Phase 1 Report

Butte Interstate Traffic Study

Project Number
IM 0002(672)
CN 5098

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EXECUTIVE SUMMARY

It is with the overall understanding of the potential for growth, perceived safety and operational issues, and requests for additional accesses that the Montana Department of Transportation commissioned the Butte Interstate Traffic Study. Phase 1 of this study provides a planning level analysis of existing conditions and identifies deficiencies. Phase 2 of the study will develop treatments for theses deficiencies. This study will provide an overall long-range planning document for the Butte Interstate system.

The objective is to complete a comprehensive traffic engineering study of the 12.2 mile interstate system including Interstates 15 (I-15), 90 (I-90), and 115 (I-115). The study includes the following interchanges located in Silver Bow County and within the Butte urban limits:

- Rocker
- West Butte
- Excelsior Avenue
- Montana Street
- Harrison Avenue
- East Butte
- Continental

Existing condition analysis was accomplished for four main categories: geometric features, safety, traffic, and noise. The interstate corridor was divided into segments between interchanges for analysis purposes.

Geometric elements reviewed for the interstate mainline and at each interchange include cross section elements, horizontal and vertical alignment, ramp geometry, interchange/intersection spacing, adjacent access locations, turning movements, and intersection sight distance. Each of these elements was evaluated and ranked based on the project design criteria, and deficiencies were identified. Deficiencies that were identified during the analysis are illustrated in Figure E.1.

The safety analysis consisted of reviewing and summarizing historical crash information and inventorying existing highway lighting, signs and striping for conformance to current standards. Several high crash areas were identified including the West Butte Interchange, the Mainline Segment between West Butte and Montana Street, the Harrison Avenue Interchange, and the East Butte Interchange. High crash areas are defined as having a higher crash rate than the corridor average. Ramp terminal and cross road intersection crash analysis revealed high crash rates on Harrison Avenue and on the cross road at the Rocker Interchange. The existing signing and pavement markings overall are in good condition and meet current guidelines, with a few minor exceptions on I-115.

Traffic operational analysis included the assessment of freeway mainline conditions, ramp merge and diverge, and local street intersections. These roadway components were analyzed separately and in relation to each other to assess traffic operations throughout the study area. The operational analysis results indicate that mainline sections and ramp sections operate at an acceptable level of service (LOS A or B) during all three peak periods of the day, for both existing and future (2025) conditions. The majority of the interchange intersections in the study area operate at an acceptable LOS in both existing and future conditions. However, the Montana Street and the I-15/90 eastbound ramp intersection and the Harrison Avenue and Amherst

Avenue intersection operate at unacceptable LOS during some portions of the day under existing and/or future conditions. Some currently unsignalized intersections meet warrants for signalization.

