US 36 CORRIDOR

Final Environmental Impact Statement/
Final Section 4(f) Evaluation

Traffic Engineering Technical Report Addendum

Prepared by

URS

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TABLE OF CONTENTS

TABLE OF CONTENTS

TABLES

TABLE OF CONTENTS

FIGURES

TABLE OF CONTENTS

TABLE OF CONTENTS

APPENDICES

TABLE OF CONTENTS

a.m.	morning
BPR	Bureau of Public Roads
BRT	bus rapid transit
CDOT	Colorado Department of Transportation
DEIS	Draft Environmental Impact Statement
DRCOG	Denver Regional Council of Governments
EIS	Environmental Impact Statement
HOV	high-occupancy vehicle
FEIS	Final Environmental Impact Statement
HCM	Highway Capacity Manual
HOT	high-occupancy toll
I-#	Interstate-# (i.e., I-25, I-270, etc.)
ITS	Intelligent Transportation System
LOS	level of service
mph	miles per hour
NCHRP	National Cooperative Highway Research Program
p.m.	evening
PHF	peak-hour factor
RTD	Regional Transportation District
SH	State Highway
SOV	single-occupant vehicle
TIP	Transportation Improvement Program
US 36	United States Highway 36

Detailed technical data and analysis for traffic operations in the United States Highway 36 (US 36) corridor were prepared in support of the Final Environmental Impact Statement (FEIS) that will be completed in 2009. The project was initiated in 2003 and during the 6-year study period, the traffic information was revised several times consistent with updates in regional planning.

This report is oriented to the travel forecasts and traffic operations of the Combined Alternative Package which has been identified as the Preferred Alternative through the FEIS process. The horizon year for the analysis is 2035, consistent with the current Regional Transportation Plan adopted by the Denver Regional Council of Governments (DRCOG).

Because of the number of years required to complete the Environmental Impact Statement (EIS), several different analysis years have been used. Travel demand and traffic operations studies have been conducted using forecast years of 2025, 2030, and 2035. Incremental decisions were made to evaluate and screen alternatives using these data and results.

To serve as a consistent base for the existing conditions, observed data for traffic volumes, operations, and transit ridership were used from 2002 to 2003. These base condition values were not updated to subsequent years during the study.

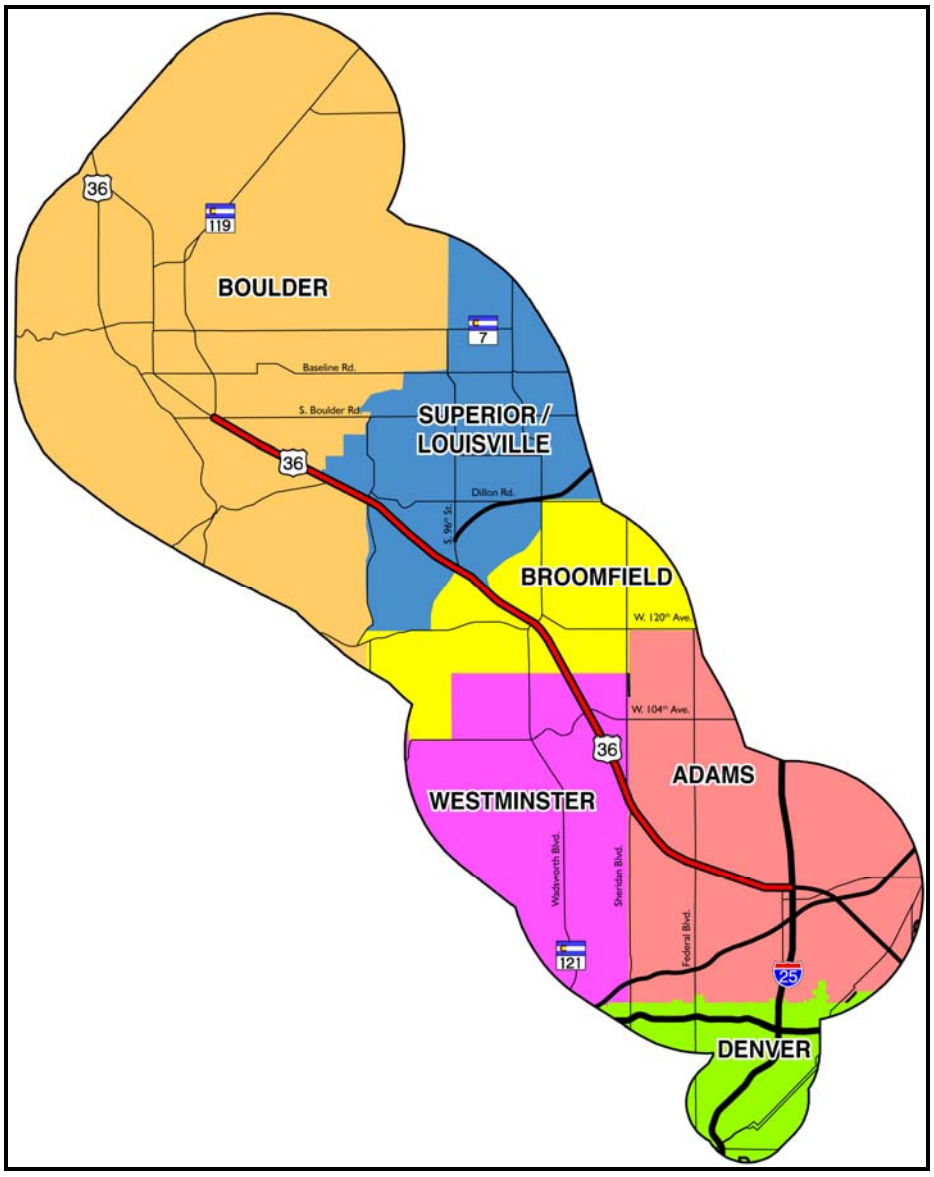
A Traffic Engineering Technical Report**,** dated April 2007, was prepared to support the Draft EIS/Draft Section 4(f)/6(f) Evaluation. Information, results, and other findings from the 2007 report were used as a foundation for the analysis results in this report. In comparing forecasts for the future years of 2025, 2030, and 2035, growth in traffic volumes is expected to be somewhat limited overall. This is because land use development is expected to be gradual over these periods. Therefore, the different years for the travel demand forecasts and transportation analyses have not shown any significant changes that require special assessment.

The 18-mile roadway corridor and associated study area are shown in Figure 1.1-1, US 36 Study Area, and the Combined Alternative Package (Preferred Alternative) typical roadway cross-sections are shown in Figure 1.1-2, Combined Alternative Package (Preferred Alternative) Typical Cross-Sections.

The alternatives evaluated in this document are:

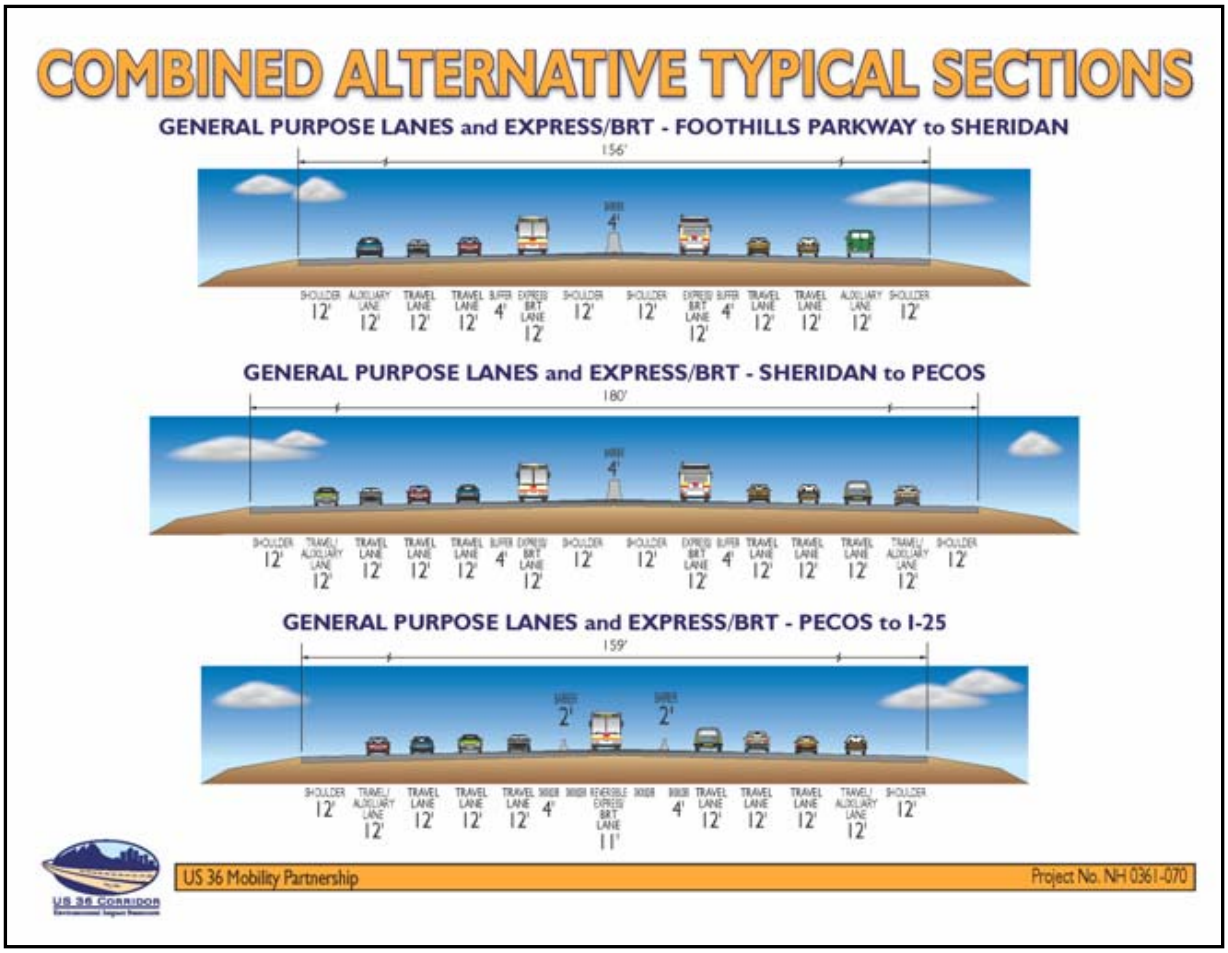
- **Package 1 (No Action)**. Defined as existing infrastructure plus planned and committed transportation improvements. This includes current transportation facilities and services in the US 36 corridor, improvements contained in the short-term fiscally constrained regional Transportation Improvement Program (TIP) within the US 36 corridor, minor transit service expansions or adjustments, and new transit facilities and services as contained in the FasTracks Program.

Figure 1.1-1: US 36 Study Area



Source: US 36 Mobility Partnership, 2009.
Note:
Subarea boundaries not necessarily consistent with actual jurisdictional boundaries.

Figure 1.1-2: Combined Alternative Package (Preferred Alternative) Typical Cross-Sections



Source: US 36 Mobility Partnership, 2009.

- **Combined Alternative Package (Preferred Alternative)**. Defined as Package 1 plus additional highway and transit improvements. The primary improvements that distinguish the Combined Alternative Package (Preferred Alternative) are as follows:
  - **Managed Lanes**: Extension of the existing US 36 high-occupancy vehicle (HOV) lanes from their current termini (Federal Boulevard westbound, Sheridan Boulevard eastbound) to the Table Mesa Drive/Foothills Parkway interchange. A 4-foot buffer area will be provided between the lane and the general-purpose lanes. The HOV status of the lane will be converted to "managed" lanes, such that HOVs can use the lane free at all times, while single-occupant vehicles (SOVs) in the lane pay a toll.
  - **Limited Capacity Improvements**: Widening of US 36 for an additional eastbound general-purpose lane between Sheridan Boulevard and Interstate 25 (I-25), in order to equalize the number of eastbound and westbound general-purpose lanes in this segment, and to provide new climbing lanes on each side of Davidson Mesa, in the Foothills Parkway-to-McCaslin Boulevard segment.

- **Interchanges**: Reconstruction of the McCaslin Boulevard, Wadsworth Parkway/120th Avenue, and Sheridan Boulevard interchanges to remove bottlenecks and improve overall traffic flow.
- **Auxiliary Lanes**: Addition of interchange-to-interchange auxiliary lanes in most segments between McCaslin Boulevard and I-25 where they do not exist today.
- **Transit Improvements**: Additional and reconfigured bus service and station and operational upgrades.

Figure 1.1-2, Combined Alternative Package (Preferred Alternative) Typical Cross-Sections, presents typical roadway cross-sections for the Combined Alternative Package (Preferred Alternative). The cross-section varies depending upon the location in the corridor and the need for auxiliary lanes or transition areas for the managed lanes. Chapter 2, Alternatives Considered, of the US 36 FEIS presents a full description of the Combined Alternative Package (Preferred Alternative).

1.1 REPORT ORGANIZATION

This Traffic Engineering Technical Report Addendum presents information in the following sections:

- Section 2 presents an overview of the analytical methods and study procedures used to complete the traffic and transportation assessment for the project.
- Section 3 describes the forecasts developed and the subsequent analysis of the US 36 mainline, including projected operations of the managed lanes.
- Section 4 presents detailed information about the interchange and intersection operations for each location in the corridor. Information on cross-street operations is included in this section.
- Section 5 contains information on transit ridership and the traffic impacts associated with station areas.
- Appendices are included to provide the following detailed information:
  - **Appendix A** – Modeling Methodology Report
  - **Appendix B** – ITS Implementation Plan
  - **Appendix C** – West End Design Options
  - **Appendix D** – Broadway Interchange Alternatives

Several methodologies were implemented over the 5-year span of the project to develop and analyze the information pertaining to US 36. Travel demand forecasting methodologies were used to develop future traffic forecasts as well as future transit ridership estimates. Methodologies were applied to forecast volumes to assess freeway and ramp operations within the corridor. Peak-hour volumes were analyzed at intersections within each interchange complex to determine intersection operations and mitigation measures. VISSIM analysis was also conducted to assess the operations of the access point into and out of the proposed managed lanes.

The traffic volume forecasts presented are based on output from the 2035 Denver Regional Travel Demand Model developed by the DRCOG, and further refined by the Regional Transportation District (RTD). The model uses projected population, employment, land use, and transit and roadway network information to forecast future regional travel demands and impacts. Land use assumptions were based on 2035 population and employment projections. Additional details on the travel demand modeling methodology are presented in the Modeling Methodology Report, which is contained in Appendix A of this report.

The roadway network within the model was adjusted based on the proposed roadway conditions for the 2035 Package 1 and the 2035 Combined Alternative Package (Preferred Alternative). The number of lanes along US 36, as well as the configuration of the US 36 interchanges, were the primary focus of the adjustments made to the model roadway network. The existing HOV lanes along I-25 and US 36 were also converted into managed toll lanes.

Different horizon years have been used over the duration of the project, each consistent with the DRCOG Regional Transportation Plan. Horizon years of 2025 and 2030 were previously used to develop forecasts and analyses. These were then updated to 2035 for the FEIS.

2.1 MANAGED LANE FORECASTING

The DRCOG travel demand forecasting model does not have the explicit ability to forecast a special use toll lane for passenger cars that is available all hours of the day. As a result, the project team developed a coding process to best estimate the operating conditions of the proposed managed lanes.

In the 2035 Package 1, high-occupancy toll (HOT) lanes were coded on US 36 and I-25 using the existing lane configuration. All HOT lanes were coded as reversible toll lanes during the a.m. (morning) and p.m. (evening) peak periods. URS developed two new USE codes within the model structure to provide the ability to model reversible toll lanes (both HOV and SOV may use the lanes). USE codes 16 and 17 were added to the model coding to simulate a.m. peak period and p.m. peak period conditions, respectively. An override capacity of 1,500 vehicles per hour was also used to approximate the lane management policy proposed by the Colorado Department of Transportation (CDOT).

In the 2035 Combined Alternative Package (Preferred Alternative) model, HOT lanes were coded along US 36 from the Foothills Parkway/Table Mesa Drive interchange in Boulder to the existing express lanes near Federal Boulevard. These lanes will be available for use during all time periods of the day. As a result, the lanes were coded with USE type 0 and TOLL type 1, with a toll charge of $0.05 per mile (1996 dollars) for SOVs. There was no toll charge applied to

HOV vehicles. The reversible sections of the HOT lanes were coded in the same manner as the 2035 Package 1. A 1,500-vehicle per hour override capacity was applied to the lanes.

One drawback of this coding strategy was that the project was not able to restrict heavy vehicles from using the managed lanes. As a result, the travel speed and travel time within the managed lanes did not accurately reflect conditions for passenger cars only.

CDOT intends to operate the managed lanes along US 36 with the goals of optimizing the use of the lanes, maximizing travel time savings, and keeping traffic flowing in the managed lanes at 45 miles per hour or faster, even when the general-purpose lanes are congested. To accomplish this goal, CDOT will employ dynamic pricing, in which the toll rate will be increased or decreased depending on levels of congestion to meet the identified goals.

2.1.1 Traffic Forecast Adjustments

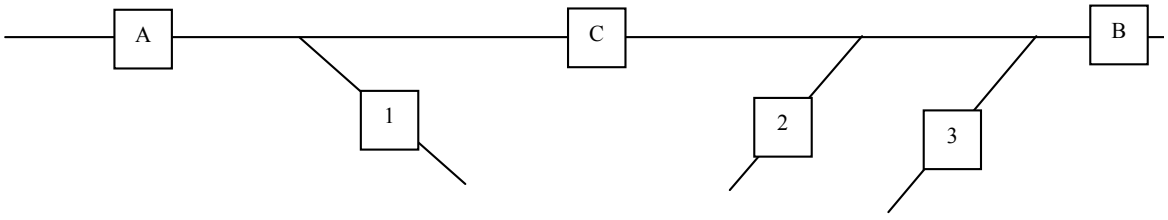
The models were run for the year 2035 in order to compare the transportation impacts that could result from implementation of each alternative (Package 1 and the Combined Alternative Package [Preferred Alternative]). Experience and data from RTD were also used in this analysis, as documented in Chapter 3, Transportation Impacts and Mitigation, of the FEIS.

Travel demand forecasts, including volumes on roadway facilities and transit ridership for daily, a.m. peak-hour, and p.m. peak-hour conditions, were produced and analyzed for transportation impacts and for design of the proposed transportation system under each alternative.

Based on standard practice, the volumes reported and used for the level of service (LOS) calculations are not directly from the model (raw volumes) but first underwent an important adjustment process. The first step was to determine an adjustment to use. The primary (between interchanges) segment volumes for the 2005 model were compared to the counts from 2005 and a ratio and a difference were calculated. The ratio and difference were then applied to the raw 2035 volumes. The average of these two results was calculated and used as the final adjusted volume. The final adjusted volumes were then subtracted from the raw volumes and this difference was the adjustment factor used to adjust the raw volumes for the other alternatives.

Next, mainline segments located between interchanges were calculated using the following equation (refer to interchange figure):

$$C = \frac{(A - 1Raw) + (B - 2Raw - 3Raw)}{2}$$



The ramp volumes were then adjusted with the following equations:

$$1Adj = A - C$$

$$2Adj = \frac{2Raw}{2Raw + 3Raw} * (B - C)$$

$$3Adj = \frac{3Raw}{2Raw + 3Raw} * (B - C)$$

The segments between the ramps of one interchange were then calculated by adding/subtracting the adjusted ramp volumes to the adjusted primary mainline segments. Adjusted corridor traffic volumes (daily, a.m. peak hour, and p.m. peak hour) are presented later in this report.

These forecasts are the best estimates available given the current knowledge and assumptions for land use projections, transportation technologies, and modeling software capabilities. The information supporting these assumptions could change several times before the completion of construction of transportation improvements on US 36, but the analysis documented here (and the travel demand projections underlying that analysis) was conducted in order to make transportation investment decisions based on the best information available at this time.

2.2 TRANSIT RIDERSHIP FORECASTING

The RTD's FasTracks Build transit network was the basis for Package 1 (No Action). Consequently, all US 36 corridor improvements were tested under the assumption that the other corridors in the program (e.g., the I-70 East Corridor, Northwest Rail Corridor, North Metro Corridor, etc.) would be in place whether or not improvements are made to US 36. The definition of the alternatives is presented in Chapter 2, Alternatives Considered, of the FEIS.

2.3 FREEWAY MAINLINE AND RAMP ANALYSIS

The LOS for eastbound and westbound US 36 was determined using the guidelines in the 2000 Highway Capacity Manual (HCM). The HCM defines LOS 'A' through 'F' with regard to the measurable parameters of maximum density, minimum speed, maximum volume to capacity ratio, and maximum service flow rate. The maximum service flow rate expressed in units of passenger cars per hour per lane was used for this analysis. Freeway LOS, as defined in the HCM, additionally depends upon the free flow speed of the highway under study. For this analysis, a free flow speed of 65 miles per hour (mph) was assumed. Table 2.3-1, Freeway Level of Service Versus Service Flow Rate, shows the LOS and the corresponding service flow rate values for a freeway section with 65 mph free flow speed. LOS are depicted graphically in Figure 2.3-1, Typical Roadway Congestion Levels for Each LOS Grade.

Table 2.3-1: Freeway Level of Service Versus Service Flow Rate (65 miles per hour Free Flow Speed)

Level of Service	Service Flow Rate (pc/h/ln)
A	< 710
B	710 < 1,170
C	1,170 < 1,680
D	1,680 < 2,090
E	2,090 < 2,350
F	> 2,350

Source: CDOT, 2000.

Notes:

< = less than

> = greater than

pc/h/ln = passenger cars per hour per lane

2.3.1 Development of Service Flow Rate Volumes

The service flow rate is dependent on the hourly volume, peak-hour factor (PHF), number of lanes, and the heavy vehicle factor. It is computed for each segment by dividing the volume for a representative cross section by the PHF, heavy-vehicle factor, and the number of lanes as shown in the equation below. The corresponding LOS was determined using Table 2.3-1, Freeway Level of Service Versus Service Flow Rate.

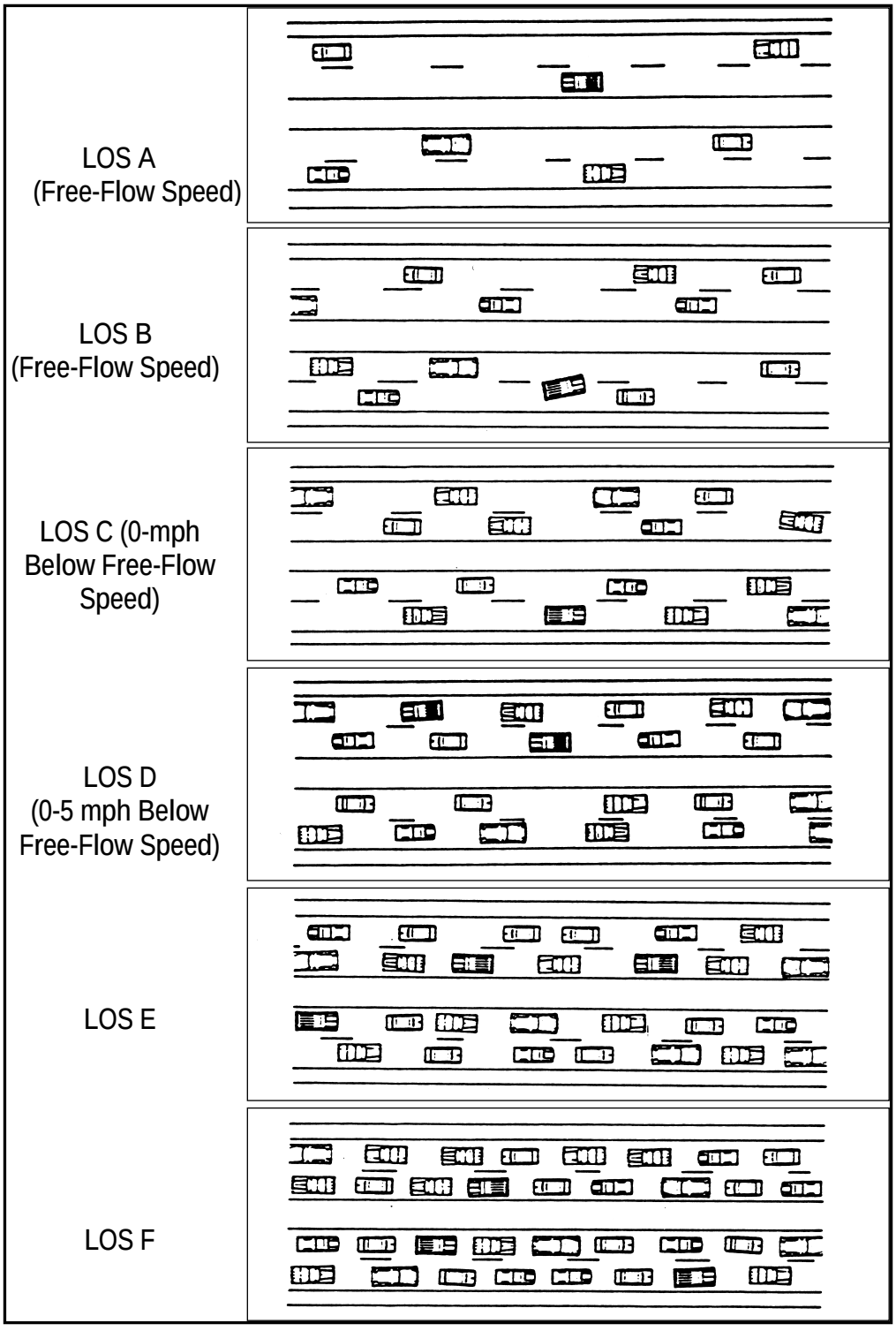
*Service Flow Rate = Hourly Volume / (PHF * Number of Lanes * Heavy Vehicle Factor)*

2.3.2 Peak-Hour Factor

The PHF represents the variation in traffic flow within an hour, by indicating the degree to which the overall peak-hour volume rate is less than the volume rate for the peak 15 minutes. The PHF is calculated by dividing the peak 1-hour volume by four times the highest 15-minute peak flow rate during the same peak-hour as shown in the equation below. According to *The Highway Capacity Manual* (CDOT Transportation Research Board 2000), PHFs in urban areas are typically between 0.80 and 0.95, and the field counts conducted for this project were also within this range. PHFs greater than 0.95 indicate that there is not much variation in the traffic flow rates between the peak-hour and the peak 15-minute flow periods. This is synonymous with urban and suburban peak-hour conditions where sustained periods of high traffic flow rates are experienced. PHFs are not directly related to the levels of congestion in the system; however, congested corridors typically have a high PHF in the peak-hours of operation. US 36 is currently a heavily traveled corridor and likely will remain so in the future; consequently, the PHF used for the future-year corridor analysis was 0.98.

*PHF=Peak-Hour Flow / (4 * Highest 15 Minute Peak Flow During Peak-Hour)*

Figure 2.3-1: Typical Roadway Congestion Levels for Each LOS Grade



Source: US 36 Mobility Partnership, 2009.

2.3.3 Heavy Vehicle Factor

The heavy vehicle factor accounts for the mix of vehicle types in the flow of traffic on a freeway. Heavy vehicle volumes are adjusted to passenger car equivalents. The effect of heavy vehicles on the traffic flow (heavy vehicle factor) depends on the number of heavy vehicles, the vertical grade conditions, and the length of the vertical grade of the segment. Long sections of steep grade have the most impact and short sections of mild grades the least. The heavy vehicle percentage used for the analysis was 4 percent, which was obtained from the CDOT website for US 36. Most of the highway was treated as level terrain, which resulted in a heavy vehicle factor of 0.98. However, there were a few sections of the highway, which had to be treated differently for the heavy vehicle factor computation due to steeper sections. The grade on US 36 between McCaslin Boulevard and Foothills Parkway is fairly steep in both directions, and the heavy vehicle factors computed for these two directions were 0.909 eastbound and 0.926 westbound. The US 36 segment between Church Ranch Boulevard and Sheridan Boulevard has a steep section in the eastbound direction. The corresponding heavy vehicle factor computed for this direction was 0.962.

2.4 INTERSECTION ANALYSIS

The analysis and evaluation of US 36 interchanges were performed iteratively with the basic design process, and focused first on maintaining acceptable operations at the ramp intersections under the existing geometric configuration through signal timing and phasing changes.

Forecast growth in traffic volume and bus service on the road network is expected to create traffic and/or neighborhood impacts that would require mitigation in the form of capital investments in additional capacity, such as local roadway improvements and/or environmental impact mitigation.

The following section evaluates the resulting Combined Alternative Package (Preferred Alternative) interchange impacts to the US 36 interchange ramp intersections and adjacent arterial intersections. Potential mitigation measures are identified that might be needed to maintain acceptable levels of traffic flow on local streets. The delay thresholds used in intersection LOS analysis appear in Table 2.4-1, Level of Service Thresholds.

Table 2.4-1: Level of Service Thresholds

Level of Service	Delay (seconds/vehicle)	
	Signalized	Unsignalized
A	0-10.0	0-10.0
B	10.1-20.0	10.1-15.0
C	20.1-35.0	15.1-25.0
D	35.1-55.0	25.1-35.0
E	55.1-80.0	35.1-50.0
F	80.1 or more	50.1 or more

Source: CDOT, Transportation Research Board, 2000.

The project standard is peak-hour LOS D or better, with no individual movements operating at LOS F. An intersection impact is defined as a situation where the proposed project would result in one of the following situations:

- An intersection meets the project standard in Package 1, but not in the Combined Alternative Package (Preferred Alternative).
- An intersection does not meet the project standard in Package 1, and would experience more average delay (in either peak hour) in the Combined Alternative Package (Preferred Alternative).

If an intersection impact is present, mitigation measures have been recommended when the impact to peak hour average delay is greater than 15 percent and the project LOS standard is not met.

The ramp junction intersections were configured in the basic design of the alternative with the goal that the overall intersection LOS would be D or better, and that no individual movements would fail (LOS E or better). The adjacent intersections were examined with respect to impact, and where forecast LOS under Package 1 conditions was satisfactory, but with the Combined Alternative Package (Preferred Alternative) would worsen beyond that standard (overall LOS D or better, movement LOS E or better), mitigation measures were tested. Additionally, for adjacent intersections already operating worse than the LOS standard under forecast 2035 Package 1 conditions, mitigation measures were tested when traffic conditions with the proposed alternative would further worsen overall intersection delay.

The DRCOG/RTD Regional Travel Demand Forecasting model is just part of the forecasting process. It is not a turn-key operation, and travel demand forecasts cannot be estimated without the application of engineering judgment. The "raw" model output is not reliable enough to be used directly for highway design, operational analysis, or alternative or economic evaluations. Oftentimes, these volumes need to undergo some type of post-processing in order for them to be useful for project planning needs. Post-processing refers to any activity that follows the execution of the travel demand forecast model run. It can be viewed as the fifth step in the traditional sequential four-step modeling process. Currently, the only guide for post-processing travel demand model forecasts is the technical report National Cooperative Highway Research Program (NCHRP) Report 255, *Highway Traffic Data for Urbanized Area Project Planning and Design* (Pedersen and Samdahl 1982). This report was published in 1982 and remains the only nationally recognized technical resource for post-processing.

The use of principles and procedures outlined in NCHRP Report 255 produced a forecast of intersection turning movements based on model link volume estimates. These volumes were used to evaluate future (2035) roadway operations. Recommended transportation mitigations were developed for each type of impact related to the future analysis. Where necessary, recommended mitigation took into account the feasibility of potential improvements such as widening for additional capacity, adding through- and turn-lanes, traffic signal coordination and optimization, and grade separation.

The analysis and evaluation of US 36 interchanges focused first on maintaining acceptable operations at the ramp intersections under the existing geometric configuration. Operations were measured using the LOS concept as defined by CDOT, Transportation Research Board Special Report 209, *The Highway Capacity Manual* (2000 edition). For intersections, LOS grades from

A (best) to F (worst) are assigned based on the average delay per vehicle experienced in the worst 15 minutes of the peak hour.

The study interchanges were evaluated using signal-timing software to determine the LOS characteristics of the study interchanges/intersections. The software used was Trafficware Corporation's Synchro™, Version 7.0. This micro-simulation software package uses turning volume data and signal timing parameters to optimize the capacity of signalized intersections. Synchro™ generates delay calculations for different signal phasing and signal offset schemes and selects the one with the least overall network delay. The selected signal phasing and offset scheme is then viewed dynamically in its companion program, SimTraffic™. SimTraffic™ graphically represents the traffic network and signal-timing scheme by displaying individual vehicles and their movements to help the user identify trouble spots in the network. The trouble spots could be the result of inadequate green time, poor progression, or insufficient turn-lane storage length.

Signal timing and offset optimization were based on providing a coordinated signal system with a cycle length between 90 and 120 seconds. Given that this is a planning-level project, the following global assumptions were made regarding signal operations:

Total Lost Time: 4 seconds

Clearance Time: 5 seconds (4 yellow, 1 all-red)

Signal Operation Mode: Actuated/coordinated

Ideal Saturation Flow Rate: 1,900 vehicles/lane/hour of green

Dual (or Triple) Left-Turns: Require protected-only phasing

The signal timings included pedestrian movements where the "walk" time was equal to 5 seconds and the "flash-don't-walk" time was equal to 11 seconds. Time for the pedestrian movements was allocated during the corresponding vehicular-through movement. Additionally, because this is a future evaluation, specific traffic parameters were set to a project-wide standard, with a PHF of 0.92 and heavy-vehicle percentage of 2 percent. All cycle lengths, offsets, and timings were optimized for all future year scenarios. Both a.m. and p.m. peak-hour operations were considered.

2.5 VISSIM ANALYSIS

A VISSIM model was developed to analyze the ingress and egress points to the managed lane along eastbound US 36 during the a.m. and p.m. peak hours. Four locations were identified for analysis within the US 36 corridor. These locations are forecast to have a volume of more than 400 vehicles per hour exiting the managed lane and entering the general-purpose lanes, eventually exiting US 36 at the next downstream interchange. The four locations that were analyzed were:

1. Eastbound a.m. between Sheridan Boulevard and Federal Boulevard
2. Eastbound a.m. between Federal Boulevard and Pecos Street
3. Eastbound p.m. between McCaslin Boulevard and Interlocken
4. Eastbound p.m. between Church Ranch Boulevard and Sheridan Boulevard

The identified locations were analyzed based on speed criteria established for different segments of US 36.

The VISSIM input files at modeled locations reflected the proposed base access condition with a single buffer-separated managed lane with 1 entry and 1 exit between each interchange, as well as auxiliary lanes where they are proposed.

2.5.1 Roadway Network Assumptions

Several assumptions were applied to the VISSIM model in order to develop a conservative estimate of corridor operations along US 36. One continuous roadway network was modeled from Foothills Parkway in Boulder to the I-25 ramps in Denver. This allowed the model to take into account all vehicle interactions throughout the corridor. The simulation network was based on a previous network developed a CDOT Ramp Metering Project (2006) that was calibrated to existing field conditions as the basis for future roadway operations.

In addition, all simulated ramp meters along the corridor were disabled during model simulation runs. This allowed the maximum amount of traffic to access the US 36 corridor during the analysis, creating a "worst case" scenario. It was assumed that ramp metering would improve operating conditions in comparison to the reported results.

The desired speed assumptions for drivers in the corridor were also modified from previous analysis efforts. A desired speed range of 55 to 70 mph was assumed. The 85th percentile speed was assumed to be 65 mph.

Since the forecast volumes at several of the ramps were greater than the expected capacity for those locations, the hourly throughput at the I-25 interchange was not able to reach the forecast hourly volumes. Since mainline operations were being analyzed, it was important for the simulation model to be as close to the forecast throughput volumes as possible. This meant that operations at ramp junctions could be diminished in order to better reflect mainline operations. To do this, input volumes at each entrance ramp were increased until the model reached 90 to 100 percent of the forecast throughput. For the a.m. peak hour, input volumes were increased 1.3 times the forecast volume. Input volumes were increased 1.2 times the forecast in the p.m. peak hour.

2.5.2 Analysis Criteria

The VISSIM output was compared to average speed criteria that was developed for different segments of the US 36 corridor. Traffic operations were considered adequate if the minimum average speeds in the analysis locations were above the speeds identified for the three different types of roadway segment. The speed thresholds identified are listed below.

- **Managed lanes**: 55 mph
- **General-purpose lanes**: 45 mph
- **Weaving sections:** 35 mph

The speed thresholds were selected to take into account the amount of vehicle interaction that takes place in each defined segment. The identified analysis locations incorporate all three types of segments between freeway interchanges.

The freeway system analysis focused on the operations along US 36, including basic freeway, weaving, and merge/diverge sections. All segments from the Broadway interchange to the Table Mesa Drive interchange were analyzed for both eastbound and westbound directions.

The operations in the existing condition (2003) on US 36 showed that several sections of the highway are congested. Increasing levels of traffic congestion will continue to result in longer travel times for both automobile drivers and transit patrons, since buses are mixed with general traffic in most of the corridor. In 2001, a.m. peak period travel time from downtown Boulder to downtown Denver was approximately 59 minutes and from Denver to Boulder the travel time was approximately 52 minutes.

The corridor roadway transportation system consists primarily of US 36. The adjacent arterial system does not significantly support longer-distance travel along the corridor primarily because US 36 is oriented generally along a diagonal from the northwest/southeast, while the arterial grid consists almost entirely of north-south and east-west roadway facilities.

The arterial system in the corridor is generally not effective as an "overflow" or "relief" option for the following three reasons:

- US 36 provides a more direct route for travel in the corridor compared to using the surrounding arterial grid. As a result, the highway carries a larger proportion of shorter, local trips than it might if more parallel arterial routes were available.
- The arterial system tends to become congested at the same times as US 36.
- The arterial network is generally not continuous throughout the study area. With a few exceptions, many of the arterial streets in the US 36 vicinity "dead-end" or have drastically reduced capacity at some point in the corridor, which requires travelers seeking an alternative route to US 36 to use the arterial system in a "stair-step" fashion.

At the corridor level, transit improvements alone do not appear to have a substantial effect on traffic volumes. However, managed lane and general-purpose lane capacity enhancements on US 36 could result in reduced traffic volumes on some routes that could be considered alternatives to US 36.

3.1 MAINLINE GEOMETRY

Table 3.1-1, US 36 Number of Lanes, indicates the number of US 36 lanes and distances between interchanges in the study corridor.

Table 3.1-1: US 36 Number of Lanes

US 36 Segment		Approx. Distance (ft)	Existing		Package 1 (No Action)		Combined Alternative Package (Preferred Alternative)	
			GP + AUX	HOV	GP + AUX	HOV	GP + AUX	Managed
Eastbound	Foothills Parkway to McCaslin Boulevard	18,400	2+0	-	2+0	-	2+0	1
	McCaslin Boulevard to West Flatiron Circle	8,800	2+0	-	2+0	-	2+1	1
	East Flatiron Circle to Broomfield	6,000	2+1	-	2+1	-	2+1	1
	Broomfield to Church Ranch Boulevard	9,600	2+0	-	2+0	-	2+1	1
	Church Ranch Boulevard to Sheridan Boulevard	7,900	2+0	-	2+0	-	2+1	1
	Sheridan Boulevard to Federal Boulevard	10,000	2+0	-1	2+0	1	3+0	1
	Federal Boulevard to Pecos Street	3,200	2+1	1	2+1	1	3+1	1
	Pecos Street to Broadway	4,200	3+0	Rev	3+0	Rev	4+1	Rev
Westbound	Broadway to Pecos Street	4,200	4+0	Rev	4+0	Rev	4+0	Rev
	Pecos Street to Federal Boulevard	3,200	3+1	1	3+1	1	3+1	1
	Federal Boulevard to Sheridan Boulevard	10,000	3+0	-	3+0	-	3+0	1
	Sheridan Boulevard to Church Ranch Boulevard	7,900	2+0	-	2+0	-	2+1	1
	Church Ranch Boulevard to Broomfield	9,600	2+0	-	2+0	-	2+1	1
	Broomfield to East Flatiron Circle	6,000	2+1	-	2+1	-	2+1	1
	West Flatiron Circle to McCaslin Boulevard	8,800	2+0	-	2+0	-	2+1	1
	McCaslin Boulevard to Foothills Parkway	18,400	2+0	-	2+0	-	2+1*	1

Source: US 36 Mobility Partnership, 2009.

Notes:

- = not applicable
+ = plus
* = auxiliary lane for bus traffic only
approx. = approximate
ft = feet
GP + AUX = general-purpose plus auxiliary lanes
HOV = high-occupancy vehicle
Rev = reversible, peak-direction only

3.2 MANAGED LANE ANALYSIS

The need for additional capacity on US 36 was identified using previous analysis conducted for the Draft EIS, and in previous studies. In particular, the travel patterns observed in existing data and reflected in future forecasts of travel demand have indicated that while many travelers in the corridor (especially commuters) have at least one trip end outside the study corridor, there is a strong general-purpose travel demand for intra-corridor trips—those that do not travel the entire length of the study corridor, but start and end within the corridor. This travel pattern stems from the fact that US 36 is the most direct route between Denver and Boulder, and is a diagonally-

oriented highway in a discontinuous grid network. The shorter-trip nature of US 36 travel has the following implications for identifying the best improvement strategy for US 36:

1. Preferential lanes for transit and HOV should extend the entire length of the corridor.
2. The high proportion of trips using interchanges (entering and exiting US 36) as a proportion of total activity generally indicates that interchange and access improvements are more important than full-corridor, line-haul capacity.
3. The diagonal nature of US 36 leads to a higher number of interchange-to-interchange trips than would exist if there were competitive parallel arterials available.

As a result of these findings, and through considerable discussion among the project team, federal agencies, and the local cities and counties along the corridor, a "combination" approach was used to take the best elements of the Draft Environmental Impact Statement (DEIS) build alternatives in crafting the Combined Alternative Package (Preferred Alternative).

The primary feature of the Combined Alternative Package (Preferred Alternative) is the extension of the HOV facilities on US 36 to Boulder from I-25 and their conversion to managed lanes, allowing excess capacity not used by buses and HOVs to be used by toll-paying SOVs. Managed lanes were presumed to have an artificial capacity, enforced through-lane management, of 1,500 vehicles per hour. This capacity has been established by the Colorado Tolling Enterprise, CDOT, and RTD as a reasonable value to approximate the boundary between LOS C and LOS D. This approach is consistent with the agreement in place for the I-25 express lanes, which opened in 2006.

3.2.1 Type of Separation from General-Purpose Lanes

The method of separating the managed lanes from the general-purpose lanes was considered carefully through the DEIS process and in crafting the Combined Alternative Package (Preferred Alternative). The following three types of separation were considered:

- **Barrier separation** is the construction of a physical jersey barrier between the bus rapid transit (BRT)/HOV lane and the same-direction, general-purpose lanes that would allow access only at openings in the barrier that are specifically signed and striped for that purpose. Such openings are called slip-ramps for the purposes of the US 36 EIS project.
- **Buffer separation** is a 4-foot-wide striped pavement separator between the BRT/HOV lane and the same-direction, general-purpose lanes that would allow access only when the buffer is broken by changing striping and signing. In some buffer applications, flexible delineators are used to prevent unauthorized access to and from the lane. It should be noted that these delineators are not preferred by CDOT due to maintenance concerns, and problems during snow removal.
- **Continuous access** is a single white stripe separating the BRT/HOV lane and the same-direction, general-purpose lanes that would allow access at any point.

Buffer separation is currently used for the US 36 HOV lanes between Federal Boulevard and Pecos Street. Continuous access separation in place along the eastbound US 36 HOV/bus lane between Sheridan Boulevard and Federal Boulevard, as well as for the HOV lanes on South Santa Fe Drive (US 85). Although these existing conditions were not considered in the decision

to select buffer separation for the Combined Alternative Package (Preferred Alternative), they provide an important point of reference for existing buffer applications.

These three configurations were evaluated qualitatively and comparatively with respect to safety, width/cost impact, capacity, and ease of access. The results of this evaluation are shown in Table 3.2-1, Assessment of Bus Rapid Transit/High-Occupancy Vehicle Lane Separation Options.

Table 3.2-1: Assessment of Bus Rapid Transit/High-Occupancy Vehicle Lane Separation Options

Criteria	Barrier Separation	Buffer Separation	Continuous Access
Safety	Best	Fair	Worst
Width/Cost Impact	Worst	Better	Best
Capacity	Best	Good	Fair
Ease of Access	Worst	Better	Best

Source: URS, 2006.

The decision to select buffer separation for the Combined Alternative Package (Preferred Alternative) was based on its generally good performance and lack of "worst" performance in any of the four categories listed. At the time of this evaluation, CDOT staff identified that the current operational policy for buffer-separated lanes stipulates that vehicles cannot cross a 4-foot-wide striped buffer. Access to buffer-separated lanes is only legal where the buffer is broken, and traditional lane separation striping (a single, white 4-inch or 8-inch stripe) is provided. Managed lane access is discussed in the following section.

3.2.2 Managed Lane Access

After buffer separation was chosen for the BRT/HOV lanes in the Combined Alternative Package (Preferred Alternative), there was no formal analytical process to determine access locations. Instead, the project team assumed that there would be a buffer break between each pair of existing service interchanges in the corridor west of Pecos Street (the Interlocken/FlatIron Crossing interchanges are counted as one interchange for the purpose of identifying BRT/HOV lane access locations). This assumption was based on the strong demand for "intra-corridor" trips identified earlier in this section. The existing access over the Pecos Street interchange would be preserved and would retain its current 1-lane reversible operation with barrier separation east of Pecos Street.

In contrast to the DEIS configuration of buffer-separated managed lane access, the Combined Alternative Package (Preferred Alternative) was configured assuming that breaks in the buffer for managed lane ingress and egress would be separated from each other—that each break is either only for ingress or only for egress. This type of access configuration would aid in reducing the weaving and merging conflicts of vehicles entering and exiting the managed lane. In addition, this configuration would maximize the distance between ramp terminals and managed lane access points.

After the initial decision to locate the Combined Alternative Package (Preferred Alternative) managed lane access points between every pair of interchanges west of Pecos Street, the access plan was reviewed carefully with respect to viability in terms of freeway weaving activities. In the summer of 2008, a VISSIM microsimulation analysis was conducted for the Combined

Alternative Package (Preferred Alternative) using data from the 2035 Combined Alternative Package (Preferred Alternative) travel demand model. This analysis showed conclusively that even without ramp metering, the placement of managed lane access points would not compromise operations, and traffic on the highway should move reasonably well, without stopping or queuing.

3.2.3 VISSIM Analysis Results

Each analysis network was simulated for 1.5 hours, recording the data from the last hour of the simulation. Ten separate simulation runs were performed for each time period. The data was then summarized for each analysis segment for each run. The results from the ten individual runs were then averaged for comparison with the defined analysis criteria.

For each location in the eastbound direction identified for analysis, five roadway segments were analyzed for both the managed lane and the general-purpose lanes. West of each exit location from the managed lane, a buffer separates the lane from the general-purpose lanes. The managed lane has a minimum average speed threshold of 55 mph in this location. The general-purpose lanes have a threshold of 45 mph. These thresholds also apply between the managed lane exit and the managed lane entrance, as well as the segment east of the managed lane entrance. Since weaving maneuvers occur in the managed lane exit segment and the managed lane entrance segment, the minimum average speed threshold is 35 mph.

A summary of average speeds for each identified analysis location is provided in Table 3.2-2, Average Speeds within Each Analysis Location.

Table 3.2-2: Average Speeds within Each Analysis Location

Analysis Location	West of Managed Lane Exit (mph)	Managed Lane Exit Weave (mph)	Between Managed Lane Exit and Entrance (mph)	Managed Lane Entrance Weave (mph)	East of Managed Lane Entrance (mph)
A.M. Peak Hour					
Sheridan Boulevard to Federal Boulevard					
Managed lane	58.3	58.1	57.7	58.1	57.5
General-purpose lanes	58.0	58.1	58.0	58.1	58.1
Federal Boulevard to Pecos Street					
Managed lane	57.2	55.8	58.4	58.2	57.6
General-purpose lanes	58.5	55.8	57.0	58.2	58.1
P.M. Peak Hour					
McCaslin Boulevard to Interlocken					
Managed lane	56.9	58.8	58.9	58.7	57.6
General-purpose lanes	59.1	58.8	58.8	57.6	58.3
Church Ranch Boulevard to Sheridan Boulevard					
Managed lane	56.8	58.2	59.0	56.2	57.6
General-purpose lanes	58.5	58.2	58.2	56.2	57.5

Source: US 36 Mobility Partnership, 2009.

Notes:

a.m. = morning

mph = miles per hour

p.m. = evening

The output from the VISSIM analysis runs shows that speeds at each analysis location are forecast to exceed the minimum thresholds identified. Average speeds range from 55 to 60 mph within the analysis locations. The output indicates that the proposed configuration of lanes and managed lane access points along US 36 should operate at acceptable standards under 2035 peak-hour conditions.

It should be noted that in many locations the average speed for the managed lane is less than the average speed for the general-purpose lanes. Since the managed lane is a single lane, it is not possible for vehicles to maneuver around slower moving vehicles. This creates a circumstance where a few slow moving vehicles can disproportionately decrease the average speed over that segment. In contrast, since there are multiple general-purpose lanes, vehicles can maneuver around slower moving vehicles, allowing the average speed in those sections to remain higher. Nevertheless, each analyzed section was able to attain the appropriate average speed threshold.

With the addition of auxiliary lanes between interchanges and the managed lane, simulation indicates that eastbound US 36 should operate at acceptable levels in 2035. No additional mitigation measures are required to maintain acceptable operating conditions within the corridor.

3.3 MAINLINE VOLUMES

Existing traffic volume data for the mainline (through-lanes on the highway) were collected from CDOT's permanent count stations in the corridor. Data for interchange ramps were collected from field counts taken during the first two full weeks of November 2003. Field counts included 72-hour tube counts of all ramps as well as peak-period intersection turning movement counts at ramp junctions and nearby major intersections. The existing US 36 highway traffic volumes are presented in Table 3.3-1, Existing (2003) US 36 Traffic Volumes.

Existing hourly traffic count data were gathered from CDOT from two permanent count stations on US 36: one between the McCaslin Boulevard and West Flatiron Circle interchanges (called the "Coal Creek" count station for this project) and one between the Broomfield and Church Ranch Boulevard interchanges (the "112th Avenue" count station). The count data from these permanent stations were made available to the project team for every hour between January 1, 2003 and September 30, 2003.

Because future daily traffic forecasts are intended to represent typical weekday traffic, the factors desired were developed using all available non-holiday weekday data in the set. Days with missing data or counts less than half the average for that day of the week were not used for determining average volumes or developing daily and directional factors. It is assumed that either construction or incident activity disrupted "normal" operations for all or part of those days. For the purpose of balancing daily volumes, the counts from the 112th Avenue count station were used as a control total because there are more valid days of data in the set than at the Coal Creek station.

A review of the 2003 count data showed that the peak one-hour volume was observed in either the 4:00 p.m. to 5:00 p.m. hour or the 5:00 p.m. to 6:00 p.m. hour. When averaged (sum of all peak-hour volumes divided by the sum of all daily volumes), the share of daily volume observed in the design hour was 8.5 percent at Coal Creek and 7.8 percent at 112th Avenue. These percentages are expressed as "K" factors of 0.085 and 0.078, respectively.

Table 3.3-1: Existing (2003) US 36 Traffic Volumes

	US 36 Segment	Lane Type	Daily	A.M. Peak Hour	P.M. Peak Hour
Eastbound	Foothills Parkway to McCaslin Boulevard	General	40,290	2,280	3,750
		Total	40,290	2,280	3,750
	McCaslin Boulevard to West Flatiron Circle	General	39,660	2,440	3,570
		Total	39,660	2,440	3,570
	East Flatiron Circle to Broomfield	General	44,860	2,380	4,100
		Total	44,860	2,380	4,100
	Broomfield to Church Ranch Boulevard	General	43,790	2,510	3,840
		Total	43,790	2,510	3,840
	Church Ranch Boulevard to Sheridan Boulevard	General	44,870	2,830	3,720
		Total	44,870	2,830	3,720
	Sheridan Boulevard to Federal Boulevard	General	53,880	3,560	4,090
		HOV	2,000[1]	400[1]	100[1]
		Total	55,880	3,960	4,190
	Federal Boulevard to Pecos Street	General	60,890	4,160	4,380
		HOV	2,500[1]	700[1]	100[1]
		Total	63,390	4,860	4,480
	Pecos Street to Broadway	General	64,960	4,480	4,500
		HOV	1,000[1]	500	-
		Total	65,960	4,980	4,500
Westbound	Broadway to Pecos Street	General	70,150	4,220	6,740
		HOV	1,000[1]	-	300[1]
		Total	71,150	4,220	7,040
	Pecos Street to Federal Boulevard	General	66,480	4,110	6,320
		HOV	2,000[1]	-	500[1]
		Total	68,480	4,110	6,820
	Federal Boulevard to Sheridan Boulevard	General	56,580	3,780	5,030
		Total	56,580	3,780	5,030
	Sheridan Boulevard to Church Ranch Boulevard	General	45,860	3,490	3,550
		Total	45,860	3,490	3,550
	Church Ranch Boulevard to Broomfield	General	44,750	3,680	3,020
		Total	44,750	3,680	3,020
	Broomfield to East Flatiron Circle	General	46,860	3,990	3,180
		Total	46,860	3,990	3,180
	West Flatiron Circle to McCaslin Boulevard	General	41,390	3,060	3,320
		Total	41,390	3,060	3,320
	McCaslin Boulevard to Foothills Parkway	General	41,000	3,360	3,100
		Total	41,000	3,360	3,100

Source: URS, 2003.

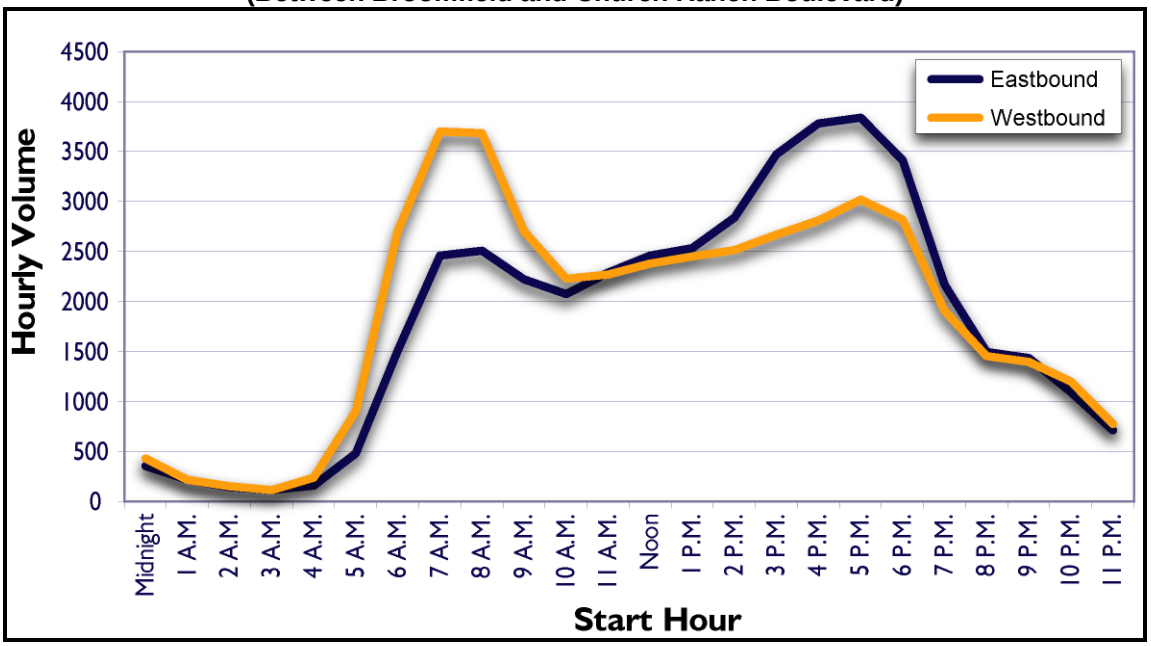
Notes:

[1]Existing daily HOV lane volumes not collected — values shown are estimates.

