SH 82
GRAND AVENUE BRIDGE

SH 82 Grand Avenue Bridge

Peer Review of Bridge Closure Phase Detour

Final Report

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1.0 INTRODUCTION

The Colorado Department of Transportation (CDOT) has identified a need for an independent peer review of the Grand Avenue Bridge project (GAB) 2017 bridge closure phase detour modeling and Traffic Control Plan (TCP) which were developed during the Environmental Assessment (EA) phase of the project. The modeling was developed during the EA to evaluate impacts associated with the anticipated 95 day bridge closure period in which all SH 82 and local traffic will be using Midland Avenue as a detour route. The TCP was developed based on the detour modeling and other considerations.

The purpose of the peer review is to determine whether the detour modeling performed during the EA provides a generally accurate representation of the anticipated detour traffic demands and route capacity. It will also confirm the magnitude of the necessary traffic volume reduction, and evaluate the Travel Demand Management (TDM) assumptions that are required to achieve a desired reduction in traffic volume for the detour operations to be successful. Finally, the peer review provides the opportunity for suggested revisions and/or improvements to the TCP.

The following materials were reviewed:

- Environmental Assessment (EA)
- Finding of No Significant Impact (FONSI)
- Construction Phasing, Traffic Control, Detour Plans & Specifications
- Construction plans for pre-detour improvements (Exit 114, 27th Street, Midland / 8th)
- RFSD and RFTA Service Plans
- Glenwood Springs Parking Map
- Available traffic data, Synchro and VISSIM models
- Travel survey data and summaries

2.0 PROJECT SUMMARY

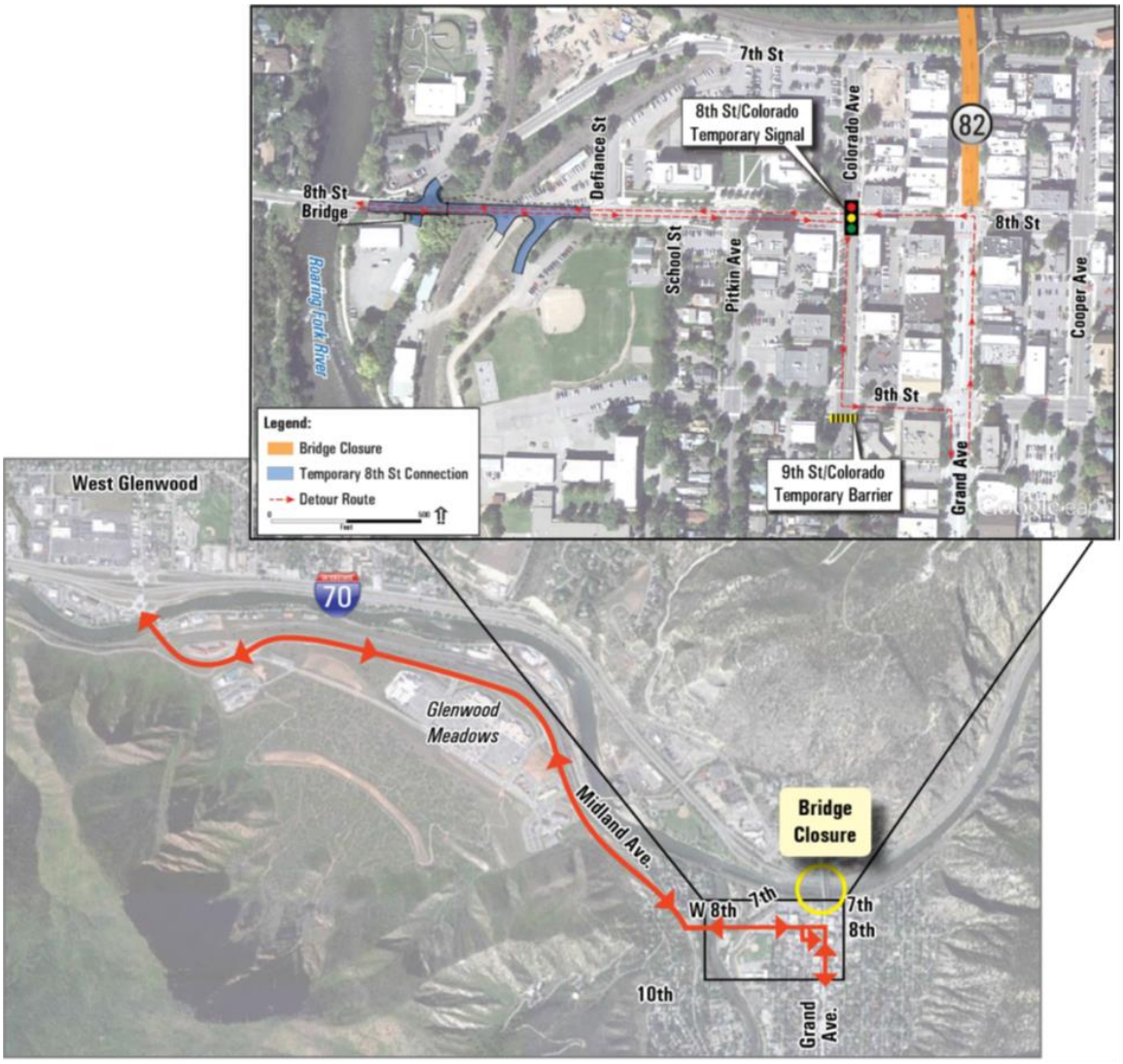
The Grand Avenue Bridge project is being constructed to improve the connection from downtown Glenwood Springs, Colorado, across I-70, the Colorado River, State Highway (SH) 82/Grand Avenue and the Union Pacific Railroad to the historic Glenwood Hot Springs area. The Grand Avenue Bridge is the gateway to Glenwood Springs, Glenwood Canyon, the Roaring Fork Valley, and Colorado's western slope communities. It serves as a vital link for local and regional travelers, the Glenwood Springs community, emergency responders, bicyclists, and pedestrians. This project replaces the existing four-lane bridge with a new four-lane bridge on a modified alignment.

