lane-changing, and gap-acceptance theories. VISSIM can be used to analyze various geometric design configurations, to evaluate and optimize localized individual intersections, and to analyze the interactions of multiple modes of transportation including cars, transit, rail, and pedestrians.

A VISSIM model for the I-70 Mountain Corridor has been developed by the University of Colorado-Denver. This model was modified to show roadway conditions for eastbound traffic using the construction detour. VISSIM determined that a reduced capacity of 2,700 vph is appropriate for the 35 mph posted speed limit and sharper curves that will be encountered on the detour. This lower capacity was input into the DynusT model of the I-70 Mountain Corridor to evaluate congested conditions that are likely to occur during construction in the summer of 2013.

7.5 What performance measures were used to compare scenarios?

The available analysis tools (HCS and DynusT) allow concepts to be evaluated and compared using a number of performance measures. CDOT Management will need to make a decision about the managed lane that is supported by objective analyses so that it isn't viewed as arbitrary and capricious. Among the important questions to be answered are:

- How will the ML Option operate in relation to the 3GPL Option (travel time, speed, reliability, etc.)?
- Are there any fatal flaws to the ML Option (travel time, safety, cost, etc.)?

The following are Performance Measures used for the results included in the remaining chapters in this document. Many of them are directly available from the DynusT model outputs:

7.5.1 Safety

- Forecasts of crashes in study area for each scenario

7.5.2 Traffic Operations

- I-70 Corridor from Georgetown to the top of Floyd Hill was divided into the following segments:

  - Georgetown to Empire Junction
  - Empire Junction to before Exit 241 (East Idaho Springs)
  - Exit 241 to Twin Tunnels
  - Twin Tunnels to bottom of Floyd Hill
  - Bottom to Top of Floyd Hill
- The following performance measures for I-70 was provided from DynusT
  - Travel Time by segment and lane type
  - Speed by segment and lane type
  - Level of Services (based on traffic density) calculated by time of day, by segment, and by lane type
  - VMT/VHT for the study area and region
- Number of hours of congestion as based on a defined operating speed such as any time operating at or below 30 mph for I-70 will be considered congested
- Queuing based on operating speeds at or below 10 mph for I-70
- Travel Reliability
  - Percent of time the managed lane operates over a set speed (assumed to be 45 mph or higher).
- Adjacent and/or Parallel Roads
  - Traffic Diversion/Attraction in terms of percent change in volumes between scenarios along frontage roads (between Georgetown and Hidden Valley interchanges) and other possible diversion routes such as SH 9 and US 285.

8.0 No Action Alternative

8.1 How will 2035 average weekday traffic operate?

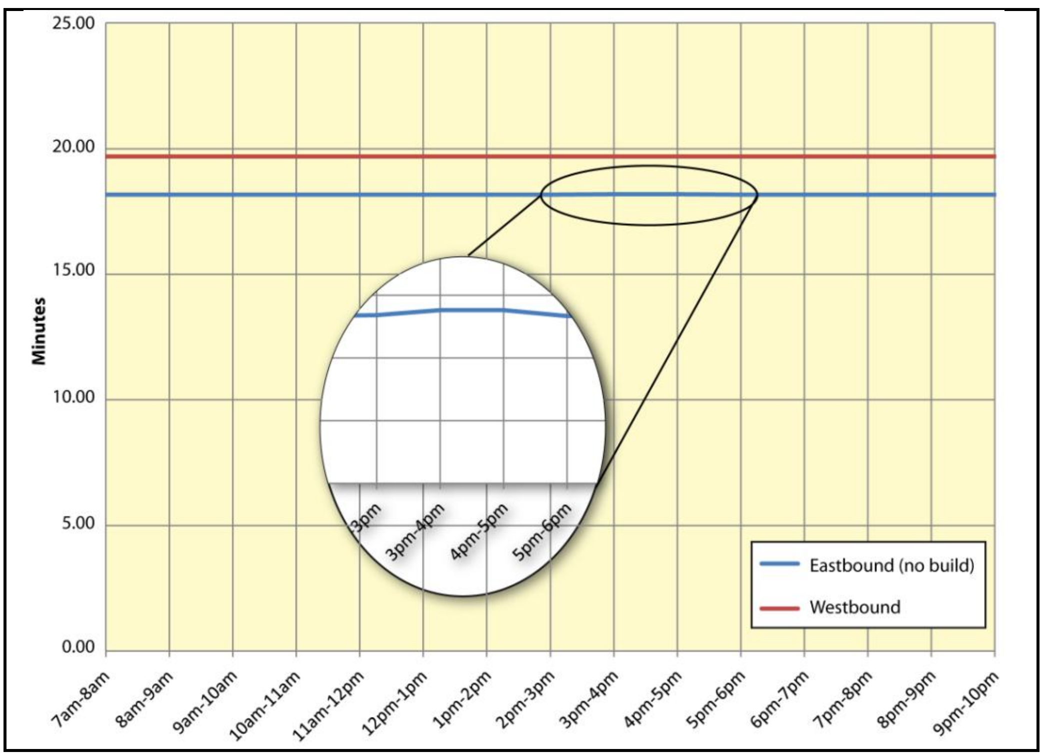
The LOS expected to be encountered in the various segments of the study area for the No Action Alternative are summarized in **Table 8.1.** This provides a summary of the daily directional volumes, peak hour volumes, and speeds and levels of service during the peak hours. This analysis shows that traffic operations will be good (LOS C or better) during weekdays through 2035 for all segments between Georgetown and Floyd Hill.

Table 8.1 2035 No Action Alternative—Average Weekday VMT and VHT

Scenario	VMT		VHT	
	I-70 Corridor	% Difference	I-70 Corridor	% Difference
2010 Existing	627,000	N/A	10, 050	N/A
2035 No Action	884,800	41%	14,180	41%

Figure 8.1 illustrates the travel times that are forecasted to be encountered during the study period on a weekday. There is a slight increase in travel times between 3:00 pm and 6:00 pm with the No Action Alternative. Uniformly good LOS is experienced throughout the average weekday. The speed data were utilized to calculate travel times between Georgetown and Floyd Hill between 9:00 am and 10:00 pm.

Figure 8.1 No Action Weekday Travel Time by Hour of Day (Exit 228 to Exit 248)



Finally, travel indicators for the average weekday (total of both directions) are provided in **Table 8.2.**

Table 8.2 No Action Alternative—2035 (Future) AAWDT and Levels of Service

I-70 Mountain Corridor Average Annual Weekday (AAWDT) Traffic								
Direction	**Scenario**	**Daily Volume (vpd)**	**Peak Hour**	**Peak Hour Volume (vph)**	**LOS**	**Speed (mph)**	**Lanes**	**Density (pc/mi/ln)**
Floyd Hill (Exit 244 to Exit 248)								
Eastbound	2035 No Action	24446	4-5pm	2327	B	65.0	3	15.4
Westbound	2035 No Action	23839	8-9am	1900	C	60.0	2	20.4
Central City (Exit 244)								
Eastbound	2035 No Action	25944	4-5pm	2470	C	64.5	2	24.7
Westbound	2035 No Action	25602	8-9am	2040	C	60.0	2	21.9
Twin Tunnels (Exit 241 to Exit 243)								
Eastbound	2035 No Action	25667	4-5pm	2443	C	64.6	2	24.3
Westbound	2035 No Action	25433	8-9am	2027	C	60.0	2	25.5
Idaho Springs (Exit 239 to Exit 241)								
Eastbound	2035 No Action	23968	4-5pm	2282	C	64.9	2	22.6
Westbound	2035 No Action	24086	8-9am	1920	C	60.0	2	20.5
Downieville (Exit 232 to Exit 238)								
Eastbound	2035 No Action	22854	4-5pm	2176	C	65.0	2	21.6
Westbound	2035 No Action	22721	8-9am	1811	C	60.0	2	19.4
Georgetown (Exit 228 to Exit 232)								
Eastbound	2035 No Action	17093	4-5pm	1627	B	65.0	2	16.1
Westbound	2035 No Action	17023	8-9am	1357	B	60.0	2	14.6

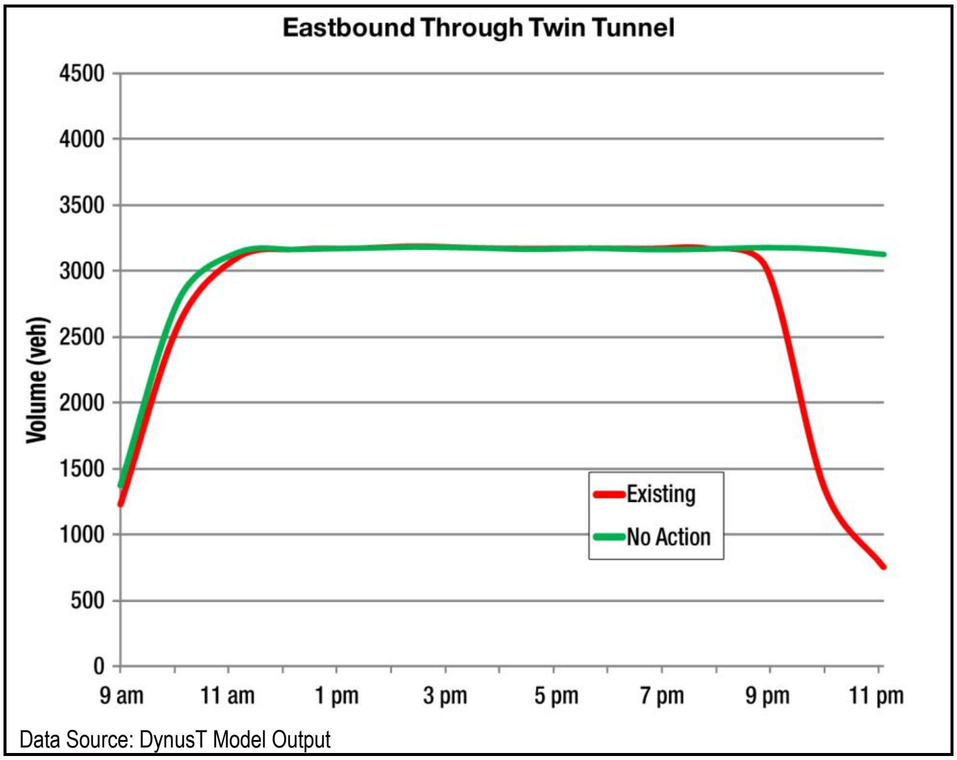
*Base free-flow speed assumed 65 mph in EB direction, 60 mph in WB direction
**LOS calculation completed using HCM 2010 freeway analysis module

The conclusion of these analyses is that there is no congestion in the study or project area on average weekdays in 2035 with the No Action Alternative. A review of individual hourly volumes shows that there would be some eastbound congestion on peak Friday afternoons, primarily during the winter, that could last for approximately three hours.

8.2 How will 2035 Sunday traffic operate?

All analysis measures in the I-70 Mountain Corridor show that traffic operations will deteriorate significantly during the peak day (Sunday) if no improvements are made. As explained in Chapter 6, peak Sunday traffic is forecasted to grow by 22 percent by 2035. **Figure 8.2** shows the hourly volume passing eastbound through the Twin Tunnels. The figure shows how the volumes remain restricted to about 3,200 vehicles per hour, or about 1,600 vehicles per lane in the 2035 No Action Alternative, since there are no improvements to the tunnel or highway. However, unlike in 2010 when the tunnels are eventually capable of processing all of the demand, the buildup of excess demand in 2035 results in the peak being spread out over more hours and late into the evening, beyond 10:00 pm.

Figure 8.2 2035 No Action vs. 2010 Existing Conditions—Peak Day Volumes through the Twin Tunnels (EB)



One of the expected impacts due to the increased travel times and reduced operations of I-70 in under the 2035 No Action Alternative is for more drivers to look for alternative routes to complete their trips eastbound out of the mountains. **Table 8.3** lists a summary of the projected increase in daily volumes that would occur on other highways . The analysis shows that if no improvements are done to I-70, the alternative routes will experience significant increase in traffic volumes. The design capacity of the frontage road (approximately 2,600 vpd) would be exceeded. The design capacity is based on providing an acceptable level of service (LOS C) for this rural, local road. The current usage of the frontage road (1930 vph—see Page 4.24) is less than this capacity.

Table 8.3 2035 No Action vs. 2010 Existing Conditions—Peak Day Traffic Volumes on Other Roads

Change in Daily Volume on Links for Different Scenarios			
		No Action*	
Location	2010 Volumes	Volumes	% Diff
I-70 Frontage Road west of Hidden Valley	1,930	4,000	107%
SH 9 North of Fairplay	6,000	9,700	61%
US 285 East of Grant	7,800	11,600	48%

Sources:
2010 Volumes: Clear Creek County and CDOT counts
2035 Forecasts: DynusT Model Output
*Compared to 2010 Existing Conditions

Figure 8.3 shows the average speed of eastbound vehicles passing through the Twin Tunnels. The results for 2035 No Action conditions are consistent with expectations. Speeds drop below 20 mph earlier in the day and remain low for the remainder of the day until the tunnels are eventually capable of processing the demand. The total volume passing through the eastbound tunnel is about 40,500 vehicles or a 13 percent increase compared to the 2010 Existing Conditions between 9:00 am and 11:00 pm. However, the figure shows that demand for the tunnel is most likely much higher than the actual volume being served.

Figure 8.3 2035 No Action vs. 2010 Existing Conditions—Peak Day Speeds through the Twin Tunnels (EB)

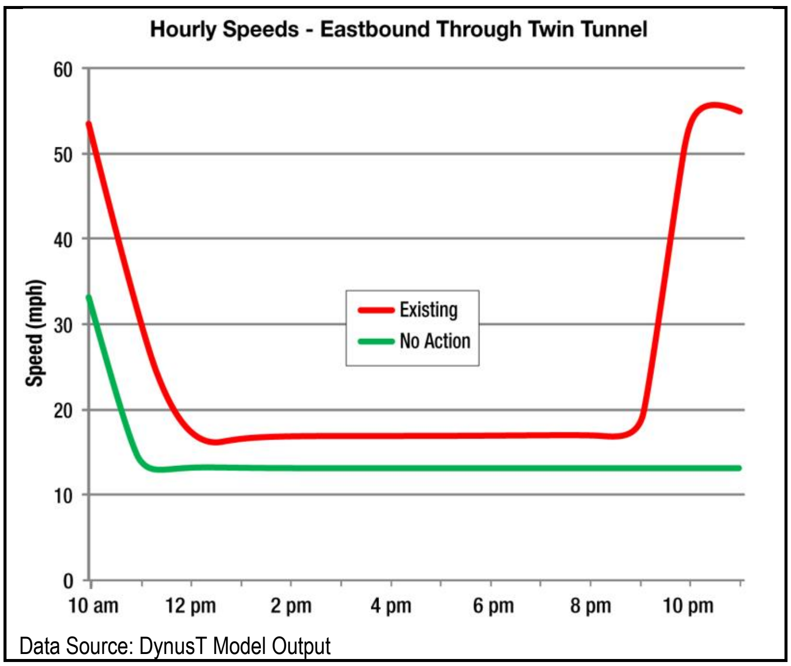
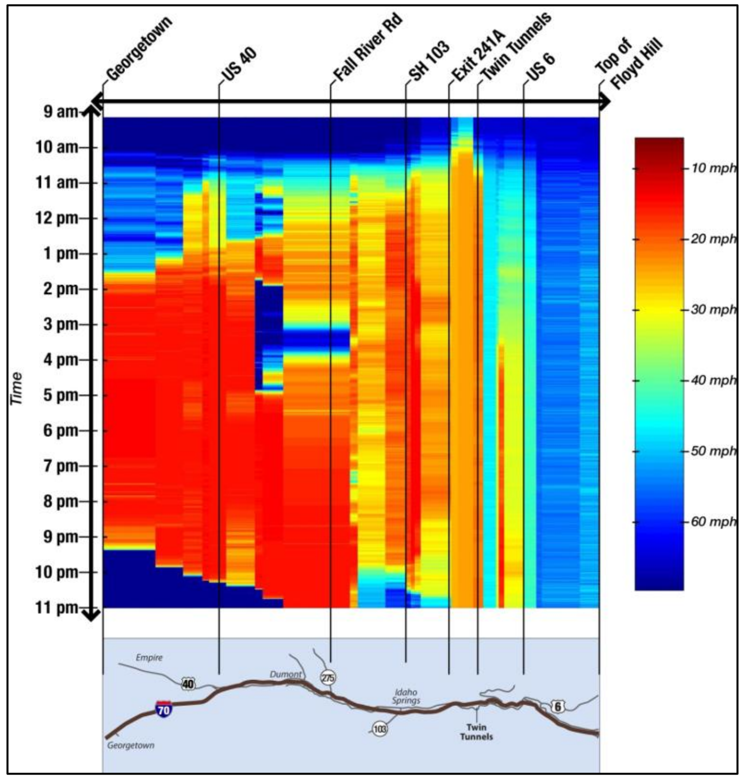


Figure 8.4 shows the average speed of vehicles traveling eastbound on I-70 between Georgetown and the top of Floyd Hill from 9:00 am to 11:00 pm on a peak day (Sunday) for the 2035 No Action Alternative. As expected, 2035 No Action conditions are generally worse than those shown in **Figure 4.12** for existing conditions. Traffic slowing near the Twin Tunnels will begin almost immediately at 9:00 am and gradually extend back to the west eventually reaching the US 40 interchange just after 1:00 pm or nearly 1.5 hours earlier than 2010. In general, a continuous queue of vehicles traveling under 30 mph will exist between the US 40 interchange and the Twin Tunnels between 1:00 pm and nearly 9:30 pm. In addition, the corridor does not show full recovery from the congestion, with significant portions of the highway still experiencing queues and slow speeds, as late as 11:00 pm. The results of the model are consistent with expected conditions with no improvements to the highway and traffic volumes increasing by more than 22 percent.