- = not applicable
a.m. = morning
HOV = high-occupancy vehicle
p.m. = evening

The peak-hour orientation of corridor traffic is such that a.m. traffic is primarily westbound at the west end of the corridor and eastbound at the east end of the corridor. In general, peak-hour volumes in the eastbound and westbound directions tend to be closest to equal near the Sheridan Boulevard interchange. The 2003 daily distribution of weekday hourly traffic by direction of travel is shown in Figure 3.3-1, Existing Weekday Hourly Distribution of US 36 Traffic at 112th Avenue.

Figure 3.3-1: Existing Weekday Hourly Distribution of US 36 Traffic at 112th Avenue (Between Broomfield and Church Ranch Boulevard)

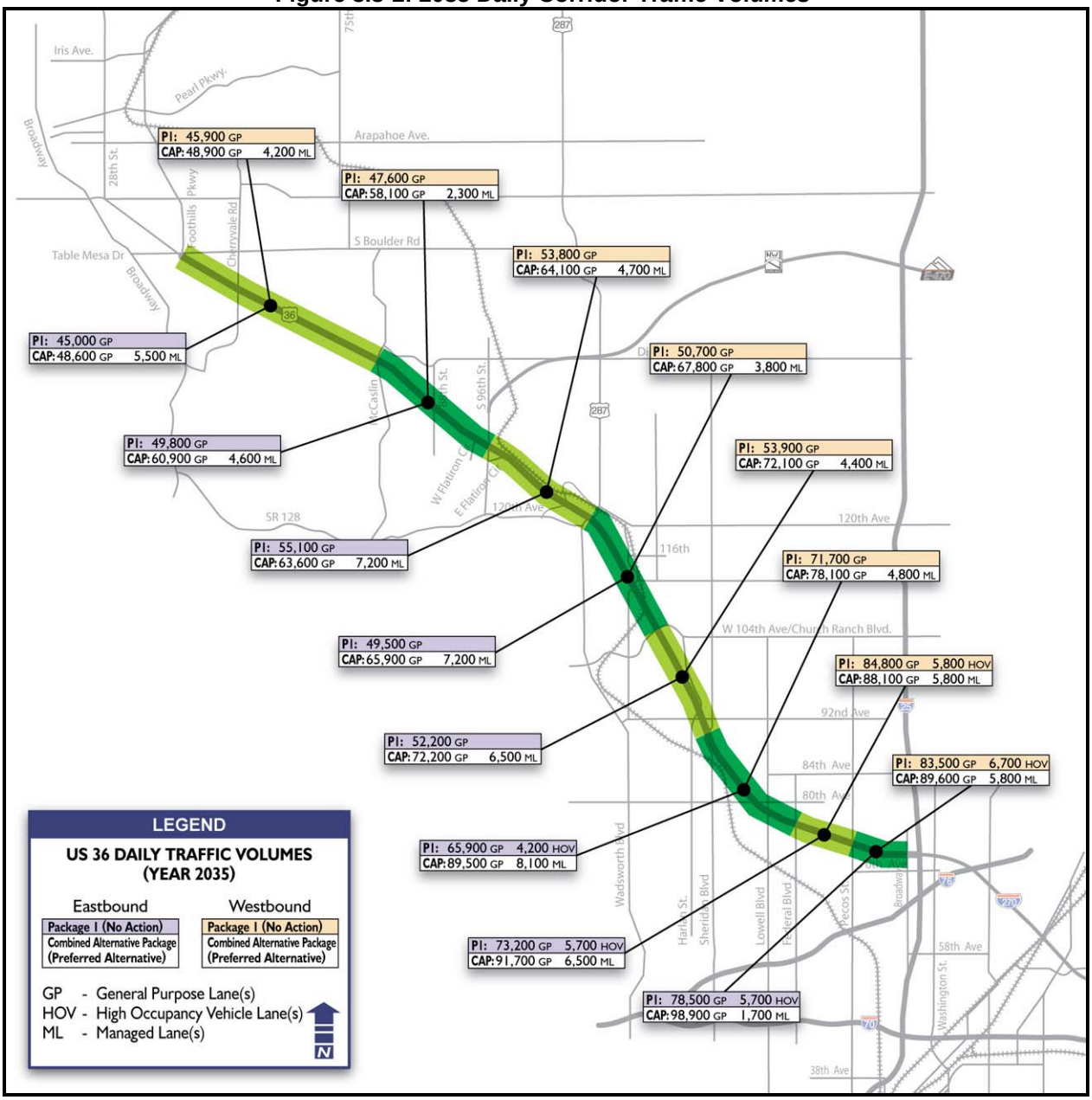


Source: CDOT, 2003.

Directional distribution of peak-hour traffic was measured using the peak-hour average volume (see Figure 3.3-1, Existing Weekday Hourly Distribution of US 36 Traffic at 112th Avenue), and was found to be 0.53 at the Coal Creek count station and 0.56 at the 112th Avenue count station. Therefore, 53 percent of the design-hour traffic at Coal Creek and 56 percent of the design-hour traffic at 112th Avenue were observed in the peak direction.

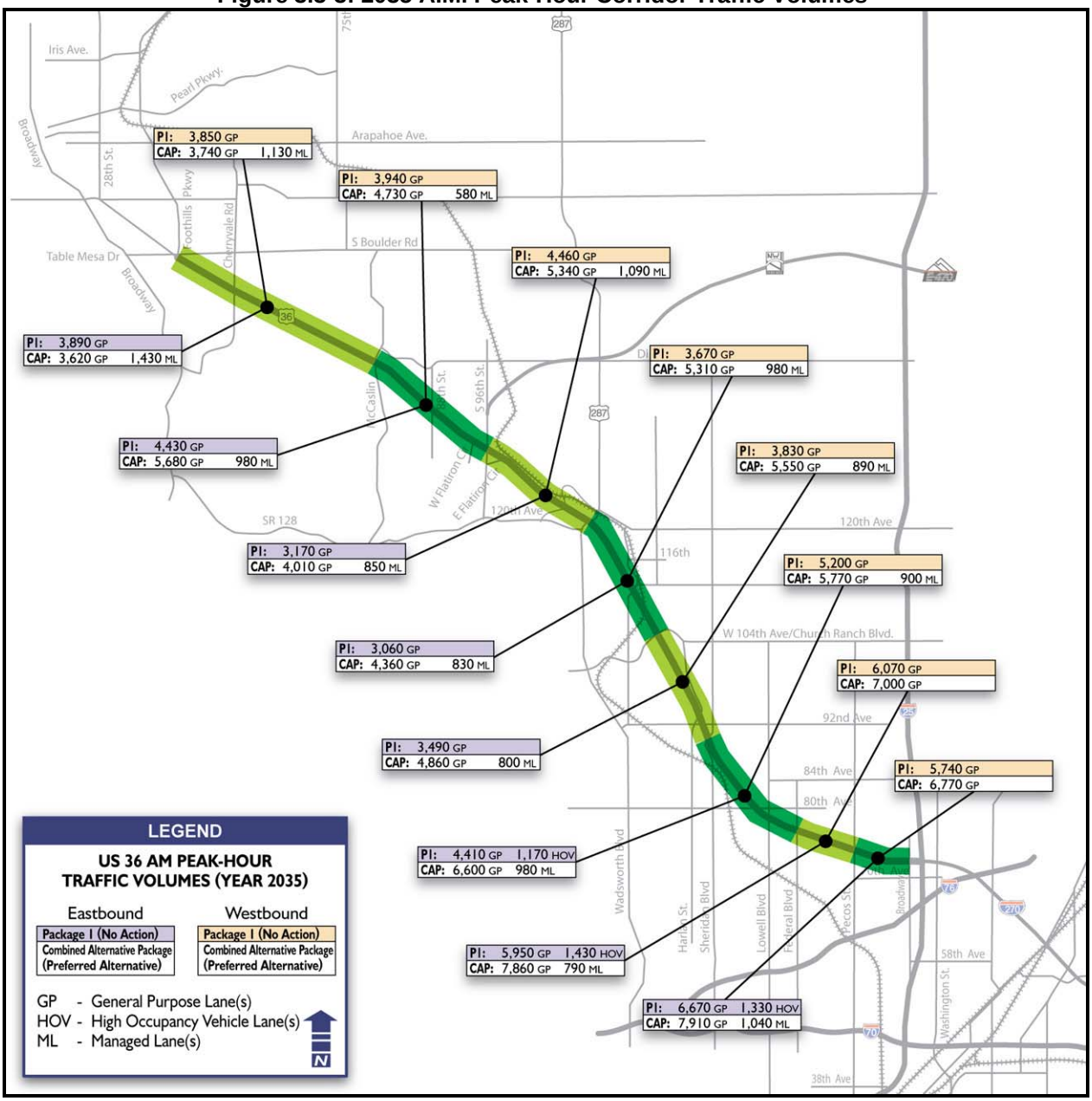
Forecasted 2035 volumes for daily, a.m. peak hour, and p.m. peak hour conditions are shown in Figures 3.3-2 through 3.3-4, respectively.

Figure 3.3-2: 2035 Daily Corridor Traffic Volumes



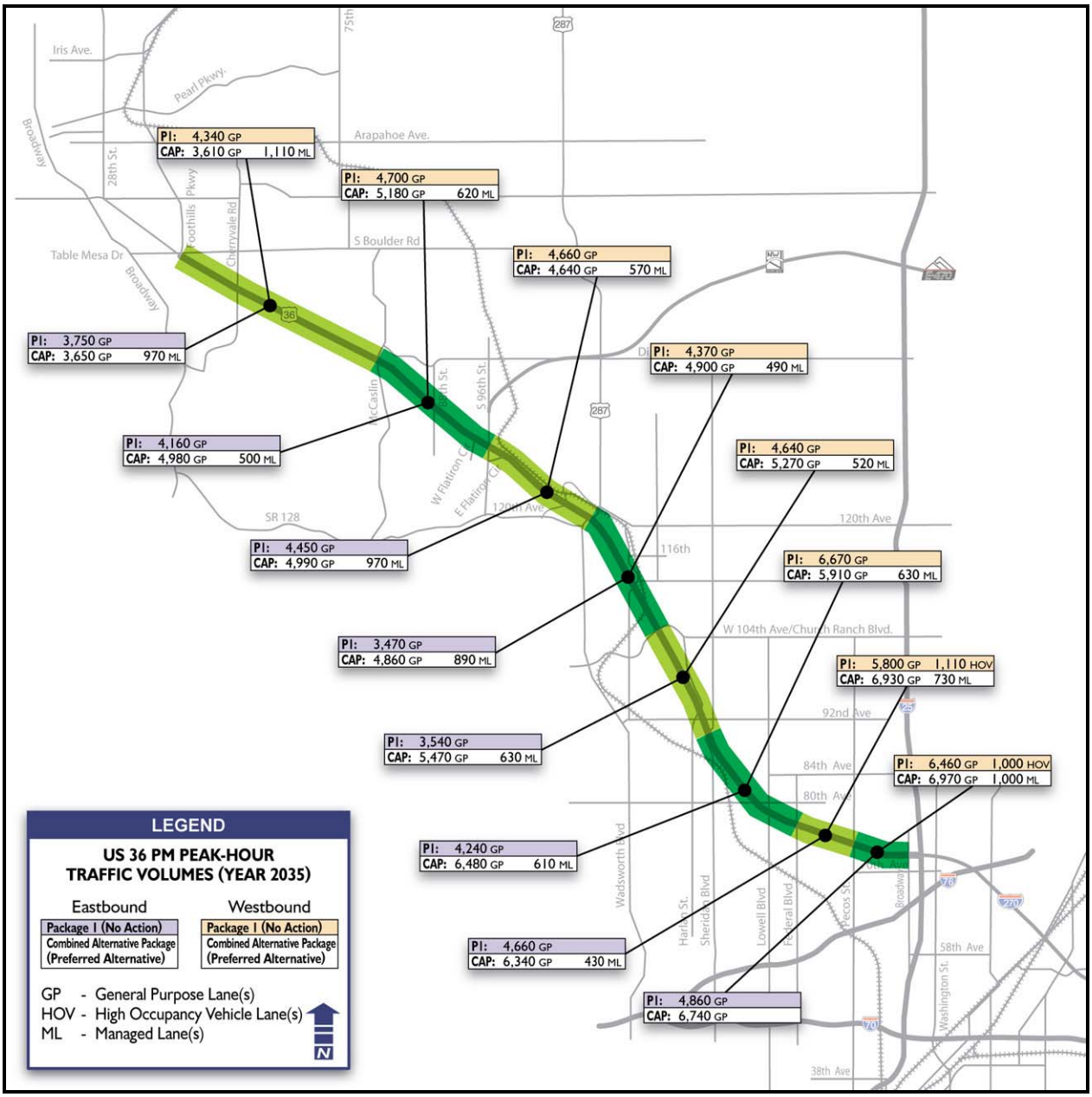
Source: US 36 Mobility Partnership, 2009.

Figure 3.3-3: 2035 A.M. Peak-Hour Corridor Traffic Volumes



Source: US 36 Mobility Partnership, 2009.

Figure 3.3-4: P.M. Peak-Hour Corridor Traffic Volumes



Source: US 36 Mobility Partnership, 2009.

3.4 MAINLINE LEVEL OF SERVICE

The quality of highway traffic flow is measured by the LOS in the a.m. peak hour and p.m. peak hour. The CDOT standard for peak-hour urban highway operations in general-purpose lanes is LOS D, meaning that any segment at LOS E or F should be considered deficient.

The LOS in special (HOV and toll) lanes is measured the same way, but there is currently no explicit standard. However, it is generally recognized that special lanes should be managed so traffic flows freely. LOS C can be considered a reasonable maximum LOS for special lanes for free flow speed. Table 3.4-1, US 36 Mainline Segments Level of Service, reports LOS separately for general-purpose and special lanes.

The LOS results for the general-purpose lanes show that traffic conditions in the p.m. peak hour are generally worse than in the a.m. peak hour. The LOS results for the special lanes show that all directional peak-hour segments analyzed would operate at LOS C or better in both packages, with the exception of the eastbound direction in the a.m. peak hour from Foothills Parkway to McCaslin Boulevard.

Conditions are expected to worsen considerably over the 32 years between 2003 and 2035 if no additional improvements are made. There are a total of 32 "peak-hour segments" analyzed for this study (eight physical segments, multiplied by directions, and multiplied by peak hours). The Combined Alternative Package (Preferred Alternative) would reduce the number of peak-hour segments operating at LOS E or LOS F to eight, from the Package 1 number of 18; and would reduce the number of peak-hour segments expected to fail (LOS F) to two, from 14 in Package 1.

Since LOS analysis does not account for ramp metering, it is possible that in practice, peak-hour metering could result in slightly better conditions than shown in this analysis. For example, if demand for the on-ramp movement has been forecast by the model to be 2,200 vehicles in 1 hour (more than the capacity of a single freeway lane), but metering has a maximum capacity of 1,800 vehicles per hour, a freeway segment might not reach LOS E or LOS F. However, according to standard ramp metering policy, the metering strategy would likely be prohibited from having traffic back up on an arterial street.

The performance of US 36 with the Combined Alternative Package (Preferred Alternative) is expected to be monitored and maintained by an array of Intelligent Transportation Systems (ITS) elements such as cameras, detectors, and signing. The preliminary implementation plan for the managed lane and its ITS elements is included in this report as Appendix B, ITS Implementation Plan.

Documentation of a supplemental analysis conducted to identify the proposed configuration of US 36 between McCaslin Boulevard and Foothills Parkway is presented in Appendix C, West End Design Options, of this report.

Table 3.4-1: US 36 Mainline Segments Level of Service

Segment/Direction	General-Purpose Lanes						Special Lanes					
	a.m. Peak Hour			p.m. Peak Hour			a.m. Peak Hour			p.m. Peak Hour		
	2003	2035 Pkg. 1 (No Action)	2035 Combined Alternative Package (Preferred Alternative)	2003	2035 Pkg. 1 (No Action)	2035 Combined Alternative Package (Preferred Alternative)	2003	2035 Pkg. 1 (No Action)	2035 Combined Alternative Package (Preferred Alternative)	2003	2035 Pkg. 1 (No Action)	2035 Combined Alternative Package (Preferred Alternative)
Eastbound Direction												
Foothills Parkway to McCaslin Boulevard	C	F	E	F	F	E	-	-	D	-	-	B
McCaslin Boulevard to West Flatiron Circle	C	F	D	E	F	D	-	-	C	-	-	B
East Flatiron Circle to Broomfield	B	B	C	C	D	D	-	-	B	-	-	B
Broomfield to Church Ranch Boulevard	C	D	C	D	D	D	-	-	B	-	-	B
Church Ranch Boulevard to Sheridan Boulevard	D	D	D	E	E	D	-	-	B	-	-	B
Sheridan Boulevard to Federal Boulevard	D	F	F	F	F	F	-	-	B	-	-	B
Federal Boulevard to Pecos Street	C	F	E	D	D	D	-	B	B	-	-	B
Pecos Street to Broadway	D	F	D	D	D	C	-	C	B	-	-	-
Westbound Direction												
Broadway to Pecos Street	B	C	D	D	D	D	-	-	-	-	B	B
Pecos Street to Federal Boulevard	B	D	D	D	D	D	-	-	A	-	B	B
Federal Boulevard to Sheridan Boulevard	C	D	E	D	F	E	-	-	B	-	A	B
Sheridan Boulevard to Church Ranch Boulevard	D	E	E	D	F	D	-	-	B	-	-	A
Church Ranch Boulevard to Broomfield	E	E	D	D	F	D	-	-	C	-	-	B
Broomfield to East Flatiron Circle	C	D	D	C	D	D	-	-	B	-	-	A
West Flatiron Circle to McCaslin Boulevard	D	E	C	D	F	D	-	-	B	-	-	B
McCaslin Boulevard to Foothills Parkway	D	F	C	D	F	C	-	-	B	-	-	B
Total Number of Segments at LOS E/LOS F	1	9	5	4	9	3						
Total Number of Segments at LSO F	0	6	1	2	8	1						

Source: US 36 Mobility Partnership, 2009.
Notes:
LOS are color-coded to facilitate comparison between alternatives.
green shading = LOS D (The Colorado Department of Transportation standard for peak-hour urban highway operations in general-purpose lanes is LOS D.)
yellow shading = LOS E
red shading = LOS F
- = not applicable
pkg. = package
a.m. = morning
p.m. = evening
LOS = level of service

One purpose of the US 36 project is to upgrade outdated highway facilities. Many interchanges throughout the corridor are still in their originally built configuration. Upgrading is needed to meet demands of future travel for almost all interchanges in the corridor. This section discusses the proposed interchange configurations, the analyses of interchange and intersection impacts, and mitigation associated with Package 1 and build packages.

Serving as the primary access points for US 36, the local interchanges and major adjacent intersections are key elements of the project. Adequate operation at these intersections is important to the corridor for two reasons. First, off-ramps that do not operate well due to poor signal operations risk developing queues that extend back on to the highway, which could result in safety concerns as well as compromise highway operations. Second, on-ramps that do not operate well due to inadequate merge capacity could limit the utility of the highway by preventing traffic from accessing the highway efficiently.

Future traffic volumes were calculated for each of the alternatives at existing and proposed interchange locations using the results of the *2035 DRCOG Regional Travel Demand Model* (DRCOG 2008). The highway and ramp volumes were adjusted using a post-processing adjustment process documented in the technical memorandum, *US 36 Modeling Methodology Report* (URS 2009a). These volumes were used to evaluate 2035 roadway operations.

The following sections describe the interchanges in the project area, any changes to the configurations proposed under each of the alternatives, the operational impacts of the proposed alternatives, and, where appropriate, proposed mitigations to those impacts. The interchanges in the project area are shown in Figure 4.1-1, US 36 Interchange Locations.

4.1 INTERSTATE 25/BROADWAY INTERCHANGE COMPLEX

Description and Context — The only US 36 system interchange (an interchange providing direct access from one regional highway to another) in the project area is the I-25 interchange at the eastern end of the corridor. The Combined Alternative Package (Preferred Alternative) includes ramp modifications at the interchange complex. The existing southbound I-25 to westbound US 36 ramp would be realigned to improve its design speed and to connect to US 36 directly instead of terminating at a signal at Broadway, as it does today. The realignment of the southbound off-ramp from I-25 to westbound US 36 would eliminate the ability to provide access from both westbound I-270 and southbound I-25 to Broadway. As a result, both access ramps from southbound I-25 and westbound US 36 to Broadway were removed in this analysis. A separate study will be conducted to determine what access can be provided to Broadway in conjunction with the directional connection between southbound I-25 and westbound US 36. The other connections and lane arrangements within the interchange complex would generally remain as configured under existing conditions.

The Broadway interchange configuration is a half diamond with arterial left-turn lanes provided between and outside the ramps, as shown in Figure 4.1-2, Broadway Interchange Combined Alternative Package (Preferred Alternative) Configuration. Broadway is generally the dividing line of land use in the area, with single-family housing to the west and industrial and commercial/retail to the east. The southwest quadrant of the interchange contains land that is currently vacant. To the north, Broadway splits with Greenwood Boulevard to serve residential land use.

Figure 4.1-1: US 36 Interchange Locations

Figure 4.1-2: Broadway Interchange Combined Alternative Package (Preferred Alternative) Configuration

Source: US 36 Mobility Partnership, 2009.

The express lanes reversible "direct-connect" ramp between I-25 and US 36 is proposed to be rebuilt in a new location so that its design speed can be increased. This realignment does not represent a substantial operational change in the express lanes.

Proposed Configuration — Under the Combined Alternative Package (Preferred Alternative), the existing southbound I-25 to westbound US 36 ramp would be realigned to improve its design speed and to connect to US 36 directly instead of terminating at a Broadway signal, as it does today. The configuration assumed under the Combined Alternative Package (Preferred Alternative) is shown in Figure 4.1-3, US 36/I-25 Interchange Combined Alternative Package (Preferred Alternative) Configuration.

There are no proposed improvements to the Broadway interchange included in Package 1. For the analysis of the Combined Alternative Package (Preferred Alternative), it was assumed that the access to Broadway from southbound I-25 and from westbound US 36 would be removed. A separate study will be undertaken to determine what access can be provided from southbound I-25 and westbound US 36 to Broadway with the addition of the system connection from southbound I-25 to westbound US 36. Additional information regarding the analysis leading to this conclusion is contained in Appendix D, Broadway Interchange Alternatives.

The westbound on-ramp from Broadway would be realigned to merge with the redesigned southbound I-25 to westbound US 36 ramp prior to joining US 36, in order to establish a single, combined on-ramp merge point. This is considered safer and more operationally efficient than having two closely spaced on-ramp merge points.

4.1.1 Interchange Volume

Broadway (State Highway [SH] 224) is a minor urban arterial. This street provides local connectivity between 58th Avenue and Greenwood Boulevard in the vicinity of its interchange with US 36. The interchange with US 36 provides regional access to the west. This portion of Broadway is not directly connected to the portion of Broadway that runs through downtown Denver and that continues south to Littleton.

A review of traffic counts and 2035 model volume forecasts indicates that a significant portion of the Broadway traffic is oriented toward 70th Avenue (SH 224) to the south. It is a primary destination because it provides east-/west connectivity with limited access to I-25. This connection to 70th Avenue is significant because Broadway traffic does not have direct access to eastbound US 36/I-270 on southbound I-25. Traffic primarily utilizes 70th Avenue to access the southbound I-25 reversible HOV lane, eastbound I-76, or points east, such as Washington Street and the Colorado Boulevard/SH 2 corridor in Commerce City. Peak-hour intersection volumes, lanes, and LOS are shown in Figures 4.1-4, 4.1-5, and 4.1-6**,** for existing, 2035 Package 1, and 2035 Combined Alternative Package (Preferred Alternative) conditions, respectively.

Figure 4.1-3: US 36/I-25 Interchange Combined Alternative Package (Preferred Alternative) Configuration

Source: US 36 Mobility Partnership, 2009.

Figure 4.1-4: Broadway Interchange Existing Volumes, Geometry, and Level of Service

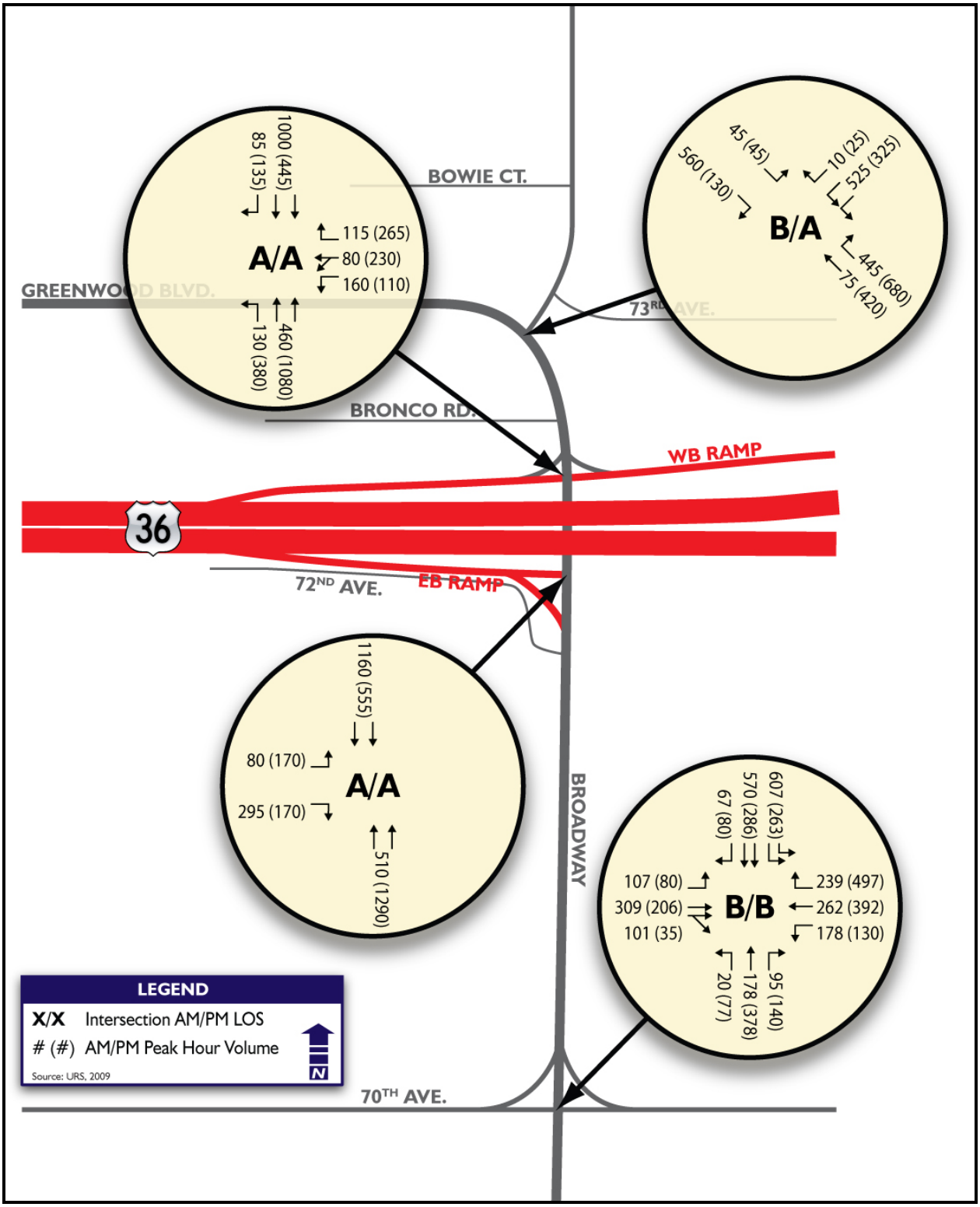


Figure 4.1-5: Broadway Interchange 2035 No Action Volumes, Geometry, and Level of Service

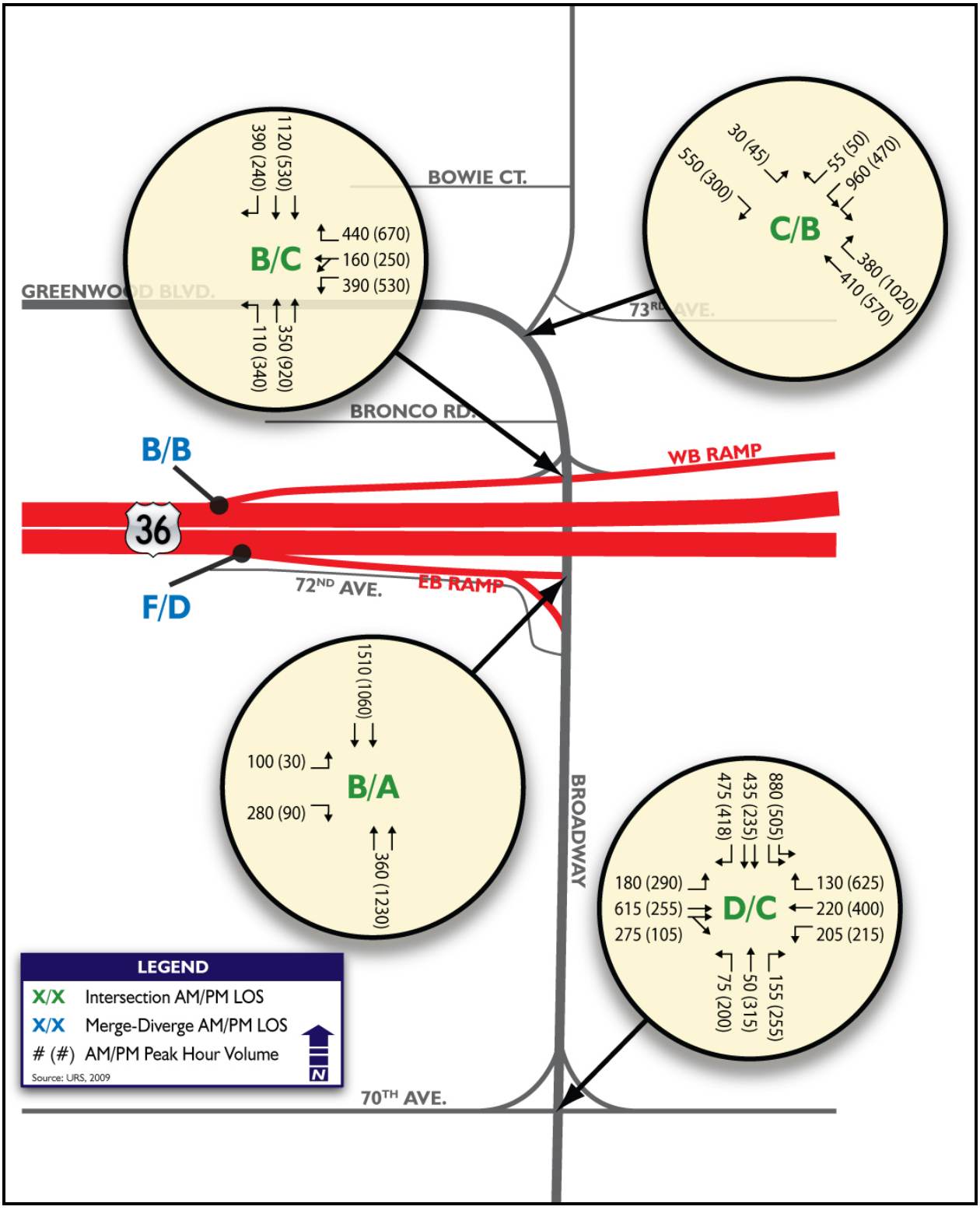
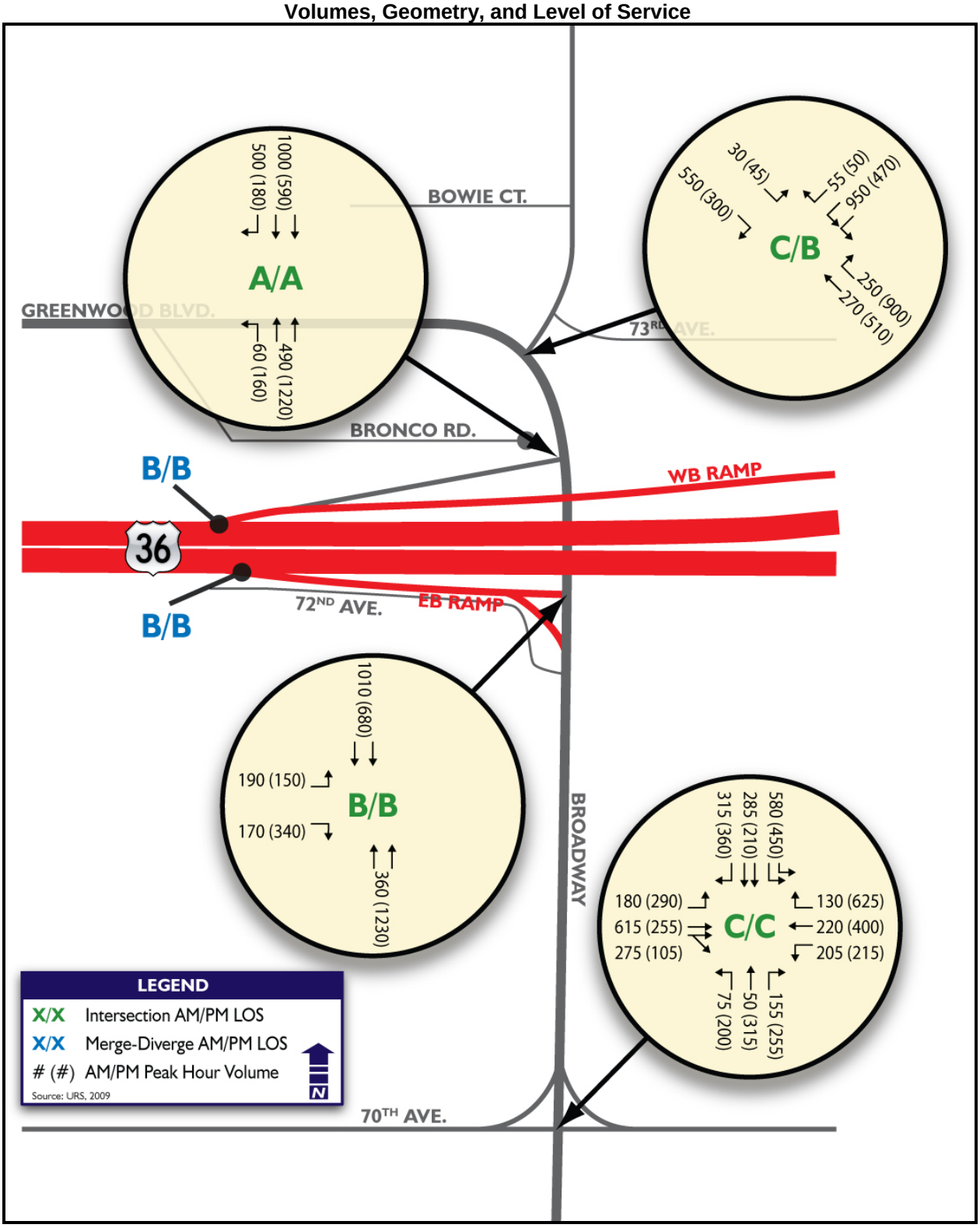


Figure 4.1-6: Broadway Interchange Combined Alternative Package (Preferred Alternative) Volumes, Geometry, and Level of Service



4.1.2 Operations Summary

With the interchange as a half diamond, signal timing would require only two phases, which would allow for much higher intersection capacity than more complex configurations. Additionally, with the limited geometry required to handle the traffic (single left-turn lane), left-turns would be phased as protected/permitted. As a result, there would be ample flexibility in the timing to accommodate the increased volume forecasts in each alternative. The resulting LOS for each alternative is shown in Table 4.1-1, Broadway Interchange Area Peak-Hour Level of Service.

Table 4.1-1: Broadway Interchange Area Peak-Hour Level of Service

Intersection: Broadway/	Level of Service (a.m./p.m. delay in seconds per vehicle)		
	Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
Greenwood Boulevard	B / A (13.4/9.7)	C / B (25.7/15.4)	C / B (26.7/15.9)
Westbound Ramps	A / A (5.9/8.5)	B / C (17.5/32.5)	A / A (2.7/8.0)
Eastbound Off-ramp	A / A (7.8/6.0)	B / A (13.2/3.1)	B / B (10.4/10.4)
70th Avenue	B / B (11.1/10.9)	D / C (36.8/28.9)	C / C (34.5/30.5)

Source: US 36 Mobility Partnership, 2009.
Notes:
a.m. = morning
p.m. = evening

The existing five-lane US 36 under-crossing width and one-lane on-/off-ramps would provide enough roadway width to maintain LOS B at the ramp intersections. Favorable operations would result in minimal queues along both Broadway and ramps, which should minimize any operational disturbance to the adjacent intersections. Since all four intersections met the project intersection LOS standard (LOS D or better, no failing movements) with the Combined Alternative Package (Preferred Alternative), no mitigation measures were tested.

The intersection at Greenwood Boulevard is approximately 400 feet north of the westbound ramp intersection. Traffic diverges at this intersection, with approximately 60 percent continuing northeast along Conifer Road and 40 percent northwest to Greenwood Boulevard. This split in traffic allows the two northbound lanes to divide between the roadways with one lane continuing to each. For the southbound direction, approximately 65 percent of the traffic comes from Conifer Road, which requires a double left-turn onto Broadway. This geometry is consistent with the existing configuration and requires no geometric changes for any alternative.

The existing signalized intersection serving the RTD park-n-Ride between the Broadway interchange and 70th Avenue was not examined because it serves very low volume.

The 70th Avenue intersection is one-quarter of a mile south of the eastbound ramp intersection. The existing geometry and signal phasing were maintained under future conditions. It is important to note that the southbound double left-turn phasing could be adjusted to allow

protected/permitted phasing. This type of phasing for a double left turn could be considered because the northbound traffic forecast is low (< 150 vehicles per hour) and can be accommodated with a single left-turn lane.

4.1.3 Transportation Impacts Summary

Transportation impacts within the interchange complex would be the loss of westbound off-ramp access to Broadway from westbound I-270, as well as the southbound off-ramp access to Broadway from I-25. Local traffic that would have used the westbound US 36 ramp would need to use the York Street interchange from westbound I-270 (to access SH 224/70th Avenue), or the 58th Avenue, 70th Avenue, or 84th Avenue off-ramp from I-25. Traffic that would have used the southbound I-25 ramp would exit I-25 at 84th Avenue and use local streets to access the Broadway area. The effect of this change is an improvement in intersection LOS to LOS A in the Combined Alternative Package (Preferred Alternative) at the Broadway/westbound on-ramp intersection.

In addition, the direct connection between southbound I-25 and westbound US 36 would eliminate the delay vehicles currently experience at the signal on Broadway.

Mitigations — Directional signage and information programs would be used to help travelers to access the uses along Broadway with the closure of the access ramp to Broadway from westbound I-270 traffic.

4.2 PECOS STREET INTERCHANGE

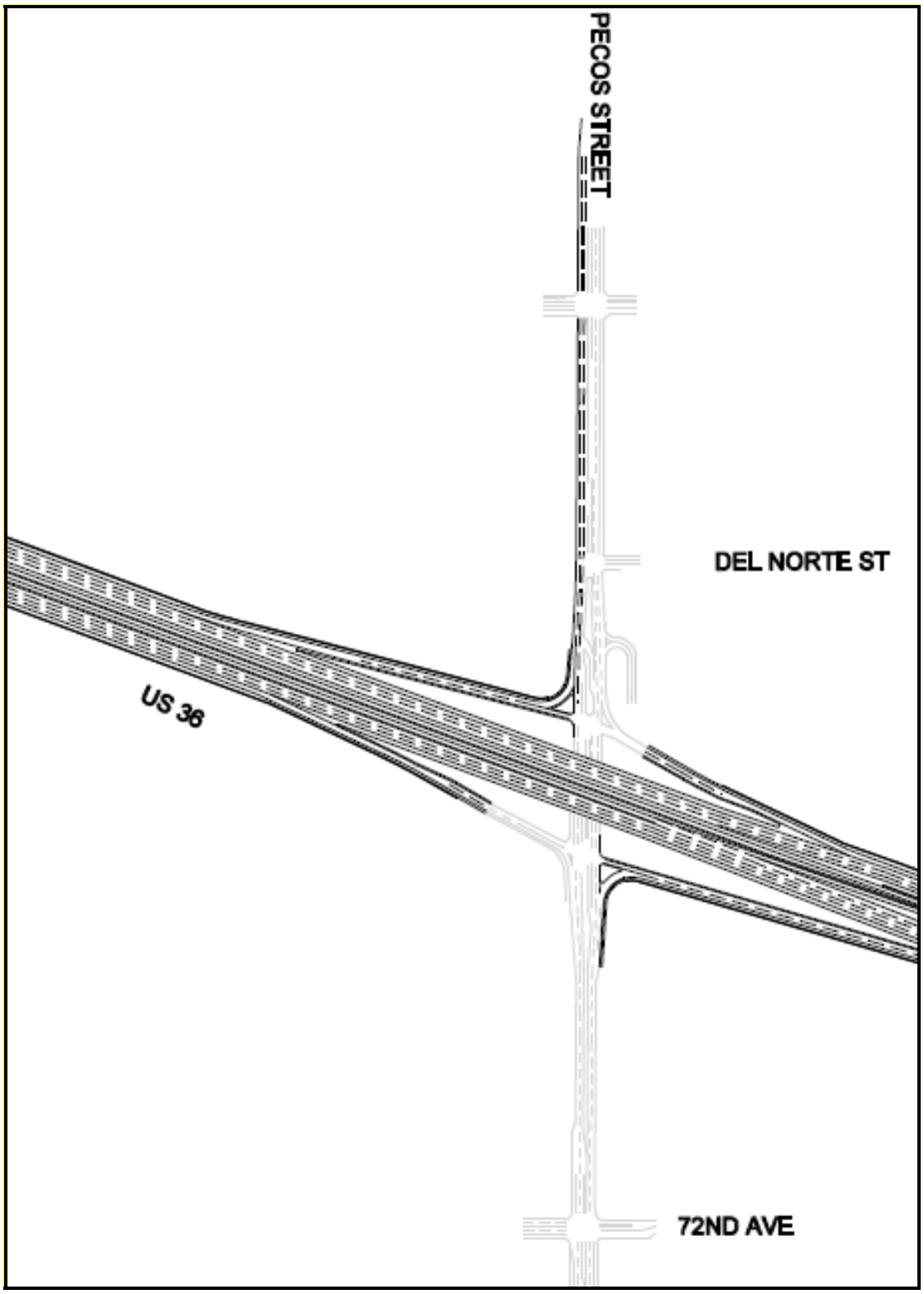
Description and Context — The existing interchange configuration at Pecos Street is a conventional diamond with left-turn lanes provided on Pecos Street. Land use in the area is primarily single-family housing with commercial/retail development in the northeast quadrant and to the south of US 36 along Pecos Street. Single-family housing also exists south of US 36 starting just one block east and west of Pecos Street.

Proposed Configuration — Neither of the alternatives contain major geometric or operational changes to the Pecos Street interchange. The interchange would look much like it does today with the exception of added turn-lane storage length and minor ramp modifications associated with US 36 widening. The proposed configuration is shown in Figure 4.2-1, Pecos Street Interchange Proposed Configuration.

4.2.1 Interchange Volumes

Pecos Street is a minor north-south arterial, providing a continuous route from 32nd Avenue to 104th Avenue. Through this segment, Pecos Street provides access to major routes such as US 36, I-76, and I-70. A review of the model volume forecasts indicates 55 to 60 percent of the traffic has a southern origin/destination, with a sizable portion destined for 72nd Avenue. This finding is the reverse of the existing count information, which indicates 55 to 60 percent of Pecos Street traffic has a northern origin/destination. This reversal in directional split is likely the result of stronger growth north of US 36 and more stable land uses to the south. Peak-hour intersection volumes, lanes, and LOS are shown for the Pecos Street interchange area in Figures 4.2-2, 4.2-3, and 4.2-4 for existing, 2035 Package 1, and 2035 Combined Alternative Package (Preferred Alternative) conditions, respectively.

Figure 4.2-1: Pecos Street Interchange Proposed Configuration



Source: US 36 Mobility Partnership, 2009.

Figure 4.2-2: Pecos Street Interchange Existing Volumes, Geometry, and Level of Service

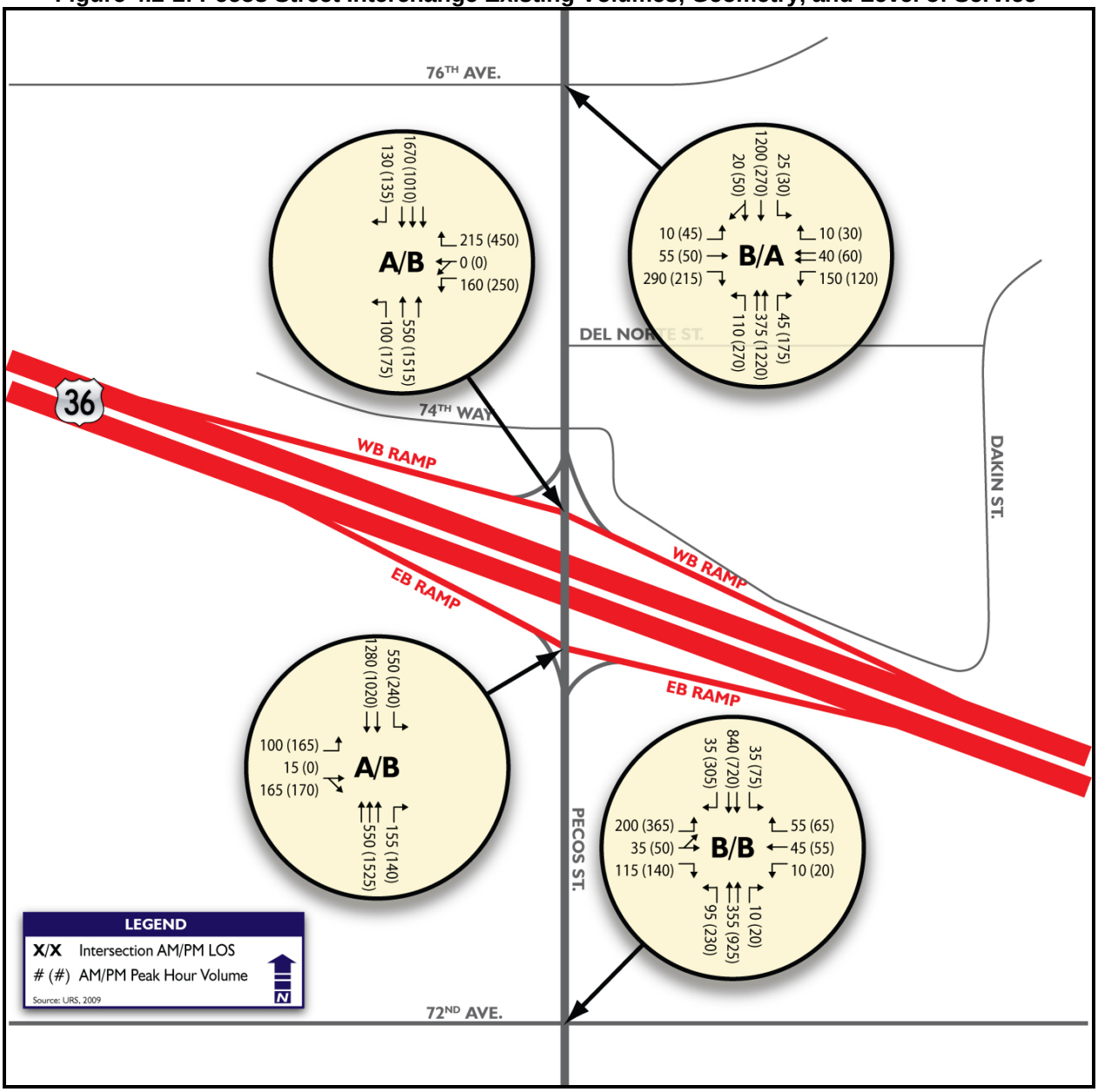


Figure 4.2-3: Pecos Street Interchange 2035 No Action Volumes, Geometry, and Level of Service

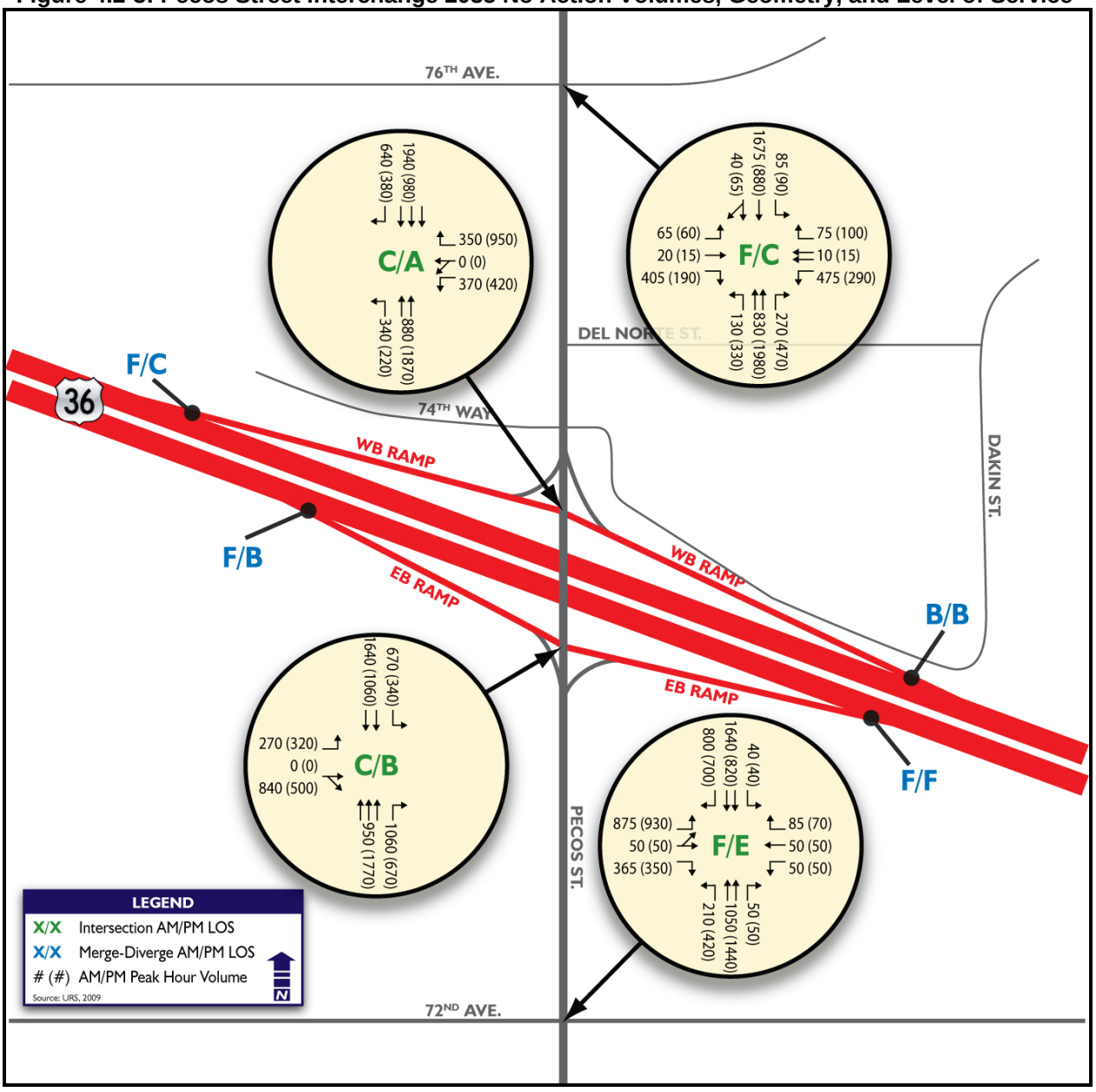
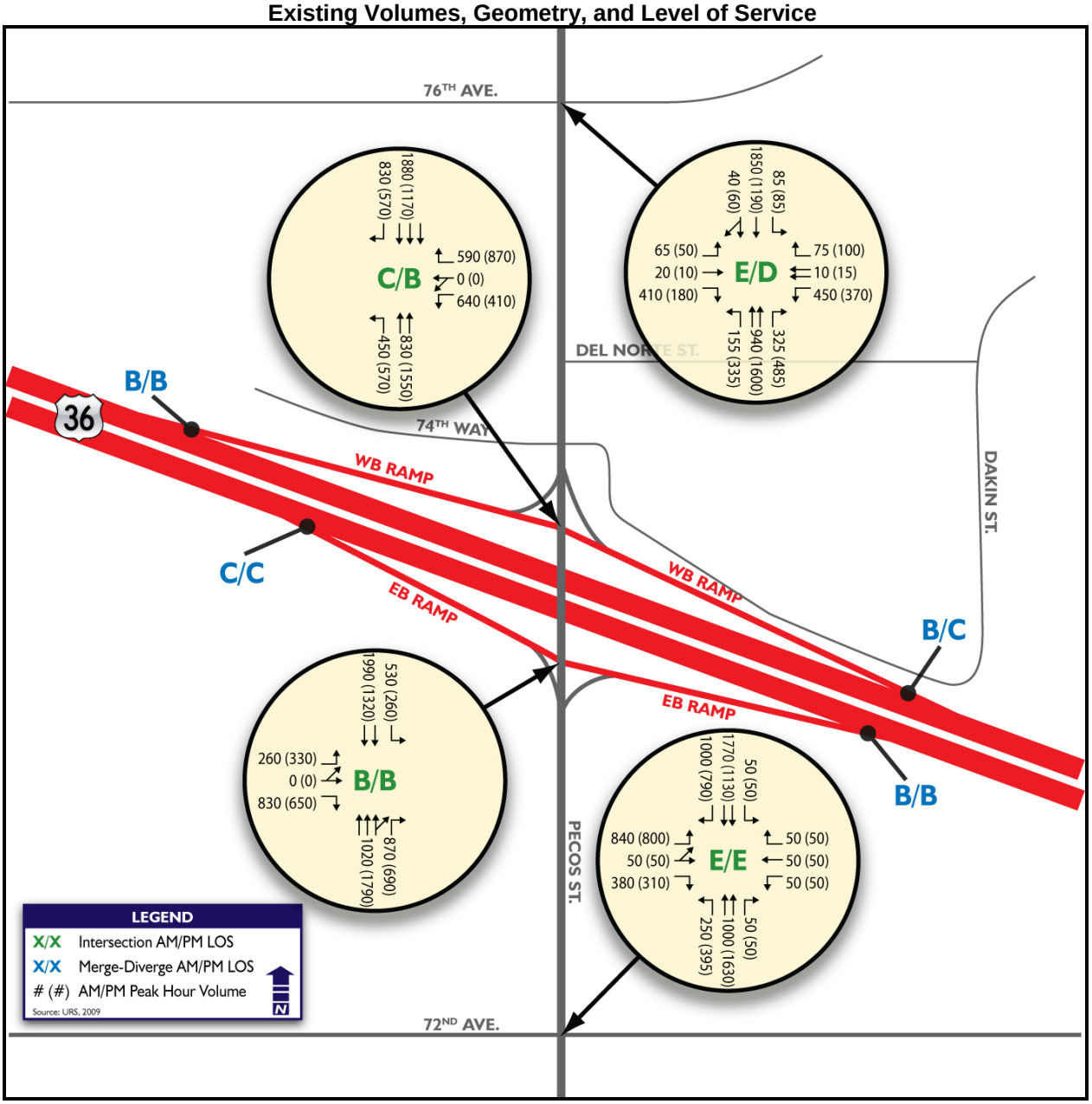


Figure 4.2-4: Pecos Street Interchange2035 Combined Alternative Package (Preferred Alternative) Existing Volumes, Geometry, and Level of Service



4.2.2 Operations Summary

Although volumes would increase at the westbound ramp intersection, the existing configuration is forecast to provide reasonable operations and left-turn vehicle storage. Maintaining the external storage lanes for Pecos Street in the Combined Alternative Package (Preferred Alternative) is warranted to provide additional capacity for the arterial left turns and through traffic as well as provide added left-turn storage to accommodate the eastbound on-ramp left-turn (southbound left turn movement) demand. The resulting LOS for each alternative are displayed in Table 4.2-1, Pecos Street Interchange Area Peak-Hour Level of Service.