The construction phasing plan calls for removing the existing Grand Avenue Bridge and installing the new bridge within an approximately 95-day period, during which the Grand Avenue Bridge would be fully closed to traffic. Before the existing bridge is removed, detours would be put in place, with changes to I-70 Exit 114, Midland Avenue, and 8th Street.

Two detour routes are proposed during construction—one for I-70 traffic during short, nighttime closure periods, and a second for SH 82 traffic during the full closure of the Grand Avenue Bridge (i.e., SH 82 Detour). The focus of the peer review is on the SH 82 Detour.

During the approximately 95-day full closure of the Grand Avenue Bridge, SH 82 traffic would be rerouted onto the designated SH 82 Detour. The temporary route for regional traffic would begin at Exit 114 on I-70 and proceed south on Midland Avenue to 8th Street across the Roaring Fork River, then along a new 8th Street connection into downtown. In the downtown grid, the traffic would be routed through a temporary "square about" for continuation south on SH 82/Grand Avenue to Aspen.

Detour Route During Grand Avenue Bridge Closure



A number of improvements are planned for implementation prior to the full closure of the Grand Avenue Bridge. These include:

Exit 114 (West Glenwood):

- **I-70 eastbound off ramp.** The I-70 deceleration lane would be lengthened by about 800 feet, and the second lane of the two-lane approach to the roundabout would be lengthened by approximately 340 feet.
- **I-70 westbound on ramp.** The existing I-70 westbound on ramp has a short two-lane segment just past the roundabout. This two lane section would be lengthened about 500 feet.
- **Roundabout intersections.** Minor changes to the curb and gutter and signing and striping would be made on the two roundabouts to better accommodatethe detour traffic volumes and larger trucks.

Temporary 8th Street Connection. The temporary 8th Street connection connects the 8th Street Bridge over the Roaring Fork River along a new alignment. Modifications have also been made at the intersection of 7th Street/8th Street to maintain bicycle access from the Rio Grande Trail along the river to downtown and sidewalk on 7th Street. In addition, the turn radius at the northeast corner of the 8th Street and Midland Avenue intersection was increased to accommodate larger vehicles.

Downtown Grid. The "square about" consists of a temporary one-way loop on 8th Street, Colorado Avenue, 9th Street, and Grand Avenue. To address higher traffic volumes, the following measures would be put into place:

- A temporary signal would be installed at the intersection of 8th Street and Colorado Avenue to facilitate pedestrian crossings and higher traffic volumes.
- A temporary physical barrier would be placed at the intersection of 9th Street and Colorado Avenue to force detour traffic to turn east toward Grand Avenue and keep detour traffic from continuing south on Colorado Avenue.

3.0 DETOUR ROUTE ANALYSIS

The EA identifies the lack of available detour alternatives. The travel survey completed during the EA also establishes the need for the detour to accommodate local trips (trips starting, ending, or both within the City of Glenwood Springs) as well as regional trips. These travel demands help establish Midland Avenue as the only viable detour alternative for the bridge closure. Connections between Midland Avenue and SH 82 are also limited: only 8th Street and 27th Street offer a connection between the detour route and SH 82.

3.1 Traffic Volumes

Based on current traffic volumes and concerns voiced by the public, full closure is scheduled to occur during the fall, when traffic volumes are typically lower. Analysis conducted for the EA determined that motorists would experience unacceptable delay without improvements to intersections and roadways along the route (summarized previously), in combination with a voluntary reduction of peak hour trips.

3.1.1 EA Traffic Volumes

The following approach was taken during the EA to estimate traffic volumes:

1: The traffic volume for all the major roads affected by the detour was calculated from counts taken in 2007. In this case, the volumes from 2007 were used, rather than a more recent year, because these pre-dated the recent recession and were believed to be a reasonable representation of existing traffic volumes.

2: Turning movement counts were conducted in the spring of 2012 along SH-82 and Midland Avenue as part of the Access Control Plan completed by CDOT, the City of Glenwood Springs and Garfield County. These were used to analyze area travel patterns, and which roads would likely be used to access the detour route.

3: The Glenwood Travel Survey was conducted in the spring of 2012. The survey collected data on trip type (commuting/school/shopping/ect.) as well as the routes followed from origin to destination. This data was used to estimate how much of a voluntary volume reduction could occur based on how flexible the route from origin to destination was, and well as the reason for the trip.

When the bridge is closed, the demand along the detour route was estimated by adding the volumes currently using Midland Avenue with the volumes currently using the Grand Avenue Bridge. Based on the EA analysis, the projections yielded a volume during the peak hour that is 20-25% above capacity; hence the need for Travel Demand Management (TDM) strategies.

3.1.2 Peer Review Traffic Volumes

For the peer review, traffic volumes along the detour route were independantly estimated. The steps included:

- The consistency between traffic volumes from 2007 (used in the EA), 2012 (used in the SH 82 ACP), and current day were evaluated using data from the continuous count station at SH 82 MP 2.194 located just south of Glenwood Springs.

The peer review determined that the traffic volume projections from the EA were a reasonable estimate of traffic volumes anticipated during the full bridge closure.

This analysis revealed that based on annual averages, traffic volumes in 2007 were 99.5% of the 2016 volumes, while the 2012 volumes were only 85.6% of the 2016 volumes. This shows that the EA's approach to volume estimates was by and large a reasonable one.

- The split of detour traffic between 8th Street and 27th Street originally assumed in the EA (78% along 8th and 22% along 27th) was also confirmed. Using the travel survey results, the amount of traffic likely to use 27th Street likely ranges from 9 to 44% (assuming that all traffic crossing the Grand Avenue bridge with an origin or destination at the South Glenwood (Airport Area) or SH 82 - Roaring Fork Valley would reasonably follow 27th Street. The 22% assumed in the EA represents the middle of this range and is therefore a good estimate for typically expected conditions.

