



US 34 and SH 257 BRT Station DEIS Evaluation

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August 20, 2007

Introduction

The North I-25 DEIS Package B alternative considers three bus-rapid-transit (BRT) routes: one that would extend from the Denver Union Station (DUS) and terminate in Fort Collins at the proposed Fort Collins South Transit Center; a second that would extend from the Denver International Airport (DIA) and also terminate in Fort Collins; and a third route from DUS to downtown Greeley. Stations would be located at various interchanges along I-25, as well as along both US 34 east of I-25 and Harmony Road west of I-25.

The proposed Bus Rapid Transit (BRT) service generally follows the exiting US 34 and SH 257 alignment. Location of the proposed BRT station is provided in Figure 1.

This report documents the potential traffic impacts of the proposed BRT station in the vicinity of the US 34 Bypass/ SH 257 interchange and provides technical documentation of the traffic data analysis. The other proposed BRT stations are addressed in separate reports.

Existing Conditions

The proposed BRT station is located north of the US 34 Bypass/SH 257 interchange at an existing park-and-ride lot and would require approximately 40 parking spaces. An existing carpool parking facility is located at the site, with about 100 parking spaces. A survey of the existing lot suggests that about 10 spaces are currently being utilized, and a shared parking facility is feasible, without expansion of this existing lot. The surrounding area includes several land use types, including residential, commercial, retail development, and small offices.

The proposed study area includes the following major roadways and intersections:

United States Highway 34 (US 34)

US 34 east of Loveland is a four lane divided expressway. The interchange with I-25, Exit 257, is a cloverleaf with 25 mph ramp speeds. East of I-25, US 34 continues east as a four-lane divided expressway with 65 mph posted speed limit. At two places, there are at-grade railway crossings, which use standard signal lights.

Six miles east of I-25, US 34 is split into two different routes, US 34 and US 34 Bypass. Eastbound, US 34 cuts off to the right as a two lane exit, and then takes a flyover off to the northeast, then continues due east towards Greeley. US 34 Bypass continues due east and just east of the flyover it has a diamond interchange at SH 257, where one

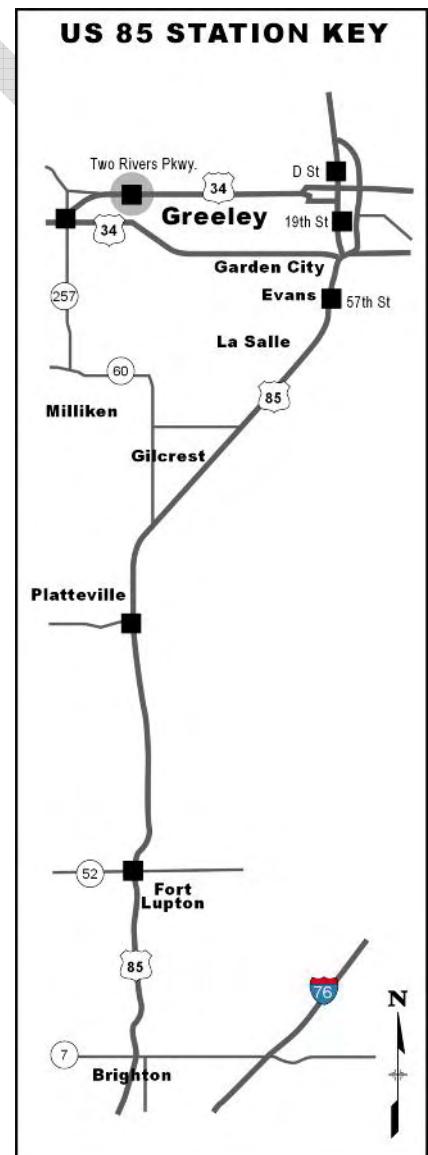


Figure 1. Vicinity Map

can go to either Windsor or Milliken. US 34 Bypass then turns southeast, then east, and at the 65th Avenue/W Ridge Road goes onto the 28th Street expressway with a 55 mph speed limit. US 34 Bypass eventually becomes a quasi-expressway "parkway" with trees in the median and a 45 mph speed limit along 28th Street and has an interchange with 23rd Avenue. US 34 Bypass becomes business route (USB 34) through Greeley.

State Highway 257 (SH 257)

SH 257 starts at SH 60 on the west side of Milliken and heads due north across the Big Thompson River, then hits US 34. This is just east of the point where US 34 splits for the Greeley business route, so SH 257 intersects US 34 twice: US 34 Bypass on the south and US 34 on the north, only about 0.3 miles apart. They are both diamond interchanges, but the interchange with US 34 only has the ramps on the east side of the interchange. From US 34, SH 257 continues north, curves northwest, goes over the Cache la Poudre River and heads north to Windsor.

SH 257/US 34 interchange

The SH 257/US 34 interchange is located 0.3 miles north of the US 34 Bypass/SH 257 interchange. US 34 only has ramps on the east side of the interchange. The posted speed limit near the ramp intersections is 30 mph. SH 257 travels in north-south direction and carries moderate through traffic between Milliken and Windsor.

SH 257/US 34 westbound off ramp intersection is unsignalized. The intersection geometry on the westbound off ramp approach consists of a left turn lane and a separate right turn bypass lane. The southbound and northbound approaches consist of a through lane in either direction.

SH 257/US 34 eastbound on ramp intersection is unsignalized. The intersection geometry on the northbound approach consists of a shared through/right turn lane. The southbound approach consists of a through lane and an exclusive left turn lane.

Figure 2 summarizes the peak hour traffic counts collected in August 2006 at this interchange. Additionally, the Average Daily Traffic (ADT) data was obtained from the North I-25 Travel Demand Model – 2001 base year. As shown, the average daily traffic on SH 257 south of the interchange is around 3,000 vehicles per day (vpd) and north of the interchange is around 3,300 vpd. The average daily traffic on US 34 east of the interchange is around 11,800 vpd and 10,800 vpd west of the interchange. The average daily traffic on the westbound US 34 off ramp is around 600 vpd and on the eastbound US 34 on ramp is around 400 vpd.