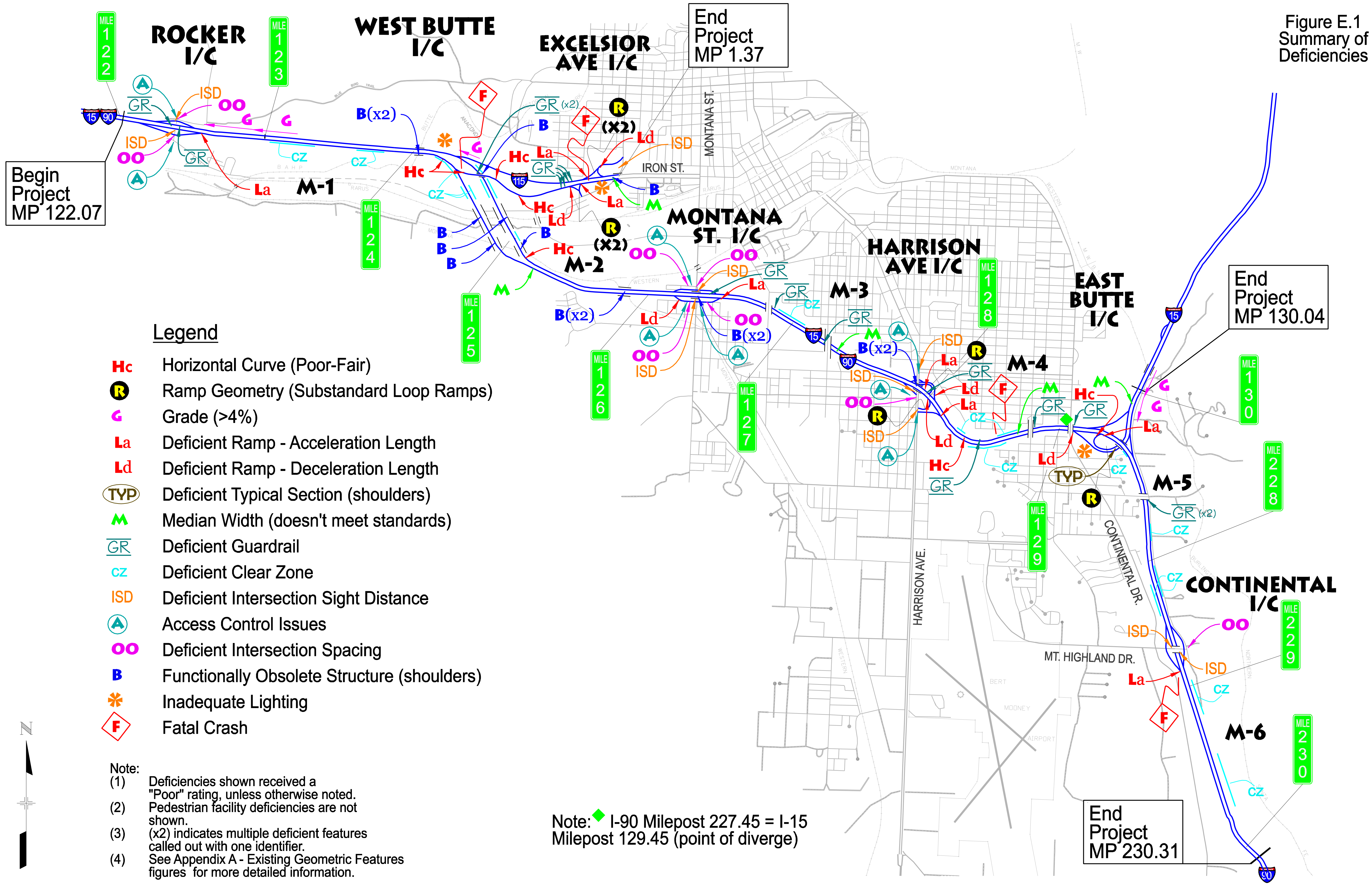
A Noise Study was completed as part of this study. The results of the noise analysis indicate that several neighborhoods are currently experiencing traffic noise impacts. The noise analysis evaluated 83 noise-sensitive receptors identified within the study area, including single-family residences, mobile homes, apartments, parks, hotels and a school. Fifteen receptors in the existing condition and eighteen in the future year exceeded the noise levels as defined by the FHWA and MDT. As a result, noise mitigation and abatement should be considered as future projects are identified during Phase 2 of this study or when future Type 1 projects are developed in areas practicing noise compatible land use planning and/or noise mitigated developments. In general a Type 1 project along I-15/90 would be defined as any Federal or Federal-Aid highway project that would significantly change the horizontal or vertical alignment or increase the number of lanes.

The completion of the Phase 1 study has developed a comprehensive understanding of existing geometric features, safety issues, traffic operation and capacity conditions, and noise. Future traffic volumes have been developed and potential traffic operational issues have been identified. Deficiencies have been identified for each interchange and interstate segment. The next step is to continue with this momentum and begin to develop alternative solutions to eliminate, minimize, or mitigate deficiencies. Alternative solutions should include both short term and long term improvements.