Midland Avenue between 8th Street and 27th Street could realize a greater share of detour traffic if the bottleneck along 27th between the roundabout and SH 82 could be improved.

- As described later in this report, analysis of the roundabout intersection at 27th Street and Midland Avenue indicates that potential exists to gain some additional capacity at that location. If so, the percentage of Grand Avenue Bridge traffic following Midland Avenue south of 8th Street could exceed the 22% estimated in the EA and in the peer review.

3.2 VISSIM Model

Vissim is a micro-simulation model capable of incorporating real-world operational characteristics. These include detailed geometric layouts, variations in traffic demand over time, and pedestrian demands. Like all micro-simulations, Vissim does not report deterministic Measures of Effectiveness (MOEs), like Level-of-Service or volume-to-capacity ratio of a specific movement. Instead, average results for multiple simulated runs are often reported for MOEs such as queue length or travel time.

It is preferable for a micro-simulation model to be calibrated to existing conditions prior to the testing of geometric or traffic demand alternatives. That being said, calibration of a model the size of the study area requires significant amounts of data and may require a level of effort that isn't justified given the relatively short-term nature of the detour.

> Calibration of the VISSIM model to existing conditions would have enabled more confidence to be placed on the travel time estimates and other simulation findings.

3.2.1 EA Model Review

The EA Vissim model used for analysis of the Grand Avenue Bridge detour included improved roundabouts at Exit 114, westbound right turn improvements at the Midland Ave/8th St intersection, a temporary traffic signal at Colorado Ave/8th St, and the "square-a-bout" layout in downtown Glenwood Springs. Traffic signals were modelled to operate in a pre-timed fashion, which is unlikely to significantly differ from actuated operation during peak periods. Traffic signal offsets were all set to zero, which makes the evaluation more conservative given that it is desirable to coordinate the heaviest movements between signals.

All traffic in the EA Vissim models was intended to reflect the 20% reduction in traffic due to demand management. In the morning peak, this resulted in 1,170 vehicles per hour using Exit 114 from eastbound I-70 and 662 vehicles per hour travelling north on SH 82, south of 27th St. In the afternoon, the reduced traffic volumes were modelled as 440 vehicles per hour at eastbound Exit 114 and 1,280 vehicles per hour northbound on SH 82. These demands are generally within 10-15% of those independently estimated in this study. Both morning and afternoon peak periods were modeled for 80 minutes, with no variations in traffic input. The intent of this was to effectively "seed" the model for 60 minutes and then observe the final 20 minutes as representative of peak traffic conditions.

The temporary traffic signal proposed at the Midland Ave/Wulfsohn Rd intersection was not included in the EA Vissim model. It is understood that this location will serve local traffic, emergency vehicles, and transit without accommodating through traffic or traffic destined for Glenwood Meadows commercial center. Traffic along Wulfsohn Rd

is expected to be light with only these limited uses, so the omission of the temporary traffic signal is unlikely to significantly impact operations.

With the intent of modelling uniform traffic control, a single-phase traffic signal was included at the southbound approach to the south Exit 114 roundabout during the morning peak period. By metering the southbound approach, the dominant I-70 eastbound off-ramp can flow with minimal interference.

Pedestrian crossings, while accounted for in the signal timings, were only specifically modelled at the Colorado Ave/8th St intersection. Pedestrian counts at this intersection were not available, so a volume of 50 pedestrians per hour was assumed to cross each leg of the intersection. Based on pedestrian counts collected at the Grand Ave/8th St intersection in 2012, the volume assumed at Colorado Ave/8th St is thought to be conservatively high. Mid-block pedestrian crossings were not included in the Vissim model.

3.2.2 Peer Review Model Update

The original Vissim model had not been updated since the Grand Avenue Bridge detour plans were finalized in October 2015. Several components of the network have changed over time and required changes. Updates to the model include channelization of the westbound right turn at the Midland Ave/8th St intersection and additional lanes in the south Exit 114 roundabout. An additional southbound lane from the south roundabout was carried 400 feet to Devereux Rd, where the two lanes merge to a single lane.

Observations of the EA Vissim model indicate significant late-merging behavior by drivers along the dominant northbound Grand Avenue to 8th St route. Lane changing behaviors and minor network revisions were made to make this behavior more realistic. Southbound stop control at the 9th Street/Colorado Avenue intersection was shown in the detour plans, but after just a brief modelling period it was apparent that a bottleneck would be created.

Elimination of the stop control for southbound Colorado Avenue at 9th Street was necessary for the detour route to function reasonably. The implications of this on the pedestrian TCP is discussed later in this report.

Data from the SH 82 Automatic Traffic Recorder (ATR) 000214 located south of 27th Street was examined to determine appropriate time intervals for analysis. Tuesday through Thursday data from September and October of 2016 was focused on as that reflects the most recent patterns. Traffic in the peak morning direction is summarized in the following table.

Table 1

SH 82 Southbound Traffic in Fall 2016 Weekday Mornings

Hour beginning at	**5:00**	**6:00**	**7:00**	**8:00**
Vehicles	653	1602	1484	1198
Percent of Peak Hour Traffic	41%	100%	93%	75%

Similarly traffic in the peak evening direction is summarized as follows:

Table 2

SH 82 Northbound Traffic in Fall 2016 Weekday Afternoons

Hour beginning at	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**
Vehicles	996	1328	1529	1467	1084
Percent of Peak Hour Traffic	65%	87%	100%	96%	71%

Traffic volumes for both time periods suggest that analysis beyond a single peak hour is appropriate to capture the building and dissipation of any queues. To model these peaking characteristics, traffic was modelled for two hour periods beginning at 6:00 AM and 4:00 PM. A 15-minute seeding interval at the hourly flow rates preceding the peak hours and a 30-minute "cool down" period were also included outside of the data collection period.