SH 257/US 34 Bypass interchange

The SH 257/US 34 Bypass interchange is located 0.3 miles south of the SH 257/US 34 interchange. It has a diamond design and the posted speed limit near the ramp intersections is 30mph. SH 257 travels in the north-south direction and carries moderate through traffic between Milliken and Windsor.

SH 257/US 34 Bypass westbound off ramp intersection is unsignalized. The intersection geometry on the westbound off ramp approach consists of a shared through/left turn lane and a separate right turn bypass lane. The southbound approach consists of a through lane and a

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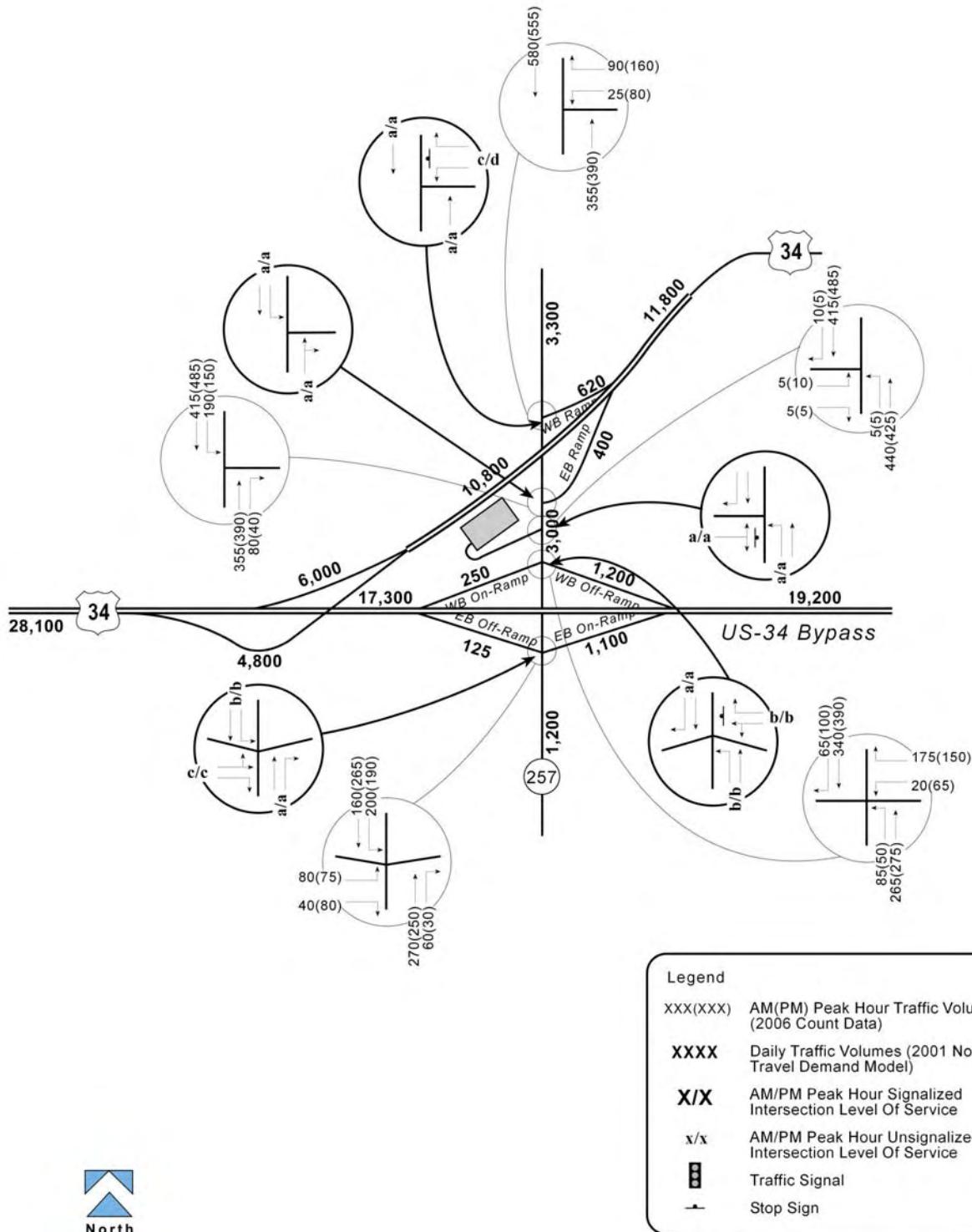


Figure 2. Existing Conditions

separate right turn bypass lane. The northbound approach consists of a through lane and an exclusive left turn lane.

SH 257/US 34 Bypass eastbound off ramp intersection is unsignalized. The intersection geometry on the eastbound off ramp approach consists of a shared through/left turn lane and a separate right turn bypass lane. The northbound approach consists of a through lane and a separate right turn bypass lane. The southbound approach consists of a through lane and an exclusive left turn lane.

The existing carpool parking facility is located west of SH 257 between US 34 and US 34 Bypass. It consists of about 100 parking spaces, of which about 10 are currently utilized daily based on a survey of the lot. Access to the lot is provided at an unsignalized intersection on SH 257, with a stop sign control on the eastbound approach of the access.

Figure 2 summarizes the peak hour traffic counts collected in January 2006 at this interchange. Additionally, the Average Daily Traffic (ADT) data was obtained from the North I-25 Travel Demand Model – 2001 base year. As shown, the average daily traffic on SH 257 south of the interchange is around 1,200 vehicles per day (vpd) and north of the interchange is around 3,000 vpd. The average daily traffic on the westbound US 34 Bypass off ramp is around 1,200 vpd and on the eastbound US 34 Bypass off ramp is around 125 vehicles per day. The average daily traffic on US 34 Bypass east of the interchange is around 19,200 vpd and 17,300 vpd west of the interchange.

Traffic Operations Evaluation

Operational analyses of each key intersection were conducted based on methodology developed in the Highway Capacity Manual (Transportation Research Board, 2000). The result of such analysis is a level of service (LOS) rating. Level of service is a qualitative assessment of the traffic flow based on the average stopped delay per vehicles at intersections controlled by traffic signals and stop-signs.