It is anticipated that during Phase 2 numerous alternative treatments for each interchange and interstate segment will be analyzed to determine cost effective solutions to the identified deficiencies. Examples of obvious potential treatments to be analyzed during Phase 2 include:

- Rocker Interchange – full interchange reconfiguration, short term geometric improvements on cross road or short term ramp improvements
- Mainline Segment 1 - auxiliary/truck climbing lanes
- West Butte - full interchange reconfiguration and short term ramp improvements, lighting improvements
- Mainline Segment 2 - structure improvements (widening, mainline realignment, automatic ant-icing systems)
- Montana Street – interchange reconfiguration, ramp terminal treatments
- Harrison Avenue – full interchange reconfiguration, operational improvements on cross road (signal timing, access management)
- East Butte – full interchange reconfiguration, short term lighting improvements
- Excelsior Avenue Interchange – lighting, signing improvements

Figure E.1
Summary of Deficiencies



1.0 INTRODUCTION

Butte, Montana is rich in history, culture and change. The current population in the Butte urban area is approximately 30,600, however as many as 100,000 people lived in Butte during the peak of the mining boom. It is anticipated that over the next ten to twenty years Butte will begin to experience growth in population and employment in a similar vein as many other southwest Montana communities. The Butte-Silver Bow local government (BSB) recently completed the *2005 Butte-Silver Bow Transportation Plan Update* (Transportation Plan) that provides a unified transportation vision that supports future growth in the Butte area. Within the Transportation Plan there are several projects identified that include the interstate highway system. There are two specific projects that call for a study of the interstate system:

- Committed project CM4 – Butte Interstate Traffic Study as previously programmed by the Montana Department of Transportation (MDT), and
- Recommended committed project RCM6 - Interstate Collaboration, which calls for an interstate study program to address specific issues.

In addition to the interstate study projects, the Transportation Plan identifies a few projects that include potential new accesses to the interstate system.

It is with the overall understanding of the potential for growth, perceived safety and operation issues, and requests for additional accesses that the Montana Department of Transportation commissioned this study. The Butte Interstate Traffic Study will provide a planning level analysis of existing conditions, identify deficiencies, and develop treatments for these deficiencies. This study will provide an overall long-range planning document for the Butte Interstate system.

1.1 SCOPE OF WORK

The objective is to complete a comprehensive traffic engineering study of the 12.2 mile interstate system including Interstates 15 (I-15), 90 (I-90), and 115 (I-115). The study will identify current and future operational, safety, and design issues of the existing interstate and interchanges. The study includes the following interchanges located in Silver Bow County and within the Butte urban limits:

- Rocker
- West Butte
- Excelsior Ave.
- Montana St.
- Harrison Ave.
- East Butte
- Continental

This project will be performed in two phases: Phase 1 (this report) will identify both immediate and future deficiencies (20-year forecast) of the Interstate system. Phase 2 (future) will define alternatives, provide conceptual treatments and cost estimates to address the identified deficiencies in Phase 1. Phase 2 will also prioritize the treatments based on needs and cost estimates.

The scope of work for this phase includes inventory, analysis, and assessment of traffic (operation and capacity), geometric, and safety conditions (crash history and lighting). A noise study is also included to analyze and document the traffic noise levels along the existing interstate system. Analysis of the interchanges includes the ramp terminals and cross roads.

This Phase 1 Report is a summary document of the inventory and analysis of the work completed to date and is supplemented by the technical analysis and appended data.

1.2 BACKGROUND

Butte is unique in that it is the only City within Montana that has two major interstate corridors pass through the city boundaries. I-15 is part of the CANAMEX trade corridor and I-90 is the longest continuous interstate on the national highway system. I-15 and I-90 converge at the Nissler interchange just west of the study area, and follow a shared alignment through Butte to the East Butte Interchange where I-15 heads North to Helena and I-90 heads southeast towards Bozeman. When I-15 and I-90 operate as one interstate I-15 holds the controlling designation and milepost references. In addition to I-15 and I-90, Butte has one of only two Interstate spurs in Montana. I-115 is a 1.37 mile spur that provides access to the west side of Butte and serves as the I-15/90 Business Loop. I-115 becomes Iron Street (U-1805), a local urban route.