Due to the lack of data, pedestrian crossings were not included in the Vissim model. It is acknowledged that pedestrian activity has the potential to constrain operations, particularly a mid-block crossing of 8th Street between Midland and Grand Avenues. Appropriate pedestrian crossing times were maintained within the traffic signal splits, so pedestrian impacts are captured at those locations. Mid-block crossings are not accounted for in the model and their impact can't be estimated without some knowledge of the pedestrian demand at those locations.

On-street parking and pedestrian crossing activity were not explicitly modeled in the EA or peer review models. Nevertheless, these activities have the potential to negatively affect mobility along the detour route and should be monitored to determine whether changes in strategy are required.

3.2.3 Results with 20% Travel Demand Reduction

The Vissim model identified system bottlenecks at Exit 114, West Meadows / Midland Avenue intersection, and 8th Street / Midland Avenue intersection.

Visual observation of the peer review Vissim model revealed several critical points on the network. During the morning peak period, traffic coming off of eastbound I-70 is the heaviest movement. While operations within the south roundabout typically operate well, a bottleneck at the merge point of the exiting roundabout lanes (along Midland Avenue) was observed. Because this merge point is only 400 feet downstream of the roundabout, the queue did back into the roundabout, impeding operations. This queue dramatically reduces the intersection capacity and may block other approaches to the roundabout. As a precaution to breakdowns in roundabout operation, a queue warning system on I-70 should be considered. Uniform traffic control may at times be required in order to minimize queues and relieve gridlock of the roundabout, if it occurs.

Further downstream, the traffic signal at West Meadows did cause some delay, but the previously documented bottleneck of the southbound left turn at 8th Avenue/Midland Avenue remains the critical bottleneck along the morning route. Once vehicles pass through that intersection, they flow with minimal impedance through downtown Glenwood Springs. It is acknowledged that no parking or pedestrian activity was included in the model and that those may have impacts that were not accounted for.

The updated Vissim model confirmed that recent improvements at Exit 114 and at the 8th Street / Midland Avenue intersection have improved detour conditions over those originally estimated in the EA.

When compared to the EA Vissim model, morning peak travel times from westbound I-70 to SH 82 south of 27th Street fell from 17 minutes to 15 minutes in the updated model. It is notable that the EA Vissim model only sampled 20 vehicles for this measurement, while the updated model sampled over 1,000 vehicles along this route. The original sampling period was for fifteen minutes while the updated model sampled data for two hours. It is noted that intersections between 9th Street and 27th Street were excluded from the models. For this reason, real-world travel times between the two points are expected to be higher than those reported.

Observation of the updated afternoon peak period model appeared to have fewer critical locations. Significant queuing for the northbound left turn from Grand Avenue to 8th Street was not observed, however pedestrian activity could impact operations at that location. The westbound right turn movement from 8th Street to Midland Avenue also appeared to function well.

Areas of concern include the West Meadows signal, where significant side street queueing was observed. A reasonable balance must be struck for signal timings at this location to ensure that traffic can exit the commercial district in a reasonable fashion. The Grand Avenue Bridge team has also identified on-site improvements at West Meadows that will minimize the impacts that on-site queuing will have on traffic flow. Some queuing for the northbound through movement at the 8th Street/Midland Avenue intersection was also observed, but is not expected to be significant as long as the detour route through Grand Avenue and 8th Street operates smoothly.

Side street traffic at the West Meadows signal will experience considerable delay. Signal timings at this location will need to balance detour mobility with access.

At the north roundabout of the Exit 114 interchange, side street backups were observed. Traffic travelling all the way around the roundabout to the westbound I-70 ramp was dense, leaving few opportunities for traffic from US 6 to enter. This location may require uniform traffic control to periodically stop the northbound approach when demand is high to afford other approaches an opportunity to pass through the roundabout.

Analysis of the Exit 114 roundabouts indicates that operational problems will arise during peak traffic demands. These problems will at times require UTC to address.

3.3 SYNCHRO Model

3.3.1 Introduction

Synchro is a capacity analysis software that was used to model the road network for the detour phase. It is a deterministic model that is best used for looking at individual intersections and comparing the effects of different geometric and signal timing scenarios on traffic flow. Synchro does not model travel time through a network or over capacity conditions very effectively, as it does not take into account the effect an over capacity intersection will have on the surrounding intersections. It was used primarily in this study to evaluate whether each individual movement in the network would remain below capacity once the vehicles were rerouted, in light of the project's stated goal of no traffic movements experiencing a volume to capacity (v/c) ratio of 1.0 or greater.

The baseline volumes used in the peer review synchro files were estimated using the 2012 traffic counts. Traffic counts were available for the intersections of Grand Ave/8th St, Grand Ave/9th St, and SH-82/27th St. The movements crossing Grand Avenue Bridge were rerouted from Grand Avenue to Midland Avenue using 8th Street or 27th Street to access the detour. The Grand Avenue Bridge Transportation Demand Management (TDM) Plan was used to calculate what percentage of the rerouted traffic

would take each route. Using the EA's predictions, it was estimated that approximately 78% of the rerouted trips would take 8th St and 22% would take 27th St to go to and from Midland.

These rerouted movements were then added to the 2012 volumes. Since available count data was limited, the turning volumes in the Synchro files from the EA were used a few locations. The thru movements were adjusted so that they would balance out with the intersections that had count data available. A comparison of the 2012 volumes with those from 2016 revealed that traffic levels have increased just over 20% over that timeframe. The unadjusted 2012 volumes therefore reflect a 20% TDM reduction when compared to existing levels.

At intersections where pedestrian count data was unavailable, a conservative estimate of 50 pedestrians per hour of each signalized crossing was assumed.