Figure 8.4 2035 No Action—Average Peak Day Speeds by Segment between Georgetown and the top of Floyd Hill



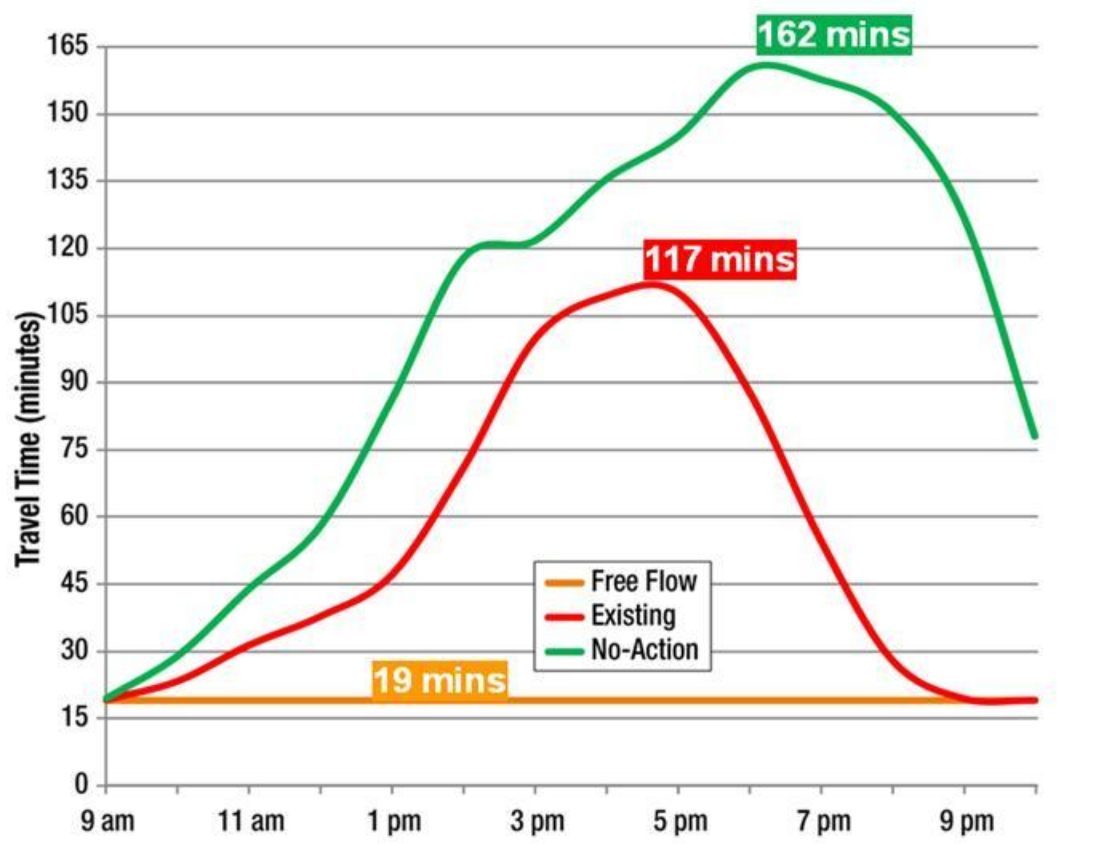
Data Source: DynusT Model Output

The additional congestion in 2035 will result in significant increases in the average travel time experienced by eastbound motorists. **Figure 8.5** shows the average travel time for eastbound travelers on a peak day (Sunday) between Georgetown and the top of Floyd Hill, for 2035 No Action and 2010 Existing Conditions. The increase in 2035 traffic volumes begin to show an impact to expected travels times almost immediately at 9:00 am and eventually reach a maximum of more than 160 minutes. Travels times in excess of 120 minutes, the longest travel time for existing conditions, will occur between the hours of 1:00 pm and 10:00 pm or nearly 65 percent of the time. The increase of 22 percent of traffic without improvements to the highway will result in more than a 70 percent increase in the longest travel times, and drivers will take nearly eight times longer to travel through the corridor compared to free flow conditions.

Figure 8.6 shows the average speeds by time of day, for the five major I-70 segments, compared to the different LOS ranges previously identified in **Figure 4.14**. As expected, the figure shows that all segments of I-70 operate at speeds below 50 mph, or LOS F, for almost the entire time between 9:00 am and 11:00 pm on a typical peak day (Sunday). **Figure 8.7** shows a summary of the operating level of service for the corridor based on an analysis of the data presented in

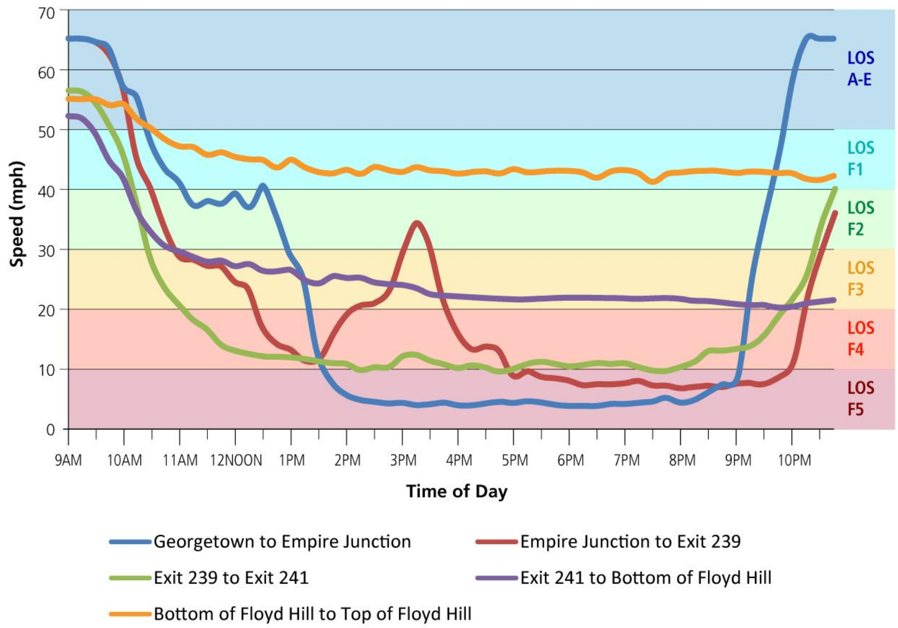
Figure 8.6 and is compared to existing conditions. The figure shows that under the 2035 No Action Alternative, drivers on I-70 experience LOS A-E operations (speeds in excess of 50 mph) for less than 10 percent of the time, while the remaining 90-plus percent of time drivers will experience LOS F (speeds below 50 mph). In the 2035 No Action Alternative, drivers spend about 75 percent of their time traveling at speeds below 20 mph (nearly stopped) compared to only 36 percent of the time in existing conditions.

Figure 8.5 2035 No Action vs. 2010 Existing—Peak Day Average Travel Time between Georgetown and the top of Floyd Hill



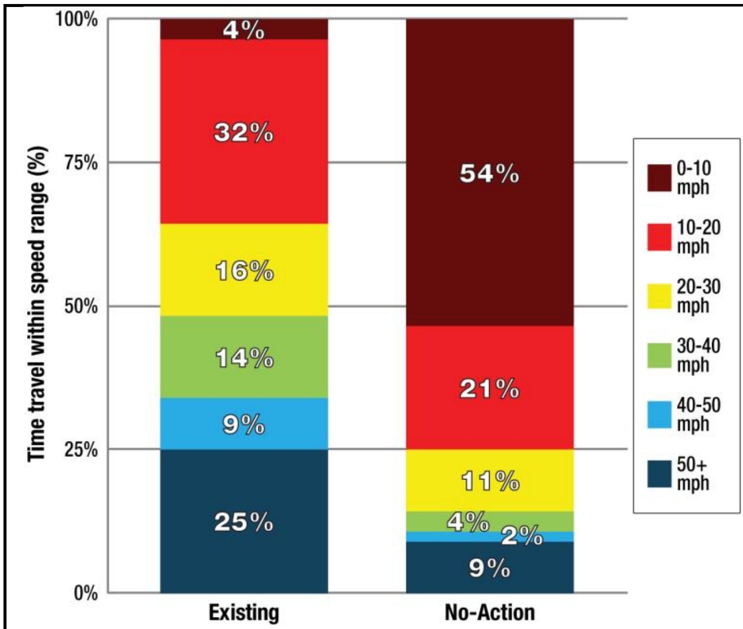
Data Source: DynusT Model Output

Figure 8.6 2035 No Action—Average Peak Day Speeds between Georgetown and the top of Floyd Hill



Data Source: DynusT Model Output

Figure 8.7 2035 No Action vs. 2010 Existing Conditions—Peak Day Percent of Time Drivers Experience each Level of Service



Data Source: DynusT Model Output

Regional travel indicators for the 2035 No Action Alternative were obtained and compared to the 2010 Existing Conditions in **Table 8.4**. Again, the travel indicators are the vehicle miles traveled and vehicle hours of travel for both the entire model network and for just the I-70 corridor (Georgetown to the top of Floyd Hill). As expected, the increase in traffic volumes results in increased VMT and VHT. The VHT for the I-70 corridor shows an increase of 80 percent, which is consistent with the travel time and speed data previously shown.

Table 8.4 2035 No Action Alternative—Peak Day VMT and VHT Summary

Scenario	VMT				VHT			
	System Wide	% Difference	I-70 Corridor	% Difference	System Wide	% Difference	I-70 Corridor	% Difference
2010 Existing	6,507,000	N/A	866,0000	N/A	208,800	N/A	33,400	N/A
2035 No Action	7,745,000	19%	983,305	14%	367,400	76%	59,900	80%

9.0 Proposed Action

9.1 What tolling options were considered for the Proposed Action?

As a result of CDOT's ongoing funding challenges, national initiatives for investigating user fees to defray the cost for transportation improvements, and the demonstrated ability of tolled or managed lanes to provide for a less congested, more reliable travel option over time, CDOT is examining the appropriate use of tolling on all of its major highway capacity projects. Tolls very rarely cover the cost of construction for a project but instead can offer a revenue source to supplement other sources of revenue. The HPTE was in fact established to pursue innovative means of more efficiently financing surface transportation projects. In addition, DRCOG guidance is that tolling should be in the mix of alternatives considered on all highway capacity projects in their region. For all of these reasons, the current CDOT practice for highway capacity projects in or adjacent to the DRCOG region is to consider tolling. The evaluation criteria for how tolling could be included in the project were discussed in Section 7.5.

During the development of the Proposed Action, a total of five tolling options were considered for inclusion in the analyses. These options were subject to analyses by the project team by applying the evaluation criteria just mentioned. This resulted in the following findings:

- <u>Toll all lanes all the time</u>—Tolling all lanes (including general purpose lanes and any added new lanes) all the time would be contrary to current CDOT practices and FHWA policy. The SAFETEA-LU legislation only allows three states to implement full-time tolling on an existing freeway as demonstration projects. Colorado is not one of these states, and recent legislation to expand the authorization to ten states (not including Colorado) was recently voted down in Congress.

  In addition, by affecting all users of I-70 all the time, it would be particularly detrimental to mountain residents and businesses as I-70 is the only practical route to travel to/from local communities. The added cost for freight traffic (which is a sizeable proportion of traffic on I-70 (8.5 percent at the Twin Tunnels and up to 11 percent near Downieville) would have an adverse effect on the I-70 Mountain Corridor's economy. Tolling all lanes on I-70 would cause congestion on the adjacent frontage road as drivers would divert to this low-capacity local access route between East Idaho Springs and Hidden Valley to avoid tolls. It is likely that enough traffic would choose to use the frontage road that the design capacity of the frontage road (approximately 2,600 vehicles per day) would be fully used. This would impact other users of the frontage road (recreationalists using the Clear Creek corridor and residents and businesses that need to access their property) as well as increase maintenance needs for this local road. The amount of diversion could be considerable but would depend on the amount of the toll. Another drawback of this option is that it would not improve the reliability of travel time (as all lanes would experience similar travel times) unless tolls were raised to a level such that the volume on I-70 would be reduced enough to maintain 45 mph or more. This could also dramatically affect traveler behavior with more drivers choosing to change the timing of their travel or not travel at all. For these reasons, this option was not continued through more detailed analyses.

- <u>Toll only the new lane all the time</u>—Tolling the new lane all the time is the current practice on the existing I-25 Express Lanes and the planned practice on the future US 36 Express Lanes. However, unlike these corridors in the Denver area which handle peak demands on a daily basis, I-70 does not have the normal pattern of commuter travel with two peak periods during weekdays. Instead, eastbound I-70 experiences congestion only during peak Sundays, holiday Mondays, and some Saturdays. At other times, two lanes provide sufficient capacity to handle the demand, and travelers would have no incentive to pay a toll. Tolling the new lane all the time would mean that it would only be used during times of congestion, or approximately 48 days a year currently. By 2035, the number of congested days may grow to 100 days. Thus, the new lane would be unused most of the time. Due to the underutilization and inefficient use of resources, this option was not continued through more detailed analyses.
- <u>Toll all lanes during congested periods only</u>—Tolling all lanes only during congested periods would be contrary to current CDOT practices and FHWA policy. The SAFETEA-LU legislation only allows three states to implement full-time tolling on an existing freeway as demonstration projects. Colorado is not one of these states, and recent legislation to expand the authorization to ten states (not including Colorado) was recently voted down in Congress.

  In addition, this option could negatively effect the economy by discouraging travel during peak periods. The cost of freight traffic would increase, which could also dampen the economy. This option would divert traffic to the low-capacity frontage road during peak periods. It is estimated that up to 3,500 vehicles per day could be shifted to the frontage road, causing congestion on this local route. The amount of diversion would depend on the amount of the toll. Another drawback of this option is that it would not improve the reliability of travel time (as all lanes would experience similar travel times) unless tolls were raised to a level such that the volume on I-70 would be reduced enough to maintain 45 mph or more. This could also dramatically affect traveler behavior with more drivers choosing to change the timing of their travel or not travel at all. For these reasons, this option was not continued through more detailed analyses.
- <u>Toll new lane during congested periods only</u>—The project team (with final decisions to be made by CDOT and FHWA) determined that tolling only the new lane during only congested periods is one of the two options that best meet the purpose and need and other evaluation criteria, and support the Core Values. This is called the Managed Lane (ML) Option in the following analyses and is assessed throughout the Environmental Assessment.