The I-15/I-90 Interstate system and associated interchanges were constructed through Butte in the late 1960's and early 1970's. The Excelsior Avenue Interchange and I-115 spur were completed in 1986. The existing mainline concrete pavement is showing signs of degradation with many cracks and broken slabs. The riding surface is continually getting worse and field observations show commercial vehicles changing lanes to avoid certain stretches of rough pavement. MDT recently completed a rehabilitation project to improve the riding surface on the east end of the study limits.

Similar to the rehabilitation project, there are several current and programmed projects within the study area. The following projects have been completed in the past year or are under development as of January 2007:

- Rocker Scale Site – IM 15-2(85)122 (completed fall 2005)
- Interstate Rehab – Butte – IM 0002(673) (completed fall 2005)
- 1999 Signal Upgrade – Butte – CM 1899(13) (completed spring 2006)
- Bridge Skid Treatment – Butte – IM 0002(695) (anticipated completion 2007)
- Mount Highland-4-Mile Vu – UPP 1809 (anticipated construction 2008)
- Excelsior –I-115 to Platinum – UPP 1801 (anticipated construction 2008)
- Welcome Signs – Butte – STPE 1899(23) (anticipated construction 2008)
- Butte Area Structures – IM 15-2 (81) 125, (construction beyond 2008)
- 2003-VMS-Butte East – HSIP 90-4(56)227 (construction beyond 2008)
- Butte Area Bridge Deck Repair – IM 0002(752) (construction beyond 2008)
- Harrison-Amherst to Front – Butte – STPP 29-4(26)87 (construction beyond 2008)

These projects were acknowledged in the review and analysis of the existing and future conditions.

1.3 STUDY AREA

I-15 and I-90 are 4-lane interstates on the National Highway System that serve as local, regional and interstate freight trucking routes as well as regional primary routes for commuter, commercial, and recreation travel. I-115 serves as a local and regional primary route for commuter and commercial travel. I-15/90 plays an important role in the local traffic system network for commuting in and around Butte. The mainline segment between Montana Street and Harrison Avenue provides an important commuting link for local Butte residents and coincidentally carries some of the higher volumes of traffic on the interstate mainline within the study area.

The interstate facilities can be characterized by rolling to level terrain along a curvilinear alignment transitioning between rural and urban land uses. The posted speed limit on the I-15/90 mainline segments is 75 MH (65mph for trucks) for the entire study area. There are numerous structures along or over I-15/90 because of the many railroad tracks or interchanges in and around Butte. There are five interchanges on I-15/90, one interchange on I-90 and one interchange on I-115 within the project study limits. Traffic control at the intersections of the interchange ramps is a mix of stop control and traffic signals. Figure 1.1 illustrates the project limits and study area intersections. A description of each interchange including configuration, adjacent land uses and traffic control follows.

Rocker Interchange – Exit 122

The Rocker interchange is a standard underpass type diamond configuration with stop controlled intersections. The cross road, Brown's Gulch (S-276), is a two lane road with no turn lanes. Parallel frontage road intersections are extremely close to the ramp terminals and the adjacent truck stop gas stations have limited access control. The eastbound off-ramp has an operational weigh station near the ramp terminal that is used sparingly. The recent construction of the I-15/90 westbound weigh station included the removal of an old weigh station on the westbound off-ramp and the addition of an auxiliary lane that creates a two-lane westbound off-ramp. The adjacent land uses are predominantly rural; however, this interchange experiences a high volume of trucks because of the adjacent truck stops and similar facilities so it will be analyzed as an urban interchange.