The Grand Avenue Bridge Memo, presented in 2013, was used to estimate volumes at the Exit 114 interchange. Basing its volumes on the 2012 traffic counts, this memo gave a prediction for the volumes at the ramp intersections during the detour. While these did not exactly balance with the downstream volumes in the peer review Synchro models, they were reasonably close. Minor adjustments were made to the ramp intersection volumes to better balance with other intersections.

Table 3

Intersection Levels of Service During Detour (assuming 20% demand reduction)

Intersection	AM LOS	AM DELAY (SEC)	PM LOS	PM DELAY (SEC)
Grand Ave/8th St	B	15.8	F	82.4
Grand Ave/9th St	A	8.3	B	14.7
Colorado Ave/8th St	F	93.3	F	137.2
Midland Ave/8th St	E	66.3	F	86.3
Midland Ave/Meadows	F	117.9	F	144.3
27th St/SH-82	C	32.1	D	38.0
27th St/Grand Ave	B	15.9	A	7.7

The intersection LOS was calculated using the peer review Synchro models. As can be seen in Table 3, several locations are expected to experience LOS F conditions. The volumes are consistently higher through the network in the PM, which is also reflected by the higher delays.

The Vissim model that was developed for the detour had different volumes than both the EA and peer review Synchro models, as can be seen in Table 4. While a difference in a minor movement may not have a significant impact on the LOS of an intersection,

there are several major movements having a noticeable difference in volume from one model to another.

The most notable difference between the Vissim model and the Synchro models is the northbound movement on Midland Ave. Both Synchro models reflect a large increase in volume along Midland Avenue once the detour is implemented. The Vissim model, however, reflects a lesser increase. Another difference between the Vissim and Synchro models is the eastbound movement on 27th Street just west of SH-82. As was discussed in a previous section, the EA Synchro model assumes a higher volume than the peer review model in the AM peak hour. The Vissim model models a lower volume than either of the Synchro models. Based on the fact that the volumes south of 27th St are similar through all three models, it appears that there is an inconsistency across models in the number of vehicles rerouted on Midland Avenue. The EA Synchro model has the largest percentage of vehicles rerouted onto Midland Ave. The peer review Synchro model falls in the middle of the other two in terms of percentage of trips diverted on each route.

Table 4

Traffic Model Volume Comparisons (reflecting 20% demand reduction)

Location	VISSIM MODEL		EA SYNCHRO MODEL		PEER REVIEW SYNCHRO MODEL	
	AM	PM	AM	PM	AM	PM
SH-82 NB (S of 27th St)	662	1280	461	1255	735	1719
27th St EB (W of SH-82)	400	240	865	460	591	526
27th St WB (E of SH-82)	25	25	22	22	23	35
Midland Ave NB (S of 8th St)	280	320	346	850	391	739
Colorado Ave SB (N of 8th St)	180	240	150	225	166	248
8th St WB (E of Grand Ave)	120	280	75	150	74	142
I-70 Off Ramp EB	1170	440	1225	1225	1532	866
I-70 Off Ramp WB	163	300	204	204	255	170
Mel Rey Rd SB (N of I-70)	98	98	122	122	122	64

3.4 LOS Evaluation

The peer review Synchro model reflected a 20% reduction in estimated fall 2016 volumes. All of the signals were evaluated as pre-timed and the cycle lengths were set to 120 seconds. The phasing for the intersections at Colorado/8th, Grand Ave/8th, Grand Ave/9th, and SH-82/27th St were based on signal phasing sheets provided by others. The remaining signal phasing came from the EA Synchro files. The splits were optimized at all of the intersections.

With the 20% reduction in volume, four of the signalized intersections in the network had movements with a v/c ratio above 1.0, as can be seen in Table 5.

Table 5

Locations of Critical V/C Ratio (20% Demand Reduction)

AM				
Intersection	Movement	LOS	Seconds	v/c
Colorado/8th	EBR	F	101.3	1.19
	WBT	F	123.6	1.15
Midland/8th	SBL	F	131.8	1.25
Meadows/Midland	EBT	F	180.2	1.35
	NBL	F	172.2	1.16

PM				
Intersection	Movement	LOS	Seconds	v/c
Grand/8th	NBL	F	88.2	1.14
Colorado/8th	WBT	F	214.6	1.42
Midland/8th	WBR	F	141.6	1.28
	NBL	F	113.4	1.11
Meadows/Midland	NBL	F	148.4	1.15
	WBT	F	224.7	1.46

Based upon the above, a 20% reduction in traffic volume is not sufficient to accomplish a maximum v/c ratio of 1.0 at all locations. A 30-35% reduction would reduce the frequency and duration of extreme congestion; however, even that level of demand reduction will not entirely eliminate over-capacity conditions that will occur from time-to-time along the detour route.

In the AM peak hour, the dominant movement is heading up valley (eastbound along Midland, then south along SH 82). Based upon the AM results, the v/c ratios and delays identified at the intersections at Midland / 8th and Colorado / 8th may be overstated as the Meadows intersection will tend to meter eastbound traffic on the detour. No traffic counts for Meadows/Midland intersection were available so it was unclear how reasonable driveway volumes at the intersection are.

In the PM peak hour, the dominant movement is traveling down valley on SH 82 through Glenwood Springs then west along Midland Avenue. The most problematic movements in the PM are located downtown. The downtown locations will be the first to develop bottlenecks because they are the first intersections that the dominant movement will come in contact with. The northbound left at Grand Ave and 8th St is operating at LOS F, as is the westbound through at Colorado Ave and 8th St. During the PM peak, these intersections will limit the number of vehicles exiting downtown Glenwood Springs and therefore the results for intersections downstream of this point may be overstated.

Bottlenecks that cannot be eliminated help manage traffic flows and prevent bottlenecks from occurring at other downstream locations, like downtown Glenwood Springs in the square about.