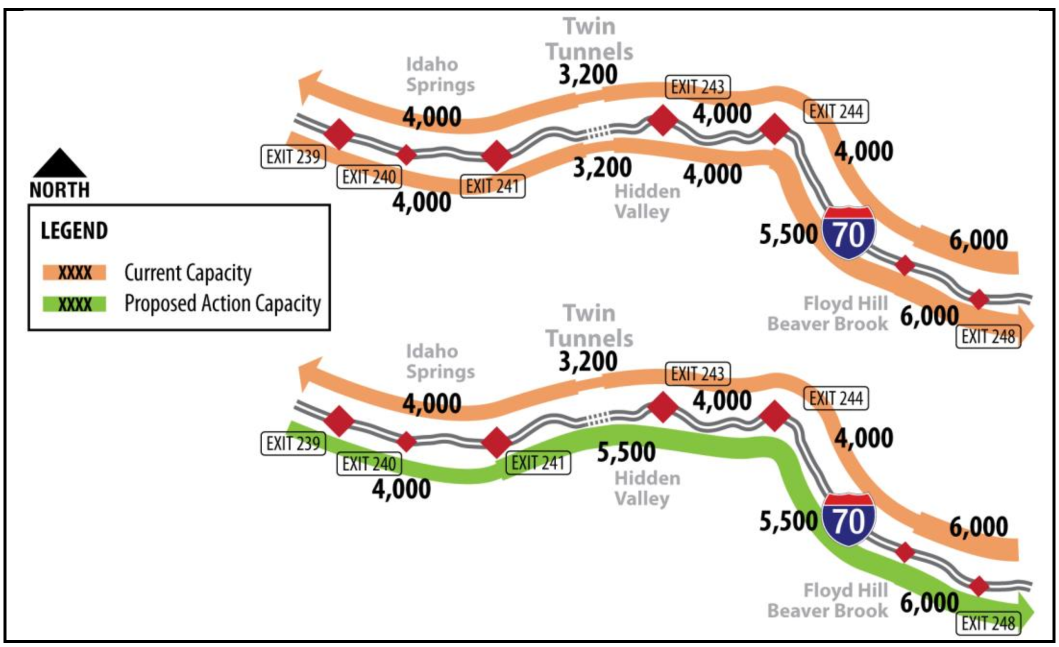
- Do not implement tolling at this time but reserve the right to implement tolling as part of a larger project in the future –The project team (with final decisions to be made by CDOT and FHWA) determined that providing three general purpose lanes while reserving the right to implement tolling as a part of a larger project in the future was also an option that best meet the purpose and need and other evaluation criteria, and support the Core Values. This is called the three General Purpose Lane (3GPL) Option in the following analyses.

9.2 What is CDOT's Proposed Action for the Twin Tunnels area?

The proposed improvement project would add a third eastbound travel lane and consistent 10-foot outside shoulder to I-70 between the East Idaho Springs interchange (Exit 241) and the US 6 interchange (Exit 244) at the base of Floyd Hill. The eastbound bore of the Twin Tunnels would be expanded to accommodate the wider roadway section, including one additional lane and shoulders. Additionally, the Proposed Action would straighten the curve west of the Hidden Valley interchange where the highest number and most serious crashes occur. This curve reconstruction involves replacing a bridge on I-70 over Clear Creek.

The third lane could operate as a general purpose lane, meaning all vehicles could travel in it for free at all times; or as a managed lane, meaning a charge would be exacted during peak periods of congestion in order to maintain a reliable travel time in the managed lane. If the managed lane option is selected as the preferred operation, CDOT would price the lane only during peak periods of congestion, which typically occur on Sundays during the summer and winter seasons. The lane would operate as a general purpose lane at all other times. The current and proposed capacity for the project area is shown in **Figure 9.1**.

Figure 9.1 Current and Proposed Daily Capacities on I-70 in the Project Area



9.3 How will 2035 average weekday traffic operate?

Traffic operations expected to be encountered in the various segments of the study area for the Proposed Action are summarized in **Table 9.1.** It should be noted that the ML Option would not operate during weekdays, i.e., the new lane in the eastbound would not be priced. **Table 9.1** provides a summary of the daily directional volumes, peak hour volumes, speeds, and LOS during the peak hours. This analysis shows that traffic operations will be good (LOS C or better) during weekdays through 2035 for all segments between the EJMT and Floyd Hill. More specifically, traffic operations through the two eastbound segments that will be widened (from Exit 241 to Exit 244) will improve to LOS B from LOS C.

Table 9.1 Proposed Action—2035 (Future) AAWDT and Levels of Service

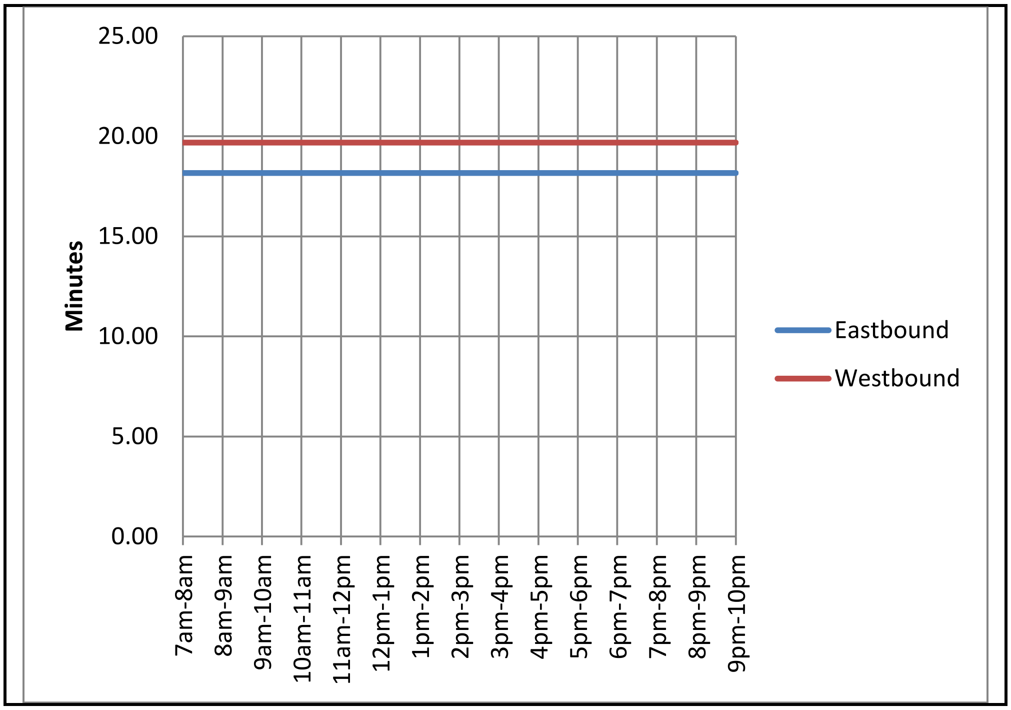
I-70 Mountain Corridor Average Annual Weekday (AAWDT) Traffic								
Direction	Scenario	Daily Volume (vpd)	Peak Hour	Peak Hour Volume (vph)	LOS	Speed (mph)	Lanes	Density (pc/mi/ln)
Floyd Hill (Exit 244 to Exit 248)								
Eastbound	2035 Proposed Action	24446	4-5pm	2327	B	65.0	3	15.4
Westbound	2035 Proposed Action	23839	8-9am	1900	C	60.0	2	20.4
Central City (Exit 244)								
Eastbound	2035 Proposed Action	25944	4-5pm	2470	B	65.0	3	16.3
Westbound	2035 Proposed Action	25602	8-9am	2040	C	60.0	2	21.9
Twin Tunnels (Exit 241 to Exit 243)								
Eastbound	2035 Proposed Action	25667	4-5pm	2443	B	65.0	3	16.1
Westbound	2035 Proposed Action	25433	8-9am	2027	C	60.0	2	25.5
Idaho Springs (Exit 239 to Exit 241)								
Eastbound	2035 Proposed Action	23968	4-5pm	2282	C	64.9	2	22.6
Westbound	2035 Proposed Action	24086	8-9am	1920	C	60.0	2	20.5
Downieville (Exit 232 to Exit 238)								
Eastbound	2035 Proposed Action	22854	4-5pm	2176	C	65.0	2	21.6
Westbound	2035 Proposed Action	22721	8-9am	1811	C	60.0	2	19.4
Georgetown (Exit 228 to Exit 232)								
Eastbound	2035 Proposed Action	17093	4-5pm	1627	B	65.0	2	16.1
Westbound	2035 Proposed Action	17023	8-9am	1357	B	60.0	2	14.6

*Base free-flow speed assumed 65 mph in EB direction, 60 mph in WB direction

**LOS calculation completed using HCM 2010 freeway analysis module

Figure 9.2 illustrates the travel times that are forecasted to be encountered during the study period on a weekday. There would be no increase in travel times with the Proposed Action, as constant speeds can be maintained in both directions.

Figure 9.2 Proposed Action Weekday Travel Time by Hour of Day (Exit 228 to Exit 248)



Finally, travel indicators for the average weekday (total of both directions) are provided in **Table 9.2**.

Table 9.2 2035 Proposed Action—Average Weekday VMT and VHT

Scenario	VMT		VHT	
	I-70 Corridor	% Difference	I-70 Corridor	% Difference
2010 Existing	627,000	N/A	10, 050	N/A
2035 No Action	884,800	41%	14,180	41%
2035 Proposed Action	884,800	41%	14,178	41%

The conclusion of these analyses is that there is currently no congestion in the study or project area on average weekdays in 2035 with the Proposed Action. Congestion is forecast to occur on occasional winter Friday afternoons for eastbound traffic for isolated hours.

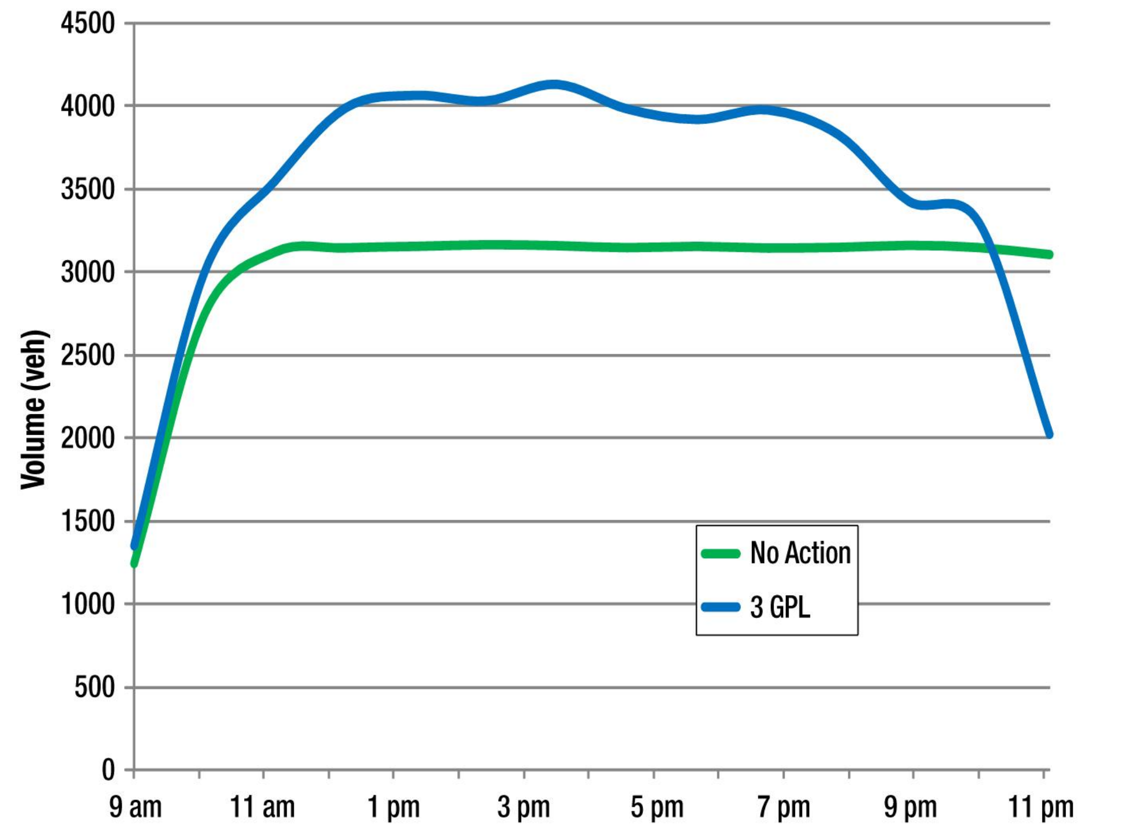
9.4 How will 2035 Sunday traffic operate under the 3GPL Option?

DynusT analyses show that widening the Twin Tunnels segment will improve traffic operations during the peak day (Sunday) compared to the No Action Alternative. The additional capacity that the additional lane removes is the most constricting bottleneck of the I-70 Mountain

Corridor. However, traffic demands will continue to exceed the capacity of the two lanes upstream of the widening project.

Figure 9.3 shows the hourly volume passing eastbound through the Twin Tunnels. The figure shows how the improvements to the tunnel will improve the capacity of the tunnel. However because there are only two lanes west of Exit 241, the volumes passing through the tunnel will reach a maximum of 4,200 vehicles per hour or about 1,400 vehicles per lane per hour.

Figure 9.3 2035 3GPL Option—Peak Day Volumes through the Twin Tunnels (EB)



Data Source: DynusT Model Output

One of the expected impacts due to the decreased travel times and improved operations of I-70 under the 2035 3GPL Option is for more drivers to complete their trips eastbound out of the mountains using I-70 and shift from alternative routes in the region. **Table 9.3** lists a summary of the projected impacts to daily volumes on alternative routes.

Table 9.3 2035 3GPL Option vs. 2035 No Action Alternative—Peak Day Traffic Shifts to Other Roads

Change in Daily Volume on Links for Different Scenarios					
		No Action*		3 GPL	
Location	2010 Volumes	Volumes	% Diff	Volumes	% Diff.**
I-70 Frontage Road west of Hidden Valley	1,930	4,000	107%	460	-88%
SH 9 North of Fairplay	6,000	9,700	61%	8,100	-17%
US 285 East of Grant	7,800	11,600	48%	10,000	-13%

*Compared to 2010 Existing Conditions
**Compared to the 2035 No Action Alternative

Figure 9.4 shows the average speed of eastbound vehicles passing through the tunnel. The results for 3GPL Option are consistent with expectations. Speeds do not drop much below 30 mph, thus the tunnels do not create a queuing issue. The 3GPL Option is capable of serving a total of 47,200 vehicles, which is a 17 percent increase over the 2035 No Action Alternative (between 9:00 am and 11:00 pm).