Levels of service are described by a letter designation ranging from "A" to "F", with LOS A representing essentially uninterrupted flow, and LOS F representing a breakdown of traffic flow with excessive congestion and delay. Signalized intersection analyses result in a level of service rating for each movement and for the entire intersection but typically only the level of service for the entire intersection is reported. For unsignalized intersections a level of service rating is determined for each turn movement that must yield to another turn movement but an overall level of service rating is not determined for the entire intersection. The following table shows how average stopped delay at controlled intersections equates to levels of service.

Table 1. Equivalent Level of Service to Average Stopped Delay

Level of Service	Average Delay at Signalized Intersections (sec./veh.)	Average Delay at Stop-Controlled Intersections (sec./veh.)
A	0 to <=10	0 to <=10
B	> 10 to <= 20	> 10.0 to <= 15
C	> 20 to <= 35	> 15.0 to <= 25
D	> 35 to <= 55	> 25.0 to <= 35
E	> 55 to <= 80	> 35.0 to <= 50
F	> 80	> 50

Figure 2 and Table 2 illustrate the existing peak hour levels of service at the study area intersections. Currently, the westbound left turn approach at the SH 257/US 34 off ramp intersection operates at LOS C during the AM peak hour and LOS D during the PM peak hour. The southbound left turn approach at the SH 257/US 34 on ramp intersection operates at LOS A during both the AM and PM peak hours.

The westbound approach at the SH 257/US 34 Bypass WB off ramp intersection operates at LOS B during both the AM and PM peak hours. The eastbound approach at the SH 257/US 34 Bypass EB off ramp intersection operates at LOS C during both the AM and PM peak hours.

Table 2 Existing Intersection LOS and Delay

Intersection / Movement	Level of Service		Delay (seconds)	
	AM	PM	AM	PM
SH 257/US 34 WB off ramp (unsignalized)				
Westbound Left Approach	C	D	20	26
SH 257/US 34 EB on ramp (unsignalized)				
Southbound Left Approach	A	A	9	9
SH 257/US 34 Bypass WB off ramp (unsignalized)				
Westbound Approach	B	B	12	15
SH 257/US 34 Bypass EB off ramp (unsignalized)				
Eastbound Approach	C	C	24	22
Park-and-Ride Lot Access/SH 257 (unsignalized)				
Eastbound Approach	A	A	4	4

2030 Conditions

2030 traffic projections were developed for the following alternatives being considered:

- 1) No Action Alternative
- 2) Package B: TEL + BRT

These packages are illustrated in Figures 3 and 4. Since there are no project elements in the SH 257/US 34 area in Package A, the No Action results are representative of Package A conditions. In developing peak hour turning movements at the study area intersections, the North I-25 Travel Demand Model – 2001 base year, 2030 No Action, and 2030 Package B results were utilized to calculate the growth factors over a 29 year period. Since the actual traffic counts were conducted in year 2006, the growth factors were adjusted to reflect a 24 year growth rate. These growth factors along with existing turning movement data were used in the NCHRP 255 balancing procedure to develop 2030 peak hour turning movement forecasts. These forecasts were checked for balancing between intersections and reasonableness.

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Figure 3. No Action Alternative

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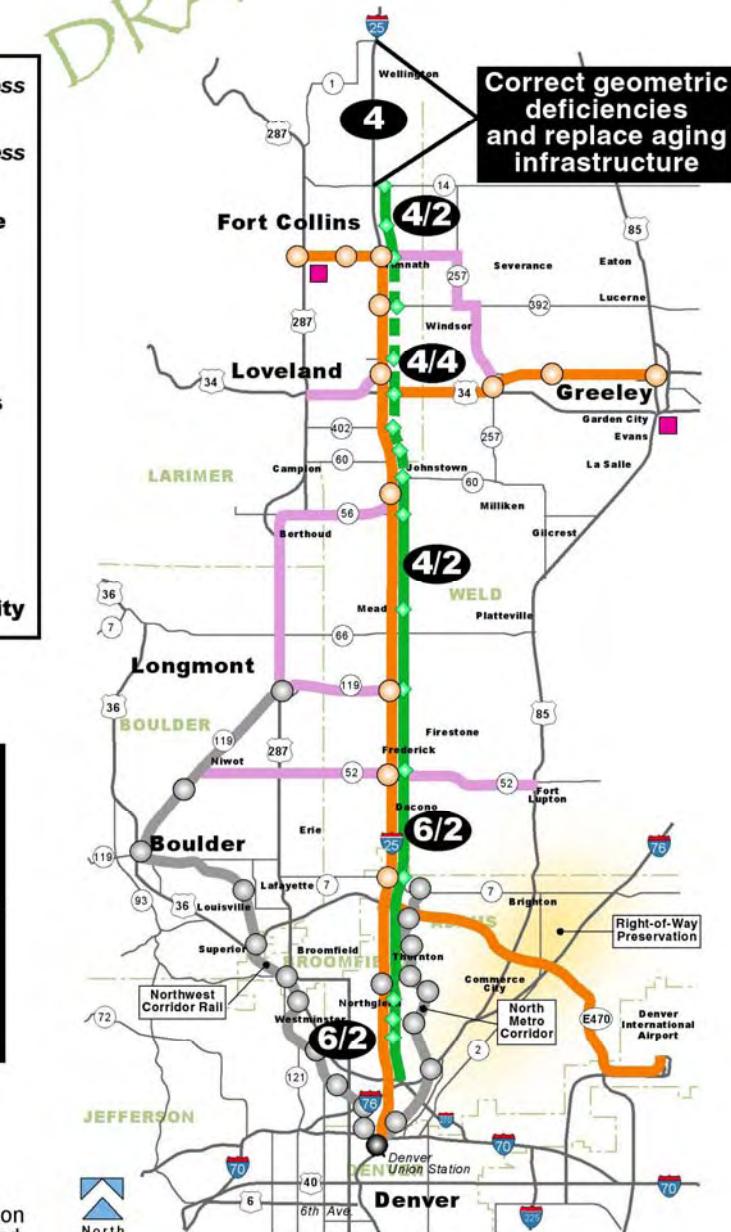
-  **1 Buffer-Separated Tolled Express Lane (TEL) in Each Direction**
 -  **2 Barrier-Separated Tolled Express Lanes (TEL) in Each Direction**
 -  **Bus Rapid Transit (BRT) Route (Uses TELs on I-25)**
 -  **Feeder Bus Service**
 -  **Interchange Upgrades**
 -  **Number of Lanes: General Purpose/Tolled Express Lanes**
 -  **Bus Rapid Transit Station**
 -  **FasTracks Rail Line**
 -  **FasTracks Transit Station**
 -  **Potential Commuter Bus Operational & Maintenance Facility**