The roundabout at Midland and 27th St was modeled using SIDRA. For both the AM and PM peak hours, SIDRA reported all legs of the roundabout to be operating at a very good level of service (LOS A).

4.0 Travel Demand Management

4.1 TDM

Transportation Demand Management (TDM) describes a wide range of programs and services that create the efficient use of existing transportation facilities by managing the actual "demand" placed on said facilities. TDM efforts are implemented through strategies including promotion of alternative transit modes, increasing vehicle occupancy, reducing travel distances and easing peak-hour congestion.

As part of the EA, an origination and destination study was performed to study vehicle trip types within Glenwood Springs, and this data was used to develop estimated needed traffic reductions for various trip types (such as commuting to/from work, shopping/errands, etc) to achieve a 20-25% reduction in vehicular trips. Based upon the peer review of volume-to-capacity ratios for critical movements, a reduction in demand of 30-35% (or more) is needed to improve opportunities for success.

The peer review has confirmed the need for demand reduction throughout the system. In fact, the EA estimate of 20-25% may not be sufficient, a 30-35% reduction is more likely to be successful.

A wide range of TDM programs have been already been identified in the EA for application during the Grand Avenue Bridge construction and full closure. The most important aspect of the TDM program is employing an effective Public Information campaign that provides useful, timely information to help minimize inconvenience for travelers. Elements of the PI / TDM program should include:

- Transit. Encouraging a mode shift from single occupant auto to transit is an important element of the project's TDM program. Commuters especially will be attracted to the "hassle-free" factor of leaving the driving to others. PI can also emphasize amenities such as on-board WI-FI enabling passengers to work (or play) while on-route to their destination.
- Incentives. Similar to the promotion that helped motivate people to respond to the travel survey, prizes can be awarded to (for example) employers that support telecommuting, variable work hours, or other innovative ways that help their employees avoid contributing to traffic congestion. Sponsored bike-to-work days with breakfast stations along key routes, prize raffles, etc. is another example of an incentive program that could be implemented..
- Support local businesses. PI can help remind people of the importance of supporting the local economy. By patronizing neighborhood businesses instead of those across town or in nearby communities, people make shorter trips which lessens the impact of those trips on the transportation system.
- Communicate an "every trip counts" mentality. Setting a specific goal gives individuals a tangible way to contribute to the trip reduction program's success. For example, "An average household makes 10 vehicle trips per day; if everyone replaced two or three of those daily vehicle trips with walking, biking or transit trips it would help lower everyone's stress level, improve air quality, and get people to work and school on-time". Consolidating trips can also help improve conditions. People completing all of their errands before returning home, rather than making several trips, would have a significant impact on their trips per day.

These are just a few examples of PI programs to help encourage the 30-35% reduction in vehicle trips needed to minimize traffic congestion during the detour phase.

5.0 Traffic Control Plan

The detour Traffic Control Plan in the final project plans was also reviewed to determine whether there may be opportunities for improvement in pedestrian or vehicular mobility. The review generally considered access control, signing/striping, signal timing considerations, transit considerations, dedicated transit lanes, traffic control and/or access control needed beyond the detour route (such as the Red Mountain neighborhood), UTC/flagging, EMS/first responder considerations, incident response/management planning, among other topics.

Objectives in reviewing the TCP included seeking ways to maximize mobility along the detour route, while maintaining access for pedestrians, residents and businesses.

"Friction" points were identified (including pedestrian crossings, on-street parking, etc) for possible improvement; however, it is recognized that bottlenecks exist along the route and reducing congestion at other locations may just get traffic to the bottleneck faster and/or highlight other capacity-constraining locations.

5.1 8th Street Detour

With respect to 8th Street,the following suggestions are offered for consideration:

- Signal timings at 8th / Midland may need to include an ability to terminate the southbound through phase early (while southbound left-turn arrow remains on) in order to manage the levels of detour traffic along both 8th St and 27th St.
- The westbound left-turn movement at 8th and Midland has been evaluated and vehicle queuing is not expected to be a concern. However, queuing would be very detrimental to detour traffic flow. Signal operations at this location should therefore be monitored to ensure that westbound left turn queues do not block the westbound right-turn movement to Midland Ave. If problems develop, signal timing adjustments will be necessary.
- 7th Street between Colorado Avenue and 8th Street could be temporarily designated as a one-lane, one-way street, while maintaining two-way travel for bike traffic to accomplish the following:
    - Provide additional opportunity for on-street parking (south-side) along 7th Street.
    - Reduce congestion along the detour route by eliminating the eastbound 8th Street left-turn movement to 7th Street. These left turns could instead occur at 8th Street / Colorado Avenue where a left-turn bay and temporary traffic signal exists.
- Unless more traffic control devices are placed, cut-through traffic may occur along School Street and Pitkin Avenue. The following options can be considered to mitigate this issue:
    - Run type III barricade / traffic cones, etc. down the center of these streets physically narrowing them to 16-ft or so
    - Prohibit parking on the existing shoulder along the west side of School St. Instead, allow parking in the northbound direction (consistent with the proposed one-way operation) in the southbound lane of the street
    - Narrow Pitkin Avenue and allow northbound parking both sides of street
- Eliminating on-street parking along 8th Street and eliminating all but the primary mid-block crossing at Pitkin Ave and the crossing at the Rio Grande Trail.

Also:

- The peer review considered making Cowdin Drive a right-in, right-out to prevent eastbound left turns; particularly when westbound traffic is stopped at the signal, from blocking upvalley traffic on the detour route. However, the intersection geometry at Midland Avenue / Overlin Drive is unable to accommodate left-turn movements larger than a passenger vehicle. Given the out-of-direction travel required right-in, right-out is not recommended unless the frequency of left-turns at this location creates a recurring problem.
- It appears from the plans that pedetrians are prohibited from crossing the south leg of the Pitkin Avenue & 8th Street intersection. If so, a pedestrian detour is needed.