Table 4.2-1: Pecos Street Interchange Area Peak-Hour Level of Service

Intersection: Pecos Street/	Level of Service (a.m./p.m. delay in seconds per vehicle)		
	Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
76th Avenue	B / A (14.7/5.6)	F / C (82.6/29.1)	E / D (75.5/37.2)
Westbound Ramps	A / B (6.7/14.2)	C / A (27.8/9.6)	C / B (33.2/13.8)
Eastbound Ramps	A / B (7.1/19.9)	C / B (22.3/14.4)	B / B (15.0/12.4)
72nd Avenue	B / B (12.0/15.7)	F / E (91.2/53.0)	E / E (77.8/60.1)

Source: US 36 Mobility Partnership, 2009.
Notes:
a.m. = morning
p.m. = evening

The Combined Alternative Package (Preferred Alternative) conditions at all intersections either met the project intersection LOS standard or would operate at a better LOS than Package 1.

To evaluate any required mitigation of any significant volume changes resulting from the proposed improvements to US 36, a review of the adjacent intersections to the interchange was completed. Mitigation measures generally evaluated include adding turn lanes and, in some instances, through-lanes to the arterial to maintain the operational performance found in Package 1.

The Pecos Street/76th Avenue intersection is located approximately one-quarter of a mile to the north of the US 36 interchange. Operations were favorable under the existing geometry. Signal timing was adjusted for the Combined Alternative Package (Preferred Alternative) to provide protected/permitted phasing due to the increase in left-turn volume along both Pecos Street and 76th Avenue. Coordination with the interchange was also provided to maximize Pecos Street progression.

The Pecos Street/72nd Avenue intersection is located approximately 1,000 feet south of the eastbound ramp intersection. The close proximity of this intersection also warrants coordination to maximize progression along Pecos Street. Model forecasts estimate a significant portion (40 to 60 percent) of the Pecos Street traffic is destined for 72nd Avenue.

The Pecos Street/Del Norte intersection is located less than 500 feet north of the westbound ramp intersection. This intersection primarily serves the commercial/retail development in the northeast quadrant. Operations are favorable for all alternatives as the "T" intersection configuration provides ample capacity to maintain operations at LOS A. It is not considered a critical intersection in this analysis.

Another intersection of note is the Cortez Street/74th Way intersection located approximately 200 feet north of the westbound ramp intersection. This intersection operates under unsignalized control with access to the east leg (Cortez Street) limited to right-in/right-out and the west leg (74th Way) limited to three-quarter movement. Cortez Street serves as a frontage road to the commercial/retail businesses located in the northeast quadrant, and maintaining the right-in/right-out access will not impact the interchange operations. However, the 74th Way leg serves approximately 100 single-family homes and could be impacted by the southbound Pecos Street queue during peak hours. Southbound Pecos Street queues are estimated at around 500 feet, which could inhibit the left-turn onto 74th Way. This condition exists in all alternatives and could be mitigated in part through "Do Not Block Intersection" signing. The operations of this intersection were not examined in detail.

4.2.3 Transportation Impacts Summary

There are no traffic impacts for the Combined Alternative Package (Preferred Alternative) compared to Package 1 in the Pecos Street interchange area. The interchange ramp junctions and the external intersections would operate within the project LOS standard.

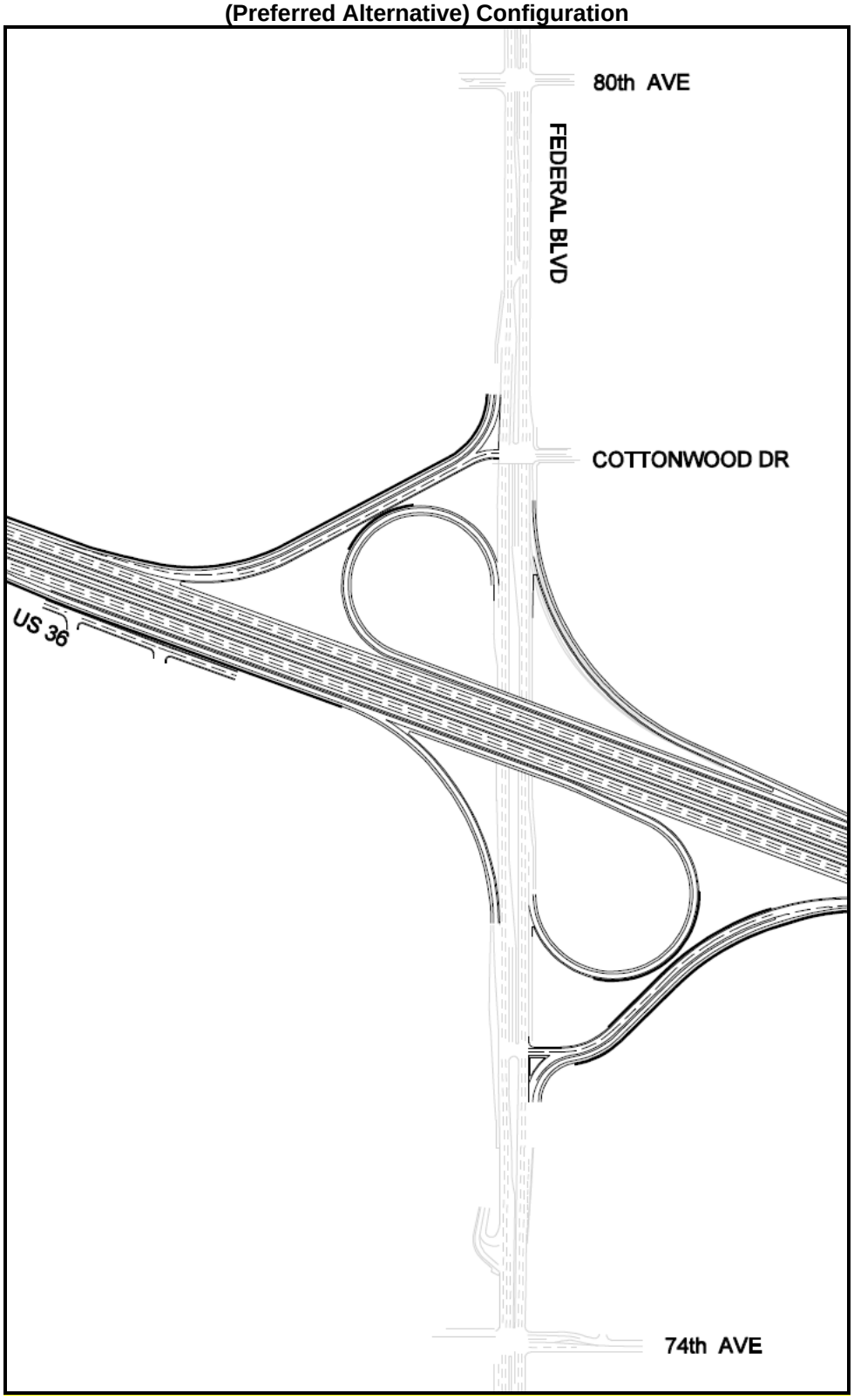
Mitigations — Because no adverse impacts would occur, no mitigation treatment is proposed.

4.3 FEDERAL BOULEVARD INTERCHANGE

Description and Context — The existing interchange configuration at Federal Boulevard is a partial cloverleaf with loop-ramps in the northwest and southeast quadrants. This configuration eliminates the signalization of left-turn off-ramp volumes allowing the intersections to operate as two-phase signals. The ramp junction intersections have three through-lanes on Federal Boulevard in each direction with double left-turn and single right-turn lanes onto US 36. Land use in the area is a combination of single-family housing and commercial/retail development. The Westminster Plaza Shopping Center and 72nd Avenue influence traffic south of the interchange, while north of the interchange Federal Boulevard serves more residential commuter traffic, with light retail and a neighborhood park/ballfield complex close to the interchange in the northeast quadrant.

Proposed Configuration — Neither Package 1 or Combined Alternative Package (Preferred Alternative) contain significant geometric or operational changes to the Federal Boulevard interchange. With the exception of possible turn-lane storage length extensions and minor ramp modifications associated with US 36 widening in the Combined Alternative Package (Preferred Alternative), the interchange would be configured much as it is today. The proposed configuration is shown in Figure 4.3-1, Federal Boulevard Interchange Combined Alternative Package (Preferred Alternative) Configuration.

Figure 4.3-1: Federal Boulevard Interchange Combined Alternative Package (Preferred Alternative) Configuration



Source: US 36 Mobility Partnership, 2009.

4.3.1 Interchange Volumes

Federal Boulevard is a north-south arterial route that provides a continuous route from Bowles Avenue in Littleton to 120th Avenue in Broomfield. Through this segment, Federal Boulevard provides access to major routes US 36, I-76, I-70, US 6, and US 285. A review of traffic counts and model volume forecasts indicates a predominant southbound directional split in the a.m. peak period in the US 36 vicinity. The p.m. peak period showed a southbound directional split south of US 36 and northbound directional split north of US 36, respectively. This shift in directional split is the result of primarily serving residential commuter traffic traveling to US 36 in the a.m. and from US 36 in the p.m. Peak-hour intersection volumes, lanes, and LOS are shown for the Federal Boulevard interchange area in Figures 4.3-2, 4.3-3, and 4.3-4 for existing, 2035 Package 1, and 2035 Combined Alternative Package (Preferred Alternative) conditions, respectively.

4.3.2 Operations Summary

The evaluation of this interchange focused on maintaining acceptable operations at the ramp intersections under the existing geometric configuration. With the interchange as a partial cloverleaf, the signal phasing is less complex, which results in higher interchange capacity than a traditional diamond configuration.

The primary operational concern at this interchange is merging off-ramp traffic within the limited ramp spacing. This concern exists today, but could worsen with forecast traffic volume growth. The existing overpass structure is wide enough to accommodate extension of the on-ramp left-turn lanes, should they become necessary.

The westbound ramp intersection operates near capacity for some movements, in part because it provides access to a residential area, with Cottonwood Drive forming the fourth (east) leg of the intersection. The 2035 peak-hour volume forecasts are relatively low for Cottonwood Drive, but the added signal phase would reduce the capacity along Federal Boulevard, resulting in marginal operations. The resulting LOS for each alternative are displayed in Table 4.3-1, Federal Boulevard Interchange Area Peak-Hour Level of Service.

Figure 4.3-2: Federal Boulevard Interchange Existing Volumes, Geometry, and Level of Service

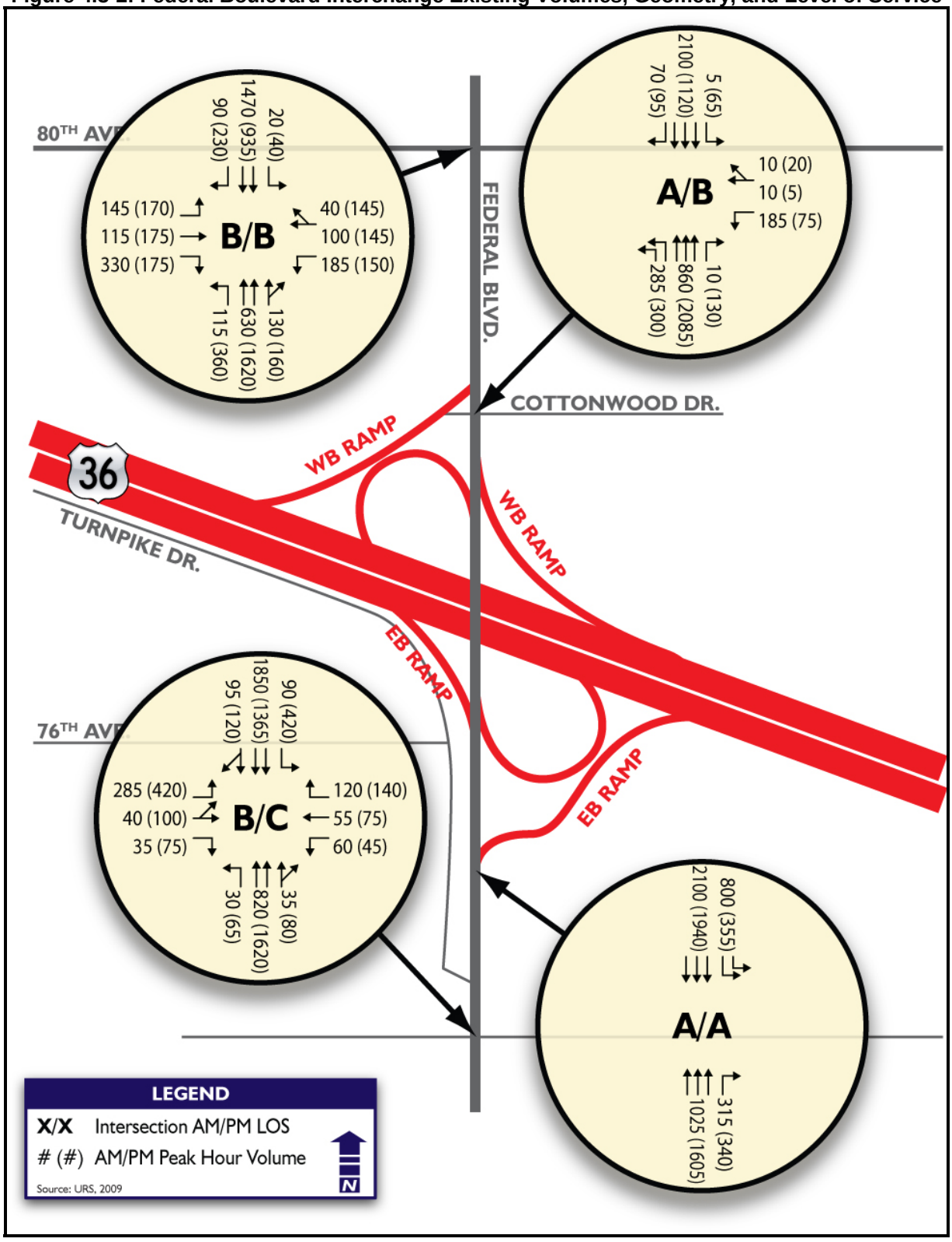


Figure 4.3-3: Federal Boulevard Interchange 2035 No Action Volumes, Geometry, and Level of Service

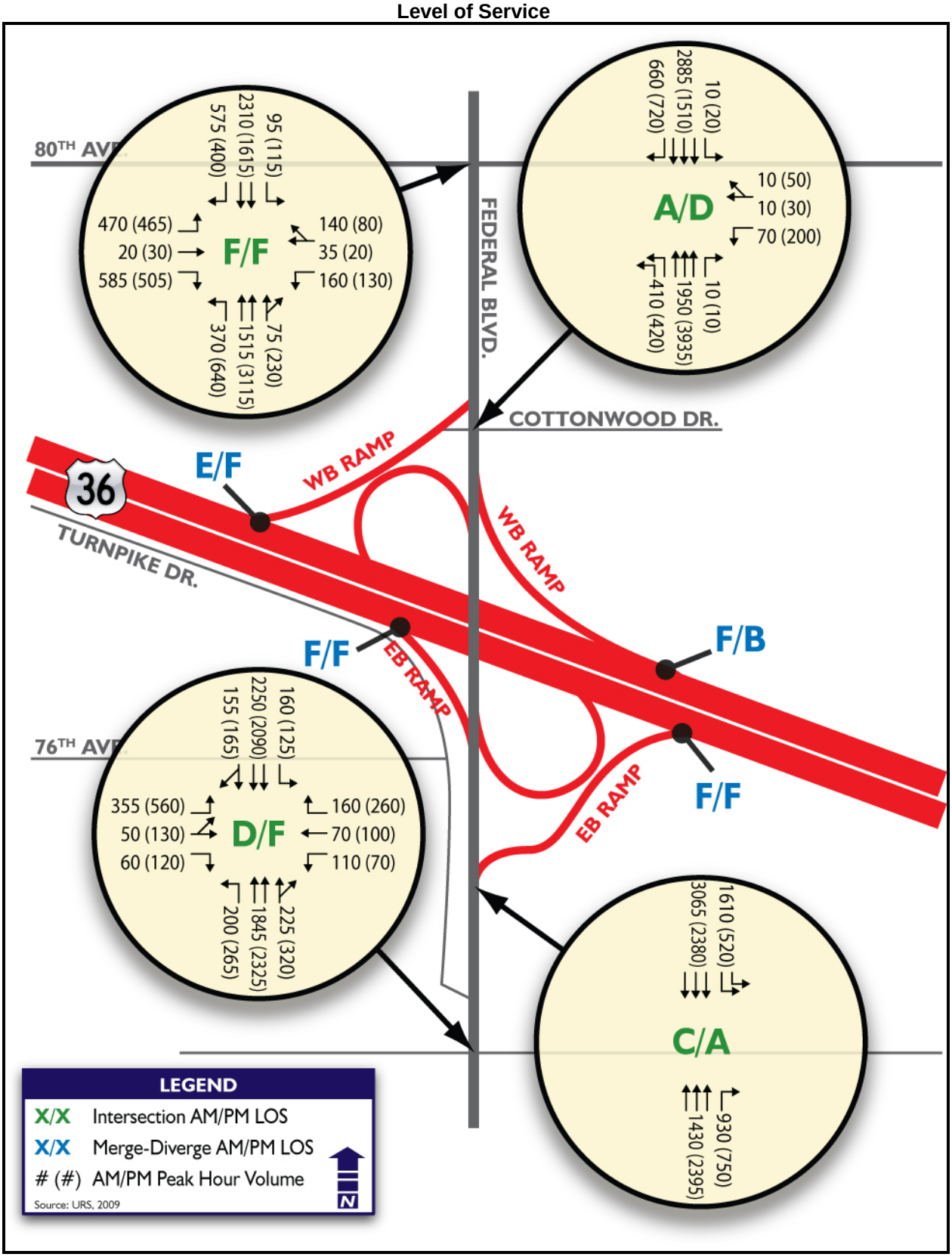


Figure 4.3-4: Federal Boulevard 2035 Combined Alternative Package (Preferred Alternative) Volumes, Geometry, and Level of Service

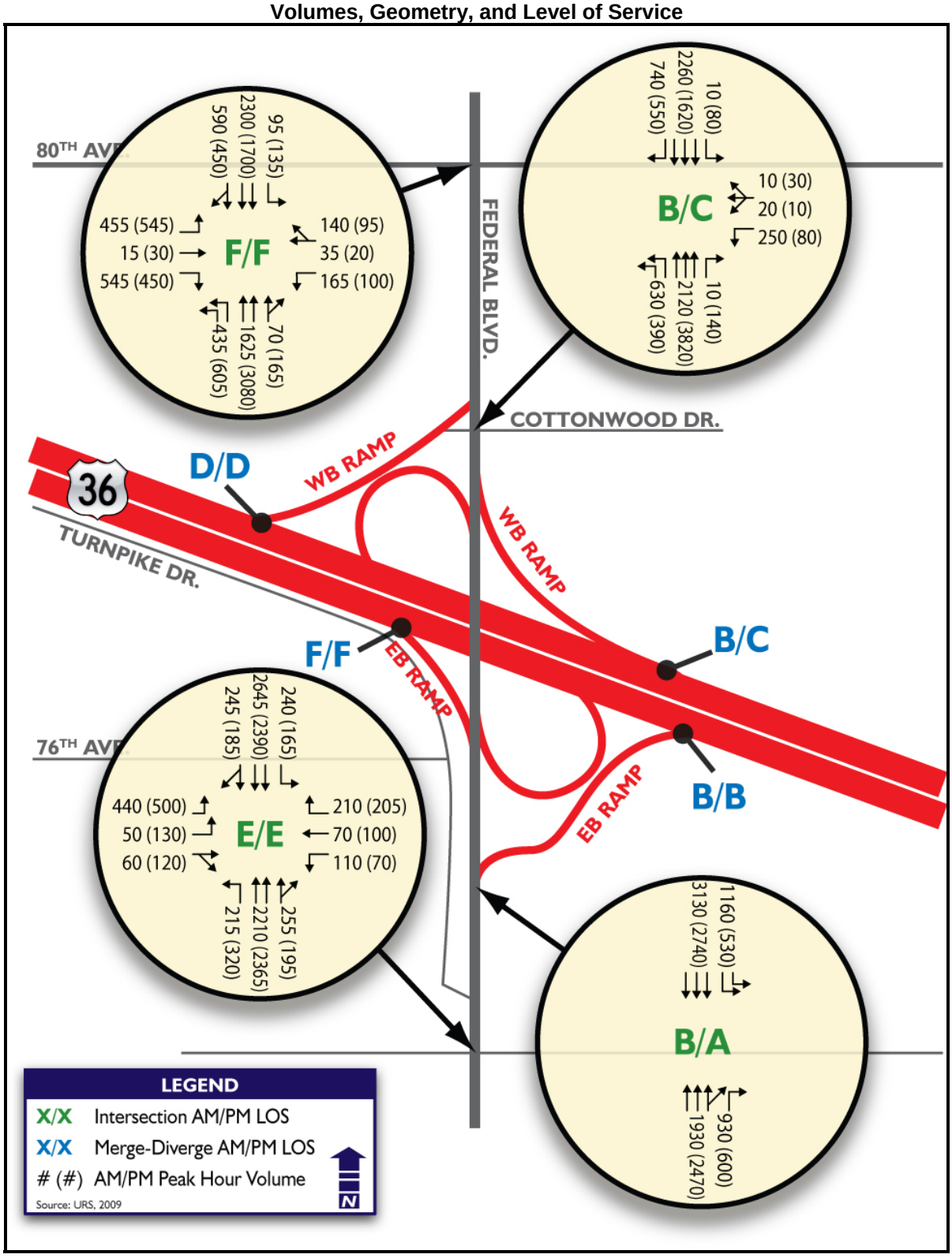


Table 4.3-1: Federal Boulevard Interchange Area Peak-Hour Level of Service

Intersection: Federal Boulevard/	Level of Service (a.m./p.m. delay in seconds per vehicle)[1]		
	Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
80th Avenue	B / B (18.5/15.3)	F / F (129.6/123.5)	F / F (121.6/128.5)
80th Avenue with Mitigation	*N/A*	*N/A*	*F / F (116.0/121.7)*
Westbound Ramp/Cottonwood Drive	A / B (9.1/10.2)	A / D (5.8/46.0)	B / C (12.8/26.7)
Eastbound Ramp	A / A (7.4/2.2)	C / A (23.8/5.9)	B / A (11.1/3.4)
74th Avenue	B / C (16.3/21.6)	D / F (43.3/88.4)	F / F (88.9/110.7)
74th Avenue with Mitigation	*N/A*	*N/A*	*E / E (66.9/78.0)*

Source: US 36 Mobility Partnership, 2009.
Notes:
[1]Average delay estimates over 100 seconds should be considered very rough.
a.m. = morning
N/A = not applicable
p.m. = evening

The forecast intersection LOS at the ramp junctions would be satisfactory in all scenarios. At the adjacent intersections (80th Avenue and 74th Avenue), LOS and delay estimates in both peak hours reflect very poor operational conditions for both Package 1 and Combined Alternative Package (Preferred Alternative). The 74th Avenue intersection would require mitigation for Combined Alternative Package (Preferred Alternative) impacts based on both a.m. and p.m. peak-hour results. This intersection was also examined with additional improvements designed to mitigate the impacts of the proposed US 36 improvements.

To evaluate any required mitigation of any significant volume changes resulting from the proposed improvements to US 36, a review of the adjacent intersections to each side of the interchange was completed. Mitigation measures evaluated included adding turn lanes and, in some instances, through-lanes to the arterial to maintain the operational performance found in Package 1.

At the Federal Boulevard interchange there are two adjacent intersections of concern:

- Federal Boulevard/80th Avenue
- Federal Boulevard/74th Avenue

The 80th Avenue intersection is located 1,200 feet north of the westbound ramp intersection. Although intersection operations would be poor in both peak hours, the Combined Alternative Package (Preferred Alternative) is not considered as having an impact to the intersection because it would operate at the same peak-hour LOS as Package 1 and would not result in any additional failing movements.

The 74th Avenue intersection is located 900 feet south of the eastbound ramp intersection. This intersection serves retail, residential, and civic uses to the west and residential uses to the east. The existing east-west split-phase arrangement would result in a relatively inefficient allocation of signal green time. The mitigation proposed is to re-stripe the three-lane eastbound approach from its current "left, left+through, right" configuration to "left, left, through+right." This change, in conjunction with improvements to the far side (outgoing leg on the east side) to accommodate the relocation of westbound through movements, would create substantial additional green time to dedicate to other movements and would mitigate the impact of the Combined Alternative Package (Preferred Alternative).

4.3.3 Transportation Impacts Summary

Since the 2035 Package 1 reflects such a large amount of growth in north-south traffic along Federal Boulevard over existing conditions, it could be difficult to isolate the effects of small changes in interchange traffic that could result from US 36 capacity enhancements. The transportation impacts at the Federal Boulevard interchange ramp junctions are minor (operations in all scenarios meet the standard set for this DEIS). The impacts at adjacent intersections would also be minor, but small increases in traffic at congested intersections could have a much larger effect on delay than they would at uncongested intersections. The mitigation measures identified for the 74th Avenue intersection would result in less overall delay and a lower (or equal) number of failing movements than in Package 1.

Mitigations — At the 74th Avenue intersection, mitigation for the Combined Alternative Package (Preferred Alternative) requires adjustments to the existing east-west, split-phase arrangement that currently results in a relatively inefficient allocation of signal green time. The mitigation is to re-stripe the three-lane eastbound approach from its current "left, left+through, right" configuration to "left, left, through+right" configuration. This change creates substantial additional green time to dedicate to failing movements, but could require a slight modification to the southeast quadrant of the intersection to accommodate the relocation eastbound through movement.

4.4 SHERIDAN BOULEVARD INTERCHANGE

The Sheridan Boulevard interchange also includes access to 92nd Avenue.

Description and Context — The Sheridan Boulevard/US 36 interchange is a modified diamond with additional arterial access to westbound 92nd Avenue via a loop-ramp and from eastbound 92nd Avenue via a collector road. Trip distribution in the area is largely influenced by the major retail centers on each side of US 36. The Westminster Mall and Brookhill Shopping Center, located southwest of US 36, are accessed from 92nd Avenue and 88th Avenue. Three other smaller retail centers located northeast of US 36 are accessed from Sheridan Boulevard and 92nd Avenue. A large portion of the remaining land in the area is single-family housing, while Sheridan Boulevard and 88th Avenue provide direct access to minor retail and office employment locations along those corridors.

Proposed Configuration — The Combined Alternative Package (Preferred Alternative) includes substantial changes to the Sheridan Boulevard interchange from Package 1. The existing Package 1 configuration would be expanded to a split diamond between 92nd Avenue and Sheridan Boulevard, with an additional on-ramp to eastbound US 36 from the frontage road. The existing loop-ramp for westbound US 36 traffic to westbound 92nd Avenue would be removed. Eastbound US 36 traffic bound for areas north of the interchange that today turns left at Sheridan Boulevard will turn left at 92nd Avenue under the Combined Alternative Package (Preferred Alternative). This change allows for the removal of a signal phase from the Sheridan Boulevard/eastbound US 36 ramps intersection, which results in substantially greater efficiency.

Since the west side of the interchange area is at a much higher elevation than the east (which limits the feasibility of direct-ramp improvements), initial evaluation and conceptual design of this interchange focused on maintaining the basic geometric layout while providing capacity enhancements to handle the volume and geometric constraints expected with the proposed US 36 improvements. The proposed configuration takes advantage of the diagonal orientation of US 36 and the fact that both Sheridan Boulevard and 92nd Avenue serve significant local and sub-regional traffic volumes. The proposed configuration is shown in Figure 4.4-1, Sheridan Boulevard Interchange Combined Alternative Package (Preferred Alternative) Configuration.

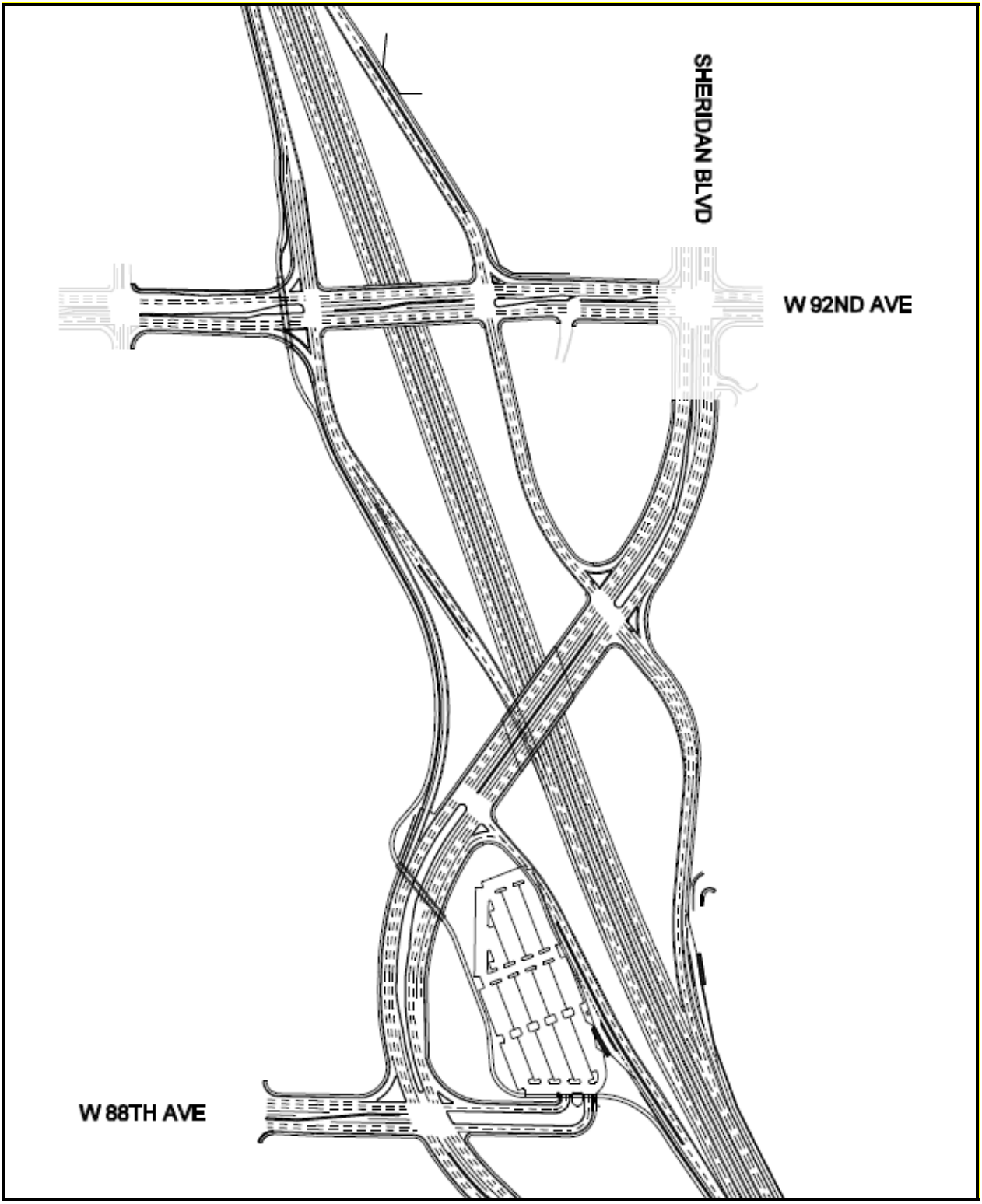
4.4.1 Interchange Volumes

The major retail centers around the Sheridan Boulevard interchange create peak midday traffic conditions during the week as well as during the weekend. The morning and afternoon peak commuting periods are influenced by the somewhat dense and diverse development in the vicinity, especially south of US 36. Peak-hour intersection volumes, lanes, and LOS are shown for the Sheridan Boulevard interchange area in Figures 4.4-2, 4.4-3, and 4.4-4 for existing, 2035 Package 1, and 2035 Combined Alternative Package (Preferred Alternative) conditions, respectively.

4.4.2 Operations Summary

The integration of full access to 92nd Avenue into the Sheridan Boulevard interchange complex has strong potential to simplify overall access and reduce localized out-of-direction travel for US 36-oriented traffic. While some movements would see increased delay over Package 1 conditions, most movements would have their access simplified, resulting in better convenience and lower delays. In particular, access to and from 92nd Avenue would be improved significantly by the proposed interchange configuration. The LOS for each alternative are displayed in Table 4.4-1, Sheridan Boulevard Interchange Area Peak-Hour Level of Service.

Figure 4.4-1: Sheridan Boulevard Interchange Combined Alternative Package (Preferred Alternative) Configuration



Source: US 36 Mobility Partnership, 2009.

Figure 4.4-2: Sheridan Boulevard Interchange Existing Volumes, Geometry, and Level of Service

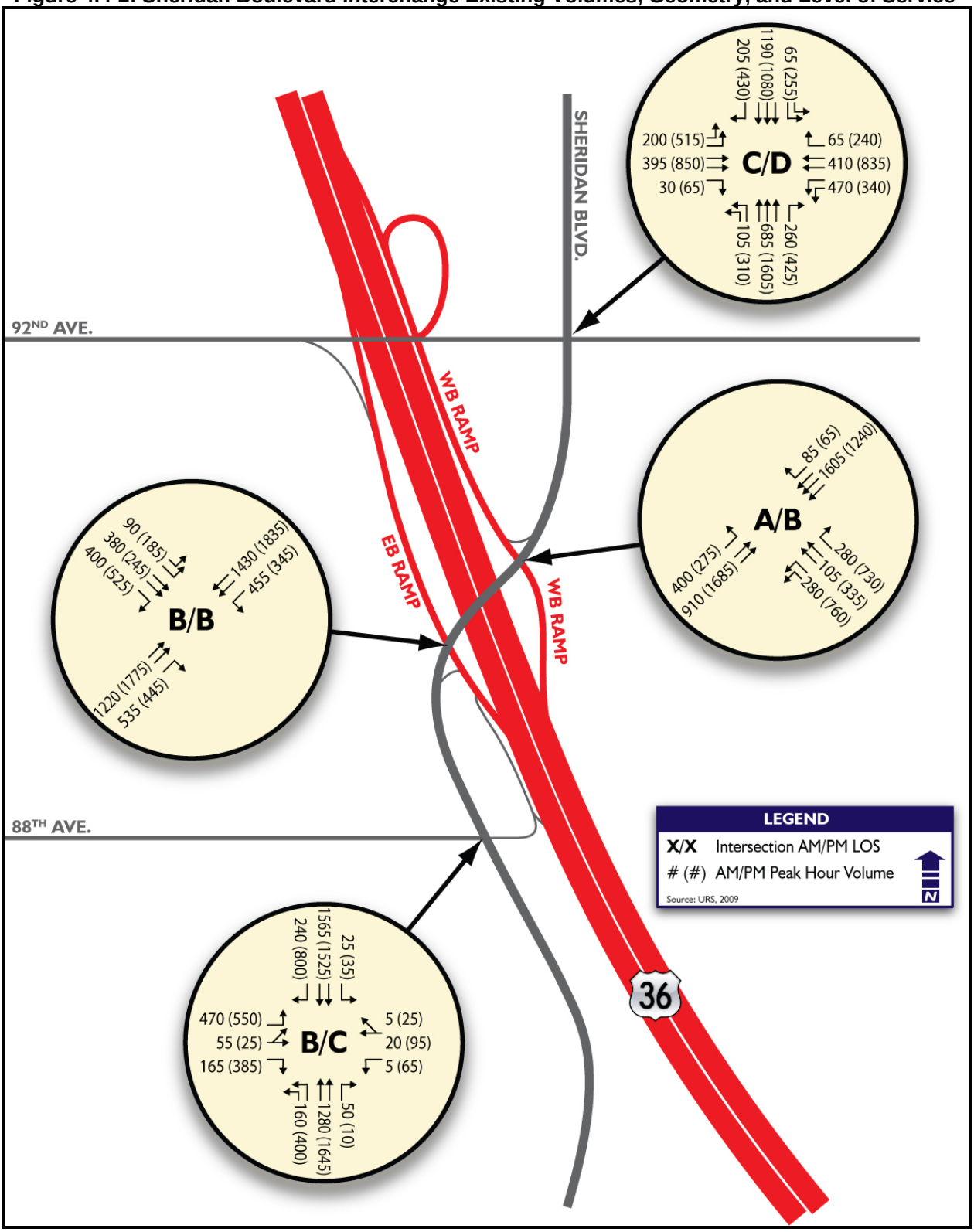


Figure 4.4-3: Sheridan Boulevard Interchange 2035 No Action Volumes, Geometry, and Level of Service

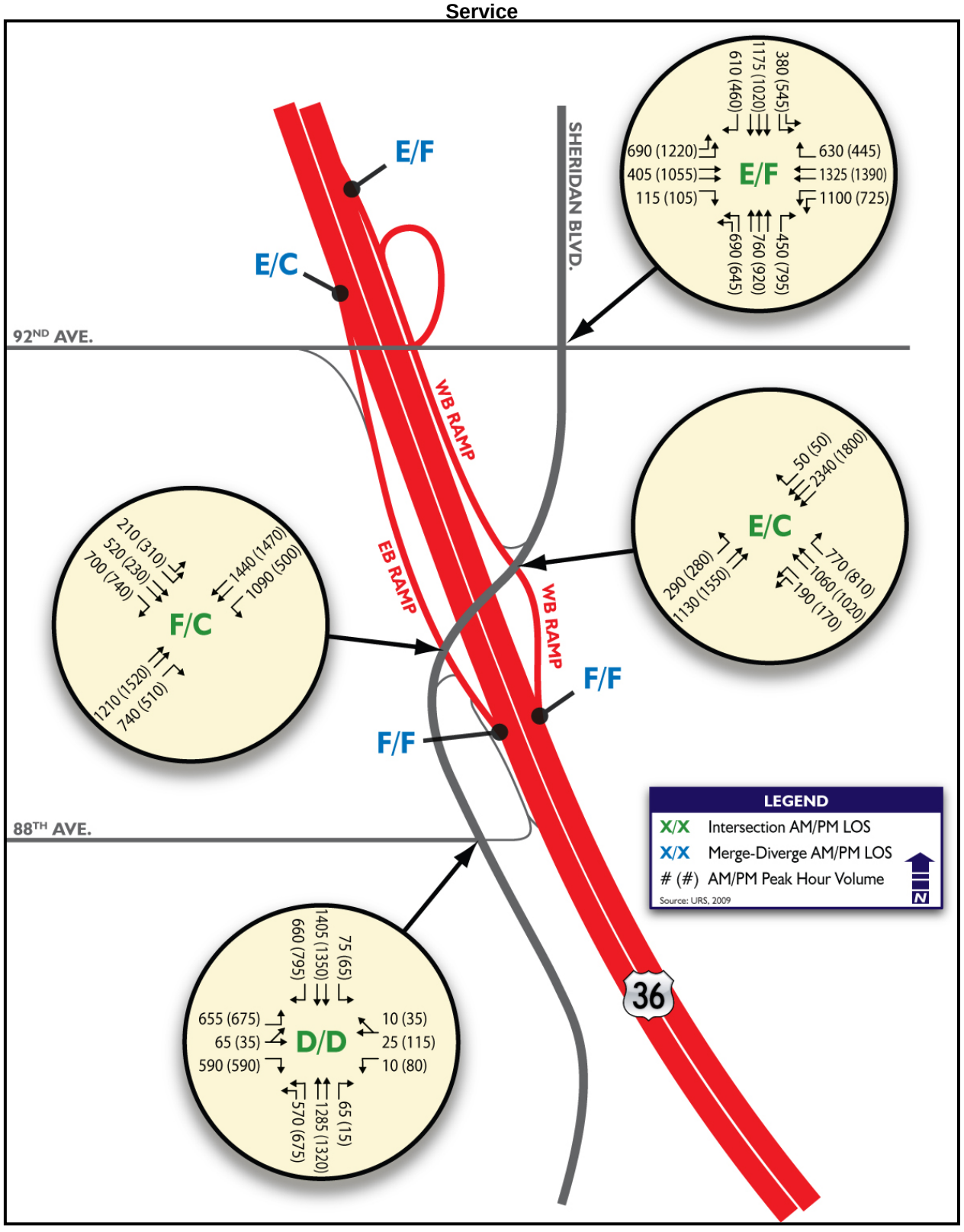


Figure 4.4-4: Sheridan Boulevard Interchange 2035 Combined Alternative Package (Preferred Alternative) Volumes, Geometry, and Level of Service

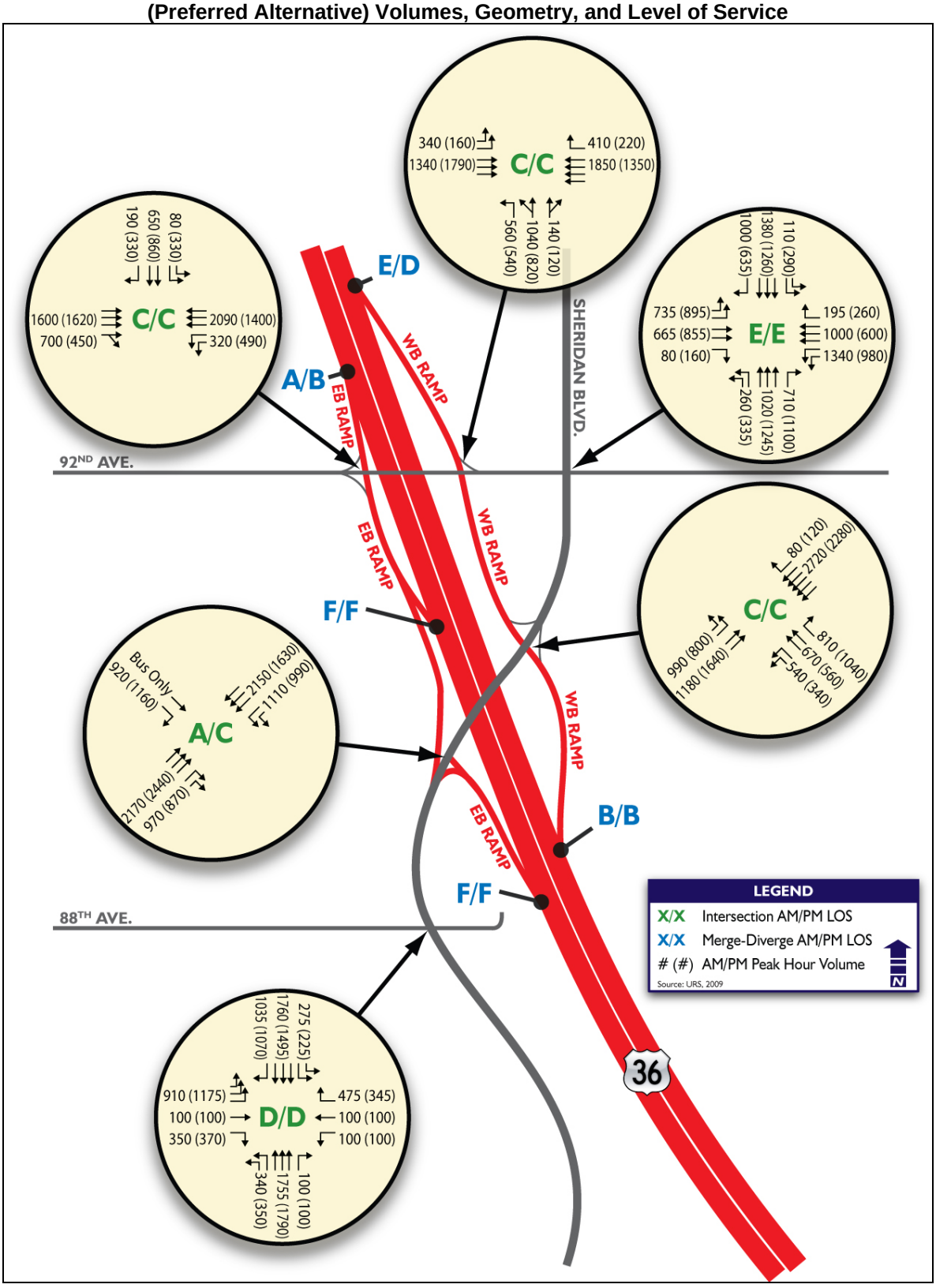


Table 4.4-1: Sheridan Boulevard Interchange Area Peak-Hour Level of Service

Intersection: Sheridan Boulevard/	Level of Service (a.m./p.m. delay in seconds per vehicle)[1]		
	Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
92nd Avenue /Eastbound Off-ramp	N/A	N/A	C / C (20.9/33.2)
92nd Avenue/Westbound On-ramp	N/A	N/A	C / C (32.1/28.3)
92nd Avenue	C / D (22.2/40.6)	E / F (73.2/108.8)	E / E (66.5/68.0)
Westbound Ramps	A / B (8.2/16.0)	E / C (62.0/20.6)	C / C (34.3/31.9)
Eastbound Ramps	B / B (17.2/18.9)	F / C (115.4/24.2)	A / C (6.6/26.9)
88th Avenue	B / C (19.6/26.2)	D / D (40.3/53.2)	D / D (35.5/35.3)

Source: US 36 Mobility Partnership, 2009.

Notes:

[1]Average delay estimates over 100 seconds should be considered very rough.

a.m. = morning

N/A = not applicable

p.m. = evening

A significant operational issue for the project is centered on the distinction between mitigation measures and project-defined improvements (those included in the project). While mitigation measures must only result in intersection LOS equal to or better than those in Package 1, project-defined improvements must result in intersection LOS results that meet the project standard (LOS D or better, with no failing movements). In the case of the Sheridan Boulevard interchange, such large volumes are projected for north-south travel demand that the basic four-lane section in Package 1 condition would not allow for the intersection LOS standard to be met at the 88th Avenue/Sheridan Boulevard intersection. As a result, the project either presumes or would contribute to the construction of Sheridan Boulevard as a six-lane arterial between Turnpike Drive and US 36.

Peak-hour intersection analysis shows that the proposed configuration would result in LOS that would meet the project standard in all build alternatives.

A particular feature of the proposed configuration is the addition of an eastbound slip on-ramp between 92nd Avenue and Sheridan Boulevard from the eastbound collector-distributor road. The addition of this ramp would essentially remove the need to provide for eastbound left and through movements at Sheridan Boulevard, thereby allowing for the signal there to operate with only two phases at most times (southbound Sheridan Boulevard would receive a full-time green signed except when an eastbound bus traverses the intersection). Traffic making the eastbound left turn movement at Sheridan Boulevard under existing conditions would make that movement at 92nd Avenue in the proposed configuration. An exception to this change would need to be made for RTD buses only, which would still need the eastbound through movement at Sheridan Boulevard to access the bus stop on the on-ramp. A special bus-only actuated signal phase would be provided for this purpose. However, this movement is not expected to have a

substantial effect on traffic operations, as only four to eight buses per hour would need this special signal phase.

The Sheridan Boulevard intersections with 92nd and 88th avenues were considered "adjacent" for this analysis. Both intersections would operate better in the Combined Alternative Package (Preferred Alternative) than Package 1. This finding is primarily attributable to the presumption that the reconfiguration of the interchange would result in more efficient traffic flow through the area, with less out-of-direction travel and more direct use of 92nd Avenue by US 36-oriented traffic. For example, under the Combined Alternative Package (Preferred Alternative), eastbound US 36 off-ramp traffic bound for the Westminster Mall area would no longer need to use Sheridan Boulevard. As another example, westbound traffic on 92nd Avenue (west of Sheridan Boulevard) bound for US 36 westbound would also avoid Sheridan Boulevard and create less congestion at the 92nd Avenue/Sheridan Boulevard intersection, shifting from the left turn movement to the through movement, which has more capacity.

4.4.3 Transportation Impact Summary

The addition of two signalized intersections on 92nd Avenue has the potential to adversely impact the signal progression along that arterial. Between the 6400 East signal (Costco access) and Yates Street, there are currently five signals in just over a half-mile. While progression through this entire stretch might not be crucial (since most of the traffic turns on to and/or off of 92nd Avenue within this stretch), the addition of two signals could make overall east-west progression more difficult.

The existing commercial parcel in the triangle formed by 92nd Avenue, Sheridan Boulevard, and US 36 westbound has a signalized left-turn entry on 92nd Avenue west of Sheridan Boulevard. This access point also allows right-in and right-out movements. The parcel's other driveway on Sheridan Boulevard south of 92nd Avenue also allows right-in and right-out access. The proposed 92nd Avenue signals could make this commercial entry signal (which was not counted in the five signals mentioned in the previous paragraph) and its westbound left-turn pocket difficult to retain. Alternate access arrangements would be explored for this parcel.

The widening of US 36 and associated potential relocation of ramps in the Combined Alternative Package (Preferred Alternative) would displace some parking at RTD's park-n-Ride lots on both sides of US 36, as well as the 88th Place roadway that connects Yates Street to Sheridan Boulevard just north of the RTD parking structure and currently provides access to Sheridan Boulevard for two hotels.

Mitigations — The closure of West 88th Place to Sheridan Boulevard would require traffic to use Sheridan Boulevard north to 92nd Avenue, then use City Center Drive and Yates Street. Signage would be developed in conjunction with businesses in the area and the City to direct patrons to these properties. Information programs would be used to help guide patrons to these properties as well.

4.5 CHURCH RANCH BOULEVARD INTERCHANGE

Description and Context — The existing interchange configuration at Church Ranch Boulevard is a conventional diamond with arterial left-turn storage provided between and external of the ramps. This type of configuration has through-lane pockets that line up with the left-turn lanes, thus creating additional storage capacity. Land use in the area is primarily commercial/retail development. The Westminster Promenade in the northeast quadrant, Shops at Walnut Creek in the northwest quadrant, and surrounding hotel, office, and retail pad space are the primary current influence of trip distribution in this area.

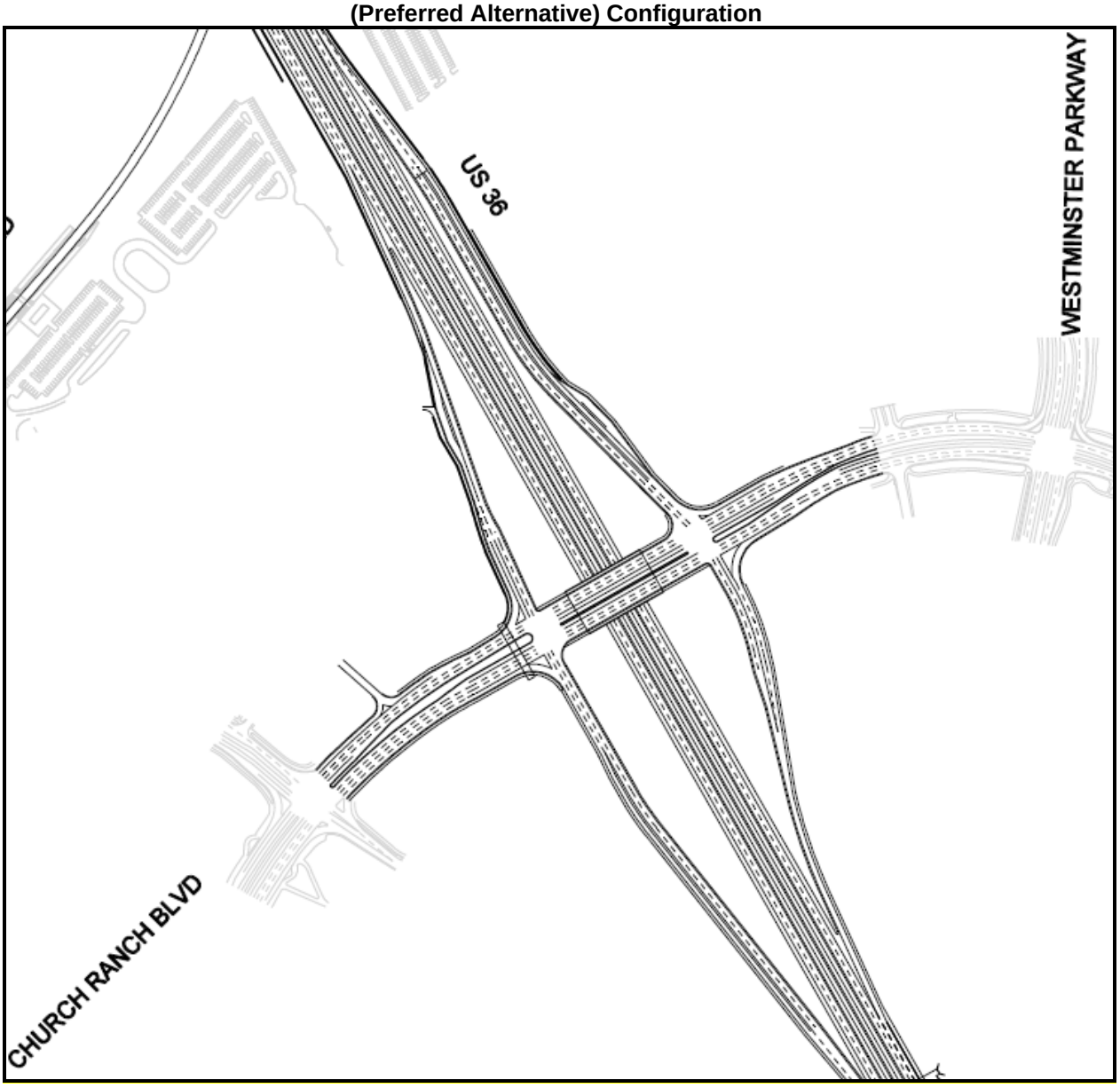
Proposed Configuration — The Combined Alternative Package (Preferred Alternative) would retain the existing diamond configuration for the Church Ranch Boulevard interchange, but it would include a wider bridge than Package 1 to accommodate additional capacity between the ramp junction intersections. With the exception of the wider bridge and possible turn lane extensions and minor ramp modifications associated with US 36 widening, the interchange in the Combined Alternative Package (Preferred Alternative) would look much like it does today. The proposed configuration is shown in Figure 4.5-1, Church Ranch Boulevard Interchange Combined Alternative Package (Preferred Alternative) Configuration.