**Congestion Management
Measures include:**

- Enhanced carpool lot parking capacity and amenities
 - Courtesy patrol (incident management) from SH 14 to SH 7
 - Variable messaging signs at all transit stations
 - Automated Vehicle Locators on all transit vehicles - "next bus" technology
 - Links to local bike and pedestrian systems at station areas
 - Support for development of Transportation Management Organization (TMO)

NOTE:

- A wider barrier and express lanes cross section is included between SH 60 and Harmony Road.
 - BRT stations located within an expanded median area.
 - Where widening is needed between SH 66 and SH 7, the median would be used.



NOT TO SCALE

TYPICAL I-25 CROSS SECTION - BUFFERED SEPARATED TOLLED EXPRESS LANES

Figure 4. Package B Alternative

2030 No Action Traffic Volumes

The 2030 No Action daily and peak hour projections for the study area intersections are shown in Figure 5. As shown, the average daily traffic on SH 257 just south of the interchange would be around 13,200 vehicles per day (vpd) and around 12,500 vpd north of the interchange. The average daily traffic on US 34 east of the interchange would be around 24,900 vpd and 21,900 vpd west of the interchange. The average daily traffic on the westbound US 34 off ramp would be around 1,400 vpd and on the eastbound US 34 on ramp would be around 1,500 vpd.

The average daily traffic on SH 257 south of the interchange would be around 6,000 vehicles per day (vpd) and north of the interchange would be around 13,200 vpd. The average daily traffic on the westbound US 34 Bypass off ramp would be around 3,900 vpd and on the eastbound US 34 Bypass off ramp would be around 3,200 vehicles per day. The average daily traffic on US 34 Bypass east of the interchange would be around 53,200 vpd and 51,800 vpd west of the interchange.

However, it should be noted that the 2030 No Action alternative assumes US 34 as a four-lane expressway instead of existing two-lane expressway in the vicinity of the proposed BRT station, based on the North Front Range MPO fiscally constrained 2030 transportation plan.

2030 Package B Traffic Volumes

The same methodology used to develop the 2030 No Action volumes was applied to estimate 2030 background traffic volumes for the Package B alternative. The North I-25 Travel Demand Model does not include park-and-ride patrons in its traffic assignment procedure. Therefore, in addition to these background forecasts – which are shown in Figure 6 – peak hour site traffic associated with the development of the commuter bus station and park-and-ride lot was estimated and assigned to the local road network according to the methodology outlined in the *Park-and-Ride Trip Generation and Distribution Methodology* report. A summary of this methodology and its application for this park-and-ride is provided below.

Park-and-Ride Trip Generation

The number of required parking spaces at the US 34/SW 257 BRT station was determined using the methodology outlined in the *North I-25 DEIS Parking Results* report (Carter & Burgess, November 2006). Because the existing lot consists of about 100 spaces, and its utilization is low, it is projected to have an adequate number of spaces for its current use as well as BRT park-and-ride patrons. Using the results of the parking results report, trip generation is estimated at each site, by applying the following factors.

- First, a conservative estimate of maximum utilized spaces is determined by multiplying the number of spaces provided by 90 percent (or 0.9). This is referred to as the *number of occupied spaces*, and is in addition to the estimated number of lot patrons utilizing the lot for carpooling.
- Then, the number of occupied spaces is multiplied by the factors shown in Table 3.

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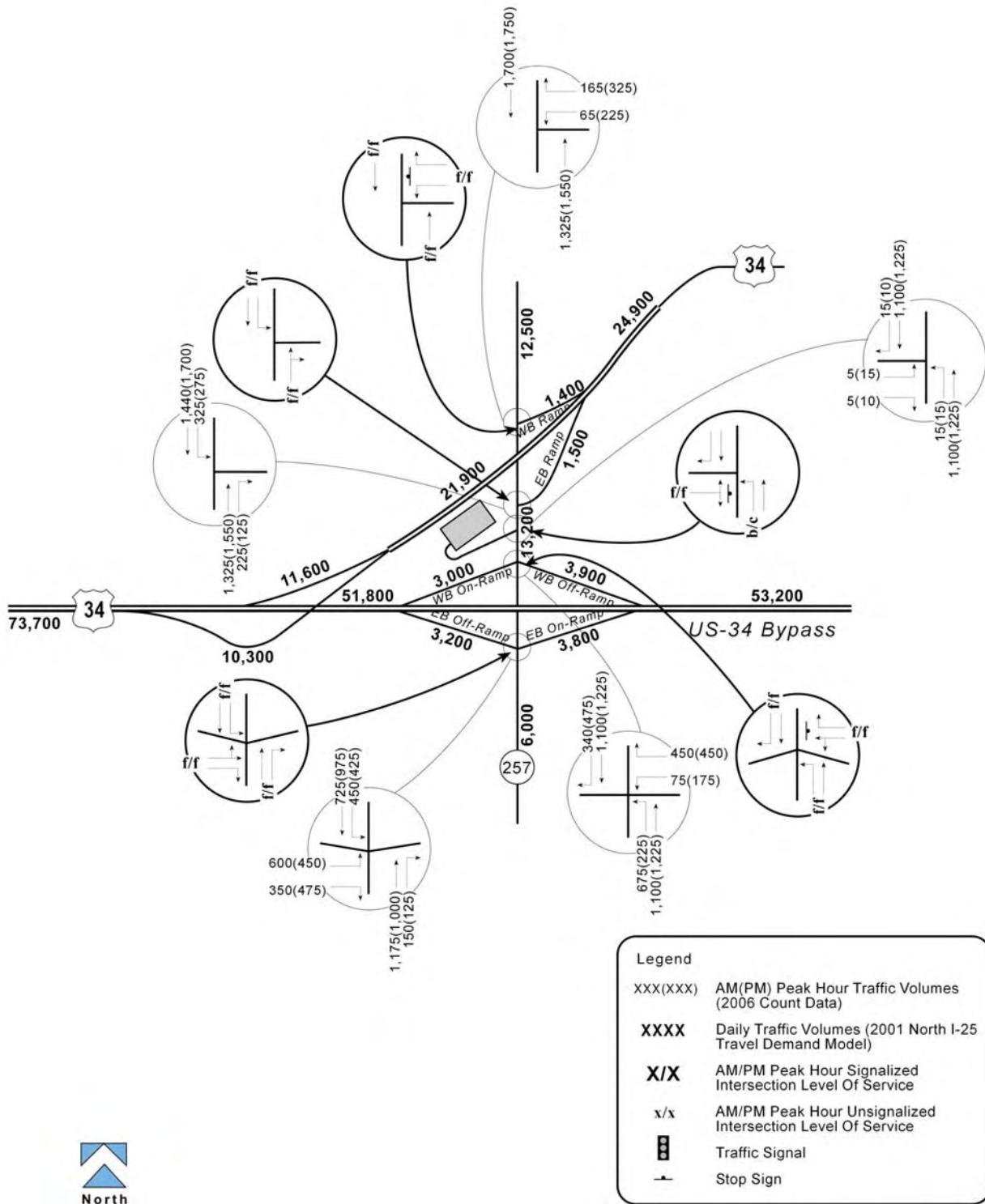