Colorado Avenue:

- The existing stop sign for southbound Colorado Avenue at 9th Street must be removed for the detour to operate acceptably through downtown.

  Once the stop sign is removed, pedestrians crossing the north and east leg will conflict with the high volume of detour traffic. This is also a school crossing location. Mitigation options include:

  - The addition of pedestrian crossing warning signs and RRFB for the north leg crosswalk. Pedestrians would be prohibited from crossing the east crosswalk (provide pedestrian detour), OR
  - Prohibit pedestrians from both crosswalks (provide pedestrian detour). This is the preferred option from a pedestrian safety perspective.

9th Street:

- Sign 74 (westbound left/right on the signal mast-arm) should be right turn only. Sign 79a (all buses turn right) does not appear to be correct.

Wulfsohn Road:

- Provide Type III Barricade across the Community Center driveway to Wulfsohn Road to discourage unauthorized traffic from turning down Wulfsohn to the first driveway for the Community Center.

5.2 Post Office Access

Vehicle access to the post office changes during the detour. Colorado Avenue to 9th Street (west) becomes the main point of access from the north and west. Pedestrian access from the east side of Colorado Avenue and from 9th Street to the east will be problematic since the southbound stop sign at Colorado Avenue / 9th Street will be removed to maintain mobility along the detour. A pedestrian detour is needed from the east to cross pedestrians to the south side of 9th Street at Grand Avenue. Pedestrians along Colorado Avenue north of 9th will be detoured up to 8th Street to cross at the signal. The diagonal parking spaces on the west side of Colorado Ave will be removed and replaced with a parallel configuration. If it is determined that congestion needs to be further reduced, the parallel parking spaces may also be eliminated or restricted during peak periods.

5.3 City/county offices access & parking

The GAB detour phase parking map indicates that parking along 8th Street west of Grand Avenue will be restricted. Because parallel parking has the potential to create congestion along the detour route the restriction is necessary; at least during peak periods. The detour plans do not include appear to include no parking or other signage for 8th Street (this is needed).

The main issue with city/county offices access & parking is the lot located on Pitkin Street south of 8th Street. As a one-way northbound, this lot will be accessed via 9th Street during the detour. Access to the other lots located along Colorado north of 8th, and along 7th are not expected to change much and therefore should not be an issue.

Consolidation and/or temporary elimination of unsignalized crosswalks of 8th Street is recommended to minimize disruption to detour traffic while enhancing safety for pedestrians.

5.4 Circulation for local schools

Based upon existing traffic patterns, circulation to/from local schools will be most critical during the a.m. peak hour when school traffic coincides with peak commuting traffic. Anticipating significant transportation difficulties with the bridge construction, the Roaring Fork School District plans to delay the start of the school year a couple of weeks to start the day after Labor Day. However, the bridge will be closed for the first two months of the 2017-2018 school year.

There are a number of schools within the project area that have the potential to be affected by the detour, these include:

5.4.1 Glenwood Springs High School (1521 Grand Avenue)

The high school is located south of the detour. The high school is located roughly in the center of the City and receives traffic and buses from all directions. Based

upon predicted traffic conditions at the 27th Street & Grand Avenue intersection, school traffic oriented to the south will be relatively unaffected; with the exception of trips between the school and South Glenwood Springs (Airport Area) which like traffic associated with Sopris Elementary School will experience delays; particularly in the morning, at the roundabout located at 27th Street & Midland Avenue. Students living north of I-70 and west of the Roaring Fork will be impacted by the detour and will need to plan additional time to get to and from school.

5.4.2 Glenwood Springs Middle School (120 Soccer Field Road)

The middle school is located north of I-70 in West Glenwood Springs. A large proportion of the school and bus traffic will be impacted by the bridge closure and will need to follow the detour route. In addition to traveling along 8th Street and Midland Avenue, this traffic will need to travel through the roundabouts at Exit 114. Additional time will need to be budgeted for school trips, particularly those occuring in the morning peak hour. Fortunately, morning traffic to the school will generally be in the off-peak direction along the detour.

5.4.3 Glenwood Springs Elementary School (915 School Street)

The elementary school is located in the midst of the detour and draws from a large area including points north of I-70 and east of the Roaring Fork. School traffic and buses take both Midland and SH 82 to access the school. For the detour, this traffic will now take 8th Street, turn south at Colorado and west at 9th.

An alternative option to provide more direct access to the school and perhaps to better accommodate buses is to keep Pitkin Street two-way (school and local traffic only) so school traffic from the north can take 8th Street to Pitkin Avenue (south) to 9th Street (west). From the south, the route would be 10th Street to Pitkin Avenue (north) to 9th Street (west). Traffic from east of SH 82 will take 10th Street (no left turns allowed westbound 8th Street to Pitkin Avenue). This scenario would require changes to the currently proposed traffic control plan.

5.4.4 Sopris Elementary (1150 Mt Sopris Drive)

Sopris Elementary is located entirely south of the detour but serves the area west of the Roaring Fork from I-70 south to Sunlight Mountain Resort. School traffic and buses serving the school travel Midland Avenue as well as SH 82 and will therefore experience delays and need to plan additional time to get to and from school. Some additional inconvience will be experienced at the already congested (weekday a.m. peak) 27th Street & Midland Avenue roundabout as a result of detour traffic.

5.4.5 Yampah Mountain High School (695 Red Mountain Drive)

Yampah Mountain is located right on the detour route. Traffic conditions on the detour will directly determine how easy (or difficult) it is to get to school. Students and staff will need to plan additional time to get to and from school.