West Butte Interchange – Exit 124 (City Center)

The West Butte Interchange is a partial system-to-system interchange between I-15/90 and I-115. This interchange provides for the entrance to and exit from Butte's west side via I-115 and Iron Street. The eastbound off-ramp to I-115 is a left-hand exit near a mainline I-15/90 eastbound curve; the ramp then crosses over I-15/90 westbound lanes. The westbound on-ramp from I-115 to I-15/90 is a conventional right hand entrance. The interchange does not provide a connection for westbound to eastbound traffic, either from I-115 (WB) to I-15/90 (EB) or from I-15/90 (WB) to I-115 (EB). The adjacent land use is undeveloped rolling hill, which has the potential to be included in a future super fund site.

Montana Street Interchange - Exit 126

The Montana Street Interchange is a standard underpass type diamond configuration, but three of the ramps converge with a local frontage road near the ramp terminals. The ramp terminals at Montana Street are stop controlled intersections. The cross road, Montana Street (U-1805), is a four lane principal arterial facility with a raised median and left turn lanes. The frontage road ramp configuration allows for on street parking near the ramp terminals and there are numerous access locations adjacent to the ramp terminals. The adjacent land use is mostly residential with a few commercial properties along Montana Street. The study area includes the intersection of Montana Street with Rowe Road south of the interchange ramp terminals.