4.5.1 Interchange Volumes

Church Ranch Boulevard is an east-west arterial that interconnects 100th Avenue and 104th Avenue. 100th Avenue provides access to Standley Lake Park while 104th Avenue provides regional east-west connectivity to I-25, I-76, and E-470. The primary difference between this interchange and adjacent interchanges along the US 36 corridor is that Church Ranch Boulevard provides more of an east-west orientation, while other cross-streets are north-south. Since Church Ranch Boulevard essentially interconnects the other major arterials along US 36, such as Wadsworth Boulevard, Sheridan Boulevard, and Federal Boulevard, much of the traffic utilizing this interchange is either destined for the retail/commercial development to the east of US 36 or is commuter traffic north of US 36 traveling west.

A review of traffic counts and model volume forecasts indicates distribution of traffic along Church Ranch Boulevard has two distinct characteristics. South of US 36 the distribution is approximately 50/50 for eastbound and westbound traffic during both the a.m. and p.m. peak periods, while north of US 36 the distribution is 65/35 for westbound during the a.m. and eastbound during the p.m. peak period. This type of distribution leads to the assumption that traffic to the northeast of US 36 is primarily commuter traffic utilizing US 36 for travel west. Peak-hour intersection volumes, lanes, and LOS are shown for the Church Ranch Boulevard interchange area in Figures 4.5-2, 4.5-3, and 4.5-4 for existing, 2035 Package 1, and 2035 Combined Alternative Package (Preferred Alternative) conditions, respectively.

Figure 4.5-1: Church Ranch Boulevard Interchange Combined Alternative Package (Preferred Alternative) Configuration



Source: US 36 Mobility Partnership, 2009.

Figure 4.5-2: Church Ranch Boulevard Interchange Existing Volumes, Geometry, and Level of Service

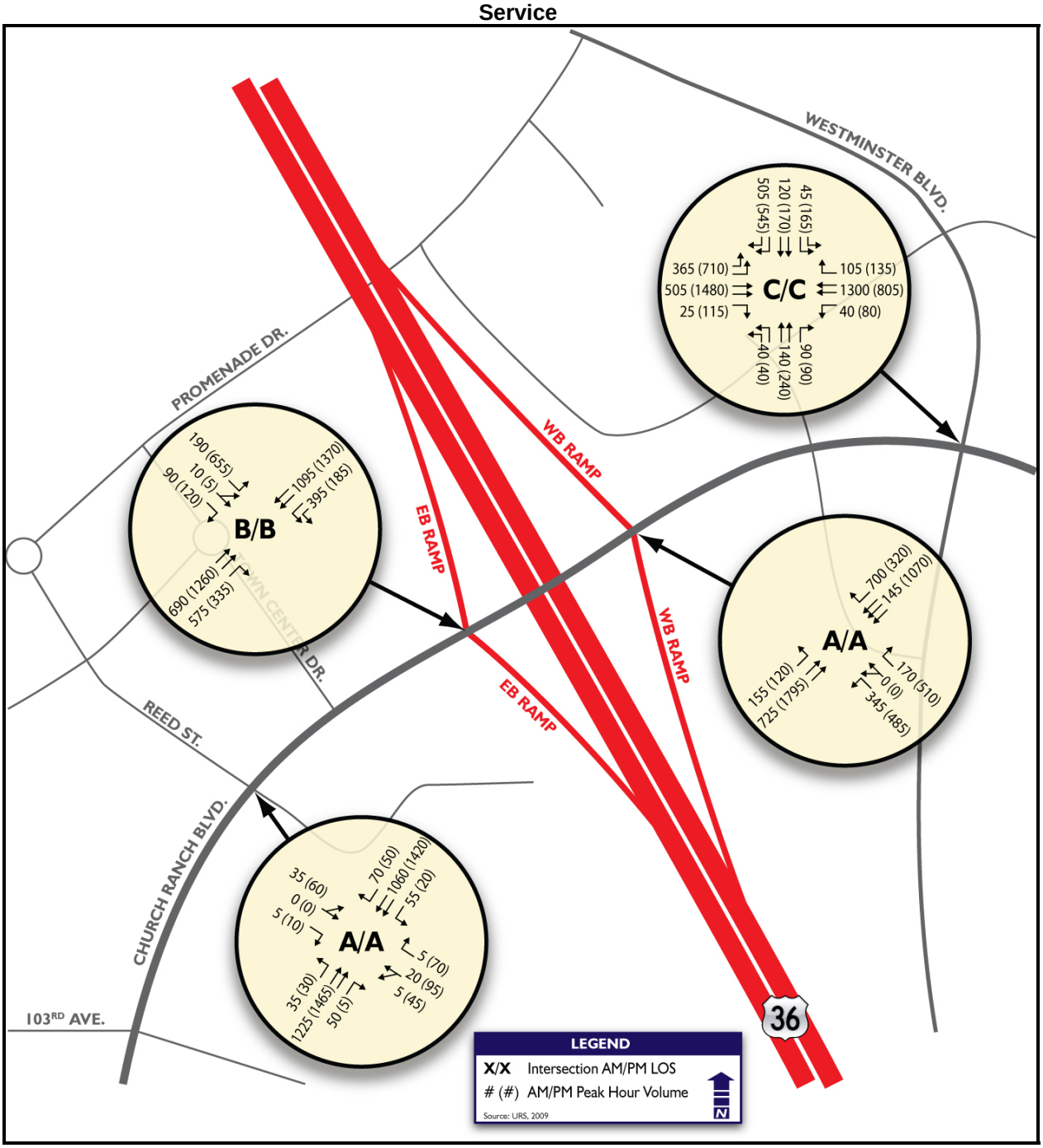


Figure 4.5-3: Church Ranch Boulevard Interchange 2035 No Action Volumes, Geometry, and Level of Service

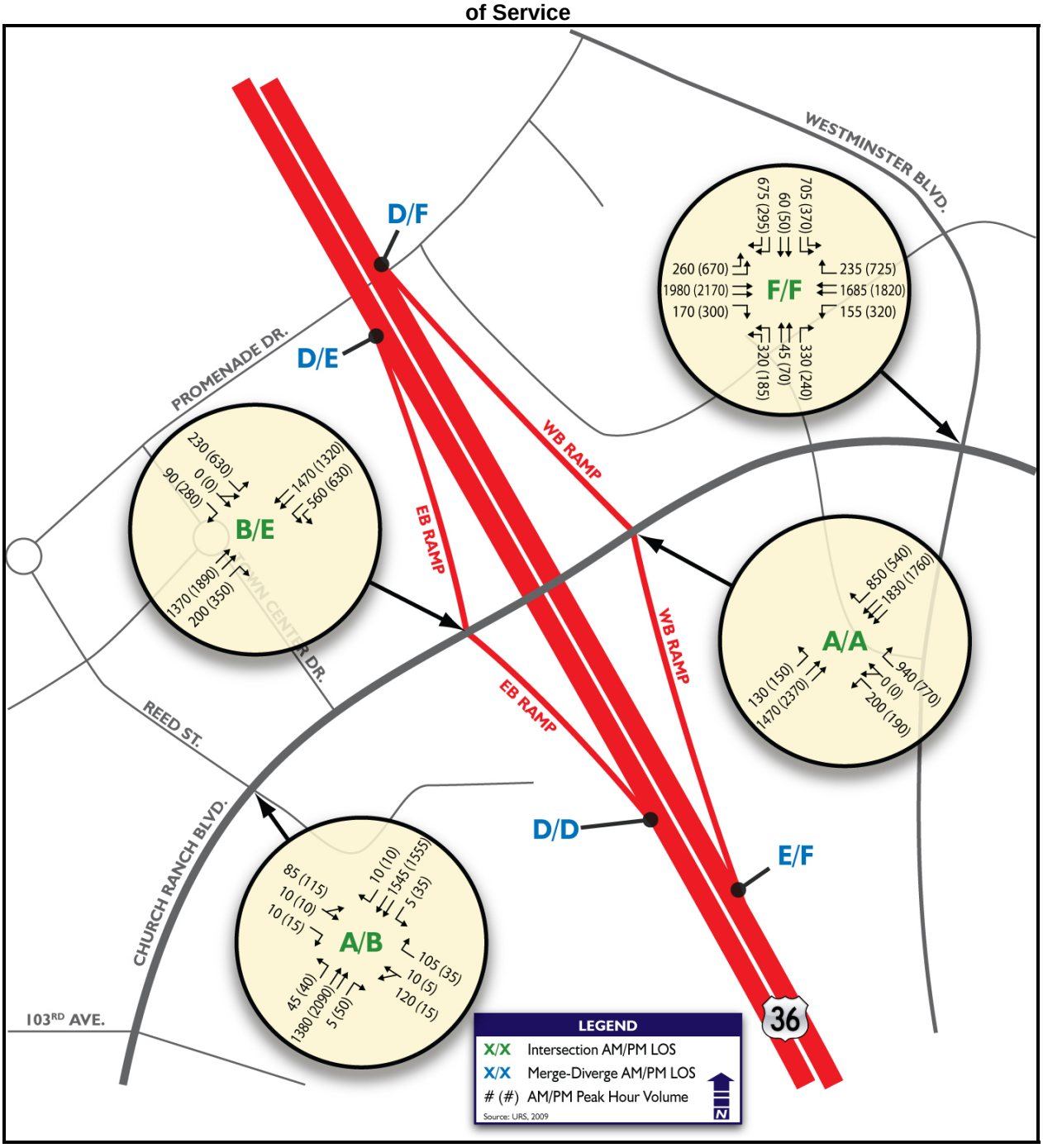
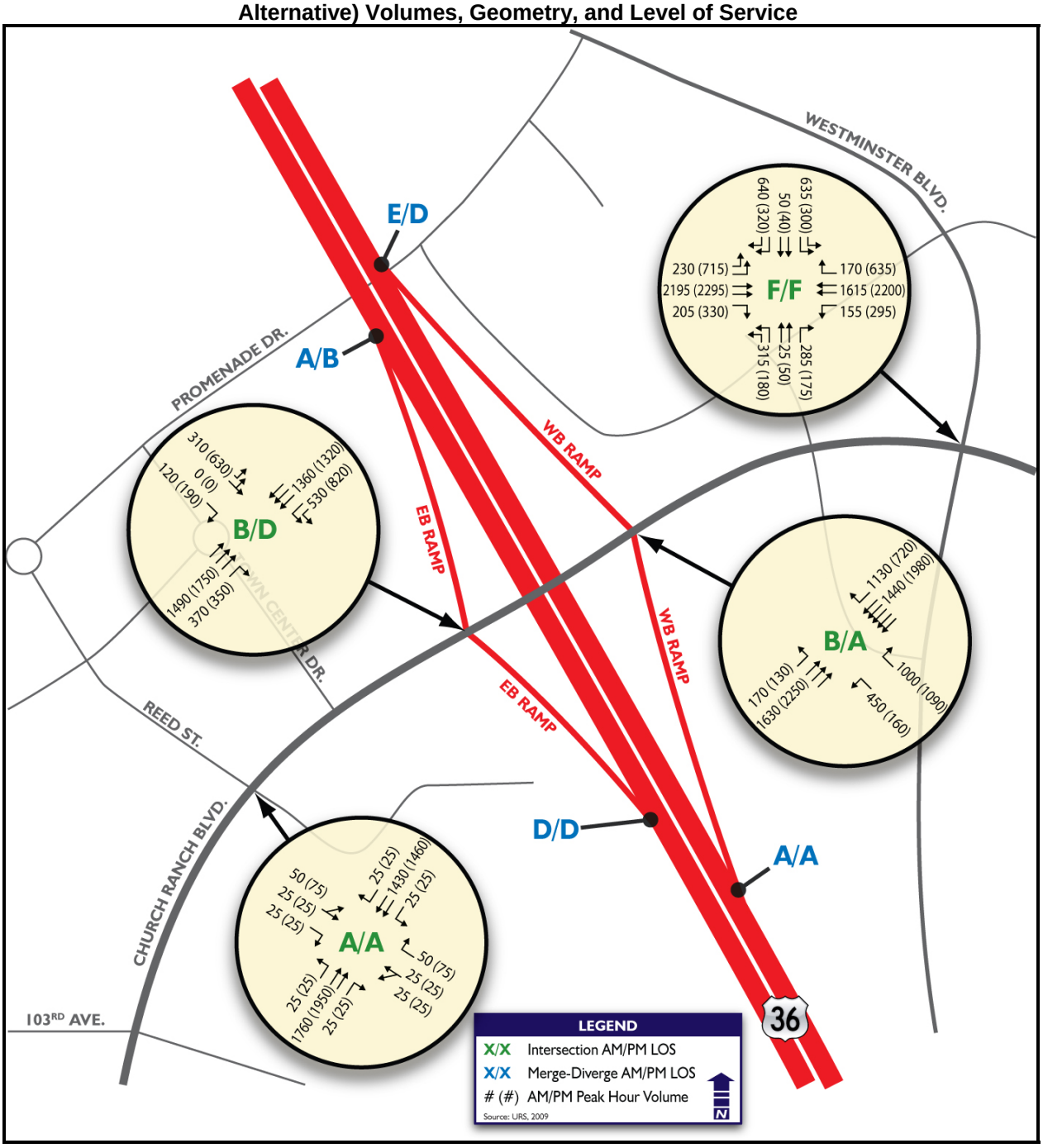


Figure 4.5-4: Church Ranch Boulevard Interchange 2035 Combined Alternative Package (Preferred Alternative) Volumes, Geometry, and Level of Service



4.5.2 Operations Summary

The evaluation of this interchange focused on maintaining acceptable operations at the ramp intersections under the existing geometric configuration. The existing configuration consists of a four-lane Church Ranch Boulevard cross-section with single left-turn (double left turn westbound) and single right-turn lanes. The cross-section between US 36 and Westminster Boulevard would be widened in the Combined Alternative Package (Preferred Alternative) to six lanes to provide additional capacity to accommodate projected traffic growth. The resulting LOS for each alternative is displayed in Table 4.5-1, Church Ranch Boulevard Interchange Area Peak-Hour Level of Service.

Table 4.5-1: Church Ranch Boulevard Interchange Area Peak-Hour Level of Service

Intersection: Church Ranch Boulevard/	Level of Service (a.m./p.m. delay in seconds per vehicle)[1]		
	Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
Westminster Boulevard	C / C (23.5/22.6)	F / F (102.1/111.0)	F / F (92.9/96.9)
Westbound Ramp	A / A (8.2/7.9)	A / A (7.3 /6.9)	B / A (12.9/6.4)
Eastbound Ramp	B / B (11.1/13.7)	B / E (19.9/71.3)	B / D (17.2/43.6)
Commercial Entrance	A / A (6.0/7.0)	A / B (9.2/11.3)	A / A (7.2/8.7)

Source: US 36 Mobility Partnership, 2009.

Notes:

[1]Average delay estimates over 100 seconds should be considered very rough.

a.m. = morning

p.m. = evening

The westbound ramp intersection is expected to operate very well in both alternatives, but the eastbound ramp intersection is expected to experience problems in the p.m. peak hour with Package 1. The widening mentioned above is expected to provide for substantially better operations at this location.

To ensure mitigation of any significant volume changes resulting from the proposed improvements to US 36, a review of the adjacent intersections to each side of the interchange was completed. Mitigation generally included adding turn lanes and, in some instances, through-lanes to the arterial to maintain the operational performance found in Package 1.

At the Church Ranch Boulevard interchange two adjacent intersections were analyzed:

- Church Ranch Boulevard/Westminster Boulevard
- Church Ranch Boulevard/Commercial Entrance

The intersection at Westminster Boulevard is approximately 1,000 feet northeast of the westbound ramp intersection. This intersection serves a significant amount of retail/commercial development as well as Westminster City Park. Westminster Boulevard also serves a residential

area to the north of Church Ranch Boulevard. This particular housing area must use either Westminster Boulevard or Sheridan Boulevard to access US 36. The resulting left and right-turn movements from these developments require double turn lanes, thereby minimizing phasing options.

The Commercial Entrance intersection is approximately 1,000 feet southwest of the eastbound ramp intersection. The existing and forecast turning volumes at this intersection are generally low. With relatively low turning movements, the majority of the green time can be applied to the Church Ranch Boulevard through volume, which represents approximately 90 percent of the intersection traffic. The low turning movements also enable permissive-only phasing resulting in very favorable operations under the existing geometry for all alternatives. Coordination with the interchange intersections is recommended to maximize progression and minimize the potential for queue spillback.

Both adjacent intersections are forecast to operate within the project intersection LOS standard, and would not require mitigation.

4.5.3 Transportation Impacts Summary

Transportation impacts are expected to be minor and beneficial with the Combined Alternative Package (Preferred Alternative). Intersection delay estimates for both peak hours are forecast to meet the project intersection LOS standard without mitigation.

Mitigations — Because no adverse impacts would occur, no mitigation treatment is proposed at this location.

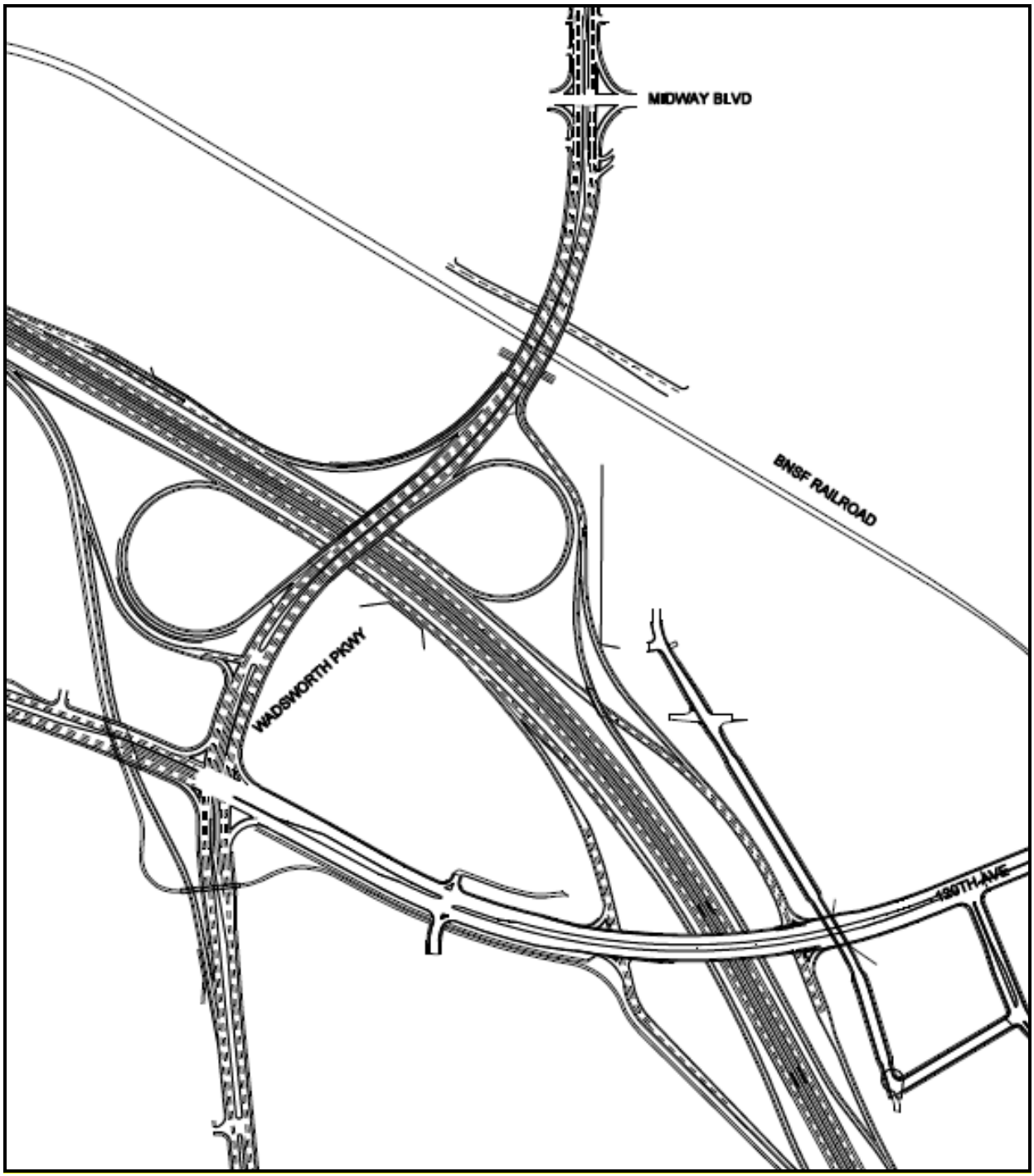
4.6 WADSWORTH PARKWAY/120TH AVENUE INTERCHANGE

The Wadsworth Parkway/120th Avenue interchange also includes access to US 287 to the north and SH 128 to the south.

Description and Context — The existing interchange configuration at Wadsworth Parkway is a conventional diamond with arterial left-turn lanes provided off the US 36 overpass structure. Currently, 120th Avenue intersects Wadsworth Parkway north of US 36 with loop-ramps and continues south along Wadsworth Parkway until splitting west along Highway 128 to the north of the Jefferson County Airport. A review of traffic counts and model volume forecasts indicates a significant number of vehicles traveling from 120th Avenue to SH 128. This traffic must travel through the Wadsworth Parkway interchange intersections, which increases the demand at these intersections. Alternatives designed to reduce this additional demand from 120th Avenue were evaluated.

Proposed Configuration — The proposed configuration of this interchange was determined by a separate feasibility study and environmental clearance process conducted by the City and County of Broomfield and CDOT. The partial-cloverleaf configuration shown in Figure 4.6-1, Wadsworth Parkway/120th Avenue Interchange Combined Alternative Package (Preferred Alternative) Configuration, would remove on-ramp left-turn movements from the Wadsworth Parkway/US 287 portion of the interchange and add considerable local capacity. Peak-hour intersection volumes, lanes, and LOS are shown for the Wadsworth Parkway interchange area in Figures 4.6-2, 4.6-3, and 4.6-4 for existing, 2035 Package 1, and 2035 Combined Alternative Package (Preferred Alternative) conditions, respectively.

Figure 4.6-1: Wadsworth Parkway/120th Avenue Interchange Combined Alternative Package (Preferred Alternative) Configuration



Source: US 36 Mobility Partnership, 2009.

Figure 4.6-2: Wadsworth Parkway/120th Avenue Interchange Existing Volumes, Geometry, and Level of Service

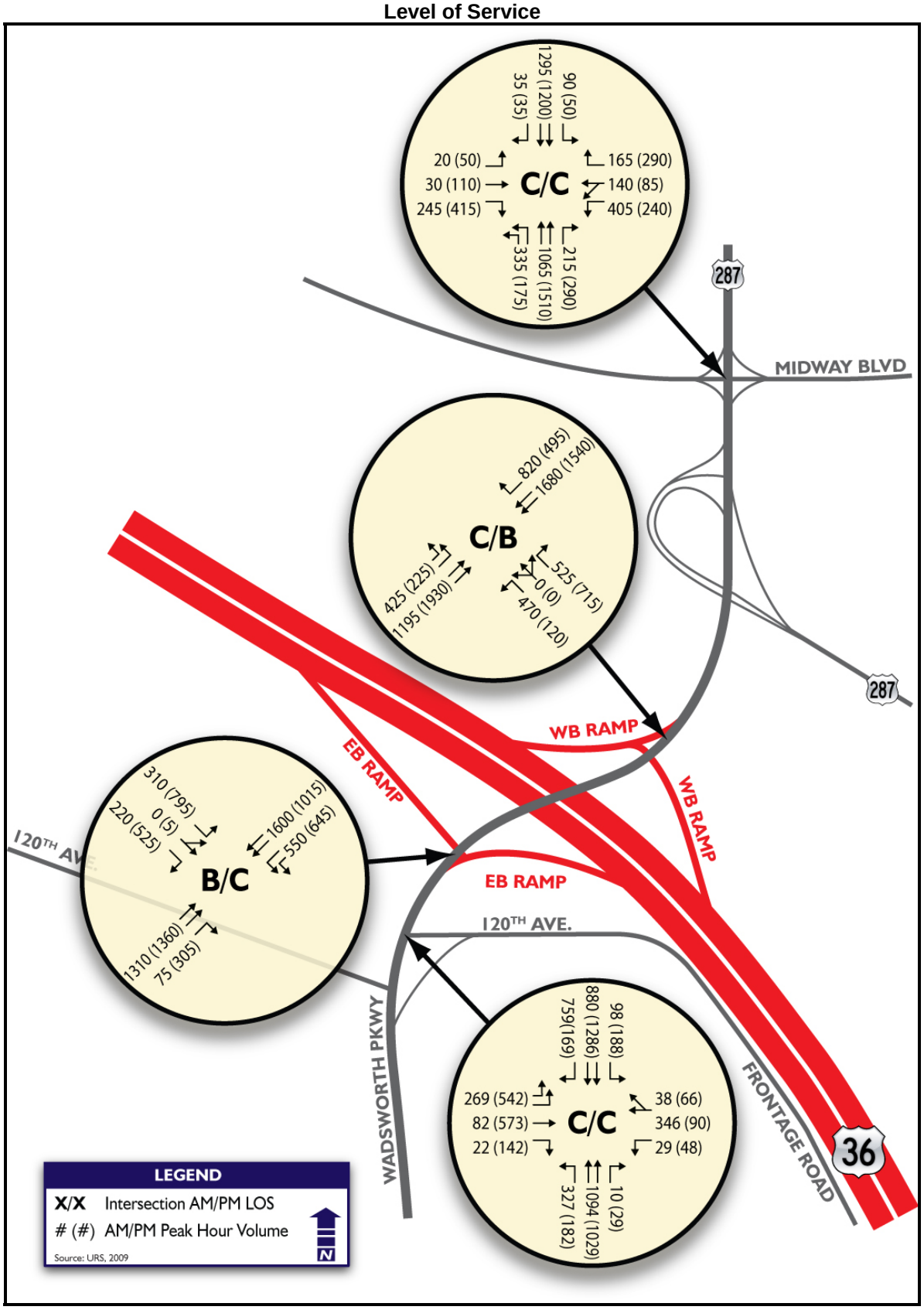


Figure 4.6-3: Wadsworth Parkway/120th Avenue Interchange 2035 No Action Volumes, Geometry, and Level of Service

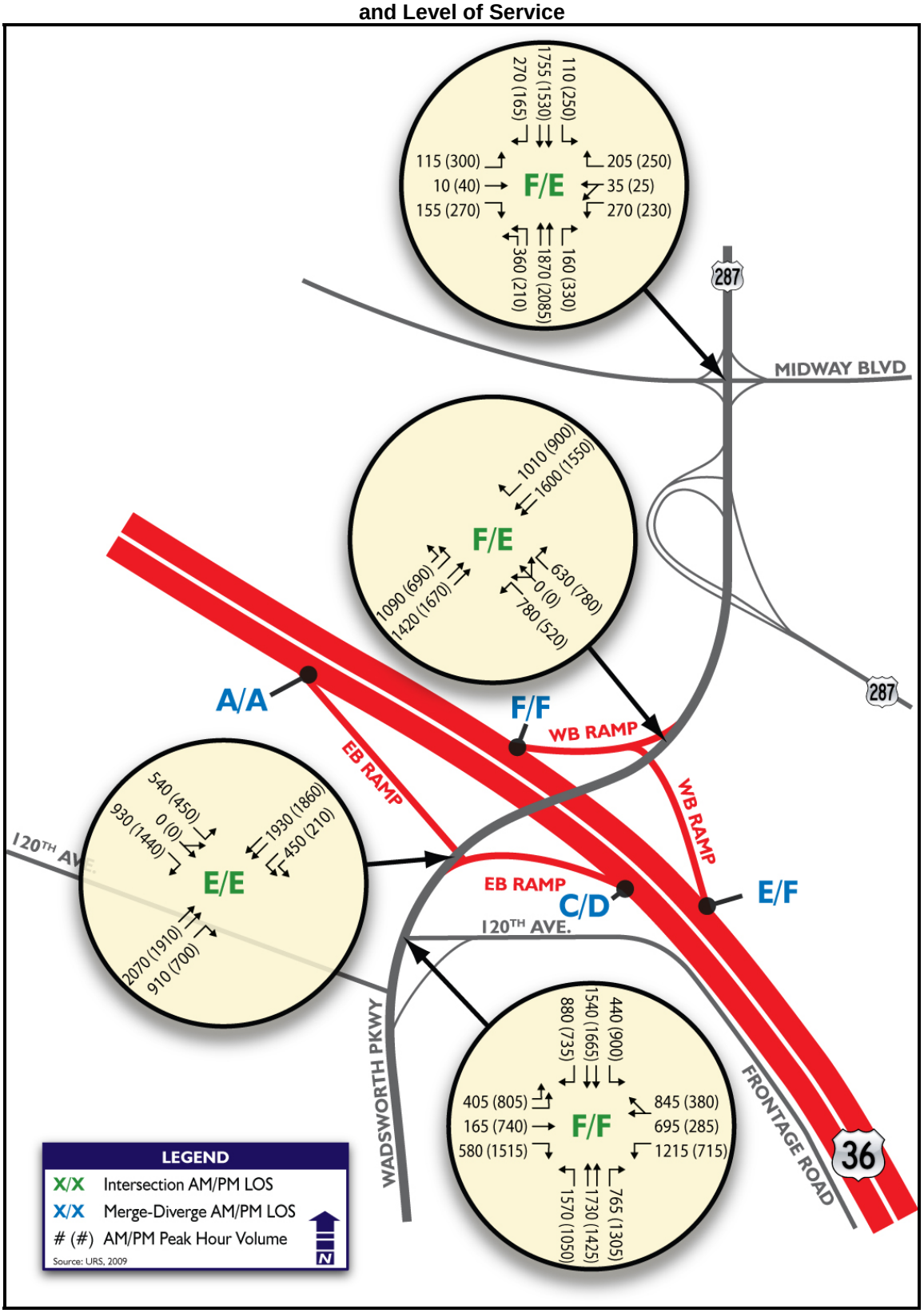
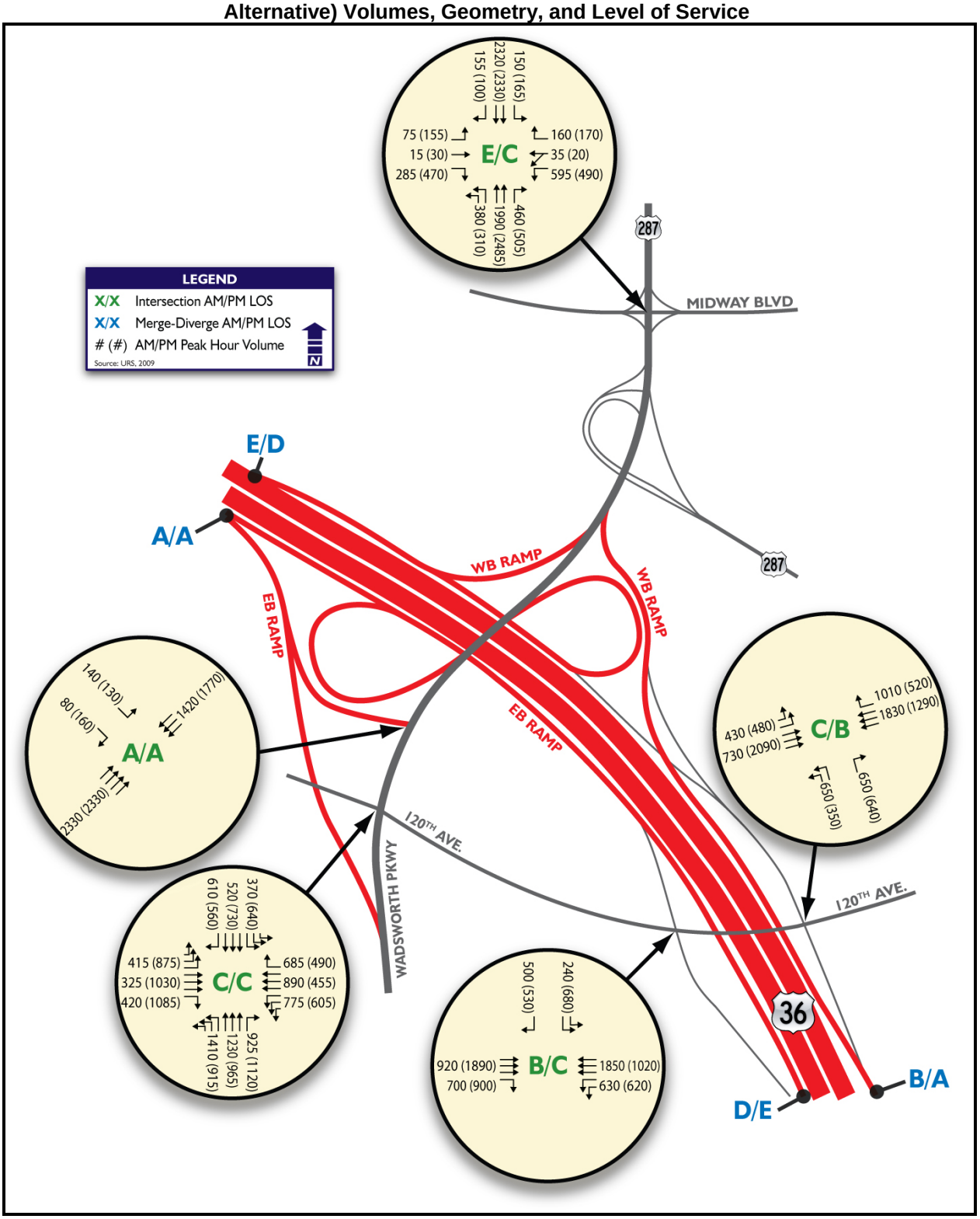


Figure 4.6-4: Wadsworth Parkway/120th Avenue 2035 Combined Alternative Package (Preferred Alternative) Volumes, Geometry, and Level of Service



4.6.1 Interchange Volumes

The single-family housing and industrial land use north of US 36, as well as the Jefferson County Airport located south of US 36 primarily influence trip distribution in this area. The principal commuter routes are Wadsworth Parkway/US 287, 120th Avenue (SH 121), and US 36. Wadsworth Parkway serves north-south traffic, while 120th Avenue serves east-west traffic.

4.6.2 Operations Summary

The Combined Alternative Package (Preferred Alternative) configuration would have substantially more capacity than the existing configuration assumed for Package 1. The Wadsworth Parkway/120th Avenue intersection was designed to handle projected traffic loads as part of this project itself, as opposed to being subjected to the more traditional impact/mitigation identification process. This treatment results from the fact that the proposed interchange improvements in the Combined Alternative Package (Preferred Alternative) would substantially change the character and amount of traffic using the intersection beyond the traditional definition of impact. Additionally, the cost of rebuilding the intersection would be included in the cost of the project. The resulting LOS for each alternative is displayed in Table 4.6-1, Wadsworth Parkway/120th Avenue Interchange Area Peak-Hour Level of Service.

Table 4.6-1: Wadsworth Parkway/120th Avenue Interchange Area Peak-Hour Level of Service

Intersection		Level of Service (a.m./p.m. delay in seconds per vehicle)[1]		
		Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
Wadsworth	Midway Boulevard	C / C (27.3/24.7)	F / E (69.0/59.6)	F / F (162.4/114.5)
	Midway Boulevard with Mitigation	*N/A*	*N/A*	*E / C (59.6/31.5)*
	Westbound Ramp	C / B (31.3/19.2)	F / E (132.1/62.6)	N/A
	Eastbound Ramp	B / C (10.6/27.5)	E / E (68.9/74.1)	A / A (4.5/4.2)
120th Avenue	Westbound Ramp	N/A	N/A	C / B (28.5/13.2)
	Eastbound Ramp	N/A	N/A	B / C (10.3/23.7)
	Wadsworth Parkway	C / C (25.9/34.9)	F / F (*/*)	C / C (30.4/31.0)

Source: US 36 Mobility Partnership, 2009.

Notes:

[1]Average delay estimates over 100 seconds should be considered very rough.

*Delays too high to measure reliably (estimated over 500 seconds per vehicle)

a.m. = morning

N/A = not applicable

p.m. = evening

When interpreting intersection LOS results at diamond interchanges, there is the potential for the overall LOS, a weighted average, to under represent ramp queuing and congestion. In the case of the Wadsworth Parkway/120th Avenue interchange, the existing intersection conditions are commonly observed to be worse than those implied by the LOS results shown in the table above. This phenomenon is caused by two factors. First, large traffic volumes moving north and south through the interchange (but not going to or coming from a US 36 ramp) do not have to stop, and therefore experience very low delay. Second, ramp traffic receives relatively less time at the intersection, which causes queues that are very visible to observers and often frustrating to drivers.

The Combined Alternative Package (Preferred Alternative) configuration would incorporate loop-ramps in the northeast and southwest quadrants of Wadsworth Parkway and US 36. These loop-ramps would provide access to both directions of US 36, thereby eliminating Wadsworth Parkway on-ramp left-turn movements. This configuration would also provide a grade-separated roadway for eastbound US 36 traffic destined for southbound Wadsworth Parkway to bypass the 120th Avenue/Wadsworth Parkway intersection. Additionally, this configuration includes a braided connection between Wadsworth Parkway and 120th Avenue to the north of US 36, which allows traffic from 120th Avenue to bypass Wadsworth Parkway for access to US 36.

The Combined Alternative Package (Preferred Alternative) configuration provides more intersection flexibility along Wadsworth Parkway because demand is well below capacity as a result of the loop-ramps removing on-ramp left-turns from the intersection. Without having to serve left turns at the Wadsworth Parkway intersections, more green time can be provided for other movements. Removing the left turns not only reduces the number of signal phases but also reduces the critical volume at each intersection, which serves to improve operational efficiency and potential volume fluctuations. Providing the northeast loop-ramp also enables the intersection to operate without signalized control. Removing this signal should provide better arterial progression while eliminating queues at this location.

To ensure mitigation of any significant volume changes resulting from the proposed improvements to US 36, a review of the adjacent intersections to each side of the interchange was completed. Mitigation generally included adding turn lanes and, in some instances, through-lanes to the arterial to maintain the operational performance found in Package 1.

At the Broomfield interchange there are two adjacent intersections of concern:

- Wadsworth Parkway/120th Avenue
- Wadsworth Parkway/Midway Boulevard

The most congested intersection is the Wadsworth Parkway/120th Avenue intersection. Improvements designed to increase the capacity were included in the Combined Alternative Package (Preferred Alternative). The regional model forecasts the Wadsworth Parkway/120th Avenue intersection to carry extremely high traffic volumes in 2035. In some cases, forecast turning movements were much higher than could reasonably be expected to make the maneuver within an hour. The existing configuration would result in extreme LOS F conditions if it were required to carry 2035 forecast volumes. The proposed configuration from the 120th Avenue Interchange Environmental Assessment was assumed to be built as part of the Combined Alternative Package (Preferred Alternative), and would accommodate projected traffic volumes within the project LOS standard.

The LOS and delay at the Midway Boulevard intersection was forecast to be worse than Package 1 and would not meet the project standard under the Combined Alternative Package (Preferred Alternative). The effective mitigation for the impact of the Combined Alternative Package (Preferred Alternative) would be a slight reconfiguration of the intersection to eliminate the need for east-west split phasing. The westbound approach would be re-striped and re-signed so that through-movement occurs from the rightmost of the three available lanes, and the two left lanes would be available for left turns only.

4.6.3 Transportation Impacts Summary

The traffic impacts of the proposed alternatives at the Wadsworth Parkway/120th Avenue interchange would be generally confined to the Midway Boulevard intersection. The interchange ramp junction intersections are forecast to operate at LOS C or better in the Combined Alternative Package (Preferred Alternative). At Midway Boulevard, the impacts of the Combined Alternative Package (Preferred Alternative) could be mitigated through a minor widening and phasing change.

4.6.4 Design of the Wadsworth Parkway/120th Avenue Intersection

The regional model projected the Wadsworth Parkway/120th Avenue intersection to carry extremely high traffic volumes in the 2035 scenarios. In some cases, projected turning movements were much higher than could reasonably be expected to make the turn within an hour. To respond to this demand, triple left-turn lanes were proposed at the Wadsworth Parkway/120th Avenue intersection in all directions. However, the volumes underlying this decision should be considered rough estimates and are subject to refinement through more detailed analysis in the FEIS process. If the very high volume projections are corroborated through more sophisticated analysis (not a part of this), the Wadsworth Parkway/120th Avenue intersection could be redesigned to include a major configuration change, possibly including the grade-separation of some turning movements.

Mitigations — Closure of Carr Street at 120th Avenue would require the properties that remain along that block to reorient access to Commerce Street to the east. Connections would be provided or the businesses' access routes would be adjusted to Commerce Street to maintain operations of these parcels.

At the Midway Boulevard and Wadsworth Parkway/US 287 intersection, the east leg of the intersection would be widened to mitigate traffic impacts because of increased delay in the Combined Alternative Package (Preferred Alternative). The approach would be re-striped for dual left-turn lanes and a separate through + right-turn lane. The resulting intersection LOS would still be F for both the a.m. and p.m. peak-hours. The mitigation would result in considerably lower delay than Package 1.

4.7 INTERLOCKEN/FLATIRON INTERCHANGE COMPLEX

Description and Context — The Interlocken interchange area contains three distinct interchanges (West Flatiron Circle, Interlocken Loop, and East Flatrion) along US 36. This interchange system provides full access at Interlocken and partial access at both West and East Flatiron Circle.

The West Flatiron Circle interchange configuration is a half-interchange, with access only provided from US 36 eastbound and to US 36 westbound. This interchange provides access to FlatIron Crossing and single-family housing to the west along Coalton Road. The West Flatiron Circle ramps terminate at a 3-legged intersection near the northwest corner of the mall property. The intersection was an all-way stop when counts were conducted, and it was signalized in 2006.

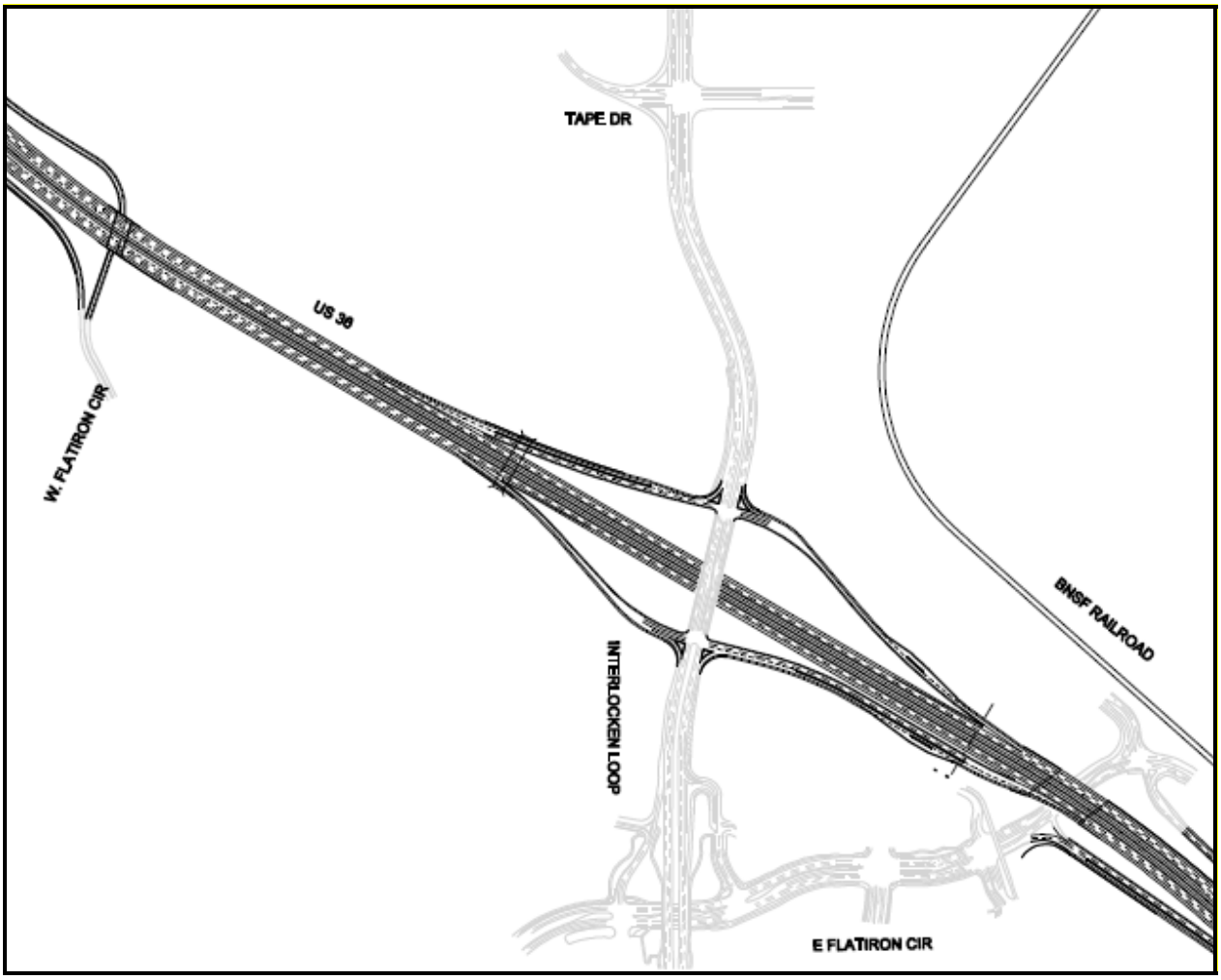
The existing interchange configuration at Interlocken Loop is a conventional diamond with external left-turn storage for southbound traffic. Interlocken Loop is the primary north-south route for this area, providing connection to regional east-west routes. To the south it connects with Highway 128 and provides access to Jefferson County Airport, while to the north it becomes Northwest Parkway, which is the extension of the E-470 loop west of I-25. The commercial/retail development to the south of US 36, which includes FlatIron Crossing, is the primary origin/destination for Interlocken interchange traffic.

The third grade-separated access at Interlocken Boulevard is provided at the East Flatiron Circle interchange. The existing interchange configuration is a half diamond with access provided to US 36 eastbound and from US 36 westbound. This interchange serves the commercial/retail development to the south of US 36, while also providing access to the RTD park-n-Ride.

Proposed Configuration — The Combined Alternative Package (Preferred Alternative) contains no significant geometric or operational changes to the Interlocken interchange area. With the exception of possible turn lane extensions and minor ramp modifications associated with US 36 widening, the interchanges would be configured much as they are today.

The roadway facilities in the Interlocken interchange area were designed and constructed to handle not only retail and office-oriented traffic from US 36 and the Northwest Parkway, but also traffic from a potential limited-access highway connection to the south, which was under study in the past, in the Northwest Corridor EIS project (terminated prior to completion). It is important to note that this US 36 Corridor EIS does not assume that such a connection is in place. If a new highway connection to the south were built at or near the current southern terminus of Interlocken Loop (at Highway 128), the traffic impacts of the Combined Alternative Package (Preferred Alternative) on such a connection would need to be examined. The proposed configuration of the Interlocken interchange is shown in Figure 4.7-1, Interlocken Loop Interchange Combined Alternative Package (Preferred Alternative) Configuration. Peak-hour intersection volumes, lanes, and LOS are shown for the Interlocken Loop interchange area in Figures 4.7-2, 4.7-3, and 4.7-4 for existing, 2035 Package 1, and 2035 Combined Alternative Package (Preferred Alternative) conditions, respectively.

Figure 4.7-1: Interlocken Loop Interchange Combined Alternative Package (Preferred Alternative) Configuration



Source: US 36 Mobility Partnership, 2009.

Figure 4.7-2: Interlocken Loop Interchange Existing Volumes, Geometry, and Level of Service

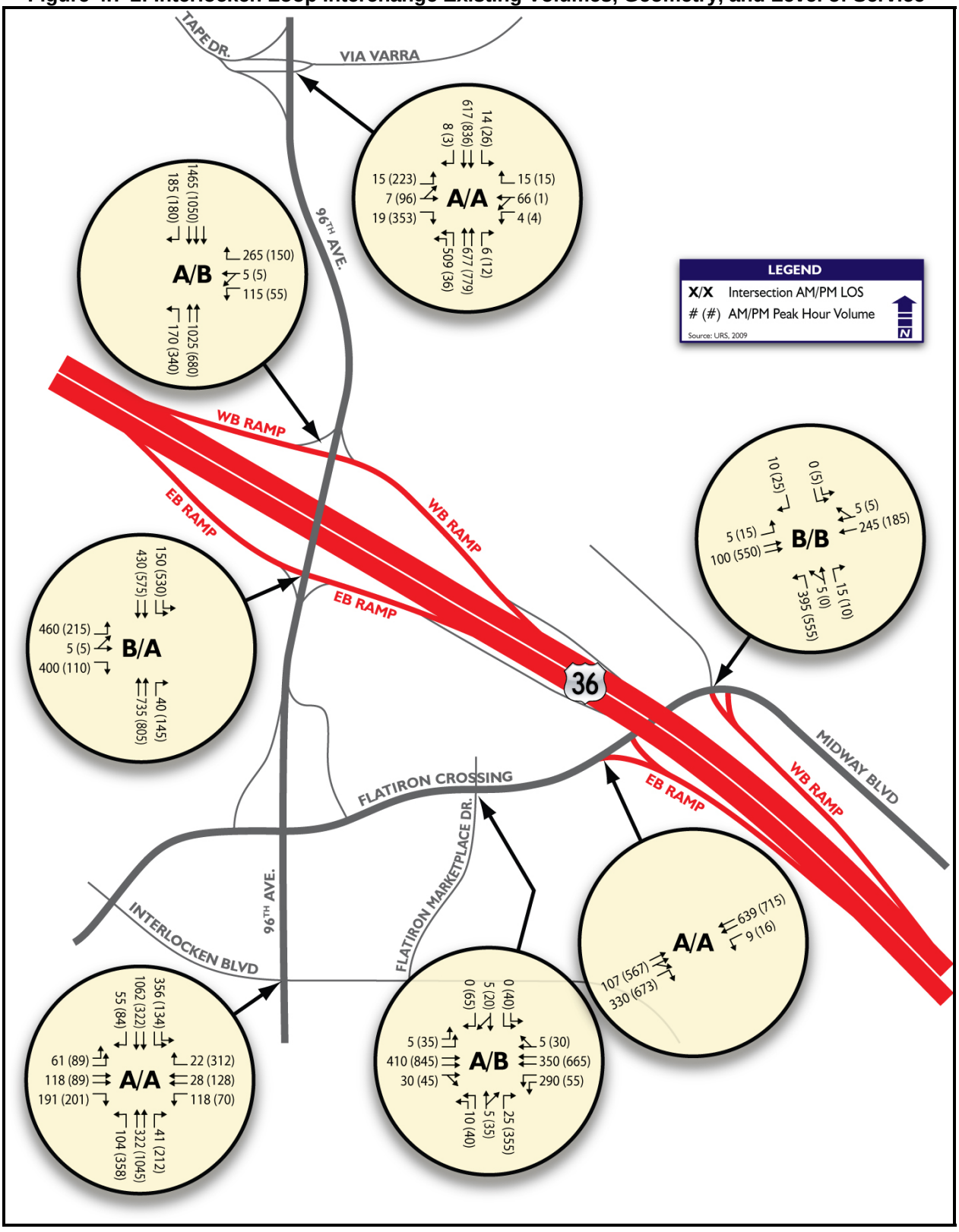


Figure 4.7-3: Interlocken Loop Interchange 2035 No Action Volumes, Geometry, and Level of Service

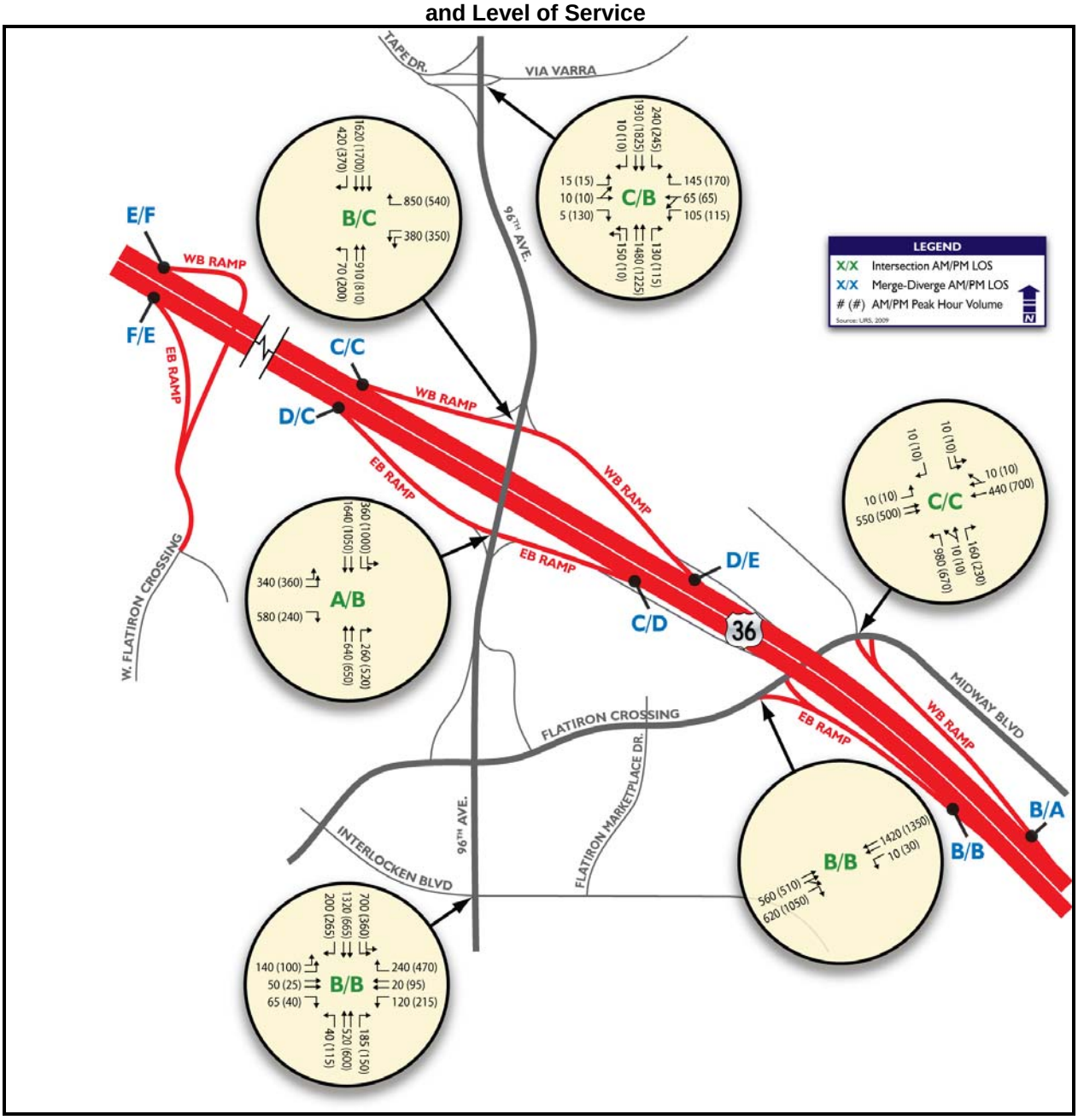
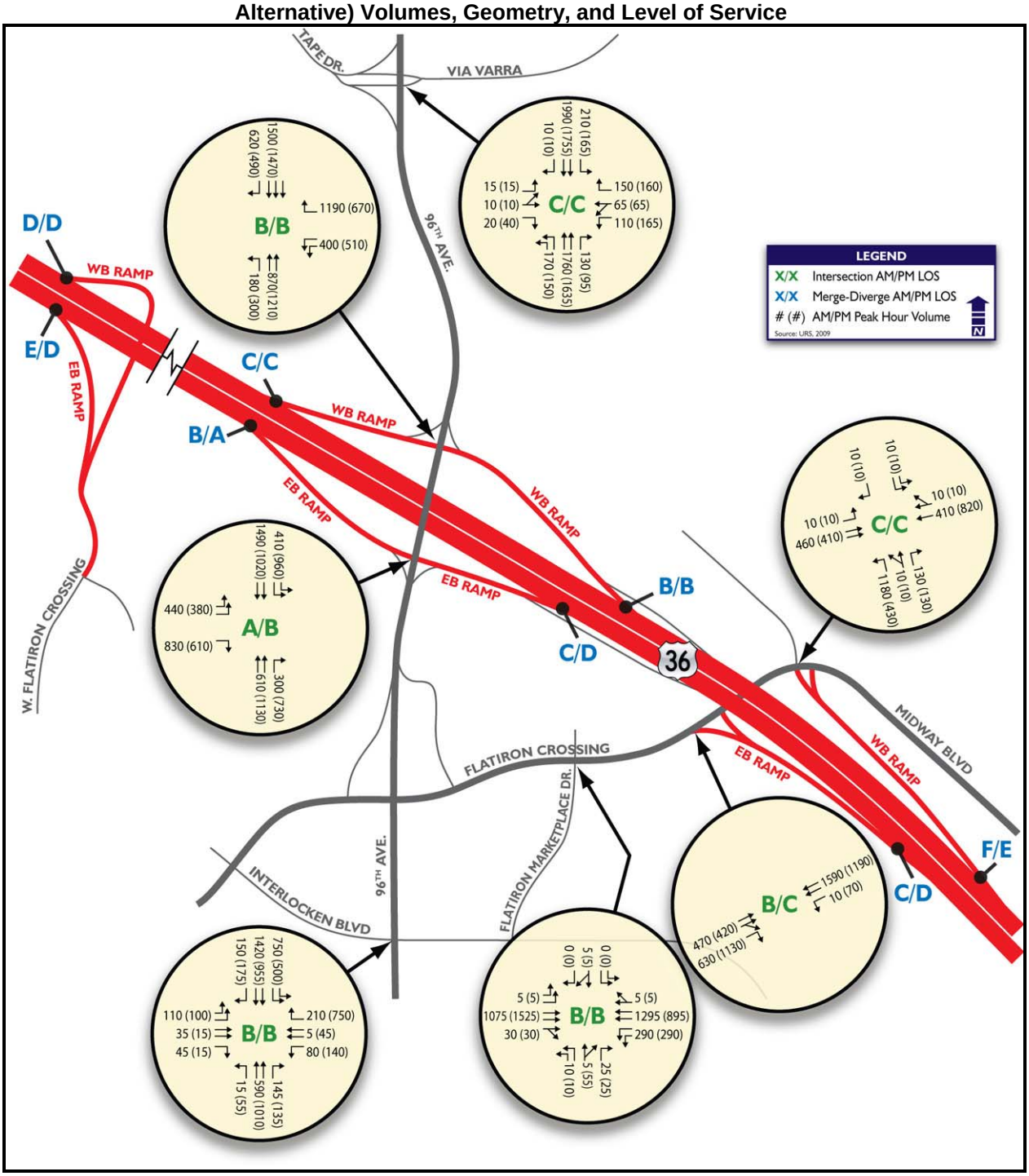


Figure 4.7-4: Interlocken Loop Interchange 2035 Combined Alternative Package (Preferred Alternative) Volumes, Geometry, and Level of Service



4.7.1 Interchange Volumes

Interlocken Loop is the primary north-south route for this area, providing connection to regional east-west routes. To the south it connects with SH 128 and provides access to Rocky Mountain Metropolitan Airport, while to the north it becomes Northwest Parkway. The commercial/retail development to the south of US 36, which includes FlatIron Crossing Mall, is a primary origin/destination for Interlocken traffic. All three interchanges provide access to the FlatIron Crossing Mall, while also serving offices, other land uses, and transit stations along US 36.