A number of the RFSD bus routes in the morning follow a pattern of either: (1) High School to (2) Middle School to (3) Sopris Elementary; OR (1) Middle School to (2) High School to (3) Sopris Elementary. Ending at Sopris Elementary in the a.m. is problematic in that it requires the RFSD buses to follow the detour in the peak direction. In particular, routes that travel from the high school up to the middle school then down to Sopris Elementary might be easier to accomplish in order from the high school to Sopris Elementary to the middle school. Routes that can follow the reverse direction on the detour will typically experience less congestion and delays.

5.5 Woodberry Drive

Woodberry Drive provides an opportunity for northbound traffic to bypass the roundabout at 27th / Midland. This may be an issue when the roundabout is congested, particularly during the p.m. peak period. Making Woodberry Drive a southbound one-way (prohibiting the northbound right-turn from 27th to Woodberry) would potentially alleviate this concern. This option would require coordination with emergency responders and residents.

5.6 Red Mountain Drive

Red Mountain Drive provides access to Trinity Church and Yampah Mountain High School as well as a residential area. There is a reduced speed school zone (20 MPH) along Midland Avenue in the vicinity. School crossing signage is obsolete compared to the current MUTCD standard. One low priority improvement is to upgrade signage to current standard and retroreflective flourescent yellow-green sign sheeting.

Red Mountain Drive also provides an opportunity for traffic on Midland to bypass the intersection with 8th Street. Given the low-speed nature of the route through Red Mountain, the single lane bridge, and the fact that the route bypasses only a short segment of the detour, not many cut-through trips are expected. However, cut-thru may be an issue when the left-turn from Midland to 8th backs up and blocks the southbound thru movement on Midland or when the northbound through movement experiences significant delay at 8th Street.

If a problem develops, Red Mountain Drive could be barricaded at a location internal to the neighborhood (perhaps just past the school or at the one-lane bridge) and NO OUTLET signing installed at both ends of the route. This would need to be coordinated with emergency responders and the neighborhood.

6.0 Findings

The peer review conducted of the detour and traffic control plans for the Grand Avenue Bridge closure has confirmed a number of the key points of concern identified in the EA and subsequent design processes. Midland Avenue, the only viable detour route, is expected to experience over capacity conditions during periods of peak traffic demand. Travelers that can will voluntarily modify their travel behavior in order to minimize their personal inconvenience. Public Information will be the critical tool to disseminate travel demand management strategies to the public.

Based upon the traffic analysis conducted of anticipated detour conditions, critical points in the detour network include the roundabouts at Exit 114, as well as the intersections at Meadows & Midland, 8th & Midland, 8th & Colorado, and 8th & Grand.

Specific recommendations resulting from this peer review include:

1. Due to a lack of available pedestrian data, the affects that on-street parking and pedestrian crossing activity have on traffic flow was not explicitly modeled in the EA or peer review. Nevertheless, these activities have the potential to negatively affect mobility along the detour route and should be monitored throughout constuction to determine whether changes to the traffic control plan (TCP) are required.

2. Although the recent improvements at the Exit 114 roundabouts result in improved conditions as compared to the EA assumptions, operational problems are expected during peak traffic demands. These problems will at times require uniform traffic control (UTC) to address. A queue warning system for the eastbound I-70 off-ramp would help alert motorists to unexepected traffic conditions ahead.

3. Elimination of the stop control for southbound Colorado Avenue at 9th Street is necessary for the detour route to function reasonably. Changes are needed to the pedestrian TCP to prohibit pedestrians from crossing the north and east leg of the 9th Street and Colorado Avenue intersection.

4. The West Meadows traffic signal is expected to experience significant delay due to detour traffic volumes. Signal timings at this location will need to balance detour mobility with commercial access. The site plan modifications proposed by CDOT will lessen the effect that side-street delays have on traffic and parking circulation within the Meadows.

5. Midland Avenue between 8th Street and 27th Street could realize a greater share of detour traffic if the bottleneck along 27th between the roundabout and SH 82 is improved. Improvements at the City's 27th Street & Grand Avenue intersection to coordinate that signal with CDOT's signal at 27th Street & SH 82 is recommended.

6. The peer review has confirmed the need for demand reduction throughout the system. In fact, the EA estimate of 20-25% may not be sufficient, a 30-35% reduction is more likely to be successful.

7. If 7th Street is converted to a one-way westbound between Colorado Avenue and 8th Street it would eliminate congestion associated with the eastbound left turn at 7th / 8th and provide an opportunity for additional on-street parking.

8. Recommendations have been provided related to minimizing cut-through traffic along School Street and Pitkin Avenue and providing additional parking opportunities. Alternatively, Pitkin Avenue could remain two-way to make access to the Elementary School easier for traffic following the detour.

9. On-street parking along 8th Street should be prohibited to maintain mobility along the detour and sight lines to crossing pedestrians. The TCP does not currently show NO PARKING areas along 8th Street.

10. A detour-specific signal timing plan will be necessary for the project. The timing plan will require field monitoring and fine-tuning throughout the detour period. Leading pedestrian intervals at high crossing locations (8th /Grand, 8th / Colorado, 9th / Colorado) may be beneficial for safety and mobility. Coordination of signals is necessary to minimize disruption to through traffic flow.

11. Many of RFSD's existing bus routes follow the detour in the peak direction during the a.m. period. Opportunities to alter the sequence of stops to minimize delays should be discussed with the school district. For example, the morning sequence of High School to Middle School to Sopris Elementary may be more efficiently accomplished by ending at the Middle School instead (i.e., High School to Sopris Elementary to Middle School).

12. At the start of the detour operations, signalized intersections should be monitored by signal technicians so that timing adjustments can be made. Roundabouts should also be monitored by UTC officers during this time. Queue warning systems or signing on I-70 should also be considered.

13. The current TCP removes the diagonal parking spaces on the west side of Colorado Ave and replaces them with a parallel configuration. If it is determined that detour route congestion needs to be further reduced, the parallel parking spaces may also be eliminated or restricted during peak periods.