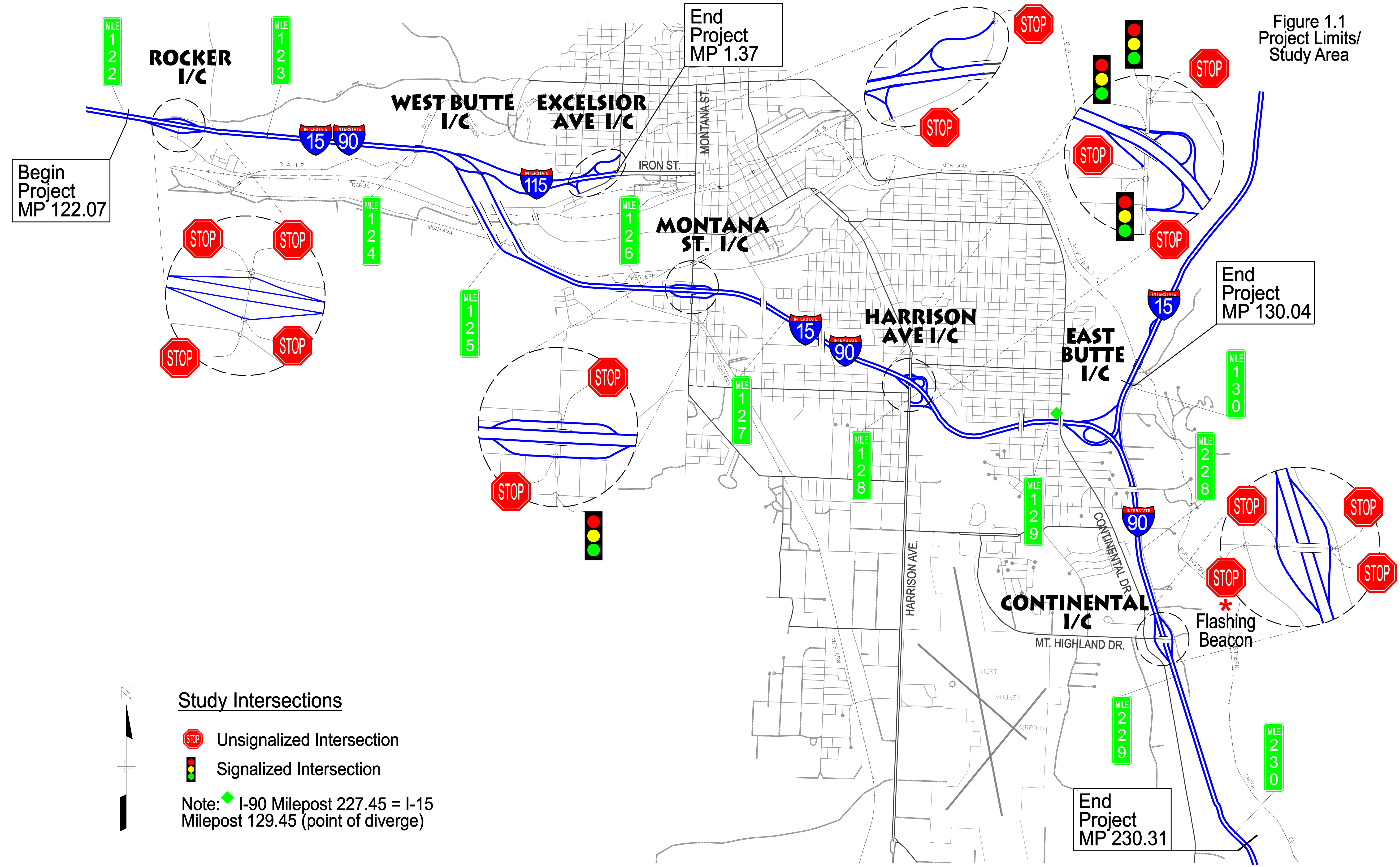


Figure 1.1
Project Limits/
Study Area
Begin Project MP 122.07
End Project MP 1.37
End Project MP 130.04
End Project MP 230.31
ROCKER I/C
WEST BUTTE I/C
EXCELSIOR AVE I/C
MONTANA ST. I/C
HARRISON AVE I/C
EAST BUTTE I/C
CONTINENTAL I/C
IRON ST.
MONTANA ST.
HARRISON AVE.
CONTINENTAL DR.
MT. HIGHLAND DR.
Flashing Beacon
STOP
Study Intersections
Unsignalized Intersection
Signalized Intersection
Note: I-90 Milepost 227.45 = I-15 Milepost 129.45 (point of diverge)

Harrison Avenue Interchange – Exit 127

The Harrison Avenue Interchange is an underpass type six-ramp partial cloverleaf configuration with two tight loop ramps on the east side. The loop ramps provide a northbound Harrison to westbound I-15/90 movement (on-ramp) and an eastbound I-15/90 to northbound Harrison movement (off-ramp). The cross road, Harrison Avenue, is a principal arterial and the main north-south arterial in Butte. Ramp terminal traffic control consists of a mix of stop controlled and signalized intersections. Additionally the study area includes Cornell Avenue and Amherst Avenue to the north of the interchange and the intersection of Montana Street and Dewey Boulevard. Harrison Avenue is also the primary retail corridor in Butte so adjacent land uses include numerous retail uses including gas stations and lodging.

East Butte Interchange – Exit 129

The East Butte Interchange is a system-to-system interchange in a trumpet configuration with a tight loop ramp on the south side. I-15 and I-90 revert to separate alignments east of this interchange. This interchange configuration promotes I-90 as the major through movement while the I-15 movements take place on the ramps. The loop ramp movement carries I-15 southbound traffic to I-90 eastbound. The adjacent land uses are mostly residential with some undeveloped land to the north. Many of the residential properties have been developed after the initial construction of the interstate system. Some of these residential properties are very close to the loop ramp.

Continental Interchange – Exit 228

The Continental Drive interchange is a standard overpass type diamond configuration with stop controlled ramp terminal intersections. The cross road, Mount Highland Drive/4-Mile Vue Road (U-1809), is a two lane minor arterial with no turn lanes. There are frontage road intersections on each side that are extremely close to the interchange ramp terminal intersections. The adjacent land use is mixed with large residential lots, retail and several undeveloped but platted parcels near the interchange. The west side frontage road (Continental Drive and Mount Highland) intersection has a flashing light in addition to the 4-way stop controlled traffic control.