Figure 5. 2030 No Action Forecasts and Levels of Service

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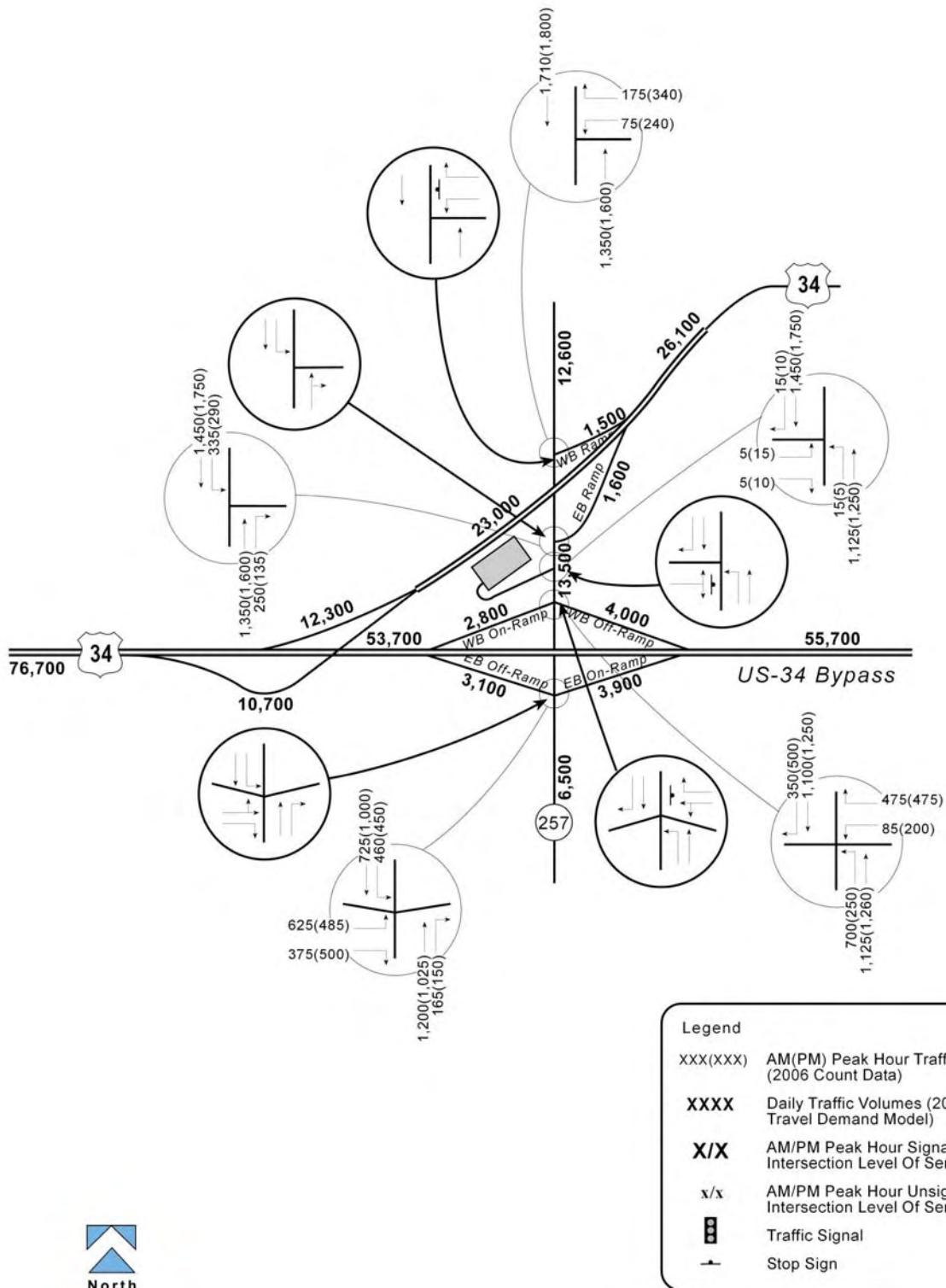


Figure 6. 2030 Package B Background Traffic Forecasts

Table 3 – Peak Hour Trip Generation for North I-25 EIS Park-and-Ride Lots

	Trip Rate	Entering	Exiting
AM Peak Hour			
Trips per occupied space	0.75	87%	13%
PM Peak Hour			
Trips per occupied space	0.50	20%	80%

The US 34/SH 257 BRT station would be located at the existing park-and-ride lot north of the US 34 Bypass/US-257 interchange and is projected use 40 of the existing 100 parking spaces. The future peak hour traffic from the proposed station is shown in Table 4 below.