4.7.2 Operations Summary

The evaluation of this interchange focused on maintaining acceptable operations at the ramp intersections under the existing geometric configuration. The existing configuration along West Flatiron Circle is a two-lane cross-section with a single left-turn lane at FlatIron Crossing. Interlocken Loop has a four-lane cross-section to the north of US 36 and a six-lane section to the south. Single and double left-turn lanes are provided, along with single right-turn lanes.

The East Flatiron Circle interchange is also a six-lane roadway to the south of US 36 and a four-lane roadway to the north. East Flatiron Circle turns east, north of US 36, and becomes Midway Boulevard, which narrows to a two-lane roadway. Low left-turn demand at the eastbound ramp intersection allows unsignalized control, which affords more spacing of the signalized intersections to the west.

The resulting LOS for each alternative are displayed in Table 4.7-1, Interlocken Loop Interchange Area Peak-Hour Level of Service.

Table 4.7-1: Interlocken Loop Interchange Area Peak-Hour Level of Service

Intersection: Interlocken Loop/		Level of Service (a.m./p.m. delay in seconds per vehicle)		
		Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
Interlocken Loop	Tape Drive	A / A (3.0/7.2)	C / B (26.2/19.0)	C / C (30.6/21.0)
	Westbound Ramp	A / B (2.6/10.6)	B / C (11.3/21.4)	B / B (12.9/16.2)
	Eastbound Ramp	B / A (10.4/5.3)	A / B (9.7/19.8)	A / B (9.4/19.6)
	Interlocken Boulevard	A / A (7.0/9.9)	B / B (10.3/19.1)	B / B (18.8/17.0)

Table 4.7-1: Interlocken Loop Interchange Area Peak-Hour Level of Service

Intersection: Interlocken Loop/		Level of Service (a.m./p.m. delay in seconds per vehicle)		
		Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
East Flatiron Circle	Westbound Ramp	B / B (19.5/11.7)	C / C (20.9/21.9)	C / C (21.8/27.1)
	Eastbound Ramp[1]	A / A (7.5/8.7)	B / B (11.3/15.0)	B / C (11.2/17.0)
	Marketplace (East)	A / B (10.0/17.0)	B / B (11.5/12.0)	B / B (13.4/16.7)

Source: US 36 Mobility Partnership, 2009.

Note:

[1] Level of service and delay at the unsignalized East Flatiron Circle/Eastbound ramp intersection are shown for the East Flatiron Circle southbound left-turn movement.

a.m. = morning

p.m. = evening

As designed, the Interlocken interchange layout provides adequate capacity to handle the forecasted traffic volumes in this area. By providing access at both East and West Flatiron Circle, the demand along Interlocken Loop is reduced. This reduction in demand results in improved operational performance for the interchange intersections as well as the arterial intersections. The drawback to this design is additional entry and exit points along US 36 are introduced, resulting in more areas of potential conflict for US 36 traffic. The West Flatiron Circle interchange is not analyzed here because it carries low volumes, and as of 2003 had no signals in the immediate vicinity. The single combined ramp junction intersection was signalized in about 2005.

Interlocken Boulevard has both at-grade and grade-separated intersections in the vicinity of US 36. The grade-separated intersection at East Flatiron Circle provides uninterrupted flow for Interlocken Boulevard; therefore, operational impacts along Interlocken Boulevard are limited to the merging/diverging of traffic. Consequently, the only adjacent intersections examined were:

- Interlocken Loop/Tape Drive
- Interlocken Loop/Interlocken Boulevard
- East Flatiron Circle/Flatiron Marketplace (East)

The Interlocken Boulevard intersection is located approximately 2,000 feet south of the eastbound ramp intersection and approximately 600 feet south of the East Flatiron Circle grade-separated intersection. Operations at this intersection are favorable under the existing geometry. As a result, no queues or individual movement delays are of concern.

The Flatiron Marketplace (east) signal on East Flatiron Circle is the closest signalized intersection to the East Flatiron Circle interchange. It serves a relatively small retail area in coordination with the Flatiron Marketplace (west) signal, about 500 feet to the west. The Flatiron Marketplace (east) signal operates at LOS B or better in all forecast 2035 peak-hour scenarios.

4.7.3 Transportation Impacts Summary

The Combined Alternative Package (Preferred Alternative) would increase ramp junction intersection activity in varying degrees, but all signalized intersections examined would operate within the project LOS standard and at LOS C or better.

Mitigations — Since no adverse impacts would occur, no mitigation treatments are proposed.

4.8 MCCASLIN BOULEVARD INTERCHANGE

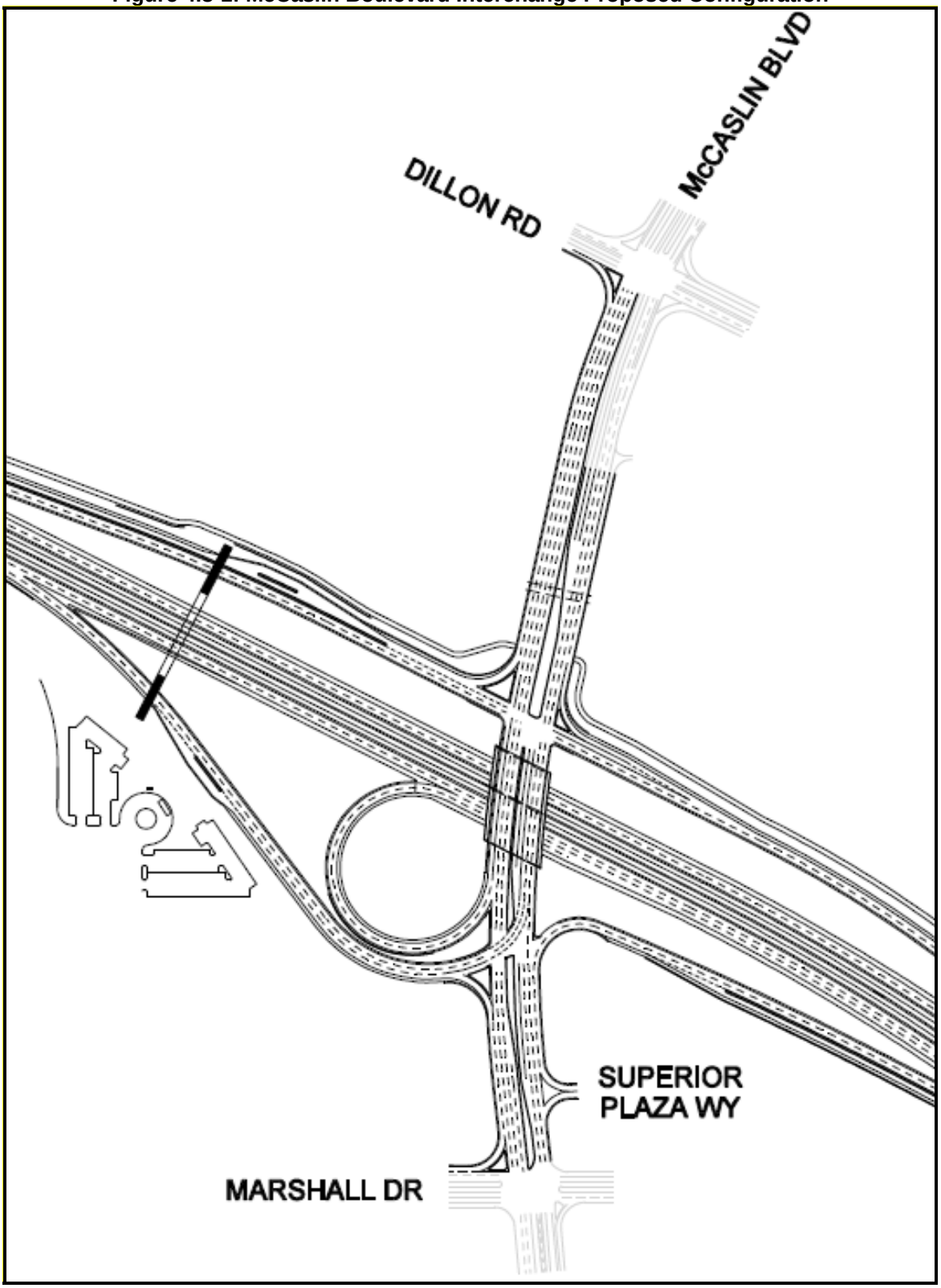
Description and Context — The existing interchange configuration at McCaslin Boulevard is a conventional diamond with a loop on-ramp to eastbound US 36. The loop on-ramp removes arterial left-turns at the eastbound ramp intersection, resulting in increased capacity for McCaslin Boulevard and the US 36 off-ramp. Land use in this area is primarily retail/commercial development. Access through this section of McCaslin Boulevard is comprised of both signalized intersections and limited access right-in/right-out intersections. The majority of the access to the retail/commercial development is provided from the adjacent roadways, Dillon Road and Marshall Drive (see Figure 4.8-1, McCaslin Boulevard Interchange Proposed Configuration).

Proposed Configuration — The McCaslin Boulevard interchange had a new loop on-ramp to eastbound US 36 added in 2005 by the Town of Superior and City of Louisville. The loop on-ramp (which is located in the southwest quadrant of the interchange) removed southbound left-turns at the eastbound ramp intersection, resulting in increased capacity for McCaslin Boulevard and the US 36 off-ramp. It also allowed for the width of the existing US 36 overpass to be used more efficiently. This loop is included in both Package 1 and Combined Alternative Package (Preferred Alternative). The proposed interchange configuration is shown in Figure 4.8-1, McCaslin Boulevard Interchange Proposed Configuration.

4.8.1 Interchange Volumes

The principal commuter routes in this area are McCaslin Boulevard, Marshall Drive, and Dillon Road. McCaslin Boulevard is a minor arterial providing north-south travel between SH 128 to the south and South Boulder Road to the north. Marshall Drive and Dillon Road are similar roadways in the fact that each provides east-west travel and access to the major retail/commercial developments in the area. Marshall Drive serves the area south of US 36 and west of McCaslin Boulevard, while Dillon Road serves the development north of US 36. A review of traffic counts and model volume forecasts indicates that traffic has a southern orientation (55/45) in the a.m. peak and a northern split (60/40) in the p.m. peak. Peak-hour intersection volumes, lanes, and LOS are shown for the McCaslin Boulevard interchange area in Figures 4.8-2, 4.8-3, and 4.8-4 for existing, 2035 Package 1, and 2035 Combined Alternative Package (Preferred Alternative) conditions, respectively.

Figure 4.8-1: McCaslin Boulevard Interchange Proposed Configuration



Source: US 36 Mobility Partnership, 2009.

Figure 4.8-2: McCaslin Boulevard Interchange Existing Volumes, Geometry, and Level of Service

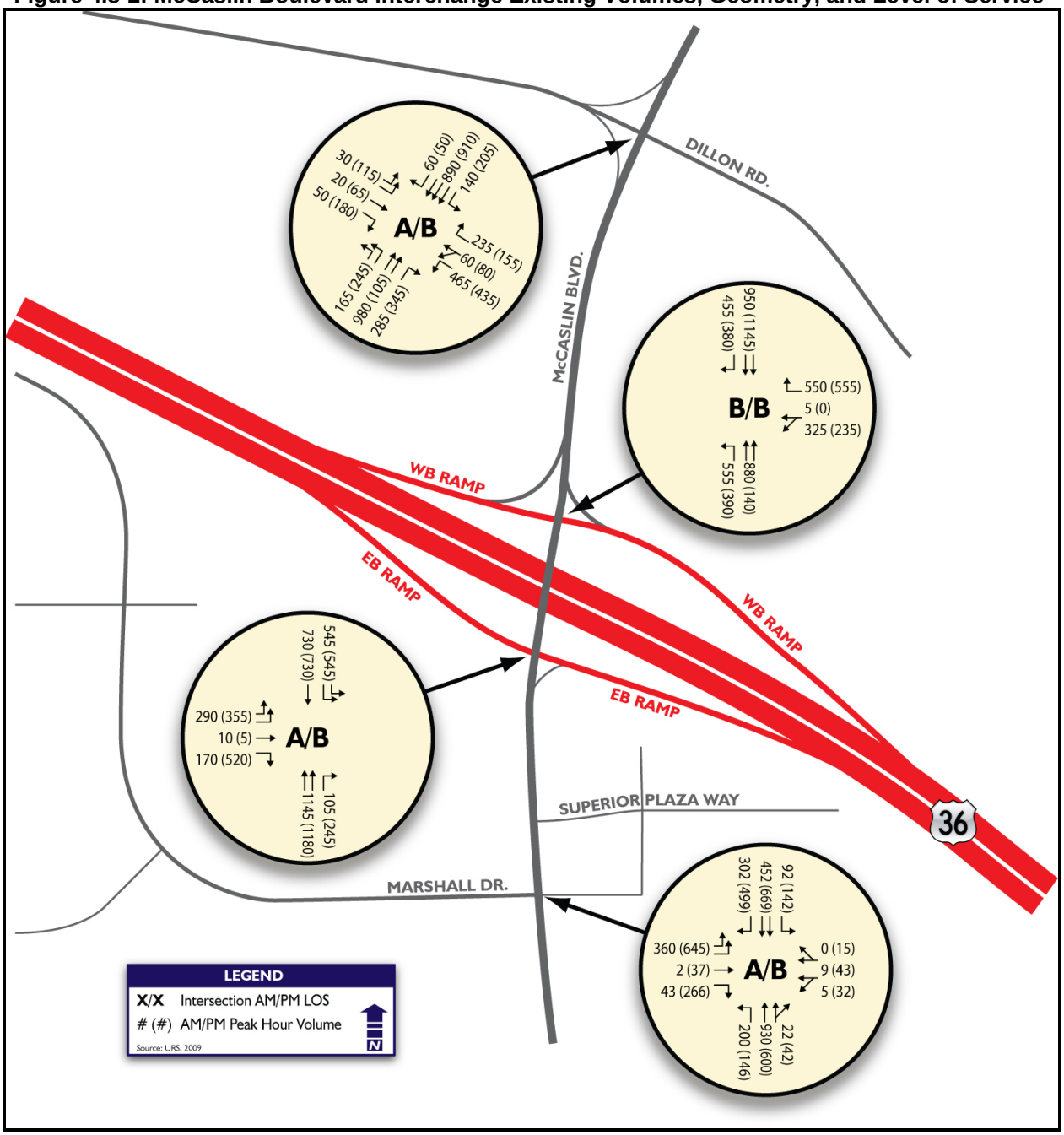


Figure 4.8-3: McCaslin Boulevard Interchange 2035 No Action Volumes, Geometry, and Level of Service

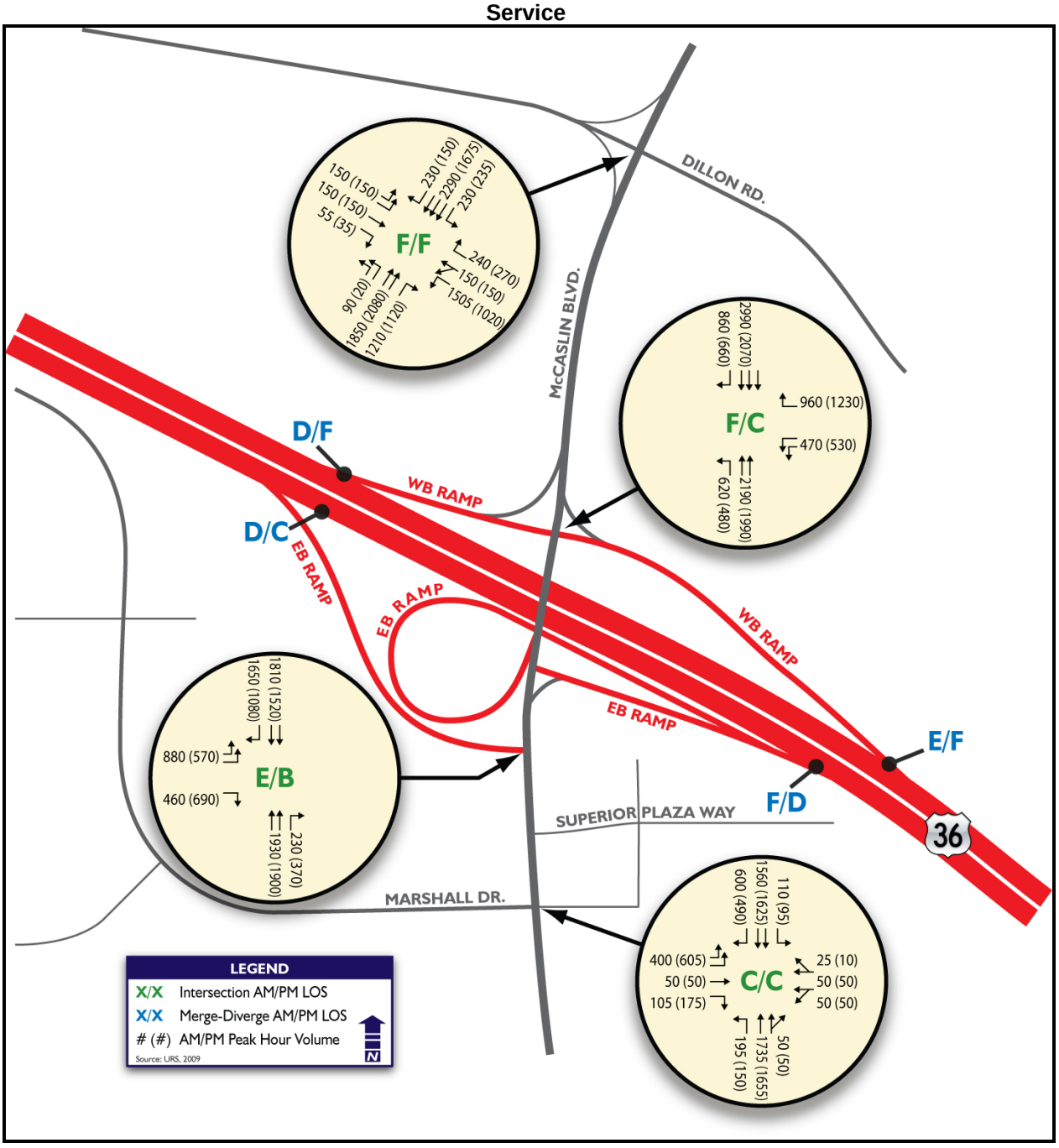
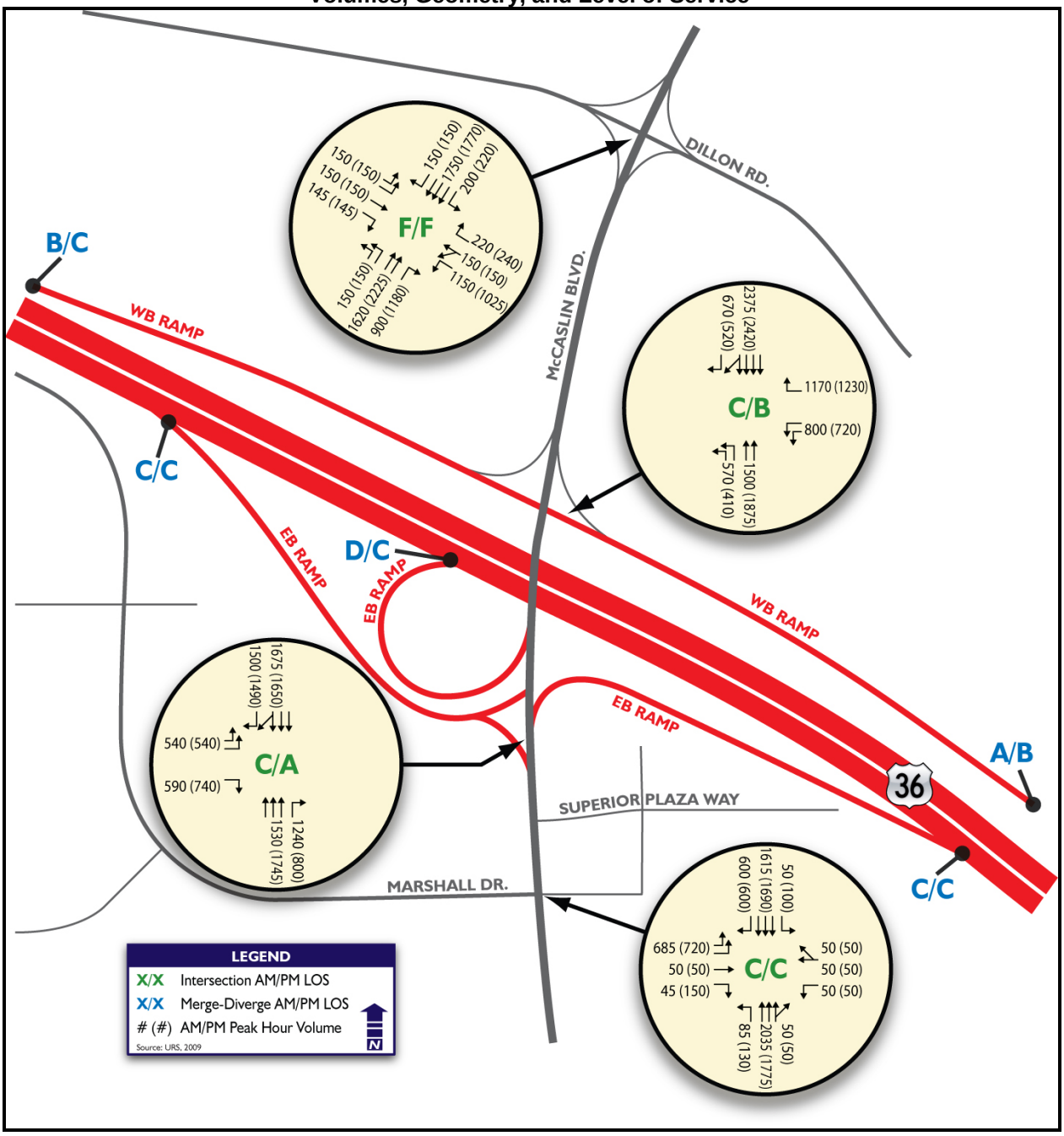


Figure 4.8-4: McCaslin Boulevard 2035 Combined Alternative Package (Preferred Alternative) Volumes, Geometry, and Level of Service



4.8.2 Operations Summary

The evaluation of this interchange focused on maintaining acceptable operations at the ramp intersections under the proposed geometric configuration. The existing configuration consists of a six-lane cross-section with single left- and right-turn lanes. The resulting LOS for each alternative are displayed in Table 4.8-1, McCaslin Boulevard Interchange Peak-Hour Level of Service**.**

Table 4.8-1: McCaslin Boulevard Interchange Peak-Hour Level of Service

Intersection: McCaslin Boulevard/	Level of Service (a.m./p.m. delay in seconds per vehicle)[1]		
	Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
Dillon Road	A / B (9.3/11.3)	F / F (173.2/140.1)	F / F (108.5/94.6)
Westbound Ramp	B / B (17.9/13.0)	F / C (94.3/32.2)	C / B (23.3/19.4)
Eastbound Ramp	A / B (9.8/17.7)	E / B (51.1/12.8)	C / A (12.4/8.7)
Marshall Drive	A / B (8.9/11.7)	C / C (23.6/30.9)	C / C (24.3/31.9)

Source: US 36 Mobility Partnership, 2009.
Notes:
[1]Average delay estimates over 100 seconds should be considered very rough.
a.m. = morning
p.m. = evening

The LOS results indicate that while the ramp intersections both experience congestion in the a.m. peak hour with Package 1, the Combined Alternative Package (Preferred Alternative) results in satisfactory operations.

To ensure mitigation of any significant volume changes resulting from the proposed improvements to US 36, a review of the adjacent intersections to each side of the interchange was completed. At the McCaslin Boulevard interchange two adjacent intersections were analyzed:

- McCaslin Boulevard/Dillon Road
- McCaslin Boulevard/Marshall Drive

The McCaslin Boulevard/Dillon Road intersection is approximately 1,100 feet north of the westbound ramp intersection. Dillon Road is an east-west arterial that provides access to SH 287 and Northwest Parkway. Dillon Road also provides primary access to the retail/commercial development north of US 36. The Dillon Road intersection is expected to encounter substantial congestion with either alternative. Since the Combined Alternative Package (Preferred Alternative) would result in less delay than Package 1, there is no impact mitigation required at this location.

The McCaslin Boulevard/Marshall Drive intersection is approximately 650 feet south of the eastbound ramp intersection. Operations were found to be favorable under the existing geometry; therefore, no mitigation improvements are needed.

4.8.3 Transportation Impacts Summary

Although forecast traffic operations are poor at the McCaslin Boulevard/Dillon Road intersection, no impact mitigation is required for the Combined Alternative Package (Preferred Alternative) because the project LOS standard would be met. All other intersections analyzed on McCaslin Boulevard would operate at LOS D or better.

Mitigations — Because no adverse impacts would occur, no mitigation treatments are proposed.

4.9 FOOTHILLS PARKWAY/TABLE MESA DRIVE INTERCHANGE

Description and Context — The existing interchange configuration at Table Mesa Drive/Foothills Parkway is not typical. Table Mesa Drive is a four-lane arterial west of the interchange and is called South Boulder Road east of the interchange. The only movement not provided at this interchange is the off-ramp access from westbound US 36, which is accommodated at the intersection east of Foothills Parkway. Access is provided to both US 36 and to SH 157, Foothills Parkway, which begins at the Table Mesa Drive interchange. The existing interchange features three closely spaced on-ramps to eastbound US 36, a condition that is not considered acceptable by current standards.

Proposed Configuration — The existing configuration, which would be preserved in Package 1, has several design and capacity limitations that can be addressed without major reconstruction. The US 36 eastbound loop on-ramp traffic volumes do not justify an exclusive loop-ramp from a capacity perspective. The forecasted left-turn volume can be accommodated with an at-grade intersection, also serving to reduce the merge points along eastbound US 36. Reducing the merge points should improve freeway operations during the peak periods.

At this location, two options that provide access from the University of Colorado, Boulder South Campus to Table Mesa Drive were evaluated. Currently this access is provided via Loop Drive, which intersects Table Mesa Drive from the south. US 36 eastbound off- and on-ramps also intersect Table Mesa Drive at the same location, creating a five-leg intersection.

The two evaluated options are described below. Each option includes the elimination of the loop-ramp from westbound Table Mesa Drive to eastbound US 36.

- **Local Streets Option (Tantra Drive):** Loop Drive would be vacated, thus eliminating the access for the University of Colorado Boulder South Campus to/from Table Mesa Drive via Loop Drive. Instead, access would be provided by extending Tantra Drive to the University of Colorado, Boulder South Campus. Westbound traffic on Table Mesa Drive would access eastbound US 36 at the Table Mesa Drive/US 36 eastbound ramp intersection.
- **Preferred Alternative (Loop Drive):** The current access for the University of Colorado, Boulder South Campus to/from Table Mesa Drive would be maintained. A new fly-over ramp to eastbound US 36 would serve westbound vehicles on Table Mesa Drive. An eastbound slip-ramp would be constructed from Loop Drive to the Table Mesa Station on the south side of US 36, providing bus access.

The Combined Alternative Package (Preferred Alternative) analyzed the Local Streets Option for access to the University of Colorado, Boulder South Campus. This section presents the analysis for the Local Streets Option. Subsequent to the analysis conducted for the Combined Alternative Package (Preferred Alternative), an agreement was made between CDOT, the University of Colorado, the City of Boulder, and Boulder County that the Preferred Alternative for this location will retain the existing Loop Drive access for the University of Colorado, Boulder South Campus. A qualitative analysis for the Combined Alternative Package (Preferred Alternative) is provided based on the detailed analysis of the Local Streets Option.

According to the agreement among CDOT, the University of Colorado, the City of Boulder, and Boulder County, the current DRCOG trip generation estimates for the University of Colorado, Boulder South Campus may significantly underestimate the eventual traffic demand at the campus. Therefore, conclusions from this analysis should be revisited once the long-term plan for the University of Colorado Boulder South Campus is fully developed. As a result, the Combined Alternative Package (Preferred Alternative) at this location is subject to the approval of a separate 1601 process submitted to CDOT by the University of Colorado, Boulder and the City of Boulder.

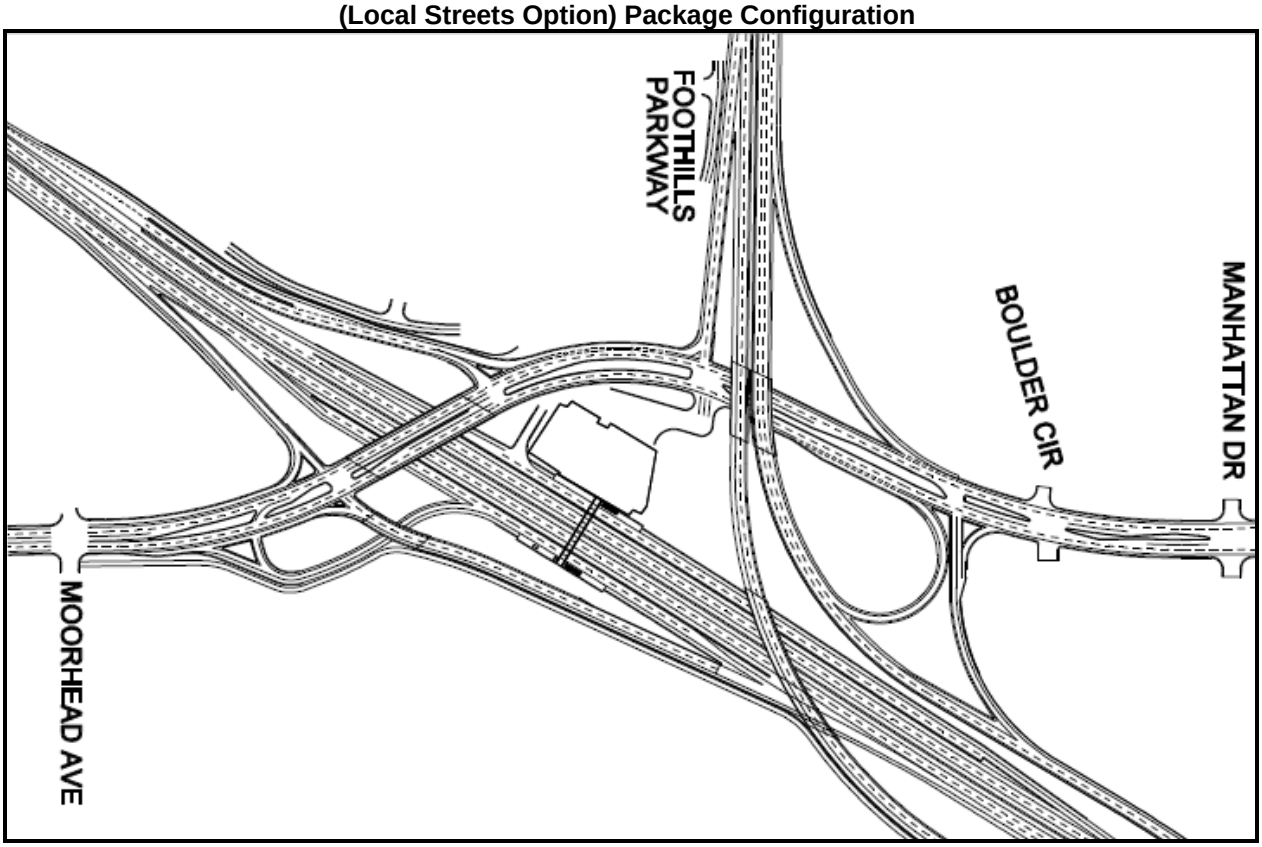
The proposed Local Streets Option configuration is shown in Figure 4.9-1, Foothills Parkway/Table Mesa Drive Interchange Combined Alternative Package (Local Streets Option) Configuration. The Combined Alternative Package (Preferred Alternative) is shown in Appendix A, Corridor Reference Maps, of the FEIS.

4.9.1 Interchange Volumes

The primary land use in the area is residential, with communities to the southwest and northeast of US 36. Table Mesa Drive/South Boulder Road is a minor east-west arterial in the area serving as a collector-distributor for regionally based traffic wishing to access US 36 and Foothills Parkway.

A review of traffic counts and model volume forecasts for US 36 indicate a predominant westbound directional split in the a.m. peak hour and eastbound directional split during the p.m. peak hour. This directional split is consistent with traffic patterns resulting from trips with an origin/destination in downtown Boulder. These trips use SH 93 to the west for travel to/from Boulder. Peak-hour intersection volumes, lanes, and LOS are shown for the Foothills Parkway/Table Mesa Drive interchange area on Figures 4.9-2 through 4.9-4 for existing, 2035 Package 1 (No Action), and 2035 Combined Alternative Package (Local Streets Option) conditions, respectively.

Figure 4.9-1: Foothills Parkway/Table Mesa Drive Interchange Combined Alternative (Local Streets Option) Package Configuration



Source: US 36 Mobility Partnership, 2009.

Figure 4.9-2: Foothills Parkway/Table Mesa Drive Interchange Existing Volumes, Geometry, and Level of Service

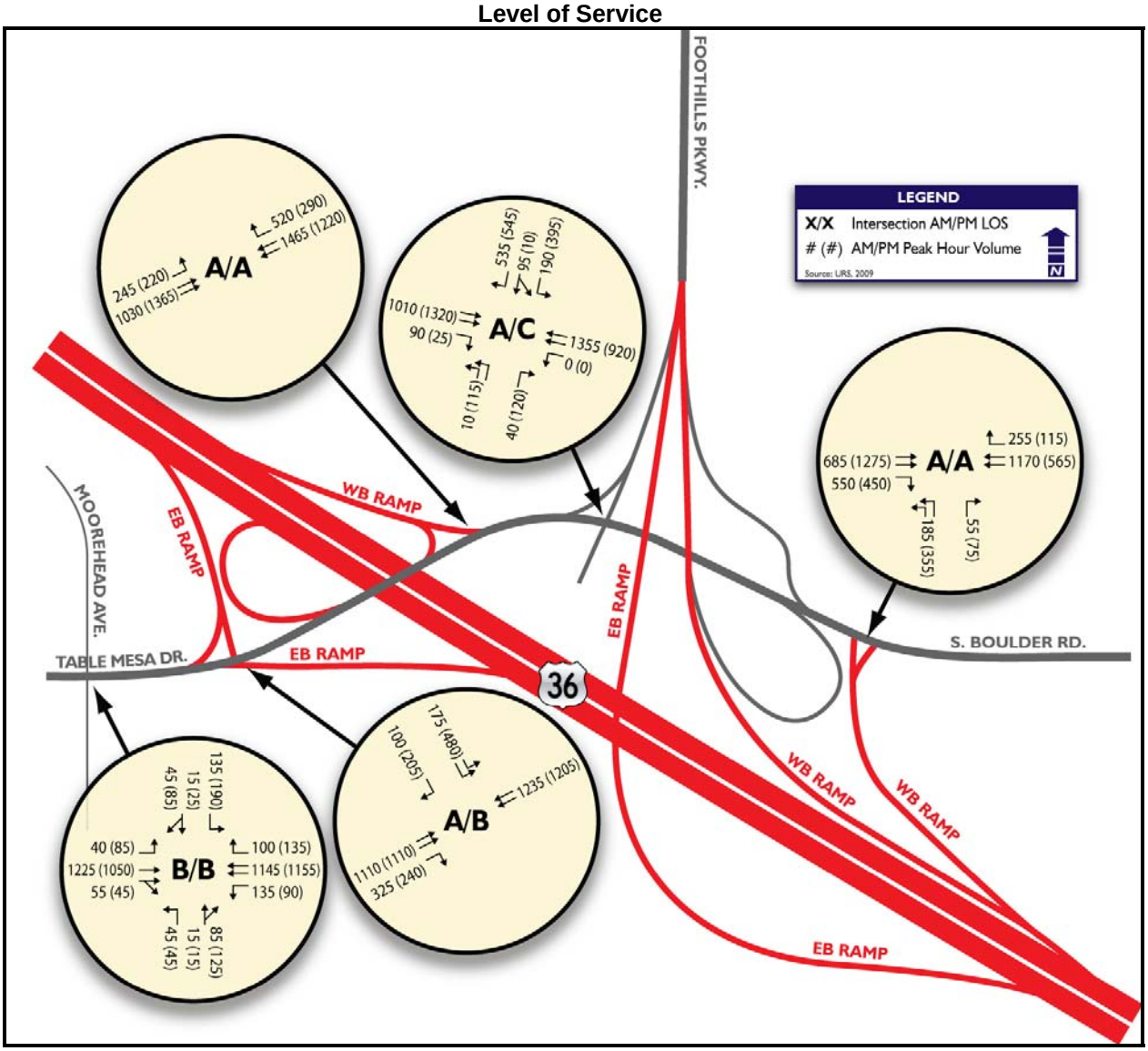


Figure 4.9-3: Foothills Parkway/Table Mesa Drive Interchange 2035 No Action Volumes, Geometry, and Level of Service

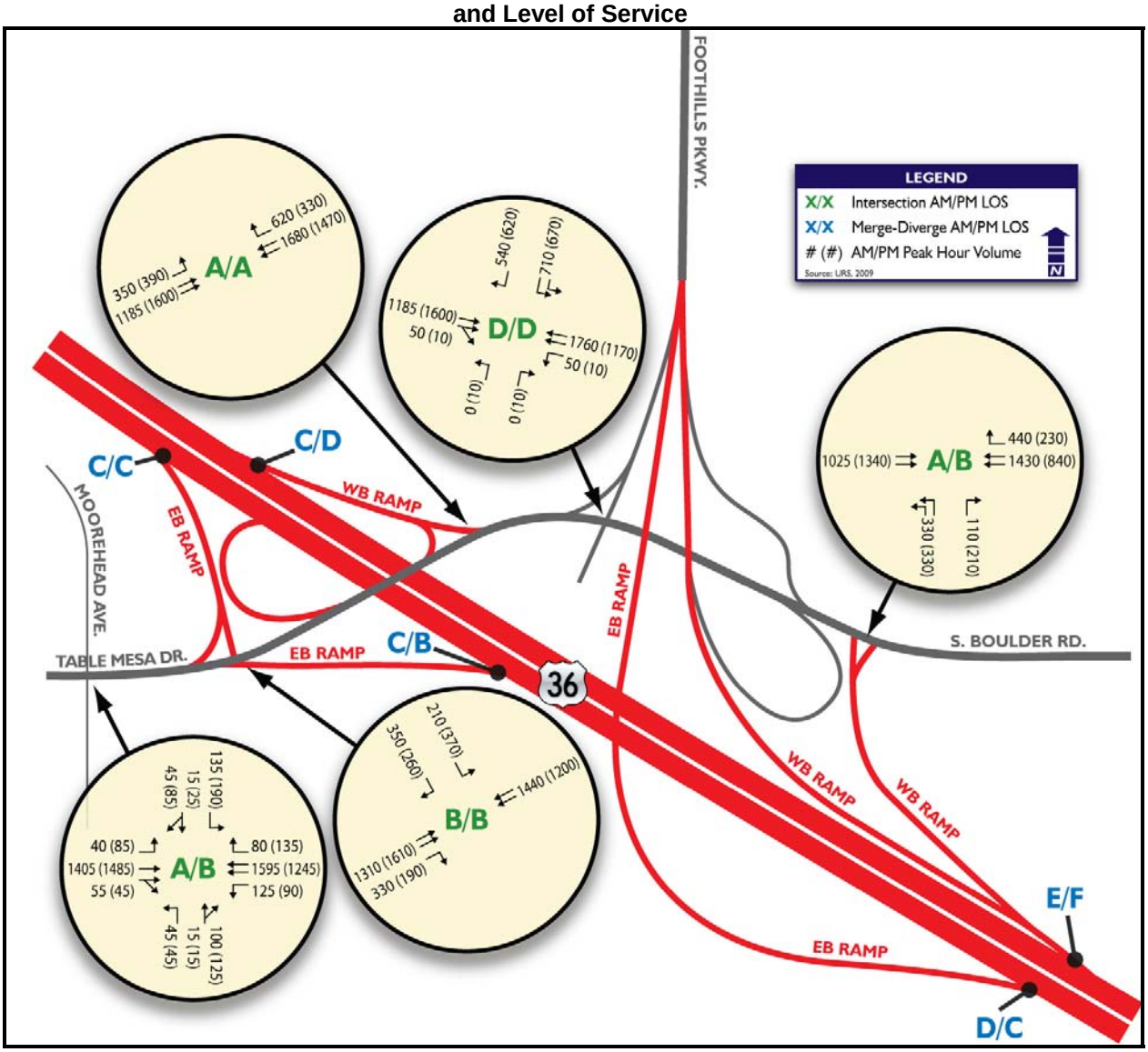
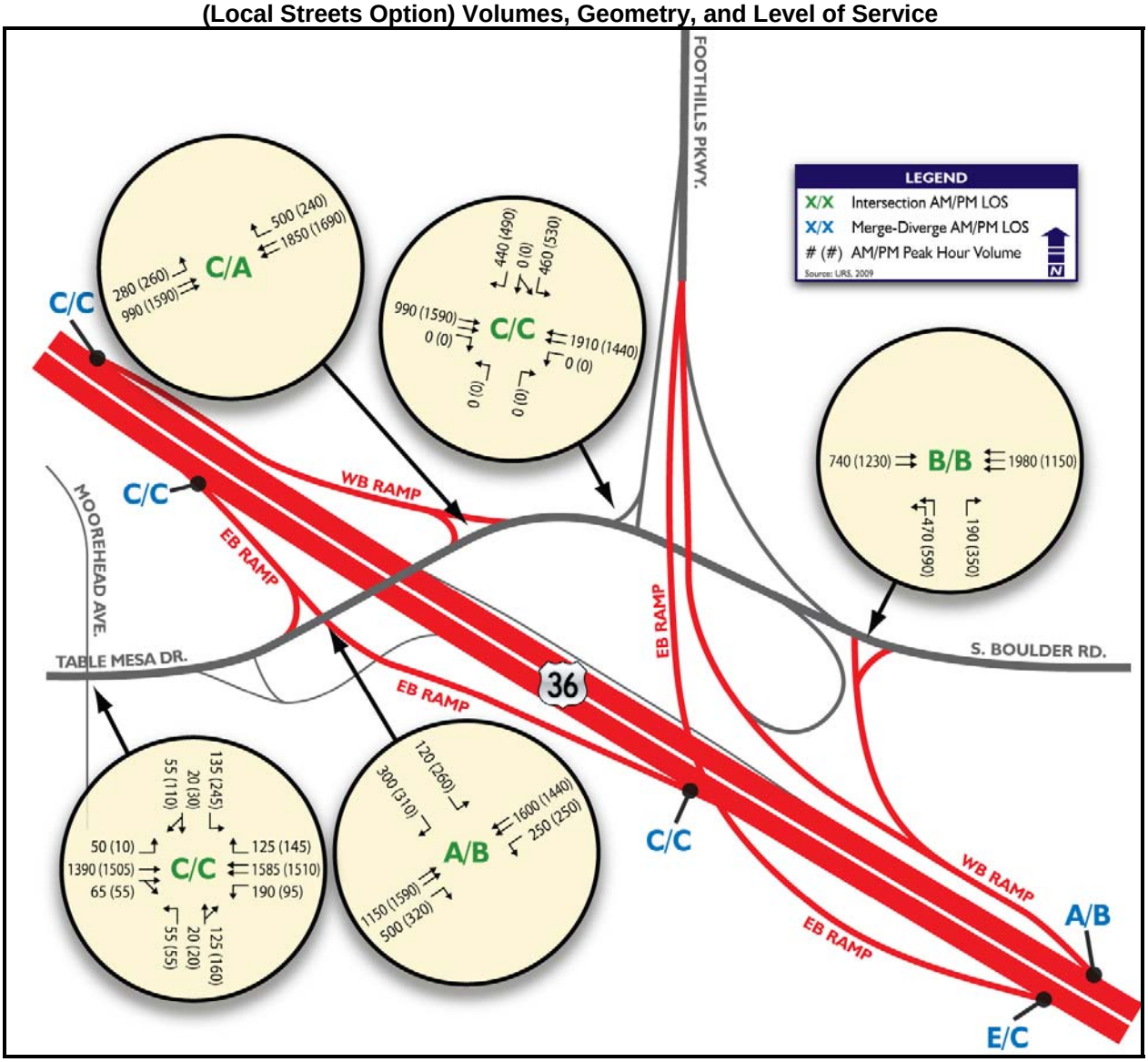


Figure 4.9-4: Foothills Parkway/Table Mesa Drive Interchange 2035 Combined Alternative Package (Local Streets Option) Volumes, Geometry, and Level of Service



4.9.2 Operations Summary

The evaluation of this interchange focused on maintaining acceptable operations at the ramp intersections along Table Mesa Drive under the geometric configuration proposed for all build alternatives. The existing configuration of Table Mesa Drive consists of a four-lane cross section with single left- and right-turn lanes at the ramp junctions. The resulting LOS for each alternative is displayed in Table 4.9-1, Foothills Parkway/Table Mesa Drive Interchange Peak-Hour Level of Service**.**

Table 4.9-1: Foothills Parkway/Table Mesa Drive Interchange Peak-Hour Level of Service

Intersection: Foothills Parkway/Table Mesa Drive/	Level of Service (a.m./p.m. delay in seconds per vehicle)		
	Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Local Streets Option) (2035)
Moorhead Avenue	B / B (12.6/13.2)	A / B (10.0/13.0)	C / C (20.1/28.2)
Eastbound Ramp	A / B (9.6/14.3)	B / B (12.1/13.3)	A / B (5.2/17.9)
Westbound On-ramp	A / A (1.8/0.7)	A / A (5.8/5.3)	C / A (22.9/6.3)
park-n-Ride Access/ Southbound Foothills Parkway Off-ramp	A / C (9.6/23.7)	D / D (47.4/37.0)	C / C (23.0/22.9)
Westbound Off-ramp	A / A (5.6/9.5)	A / B (8.9/11.7)	B / B (12.3/19.2)

Source: US 36 Mobility Partnership, 2009.
a.m. = morning
p.m. = evening

All intersections would meet or maintain the project LOS standard and most intersection operations would be improved under the Combined Alternative Package (Preferred Alternative). Progression through this segment of Table Mesa Drive/South Boulder Road is favorable, with bandwidths in the range of 30 to 35 percent. All intersections operate with either two- or three-phase cycles, resulting in increased green time for Table Mesa Drive/South Boulder Road.

All adjacent intersections showed acceptable operations under both alternatives and for each peak period. No geometric improvements would be required, as the existing laneage is adequate to handle projected growth.

Results were compiled for three adjacent signalized intersections:

- Moorhead Avenue/Table Mesa Drive
- Foothills Parkway southbound off-ramp/South Boulder Road
- US 36 westbound off-ramp/South Boulder Road

All intersections showed acceptable operations during both peak periods and under each package. No geometric improvements are required, as the existing laneage is adequate to meet forecast 2035 traffic demand.

The Moorhead Avenue/Table Mesa Drive intersection is less than 500 feet west of the eastbound ramp intersection. The close proximity of the intersections warrants coordination to maintain favorable progression through this area. The only queues of significance at this intersection are the southbound left-turn along Moorhead Avenue and the eastbound through-lane along Table Mesa Drive. The longest queue is estimated at approximately 425 feet, which could disrupt some of the adjacent driveway operations along Moorhead Avenue, but neither queue is long enough to disrupt an adjacent signalized intersection.

The Foothills Parkway southbound off-ramp/South Boulder Road intersection is less than 500 feet east of the westbound ramp intersection, warranting coordination. The westbound through queue during the a.m. peak period is significant at this intersection. The high forecast traffic volume (1,910 vehicles/hour) in two lanes results in estimated queues ranging from 700 feet to 900 feet. This queue length could disrupt the discharge of vehicles at the US 36 westbound off-ramp/South Boulder Road intersection from time to time. The queue could be reduced if a third through-lane is added, which could then be dropped at the westbound on-ramp intersection as a right-turn only lane. However, this improvement is not proposed at this time.

The US 36 westbound off-ramp/South Boulder Road intersection is 800 feet east of the Foothills Parkway southbound off-ramp intersection, which would warrant coordination based on spacing. There are no queues of concern at this intersection, but the westbound through queue is estimated to block the unsignalized intersection at Manhattan Circle to the east during the a.m. peak hour.

Since the Combined Alternative Package (Preferred Alternative) for access to the University of Colorado, Boulder South Campus would be forecast to serve the same volumes of total traffic under a different geometric configuration, traffic operations are not estimated to be considerably different than operations for the Local Streets Option. Average delay at the Table Mesa Drive/Loop Drive/US 36 eastbound ramp intersection would likely increase with the additional leg serving the intersection.

4.9.3 Transportation Impacts Summary

The overall intersection and arterial operations are favorable based on the Local Streets Option to remove the US 36 eastbound loop on-ramp and reduce the eastbound on-ramp merge points. All signals along this section of Table Mesa Drive/South Boulder Road should be coordinated to maximize east-west progression. This preliminary analysis indicates the need for only single left-turn lanes along Table Mesa Drive, resulting in a five-lane cross-section over US 36. The benefit of the single left-turn lanes is twofold, as the required structure width would be less and the signal timing could operate with protected-permitted phasing, resulting in improved intersection capacity. Qualitative analysis of the Combined Alternative Package (Preferred Alternative) indicates similar intersection and corridor operations compared to the Local Streets Option. Each access option would serve the same forecast traffic volumes under different geometric configurations.

Impact on Neighborhoods: Both the Combined Alternative Package (Preferred Alternative) and the Local Streets Option are expected to have minimal impact on the residential areas west of Loop Drive, as traffic volumes are not expected to increase dramatically at this time.

Impact on Bus Operations: Under the Combined Alternative Package (Preferred Alternative), buses would have to use the slip-ramp on Loop Drive to access the Table Mesa Station on the south side of US 36. This introduces a series of traffic conflicts between buses and other vehicular traffic, as all buses from Table Mesa Drive would have to turn onto Loop Drive and then immediately turn left onto the slip-ramp to the Table Mesa Station. Due to the relatively short distance between the bus access ramp and Table Mesa Drive, buses turning left onto the slip-ramp may be delayed by the northbound queues on Loop Drive. A potential solution to this delay would be bus transit priority control at this location. The Local Streets Option would have minimal impact on bus transit operations.

Mitigations — Because no adverse impacts would occur, no mitigation treatments are proposed.

A supplemental analysis of traffic impacts to key intersections within the City of Boulder was completed previously for the DEIS.

5.1 TRANSIT RIDERSHIP FORECASTS

Daily transit ridership projections for the project area by type of transit service are presented for each package in Table 5.1-1, Project Area Daily Transit Ridership.

Table 5.1-1: Project Area Daily Transit Ridership

Service Type	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
Regional/Express/skyRide	3,500	8,000
Activity Center Circulator/Connectors	0	2,000
Corridor Bus total	3,500	10,000
		(+185.7%)
Commuter Rail	9,500	8,200
Total Daily Transit Ridership	13,000	18,200
Change over 2035 Package 1		
Regional/Express/skyRide	N/A	+4,500
Activity Center Circulator/Connectors	N/A	+2,000
Commuter Rail	N/A	-1,300
Total Daily Change in Transit Ridership	N/A	+5,200
	N/A	(+40.0%)

Source: US 36 Mobility Partnership, 2009.

Notes:

+ = increase
- = decrease
% = percent
N/A = not applicable

The Combined Alternative Package (Preferred Alternative) provides expanded bus service and shows total transit ridership increases over Package 1 of approximately 190 percent in bus ridership and 40 percent in transit ridership overall. Rail ridership drops by approximately 15 percent in the build packages due to the increased level of BRT service in the corridor.