Figure 9.4 2035 3GPL Option—Peak Day Speeds through the Twin Tunnels (EB)

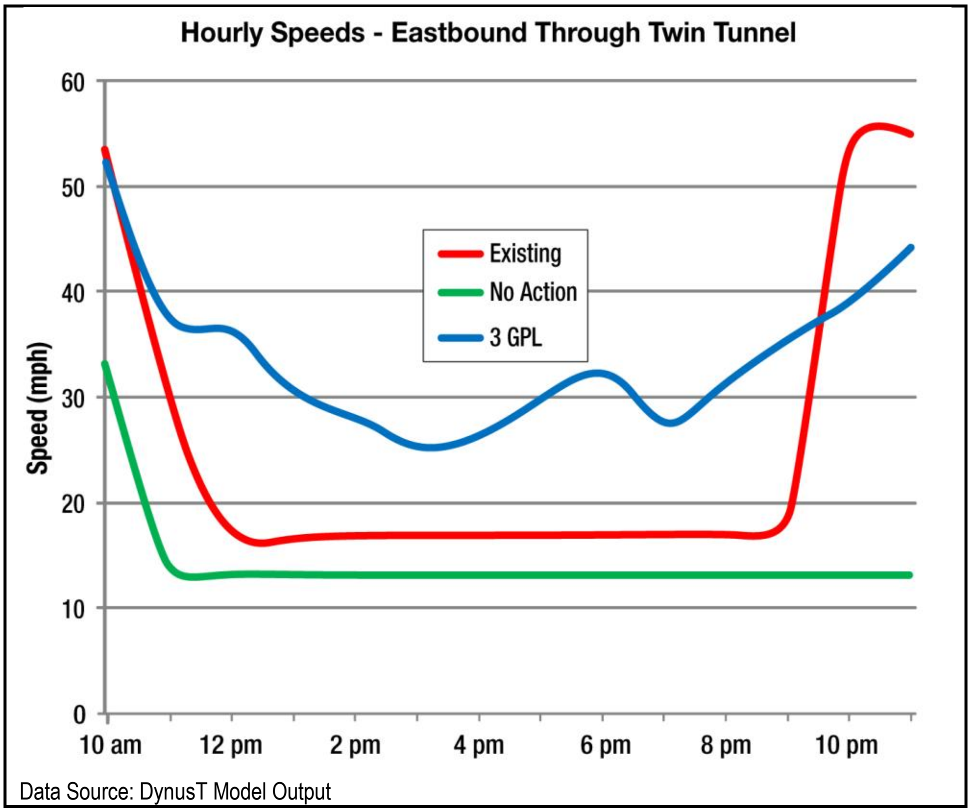
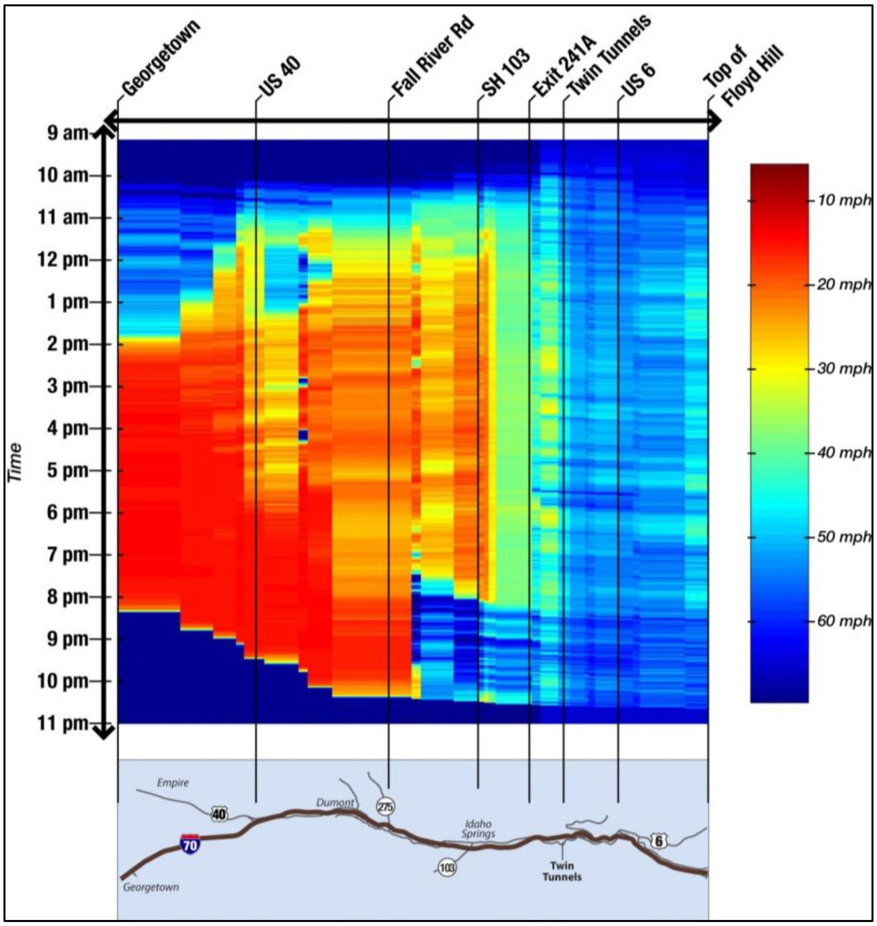


Figure 9.5 shows the average speed of vehicles traveling eastbound on I-70 between Georgetown and the top of Floyd Hill from 9:00 am to 11:00 pm on a peak day (Sunday) for the 2035 3GPL Option. As expected, the 2035 3GPL Option are generally better than those shown in **Figure 8.4** for 2035 No Action Alternative. The improvements to the Twin Tunnels area result in improved flow through the tunnel, which means traffic does experience some slowing near the Twin Tunnels, however, the slowing does not create a queue or cause a queue to extend back to the west toward US 40. In general, queuing begins to form near the SH 103 interchange around 11:00 am and extends back to US 40 by 2:00 pm. The queues will exist until about 8:00 pm and then gradually dissipate until the corridor fully recovers by a 10:30 pm. Unlike the No Action Alternative, the improved highway will be able to process all of the traffic demand and restore free flow conditions more quickly.

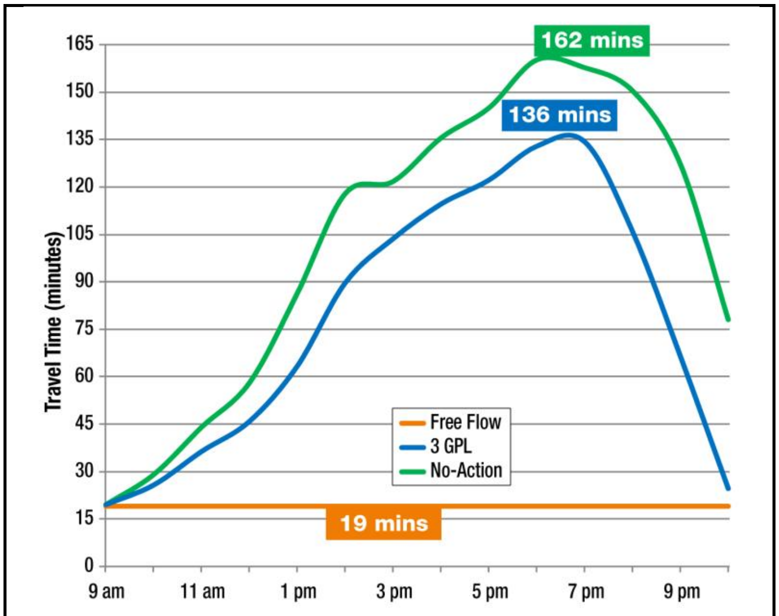
Figure 9.5 2035 3GPL Option—Average Peak Day Speeds by Segment between Georgetown and the top of Floyd Hill



Data Source: DynusT Model Output

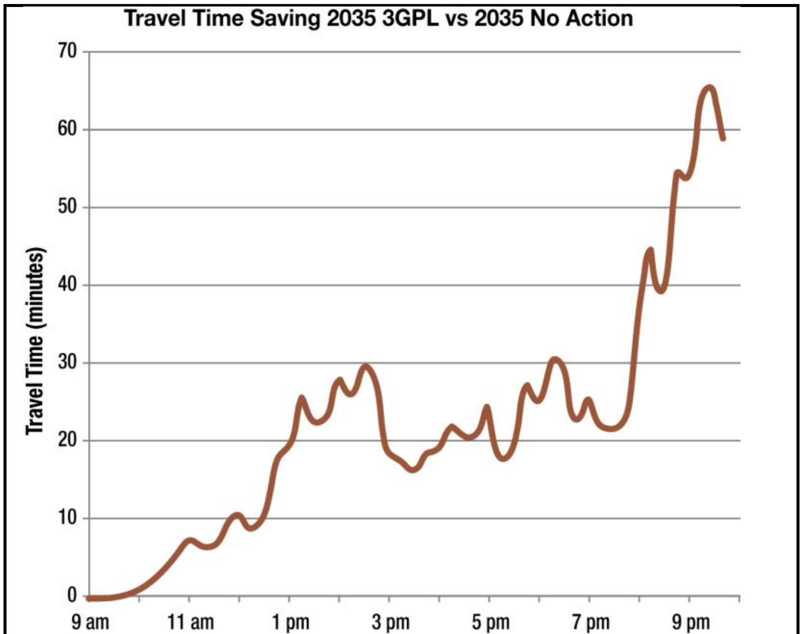
The addition of a third general purpose lane at the Twin Tunnels area will result in improved average travel time experienced by eastbound motorists in 2035. **Figure 9.6** shows the average travel time for eastbound travelers will reach a maximum of about 136 minutes with the 3GPL Option, which is about 19 minutes longer than existing travel times, but on average about 26 minutes shorter than No Action times. This figure also shows that speeds will return to near free-flow conditions shortly after 11:00 pm. **Figure 9.7** shows the average time a driver will save traveling eastbound with the improvements at the Twin Tunnels under 2035 projected traffic conditions.

Figure 9.6 2035 3GPL Option—Average Peak Day Travel Time between Georgetown and the top of Floyd Hill



Data Source: DynusT Model Output

Figure 9.7 2035 3GPL Option—Average Peak Day Travel Time Savings between Georgetown and the Top of Floyd Hill



Data Source: DynusT Model Output

Figure 9.8 shows the average speeds by time of day for the five major I-70 segments compared to the different LOS ranges previously identified in **Figure 4.14**. As expected, the figure shows that all segments of I-70 operates at improved speeds compared to the No Action Alternative; however, all segments still operate at LOS F1 to LOS F5 for a majority of the day. **Figure 9.9** shows a summary of the operating level of service for the corridor by doing a minute by minute analysis of the data presented in **Figure 9.8** and comparing it to the 2035 No Action Alternative. This figure shows that the 2035 3GPL Option will have drivers on I-70 experiencing LOS A-E operations (speeds in excess of 50 mph) for about 13 percent of the time, which is a slight improvement over the No Action Alternative. Since the improvements to the Twin Tunnels area are limited to a small section of roadway (less than three miles in length), the overall improvement in speed to the entire 19 miles study segment is expected to be small. However, the 3GPL Option does reduce the time drivers will travel at speeds below 20 mph from 75 percent to about 61 percent, and the time drivers are basically stopped (less than 10 mph) from about 54 percent to about 27 percent. Although the overall LOS of the corridor does not improve significantly, the drivers experience higher average travel speeds and will spend much less time travel at low speeds or stopped in queues.

Figure 9.8 2035 3GPL Option—Average Peak Day Speeds between Georgetown and the top of Floyd Hill

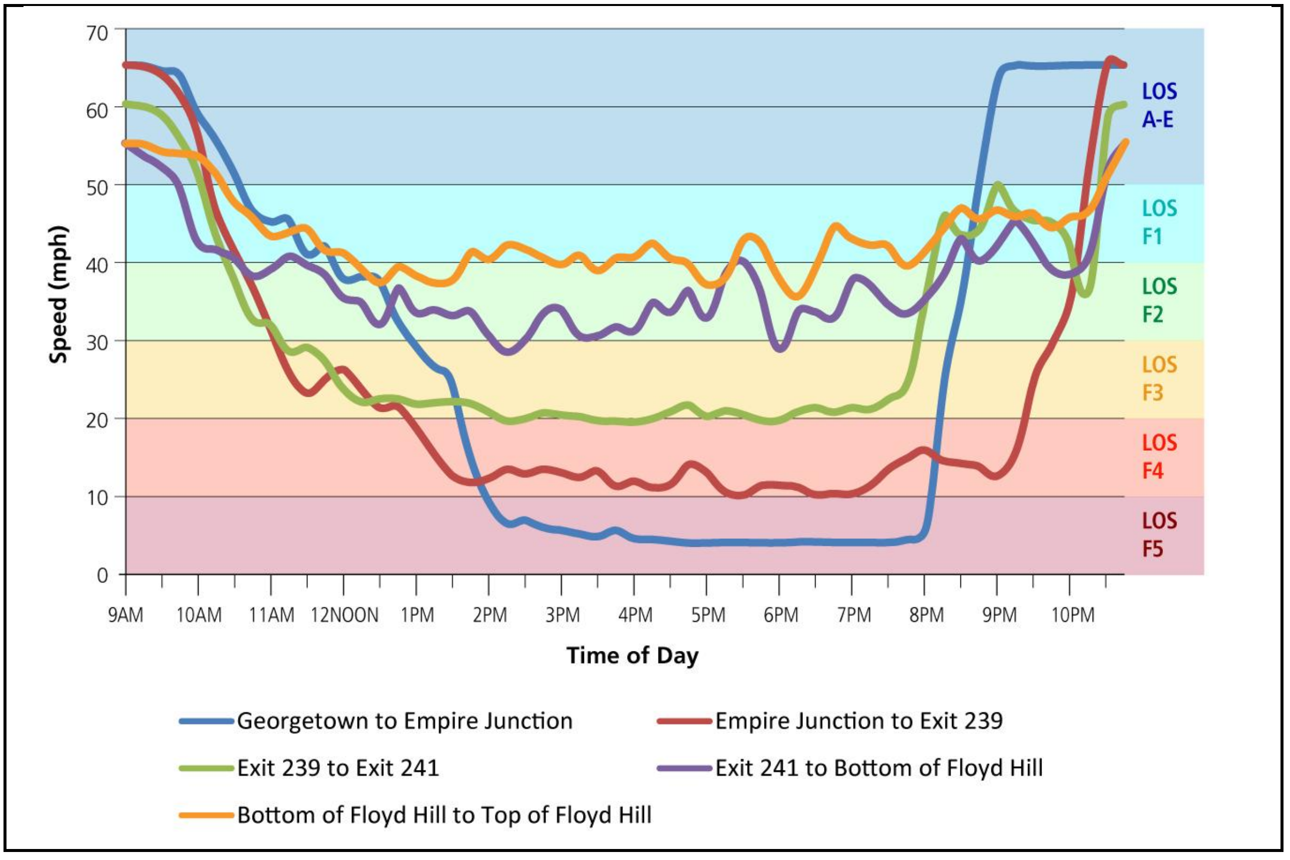
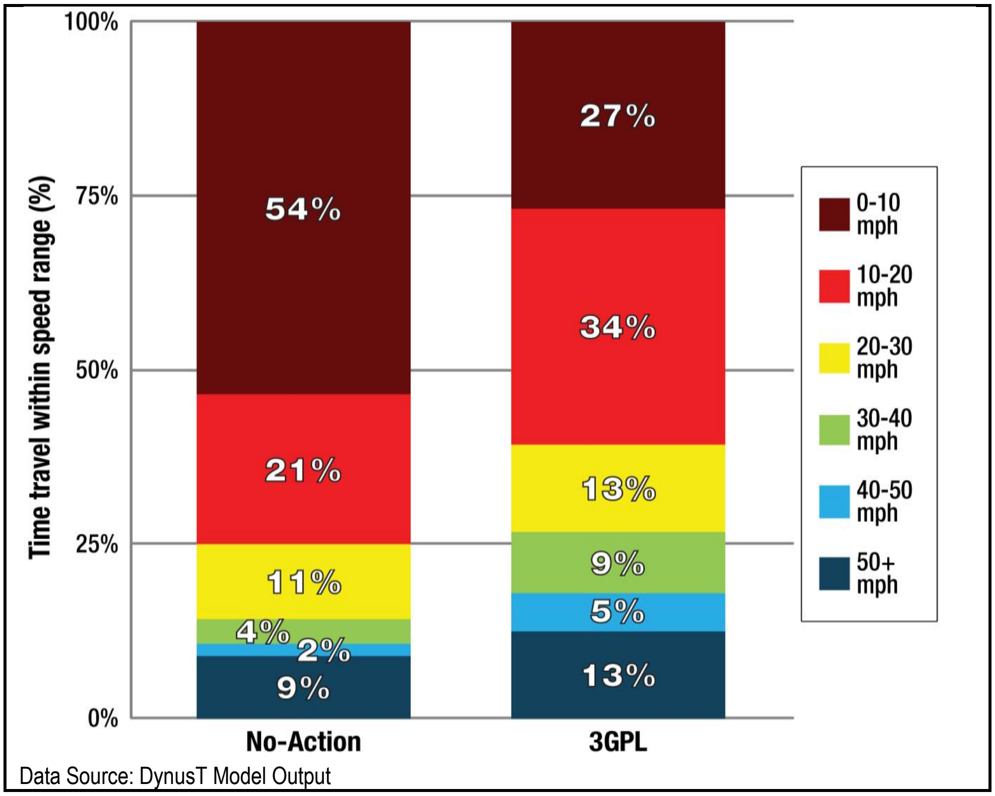


Figure 9.9 2035 3GPL Option Peak Day Percent of Time Drivers

Experience each Level of Service



These low traffic speeds (symptomatic of congested traffic) mean that the travel time for any one individual drive would be much less reliable than could be achieved by drivers choosing to use the managed lane. Emergency vehicles would also be affected by the lower travel speeds, and the time to respond to incidents would be subject to the specific level of congestion when the call is received.