Table 4 – New Peak Hour Traffic from BRT Implementation

Location	Daily Trips	AM Peak			PM Peak		
		In	Out	Total	In	Out	Total
US 34/SH 257 BRT Station	90	25	5	30	5	15	20

Trip Distribution

The trip distribution and assignment for the BRT station was determined based on existing and future residential land use patterns in the vicinity of the site and existing park-and-ride use. Since the BRT station is proposed at an existing park-and-ride lot, the existing access will be shared. The peak hour trip generation and distribution estimates for the proposed park-and-ride lot are shown in Figure 7. These peak hour trip generation estimates were combined with the background traffic projections to arrive at the total 2030 Package B peak hour projections in Figure 8. In general, daily traffic is projected to be about the same along US 34 in the Package B alternative.

2030 No Action Traffic Operations

Figure 5 shows the projected levels of service at the study area intersections under the No Action scenario. For the purpose of the No Action analysis it was assumed that the US 34 in the vicinity of the study area would be a four-lane expressway, based on the North Front Range MPO fiscally constrained 2030 transportation plan.

As Figure 5 and Table 5 indicate, the westbound left turn approach at the SH 257/US 34 off ramp intersection would operate at LOS F during both the AM and PM peak hours. The southbound left turn approach at the SH 257/US 34 on ramp intersection would operate at LOS F during both the AM and PM peak hours.

The westbound approach at the SH 257/US 34 Bypass WB off ramp intersection would operate at LOS F during both the AM and PM peak hours. The eastbound approach at the SH 257/US 34 Bypass EB off ramp intersection would operate at LOS F during both the AM and PM peak hours.

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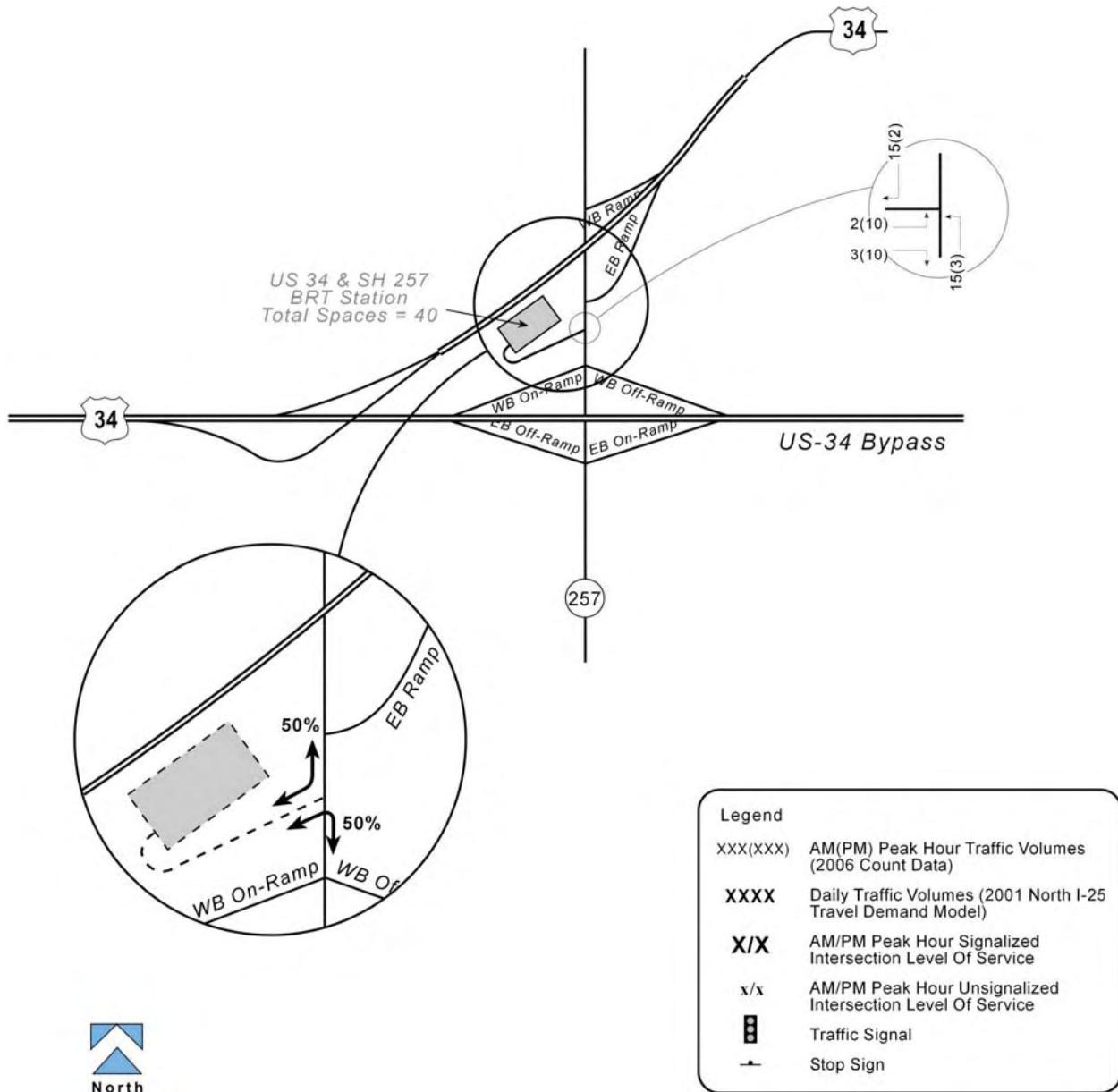