5.1.1 Transit Station Boardings

Station boardings indicate the relative attractiveness of a transit station (i.e., how much different areas in the transit corridor are expected to take advantage of the new transit options). The DRCOG model typically does a better job of predicting boardings by corridor and route type than at the transit station level. Therefore, it is useful to look at the distribution of boardings among transit stations, as well as the change in transit station boardings for the Combined Alternative Package (Preferred Alternative) compared with Package 1. Table 5.1-2, Weekday Bus Rapid Transit and Rail Daily Boardings (Year 2035), shows the BRT and rail daily boardings by transit station for Package 1 and the change compared to Package 1 for the Combined Alternative Package (Preferred Alternative). Transit stations that experience an increase of greater than 100 boardings are shaded in green. Transit stations that experience a decrease of more than 100 boardings are shaded in pink.

Table 5.1-2: Weekday Bus Rapid Transit and Rail Daily Boardings (Year 2035)

Station	BRT/Rail	Package 1 (No Action) (Year 2035)			Change Over Package 1 Combined Alternative Package (Preferred Alternative) (Year 2035)		
		BRT[1]	Rail	*Total*[2]	BRT	Rail	*Total*
Boulder Transit Village	BRT/Rail	10	1,500	*1,510*	+150	-250	*-100*
Boulder Station	BRT	190	N/A	*190*	+140	N/A	*+140*
Boulder Super Stops[3]	BRT	270	N/A	*270*	+380	N/A	*+380*
Table Mesa Station	BRT	200	N/A	*200*	+290	N/A	*+290*
Downtown Louisville Station	Rail	N/A	670	*670*	N/A	-130	*-130*
McCaslin Station	BRT	260	N/A	*260*	+480	N/A	*+480*
Flatiron Station	BRT/Rail	120	740	*860*	+290	-210	*+80*
Interlocken / ConocoPhillips Stops[3]	BRT	N/A	N/A	N/A	+720	N/A	+720
Broomfield Station	BRT	360	N/A	N/A	N/A	N/A	N/A
Church Ranch/104th Avenue Station	BRT/Rail	110	820	*930*	+300	-120	*+180*
Westminster Center Station	BRT	410	N/A	*410*	+620	N/A	*+620*
South Westminster Center Station	Rail	N/A	940	*940*	N/A	-80	*-80*
Broadway Station	BRT	10	N/A	*10*	+260	N/A	*+260*
Denver Union Station	BRT/Rail	680	3,480	*4,160*	+440	-320	*+120*
Downtown Denver Stops[3]	BRT	20	N/A	*20*	+350	N/A	*+350*
Civic Center Station	BRT	10	N/A	*10*	+130	N/A	*+130*
Total	N/A	2,650	8,150	*10,800*	+4,950	-1,110	*+3,840*

Source: US 36 Mobility Partnership, 2009.

Notes:

[1]BRT routes include: AB, B, DD, DM, H, L, T, 31X, 80X, 86X, and Activity Center Circulator/Connectors.

[2]Total = BRT + Rail.

[3]Group of stops.

Transit stations that experience an increase of greater than 100 boardings are shaded in green.

Transit stations that experience a decrease of more than 100 boardings are shaded in pink.

+ = increase

- = decrease

BRT = bus rapid transit

N/A = not applicable

Note that Table 5.1-1, Project Area Daily Transit Ridership, includes boardings for all stops on all routes that cross the project area (even if the stop is not within the project area). Meanwhile, Table 5.1-2, Weekday Bus Rapid Transit and Rail Daily Boardings (Year 2035), only includes certain transit stations of interest within the project area.

As shown in Table 5.1-2, Weekday Bus Rapid Transit and Rail Daily Boardings (Year 2035), the Combined Alternative Package (Preferred Alternative) exhibits an increase of over 35 percent (+3,840) boardings compared to Package 1 at the selected study area transit stations. The transit stations with the highest boardings typically serve commuter rail, although the BRT-only Boulder Super Stops also handle a relatively high number of boardings. With the introduction of BRT in the Combined Alternative Package (Preferred Alternative), several transit stations gain boardings, notably the Boulder Super Stops (along Broadway and 28th Street), Table Mesa Station, McCaslin Station, the Interlocken/Conoco-Phillips Stops, Westminster Center Station,

the Broadway park-n-Ride (served by the new Activity Center Circulators/Connectors), and the various stops in downtown Denver.

Most rail stations would maintain or see an increase in total boardings in the Combined Alternative Package (Preferred Alternative) compared to Package 1. The only exceptions are at the Downtown Louisville and South Westminster Center stations, which have rail service but no BRT; they have fewer boardings under the build package because some users have been diverted to other BRT stations to use the BRT service that serves their travel needs better than rail.

5.2 STATION AREA ACCESS

The park-n-Ride areas associated with proposed BRT stations were examined with respect to the anticipated peak-hour traffic demands generated by transit activity and the impacts to the driveway and surrounding intersections. As with the interchange and overall intersection analysis, impacts and conditions were measured with intersection LOS. Each BRT station area is discussed separately below (see Chapter 2, Alternatives Considered, of the FEIS for detailed descriptions of each candidate station).

5.2.1 Station Access Analysis Methodology

The general assumption made when assigning traffic to the station access intersections is that people would use a transit station closest to their origin in their desired direction of travel, instead of back-tracking (traveling in the opposite direction of their desired trip). Section 4 included an analysis of the impacts of interchange and intersection redesigns that were included in the build alternatives. To analyze traffic impacts at stations, the travel model took into account the traffic accessing stations at these intersections, and the station area analysis focused on the station driveway access. Each station area and its major access issues are described in the following sections.

Westminster Center

The existing Westminster Center park-n-Ride at 88th Avenue/Sheridan Boulevard was analyzed for the addition of the BRT station on US 36 under the Combined Alternative Package (Preferred Alternative). Analysis of the intersection of 88th Avenue/Yates Street is relevant because although most of the parking capacity is north of US 36, the existing surface lot south of the highway (which is the original Hallack Junction park-n-Ride) would remain open in the Combined Alternative Package (Preferred Alternative). The intersection of 88th Place/Yates Street would also be modified under the build alternatives because 88th Place would provide access to the park-n-Ride and local business, but would not connect through to Sheridan Boulevard in the proposed Sheridan Boulevard interchange configuration. It was assumed that most traffic (approximately two-thirds of all parking at the site) would be parking at the traffic garage on the east side of US 36 because it has more spaces (most spaces are covered).

Church Ranch /104th Avenue

Most patrons would be likely to park near the station platforms on the west side of the park-n-Ride and access the station using either the retail access signal or via the underpass from the east side of the park-n-Ride. The access to the east side of the park-n-Ride would be at Westminster Boulevard/Promenade Street. Westminster Boulevard is a four-lane street, and the intersection with Promenade Street is signalized. Sufficient capacity exists at that signal for station traffic.

116th Avenue

The Broomfield park-n-Ride will be moved to this location during the construction of the 120th Avenue extension over US 36. The traffic accessing this station will park predominantly on the south side if US 36, where the new street network associated with the Arista development provides sufficient capacity.

Flatiron

In 2003, traffic could only exit this park-n-Ride at the intersection of Midway Boulevard/Flatiron Circle. Midway Boulevard has since been extended north to connect to Tape Drive. It was assumed that more station access traffic would use this exit. It is predicted that there would be very little traffic on Tape Drive, so by inspection the unsignalized intersection at this location should operate acceptably.

McCaslin

The McCaslin Boulevard interchange configuration analysis, discussed in Section 4.8, was used to determine the LOS at the intersections of Marshall Road/McCaslin Boulevard and Dillon Road/McCaslin Boulevard. Transit traffic using the McCaslin Station would use the same intersections included in the interchange analysis.

Table Mesa

The existing park-n-Ride would not be changed in the Combined Alternative Package (Preferred Alternative). It is assumed that most station-oriented p.m. vehicle traffic would travel west into Boulder after exiting the park-n-Ride.

5.3 STATION ACCESS LEVEL OF SERVICE

Table 5.3-1, Station Access Intersection Level of Service, shows the LOS for the access intersections of the stations for the p.m. peak-hour. At unsignalized intersections, LOS is reported as the worst signal movement. Some LOS E operations are listed in the table, but this is due to an individual movement and would consequently still meet the LOS standard. The intersection of McCaslin Boulevard/Dillon Road is listed as LOS E and this would not change with mitigation (see McCaslin Boulevard interchange analysis section), but the delay does decrease to at least meet/improve Package 1 conditions.

Table 5.3-1: Station Access Intersection Level of Service

Station Access	Existing (2003)	Package 1 (No Action) (2035)	Combined Alternative Package (Preferred Alternative) (2035)
Westminster Center			
88th Avenue/Yates Street	-	-	A
Yates Street/88th Place (unsignalized)	A	B	E
Church Ranch/104th Avenue			
Church Ranch Boulevard/Retail Access	A	A	A
Westminster Boulevard/Promenade Street	-	-	A
116th Avenue			
116th Avenue /Old Wadsworth Boulevard (unsignalized)	-	-	E
Flatiron			
Midway Boulevard/Flatiron Circle	B	B	B
Midway Boulevard/Tape Drive (unsignalized)	-	A	A
McCaslin			
McCaslin Boulevard/Marshall Road	B	B	B
McCaslin Boulevard/Dillon Road	B	E	E
Table Mesa			
Table Mesa Drive/park-n-Ride Access	C	C	D

Source: URS, 2004.

Notes:

Unsignalized intersection level of service based on movement with the highest delay.

- = not applicable

Overall observations about these results are summarized as follows:

- Most intersections would operate with acceptable LOS at station access points.
- Unsignalized intersections at the busier stations, such as the Broomfield and Westminster Center park-n-Rides, could experience high delays for station exiting traffic for brief periods of time in the p.m. peak hour. Although a detailed signal warrant analysis has not been conducted, the sporadic nature of high-demand conditions (related only to the arrival of the busiest trains in the p.m. peak hour) do not appear to indicate the need for signalization at this time.
- Appropriate intersection design at access points during preliminary engineering and final design will ensure acceptable operations.

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Pedersen and Samdahl. 1982. National Cooperative Highway Research Program (NCHRP) Report 255. *Highway Traffic Data for Urbanized Area Project Planning and Design*.

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Appendix A
Modeling Methodology Report

US 36 CORRIDOR
Environmental Impact Statement

Modeling Methodology Report (DRAFT)

Project No. NH 0361-070(14133)

Prepared by

URS

May 6, 2009

Table of Contents

List of Tables

Overview

The purpose of this document is to provide details of the model development for the US 36 Final Environmental Impact Statement (FEIS).

The US 36 FEIS will include No Action and Preferred (Build) models for the years 2015 and 2035 (four models total). These models will use the 2015 and 2035 Regional Transportation Plan (RTP) models from DRCOG[1] as a base.

In accordance with standard practice, each No Action model will be defined as the RTP model with non-funded projects along US 36 removed. In addition, the project team will also review the models and make modifications to enhance the level of detail for this study.

The Preferred (Build) models will include RTP projects on US 36, as applicable, with the FEIS proposed improvements to the US 36 roadway and transit service. The US 36 models are summarized in Table 1 below.

Table 1. US 36 Model Summary

Model	US 36 Highway	US 36 Transit
2015 No Action	Existing + TIP projects	Existing + NWR
2015 Preferred	Existing + TIP projects + HOT lane extension / conversion	Existing + NWR + Additional BRT service
2035 No Action	Existing + TIP projects	Existing + NWR
2035 Preferred	Existing + TIP projects + HOT lane extension / conversion + New GP lanes + New aux lanes	Existing + NWR + Additional BRT service

Source: US 36 Project Team, 2008
Note: The rest of the region includes existing infrastructure plus RTP projects appropriate for the respective year. The RTP includes the FasTracks transit program.

[1] C2_08_2015RTP and C2_08_2035RTP from October 2008

Existing Configuration

Highway

The existing configuration of mainline US 36 is shown in Table 2 below; this is the same as what was coded in the 2005 DRCOG model.

Table 2. US 36 Existing (2008) Number of Lanes

	Existing Number of Lanes	
	2005 model from DRCOG	
Segment	**GP**	**Special**
I-25 to Broadway	4WB, 3EB	1 HOV Rev
Broadway to Pecos	4WB, 3EB	1 HOV Rev
Between Pecos Ramps	3WB, 2EB	1 HOV Rev
Pecos to Federal	4WB, 3EB	1 HOV Each Dir
Between Federal Ramps	3WB, 2EB	1 HOV EB
Federal to Sheridan	3WB, 2EB	1 HOV EB
Between Sheridan Ramps	2WB, 2EB	
Sheridan to Church Ranch	2WB, 2EB	
Between Church Ranch Ramps	2WB, 2EB	
Church Ranch to 120th	2WB, 2EB	
Between 120th Ramps*	N/A	
120th to Wadsworth	2WB, 2EB	
Between Wadsworth Ramps	2WB, 2EB	
Wadsworth to E. Flatiron	3WB, 3EB	
E. Flatiron to Interlocken	2WB, 2EB	
Between Interlocken Ramps	2WB, 2EB	
Interlocken to W. Flatiron	2WB, 2EB	
W. Flatiron to McCaslin	2WB, 2EB	
Between McCaslin Ramps	2WB, 2EB	
McCaslin to Cherryvale	2WB, 2EB	
Cherryvale to Foothills	2WB, 2EB	

Source: US 36 Project Team, 2008

Note:

*120th ramps will be built as part of the Broomfield interchange update (2035 RTP and Preferred models only).

Transit

Current transit service in the US 36 corridor is listed in Table 3. Headways are calculated based on the maximum number of buses that passes a certain location during each period. For example, the Peak Period lasts from 6:30AM to 9AM (150 minutes). In the EB direction, the AB has three buses serving DIA during that time, so the headway is 150 minutes / 3 buses = 50 minutes/bus. In the WB direction, the AB has two buses serving DIA during that time, so the headway is 150 minutes / 2 buses = 75 minutes/bus. 50 minutes is the better headway, so it is the one shown in the table below.

Table 3. US 36 Existing (2008) Transit Service

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Notes
Regional / Express / skyRide					
AB	Boulder to DIA (via US 36)	50	50	120	
B	Boulder - Denver (all stop)	15	30	30	
BX	Boulder - Denver (express)	10	30	180	
BF	Broomfield - Denver (express)	15	-	-	Peak direction only
BOLT	Boulder/Longmont	30	50	50	
DD	Boulder - Colorado Blvd.	40	-	-	
DM	Boulder - Fitzsimons	30	-	-	Peak direction only
H	Boulder Transit Village - CCS (all stop)	N/A			
HX	Boulder Transit Village - CCS (express)	20	-	-	Peak direction only
J	Longmont/East Boulder/CU	30	-	-	Peak direction only
L	Longmont - Denver	30	90	180	
S	Denver - East Boulder	40	-	-	Off-peak direction only
T	Boulder - Greenwood Plaza	50	-		Peak direction only
31x	North Federal Express	50	-	-	Peak direction only
80x	80th Ave. - Denver	50	-	-	Peak direction only
82x	Pomona Express/Feeder	30	-	-	Peak direction only
86x	Westminster Express	15	-	-	Peak direction only
108x	Countryside Express/Feeder	50	-	-	Peak direction only
Boulder Local					
201	North 4th Street	Deleted			
203	Baseline	30	30	70	
204	Table Mesa/Yarmouth	15	25	40	
205	Gunbarrel/Boulder Mall	15	30	40	
206	Pearl - Eisenhower	30	30	-	
208	Iris - Valmont	30	30	-	
209	CU - Thunderbird	15	20	-	
225	Boulder - Lafayette via Baseline	35	40	-	
228	Louisville - Broomfield via Interlocken	30	30	180	
230	Lafayette-Louisville-Interlocken	N/A			
BOUND	Up 30th	10	10	35	
DASH	To Lafayette	15	15	45	
HOP	CU/Pearl - Loop	10	10	15	
JUMP	Arapahoe - Short	30	30	90	
JUMP	Arapahoe - Long	30	30	90	
JUMP	Arapahoe - Extra-Long	30	30	90	
LYNX	Broomfield - Louisville	30	60	-	
SKIP	Broadway Loop	7	10	20	
STAMPEDE	CU - Loop	15	10	-	

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Notes
Activity Center Connector					
AC-I	Denver - Boulder via Interlocken	N/A			
AC-CP	Denver - Boulder via ConocoPhillips	N/A			
Rail					
DUS30	Denver - Boulder	N/A			
DUSLM	Denver - Longmont	N/A			

Base Models

The base models used include the existing (2005 base year), 2015 RTP, and 2035 RTP models from DRCOG. These models were reviewed here and suggested changes are detailed for possible update by DRCOG in future versions.

2015 RTP Model

Based on a review of the 2008-2013 TIP the 2015 RTP configuration should include the following highway improvements to the US 36 corridor:

- Addition of the 120th overcrossing (TIP ID#2007-029)
- Relocated Broomfield pnR (2007-044)
- Updated McCaslin interchange (new loop ramp) (2007-032)
- New pedestrian bridge and on-ramp platform plus transit service routing at Table Mesa pnR (2007-051, 2007-157)
- Northwest Rail: Denver Union Station to Longmont (2007-050)
- US-36 BRT: Denver Union Station to Table Mesa, Phase I[2] (2007-051)

The above improvements are all funded, so they should also be included in the 2015 No Action model. It should be noted that no improvements to the mainline portion of US 36 are expected prior to 2015.

Highway

The project team reviewed the 2015 RTP model in preparation for 2015 model development for the US 36 FEIS. The 2015 RTP network on US 36 is currently coded as shown in Table 4. Proposed changes to the coding are noted in bold/red and are described in more detail under the Recommended Change column.

[2] Per the TIP: Phase I BRT includes slip ramps and access improvements to US 36 park-n-Rides for future 18-mile BRT facility. Includes 6 park-n-Rides with a total of 5,400 parking spaces. Specific projects will include funding support for the 28th St. 'Super Stops' in Boulder, a pedestrian bridge and platform at the Table Mesa park-n-Ride, and construction of a portion of the Shops at Walnut Creek park-and-Ride in Westminster.

Table 4. US 36 2015 RTP Model Number of Lanes

Segment	2015 RTP Number of Lanes		
	2015 model from DRCOG		
	GP	**Special**	**Recommended Change**
I-25 to Broadway	4WB, 3EB	1 HOV Rev	
Broadway to Pecos	4WB, **2EB**	1 HOV Rev	Should be 3EB to reflect existing conditions
Between Pecos Ramps	3WB, 2EB	1 HOV Rev	
Pecos to Federal	4WB, **2EB**	1 HOV Each Dir	Should be 3EB to reflect existing conditions
Between Federal Ramps	3WB, 2EB	1 HOV EB	
Federal to Sheridan	3WB, 2EB	1 HOV EB	
Between Sheridan Ramps	2WB, 2EB		
Sheridan to Church Ranch	2WB, 2EB		
Between Church Ranch Ramps	2WB, 2EB		
Church Ranch to 120th	2WB, 2EB		
Between 120th Ramps*	N/A		
120th to Wadsworth	2WB, 2EB		
Between Wadsworth Ramps	2WB, 2EB		
Wadsworth to E. Flatiron	**2WB, 2EB**		Should be 3WB, 3EB to reflect existing conditions
E. Flatiron to Interlocken	2WB, 2EB		
Between Interlocken Ramps	**3WB, 3EB**		Should be 2WB, 2EB to reflect existing conditions
Interlocken to W. Flatiron	2WB, 2EB		
W. Flatiron to McCaslin	2WB, 2EB		
Between McCaslin Ramps	2WB, 2EB		
McCaslin to Scenic Overlook	2WB, 2EB		
Scenic Overlook to Cherryvale	2WB, 2EB		
Cherryvale to Foothills	2WB, 2EB		

Source: 2015 DRCOG model (C2_08_2015RTP.dbd, dated 09/24/08)
Notes:
*120th ramps will be built as part of the Broomfield interchange update (2035 RTP and Preferred models only).
GP = General Purpose
Special = HOV or HOT lane (as indicated)
Rev = Reversible

The project team recommends the following additional corrections to the 2015 RTP network coding in the US 36 corridor, listed in Table 5.

Table 5. US 36 2015 RTP Recommended Corrections/Refinements

	2015 RTP Recommended Corrections/Refinements
Interchange	**Notes**
I-25	- EB US 36 GP off-ramp to SB I-25 (3 to 2 lanes) - NB I-25 off-ramp to WB US 36 (3 to 2 lanes) - SB I-25 between I-76 WB off-ramp and US 36 GP on-ramp (4 to 3 lanes) - EB I-270 between I-25 on-ramp and I-76 off-ramp (2 to 3 lanes) - WB I-270 between I-76 on-ramp and I-25 off-ramp (2 to 3 lanes) - SB I-25 off-ramp to EB I-270 moved to start at same location as off-ramp to WB US 36 - NB I-25 between 58th Avenue on-ramp and off-ramps to I-76 (5 to 6 lanes) - NB I-25 between off-ramps to I-76 and segment north of I-76 (4 to 5 lanes) - NB I-25 between off-ramp to US 36 WB and WB I-270 on-ramp (4 to 3 lanes) - EB I-76 off-ramp to I-25 NB moved to connect to NB I-25 on-ramp from EB US 36
Broadway	N/A

	2015 RTP Recommended Corrections/Refinements
Interchange	**Notes**
Pecos	N/A
Federal	- Add loop ramps and turn penalties to prevent incorrect movements onto loop ramp[3]
Sheridan	- Fix direction of US 36 WB to 92nd Avenue loop ramp to reflect existing conditions
Church Ranch	- Move centroid connectors at Church Ranch to not feed directly into intersection
Broomfield	- Remove road connecting Wadsworth Parkway/120th Avenue intersection to new pnR and add a 4-lane minor arterial between the Broomfield pnR and Uptown Avenue to reflect planned conditions
Flatiron	- Move centroid connector at Interlocken to not feed directly into intersection - Change number of lanes of WB on-ramp at W. Flatiron (1 to 2) to reflect existing conditions - Add Midway Boulevard (2-lane minor arterial) between E. Flatiron Circle and Brainard Drive
McCaslin	- Move Dillon Rd. north to avoid connecting directly to the McCaslin Interchange (McCaslin should be coded as 3 lanes in each direction between the south ramps and Dillon Road.) - Add NB to WB loop ramp and turn penalties to reflect planned TIP project - Add turn penalties to prevent incorrect movements onto existing loop ramp
Foothills / Table Mesa	- Change number of lanes on Foothills SB to US 36 EB on-ramp (1 to 2) to reflect existing conditions - Add pedestrian bridge and platform (walk link) to reflect TIP projects 2007-051, 2007-157
Other Network Refinements	- Remove centroid connector attached to US 36 between Federal and Pecos - Add 98th Street between Sheridan and Harlan to reflect existing conditions - Change number of lanes on streets in Boulder - Changed number of lanes on Baseline Road between Foothills Parkway and 55th Street (1 to 2) to reflect existing conditions - Changed number of lanes on Colorado Avenue between 30th Street and Foothills Parkway (1 to 2) to reflect existing conditions - Add turn penalties to ban off-ramp to on-ramp through movements at interchanges on US 36

Source: US 36 Project Team, 2008
Notes:
N/A=Not Applicable

Transit

The US 36 2015 RTP model transit service is shown in Table 6. The RTP includes additional US 36 BRT service, as well as the addition of the NWR rail pattern running between Denver and Boulder (DUS30). The AB has been rerouted to NW Parkway (instead of US 36+I-25+I-270). As shown in the table, the existing S route has been deleted under this scenario. Furthermore, service on the BOLT has been reduced because of the introduction of the parallel Northwest Rail service.

[3] Although technically having the ramp coded as loop versus a regular diamond doesn't greatly influence model processing, we recommend coding the separate connection to isolate the ramp volume and simplify post-processing.

Table 6. US 36 2015 RTP Model Transit Service

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Recommended Change
Regional / Express / skyRide					
AB	Boulder to DIA (via NW Pkwy)	30	60	60	
B	Boulder - Denver (all stop)	15	15	30	
BX	Boulder - Denver (express)	10	30	-	**Should be 180 Early-Late to reflect existing service**
BF	Broomfield - Denver (express)	15	-	-	
BOLT	Boulder/Longmont	30	60	60	
DD	Boulder - Colorado Blvd.	40	-	-	
DM	Boulder - Fitzsimons	30	-	-	
H	Boulder Transit Village - CCS (all stop)	15	30	-	
H	Boulder Transit Village - CCS (express)	10	-	-	
J	Longmont/East Boulder/CU	30	-	-	
L	Longmont - Denver	30	60	180*	***LopNB should also be 180 Early-Late to reflect existing service**
S	Denver - East Boulder	Deleted			
T	Boulder - Greenwood Plaza	**25**	-	-	**Should be 50 Peak to reflect existing service**
31x	North Federal Express	50	-	-	**Per Post-2005 service change: Discontinue service on Lowell Boulevard between 84th and 104th Avenue and start the route at Hooker/104th Avenue.**
80x	80th Ave. - Denver	50	-	-	
82x	Pomona Express/Feeder	30	-	-	
86x	Westminster Express	15	-	-	
108x	Countryside Express/Feeder	30	-	-	
Boulder Local					
201	North 4th Street	30	90	-	**Delete (no longer in service)**
203	Baseline	30	30	70	**Change route names to 203EB and 203WB**
204	Table Mesa/Yarmouth	15	**30**	40	**Should be 25 Peak to reflect existing service**

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Recommended Change
205	Gunbarrel/Boulder Mall	15	30	**30**	**'a' pattern should have 30 min Off-Peak Headway; 'b' pattern should have no Off-Peak service**
206	Pearl - Eisenhower	30	30	-	
208	Iris - Valmont	30	30	180	
209	CU - Thunderbird	15	20	-	
225	Boulder - Lafayette via Baseline	35	45	-	
228	Louisville - Broomfield via Interlocken	30	30	-	
229	Louisville - Broomfield via ConocoPhillips	-	30	-	**Update this to be current LYNX route**
230	Lafayette-Louisville-Interlocken	N/A			
BOUND	Up 30th	10	10	35	
DASH	To Lafayette	15	15	45	
HOP	CU/Pearl - Loop	10	10	15	
JUMP	Arapahoe - Short	30	30	90	
JUMP	Arapahoe - Long	30	30	90	
JUMP	Arapahoe - Extra-Long	30	30	90	
LYNX	Broomfield - Louisville	Deleted			**See 229**
SKIP	Broadway Loop	7	10	20	
STAMPEDE	CU - Loop	15	10	-	
Activity Center Connector					
AC-I	Denver - Boulder via Interlocken	15	-	-	
AC-S	Denver - Boulder via ConocoPhillips	15	-	-	
Rail					
DUS30	Denver - Boulder	N/A			
DUSLM	Denver - Longmont	30	60	-	

The characteristics for the Northwest Rail line are shown in Table 7.

Table 7. Northwest Rail Distance, Speed, and Travel Time

#	From	To	Distance (miles)	Avg Speed (mph)	Travel Time (minutes)
1	DUS	South Westminster	6.11	33.3	11.0
2	South Westminster	Church Ranch	6.29	46.0	8.2
3	Church Ranch	Flatiron Crossing	3.90	42.6	5.5
4	Flatiron Crossing	Downtown Louisville	3.30	33.0	6.0
5	Downtown Louisville	Boulder Transit Village	8.27	40.0	12.4
6	Boulder Transit Village	Gunbarrel	3.93	39.3	6.0
7	Gunbarrel	Downtown Longmont	8.61	43.1	12.0
Avg Speed = Total Distance/Total Travel Time:			*40.41*	*39.7*	*61.1*

2035 RTP Model

The 2035 RTP configuration should look like 2015 RTP configuration with the following additional improvements:

- US 36 widening between E Flatiron and 96th Street (Interlocken) – Both directions widened from 2 to 3 lanes
- US 36 HOV lane extension throughout corridor
- Updated Sheridan interchange – Add EB slip on-ramp between 92nd and Sheridan and WB remove loop ramp and create split diamond configuration, widen Sheridan over US 36.
- Updated Broomfield (Wadsworth) interchange – Convert to split diamond configuration with collector-distributor system[4].
- Updated Table Mesa interchange with new pedestrian bridge and transit ramp stops.

[4] Based on Carter & Burgess (Jacobs) interchange design

Highway

The project team reviewed the 2035 RTP model in preparation for 2035 model development for the US 36 FEIS. The 2035 RTP network is currently coded as shown in Table 8. Proposed changes to the coding are noted in bold/red and are described in more detail under the Recommended Change column.

Table 8. US 36 2035 RTP Model Number of Lanes

Segment	2035 RTP Number of Lanes		
	2035 model from DRCOG		
	GP	Special	Recommended Change
I-25 to Broadway	4WB, 3EB	1 HOV Rev	
Broadway to Pecos	4WB, 3EB	1 HOV Rev	
Between Pecos Ramps	3WB, 2EB	1 HOV Rev	
Pecos to Federal	4WB, 3EB	1 HOV Each Dir	
Between Federal Ramps	3WB, 2EB	1 HOV Each Dir	
Federal to Sheridan	3WB, 2EB	1 HOV Each Dir	
Between Sheridan Ramps	2WB, 2EB	1 HOV Each Dir	
Sheridan to Church Ranch	2WB, 2EB	1 HOV Each Dir	
Between Church Ranch Ramps	2WB, 2EB	1 HOV Each Dir	
Church Ranch to 120th	2WB, 2EB	1 HOV Each Dir	
Between 120th Ramps*	2WB, 2EB	1 HOV Each Dir	
120th to Wadsworth	2WB, 2EB	1 HOV Each Dir	
Between Wadsworth Ramps	2WB, 2EB	1 HOV Each Dir	
Wadsworth to E. Flatiron	3WB, 3EB	1 HOV Each Dir	
E. Flatiron to Interlocken	3WB, 3EB**	1 HOV Each Dir	
Between Interlocken Ramps	**3WB, 3EB**	1 HOV Each Dir	Should be 2WB, 2EB to reflect existing conditions
Interlocken to W. Flatiron	**3WB, 3EB**	1 HOV Each Dir	Should be 2WB, 2EB to reflect existing conditions
W. Flatiron to McCaslin	2WB, 2EB	1 HOV Each Dir	
Between McCaslin Ramps	2WB, 2EB	1 HOV Each Dir	
McCaslin to Scenic Overlook	2WB, 2EB	1 HOV Each Dir	
Scenic Overlook to Cherryvale	2WB, 2EB	1 HOV Each Dir	
Cherryvale to Foothills	2WB, 2EB	1 HOV Each Dir	

Source: 2035 DRCOG model (C2_08_2035RTP.dbd, dated 09/17/08)

Notes:

*120th ramps will be built as part of the Broomfield interchange update (2035 RTP and Preferred models only).

**2035 RTP Project: US 36: 96th St to Interlocken East Widening – Add through lane(s) [0.5 miles, 2 new lanes] ($47 million)

GP = General Purpose

Special = HOV or HOT lane (as indicated)

Rev = Reversible

The other additional corrections to the 2035 RTP network coding would be the same as those listed above for the 2015 RTP network in Table 5 with one addition at the Broomfield Interchange: Correct SB to EB loop ramp direction.

Transit

The US 36 2035 RTP model transit service is shown in Table 9. The only difference between the 2015 RTP and the 2035 RTP is the addition of the short NWR rail pattern running between Denver and Boulder (DUS30). As with the 2015 RTP model, the existing S route has been eliminated under this scenario.

Table 9. US 36 2035 RTP Model Transit Service

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Recommended Change
Regional / Express / skyRide					
AB	Boulder to DIA (via NW Pkwy)	30	60	60	
B	Boulder - Denver (all stop)	15	15	30	
BX	Boulder - Denver (express)	10	30	-	**Should be 180 Early-Late to reflect existing service**
BF	Broomfield - Denver (express)	15	-	-	
BOLT	Boulder/Longmont	30	60	60	
DD	Boulder - Colorado Blvd.	40	-	-	
DM	Boulder - Fitzsimons	30	-	-	
H	Boulder Transit Village - CCS (all stop)	15	30	-	
H	Boulder Transit Village - CCS (express)	10	-	-	
J	Longmont/East Boulder/CU	30	-	-	
L	Longmont - Denver	30	60	180*	***LopNB should also be 180 Early-Late to reflect existing service**
S	Denver - East Boulder	Deleted			
T	Boulder - Greenwood Plaza	**25**	-		**Should be 50 Peak to reflect existing service**
31x	North Federal Express	30	-	-	**Per Post-2005 service change: Discontinue service on Lowell Boulevard between 84th and 104th Avenue and start the route at Hooker/104th Avenue.**
80x	80th Ave. - Denver	50	-	-	
82x	Pomona Express/Feeder	30	-	-	
86x	Westminster Express	10	-	-	
108x	Countryside Express/Feeder	30	-	-	
Boulder Local					
201	North 4th Street	30	90	-	**Delete (no longer in service)**
203	Baseline	30	30	70	**Change route names to 203EB and 203WB**
204	Table Mesa/Yarmouth	15	30	40	**204NB should be 15/30 (instead of 20/30)**

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Recommended Change
205	Gunbarrel/Boulder Mall	15	30	30	**'a' pattern should have 30 min Off-Peak Headway; 'b' pattern should have no Off-Peak service**
206	Pearl - Eisenhower	30	30	-	
208	Iris - Valmont	30	30	-	
209	CU - Thunderbird	15	20	-	
225	Boulder - Lafayette via Baseline	35	45	-	
228	Louisville - Broomfield via Interlocken	30	30	180	
229	Louisville - Broomfield via ConocoPhillips	-	30	-	**Update this to be current LYNX route**
230	Lafayette-Louisville-Interlocken	N/A			
BOUND	Up 30th	10	10	35	
DASH	To Lafayette	15	15*	45	***DASHaWB should be 25 Peak**
HOP	CU/Pearl - Loop	10	10	15	
JUMP	Arapahoe - Short	30	30	90	
JUMP	Arapahoe - Long	30	30	90	
JUMP	Arapahoe - Extra-Long	30	30	90	
LYNX	Broomfield - Louisville	Deleted			**See 229**
SKIP	Broadway Loop	7	10	20	
STAMPEDE	CU - Loop	15	10	-	
Activity Center Connector					
AC-I	Denver - Boulder via Interlocken	15	-	-	
AC-S	Denver - Boulder via ConocoPhillips	15	-	-	
Rail					
DUS30	**Denver - Boulder**	**30**	-	-	
DUSLM	Denver - Longmont	30	**60**	-	**Should be 30 Off-Peak to reflect future service**

US 36 Models

The US 36 models include 2015 No Action, 2015 Preferred, 2035 No Action, and 2035 Preferred.

Preferred BRT Coding

The skyRide/Regional BRT routing is as follows:

AB

- EB
    - Stops at Table Mesa, McCaslin
    - In GP lane entire length; exits at Interlocken Loop (Flatiron Crossing) to go to NWR Parkway
- WB
    - Stops at McCaslin, Table Mesa
    - In GP lane entire length; enters at Interlocken Loop (Flatiron Crossing) from NWR Parkway

BV/HV

- SB
    - Stops at Table Mesa, McCaslin, Flatiron Crossing, Broomfield, Church Ranch, Sheridan
    - Peak: In GP lane until Federal, enters HOT lane and continues to I-25 special lanes
    - Off-Peak: In GP (aux) lane entire length, continues to I-25 SB GP
- NB
    - Stops at Sheridan, Church Ranch, Broomfield, Flatiron Crossing, McCaslin, Table Mesa
    - Peak: From I-25 GP, in US 36 GP (aux) lane entire length
    - Off-Peak: From I-25 special lanes, exits to GP lane at Federal, in US 36 GP (aux) lane through the rest of corridor

BX/HX

- SB
    - Stops at Table Mesa, McCaslin
    - Peak: In GP lane until Flatiron Crossing, enters HOT lane and continues to I-25 special lanes
    - Off-Peak: In GP lane until Flatiron Crossing, enters HOT lane, exits at Federal to GP lanes, and continues to I-25 SB GP
- NB
    - Stops at McCaslin, Table Mesa

- Peak: From I-25 GP, enters HOT lane at Federal, exits HOT lane at Flatiron Crossing, in US 36 GP (aux) lane through the rest of corridor
- Off-Peak: From I-25 special lanes, enters HOT lane, exits to GP lane at Flatiron Crossing, in US 36 GP (aux) lane through the rest of corridor

2015 No Action Model

Highway

The 2015 No Action model should reflect existing plus committed projects along US 36 and the 2015 RTP in the rest of the region. As mentioned above, no committed projects are expected that will add capacity to US 36 prior to 2015, so the 2015 No Action Model should reflect existing conditions. The US 36 2015 No Action model proposed coding is shown in Table 10.

Table 10. US 36 2015 No Action Model Number of Lanes

	2015 No Action Number of Lanes	
Segment	**GP**	**Special**
I-25 to Broadway	4WB, 3EB	1 HOV Rev
Broadway to Pecos	4WB, 3EB	1 HOV Rev
Between Pecos Ramps	3WB, 2EB	1 HOV Rev
Pecos to Federal	4WB, 3EB	1 HOV Each Dir
Between Federal Ramps	3WB, 2EB	1 HOV EB
Federal to Sheridan	3WB, 2EB	1 HOV EB
Between Sheridan Ramps	2WB, 2EB	
Sheridan to Church Ranch	2WB, 2EB	
Between Church Ranch Ramps	2WB, 2EB	
Church Ranch to 120th	2WB, 2EB	
Between 120th Ramps*	N/A	
120th to Wadsworth	2WB, 2EB	
Between Wadsworth Ramps	2WB, 2EB	
Wadsworth to E. Flatiron	3WB, 3EB	
E. Flatiron to Interlocken	2WB, 2EB	
Between Interlocken Ramps	2WB, 2EB	
Interlocken to W. Flatiron	2WB, 2EB	
W. Flatiron to McCaslin	2WB, 2EB	
Between McCaslin Ramps	2WB, 2EB	
McCaslin to Scenic Overlook	2WB, 2EB	
Scenic Overlook to Cherryvale	2WB, 2EB	
Cherryvale to Foothills	2WB, 2EB	

Source: US 36 Project Team, 2008

Notes:

*120th ramps will be built as part of the Broomfield interchange update (2035 RTP and Preferred models only).

GP = General Purpose

Special = HOV or HOT lane (as indicated)

Rev = Reversible

The interchange configurations on US 36 for the 2015 No Action model are listed in Table 11 Changes compared to existing are noted in bold/blue.

Table 11. US 36 2015 No Action Model Interchange Configurations

	2015 No Action Interchange Configurations	
Interchange	**Configuration**	**Notes**
I-25	Existing	
Broadway	Existing	
Pecos	Existing	
Federal	Existing	
Sheridan	Existing	
Church Ranch	Existing	
Broomfield	**TIP Improvement**	**Relocate pnR**
Flatiron	Existing	

	2015 No Action Interchange Configurations	
Interchange	**Configuration**	**Notes**
McCaslin	**TIP Improvement**	**Replace NB to WB ramp with loop ramp**
Foothills/Table Mesa	**TIP Improvement**	**Add pedestrian bridge to/from pnR and bus platform (EB)**
I-25	Existing	

Source: US 36 Project Team, 2008
Notes:
pnR = park-n-Ride
TIP = Transportation Improvement Program (2008-2013)

Transit

The transit system in the 2015 No Action model should reflect existing plus committed projects along US 36 and the 2015 RTP in the rest of the region, which includes FasTracks service (and notably the Northwest Rail line, which connects Denver, Boulder, and Longmont). The US 36 2015 No Action Model Transit Service is shown in Table 12. Changes compared to existing are noted in bold/blue.

Table 12. US 36 2015 No Action Model Transit Service

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Alignment Change
Regional / Express / skyRide					
AB	Boulder to DIA (via NW Pkwy)	50	90	120	
B	Boulder - Denver (all stop)	15	30	30	
BX	Boulder - Denver (express)	10	30	180	
BF	Broomfield - Denver (express)	15	-	-	
BOLT	Boulder/Longmont	**30**	**60**	60	
DD	Boulder - Colorado Blvd.	40	-	-	
DM	Boulder - Fitzsimons	30	-	-	
H	Boulder Transit Village - CCS (all stop)	N/A			
H	Boulder Transit Village - CCS (express)	20	-	-	
J	Longmont/East Boulder/CU	30	-	-	
L	Longmont - Denver	30	90	180	
S	Denver - East Boulder	**Deleted**			
T	Boulder - Greenwood Plaza	50	-		
31x	North Federal Express	50	-	-	
80x	80th Ave. - Denver	50	-	-	
82f	Pomona Express/Feeder	30	-	-	**Converted to feeder for NWR**
86x	Westminster Express	15	-	-	
108f	Countryside Express/Feeder	**30**	-	-	**Converted to feeder for NWR**
Boulder Local					
201	North 4th Street	Deleted			
203	Baseline	30	30	70	
204	Table Mesa/Yarmouth	15	25	40	
205	Gunbarrel/Boulder Mall	15	30	40	
206	Pearl - Eisenhower	30	30	-	
208	Iris - Valmont	30	30	-	
209	CU - Thunderbird	15	20	-	
225	Boulder - Lafayette via Baseline	35	40	-	
228	Louisville - Broomfield via	30	30	180	

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Alignment Change
	Interlocken				
230	Lafayette-Louisville-Interlocken	N/A			
BOUND	Up 30th	10	10	35	
DASH	To Lafayette	15	15	45	
HOP	CU/Pearl - Loop	10	10	15	
JUMP	Arapahoe - Short	30	30	90	
JUMP	Arapahoe - Long	30	30	90	
JUMP	Arapahoe - Extra-Long	30	30	90	
LYNX	Broomfield - Louisville	30	60	-	
SKIP	Broadway Loop	7	10	20	
STAMPEDE	CU - Loop	15	10	-	
Activity Center Connector					
AC-I	Denver - Boulder via Interlocken	N/A			
AC-CP	Denver - Boulder via ConocoPhillips	N/A			
Rail					
DUS30	Denver - Boulder	N/A			
DUSLM	Denver - Longmont	30	60	-	

Source: US 36 Project Team, 2008
Notes:
Changes compared to Existing conditions are noted in bold/blue.

Summary of Changes

To code the 2015 No Action model the project team started with the 2015 RTP model and made the following changes:

Highway

Corrections

1) Modified I-25/I-270 Interchange
2) Modified Federal Interchange
3) Modified Sheridan Interchange
4) Modified Church Ranch Interchange
5) Modified Flatiron Crossing interchange
6) Modified McCaslin Interchange
7) Modified Foothills/Table Mesa interchange
8) Made other network refinements
   - Removed CC between Federal and Pecos
   - Added 98th Street between Sheridan and Harlan
   - Changed number of lanes on streets in Boulder
   - Added turn penalties to ban off-ramp to on-ramp through movements at interchanges on US 36

RTP Removals

9) Removed US 36 HOV lanes
10) Removed Sheridan interchange update
11) Removed Broomfield interchange update

Other

12) Changed HOV capacity to 1,500 vphpl (US 36 and I-25)

Transit

Corrections

1) T: Corrected headway
2) 31x: Corrected alignment
3) DASH: Corrected headway
4) LYNX: Added route
5) 201: Deleted route
6) 203: Corrected route names
7) 204: Corrected headways
8) 205: Corrected headways
9) DUSLM: Corrected stops

RTP Removals

10) 229: Deleted route
11) AB: Reverted headways, alignment back to existing
12) B (Local): Reverted headways, alignments back to existing
13) B (Express): Reverted headways, alignments back to existing
14) BF: Reverted alignment back to existing
15) DD: Reverted alignment back to existing
16) DM: Reverted alignment back to existing
17) H (Local): Deleted route
18) H (Express): Reverted headway, alignment back to existing
19) L: Reverted headways, alignment back to existing
20) US36-I: Deleted route
21) US36-S: Deleted route

2015 Preferred Model

Highway

The 2015 Preferred model uses the 2015 No Action model as a base and adds the US 36 project components that are expected to be in place by 2015. It is expected that two elements of the US 36 project will be implemented by 2015:

1) Conversion of the existing HOV lane to a HOT lane; and
2) HOT lane extension.

The corresponding coding changes are shown in Table 13, and changes compared to 2015 No Action are noted in bold/blue. Note that the special lane access is also included in the table.

Table 13. US 36 2015 Preferred Model Number of Lanes

Segment	2015 Preferred			
	Number of Lanes		Special Lane Access	
	GP	Special	Entrance	Exit
I-25 to Broadway	4WB, 3EB	1 **HOT** Rev	WB (From I-25)	EB (To I-25)
Broadway to Pecos	4WB, 3EB	1 **HOT** Rev		
Between Pecos Ramps	3WB, 2EB	1 **HOT** Rev	EB	WB
Pecos to Federal	4WB, 3EB	1 **HOT** Each Dir	WB, EB	EB
Between Federal Ramps	3WB, 2EB	**1 HOT Each Dir**		
Federal to Sheridan	3WB, 2EB	**1 HOT Each Dir**	WB, EB	WB, EB
Between Sheridan Ramps	2WB, 2EB	**1 HOT Each Dir**		
Sheridan to Church Ranch	2WB, 2EB	**1 HOT Each Dir**	WB, EB	WB, EB
Between Church Ranch Ramps	2WB, 2EB	**1 HOT Each Dir**		
Church Ranch to 120th	2WB, 2EB	**1 HOT Each Dir**	EB	WB
Between 120th Ramps*	N/A	N/A		
120th to Wadsworth	2WB, 2EB	**1 HOT Each Dir**		
Between Wadsworth Ramps	2WB, 2EB	**1 HOT Each Dir**		
Wadsworth to E. Flatiron	3WB, 3EB	**1 HOT Each Dir**	EB	WB, EB
E. Flatiron to Interlocken	2WB, 2EB	**1 HOT Each Dir**	WB	
Between Interlocken Ramps	2WB, 2EB	**1 HOT Each Dir**		
Interlocken to W. Flatiron	2WB, 2EB	**1 HOT Each Dir**		
W. Flatiron to McCaslin	2WB, 2EB	**1 HOT Each Dir**	WB, EB	WB, EB
Between McCaslin Ramps	2WB, 2EB	**1 HOT Each Dir**		
McCaslin to Scenic Overlook	2WB, 2EB	**1 HOT Each Dir**	EB	WB
Scenic Overlook to Cherryvale	2WB, 2EB	**1 HOT Each Dir**		
Cherryvale to Foothills	2WB, 2EB	**1 HOT EB**	2EB	WB

Source: US 36 Project Team, 2008
Notes:
*120th ramps will be built as part of the Broomfield interchange update (2035 RTP and Preferred models only).
GP = General Purpose
Special = HOV or HOT lane (as indicated)
Rev = Reversible

Previous experience has shown that the model volumes in tolled lanes are not as sensitive to price changes as we would expect, so to better simulate the expected real-life management of the US 36 HOT lanes, they will be modeled with a capacity of 1,500 vehicles per hour per lane (vphpl) rather than the default model capacity of 2,000 vphpl for freeways. Note that the capacity of the adjacent and connecting I-25 lanes was also updated so that the HOV/HOT lane system would be consistent.

The interchange configurations on US 36 for the 2015 Preferred model are listed in Table 14. No changes to US 36 interchanges are expected to take place prior to 2015, beyond what was already

programmed in the TIP, so the US 36 interchanges in the 2015 Preferred Model are coded identically to the 2015 No Action model.

Table 14. US 36 2015 Preferred Model Interchange Configurations

	2015 Preferred Interchange Configurations	
Interchange	**Configuration**	**Notes**
I-25	Existing	
Broadway	Existing	
Pecos	Existing	
Federal	Existing	
Sheridan	Existing	
Church Ranch	Existing	
Broomfield	TIP	Relocate pnR
Flatiron	Existing	
McCaslin	TIP	Replace NB to WB ramp with loop ramp
Foothills/Table Mesa	TIP	Add pedestrian bridge to/from pnR and bus platform (EB)
I-25	Existing	

Source: US 36 Project Team, 2008
Notes:
pnR = park-n-Ride
TIP = Transportation Improvement Program (2008-2013)

Transit

The transit system in the 2015 Preferred model is shown in Table 15 and includes additional US 36 BRT service compared to No Action and new alignments routing Regional/Express/skyRide service in the new HOT lanes. Changes compared to No Action are noted in bold/blue.

Table 15. US 36 2015 Preferred Model Transit Service

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Alignment Change
Regional / Express / skyRide					
AB	Boulder to DIA (via NW Pkwy)	**30**	**60**	**60**	
B	Boulder - Denver (all stop)	15	**15**	30	
BX	Boulder - Denver (express)	10	30	180	**Use new HOT lanes**
BF	Broomfield - Denver (express)	15	-	-	**Use new HOT lanes**
BOLT	Boulder/Longmont	30	60	60	
DD	Boulder - Colorado Blvd.	40	-	-	
DM	Boulder - Fitzsimons	30	-	-	
H	**Boulder Transit Village - CCS (all stop)**	**15**	**30**	-	**New route**
H	Boulder Transit Village - CCS (express)	**10**	-	-	**Remove Flatiron Crossing stop; use new HOT lanes**
J	Longmont/East Boulder/CU	30	-	-	
L	Longmont - Denver	**30**	**60**	180	**Use new HOT lanes**
S	Denver - East Boulder	Deleted			
T	Boulder - Greenwood Plaza	50	-		**Use new HOT lanes**

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Alignment Change
31x	North Federal Express	30	-	-	
80x	80th Ave. - Denver	50	-	-	**Use new HOT lanes**
82x	Pomona Express/Feeder	30	-	-	
86x	Westminster Express	15	-	-	**Use new HOT lanes**
108x	Countryside Express/Feeder	30	-	-	
Boulder Local					
201	North 4th Street	Deleted			
203	Baseline	30	30	70	
204	Table Mesa/Yarmouth	15	25	40	
205	Gunbarrel/Boulder Mall	15	30	40	
206	Pearl - Eisenhower	30	30	-	
208	Iris - Valmont	30	30	-	
209	CU - Thunderbird	15	20	-	
225	Boulder - Lafayette via Baseline	35	40	-	
228	Louisville - Broomfield via Interlocken	30	30	180	
230	**Lafayette-Louisville-Interlocken**	**30**	**30**	-	**New route**
BOUND	Up 30th	10	10	35	
DASH	To Lafayette	15	15	45	
HOP	CU/Pearl - Loop	10	10	15	
JUMP	Arapahoe - Short	30	30	90	
JUMP	Arapahoe - Long	30	30	90	
JUMP	Arapahoe - Extra-Long	30	30	90	
LYNX	Broomfield - Louisville	30	60	-	
SKIP	Broadway Loop	7	10	20	
STAMPEDE	CU - Loop	15	10	-	
Activity Center Connector					
AC-I	**Denver - Boulder via Interlocken**	**15**	-	-	**New route; use new HOT lanes**
AC-S	**Denver - Boulder via ConocoPhillips**	**15**	-	-	**New route; use new HOT lanes**
Rail					
DUS30	Denver - Boulder	N/A			
DUSLM	Denver - Longmont	30	60	-	

Summary of Changes

To code the 2015 Preferred model the project team started with the 2035 RTP model and made the following changes:

Highway

Corrections

1) Modified I-25/I-270 Interchange
2) Modified Federal Interchange
3) Modified Sheridan Interchange
4) Modified Church Ranch Interchange
5) Modified Flatiron Crossing interchange
6) Modified McCaslin Interchange

7) Modified Foothills/Table Mesa interchange
8) Made other network refinements
   - Removed CC between Federal and Pecos
   - Added 98th Street between Sheridan and Harlan
   - Changed number of lanes on streets in Boulder
   - Added turn penalties to ban off-ramp to on-ramp through movements at interchanges on US 36

Build Elements

9) Converted existing HOV lanes to HOT lanes
10) Added US 36 HOT lanes

Other

11) Changed HOT and HOV capacity to 1,500 vphpl (US 36 and I-25)

Transit

Corrections

1) T: Corrected headway
2) 31x: Corrected alignment
3) DASH: Corrected headway
4) LYNX: Added route
5) 201: Deleted route
6) 203: Corrected route names
7) 204: Corrected headways
8) 205: Corrected headways
9) 229: Deleted route
10) DUSLM: Corrected stops

Build Elements

11) 230: Added route
12) Moved routes to HOT lane (B, H, T)

2035 No Action Model

Highway

The 2035 No Action model should reflect existing plus committed projects along US 36 and the 2035 RTP in the rest of the region. As mentioned above, no committed projects are expected that will add capacity to US 36 prior to 2035, so the 2035 No Action Model should reflect existing conditions. The US 36 2035 No Action model proposed coding is shown in Table 16.

Table 16. US 36 2035 No Action Model Number of Lanes

	2035 No Action Number of Lanes	
Segment	**GP**	**Special**
I-25 to Broadway	4WB, 3EB	1 HOV Rev
Broadway to Pecos	4WB, 3EB	1 HOV Rev
Between Pecos Ramps	3WB, 2EB	1 HOV Rev
Pecos to Federal	4WB, 3EB	1 HOV Each Dir
Between Federal Ramps	3WB, 2EB	1 HOV EB
Federal to Sheridan	3WB, 2EB	1 HOV EB
Between Sheridan Ramps	2WB, 2EB	
Sheridan to Church Ranch	2WB, 2EB	
Between Church Ranch Ramps	2WB, 2EB	
Church Ranch to 120th	2WB, 2EB	
Between 120th Ramps*	N/A	
120th to Wadsworth	2WB, 2EB	
Between Wadsworth Ramps	2WB, 2EB	
Wadsworth to E. Flatiron	3WB, 3EB	
E. Flatiron to Interlocken	2WB, 2EB	
Between Interlocken Ramps	2WB, 2EB	
Interlocken to W. Flatiron	2WB, 2EB	
W. Flatiron to McCaslin	2WB, 2EB	
Between McCaslin Ramps	2WB, 2EB	
McCaslin to Scenic Overlook	2WB, 2EB	
Scenic Overlook to Cherryvale	2WB, 2EB	
Cherryvale to Foothills	2WB, 2EB	

Source: US 36 Project Team, 2008

Notes:

*120th ramps will be built as part of the Broomfield interchange update (2035 RTP and Preferred models only).

GP = General Purpose

Special = HOV or HOT lane (as indicated)

Rev = Reversible

The 2035 No Action interchange configurations on US 36 are identical to those assumed in the 2015 No Action model and are listed in Table 17. Changes compared to existing are noted in bold/blue.

Table 17. US 36 2035 No Action Model Interchange Configurations

	2035 No Action Interchange Configurations	
Interchange	**Configuration**	**Notes**
I-25	Existing	
Broadway	Existing	
Pecos	Existing	
Federal	Existing	
Sheridan	Existing	
Church Ranch	Existing	
Broomfield	**TIP Improvement**	**Relocate pnR**
Flatiron	Existing	
McCaslin	**TIP Improvement**	**Replace NB to WB ramp with loop ramp**
Foothills/Table Mesa	**TIP Improvement**	**Add pedestrian bridge to/from pnR and bus platform (EB)**
I-25	Existing	

Source: US 36 Project Team, 2008
Notes:
pnR = park-n-Ride
TIP = Transportation Improvement Program (2008-2013)

Transit

The transit system in the 2035 No Action model should reflect existing plus committed projects along US 36 and the 2035 RTP in the rest of the region, which includes FasTracks service (and notably the Northwest Rail line, which provides service between Denver, Boulder, and Longmont).