Excelsior Avenue Interchange – Exit 1

The Excelsior Avenue interchange is an underpass type four leg button hook ramp configuration with stop controlled ramp terminal intersections. The cross road, Excelsior Avenue (U-1801), is a collector road with no turn lanes. The adjacent land use is predominantly residential. This interchange has low traffic volumes and does not have any highway lighting on the interchange or Excelsior Avenue.

2.0 EXISTING CONDITIONS

The analysis of existing conditions was initiated with the collection and inventorying of traffic data, field measurements and observations, MDT as-built plans, aerial mapping, and Graphical Information System (GIS) data. Analysis was accomplished for three main categories: geometric features, safety, and traffic. The interstate corridor was divided into segments between interchanges for analysis purposes. Figure 2.1 shows the project study area broken into specific interchange and mainline segments identified in the analysis.

2.1 GEOMETRIC FEATURES

Geometric elements reviewed for the interstate mainline and at each interchange include cross section elements (typical section information, structures, and pedestrian facilities), horizontal alignment, vertical alignment, ramp geometry, interchange/intersection spacing, adjacent access locations, turning movements, and intersection sight distance. Each of these elements was evaluated and ranked based on design criteria that were developed for the project. Rankings were "Good," "Fair," and "Poor." Table 2.1 was developed through a review of procedures, practices, guidelines and recommendations in the American Association of State Highway and Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets, 2004 Edition*, the MDT *Traffic Engineering Manual*, AASHTO *Roadside Design Manual* and the MDT *Road Design Manual*. The design speed for the interstate mainline segments is 70 MPH and the design speed for the cross roads is 45 MPH. The design vehicle is a WB-67 interstate tractor-semitrailer.