Figure 7. BRT Station Lot Trip Distribution and Assignment

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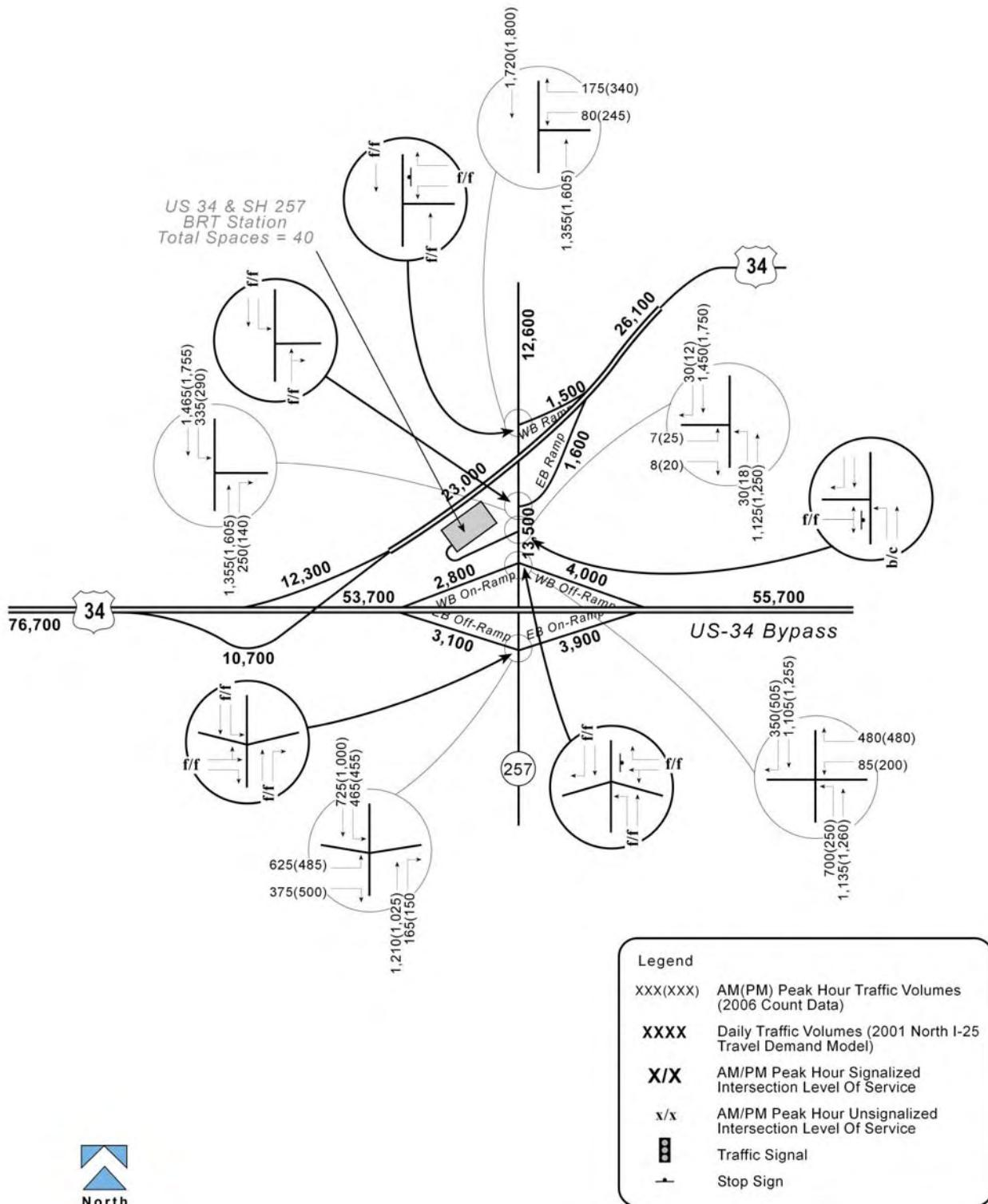


Figure 8. 2030 Package B Total Traffic Forecasts and Levels of Service

Table 5 2030 No Action Intersection LOS and Delay

Intersection / Movement	Level of Service		Delay (seconds)	
	AM	PM	AM	PM
SH 257/US 34 WB off ramp (unsignalized)				
Westbound Left Approach	F	F	>100	>100
SH 257/US 34 EB on ramp (unsignalized)				
Southbound Left Approach	F	F	>100	>100
SH 257/US 34 Bypass WB off ramp (unsignalized)				
Westbound Approach	F	F	>100	>100
SH 257/US 34 Bypass EB off ramp (unsignalized)				
Eastbound Approach	F	F	>100	>100
Park-and-Ride Lot Access/SH 257 (unsignalized)				
Eastbound Approach	F	F	>100	>100

Thus, all side street movements at the unsignalized intersections are projected to operate at LOS F in both peak hours. It is not uncommon for movements from driveways and side streets along higher volume roadways to experience poor levels of service, however. As noted in Chapter 17 (Unsignalized Intersections) of the [Highway Capacity Manual \(2000\)](#):

In evaluating the overall performance of two-way stop control intersections, it is important to consider measures of effectiveness in addition to delay, such as v/c ratios for individual movements, average queue lengths, and 95th percentile queue lengths. By focusing on a single measure of effectiveness for the worst movement only, such as delay for the minor street left turn, users may make less effective traffic control decisions.

Table 6 indicates a more detailed traffic analysis at the study area intersections. The v/c ratio for the side street movements was exceeding 1.00 and the 95th percentile queue length was more than 300-foot for most of the intersections, which indicated that improvements are necessary at these intersections. The Park-and-Ride Lot Access/SH-257 intersection indicated acceptable traffic operations. Also, considering that the intersections on the upstream and downstream of the Park-and-Ride lot would be signalized, there would be enough time and gaps for the side street traffic to access SH 257.

Table 6 2030 No Action Intersection V/c Ratio and Queue lengths

Intersection / Movement	V/c Ratio		Queue Length (ft)	
	AM	PM	AM	PM
SH 257/US 34 WB off ramp (unsignalized)				
Westbound Left Approach	>2.00	>2.00	>250	>350
SH 257/US 34 EB on ramp (unsignalized)				
Southbound Left Approach	>1.00	>1.00	175	250
SH 257/US 34 Bypass WB off ramp (unsignalized)				
Westbound Approach	>2.00	>350	>350	>350
SH 257/US 34 Bypass EB off ramp (unsignalized)				
Eastbound Approach	>2.00	>350	>500	>350
Park-and-Ride Lot Access/SH 257 (unsignalized)				
Eastbound Approach	0.22	0.78	25	100

2030 Package B Traffic Operations

Total Traffic LOS

As Figure 8 and Table 7 indicate, the westbound left turn approach at the SH 257/US 34 off ramp intersection would operate at LOS F during both the AM and PM peak hours. The southbound left turn approach at the SH 257/US 34 on ramp intersection would operate at LOS F during both the AM and PM peak hours.