Table 18. US 36 2035 No Action Model Transit Service

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Alignment Change
Regional / Express / skyRide					
AB	Boulder to DIA (via NW Pkwy)	50	150	140	
B	Boulder - Denver (all stop)	35	30	40	
BX	Boulder - Denver (express)	20	45	70	
BF	Broomfield - Denver (express)	15	-	-	
BOLT	Boulder/Longmont	**30**	**60**	60	
DD	Boulder - Colorado Blvd.	40	-	-	
DM	Boulder - Fitzsimons	30	-	-	
H	Boulder Transit Village - CCS (all stop)	N/A			
H	Boulder Transit Village - CCS (express)	20	-	-	
J	Longmont/East Boulder/CU	30	-	-	
L	Longmont - Denver	35	105	-	
S	Denver - East Boulder	**Deleted**			
T	Boulder - Greenwood Plaza	25	-		
31x	North Federal Express	50	-	-	
80x	80th Ave. - Denver	50	-	-	
82f	Pomona Express/Feeder	**30**	-	-	**Converted to feeder for NWR**
86x	Westminster Express	15	-	-	
108f	Countryside Express/Feeder	**30**	-	-	**Converted to feeder for NWR**

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Alignment Change
Boulder Local					
201	North 4th Street	**Deleted**			
203	Baseline	30	30	70	
204	Table Mesa/Yarmouth	15	30	40	
205	Gunbarrel/Boulder Mall	15	30	30	
206	Pearl - Eisenhower	30	30	-	
208	Iris - Valmont	30	30	180	
209	CU - Thunderbird	15	20	-	
225	Boulder - Lafayette via Baseline	35	45	-	
228	Louisville - Broomfield via Interlocken	30	30	-	
230	Lafayette-Louisville-Interlocken	N/A			
BOUND	Up 30th	10	10	35	
DASH	To Lafayette	15	15	45	
HOP	CU/Pearl - Loop	10	10	15	
JUMP	Arapahoe - Short	30	30	90	
JUMP	Arapahoe - Long	30	30	90	
JUMP	Arapahoe - Extra-Long	30	30	90	
LYNX	Broomfield - Louisville	30	60	-	
SKIP	Broadway Loop	7	10	20	
STAMPEDE	CU - Loop	15	10	-	
Activity Center Connector					
AC-I	Denver - Boulder via Interlocken	N/A			
AC-CP	Denver - Boulder via ConocoPhillips	N/A			
Rail					
DUS30	**Denver - Boulder**	**30**	**-**	**-**	
DUSLM	Denver - Longmont	30	**30**	-	

Source: US 36 Project Team, 2008
Notes:
Changes compared to Existing conditions are noted in bold/blue.

Summary of Changes

To code the 2035 No Action model the project team started with the 2035 RTP model and made the following changes:

Highway

Corrections

1) Modified I-25/I-270 Interchange
2) Modified Federal Interchange
3) Modified Sheridan Interchange
4) Modified Church Ranch Interchange
5) Modified Flatiron Crossing interchange
6) Modified McCaslin Interchange
7) Modified Foothills/Table Mesa interchange
8) Made other network refinements
   - Removed CC between Federal and Pecos
   - Added 98th Street between Sheridan and Harlan

- Changed number of lanes on streets in Boulder
- Added turn penalties to ban off-ramp to on-ramp through movements at interchanges on US 36

RTP Removals

9) Removed US 36 HOV lanes
10) Removed Sheridan interchange update
11) Removed Broomfield interchange update

Other

12) Changed HOV capacity to 1,500 vphpl (US 36 and I-25)

Transit

Corrections

1) T: Corrected headway
2) 31x: Corrected alignment
3) DASH: Corrected headway
4) LYNX: Added route
5) 201: Deleted route
6) 203: Corrected route names
7) 204: Corrected headways
8) 205: Corrected headways
9) DUSLM: Corrected headway, stops

RTP Removals

10) 229: Deleted route
11) AB: Reverted headways, alignment back to existing
12) B (Local): Reverted headways, alignments back to existing
13) B (Express): Reverted headways, alignments back to existing
14) BF: Reverted alignment back to existing
15) DD: Reverted alignment back to existing
16) DM: Reverted alignment back to existing
17) H (Local): Deleted route
18) H (Express): Reverted headway, alignment back to existing
19) L: Reverted headways, alignment back to existing
20) US36-I: Deleted route
21) US36-S: Deleted route

2035 Preferred Model

Highway

The 2035 Preferred model uses the 2035 No Action model as a base and adds the US 36 project components that are expected to be in place by 2035. It is expected that the following elements of the US 36 project will be implemented by 2035:

1) Conversion of the existing HOV lane to a HOT lane;
2) HOT lane extension; and
3) Addition of EB general purpose lane between I-25 and Federal; and
4) Addition of auxiliary lanes throughout much of the corridor.

The corresponding coding changes are shown in Table 19, and changes compared to 2015 No Action are noted in bold/blue. Note that the special lane access is also included in the table.

Table 19. US 36 2035 Preferred Model Number of Lanes

Segment	2035 Preferred			
	Number of Lanes		Special Lane Access	
	GP	Special	Entrance	Exit
I-25 to Broadway	4WB, **4EB**	1 **HOT** Rev	WB (From I-25)	EB (To I-25)
Broadway to Pecos	4WB, **4EB**	1 **HOT** Rev		
Between Pecos Ramps	3WB, **3EB**	1 **HOT** Rev	EB	WB
Pecos to Federal	4WB, **4EB**	1 **HOT** Each Dir	WB, EB	EB
Between Federal Ramps	3WB, **3EB**	**1 HOT Each Dir**		
Federal to Sheridan	3WB, **3EB**	**1 HOT Each Dir**	WB, EB	WB, EB
Between Sheridan Ramps	2WB, 2EB	**1 HOT Each Dir**		
Sheridan to Church Ranch	**3WB, 3EB**	**1 HOT Each Dir**	WB, EB	WB, EB
Between Church Ranch Ramps	2WB, 2EB	**1 HOT Each Dir**		
Church Ranch to 120th	**3WB, 3EB**	**1 HOT Each Dir**	EB	WB
Between 120th Ramps*	**3WB, 3EB**	**1 HOT Each Dir**	WB	EB
120th to Wadsworth	**3WB, 3EB**	**1 HOT Each Dir**		
Between Wadsworth Ramps	2WB, 2EB	**1 HOT Each Dir**		
Wadsworth to E. Flatiron	3WB, 3EB	**1 HOT Each Dir**	EB	WB, EB
E. Flatiron to Interlocken	3WB, 3EB	**1 HOT Each Dir**	WB	
Between Interlocken Ramps	2WB, 2EB	**1 HOT Each Dir**		
Interlocken to W. Flatiron	**3WB, 3EB**	**1 HOT Each Dir**		
W. Flatiron to McCaslin	**3WB, 3EB**	**1 HOT Each Dir**	WB, EB	WB, EB
Between McCaslin Ramps	2WB, 2EB	**1 HOT Each Dir**		
McCaslin to Scenic Overlook	**3WB**, 2EB	**1 HOT Each Dir**	EB	WB
Scenic Overlook to Cherryvale	2WB, **3EB**	**1 HOT Each Dir**		
Cherryvale to Foothills	**3WB, 3EB**	**1 HOT EB**	2EB	WB

Source: US 36 Project Team, 2008
Notes:
*120th ramps will be built as part of the Broomfield interchange update (2035 RTP and Preferred models only).
GP = General Purpose
Special = HOV or HOT lane (as indicated)
Rev = Reversible

The interchange configurations on US 36 for the 2035 Preferred model are listed in Table 20. As part of the US 36 FEIS Preferred alternative, improvements are expected at the Broadway, Sheridan, and Broomfield interchanges.

Table 20. US 36 2035 Preferred Model Interchange Configurations

	2035 Preferred Interchange Configurations	
Interchange	**Configuration**	**Notes**
I-25	Existing	
Broadway	**Build**	**New SB I-25 to WB US 36 direct connect and exit to Broadway**
Pecos	Existing	
Federal	Existing	
Sheridan	**Build**	**Widen Sheridan over US 36 (same as RTP)** **Add EB slip on-ramp between 92nd and Sheridan, remove WB loop ramp, and create split diamond configuration (Build)**
Church Ranch	Existing	
Broomfield	TIP, **Build**	TIP: Relocate pnR; **Build: Convert to split diamond configuration with collector-distributor system (same as RTP)**
Flatiron	Existing	
McCaslin	TIP	Replace NB to WB ramp with loop ramp
Foothills/Table Mesa	TIP	Add pedestrian bridge to/from pnR and bus platform (EB)
I-25	Existing	

Source: US 36 Project Team, 2008
Notes:
pnR = park-n-Ride
TIP = Transportation Improvement Program (2008-2013)

Transit

The transit system in the 2035 Preferred model includes additional US 36 BRT service compared to No Action.

Table 21. US 36 2035 Preferred Model Transit Service

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Alignment Change
Regional / Express / skyRide					
AB	Boulder to DIA (via NW Pkwy)	**30**	**60**	**60**	**Use new HOT lanes**
B	Boulder - Denver (all stop)	**15**	**15**	**30**	**Use new HOT lanes**
BX	Boulder - Denver (express)	**10**	**30**	**-**	**Use new HOT lanes**
BF	Broomfield - Denver (express)	15	-	-	**Use new HOT lanes**
BOLT	Boulder/Longmont	30	60	60	
DD	Boulder - Colorado Blvd.	40	-	-	**Use new HOT lanes**
DM	Boulder - Fitzsimons	30	-	-	**Use new HOT lanes**
H	**Boulder Transit Village - CCS (all stop)**	**15**	**30**	-	**New route (uses new HOT lanes)**
H	Boulder Transit Village - CCS (express)	**10**	-	-	**Remove Flatiron Crossing stop; use new HOT lanes**
J	Longmont/East Boulder/CU	30	-	-	

Route	Route Name	Peak Hdwy.	Off-Peak Hdwy.	Early / Late Hdwy.	Alignment Change
L	Longmont - Denver	**30**	**60**	**180**	**Use new HOT lanes**
S	Denver - East Boulder	Deleted			
T	Boulder - Greenwood Plaza	25	-		**Use new HOT lanes**
31x	North Federal Express	30	-	-	
80x	80th Ave. - Denver	50	-	-	**Use new HOT lanes**
82x	Pomona Express/Feeder	30	-	-	
86x	Westminster Express	10	-	-	**Use new HOT lanes**
108x	Countryside Express/Feeder	30	-	-	
Boulder Local					
201	North 4th Street	Deleted			
203	Baseline	30	30	70	
204	Table Mesa/Yarmouth	15	30	40	
205	Gunbarrel/Boulder Mall	15	30	30	
206	Pearl - Eisenhower	30	30	-	
208	Iris - Valmont	30	30	180	
209	CU - Thunderbird	15	20	-	
225	Boulder - Lafayette via Baseline	35	45	-	
228	Louisville - Broomfield via Interlocken	30	30	-	
230	**Lafayette-Louisville-Interlocken**	**30**	**30**	-	**New route**
BOUND	Up 30th	10	10	35	
DASH	To Lafayette	15	15	45	
HOP	CU/Pearl - Loop	10	10	15	
JUMP	Arapahoe - Short	30	30	90	
JUMP	Arapahoe - Long	30	30	90	
JUMP	Arapahoe - Extra-Long	30	30	90	
LYNX	Broomfield - Louisville	30	60	-	
SKIP	Broadway Loop	7	10	20	
STAMPEDE	CU - Loop	15	10	-	
Activity Center Connector					
AC-I	**Denver - Boulder via Interlocken**	**15**	-	-	**New route; use new HOT lanes**
AC-S	**Denver - Boulder via ConocoPhillips**	**15**	-	-	**New route; use new HOT lanes**
Rail					
DUS30	Denver - Boulder	30	-	-	
DUSLM	Denver - Longmont	30	30	-	

Summary of Changes

To code the 2035 Preferred model the project team started with the 2035 RTP model and made the following changes:

Highway

Corrections

1) Modified I-25/I-270 Interchange
2) Modified Federal Interchange
3) Modified Church Ranch Interchange

4) Modified Flatiron Crossing interchange
5) Modified McCaslin Interchange
6) Modified Foothills/Table Mesa interchange
7) Made other network refinements
   - Removed CC between Federal and Pecos
   - Added 98th Street between Sheridan and Harlan
   - Changed number of lanes on streets in Boulder
   - Added turn penalties to ban off-ramp to on-ramp through movements at interchanges on US 36

Build Elements

8) Converted existing HOV lanes to HOT lanes
9) Added US 36 HOT lanes
10) Added GP lanes
11) Added auxiliary lanes
12) Added Broadway interchange update
13) Added Sheridan interchange update
14) Added Broomfield interchange update

Other

15) Changed HOT and HOV capacity to 1,500 vphpl (US 36 and I-25)

Transit

Corrections

1) T: Corrected headway
2) 31x: Corrected alignment
3) DASH: Corrected headway
4) LYNX: Added route
5) 201: Deleted route
6) 203: Corrected route names
7) 204: Corrected headways
8) 205: Corrected headways
9) 229: Deleted route
10) DUSLM: Corrected headway, stops

Build Elements

11) 230: Added route
12) Moved routes to GP/HOT lanes

Table 22. US 36 Transit Route Summary (Comparison to Existing)

Route	Route Name	2015 No Action	2015 Preferred	2035 No Action	2035 Preferred
Regional / Express / skyRide					
AB	Boulder to DIA	Existing	**Increased service; moved to NW Pkwy**	Existing	**Increased service; moved to NW Pkwy**
BV*	Boulder - Denver (all stop)	Existing	**Increased service***	Existing	**Increased service***
BX*	Boulder - Denver (express)	Existing	**Increased service***	Existing	**Increased service***
BF*	Broomfield - Denver (express)	Existing	Existing*	Existing	Existing*
BOLT	Boulder/Longmont	**Decreased service (NWR)**	**Decreased service (NWR)**	**Decreased service (NWR)**	**Decreased service (NWR)**
DD	Boulder - Colorado Blvd.	Existing	Existing	Existing	Existing
DM	Boulder - Fitzsimons	Existing	Existing	Existing	Existing
H*	Boulder Transit Village - CCS (all stop)	N/A	**New Route***	N/A	**New Route***
HX*	Boulder Transit Village - CCS (express)	Existing	**Increased service*; removed Flatiron Crossing stop**	Existing	**Increased service*; removed Flatiron Crossing stop**
J	Longmont/East Boulder/CU	Existing	Existing*	Existing	Existing*
L*	Longmont - Denver	Existing	**Increased service***	Existing	**Increased service***
S	Denver - East Boulder	**Deleted (NWR)**	**Deleted (NWR)**	**Deleted (NWR)**	**Deleted (NWR)**
T*	Boulder - Greenwood Plaza	Existing	Existing*	Existing	Existing*
31x	North Federal Express	Existing	Existing	Existing	Existing
80x*	80th Ave. - Denver	Existing	Existing*	Existing	Existing*
82f	Pomona Express/Feeder	**Converted to feeder; increased service (NWR)**	**Converted to feeder; increased service (NWR)**	**Converted to feeder; increased service (NWR)**	**Converted to feeder; increased service (NWR)**
86x*	Westminster Express	Existing	Existing*	Existing	Existing*
108f	Countryside Express/Feeder	**Converted to feeder (NWR)**	**Converted to feeder (NWR)**	**Converted to feeder (NWR)**	**Converted to feeder (NWR)**
Boulder Local					
201	North 4th Street	Deleted			
203	Baseline	Existing	Existing	Existing	Existing
204	Table Mesa/Yarmouth	Existing	Existing	Existing	Existing
205	Gunbarrel/Boulder Mall	Existing	Existing	Existing	Existing
206	Pearl - Eisenhower	Existing	Existing	Existing	Existing

Route	Route Name	2015 No Action	2015 Preferred	2035 No Action	2035 Preferred
208	Iris - Valmont	Existing	Existing	Existing	Existing
209	CU - Thunderbird	Existing	Existing	Existing	Existing
225	Boulder - Lafayette via Baseline	Existing	Existing	Existing	Existing
228	Louisville - Broomfield via Interlocken	Existing	Existing	Existing	Existing
230	Lafayette-Louisville-Interlocken	N/A	**New Route**	N/A	**New Route**
BOUND	Up 30th	Existing	Existing	Existing	Existing
DASH	To Lafayette	Existing	Existing	Existing	Existing
HOP	CU/Pearl - Loop	Existing	Existing	Existing	Existing
JUMP	Arapahoe - Short	Existing	Existing	Existing	Existing
JUMP	Arapahoe - Long	Existing	Existing	Existing	Existing
JUMP	Arapahoe - Extra-Long	Existing	Existing	Existing	Existing
LYNX	Broomfield / Louisville	Existing	Existing	Existing	Existing
SKIP	Broadway Loop	Existing	Existing	Existing	Existing
STAMPEDE	CU - Loop	Existing	Existing	Existing	Existing
Activity Center Connector					
AC-I	Denver - Boulder via Interlocken	N/A	**New Route**	N/A	**New Route**
AC-CP	Denver - Boulder via ConocoPhillips	N/A	**New Route**	N/A	**New Route**
Rail					
DUS30	Denver - Boulder	N/A	N/A	***New Route***	***New Route***
DUSLM	Denver - Longmont	**New Route**	**New Route**	***Increased Service***	***Increased Service***

Notes:
*Route uses all or part of US 36 HOT lane Build element.
Bold/blue indicates change over Existing.
The only change between the 2015 data set and the 2035 data set is the addition of DUS30 Denver – Boulder NWR and increase in service for the DUSLM Denver – Longmont NWR in 2035.

Appendix B
ITS Implementation Plan

US 36 EIS: ITS and Engineering Elements

Implementation Plan for Managed Lanes

Prepared for CDOT

Prepared by Apex Design

December 2008

Table of Contents

B.1 INTRODUCTION

This technical memorandum describes potential approaches and considerations for implementing High Occupancy Toll (HOT) lanes along the US 36 corridor, which will be referred to in this report as managed lanes. The managed lanes will be comprised of single-occupant vehicles (SOV), which will be tolled, and high-occupancy vehicles (HOV), transit vehicles, and motorcycles that can use the managed lanes for free. It is anticipated that the Colorado Tolling Enterprise (CTE) will manage these lanes. The major components of this report include:

- Assumptions
- Geometric Configurations
- Signing and Striping
- Infrastructure
- Interoperability
- Enforcement
- Maintenance
- Personnel and Equipment Needs

B.2 ASSUMPTIONS

Since this implementation plan is being performed as part of the US 36 Corridor EIS, the following assumptions were made regarding base conditions during opening day:

B.2.1 Segment

The managed lanes will extend from the current reversible lane section at Pecos Street in Denver west to Foothills Parkway in Boulder.

B.2.2 Facility Opening

For planning purposes, it is assumed that the managed lanes will be operational by the year 2015. The corridor is assumed to be built in phases with the managed lanes being constructed in the initial phase. The US 36 managed lanes are not anticipated to directly connect to the Northwest Parkway at the time of opening.

B.2.3 Geometry

There will be one managed lane in each direction, eastbound and westbound, that will be separated from the general-purpose lanes by a four-foot-wide striped buffer. The managed lane will be the leftmost traveled lane.

B.2.4 Volumes

Year 2035 volumes were forecast for the entire corridor and used to calculate anticipated ridership in the managed lanes. As expected, volumes in the managed lanes vary throughout the segment. In the peak direction of the peak hour, volumes for SOV and HOV users in the managed lane ranged from approximately 800 to 1,100 vehicles. The exception is the a.m. westbound peak hour at Foothills Parkway where volumes reached roughly 1,500. If needed, SOV volumes can be regulated through pricing strategies. For instance, if the managed lane becomes too congested and performance degrades then the pricing can be increased to deter SOV users; in comparison, if there are few users of the managed lane, then the pricing can be decreased to encourage SOV use of the facility and make the most of the available capacity.

B.2.5 Operations

The managed lanes will be open 24 hours a day, seven days a week, except for approved closures due to incidents or maintenance. CTE will charge SOV drivers a toll for use of the managed lane. Qualified HOV users, including buses and motorcycles, will be able to use the facility without charge.

B.2.6 Access

Crossing the managed lane buffer, which is comprised of double solid white lines and which delineates the managed lane from general-purpose lanes, will be prohibited. There will be a separated single ingress and egress area between each full movement interchange providing access between the managed lanes and general-purpose lanes. These access areas will be striped with broken lane lines.

B.2.7 Dynamic Pricing

The managed lane facility will be dynamically priced upon opening, as opposed to the current time of day variable pricing in use by CTE today.

B.2.8 Collections

The E-470 Toll Authority will perform revenue collections, including toll fees and violations.

B.2.9 Enforcement

Colorado State Patrol will be responsible for enforcement.

B.2.10 Maintenance

Maintenance will be performed by a combination of CDOT personnel, or its contractors, and the system(s) vendor(s).

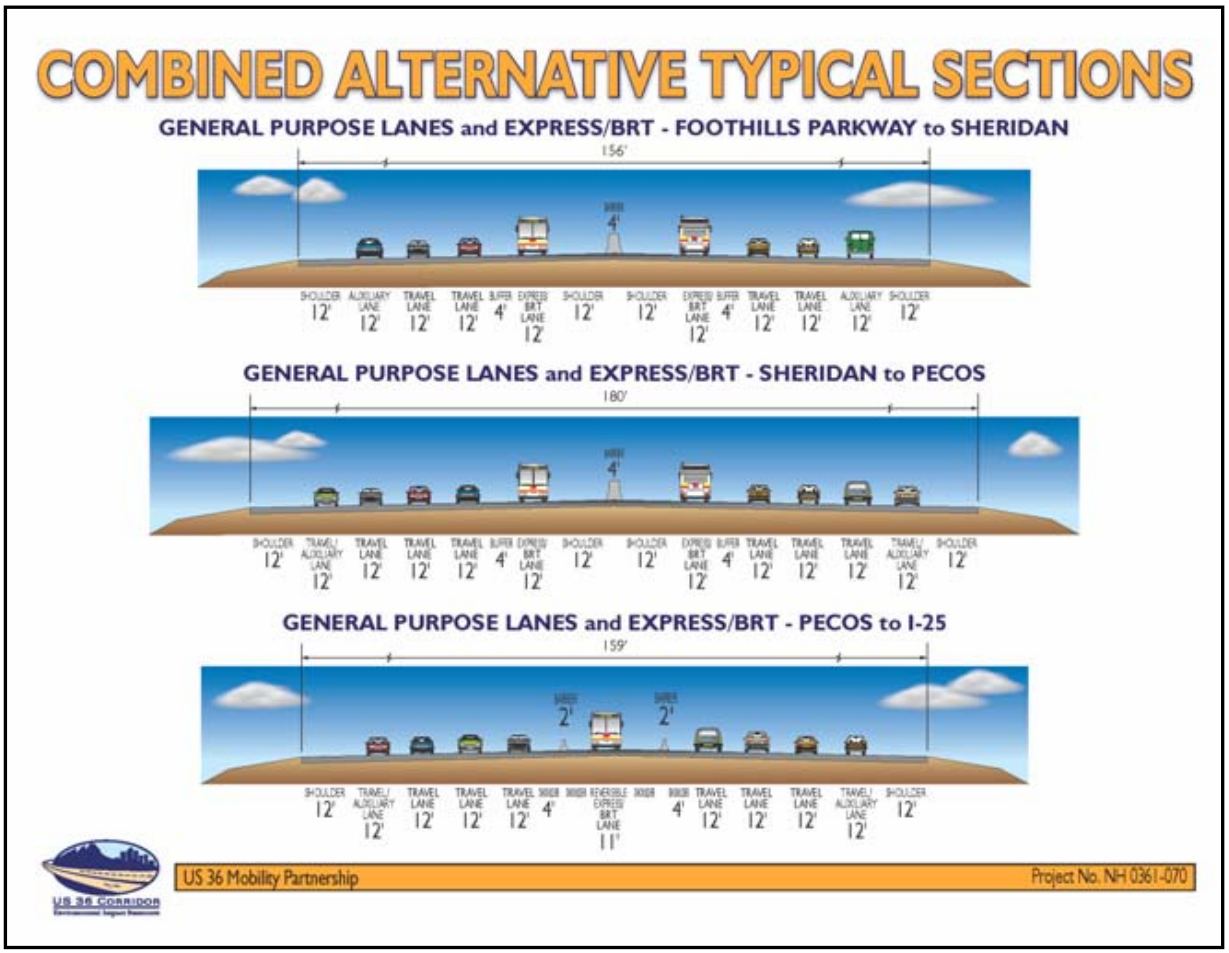
B.3 GEOMETRIC CONFIGURATIONS

This section describes the future US 36 lane configurations along the corridor for the mainline and ramps.

B.3.1 Maintenance

Figure B-1, Combined Alternative Package (Preferred Alternative) Typical Sections, shows the typical cross-sections of the Combined Alternative Package (Preferred Alternative) along US 36 in three different segments.

Figure B-1: Combined Alternative Package (Preferred Alternative) Typical Sections



Source: US 36 Mobility Partnership, 2009.

As illustrated in the typical sections, the managed lanes (one in each direction of travel) include a 12-foot-wide inside shoulder to the left of the managed lane and a 4-foot-wide striped buffer to the right of the managed lane, separating it from the general-purpose lanes. These widths are of particular interest because they could potentially be decreased to provide for other configurations. For example, either width could be decreased in a section to allow for an enforcement area or a parallel access lane as discussed later in this report.

Figure B-2, Typical Segment, shows a plan view of a segment between the Sheridan Boulevard and Pecos Street interchanges. The segment shows the single managed lane in either direction of travel on US 36 and the typical access configuration. As seen in the graphic, there is a single ingress and egress between each interchange. In this particular segment, the tie-in to the existing reversible lane at Pecos Street is also displayed.

Figure B-2: Typical Segment

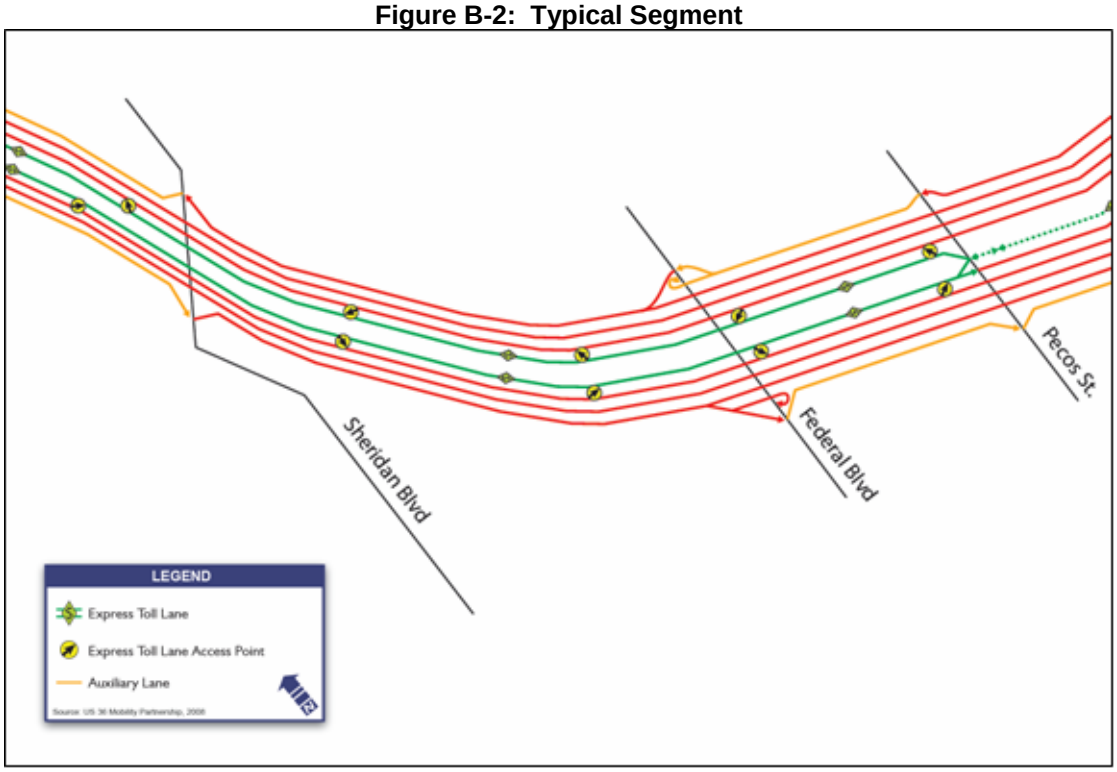
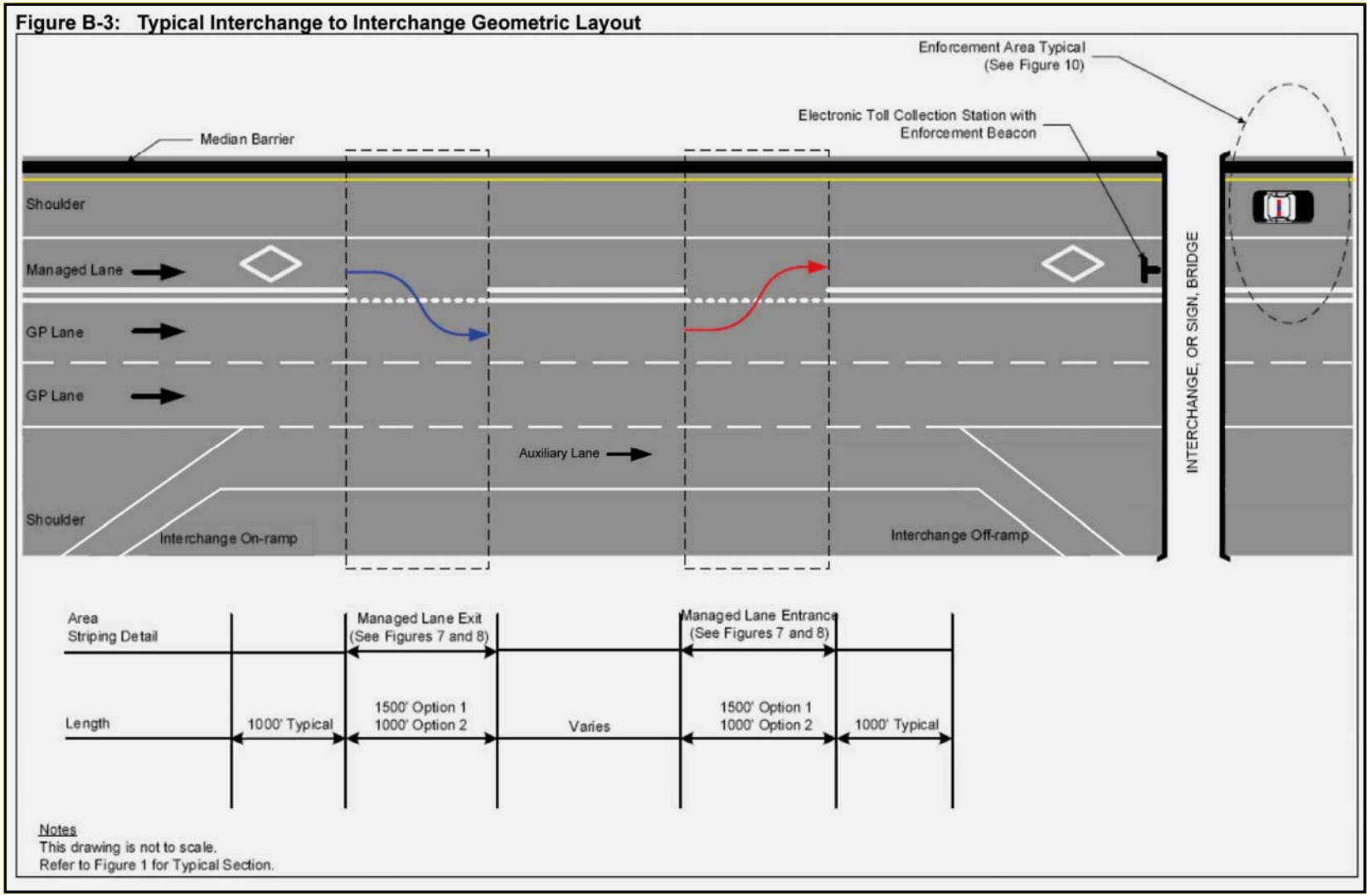


Figure B-3, Typical Interchange to Interchange Geometric Layout, illustrates a typical layout between two interchanges along US 36. It illustrates typical spacing between the managed lane exit and entrance areas. Note that the exit and entrance distances vary between two options. Option 1 considers a constant typical section in which there are no lane shifts. In Option 1 a vehicle in the managed lane maneuvers into the general-purpose lane at the managed lane exit area by simply crossing the single dotted white pavement marking. Option 2 considers a parallel access lane at both the managed lane exit and entrance areas. This results in reducing the width of the inside shoulder (or buffer) to accommodate the parallel access lane and requires a lane shift for the managed lane. For instance, a vehicle in the managed lane maneuvers into an auxiliary lane then merges into the general-purpose lane. This is discussed further in the striping layout discussion. Figure B-3 also shows that an enforcement area will be provided after the toll collection stations.

Figure B-3: Typical Interchange to Interchange Geometric Layout



Source: US 36 Mobility Partnership, 2009.

B.3.2 Exceptions to the Typical Lane Configuration

One exception to the typical interchange-to-interchange geometric layout occurs eastbound between Foothills Parkway and McCaslin Boulevard. In this instance, the distance between the ramp entrance and exit points is 3.37 miles. This long distance lends itself to having the managed lane entrance prior to the exit (shown in Figure B-3). The other segment that could be reversed in the same manner is Sheridan Boulevard to Federal Boulevard (in both directions of travel). This segment is roughly 2.15 miles long. Reversing the egress and ingress in these locations would allow for managed lane users to stay in the managed lanes as long as possible and still have sufficient room to complete all lane maneuvers across US 36.

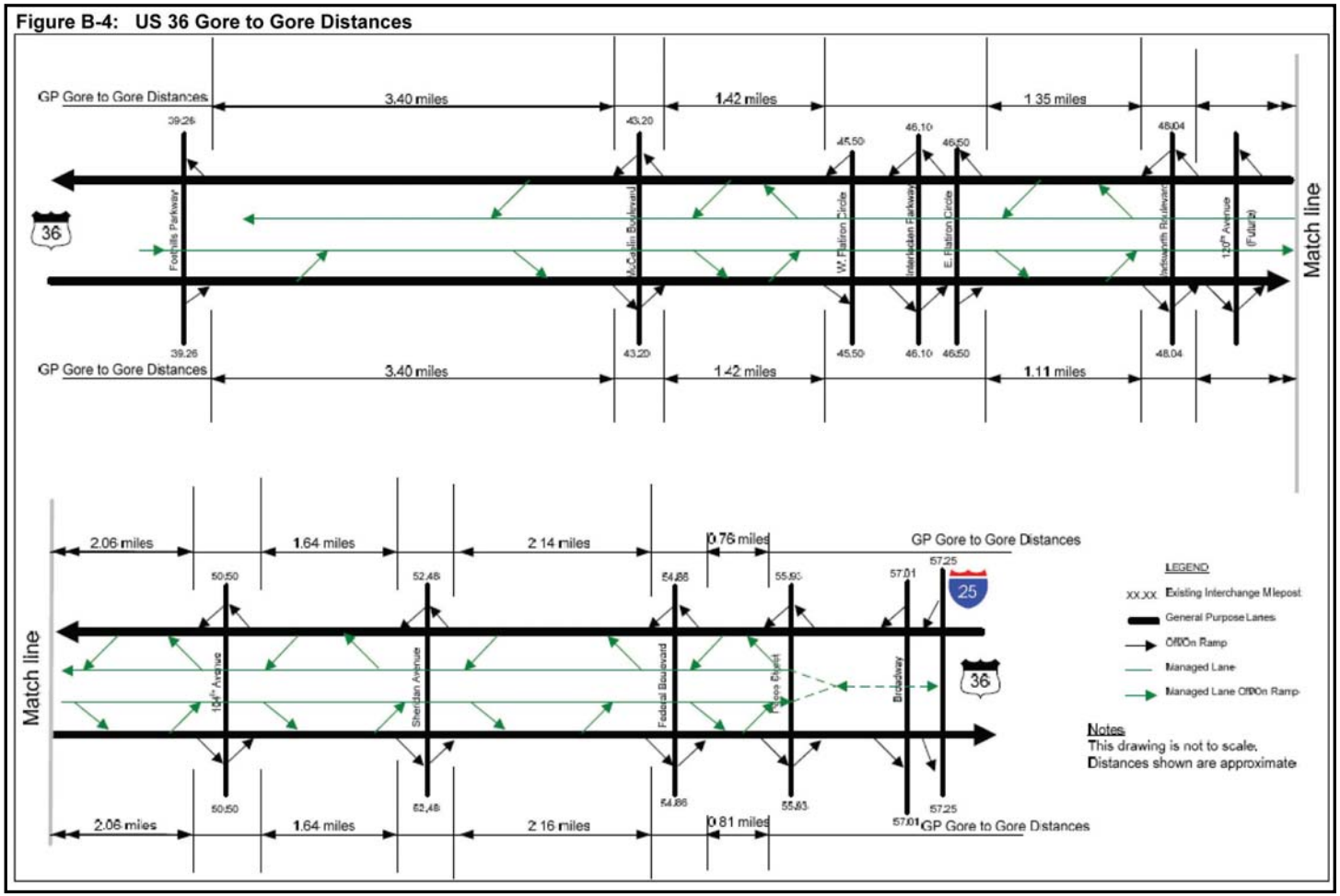
Another exception to the typical interchange geometric layout occurs between Federal Boulevard and Pecos Street (in both directions of travel). Both of these segments are short enough in distance between entrance and exit ramp gores that there is not room for the typical 1,000-foot distance before starting the ingress and egress points. As a result, the 1,000-foot distance from the ramp gores (shown in Figure B-4, US 36 Gore to Gore Distances) cannot be achieved. For Option 1 (shown in Figure B-5, Option 1 Managed Lane Exit and Entrance Striping), the 1,000 foot distance will need to be shortened. For Option 2 (shown in Figure B-6, Option 2 HOV Exit and Entrance Striping), the distance from the ingress to the egress between Federal Boulevard and Pecos Street would also need to be shortened and continuously striped with chevrons between the auxiliary lanes. As a result, the inside shoulder would only be 4 feet wide for this segment of US 36.

B.3.3 Ramp Lane Configurations

In the CAP there are 12 interchanges along US 36. The managed lanes should be designed to facilitate access to and from the on- and off-ramps for each interchange. More specifically, ingress and egress points should be located at a distance great enough to allow vehicles sufficient length to complete all merge and diverge maneuvers.

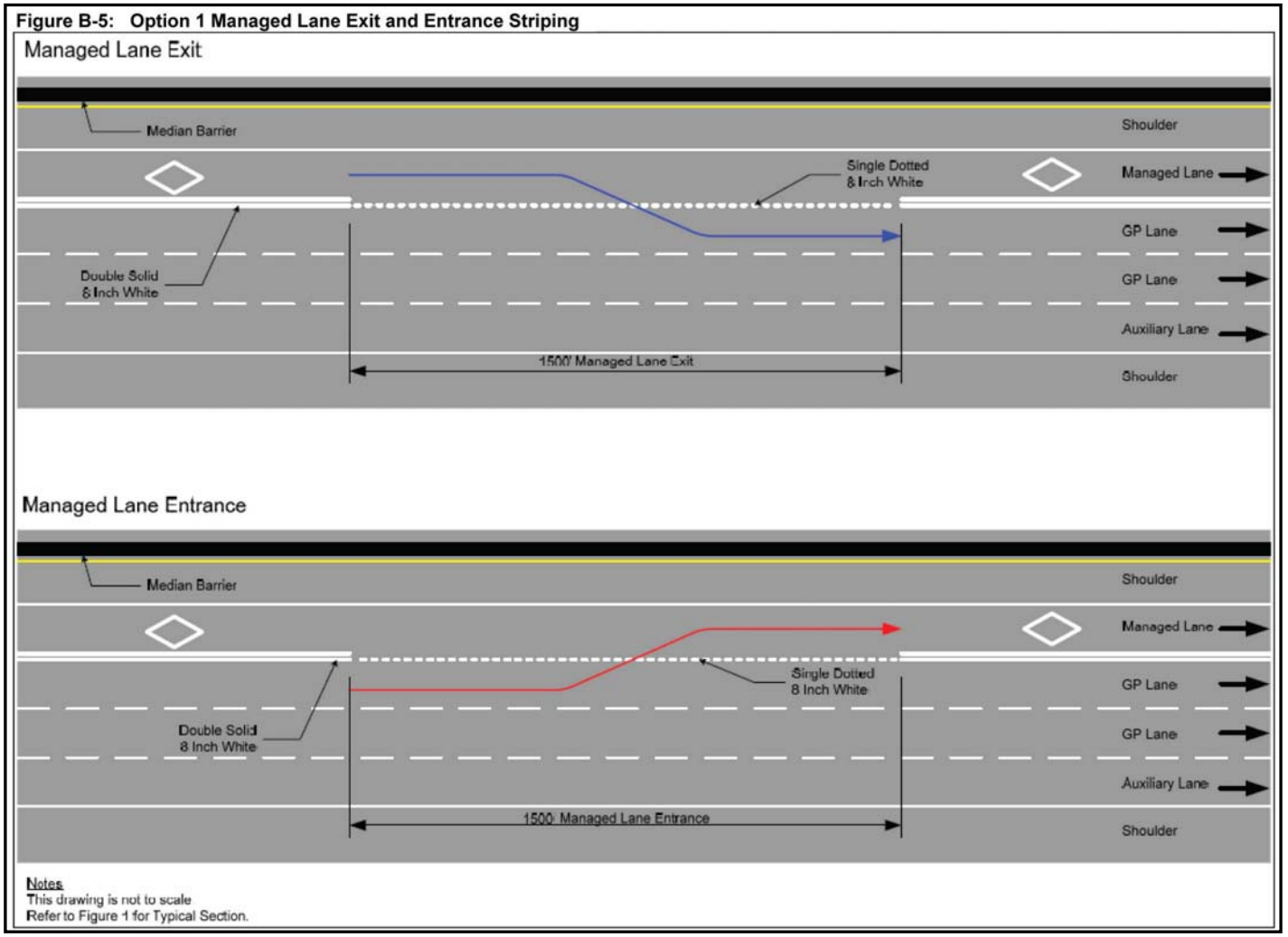
On-ramps are comprised of single-lane and two-lane entrances to the freeways. Ramp meters are currently operating at eight of the on-ramps, and most on-ramps are expected to have ramp meters in the future. After reconstruction, these on-ramps may contain HOV bypass lanes allowing vehicles with occupancies of two or more persons to proceed around the ramp metering control without stopping. Figure B-7, On-ramp Configuration, is a photo of the existing westbound US 36 ramp meter and bus bypass lane located at the McCaslin Boulevard on-ramp. This photo illustrates the maximum number of on-ramp lanes (three) at any given ramp; two lanes for general-purpose traffic subject to ramp metering control and one HOV bypass lane.

Figure B-4: US 36 Gore to Gore Distances



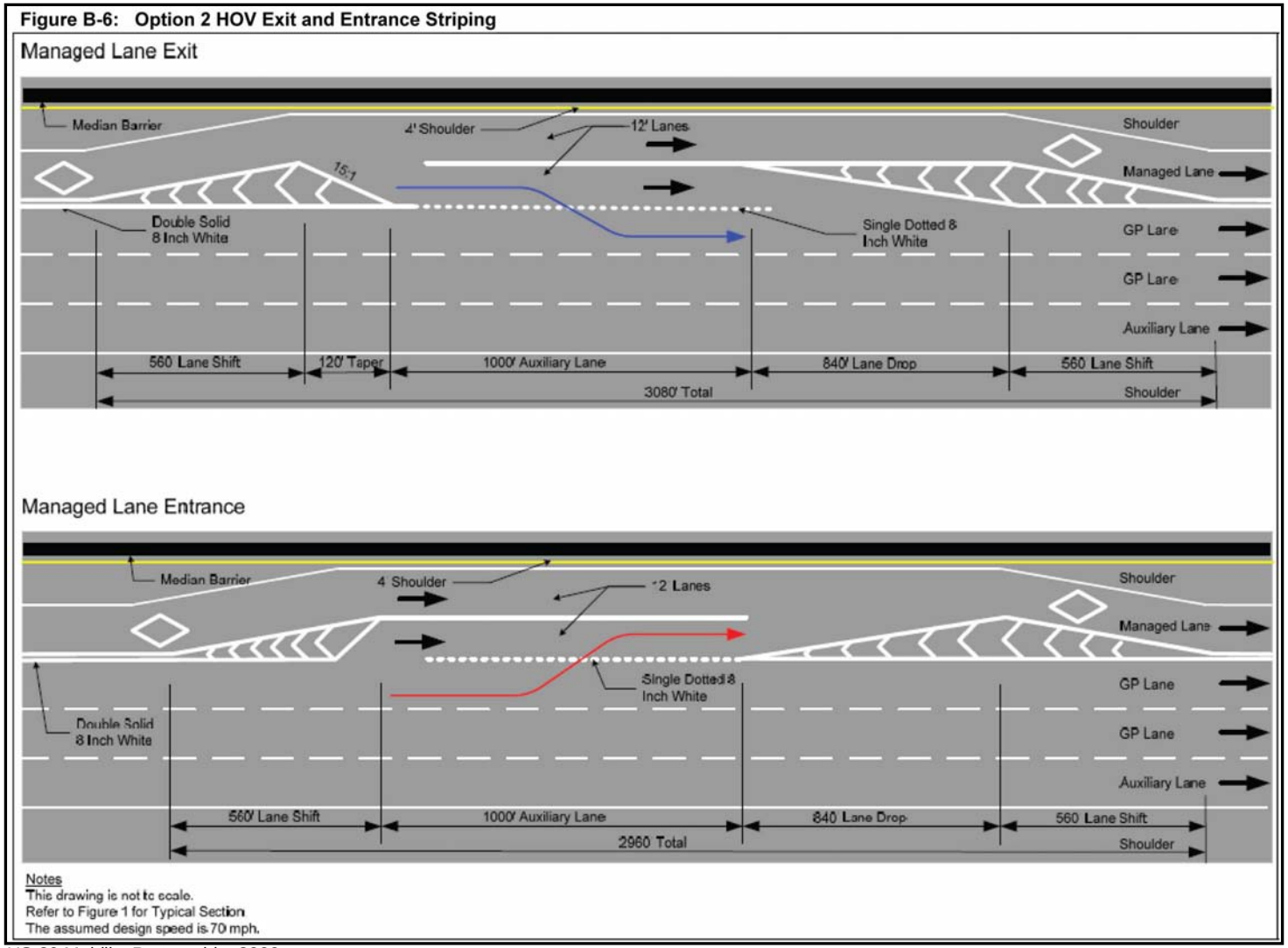
Source: US 36 Mobility Partnership, 2009.

Figure B-5: Option 1 Managed Lane Exit and Entrance Striping



Source: US 36 Mobility Partnership, 2009.

Figure B-6: Option 2 HOV Exit and Entrance Striping



US 36 Mobility Partnership, 2009.

Figure B-7: On-ramp Configuration

Source: US 36 Mobility Partnership, 2009.

It is not recommended that any additional lanes be added to the on-ramps specifically for toll vehicles. Also, it is not recommended that SOV toll vehicles be allowed to utilize the HOV ramp meter bypass lane. There are several reasons for this. First, there may not be capacity to add toll users to the HOV ramp meter bypass lane. Adding a fourth ramp lane could create merging difficulties as the two proposed bypass lanes vie for gaps with the two ramp meter controlled lanes. Second, the toll vehicles would not be privy to information about toll rates and freeway traffic conditions before entering the freeway, so they should be treated like the other users. If there was a bypass lane, SOVs would need to be tolled at the on-ramp location. This would mean that tolled vehicles would be paying for the time and distance spent merging across all of the freeway lanes. If tolls were collected at the on-ramp then enforcement would be difficult to conduct as the drivers would still have the option to not enter the managed lanes after merging with US 36 traffic.

It is recommended that potential toll SOVs continue to flow through the ramp meter control and general-purpose merge areas as they do for the existing I-25 HOV/TOLL lanes (with the exception of the direct access points along I-25 at 70th Avenue and from Downtown). The only proposed direct connection to the US 36 managed lanes will be the continuation of the existing US 36 lanes on the eastern end of the corridor.

Figure B-4, US 36 Gore to Gore Distances, illustrates the distances between US 36 interchange on-/off-ramp gores.

B.4 SIGNING AND STRIPING

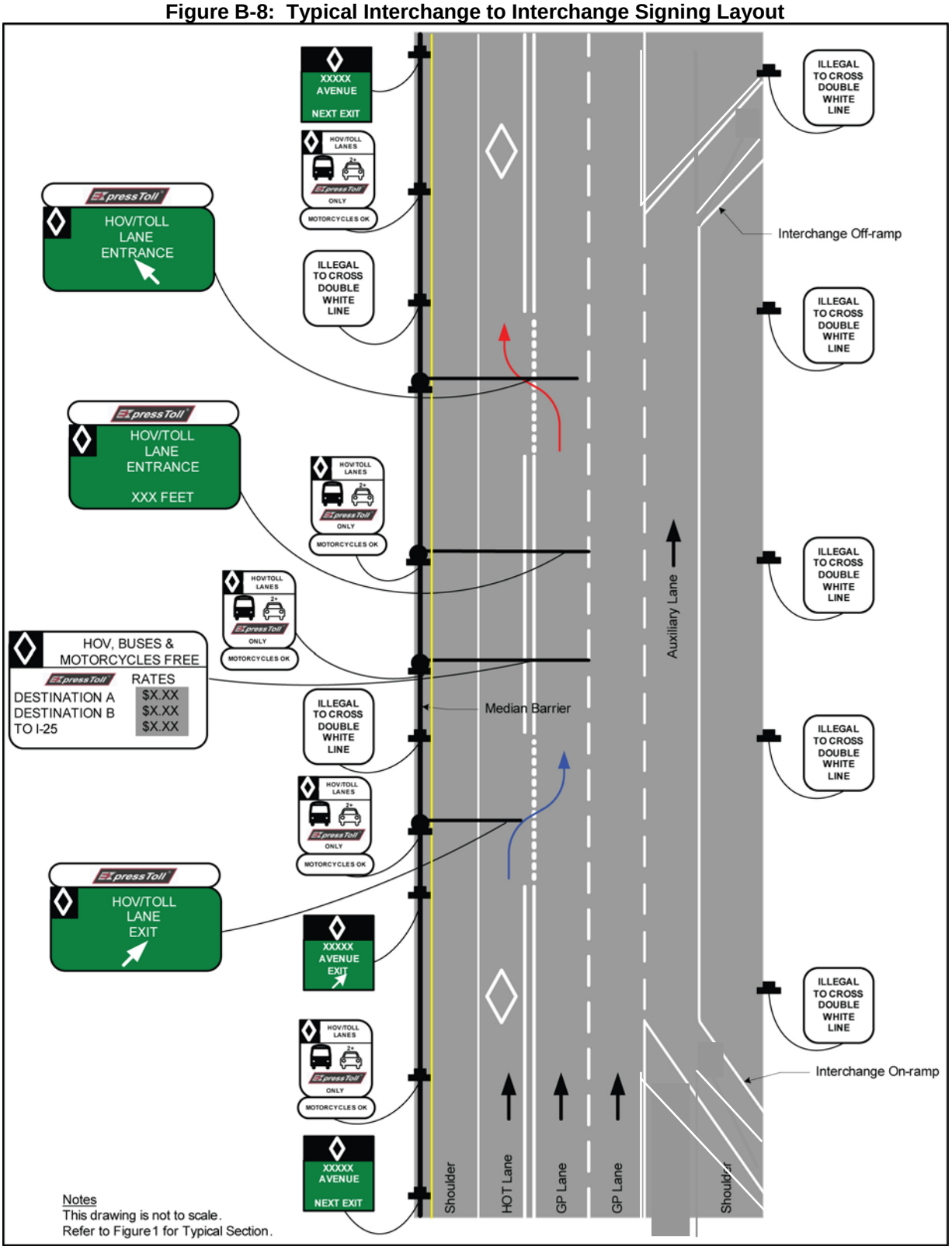
This section proposes a signing plan and two striping plan options for the managed lanes. Signing and striping provides road users with information needed to properly navigate the roadway. With respect to the managed lanes, signing and striping advises users of warnings and regulations governing the use of the lanes. Signing and striping should provide road users with enough information for drivers to make decisions about utilizing the managed lanes and adequate response time to make maneuvers to do so. This is particularly important to SOV users as these drivers will need enough time to process the information and decide whether to proceed into the managed lane and pay the toll.

There are multiple layers of information that need to be received and processed. In addition to the decision time, drivers entering and exiting the freeway via ingress and egress areas will need enough distance to safely complete the lane changes across US 36. Throughout most of the corridor, the lane changing maneuvers must be completed across two full freeway general-purpose lanes. The exception is the segment from Sheridan Boulevard east to Pecos Street where there are three general-purpose lanes to traverse before entering the managed lane. East of Pecos Street the managed lane is barrier separated and cannot be entered.

Figure B-8, Typical Interchange to Interchange Signing Layout, illustrates a typical signing layout for the managed lanes only. This layout was based on existing signing used for the I-25 HOV/TOLL lane, the Manual on Uniform Traffic Control Devices (MUTCD), and typical signing used for managed lanes across the nation. Considerations for the signing layout include:

- Provide users information about not crossing the buffer area. The sign that reads, 'ILLEGAL TO CROSS DOUBLE WHITE LINE' is recommended on both sides of the highway. It is prohibited to cross the double white line. However, it is not always common knowledge so appropriate signing will reinforce this.
- Provide barrier-mounted guide signs for the exit information in advance of the managed lane exit area will reinforce the overhead sign bridge information over the general-purpose lanes.
- Call the managed lane HOV/TOLL, which will provide consistency with respect to the I-25 managed lane. In addition, using the 'ExpressToll' logo also remains consistent with I-25 and should be used for this corridor.
- Provide overhead signing at the managed lane entrance and exit areas. This enables both the managed lane and general-purpose lane users to see advance signing for these areas and reinforces the area, especially in snow conditions when it may be difficult to see the striping.
- Provide toll rate information between the managed lane exit and entrance areas for the next two segments as well as the final trip rate to I-25. This will allow the driver in the managed lane to decide if they will remain in the lane or exit at the next opportunity. It also enables the driver in the general-purpose lane to decide if they want to enter into the managed lane.
- Provide ample reminders that the managed lane is for buses, HOV vehicles, and motorcycles. Other drivers must pay a toll.

Figure B-8: Typical Interchange to Interchange Signing Layout



Source: US 36 Mobility Partnership, 2009.

- Consolidate as many signs as possible and/or mount overhead signs on the same sign structure whenever possible. For instance, as shown in Figure B-8, the overhead toll rate sign and the overhead entrance ahead sign may be mounted on the same overhead structure.

Figure B-5 graphically displays the managed lane striping recommendation for Option 1. This option has a 1,500-foot buffer opening in which there are no impacts to the typical section. The double white line transitions to a single dotted line during the buffer opening. Considerations to this option include:

- Without appropriate signing to reinforce the entrance/exit area, the areas are not differentiated by pavement markings alone.
- There are no impacts to the shoulder or buffer width, which maintains consistency.
- If there is a high-speed differential between the managed lane and the general-purpose lane, there are safety and operational concerns. In terms of safety, likely crash types will be rear ends and sideswipes. In terms of operations, performance expectations on the managed lane may degrade if vehicles are slowing to merge into the general-purpose lanes.