Regional travel indicators for the 2035 3GPL Option were obtained and compared to the 2010 Existing and 2035 No Action Alternative. Again, the travel indicators are the vehicle miles traveled and vehicle hours of travel for both the entire model network and for just the I-70 corridor (Georgetown to the top of Floyd Hill). **Table 9.4** shows the results of the comparison of travel indicators for the different scenarios. The results show a slight increase in VMT for the system and I-70 corridor. This is primarily because with more lanes on I-70, more vehicles are choosing to use I-70 as the route of choice. Although VMT slightly increases, VHT for the system and I-70 show significant improvements under the 3GPL Option. Thus, more cars are traveling on I-70, but they are completing their trips in less time resulting in lower VHT.

Table 9.4 2035 3GPL Option—Peak Day VMT and VHT Summary

Scenario	VMT				VHT			
	System Wide	% Difference	I-70 Corridor	% Difference	System Wide	% Difference	I-70 Corridor	% Difference
2010 Existing	6,507,000	N/A	865,900	N/A	208,800	N/A	33,400	N/A
2035 No Action	7,745,000	19% *	983,300	14% *	367,400	76% *	59,900	80% *
2035 3GPL	8,006,200	3% **	996,900	1% **	309,200	-16% **	47,700	-20% **

*Compared to 2010 Existing Conditions

**Compared to the 2035 No Action Alternative

9.5 What are the advantages of ML Operations?

Travel Time Reliability

As travel demand on I-70 continues to grow, congestion, long travel times and uncertain travel time reliability will increase. Congestion, which in 2010 is confined primarily to peak periods on weekends, will grow over time to encompass weekday periods as well. A managed lane provides a mechanism for CDOT to assure a reliable and efficient travel time for 2035 and beyond as travel time reliability degrades in the general purpose lanes. Studies have shown that travelers are willing to pay a toll for travel time reliability.

Managed Lanes Provide Options

Managed lanes that are added in the same corridor as existing general purpose lanes provide options for travelers. Travelers are not required to use the facility, and many will only use them periodically, but travelers are provided the option for a faster, more reliable trip.

Future I-70 Mountain Corridor Connectivity/Flexibility

Managed lanes build in flexibility for future tolling of I-70. They provide CDOT with ultimate flexibility to determine when and how pricing will be implemented. Colorado law is clear that the hurdles to adding tolls to existing lanes are greater than adding tolls to new lanes.

Managed Lanes are More Consistent with a User Pay Philosophy

Nationwide, highway funding and environmental groups have been advocating funding of highway capacity that ties highway travel more closely to a user pay philosophy. A managed lane that clearly matches an increasing cost with higher demand is more likely to encourage alterations in travel behavior.

Environmental groups nationwide support this approach because it more clearly passes on transportation costs to the user and serves to encourage transit use or carpooling, which increase person throughput rather than vehicle throughput.

Managed Lanes are a More Efficient Use of a Highway

There is a substantial premium in adding highway capacity in most highway corridors and the I-70 Mountain Corridor has greater constraints than most. Providing the long-term ability to maintain a lane of free-flow travel will greatly enhance the capacity of the corridor.

Managed Lanes Can be Used to Encourage Transit and Carpooling
The pricing of highway usage has been clearly shown to encourage travelers to consider transit options and to increase vehicle occupancy rates. For the Twin Tunnels project, CDOT has committed to allowing public or privately operated buses to use the managed lanes for free. This will serve to provide a built in incentive for travelers to use the buses, as travel time will be faster and more reliable.

Managed Lanes Improve Emergency Response Reliability
Emergency vehicles will be allowed to use the lanes without paying a toll as long as they have been dispatched to run with lights and sirens for emergency purposes. The managed lane will provide a less congested alternative for emergency vehicles, increasing their reliability and response time.

Managed Lanes Improve Economic Viability
In contrast to congestion gridlock, managed lanes provide an option for those willing to pay to travel through the corridor with a reliable travel time. This not only will improve conditions for recreational travelers as well as other providers of goods and services along the I-70 corridor. This enhances the economic competitiveness of all users of I-70 as well as those communities adjacent to I-70.

9.6 What are the disadvantages of the ML Option?

The primary disadvantages of the managed lane option are related to misconceptions and fears about its impacts. CDOT is undertaking a public education campaign in the I-70 Corridor to answer questions and concerns.

Local Travel
I-70 is the sole route that traverses Clear Creek County. Local residents may be concerned that they may not be able to take advantage of the additional capacity that is being provided on I-70. (Response: The two existing, general purpose lanes on I-70 will remain non-priced at all times of the week, even during peak, weekend congested periods. Local drivers, as well as those passing through, will be able to use I-70 with no charge.) In addition, improvements will be made to the frontage road as well as investments for non-motorized travelers using the Clear Creek County Greenway trail.)

Tolling
There will be a segment of motorists who will oppose the basic concept of paying a toll on a facility that has previously been free at all times, including on newly added capacity. (Response: As noted previously, the existing two lanes will not be priced at any time; only the new capacity will be priced during congested periods. Managed lanes provide the ability to manage congestion in a way that is sustainable into the future; as traffic volumes grow, the priced lane will always be available to provide a congestion-free choice to drivers. Although a secondary consideration, on the funding side, due to the overall scarcity of funds for new highway construction, CDOT has determined that new highway capacity in and adjacent to the Denver metropolitan area must consider managed lanes to preserve the utility of the new capacity into the future and allow drivers to pay for reliable travel time into the future.

Otherwise, growth will overwhelm the additional capacity, and all drivers will experience increasing levels of congestion.)

Project Length

There could be concerns that the proposed widening is too short a section of roadway to make a difference in travel time savings between the free lanes and the managed lane. (Response: Widening the eastbound Twin Tunnel and adding a third lane will remove one of the critical bottlenecks along the entire I-70 Mountain Corridor and will therefore produce a noticeable difference in congestion for all users of the Corridor. However, this is only one project and will not solve all the congestion problems in the Corridor. It is anticipated that other capacity improvements in the I-70 Corridor may also be priced in order to preserve new capacity and provide opportunity for reliable travel times. In March 2012, Santa Clara County implemented the SR 237 and I-880 Express Connector project in Santa Clara, CA. The project converted an eastbound to northbound HOV direct connection that is 3.5 miles in length and a southbound to westbound HOV direct connection that is 6.5 miles in length. Both segments are relatively short and are operating successfully.)

Traffic Operations

There may be the concern that drivers may be confused about whether they should or want to use the managed lane. Unlike other managed lanes around the country, the I-70 managed lane will not be in an urban area and will not be used consistently during peak weekday commuter periods. (Response: Design engineers with nation-wide experience with similar facilities will have key input into the design of the managed lane; including the signing and striping. The guidance provided in the *Manual of Uniform Traffic Control Devices* (MUTCD) will be followed to provide clear and concise messages to all drivers regarding the use of the managed lanes; thus providing a safe operating facility. Most of the peak period traffic on the weekends are "regular" users of the corridor and are therefore similar to commuters in urban areas. They will see and learn how the managed lane works after one or two trips through the lane. In addition, the hours of operation for the managed lane will be set to reflect the unique traffic demand patterns of this corridor.)

Aesthetic Considerations

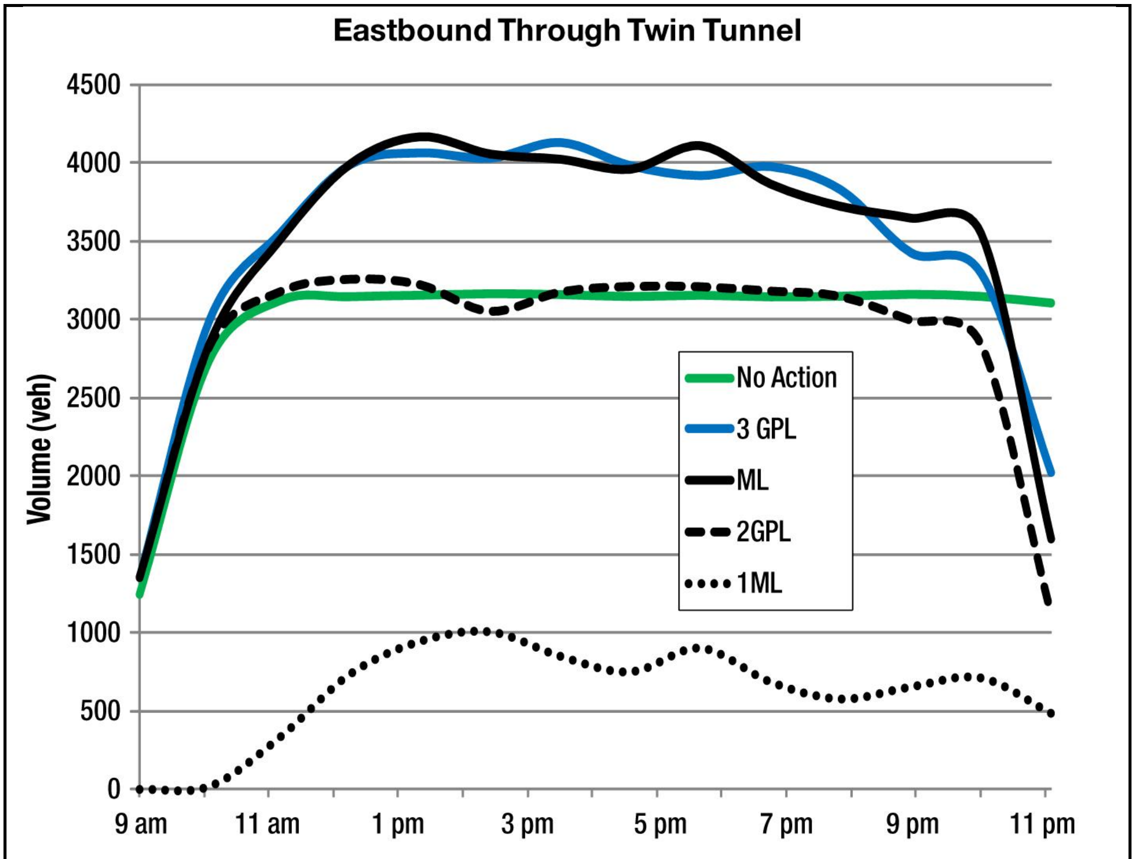
There may be concern from local residents that the additional signs necessary for the managed lane will further degrade the view of the historic community of Idaho Springs from I-70. (Response: Local stakeholders have been involved throughout the development of the Twin Tunnels Environmental Assessment. This process has followed the guidelines of the Context Sensitive Solutions (CSS) process through participation in a Project Leadership Team (PLT) and Technical Team (TT). The signing plan is also being developed to comply with I-70 Mountain Corridor design and aesthetic criteria, and is being developed in coordination with the Section 106 Programmatic Agreement for historic resources to ensure that the historic character of the area is not compromised. This concern has been addressed through the preparation of a comprehensive signing plan and visual simulations. Local stakeholders will continue to be involved in the design and construction of the project through the CSS process.)

9.7 How will 2035 Sunday traffic operate under the ML Option?

As discussed in Section 7.3.6, the ML Option was analyzed by DynusT based on a VTTS of $43.40 (2010 Dollars) which results in a toll of approximately $1.50 for the majority of the peak day for each vehicle using the managed lane. DynusT analyses show that the two operational options for the Proposed Action result in similar improvements in traffic operations during the peak day (Sunday) compared to the No Action Alternative. **Figure 9.10** shows the hourly volume passing eastbound through the Twin Tunnels. In addition, the dashed lines provide a breakout of the volumes in the managed lane and in the two general purpose lanes.

Table 9.5 lists a summary of the projected impacts to volumes (9:00 am to 11:00 pm) on alternative routes if the ML Option were to be implemented. Overall the managed alternative will pull less traffic off the diversion routes and back onto I-70 compared to the 3GPL Option. However, compared to the No Action Alternative, the ML option will result in much fewer vehicles shifting away from I-70.

Figure 9.10 2035 ML Option—Peak Day Volumes through the Twin Tunnels (EB)



Data Source: DynusT Model Output

Table 9.5 2035 ML Option—Peak Day Traffic Shifts to Other Roads

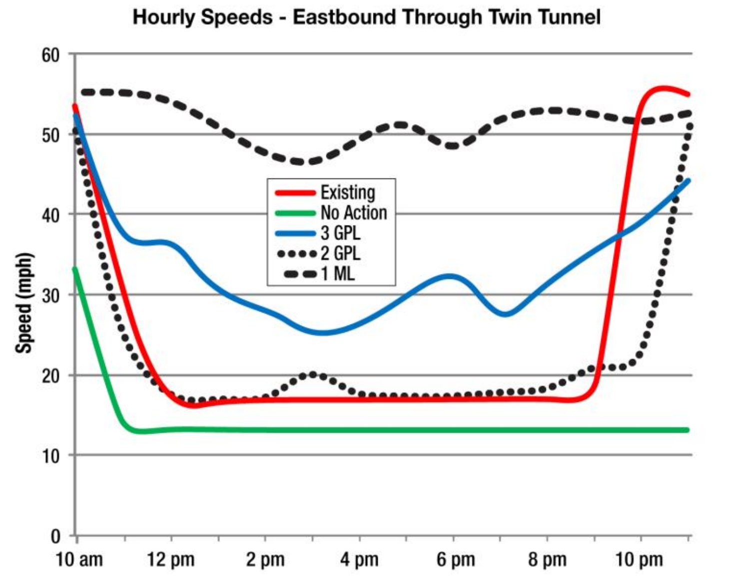
Change in Volume on Links for Different Scenarios							
Location	2010 Vol.	No Action*		3 GPL		ML	
		Vol.	% Diff	Vol.	% Diff.**	Vol.	% Diff.**
I-70 Frontage Road west of Hidden Valley	1,930	4,000	107%	460	-88%	500	-87%
SH 9 North of Fairplay	6,000	9,700	61%	8,100	-17%	8,200	-16%
US 285 East of Grant	7,800	11,600	48%	10,000	-13%	10,100	-12%

*Compared to 2010 Existing Conditions

**Compared to the 2035 No Action Alternative

Figure 9.11 shows the average speed of eastbound vehicles passing through the tunnel. For the ML Option, speeds in the two general purpose lanes drop below 20 mph while speeds in the managed lane remain above 45 mph for the entire day. Approximately 20 percent of the vehicles will reliably experience higher speeds under the ML Option while the remainder will experience slightly slower speeds through the short project area. The ML Option is capable of serving a total of 47,000 vehicles (38,300 in the general purpose lanes and 8,700 in the managed lanes) which is a 16 percent increase over the No Action Alternative (between 9:00 am and 11:00 pm) and less than 1 percent lower than the 3GPL Option.

Figure 9.11 2035 ML Option—Peak Day Speeds through the Twin Tunnels (EB)



Data Source: DynusT Model Output

Figure 9.11 best illustrates one of the major benefits of the managed lane—reliability of travel time. Drivers are willing to pay for higher, more reliable speeds. A travel speed of 45 mph in the managed lane can be achieved over 95 percent of the time by manipulating the toll charge in response to demand volumes. As will be shown in following discussions, this can result in up to three minutes savings in travel time through this relatively short project area.

This pattern of reliable travel in the managed lane also means that emergency vehicles responding to incidents will not be held up in congested eastbound traffic east of Idaho Springs, since emergency vehicles would be allowed to use the managed lanes.

The increased reliability of travel that is assured in the managed lanes would be expected to benefit riders in buses, since the current scenario assumes that public buses (and possibly private buses) would be able to use the managed lane for free. The toll to use the managed lane would also be expected to result in increased vehicle occupancy. Currently, there are relatively few single occupant vehicles on the I-70 during periods of peak congestion (Sunday afternoons). The I-70 Mountain Corridor PEIS reports vehicle occupancy of 2.6, which is much higher than that experienced during the normal urban commute. Logic would lead to the conclusion that the toll for the managed lane would not encourage less carpooling but more in order to have an extra passenger to share the toll costs. However, the increase in average vehicle occupancy may not be measurable.

The increased reliability of travel better serves I-70 users as travel demand continues to increase post 2035. The managed lane offers a sustainable choice to travelers so that a congestion free option is always available.

The Managed Lane Option is more consistent with a “user pay” philosophy of transportation funding. This may serve a purpose over time to alter travel behavior to make more efficient use of our current transportation infrastructure. Travelers may choose to use alternate forms of transportation (carpooling, vanpooling, taking a bus or ultimately, taking other forms of mass transit such as AGS) or travel at less congested times.