The westbound approach at the SH 257/US 34 Bypass WB off ramp intersection would operate at LOS F during both the AM and PM peak hours. The eastbound approach at the SH 257/US 34 Bypass EB off ramp intersection would operate at LOS F during both the AM and PM peak hours. These are the same levels of service as in the No Action scenario except for the Park-and-Ride Lot/SH 257 unsignalized intersection.

Existing access to the park-and-ride lot from SH 257 will be used for the proposed BRT station. As shown in Figure 8 and Table 7, this access is a single lane with stop-control, and would operate at LOS F (the same as in the No Action scenario) during both the AM and PM peak hours. However, considering that the intersections on the upstream and downstream of the Park-and-Ride lot would be signalized, there would be enough time and gaps for the side street traffic to access SH 257. The 95th percentile queue length and V/c ratio for the eastbound approach indicates reasonable operations, hence, no improvements are recommended at this intersection.

However, it should be noted that both the No Action alternative and Package B alternative assume that SH 257 will be improved to four lanes to accommodate north-south through traffic volume, based on the North Front Range MPO fiscally constrained 2030 transportation plan.

Table 7 2030 Package B Intersection LOS and Delay

Intersection / Movement	Level of Service		Delay (seconds)	
	AM	PM	AM	PM
SH 257/US 34 WB off ramp (unsignalized)				
Westbound Left Approach	F	F	>100	>100
SH 257/US 34 EB on ramp (unsignalized)				
Southbound Left Approach	F	F	>100	>100
SH 257/US 34 Bypass WB off ramp (unsignalized)				
Westbound Approach	F	F	>100	>100
SH 257/US 34 Bypass EB off ramp (unsignalized)				
Eastbound Approach	F	F	>100	>100
Park-and-Ride Lot Access/SH 257 (unsignalized)				
Eastbound Approach	F	F	>100	>100

Proposed Mitigation

The Package B alternative includes toll/express lanes on I-25 in addition to the proposed bus routes. This would result in more trip attractions towards I-25 increasing the average daily traffic and peak hour traffic volumes on US 34 and SH 257. However, the results of the traffic analysis indicate that major improvements would be needed at the study area intersections in the vicinity of the proposed site regardless of the Package B consideration. The proposed mitigation is discussed below:

SH 257/US 34 Ramp intersections

- The 2030 No Action Travel Demand model assumes US 34 in the vicinity of the proposed site as a four-lane expressway instead of existing two-lane; hence, it is assumed that US 34 would be improved to four-lanes by year 2030.
- SH 257 shall be improved to four-lanes instead of existing two-lanes to accommodate future north-south through traffic volume.
- Provision of signal control, with protected left-turn phasing at the EB on-ramp intersection. When signalized, provide a southbound exclusive left-turn lane with 250-foot pocket length and a separate northbound right-turn lane with 250-foot pocket length on SH 257.
- Provision of signal control, with protected left-turn phasing at the WB off-ramp intersection. When signalized, provide a westbound exclusive left-turn lane and a separate right-turn lane with a pocket length of 250-foot.

These improvements would result in LOS C or better during both the AM and PM peak hours.

SH 257/US 34 Bypass interchange

- SH 257 shall be improved to four-lanes instead of existing two-lanes to accommodate future north-south through traffic volume.
- SH 257 and WB ramp intersection: Provision of signal control, with protected left-turn phasing. When signalized, provide two northbound left-turn lanes with 250-foot pocket length and a separate southbound right-turn lane with 250-foot pocket length on SH 257. WB off-ramp shall be improved by providing a separate 150-foot right-turn lane.
- SH 257 and EB ramp intersection: Provision of signal control, with protected left-turn phasing. When signalized, provide two southbound left-turn lanes with 250-foot pocket length and a separate northbound right-turn lane with 250-foot pocket length on SH 257. EB off-ramp shall be improved by providing a separate 150-foot right-turn lane.

These improvements would result in LOS C or better during both the AM and PM peak hours.

Alternatives Evaluation Comparison

Traffic Operational Analysis

Table 8 compares the levels of service and delay at the study area intersections for the two packages. As the table indicates, major improvements to the intersections in the vicinity of the BRT station would be required to address the LOS and delay issues. The proposed mitigation measures mentioned above would cause these intersections to operate at acceptable levels of service under both the No Action and Package B alternatives.

Table 8. Intersection Level of Service and Delay

Intersection	No Action		Package B	
	AM Peak	PM Peak	AM Peak	PM Peak
SH 257/US 34 WB off ramp (unsignalized)				
Westbound Left Approach	LOS F (>100 sec.)	LOS F (>100 sec.)	LOS F (>100 sec.)	LOS F (>100 sec.)
SH 257/US 34 EB on ramp (unsignalized)				
Southbound Left Approach	LOS F (>100 sec.)	LOS F (>100 sec.)	LOS F (>100 sec.)	LOS F (>100 sec.)
SH 257/US 34 Bypass WB off ramp (unsignalized)				
Westbound Approach	LOS F (>100 sec.)	LOS F (>100 sec.)	LOS F (>100 sec.)	LOS F (>100 sec.)
SH 257/US 34 Bypass EB off ramp (unsignalized)				
Eastbound Approach	LOS F (>100 sec.)	LOS F (>100 sec.)	LOS F (>100 sec.)	LOS F (>100 sec.)
BRT Station Access/SH 257 (unsignalized)				
Eastbound Approach	LOS A (10 sec.)	LOS B (10sec.)	LOS B (15 sec.)	LOS C (17 sec.)

LOS X – Level of service

##.# - Average delay in seconds per vehicle