Figure B-6 graphically displays the managed lane striping recommendation for Option 2. This option has a proposed lane shift towards the inside shoulder, then a 1,000-foot auxiliary lane, followed by the auxiliary lane drop, and then a lane shift back towards the general-purpose lane. This proposed option does not impact the proposed ROW template, but rather reduces the shoulder from 12 feet to 4 feet and maintains the managed lane and auxiliary lane at 12 feet. Considerations to this option include:

- It was assumed that the distances for lane shifting and lane drop were based on a 70 mph design speed. If a greater design speed is used, the lane shifting and lane drop distances will be increased.
- It was assumed that the lane shifting would be taken from the insider shoulder as opposed to modifying the ROW template.
- The striping in this option stands alone and is intuitive to drivers in both the managed lane as well as the general-purpose lane. Appropriate signing will reinforce this.
- Lane shifts will be needed at every managed lane entrance and exit. To maintain a smooth shift, Option 2 uses longer taper lengths to lessen driver impact. However, the trade-off is that only a 4-foot shoulder width is available for use within these areas.
- If there is a high-speed differential between the managed lane and the general-purpose lane, the traffic that will enter or exit the managed lane is separated from that lane and is given an opportunity to decelerate or accelerate in its own lane.
- The graphic represented is only a typical representation and does not account for potential median barrier bulb-outs beyond 4 feet for overhead sign structure placement, enforcement, and vehicle breakdowns, in which case there may be less or no usable shoulder available.

B.5 INFRASTRUCTURE

For the purpose of this report, infrastructure refers to the tolling equipment, communications components, and other ITS devices comprising the entire field system. Equipment at traffic operations centers or other off-corridor facilities are not addressed in this section, but are discussed in the Interoperability section of this technical memorandum.

It should be noted that the timeframe of this implementation is projected to be 2015. By then, technology is expected to have changed rapidly and substantially. New technology may become available in the private market that resolves some of the issues and limitations that are currently faced in the industry. For instance, transponders could be replaced by on-board equipment integrated into cars by manufacturers. Or technology used in military applications such as infrared technology could become available to detect occupancy in vehicles to aid enforcement efforts. The market dictates technology and this means that methodologies will almost certainly change from what is identified in this report. Nonetheless, the same basic principles discussed in this section should remain applicable despite the changing technologies.

B.5.1 Tolling Equipment

Major equipment components of managed lane tolling systems include:

- **Lane controllers** – a microprocessor electronic toll collection component that coordinates the activities of all equipment in a single lane and generates the transactions assigned to individual customers using that lane. The lane controller also validates the tag information from the Automated Vehicle Identifier (AVI) and performs status checks of the system.
- **Toll tag antennas/readers** – requests, receives, and transmits data from in-vehicle transponders back to the central system for processing using AVI.
- **Transponders** – transmits identification to the toll tag reader.
- **License-plate technology cameras** – performs optical character recognition of vehicle license plates in order to collect tolls from vehicles without a functioning transponder.
- **Toll rate signs** – displays variable/dynamic toll rates within a static highway sign.
- **Structures** – for mounting roadside or overhead equipment.
- **Enforcement beacon** – light signal that indicates the status of transactions to patrol officers.

The proposed configuration of tolling equipment is discussed further in the Equipment Layout and Interoperability sections of this report.

B.5.2 Communications Components

It is recommended that a fiber optic backbone with laterals to devices be installed as part of the US 36 managed lane implementation. Currently, the US 36 corridor has limited fiber installed primarily on the eastern end and a high bandwidth mesh wireless network along the entire length. The existing fiber is completely used and even if reconfigured with single strand equipment there still would not be enough strands or enough coverage area to adequately connect to all required devices. The wireless backbone may be able to handle the data transmission. However, wireless technologies are currently not deployed for tolling operations due to security concerns regarding the transmission of credit card and license plate information.

The fiber backbone would logically connect to the Region 6 Node 2 building at I-25 and 70th Avenue due to its proximity to this corridor. The optical distance from this node building to the western terminus of the proposed managed lanes is within the acceptable range of communications. From Node 2, data could be transmitted around the Denver Metro Area on the Metro-wide JMUX and back to the Colorado Transportation Management Center (CTMC), Region 6, and E-470.

The backbone should be constructed with multiduct conduit to allow for communication, power, and other cabling to be coincident within the trench.

Partnering

B.5.3 Partnering

There may be other agencies within the corridor that would benefit from a fiber extension throughout the corridor. For example, local agencies may wish to connect to one another for regional data sharing, and transportation and business management. RTD may desire to have wireline connectivity to its facilities throughout the corridor for kiosks, pay stations, and surveillance. The potential for mutual benefits through partnering should be explored as part of the planning process.

B.5.4 Other ITS Devices

Other ITS devices include field equipment not directly linked to the tolling operations—equipment that is part of a larger, integrated ITS system that may or may not be connected to the tolling authority. These ITS devices include:

- Variable Message Signs
- Closed Circuit Television Cameras
- Highway Advisory Radios
- Road and Weather Information Stations

- Traffic Monitoring Stations
- Ramp Meter Signals

Variable Message Signs

Variable Message Signs (VMS) should be strategically located for use as a decision-making instrument by providing messages about traffic conditions. VMS should serve two purposes. One set of VMS would exist to provide information to the general traveling public about construction activities, alerts, accidents, alternate routes, and so forth. Another set of VMS should be provided specifically for the managed lanes with the sole purpose of providing information for managed lane users, such as status of the managed lane (open or closed). These VMS are not used for displaying toll rates. The combined static/dynamic rate signs will provide toll price information. A smaller, side-mounted VMS may also be installed on the on-ramps to indicate travel time to drivers so they can make a decision on whether or not to use the managed lane.

Closed Circuit Television Cameras

Closed circuit television (CCTV) cameras should be located along the entire corridor to provide full coverage of the mainline and interchanges. CCTV cameras would provide visual inspection of roadway and traffic conditions. For example, if a crash occurred blocking several of the mainline lanes, then the CTMC operators could dispatch the courtesy patrol to help clear the incident and close the managed lanes, if proper protocol. This is also consistent with the Federal Boulevard mandate that managed lane systems are tied to performance criteria.

Highway Advisory Radios

A highway advisory radio (HAR) could be placed along the corridor to provide broadcast radio messages relaying the status of the facility to users. The usefulness of a HAR will be largely dependent upon the future state of the technology.

Road and Weather Information Stations

Road and Weather Information Stations (RWIS) can be provided to relay weather conditions to the traveling public and can work in conjunction with road sensors that determine the pavement conditions (e.g., wet or icy). This information could be tied to de-icing systems and VMS.

Traffic Monitoring Stations

As previously mentioned, there are Federal requirements for operating a managed lane facility tied to performance. More specifically, Certification – 23 U.S.C. 166 9 (d) language states that "When States implement low emission and energy-efficient and/or managed lane vehicle exception(s), they must annually certify that operational and performance monitoring and enforcement programs are in place to ensure that the performance of the subject facility is not degraded…."

In the context of this write up, Traffic Monitoring Stations (TMS) covers a broad range of technologies and performance monitoring techniques. TMS could include:

- **Automatic Vehicle Identifier** – used to track travel time across the segment(s).
- **Side-fire, microwave, or Doppler radar, and/or Automatic Traffic Recorder** – used to determine a point speed, occupancy, volume, and/or vehicle classification.

These devices, individually or in combination, could be deployed to:

- Automatically report traffic conditions for both general-purpose and managed lanes to aid in reporting and performance monitoring.
- Determine travel time, volume, speeds, and/or occupancy, and any other metrics for calculating the dynamic rates for tolling based upon traffic flow characteristics from the managed lanes and the general-purpose lanes.
- Relay information to the general public on how well the managed lane is being utilized.
- Track travel patterns over days, seasons, and years.
- Alert CTMC operators of potential incidents along the corridor.

Ramp Meter Signal

At the time of this report, there are eight existing ramp meters along the US 36 corridor with a ninth meter programmed for installation in the coming months. It is anticipated that meters will be installed at most, if not all, on-ramps as part of the construction effort and that many of these ramp meters will have HOV queue bypass lanes.

The ramp meters serve dual roles. First, they aid in regulating traffic entering the freeway by dynamically controlling the vehicle release rate at the transition point between the interrupted flow

facilities (i.e., arterials) and the uninterrupted flow facilities (i.e., freeways). Second, ramp meters also function as TMS by reporting back point volume, occupancy, and speed data that can be aggregated as fine as every minute.

B.5.5 Equipment Layout

This section discusses where tolling and ITS equipment could be deployed to help facilitate operations within, and proximate to, the managed lanes.

Table B-1, US 36 Toll Collection Station Segment, divides the US 36 corridor into segments that are proposed to contain toll collection stations, in both directions of travel.

Table B-1: US 36 Toll Collection Station Segment

Segment	Milepost[1]		Distance	
	From	To	Miles	Feet
Foothills Parkway to McCaslin Boulevard	39.26	43.20	3.94	20,803
McCaslin Boulevard to Interlocken	43.20	46.10	2.90	15,312
Interlocken to Wadsworth Boulevard	46.10	48.04	1.94	10.243
Wadsworth Boulevard to 104th Avenue	48.04	50.50	2.46	12,989
104th Avenue to Sheridan Boulevard	50.50	52.20	1.70	8,976
Sheridan Boulevard to Federal Boulevard	52.20	54.86	2.66	14,045
Federal Boulevard to Pecos Street	54.86	55.93	1.07	5,650
Pecos Street to I-25	55.93	57.25	1.32	6,970

Source: US 36 Mobility Partnership, 2009.

Notes:

[1]Based upon the Colorado Department of Transportation Coris File database.

I-25 = Interstate 25

US 36 = United States Highway 36

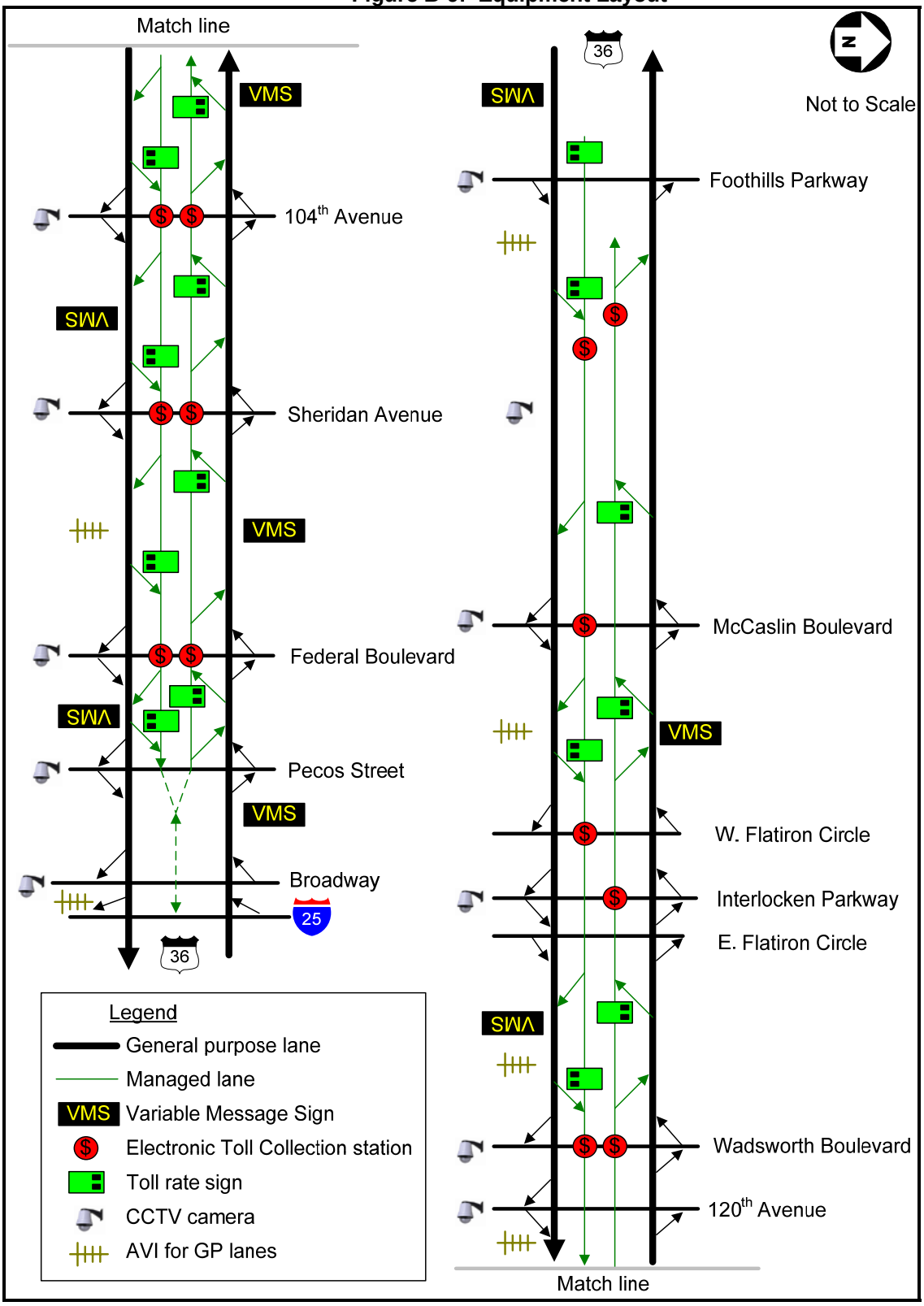
It is recommended that Electronic Toll Collection stations be located within each of the eight segments shown in Table B-1 as this provides the most flexibility for tolling. Between the existing managed lane exit at Pecos Street and I-25, a variable message sign is proposed for westbound traffic. Figure B-9, Equipment Layout, illustrates the recommended equipment layout for the entire corridor. This layout includes both tolling equipment and other ITS devices.

B.6 INTEROPERABILITY

Interoperability refers to how the system is logically and physically connected. In the broadest sense, it is how the different components function together as a whole. The "logical" part is meant to describe how the engineering systems and software interface, while the "physical" connection refers to the infrastructure interconnecting the equipment.

The intent is not to assign agency roles and responsibilities, but rather to think through the process of disseminating information to the interested parties. It should also be noted that this interoperability is based upon the functions that are currently in place since future technologies are unknown.

Figure B-9: Equipment Layout



Source: US 36 Mobility Partnership, 2009.

The following agencies need to be interconnected to some extent since they are involved in the tolling system.

- **Colorado Tolling Enterprise (CTE)** – The CTE will be overseeing the entire planning and operations efforts and will need connectivity to the system for reporting and data sharing. The CTE will not need a direct connection to the field devices, but could benefit from a data feed or any automated reports being "pushed" out.
- **Colorado Transportation Management Center (CTMC)** – The CTMC will need a direct connection to all "Other ITS Devices" as listed in Section B.5.3, ITS Devices, to monitor the corridor. Monitoring the corridor includes viewing traffic conditions, dispatching the courtesy patrol, implementing incident management plans, viewing device status and initiating repairs and maintenance, and gathering data to/from devices. The ITS devices will need to be compatible with, or integrated to, the Colorado Transportation Management Software (CTMS) application. The CTMC is staffed 24/7 and may be a logical source for performing other managed lane duties or providing a physical space for staff to be housed.
- **CDOT Region 4** – CDOT Region 4 oversees the engineering and maintenance from the Wadsworth Boulevard interchange west to Boulder.
- **CDOT Region 6** – CDOT Region 6 oversees the engineering and maintenance from I-25 to Wadsworth Boulevard. Also, CDOT Region 6 currently performs equipment maintenance and support for the existing US-36 and I-25 reversible, barrier-separated managed lanes. CDOT Region 6 already has connectivity to the existing managed lane equipment and would benefit from connectivity to the extension, regardless of their specific role(s).
- **Colorado State Patrol (CSP)** – CSP may need remote access to the system if enforcement transponders are utilized. Otherwise, CSP would benefit from receiving data regarding violation rates and equipment status and could also be interested in camera viewing and control capabilities. It is anticipated that most of the enforcement efforts will be through visual inspection of vehicles crossing the proposed double white lines and through pullovers when vehicles pass underneath a toll station and the enforcement beacon does not "light up."
- **Denver Regional Council of Governments (DRCOG)** – DRCOG, through its duties as the regional Metropolitan Planning Organization (MPO), is required to oversee any tolling implementations and operations. As such, DRCOG will be interested in similar information to that of the CTE. DRCOG does not need direct connections to the field equipment.
- **E-470 Toll Authority (E-470)** – E-470 will presumably be the system operations manager and collection agency and thus requires a direct connection to the tolling system and equipment as discussed in Section B.5.1, Tolling Equipment.
- **Local agencies** – Local agencies adjacent to the corridor will be interested in receiving information about the corridor planning, construction, and operations. However, these agencies do not require a direct connection to field equipment.
- **Regional Transportation District (RTD)** – RTD will be interested in receiving information about system monitoring and performance, but will not require a direct connection to the system.

However, it may be in the interest of RTD to partner with CDOT to build the communications (fiber) infrastructure since that would allow RTD to relay real-time bus scheduling to the end

user, perform park-n-Ride surveillance, and communicate with kiosks and pay stations, and any other devices or business services that may require communications.

System Vendor(s) – System vendors include those software and hardware manufacturers whose products are procured and installed for the tolling efforts. These vendors will likely be providing product warranties, performing maintenance, troubleshooting devices, and installing upgrades. For these reasons, the vendors would benefit from remote access to the system as needed.

B.6.1 Tolling Equipment

The tolling equipment will need to reside on a secure network that will transmit transponder and license plate data to E-470 for processing. Transponder tag data should also be sent to the CTMC for processing into the travel time algorithm linked to the CTMS software.

At this time, tolling equipment is expected to consist of similar equipment to that of E-470. An Open Road Tolling (ORT) system will be deployed that does not require motorists to stop at cash booths. Technology is expected to consist of AVI readers and lane controllers for processing. As mentioned previously, the technology is rapidly changing and it is likely that other options will become available to the private market before the facility opens.

Toll equipment can be mounted on existing bridge structures, new sign bridges, or cantilever sign structures.

B.7 ENFORCEMENT

The following section discusses considerations for enforcement and enforcement technology.

B.7.1 Considerations for Enforcement

Considerations for safe and effective enforcement include:

Involvement – Seek input early in the planning and design process for specific enforcement needs and desires.

Enforcement areas – Patrol officers will need enforcement areas that accommodate a parked vehicle and are located where violations can be observed and properly enforced. A graphic showing a sample enforcement area is included in Figure B-10, Enforcement Area. This example allows for a patrol officer to be protected from mainline traffic while having good line-of-sight of the vehicles passing by in the managed lane. This configuration also allows the patrol officer to face either direction, or allows two patrol officers to face both directions. Dimensions for the enforcement area were specifically left out because discussions with law enforcement personnel need to occur to determine the exact geometric configuration needed. This exercise is more appropriate at a design level as opposed to a planning level.

Pull-over points – Locations need to exist where potential violators can be safely pulled over. The locations include full shoulder width areas downstream of tolling locations and segments where vehicles may cross the double white lane lines.

Visibility – The managed lanes should have enforcement spots that are visible to all traffic to aid in effective patrolling.

Notification of violation – Patrol officers need notification of potential violations in order to conduct effective enforcement. This is especially true since it is difficult to ascertain vehicle occupancy, due to passengers in the back seat, by visual inspection alone.

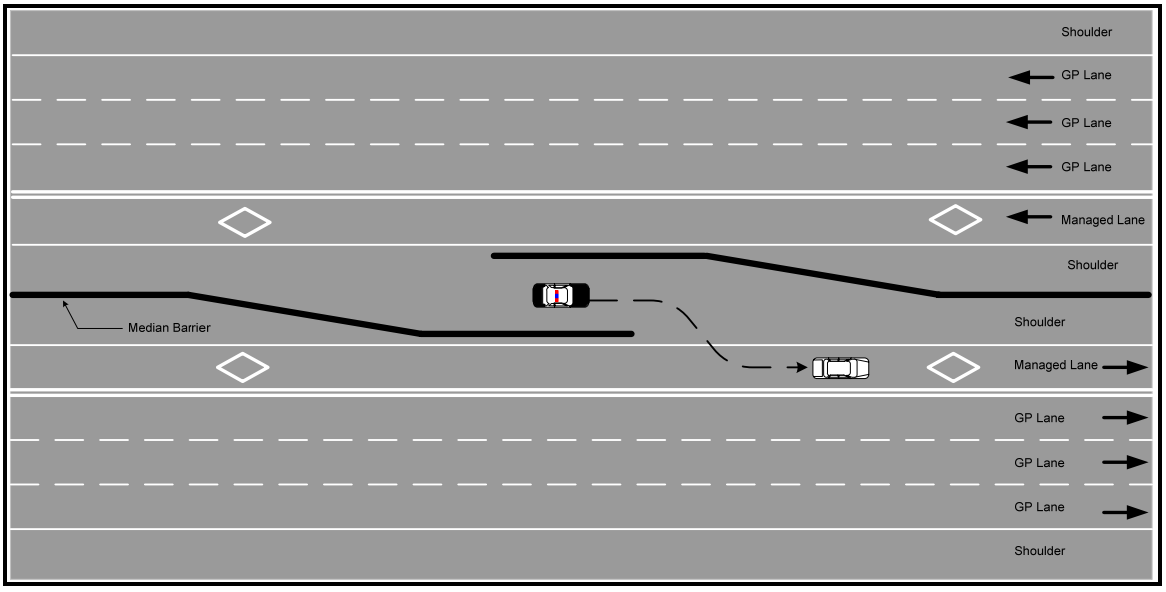
B.7.2 Enforcement Technology

Enforcement technology should be deployed to assist with compliance of the managed lanes. Enforcement technology would inform CSP officers of a potential violation. The common mechanisms that exist for managed lane violation enforcement are listed below.

- **Enforcement beacon** – An enforcement beacon is a visible light that illuminates when a vehicle passes through the toll zone with a valid transponder that was read. With this type of enforcement, an officer is stationed in proximity to the toll location and will visibly inspect the vehicle occupancy and/or in-vehicle transponder if the indicator does not light up.
- **Handheld readers** – Handheld readers may be used at the discretion of the patrol officers. Handheld readers allow an officer to scan the windshield transponder and find out when a toll transaction last occurred.
- **License plate technology cameras** – These cameras save an image of vehicles' license plates as they pass through the managed lane. These images can be used to request a toll collection or issue a violation. In 2009, E-470 is migrating to an ORT system that will utilize license plate technology cameras. This technology will not be useful for the US 36 corridor since there is no way to determine vehicle occupancy from a photo of the license plate.

Figure B-10, Enforcement Area, shows a typical enforcement area located downstream of the toll reader. Police can visually inspect vehicle occupancy and the enforcement beacon from a stationary position and can face either direction of travel. Note that this area can also be placed at midstream locations to inspect violators who cross the double white lane line.

Figure B-10: Enforcement Area



Source: US 36 Mobility Partnership, 2009.
Note:
This drawing is not to scale. Refer to Figure B-1, Combined Alternative Package (Preferred Alternative) Typical Section.

B.8 MAINTENANCE

Maintenance is essential for maintaining facility operations, including the roadway and tolling equipment. As stated previously, it is assumed that CDOT or their contractor will be responsible for maintenance of the roadway and ITS devices while the system vendor(s) will be responsible for maintenance of the tolling equipment.

B.8.1 Considerations for Maintenance

Infrastructure Location

Equipment should be located where maintenance personnel can safely access it by setting up traffic control for a shoulder closure. The exception is any overhead signs or gantries requiring closure of the corresponding lane(s).

Infrastructure should also be installed at locations that minimize exposure to traffic and the possibility of being struck by an errant vehicle or debris. This includes mounting position on structures, placing equipment in the traveled way, and installing equipment inside barrier.

Maintenance Planning

Special consideration will have to be given to the impact on the managed lane and coordination will need to take place to schedule activities and any special closures for maintenance. These efforts should be documented in the form of a "policy" or "operations" manual. This exercise would prompt the agencies to enter into discussions and consider how to best perform maintenance procedures. For example, if a closure is needed in the managed lanes then the public needs to be notified and proper traffic control should be put in place to prevent drivers from using the managed lanes and being tolled for a portion of the facility that may be closed for repair.

Street Maintenance

Street maintenance includes removing debris from the roadway, snow plowing, roadway repair, sign repair, and street sweeping.

Within the existing barrier-separated managed lanes on US 36 and I-25, snow removal and street sweeping is contracted through the CTE. CDOT CTMC and Region 6 personnel handle all other maintenance duties within the managed lanes.

Equipment Maintenance

Equipment maintenance will include items such as removing debris from the roadway, snow plowing, roadway repair, sign repair, street sweeping, and replacement. CDOT Regions 4 and 6 are already familiar with these practices.

Courtesy Patrol

At the time of this report, two courtesy vehicles patrol on US 36 between I-25 and 120th Avenue. The times are the same city-wide for all courtesy patrol units; 6:30 a.m. – 9:00 a.m. and 3:30 p.m. - 6:30 p.m. on weekdays.

Courtesy patrol is dispatched through the CTMC with funding contributions for US 36 through CDOT Region 6. It is recommended that the courtesy patrol program be expanded to include the entire US 36 corridor. This will help clear incidents from both the general-purpose and managed lanes.

B.9 PERSONNEL AND EQUIPMENT NEEDS

With the addition of the managed lanes and associated infrastructure, maintenance and operations burdens will increase. It is recommended that CDOT determine the magnitude of impact the expanded managed lane system will have on personnel and equipment needs. In preparation, CDOT should prepare a staffing plan to quantify these personnel and equipment needs. Considerations for this plan should include:

- **Travel** – The travel distances from the CDOT dispatch points to the field vary greatly and may include over an hour of travel time just to arrive on site.
- **Region responsibilities** – Responsibilities should be designated for each region and staff. Region 6 may elect to maintain the entire facility due to proximity and current managed lane experience. If cross-jurisdictional responsibilities are agreed upon, the CDOT maintenance management system needs to be re-coded to allow for US 36 mileposts to be accepted outside of the Region 6 defined maintenance boundaries.
- **Communication infrastructure and equipment** – Personnel need to be trained and equipped to perform routine and emergency troubleshooting and repair.
- **System monitoring** – The managed lanes will operate continuously and service will be of utmost importance given that drivers, whether free or paying, will expect a certain quality of service from the system.
- **Utility locates** – CDOT will be responsible for locating longitudinal and latitudinal crossings through the Utility Notification Center of Colorado (UNCC) and will need to have the resources available to perform these functions.
- **Equipment** – The additional communications infrastructure and potentially new technology may create a need for new tools to perform maintenance.
- **Vehicles** – Appropriate vehicles are needed for the installation, repair, and testing of equipment. Vehicles will be needed to access toll rate signs, CCTV cameras, toll readers, and so on. Vehicles may include aerial trucks, splicing vans, and/or courtesy patrol assistance trucks.

- **On-call personnel** – It is proposed that the managed lanes will operate 24 hours per day, seven days a week. Depending upon the frequency of maintenance patrolling and equipment failures, personnel may be needed to perform dedicated or rotational shifts for on-call duties.
- **Training** – All staff must be appropriately trained to handle routine and emergency maintenance response for the system.

These maintenance considerations will require additional resources. Personnel needs may translate into full-time equivalent (FTE) or may result in a fractional increase in personnel time (e.g., ½ FTE). Staffing could come in the form of CDOT personnel, contract employees, or a combination of both.

Appendix C
West End Design Options

Resolution of West End Lane Configuration

One of the key areas of comment received on the US36 DEIS from jurisdictions related to the lane configuration of the West End. This segment was defined as the mainline from just east of the McCaslin interchange in Louisville/Superior to the Foothills/Table Mesa interchange in Boulder. Comments from jurisdictions addressed a range of concerns with an emphasis on:

- Providing only enough capacity entering Boulder for efficient operations while enhancing the attractiveness of alternate modes to the single-occupant automobile.
- Providing sufficient capacity to accommodate demand from the east while minimizing diversion to arterial roadways because of congestion on US 36.
- Providing a climbing lane in both directions to help slower moving vehicles to gain speed and safely merge with general lane traffic.

In order to address these comments and to resolve the issues among the jurisdictions, the Preferred Alternative Committee (PAC) was engaged to identify and evaluate options. The PAC began this process in January and concluded in March 2009.

Technical information was developed and reviewed with Working Groups composed of staff from the jurisdictions. Recommendations from the Working Groups were than forwarded to the PAC for consideration.

Resolution of the lane configuration on the West End included additional technical analysis to update forecasts and operations to 2035. The concept of establishing transportation demand thresholds or "triggers" when an additional lane might be warranted was adopted by the PAC.

This concept grew out of the desire of the corridor communities to plan for, from a NEPA environmental clearance standpoint, the extension of the climbing lanes to the next interchange, but to avoid building them until certain adverse operational condition thresholds are met. The meeting of these conditions would "trigger" a more detailed examination of the impacts and benefits of the lane extension, with the goal of alleviating the adverse conditions in question.

Lane between McCaslin Boulevard and Foothills Parkway/Table Mesa Drive

Fact Sheet January 8, 2009

In the US 36 DEIS, two variations of Package 4 were evaluated that modified the westbound auxiliary lane between McCaslin Boulevard and the Foothills Parkway/Table Mesa Drive interchange. The "Reduced Auxiliary Lane Option" replaced the westbound auxiliary lane with two elements: an extended on-ramp merging lane/climbing lane from McCaslin Boulevard to the scenic overlook at the top of Davidson Mesa, and an extended off-ramp diverging lane for traffic exiting westbound US 36 at the Foothills Parkway/Table Mesa Drive interchange. A second variation eliminated the auxiliary lane from Package 4 altogether (the "Eliminated Auxiliary Lane Option").

These two variations, along with Package 4, were compared with respect to 2030 a.m. peak hour westbound traffic volume estimates and LOS, with the recommendation that a continuous auxiliary lane be included between McCaslin Boulevard and the Foothills Parkway/Table Mesa Drive interchange. However, during the development of the Combined Alternative, preliminary 2035 traffic analysis, along with the extension of the managed lane to Foothill Pkwy showed that the continuous auxiliary lane may not be needed.

As a result, the Combined Alternative agreement included one new climbing lane in each direction, extending westbound from McCaslin Boulevard and eastbound from Foothills Parkway/Table Mesa Drive to the top of Davidson Mesa. This configuration is in essence the "Reduced Auxiliary Lane Option" considered in the DEIS. The Combined Alternative agreement recommended additional analysis to evaluate the extension of these climbing lanes on US 36 between McCaslin Boulevard and Foothills Parkway/Table Mesa Drive as continuous auxiliary lanes for bus-only vs. all vehicle use.

The climbing lane included in the Combined Alternative was analyzed using the most recent 2035 travel forecasting model. The continuous auxiliary lane was also compared to the most recent 2035 numbers based on the results of the 2030 west-end lane analysis by assuming the same percentage increase would result from extending the climbing lane—it was not subject to 2035 travel demand modeling. These results were then compared to the "No-Action Alternative." This information is summarized in the table and graphic below.

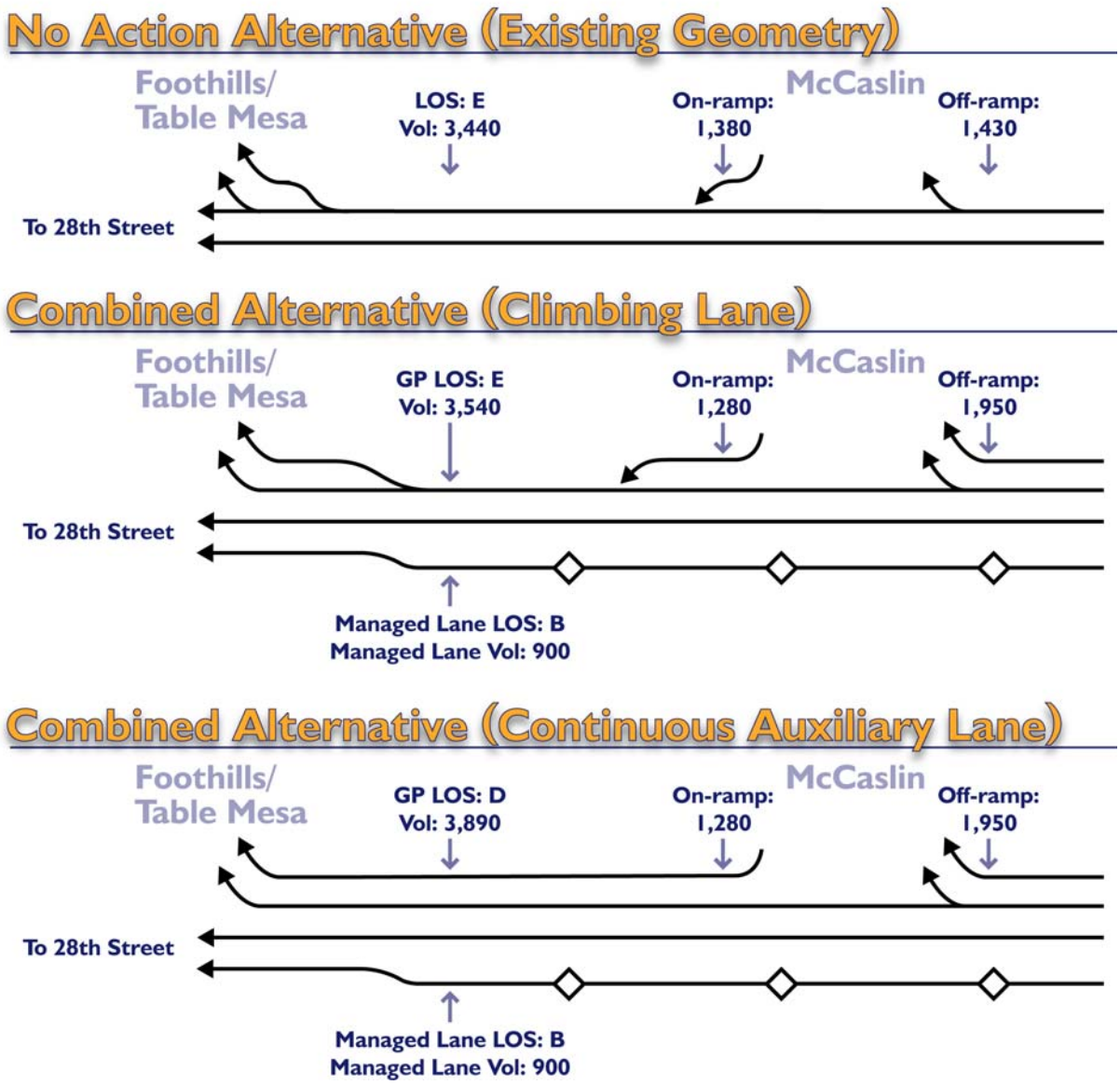
Option	Lanes			Westbound 2035 a.m. Peak Hour Volume (per lane)		LOS (% of Capacity*)	
	General Purpose	Managed Lane	Climbing /Cont Aux Lane	General Purpose	Managed Lane	General Purpose	Managed Lane
No Action Alternative (Existing Geometry)	2	0	N/A	3,440 (1,720)	N/A	E (86%)	N/A
Combined Alternative (Climbing Lane)	2	1	1 Climbing	3,540 (1,770)	900	E (89%)	B (60%)
*Combined Alternative (Continuous Aux Lane)***	*2*	*1*	*1 Continuous Aux*	*3,890 (1,300)*	*900*	*D (65%)*	*B (60%)*

Source: DRCOG 2035 Forecasts for Combined Alternative Package; URS Corporation, 2009.

* Capacity is estimated at 2,000 vehicles per hour per lane for general/auxiliary lanes and 1,500 for Managed Lanes.

***** The Continuous Aux. Lane alternative was not subject to 2035 travel demand modeling***

West End Lane Options -- 2035 Westbound, a.m. peak hour



Given this analysis, we offer the following options:

Option 1 – Climbing Lane Only: Include climbing lanes as stated in Combined Alternative agreement. No additional improvements recommended.

Pros/Cons: No additional analysis or triggers required. If an additional lane is needed in the future, a separate NEPA process would be conducted. This option performs at LOS E.

Option 2 – Environmental Clearance of Continuous Auxiliary Lane: Include the auxiliary lane (for bus only or for all vehicles from McCaslin Blvd. to Foothills PKWY) in the FEIS, but do not construct it unless triggers are met and proposed solution is still acceptable to stakeholders.

Pros/Cons: Requires a commitment to monitor traffic operations periodically through 2035. This option must meet the U.S. Army Corps of Engineers (USACE) least damaging practical alternative (LEDPA) screening and US Fish and Wildlife Service must agree to the endangered species impacts.

Option 3 – Environmental Clearance and Construction of Continuous Auxiliary Lane: Include the continuous auxiliary lane in the FEIS and construct it in Phase 3.

Pros/Cons: Increased cost and additional environmental impacts. Provides better LOS for all lanes if additional lane is used for all vehicles. This option must meet USACE and US Fish and Wildlife Service guidelines regarding the LEDPA and the endangered species impacts.

If Option 1 is selected, no further construction costs or endangered species/wetland impacts will be incurred. If Option 2 is selected, "triggers" would be used to determine when the additional lane would be evaluated. The proposed triggers were presented and discussed in a separate at the PAC meeting in January 2009. At the meeting it was described that if Option 3 was selected, bus only use of the auxiliary lane would not significantly improve the performance of the other lanes but would improve bus transit travel time by approximately one minute. Use of the auxiliary lane by all vehicles would improve the a.m. peak hour condition of the general purpose lanes from LOS E to LOS D.

Results of the PAC Assessment

At the PAC working group meeting on January 13, 2009, the working group agreed that the climbing lane extension goals should:

- Be measurable;
- Be person-based, not vehicle-based;
- Be based on regular conditions, not just those reflective of a single day or week;
- Have equitably-distributed costs associated with monitoring and further study.

Working Group meetings were held to further define the triggers and to develop an appropriate process to follow.

West End Lanes

(Lanes between McCaslin Boulevard and Foothills Parkway/Table Mesa Drive)

Concept and Language to be included in the US 36 FEIS

- The Combined Alternative (July 9, 2008) agreement included one new climbing lane in each direction, extending westbound from McCaslin Boulevard and eastbound from Foothills Parkway/Table Mesa Drive to the top of Davidson Mesa; and committed to: *"Evaluate the extension of climbing lanes on U.S. 36 between McCaslin Boulevard and Table Mesa to bus-only lanes as well as the use of shoulders* for transit during peak travel periods. Identify 'triggers' for when this design approach would be considered."*

- Based on such analysis and PAC discussions (January 27, 2009) the US 36 FEIS will clear the footprint for a bus-only continuous auxiliary lane to cover the "gap" between the end of the climbing lane and the beginning of the downstream interchange off-ramp deceleration lane. This gap is approximately 2,700 feet in the eastbound direction and approximately 8,000 feet in the westbound direction. The need for this bus-only continuous auxiliary lane will be based on 2035 bus-related measures of effectiveness with the goal of improving the number of person trips. The established need in the FEIS is based on projections in the 2035 analysis so that the FEIS can clear the project footprint for the continuous auxiliary bus-lane option plus any analysis of impacts and mitigation for those impacts identified in the FEIS.

- Any land impacts will be addressed consistent with mitigation identified in Section 4.9, Parks and Open Space, and Chapter 7, Section 4(f) Evaluation. The construction of the auxiliary lane will not commence until approved. Acquisition of any additional right-of-way required for the bus-only auxiliary lanes will not take place until the re-analysis is complete and the lanes approved.

- This bus-only continuous auxiliary lane will be addressed and evaluated for construction only if certain bus-related "triggers" are met; only after a re-analysis process has been completed; and only after the Phase I improvements (one managed lane in each direction and bikeway elements) and climbing lanes have been built. The triggers for considering the bus-only auxiliary lane will include:

  - Degradation of average peak period bus travel times along US 36 in the segment between the existing McCaslin park-n-Ride and Table Mesa park-n-Ride due to persistent congestion. The degradation, for each respective direction, officially occurs when the peak period peak direction bus travel time (initially measured and established one year after the managed lanes are open) has delays of two minutes or more for at least two days per week for at least three weeks in a row. The delay shall not include those associated with inclement weather, road maintenance, or special events but shall include days with vehicle accidents or stalls since these are typical causes of congestion and would likely be avoided with a bus only auxiliary lane.

  - Degradation of average peak period bus (Dash) travel times resulting from congestion on US 36 along South Boulder Road between the Table Mesa park-n-Ride and McCaslin Boulevard. The degradation, for each respective direction, officially occurs when the peak period peak direction bus travel time (initially measured and established one year after the managed lanes are open) has delays of three minutes or more for at least two days per week for at least three weeks in a row. The delay shall not include those associated with inclement weather, road maintenance, road construction, or

special events but shall include days with vehicle accidents or stalls since these are typical causes of congestion.

- Degradation of average peak period bus travel times resulting from congestion on US 36 for Route 228 along McCaslin Boulevard between the McCaslin park-n-Ride at US 36 and South Boulder Road due to persistent congestion. The degradation officially occurs when the northbound peak period bus travel time (initially measured and established one year after the managed lanes are open) has delays of two minutes or more for at least two days per week for at least three weeks in a row. The delay shall not include those associated with inclement weather, road maintenance, road construction, or special events but shall include days with vehicle accidents or stalls since these are typical causes of congestion.

- It is expected that the above triggers will be measured during normal monitoring cycles by RTD, CDOT, or the local agencies that have responsibility for these routes or modes so that extra efforts to monitor these triggers will not be necessary. At a minimum, the above triggers will be looked at when traffic numbers require updating during re-evaluation processes.

- If a trigger is met, a re-analysis process will be initiated and include all US 36 communities along with FHWA, CDOT, and RTD representatives to develop and evaluate methods to improve bus operations. Goals of this process are to improve bus operations on US 36 and parallel arterials.

- When a trigger is met, some action will be taken to improve transit operations as defined above. Should actions other than construction of the bus-only lane occur and the "triggers" are met again the re-analysis process will be re-initiated as necessary.

- The re-analysis process will follow the basic NEPA steps of establishment of need (based on current conditions), development of various options to respond to that need, including such options as, but not limited to, bus operations changes on US 36 or parallel arterials, addition of queue jump lanes or transit signal priority on parallel arterials, congestion pricing, or building the continuous bus-only lane. Then these various options will be evaluated in an objective manner to determine the effect of each on factors such as bus and passenger travel times, safety, capital and operating costs, air quality, environmental impacts. The most cost-effective and practical alternatives shall be implemented. Full public and agency involvement will be included in this re-analysis process.

- No use of the bus-only auxiliary lane for any other modes (such as general-purpose or HOV) is included as a part of this FEIS. If such a use were to be contemplated in the future, a separate, and new NEPA evaluation would be initiated to include:

  - Full public involvement

  - Full analysis of impacts

  - Full agency involvement with FHWA, USACE, CDOT, RTD, and all US 36 communities

**** Use of Shoulders:*** *The use of shoulders for transit operations or bus travel cannot be included in the FEIS as a possible action or as part of an alternative that will be evaluated. FHWA typically does not allow the long-term use of the shoulders for buses (or anyone else) because that area is intended to be used for emergencies such as breakdowns or as a recovery area for vehicles that have to leave the travel lane. For a project such as the US 36 EIS, where long-term improvements are being made, it is required that everything must meet standards, such as full-width shoulders. Additionally, road shoulders are typically not constructed to handle the weight of buses on a consistent basis and would break down over time with that use.*

Appendix D

Broadway Interchange Alternatives Information

The Adams County counts show 6,560 vehicles use the southbound I-25 exit on a daily basis. Of these, 4,850 continue through the Broadway intersection to access US 36. Approximately 2,540 vehicles were counted on the westbound off-ramp from I-270 to Broadway. It was assumed all of these vehicles were destined for Broadway. Since the Adams County counts provide an estimate of the number of vehicles that continue through the Broadway intersection, they were used as the basis of future year model adjustments.

The adjustment process is used to modify future year forecasts based on existing traffic volumes. In most cases there are differences between existing counts and the base year model (2005). Adjustments are used to help account for these errors. To adjust the forecast volumes, existing traffic volumes are compared to traffic forecasts in an "existing year" model, in this case 2005. The model forecasts are increased based on projected growth to represent traffic for the same year the count was taken (2009). Then both a difference and ratio between the existing count and model forecast are calculated. The difference and ratio will be applied to future year forecasts to generate an adjusted forecast. Table D-1 presents the data used in the adjustment process for the three ramps at the interchange. The adjusted forecasts will be used in the future analysis of the interchange.

Table D-1
Model Daily Forecast Adjustments

				2009 Count vs. 2009 Model		2035 No Action		2035 Preferred	
Location	2009 Daily Count	2005 Model ADT	2009 Model ADT Estimate	Difference	Ratio	Model ADT Forecast	Adjusted ADT Forecast	Model ADT Forecast	Adjusted ADT Forecast
Off-ramp from I-25	6,560	2,525	2,628	3,932	2.496	4,121	9,170	4,569	9,950
To Broadway	*1,710*						*2,390*		*2,590*
To US 36	*4,850*						*6,780*		*7,360*
Off-ramp from I-270	2,540	10,887	11,329	-8,789	0.224	12,863	3,480	N/A	N/A
On-ramp to US 36	8,470	6,941	7,223	1,247	1.173	9,701	11,160	8,748	10,130

Source: 2009 Daily Counts by Adams County March 18 and 19, 2009. Model forecasts from DRCOG regional travel demand model, adjusted by URS.

It is important to note the forecasts for the off-ramp from I-270 to Broadway. In the travel demand forecasting model, the ramp is modeled in such a way that traffic exiting northbound I-25 to westbound US 36 can access the off-ramp. This maneuver is not possible under existing conditions within the I-25/US 36 interchange. In addition, the off-ramp was removed from the roadway network in the 2035 preferred model run.

The adjusted forecasts for 2035 can be applied to the different interchange configurations developed by CDOT to address the benefits and challenges of each option.

Option A – Southbound I-25 to Westbound US 36 Direct Connect Ramp Only

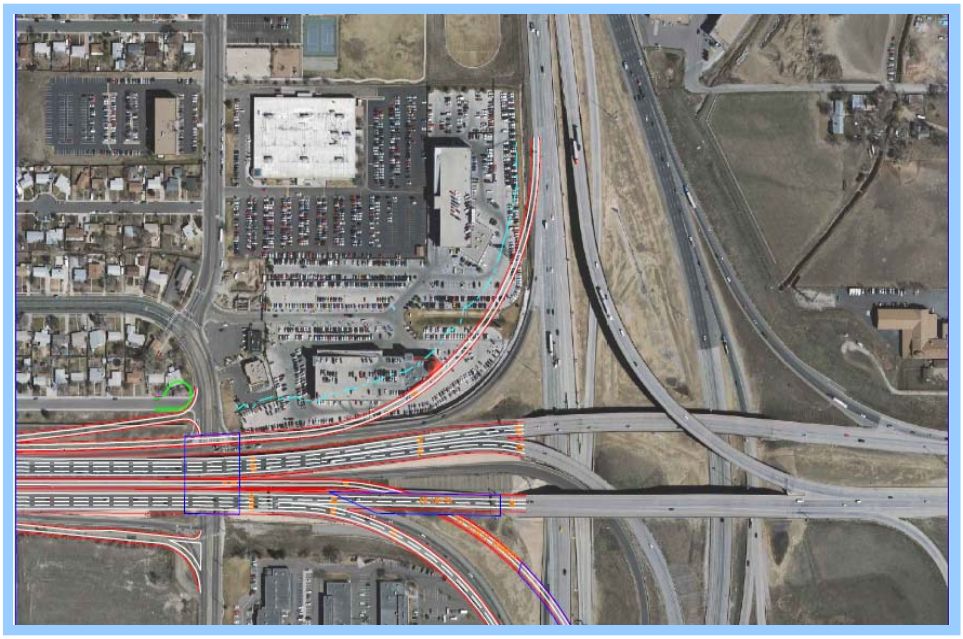
Interchange Option A realigns the southbound off-ramp from I-25 to provide a direct connection to US 36. Drivers making this maneuver would no longer traverse the signalized intersection at Broadway. No connection would be provided to Broadway from southbound I-25 or westbound I-270.

Benefits

- Provides a direct connection from I-25 to US 36 for 7,360 vehicles per day in 2035.

Challenges

- Loss of access to Broadway for southbound I-25 (2035 ADT ≈ 2,590 vpd)
- Loss of access to Broadway from westbound I-270 (2035 ADT ≈ 3,480 vpd)



Option B – Southbound I-25 to Westbound US 36 Direct Connect Ramp & I-25 Slip Ramp to Broadway

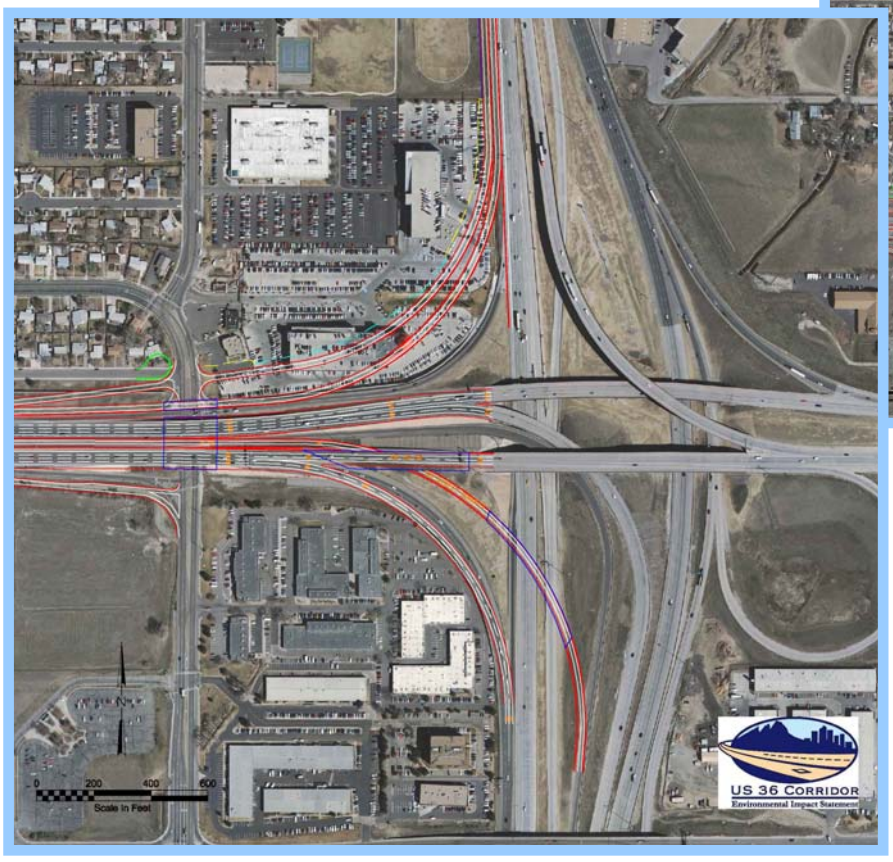
Interchange Option B realigns the southbound off-ramp from I-25 to provide a direct connection to US 36. Drivers making this maneuver would no longer traverse the signalized intersection at Broadway. In addition, a slip-ramp would be provided from the southbound I-25 off-ramp to Broadway. The Broadway access from westbound I-270 would be removed.

Benefits

- Continued access to Broadway from southbound I-25 serving 2,590 vehicles per day in 2035.

Challenges

- Loss of access to Broadway from westbound I-270 (2035 ADT ≈ 3,480 vpd)



Option C – Southbound I-25 to Westbound US 36 Direct Connect Ramp & I-270 Slip-Ramp to Broadway

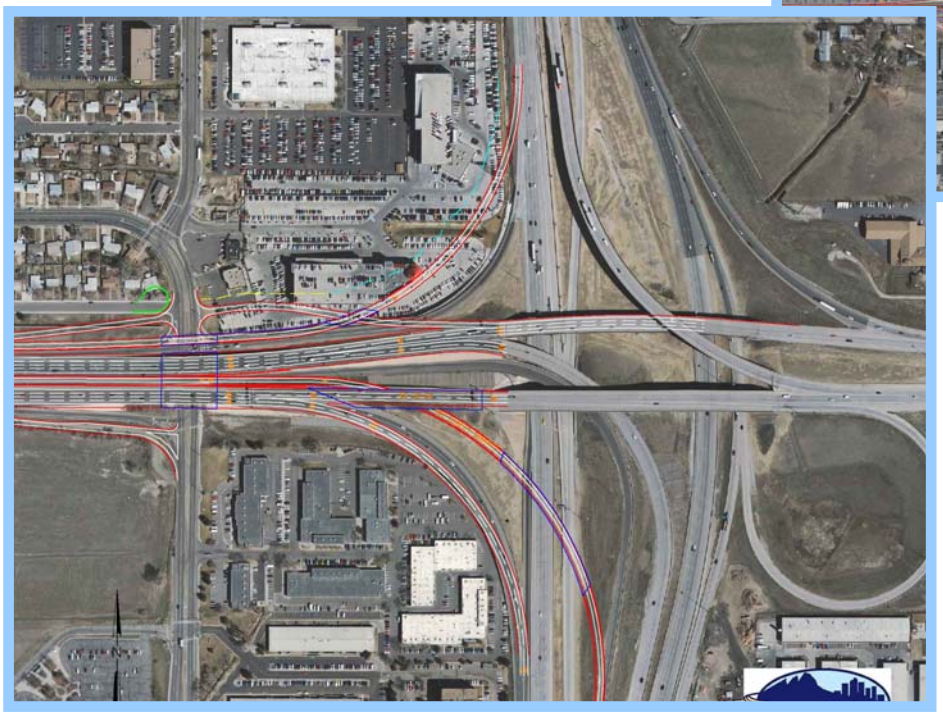
Interchange Option C realigns the southbound off-ramp from I-25 to provide a direct connection to US 36. Drivers making this maneuver would no longer traverse the signalized intersection at Broadway. In addition, the access to Broadway from westbound I-270 would be served by a new off-ramp. No access will be provided to Broadway from southbound I-25.

Benefits

- Continued access to Broadway from westbound I-270 serving 3,480 vehicles per day.

Challenges

- Loss of access to Broadway from southbound I-25 (2035 ADT ≈ 2,590 vpd)



Previous Forecasts Provided to CDOT

Preliminary peak-hour forecasts were provided to CDOT on December 22, 2008 for the ramps at the US 36/Broadway interchange. These forecasts were based on the raw model volumes from DEIS No Action Package model runs and an initial FEIS preferred model run. None of the numbers presented had been adjusted to reflect existing traffic counts, since counts at those locations were not available. At that point in time, adjusted model output was not available to provide the best estimate of future forecasts since the FEIS modeling effort had not been finalized.

The previous forecasts should not be used for further analysis. They were based on raw model volumes with no means of adjustment to real-world conditions. Rather, peak-hour volumes can be derived from the new adjusted 2035 forecasts presented in this memo. The 24-hour traffic counts from CDOT and Adams County can be used to determine the proportion of daily traffic that occurs during the a.m. and p.m. peak hours. The resulting peak-hour volumes are provided in Table D-2.

Table D-2
Adjusted 2035 Peak- HourVolumes

	2035 No Action		2035 Preferred	
Location	**a.m. Peak Hour**	**p.m. Peak Hour**	**a.m. Peak Hour**	**p.m. Peak Hour**
Off-ramp from I-25	350	650	380	700
To Broadway	*90*	*170*	*100*	*180*
To US 36	*260*	*480*	*280*	*520*
Off-ramp from I-270	230	350	N/A	N/A
On-ramp to US 36	470	1,010	420	910

Source: URS Corporation.

Configuration of Preferred Alternative at US 36/Broadway Interchange

The Preferred Alternative described in Chapter 2, Alternatives Considered, of the FEIS is Option A at the US 36/Broadway interchange. The configuration is based on the Interstate Access Report that was prepared for the I-25/I-270/I-76/US-36 interchange complex and previously approved by FHWA.

FHWA, CDOT and Adams County are developing a process to conduct further evaluations of access configurations in the area of the system interchange. This evaluation will include local service interchanges such as the US 36/Broadwy interchange. Further refinements in the configuration of local access in the area may result from these evaluations.