Figure 9.12 shows the average speed of vehicles traveling eastbound on I-70 between Georgetown and the top of Floyd Hill from 9:00 am to 11:00 pm on a peak day (Sunday) for the 2035 ML Option. As expected, the 2035 ML Option are generally better than those shown in **Figure 8.3** for 2035 No Action Alternative. The results of the ML analysis are very similar to those for the 3GPL Option. The big difference is in the area directly before the start of the managed lane. Drivers will not begin to use the managed lane until a time when the operating conditions in the general purpose lanes gets to a point where drivers will make the choice to pay the fee to gain a benefit of a reliable travel time through the improvements.

The addition of a third lane in the form of a managed lane at the Twin Tunnels area will result in improved average travel time experienced by eastbound motorists in 2035 compared to the No Action Alternative. **Figure 9.13** shows the average travel time for the 2035 ML Option is very similar to that for the 3GPL Option: the ML Option takes longer during the first part of the peak hours, but once the managed lane reaches its capacity and continues to operate with maximum flow (ensuring the lane operates at or above 45 mph), then the travel times show slight improvement during the later peak hours. Overall throughout the day, the travel times basically balance out between the ML and 3GPL options.

Figure 9.12 2035 ML Option—Average Peak Day Speeds by Segment between Georgetown and the top of Floyd Hill

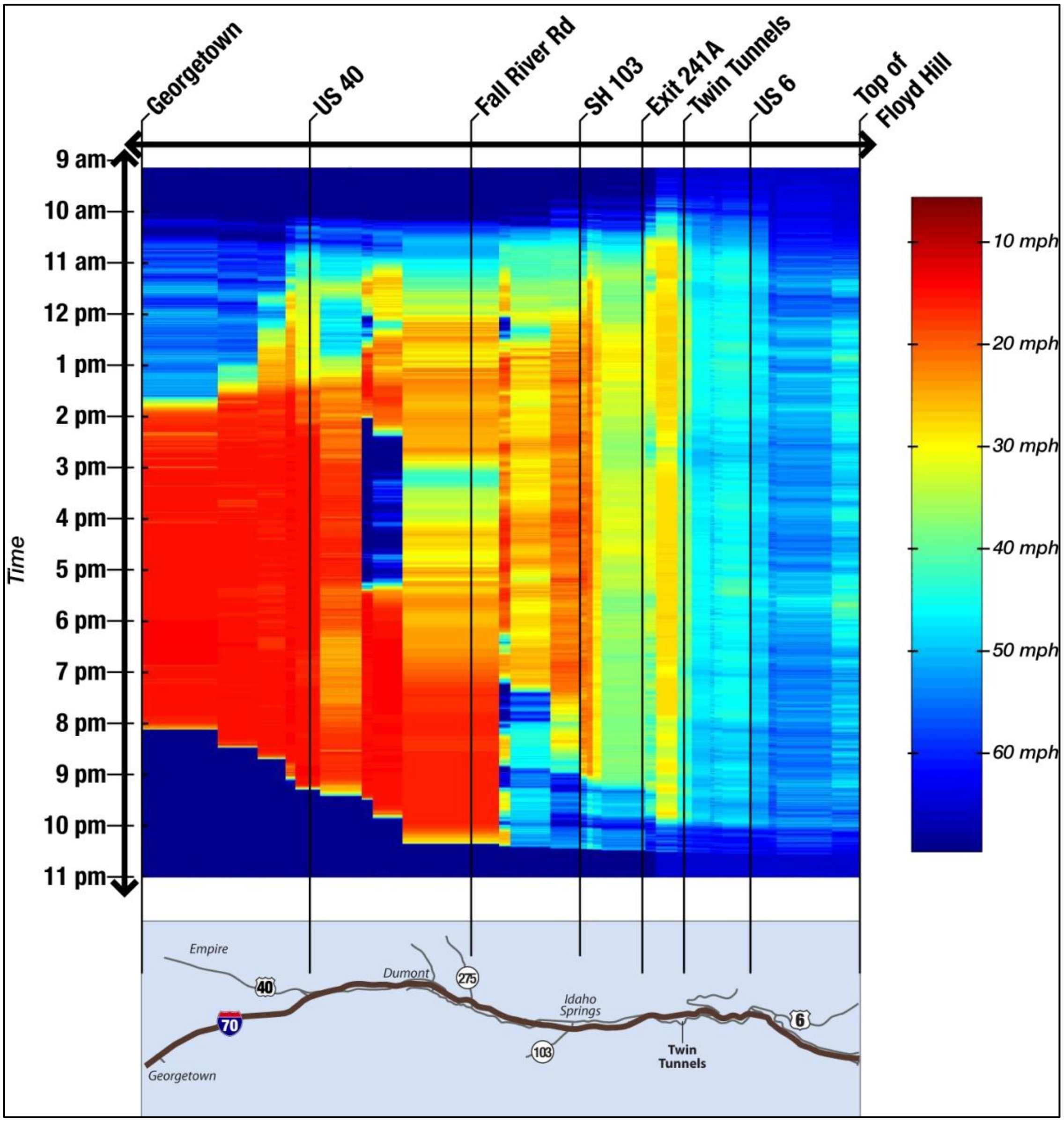
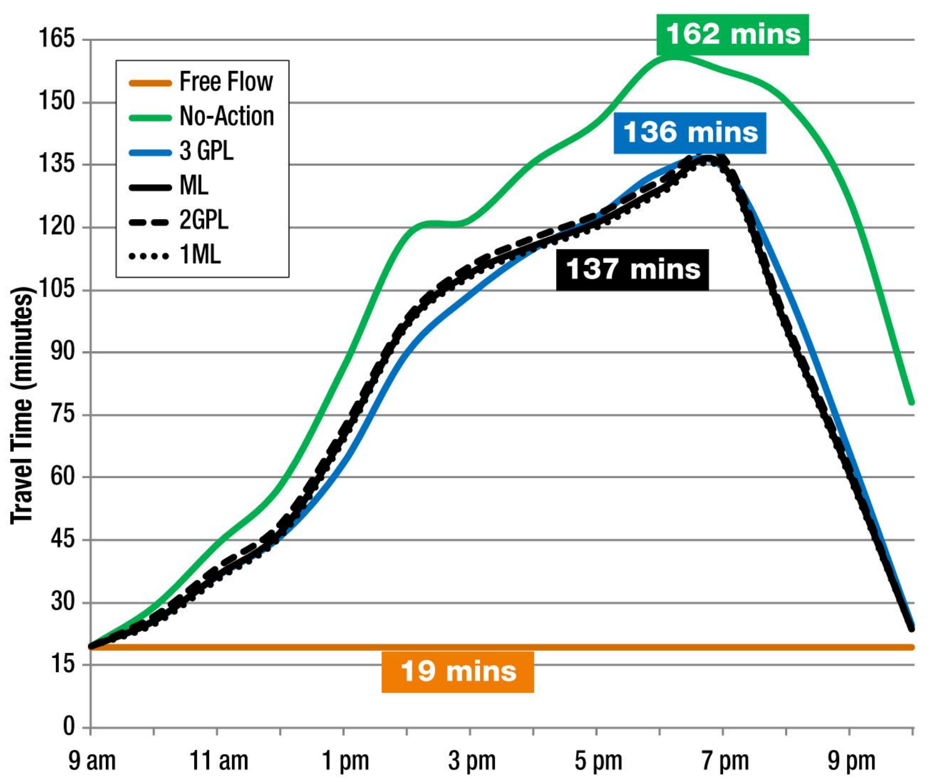


Figure 9.13 2035 ML Option—Average Peak Day Travel Time between Georgetown and the top of Floyd Hill



Data Source: DynusT Model Output

Figure 9.14 shows the average time a driver will save for the 2035 ML Option if they use the managed lane versus staying in the general purpose lanes from Georgetown to the Top of Floyd Hill. Since the managed lane is about three miles in length, the maximum time saving for the managed over the general purpose lanes is about three minutes throughout the day and is consistently about 2.5 minutes faster.

Figure 9.15 shows the average speeds by time of day for the five major I-70 segments compared to the different LOS ranges previously identified in **Figure 4.14**. As expected, the figure shows that all segments of I-70 operate at improved speeds compared to the No Action Alternative, but all segments still operate at LOS F1 to LOS F5 for a majority of the day. The results are slightly better than those for the 3GPL Option, as expected, based on the previously reported data.

Figure 9.16 shows a summary of the operating level of service for the corridor by doing a minute by minute analysis of the data presented in **Figure 9.15** and comparing it to all of the scenarios previous discussed. The figure shows the 2035 ML Option is very similar to the 3GPL Option (but slightly better in almost all measures) and is much better than the No Action Alternative.

Figure 9.14 2035 ML Option—Average Peak Day Travel Time Savings between Georgetown and the Top of Floyd Hill Using ML vs. GP Lane

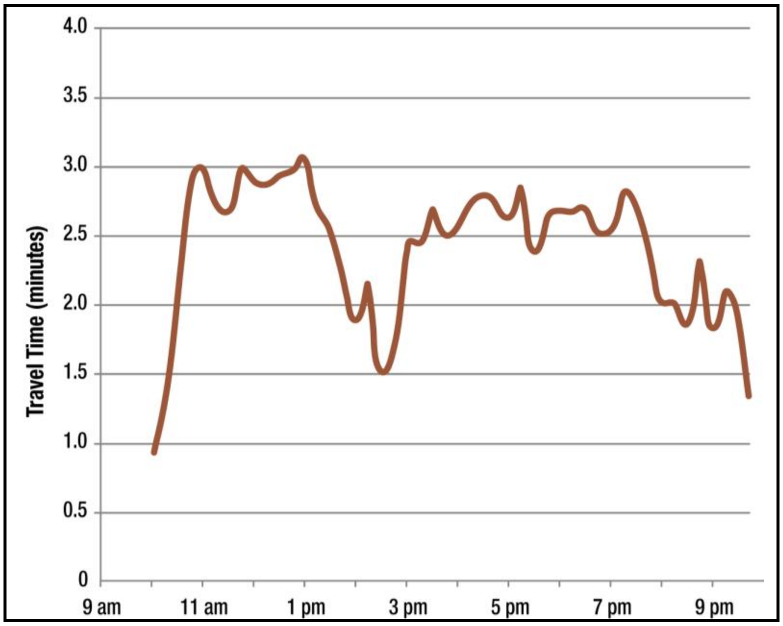
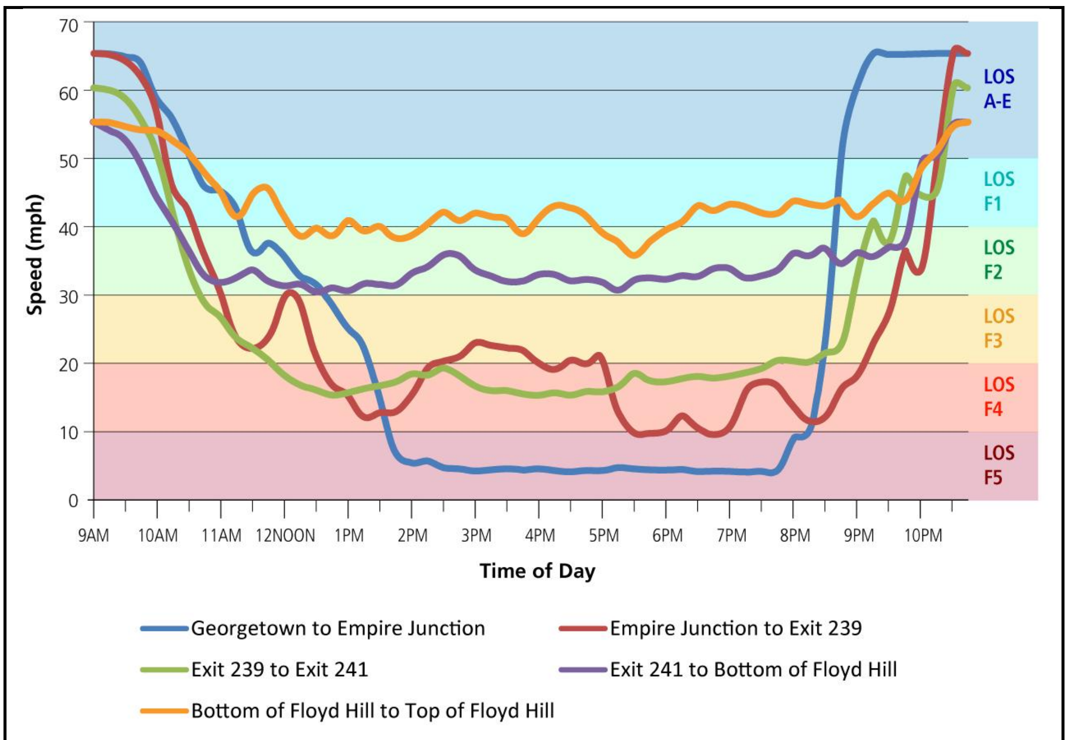
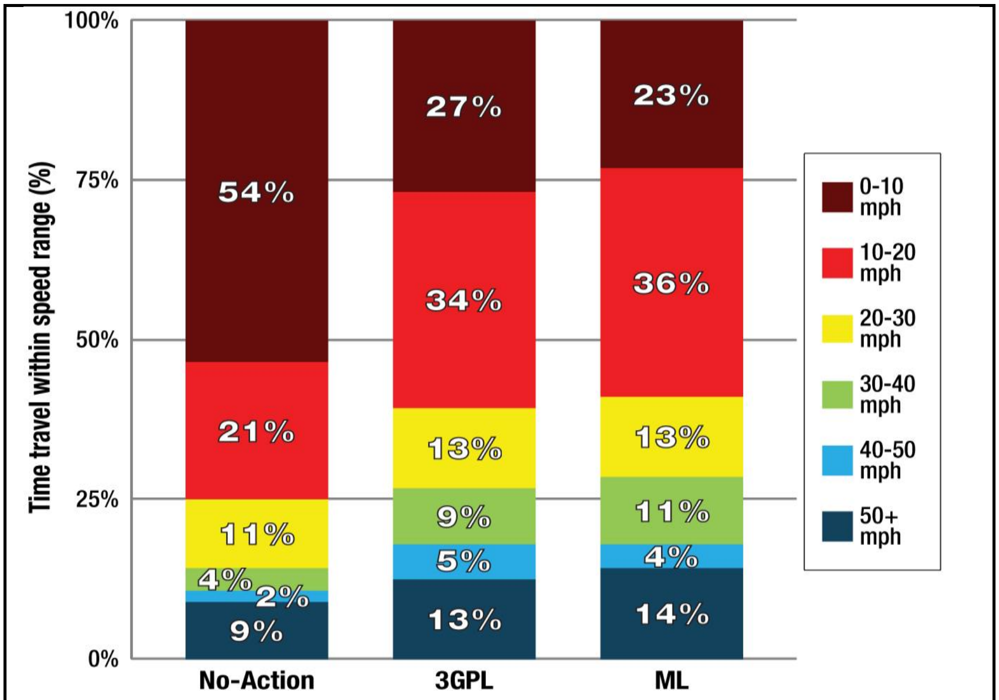


Figure 9.15 2035 ML Option—Average Peak Day Speeds between Georgetown and the top of Floyd Hill



Data Source: DynusT Model Output

Figure 9.16 2035 ML Option—Peak Day Percent of Time Drivers Experience each Level of Service



Data Source: DynusT Model Output

Regional travel indicators for the 2035 ML Option were obtained and compared to the other scenarios. **Table 9.6** shows the results of the comparison of travel indicators for the different scenarios. The results for the ML and 3GPL options are basically identical with slightly lower VMT and VHT for the ML Option. This reduction in VMT results in less air pollution and less energy consumption, a clear advantage of the Proposed Action. This reduction in VMT is anticipated to become more pronounced as traffic volumes continue to increase post 2035.

Table 9.6 2035 ML Option—Peak Day VMT and VHT Summary

Scenario	VMT				VHT			
	System Wide	% Difference	I-70 Corridor	% Difference	System Wide	% Difference	I-70 Corridor	% Difference
2010 Existing	6,507,00 0	N/A	865,900	N/A	208,800	N/A	33,400	N/A
2035 No Action	7,745,00 0	19% *	983,300	14% *	367,400	76% *	59,900	80% *
2035 3GPL	8,006,20 0	3% **	996,900	1% **	309,200	-16% **	47,700	-20% **
2035 ML	8,003,90 0	3% **	988,200	1% **	311,900	-15% **	46,600	-22% **

*Compared to 2010 Existing Conditions

**Compared to the 2035 No Action Alternative

10.0 Future Safety Conditions

The following provides a summary of the expected crash experience on I-70 in the project area, between mile point (MP) 241.30 (Curve 1 east of Idaho Springs) and MP 244.42 (Curve 10/11 at the base of Floyd Hill).

10.1 What are the geometric assumptions for the No Action Alternative and Proposed Action?

This analysis is based on the following geometric assumptions:

- The No Action Alternative assumes I-70 would remain in its current alignment and continue to have a four lane cross section (two eastbound lanes and two westbound lanes).
- Proposed Action assumptions:
  - Eastbound I-70 will have a continuous three lane cross section from Idaho Springs to Floyd Hill. One Operational Option assumes that all three lanes will be untolled and open to all traffic (3GPL Option)
  - The horizontal curvature of Curve 5 will be improved to a 55 mile per hour design speed. Westbound I-70 will remain within its current alignment and cross section.
  - The ML Option assumes the new eastbound travel lane is tolled on Sunday only during peak hours. This lane is a general purpose lane at all other times of the week.

10.2 What are the crash totals for the No Action Alternative?

The SPF chart developed by CDOT for rural mountainous four-lane interstates was utilized to forecast 2035 No Action crashes. This 2035 future condition crash total was estimated by assuming that the crash total for 2035 No Action would be the same proportion above the average rural mountainous four-lane interstate crash value, as is currently experienced. **Table 10.1** shows the crash totals for the 2035 No Action and compares them to existing conditions.

Table 10.1 Existing and 2035 No Action Crash Totals (Eastbound and Westbound)

	Existing	2035 No Action
Average Annual Daily Traffic (AADT)	42,000	59,200
Actual/Estimated Crashes per year between MP 241 and MP 244	86	100
Actual/Estimated crashes per mile per year (CPMPY)	27.6	32.1
Four-lane mountainous SPF Expected CPMPY	18.5	21.5
Difference between SPF and Actual/Estimated	49%	49%

As can be seen in this table, the existing and projected No Action crash totals are approximately 49 percent above what is normally expected for a four-lane mountainous freeway.

10.3 What factors are necessary to predict the crash totals for the Proposed Action?

Each of the geometric changes to eastbound I-70 listed previously will change the expected crash total on I-70. Widening eastbound to three lanes and straightening the horizontal curvature are expected to reduce the number of crashes on I-70. The following factors summarize the expected impact of the Proposed Action on the crash experience on I-70:

- The widening of the eastbound direction from two to three lanes can lead to a reduction in crashes in the short term while traffic volumes remain at about the same level. The reduction in the number of crashes due to the widening of eastbound I-70 is estimated to be approximately 15 percent. This is a conservative estimate as the reduction in crashes due to widening could be greater. This estimate is based on the comparison of four and six lane SPF charts that have been developed by CDOT.
- The improvement of the horizontal curvature of Curve 5 in the eastbound direction is expected to reduce the crashes on that curve by approximately 75 percent. This reduction is based on the review of the existing crash experience on the other eastbound curves along the corridor and assuming that the crash experience on the realigned Curve 5 will likely be more in line with the other curves along the corridor.
- Two roadway cross section options are being evaluated under the Proposed Action: a 50-foot cross section and a 56-foot cross section. They would have either a 4-foot inside (left) shoulder or a 10-foot inside shoulder, respectively. It is reasonable to expect that the wider shoulder would have a safety benefit, because there would be more room for breakdowns and recovery.

The ML Option for I-70 would be the first application of a new, priced capacity, managed lanes in a non-urban freeway setting. The I-70 project serves predominantly recreational trips, which are centered around weekends. Based on a review of the current research literature and professional experience; the safety implications for ML facilities vary widely and overall safety implications of such facilities are based more on the facility characteristics, with inconclusive general crash trend data. With 13 priced managed lanes in operation, the most recently of which opened in March 2012, it is very difficult to extrapolate conclusive safety trends as these are special use lanes within a larger corridor. The limited number of research studies and evaluation reports from the various operational ML projects show that some projects reduce the number of crashes, while others have seen an increase in the number of crashes. Furthermore, the transferability of safety and crash trends from urban ML projects, such as I-394 MnPASS, is not recommended due to the unique characteristics of the I-70 Twin Tunnels project.

The primary objective of a prospective I-70 Twin Tunnels managed lanes is to provide reliable, free flowing trips on a facility that commonly experiences heavy congestion during the recreational peak periods. Technical research would lead transportation professionals to surmise that expanding capacity of the eastbound Twin Tunnel would have an overall positive impact on safety. The current eastbound Twin Tunnel is a major constriction and its expansion will improve sight distance, shoulder widths and overall driver comfort. Moreover, it is commonly accepted that uniform flow (i.e. free flowing traffic) is safer than variable flow (i.e. stop and go traffic). The I-70 Twin Tunnels managed lanes will have one entrance located west of the Twin Tunnel between the Idaho Spring entrance ramp and tunnel portal. It will also have one exit area east of the Twin Tunnels between the Hidden Valley interchange and left exit ramp to US 6. Having one entrance and exit point will simplify weaving between the managed lane and general purpose lanes and provide for safer operations. This managed lane segment will function similar to a left side auxiliary lane.

An operational feature of managed lanes is the likely speed differential between the ML and adjacent general purpose lanes. The following parameters will be incorporated in the design.

- Appropriate separation striping between the managed lane and general purpose lanes as prescribed in the 2009 Manual on Uniform Traffic Control Devices (MUTCD).
- Adequate access openings providing time to maneuver into the managed lane but not so much space that vehicles are overtaking other vehicles at the same access area.
- Clear, concise, and appropriate arterial and freeway signing that supports and informs driver expectations.
- Adequate distance to make lane changes at the ML entrance and exit points. This will provide prospective ML users with more comfortable weaving between the ML and general purpose lanes. Where possible, the same geometric criteria should be applied as would be used for other access areas, such as at a freeway entrance and exit ramp.
- A configuration that requires vehicles entering the managed-lanes facility to make an overt maneuver to enter the lane. The left lane should not end at a managed lane entrance; the freeway lane should be moved laterally and the managed-lanes entrance located out of the normal path of travel.
- Although the current approach is to not light the managed lane entrance because there is no physical gore that would represent a hazard (pavement markings only), as the final

design proceeds, this approach will be analyzed with the rest of the design to ensure that it meets the safety warrants applied for urbanized freeway entrance and exit ramps.

10.4 What are the impacts to the crash totals for the Proposed Action?

The crash impact factors described above were applied to the 2010 and 2035 No Action eastbound I-70 crash totals. Crash calculations were completed for the two operational options for the future Proposed Action for each horizon. The first operational option assumes the additional third lane on eastbound I-70 is always a general purpose lane. The second operational option condition assumes the additional third lane is a managed lane on peak Sundays. **Table 10.2** shows the expected annual crash total ranges for each of the operational options as well as the No Action Alternative.

Table 10.2 Expected Crash Totals—MP 241.30 to MP 244.42 (Both Directions)

	Existing	2010—Proposed Action
AADT	42,000	42,000
Crashes per Year	86	55—67
Comparison to No Action	-	22% to 36% decrease
	2035 No Action	**2035—Proposed Action**
AADT	59,200	59,200
Crashes per Year	100	65—80
Comparison to No Action	-	20% to 35% decrease

Annual crash ranges have been provided since there are many complex factors that can affect the number of crashes that occur along this corridor in the future, including but not limited to weather, speed and geometrics. However, as shown in **Table 10.2**, the 2035 crash total on this portion of I-70 with the Proposed Action in place should still have noticeably fewer crashes than a 2035 No Action Alternative.

Overall, the entire corridor is expected to see anywhere from about a 20 to 35 percent reduction in the number of crashes along the corridor as shown in **Table 10.2**. In addition, for the ML Option, the annual crash total on the corridor could be expected to increase anywhere from two to five percent per year (up to 5 additional crashes) compared to the 3GPL Option.

A more detailed review of the day and nighttime crash patterns in the study area revealed that sections that have higher than expected night crash occurrences generally coincide with the existing interchanges at the I-70 Business Route (East Idaho Springs), Hidden Valley, and US 6 (Kermitts) as well as the east side of the Twin Tunnels. There are currently light fixtures at or in the vicinity of all of these locations. Based on this, it is recommended that a field review of the existing lighting in the vicinity of the interchanges and Twin Tunnels be completed to ensure that the current light fixtures are providing the level of illumination that was anticipated when they were designed. It is realized that the Twin Tunnels project is considered to be an interim improvement so no significant changes are anticipated to the design of the lighting to minimize "throw away" costs. However, with the new bridge at Curve 5/6, the light fixtures at this location will meet current design standards and along with the flattening of this curve, should help to reduce the number of crashes at this location.

11.0 Construction Phase Operational Analyses

11.1 What is the construction context for widening the eastbound Twin Tunnel?

The I-70 Mountain Corridor is a link in the national interstate highway system and is part of the only east-west interstate crossing Colorado. The corridor provides for the movement of people, goods, and services across the state and is a major corridor for access to many of Colorado's recreation and tourism destinations. As such, it is very important to minimize disruptions to traffic flow in both directions during the construction period. Construction of the wider tunnel is currently scheduled to begin in April 2013 and be completed by the end of October 2013.

Construction of the Twin Tunnels will present unique challenges. Tunnels are necessary to overcome significant geographic barriers. Due to their costs, they are never "overbuilt," and there is no room available to maintain traffic through a tunnel construction zone when they are undergoing significant reconstruction. Other than I-70, US 285 is the only other route that can serve traffic between Denver and the Continental Divide. SH 14 west of Fort Collins is too far north. US 34 over Trail Ridge Road is closed to commercial traffic and closed during the early and latter months of the construction period. US 24 west of Colorado Springs is too far south.

11.2 How will traffic be detoured during construction of the Twin Tunnels?

US 6/40 was constructed before I-70 and followed the route of the Colorado Central Railroad. As such, the highway was built adjacent to Clear Creek. The Twin Tunnels were constructed so that I-70 would avoid a significant bend in the creek. When I-70 was complete, a small portion US 40 remained. It was used as a game check area during the fall hunting season for a number of years. Portions are currently used as a Frontage Road (CR 314) between east Idaho Springs (Exit 241) and the Hidden Valley interchange (Exit 243).

The Frontage Road will be used as the detour for I-70 traffic during the construction of the Twin Tunnels and the new straighter bridge over Clear Creek just to the west of the Hidden Valley interchange. CDOT is reconstructing the Frontage Road east of the Doghouse Rail Bridge to a wider standard under a separate project in 2012. The Doghouse Rail Bridge will be strengthened to handle interstate truck loads. There will be a smooth transition back to the I-70 alignment at the west end of the Hidden Valley interchange. The detour will provide two, 12-foot lanes of traffic with adequate shoulders on each side. It will have a design speed of 35 mph, which will require particular attention to advance warning signs.

Westbound I-70 through the construction zone will not require a detour. The only physical change to the westbound lanes that is currently anticipated is that there will be a break in the median barrier at the west end of the Hidden Valley interchange (Exit 243) to allow access for construction vehicles to the unused eastbound roadway and bridge over Clear Creek. This break will be on the inside of a curve and thus out of the normal path of any out of control vehicles. Appropriate signing to designate the break for construction traffic will be used to tell other traffic not to follow construction vehicles as they exit.

11.3 How will construction affect travel on the I-70 highway, and how long will traffic be disrupted?

Widening the tunnel will progress simultaneously from both the east and west portals. Blasts will be small and highly focused to limit collateral effects. In spite of this, tunnel blasting will require that all traffic on I-70 be stopped for approximately 10 minutes before and 20 minutes after each detonation (although this may increase to 30 minutes under certain circumstances). There could be four to six blasts per day depending on the sequence and the number of the benches.

In the interval after the blast, the westbound tunnel will be checked for integrity. After the boring at the west portal has progressed inside the tunnel sufficiently, it may be possible to allow eastbound traffic to flow during these shots, depending on the direction of movement in the blast and whether the contractor can demonstrate that they can protect the public and successfully control each shot. Blasting during peak directional periods will be limited to the extent possible. These peaks are anticipated to be Friday afternoons and early evenings, Saturday mornings, and Sunday afternoons and evenings.

11.3.1 How were traffic operations during the construction period analyzed?

Traffic operations during the construction were analyzed using both VISSIM and DynusT. DynusT can analyze specific geometric situations like the construction detour, which has sharp curves that will limit the posted speed to 35 mph. This analysis determined that the capacity of the detour is approximately 2,700 vph. This capacity was used to modify this segment of I-70 in the DynusT model. The model was then able to provide operational statistics similar to those previously discussed for the No Action Alterative and Proposed Action.

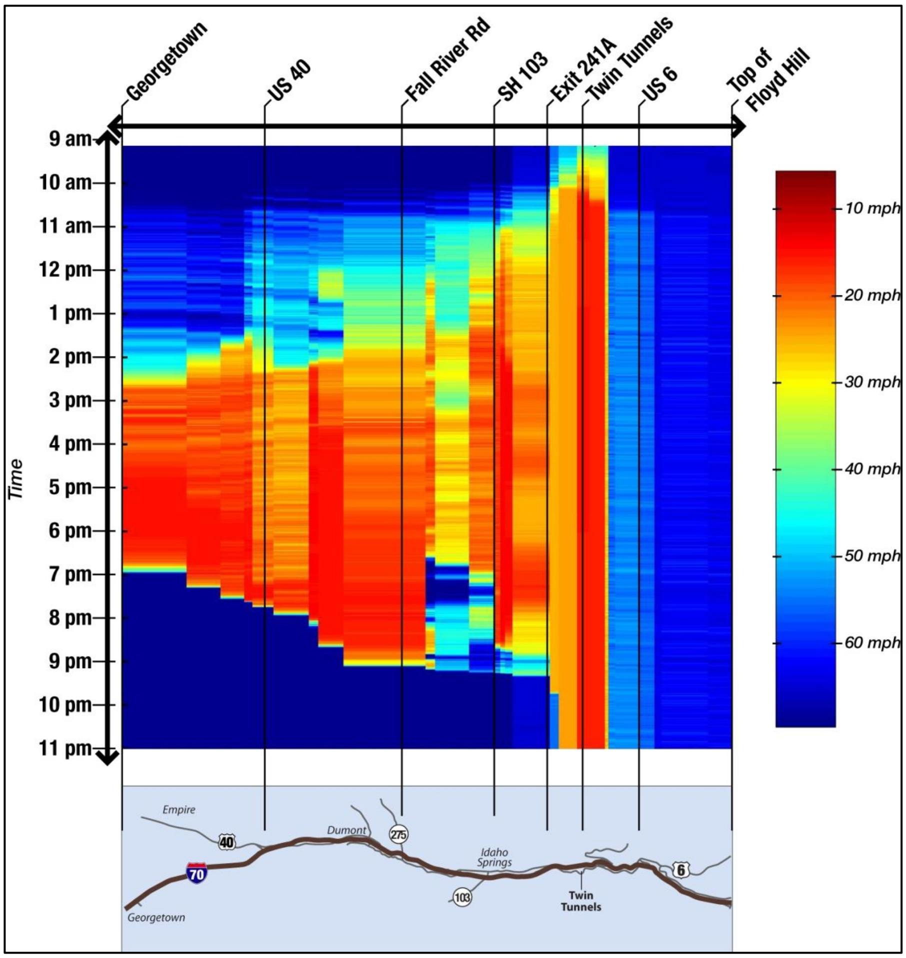
11.3.2 What are the expected traffic conditions during average weekdays?

Average weekday traffic should present only minor problems. **Figure 4.13** shows that the highest eastbound volume is approximately 1,700 vph between 4:00 pm and 5:00 pm. This is much less than 2,700 vph capacity, and traffic should be largely unaffected. Queues resulting from traffic closures for blasting should dissipate within approximately one hour. If a half-hour closure were to coincide with one of the weekday peak hours (over 3,000 vph), the resulting queue could take approximately three hours to clear. Westbound capacity would not be affected by construction so westbound queues would be expected to clear more quickly.

11.3.3 What are the expected traffic conditions during peak Sunday afternoons?

Figure 11.1 shows the average speed of vehicles traveling eastbound on I-70 between Georgetown and the top of Floyd Hill from 9:00 am to 11:00 pm on a peak day (Sunday) for the 2010 Construction conditions. As expected, the construction impacts to traffic are worse than those shown in **Figure 4.12** for 2010 Existing Conditions. Since the construction traffic zone will be operating at a speed of about 35 mph and the capacity of the roadway will be reduced by about 20 percent, queuing will begin at the Twin Tunnels before 10:00 am and will reach the US 40 area by about 2:30 pm. Queues will persist up to the 7:00 pm hour (about one hour longer than the existing conditions) and the average speeds throughout the corridor will be typically lower than existing conditions.

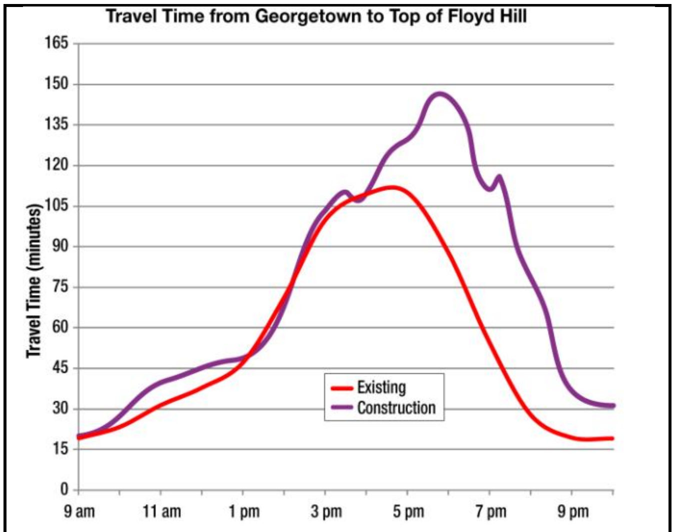
Figure 11.1 Average Peak Day Speeds by Segment between Georgetown and the top of Floyd Hill during Construction



Data Source: DynusT Model Output

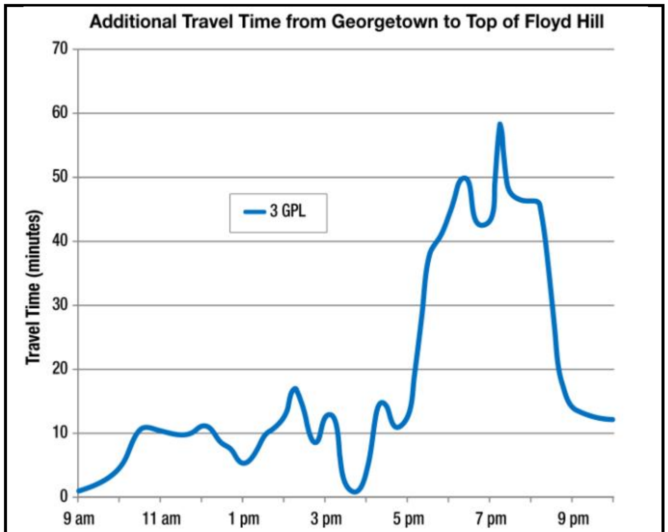
Construction at the Twin Tunnels area will result in increased travel time experienced by eastbound motorists. **Figure 11.2** shows the average travel time for eastbound travelers during construction will reach a maximum of about 145 minutes, which is about 30 minutes longer than existing travel times. However, travel times later in the day will continue to be much longer than existing conditions with drivers experiencing more than one hour of additional delay due to the construction. **Figure 11.3** shows the average additional travel time that eastbound drivers will experience during construction of the improvements. Travel times even under the lowest volumes will be about 30 minutes or about 33 percent longer than existing conditions.

Figure 11.2 Average Peak Day Travel Time between Georgetown and the top of Floyd Hill during Construction vs. 2010 Existing Conditions



Data Source: DynusT Model Output

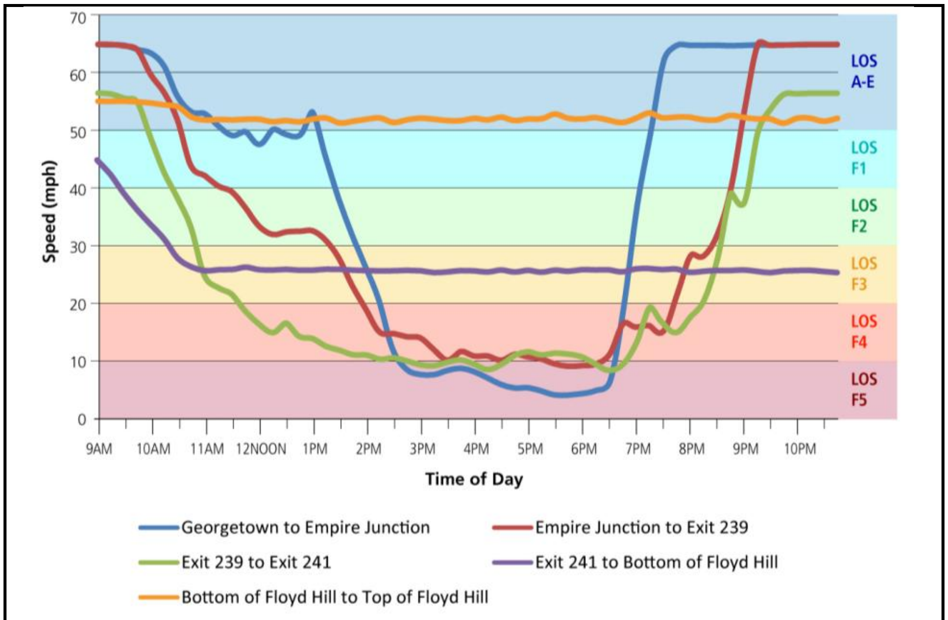
Figure 11.3 Additional Peak Day Average Travel Time between Georgetown and the Top of Floyd Hill during Construction vs. 2010 Existing Conditions



Data Source: DynusT Model Output

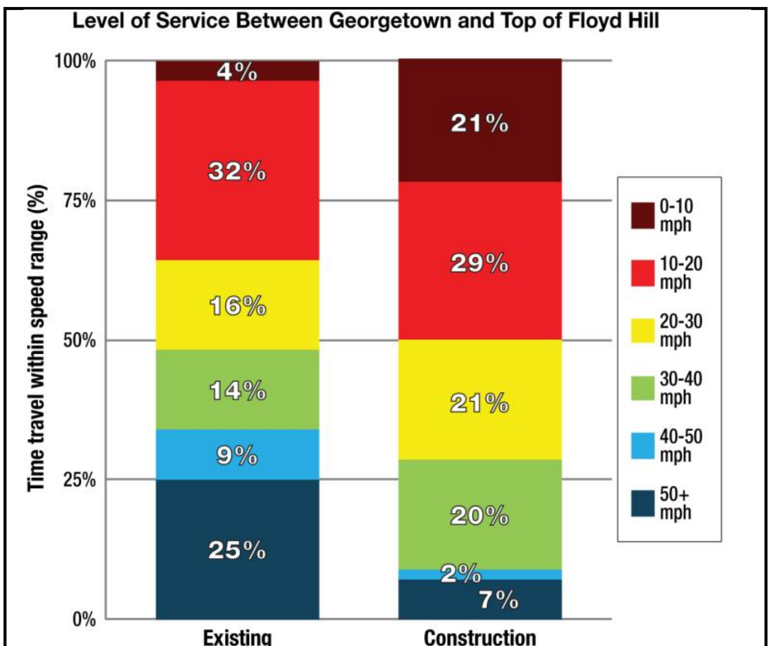
Figure 11.4 shows the average speeds by time of day for the five major I-70 segments compared to the different LOS ranges previously identified in **Section 1.7**. As expected, the figure shows that all segments of I-70 operate at speeds that are slower than those for existing conditions (see **Figure 4.14**) with the exception of the segment between the bottom and top of Floyd Hill, which will operate above 50 mph for the entire day due to the metering of traffic through the work zone. **Figure 11.5** shows a summary of the operating level of service for the corridor by doing a minute by minute analysis of the data presented in **Figure 11.4** and comparing it to 2010 Existing Conditions. The figure shows the construction will have significant impacts to the Level of Service being experienced by drivers on I-70. During construction drivers will experience LOS A to LOS E less about seven percent of the time compared to 25 percent for Existing Conditions, and LOS F1 to LOS F5 up to 93 percent of the time compared to only 75 percent of the time without construction. Furthermore, during construction, drivers will spend about 50 percent of their time traveling at speeds that are less than 20 mph (nearly stopped).

Figure 11.4 Average Peak Day Speeds between Georgetown and the top of Floyd Hill during Construction vs. 2010 Existing Conditions



Data Source: DynusT Model Output

Figure 11.5 Percent of Time Drivers Experience each Level of Service during Construction vs. 2010 Existing Conditions (during the Peak Day)



Data Source: DynusT Model Output

Regional travel indicators for the construction conditions were obtained and compared to the 2010 Existing conditions. Again, the travel indicators are the vehicle miles traveled and vehicle hours of travel for both the entire model network and for just the I-70 corridor (Georgetown to the top of Floyd Hill). **Table 11.1** shows the results of the comparison of travel indicators. The results show a slight increase in VMT for the system during construction and a decrease of VMT on the I-70 corridor. During construction more vehicles choose to use alternate routes or stay on the frontage roads longer to avoid I-70. VHT shows significant increases for both the system and I-70 corridor. Thus, all of the trips being completed in the network are taking longer to complete, regardless of route choice.

Table 11.1 Travel Indicators

	VMT			
Scenario	**Systemwide**	**% Difference**	**I-70 Corridor**	**% Difference**
2010 Existing	6,507,000	--	865,900	--
2010 Construction	6,840,700	5%	844,500	-49%
	VHT			
Scenario	**Systemwide**	**% Difference**	**I-70 Corridor**	**% Difference**
2010 Existing	208,800	--	33,400	--
2010 Construction	279,000	34%	41,600	28%

One of the expected impacts due to the increased travel times while I-70 is under construction is for more drivers to complete their trips eastbound out of the mountains by diverting off of I-70 and onto the alternative routes in the region. **Table 11.2** lists a summary of the projected impacts to daily volumes on alternative routes during construction. The results show significant traffic shifting onto the SH 9 and US 285 corridor.

Table 11.2 2010 Construction vs. 2010 Existing Conditions—Traffic Shifts

Change in Daily Volume on Links			
	2010	**Construction***	
Location	**Volumes**	**Volumes**	**% Diff**
I-70 Frontage Road west of Hidden Valley	1,930	N/A	N/A
SH 9 North of Fairplay	6,000	8,200	36%
US 285 East of Grant	7,800	10,000	28%

*Compared to 2010 Existing Conditions

11.3.4 How will traffic impacts be mitigated during the construction period?

CDOT will continue to work closely with local agencies (including Clear Creek County and Idaho Springs) through the Context Sensitive Solutions (CSS) process regarding the design of the widening project. Design guidelines that were agreed to as part of the Record of Decision (ROD) for the I-70 Mountain Corridor PEIS will be thoroughly coordinated during design and construction. Construction phasing, tunnel blasting, and other activities will be planned to minimize the impact to the traveling public and area residents and businesses.

In addition to the full-time detour necessary to accommodate tunnel widening activities, one lane closures will be necessary west of the tunnel and east of the Hidden Valley interchange during activities related to constructing the new third lane. The *Region 1 Lane Closure Strategy – Second Edition*, 2008 (LCS) provides general guidance for lane closures along I-70. The LCS also provides procedures that allow variances to the basic schedules for unique projects and activities. Any variances must be approved by the Region 1 Traffic Engineer. Since the Twin Tunnels ATR provides a wealth of specific traffic data on a daily and hourly basis, it is anticipated that specific lane closures schedules encompassing the multitude of construction activities will be developed during the design phase of the project in close coordination with the CM/GC contractor and Region 1 Traffic Engineer. In addition, queues and delays will be monitored throughout the construction phases to make sure that impacts to travelers are minimized to the greatest extent possible.

Advanced notice will be provided for construction activities through variable message signs (VMS) to provide motorists with real-time notification and expected delays. CDOT's Public Information Office will provide frequent and timely updates about construction activities through all relevant media.

Table 11.3 outlines the mitigation commitments for transportation resources.

Table 11.3 Mitigation Commitments for Transportation Resources

Activity	Location	Impact	Mitigation*
Construction on or adjacent to I-70	Twin Tunnels Project Area	Traffic backups due to lane restriction during construction in the peak direction during peak periods.	Lane closures will follow the guidelines of the Region 1 Lane Closure Strategy. Any variances will be developed in close coordination with the contractor and approved by the Region 1 Traffic Engineer. CDOT will work with local communities to minimize impacts to local traffic. Work requiring closure of one lane will be conducted at night as much as possible. CDOT will work closely with the contractor to avoid all daytime construction during peak directional periods
Roadway closures for blasting (anytime round the clock)	On I-70 westbound; on CR 314 for eastbound	Traffic backups	Stoppages will be minimized to the greatest extent possible during peak periods (WB—Friday afternoon, Saturday morning) (EB—Sunday afternoon). Advance signage along I-70 will be give warning of impending closures.
Day versus night work for roadway widening	West of Twin Tunnels and east of Hidden Valley interchange	Slower traffic through work zone.	Work requiring closure of one lane will be conducted at night as much as possible. CDOT will work closely with the contractor to avoid all daytime construction during peak directional periods.

Table 11.3 Mitigation Commitments for Transportation Resources

Activity	Location	Impact	Mitigation*
Construction on or adjacent to I-70	On I-70 westbound; on CR 314 for eastbound	Disruption of emergency vehicles	CDOT and the contractor will notify emergency service providers (CSP, sheriff, police, fire dispatchers, ambulance providers, etc.) of the timing of impending closures for blasting.
Effective directional signing during construction	Twin Tunnels Study Area	Economic losses due to drivers not stopping to patronize local businesses.	CDOT will provide frequent and timely updates about construction activities and remind the public that the corridor is open except for necessary interruptions. Signs notifying drivers of access to local business will be placed in both directions in advance of the East Idaho Springs interchange (Exit 241).
Safety during construction	Twin Tunnels Study Area	Increased potential for crashes.	There will be extensive warning of the detour for eastbound traffic so that they know to slow to the posted speed limit of 35 mph. CSP and police will be encouraged to monitor speeds during off-peak periods when enforcement activities won't create traffic congestion. Reducing crashes should also reduce the need of emergency response and attendant local costs to service providers.
Crashes at night	Locations as determined by safety analyses	Crashes at night	Existing lighting will be reviewed to make sure current light fixtures are operating as designed. Safety will be monitored closely after construction to see if nighttime crash patterns persist that could be addressed with localized lighting treatments.
Crashes associated with managed lane	Entrance to managed lane	Crashes at entrance to managed lane	Current approach is to not light the managed lane entrance because there is no physical gore, which would be a hazard. This will be reanalyzed during the final design process.
Traffic shifts from I-70 during construction	US 285 and SH 9	Increased volumes shifted to less capable facilities	As feasible, CDOT will minimize I-70 construction activities on weekends that could shift travel to alternative routes (SH 9 and US 285, in particular). No scheduled construction projects on US 285 and SH 9 are planned to involve weekend activities. CDOT will monitor signal operations and timing on these alternative routes during peak periods and will modify signal timing, if necessary.

Appendix A: Growth Panel Meeting Summary (December 15, 2011)

Appendix B:
Future Growth on I-70 at the Twin Tunnels

Appendix C:
List of References

- *I-70 Mountain Corridor Final Programmatic Environmental Impact Statement,* CDOT, 2011 (PEIS)
- *Safety Assessment Report – State Highway 70A Twin Tunnels Environmental Assessment (EA) – MP 240.00 to MP 247.24*, CDOT, 2011
- *2035 Transportation Analysis Technical Report,* August 2010, Reissued March 2011
- *NCHRP 255 – Highway Traffic Data for Urbanized Area Project Planning and Design*, TRB, 1982
- *HCM2010 Highway Capacity Manual*, Transportation Research Board, 2010
- *Dynamic Traffic Assignment – a Primer*, Transportation Research Circular, E-C153, June 2011
- *Departmental Guidance on Valuation of Travel Time in Economic Analysis*, FHWA, September 28, 2011
- *2009 Manual on Uniform Traffic Control Devices (MUTCD)*, FHWA 2009
- *Colorado Department of Transportation Region 1, Lane Closure Strategy – Second Edition,* CDOT 2008
- I-70 Coalition—2012 Dinosaur Lots Winter Survey, Overview of Findings, RRC Associates, Inc., February 2012