Figure 2.1
Interstate Analysis Segments

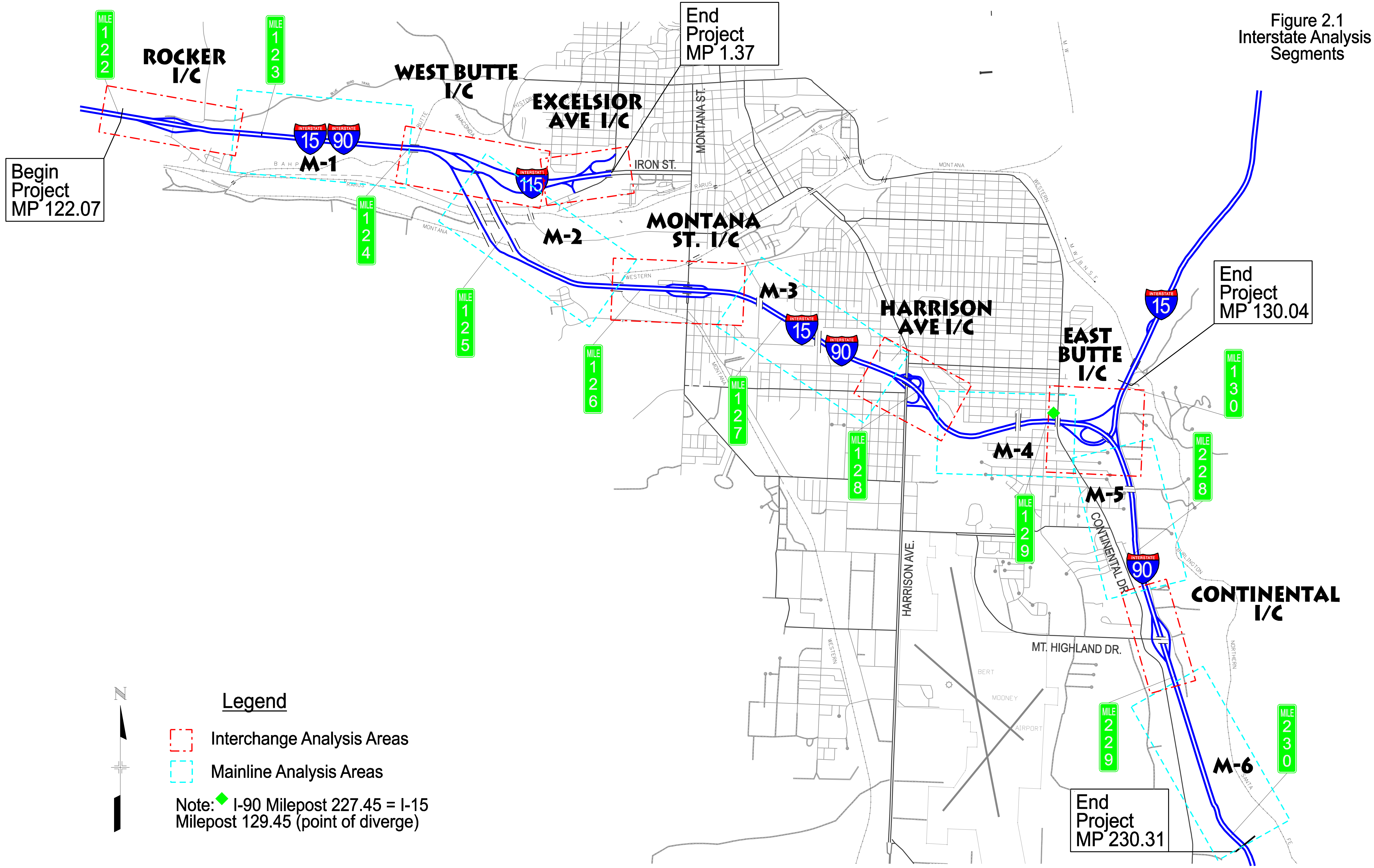


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Table 2.1
Design Criteria

Horizontal Alignment			
Criteria	**Good**	**Fair**	**Poor**
Radius of Curve (ft) (1)	>= 1820 (70 mph)	761-1819 (51-69 mph)	<= 760 (50 mph)
Stopping Sight Distance (2)	>= 730 ft	426-729 ft	<= 425 ft
Vertical Alignment			
Criteria	**Good**	**Fair**	**Poor**
Vertical Curve–Stopping Sight Dist. (2)	>= 70 mph	51-69 mph	<= 50 mph
Gradient (3)	< 3 percent	3-4 percent	> 4 percent
Vertical Clearance – Structures	> 16.5 feet	16.5 – 14.5	< 14.5 feet
Cross Section Elements			
Element	**Good**	**Fair**	**Poor**
Lane Width (3)	12 ft		< 12ft
Outside Shoulder Width (3)	10 ft		< 10 ft
Inside Shoulder Width (3)	4 ft		< 4ft
Superelevation (3)	meets standards	(+/-) < 1 percent	(+/-) > 1 percent
Clear Zone Distance (4)	meets standards		does not meet standards
Guardrail/Barriers (1)	meets standards		does not meet standards
Structural Width – Shoulder widths	matches travel roadway widths	8 ft to < 3 ft	< 3 ft
Median Widths	> 36 ft	36-16	< 16 ft
Exit Ramp Criteria			
Type	**Good**	**Fair**	**Poor**
Taper Rate (3)			
Taper Design (Diverge Angle)	2-5 degrees		> 5 degrees
Parallel Design	>= 250 ft	211-249 ft	<= 210 ft
Deceleration Length (Ld) (2)	meets standards		does not meet standards
Decision Sight Distance in Advance of Gore (2)	>= 1445 ft	1031-1444 ft	<= 1030 ft
Entrance Ramp Criteria			
Type	**Good**	**Fair**	**Poor**
Taper Rate (3)			
Taper Design	>= 60:1	60:1-50:1	<= 50:1
Parallel Design	>= 300 ft	261-299 ft	<= 260 ft
Acceleration Length (La) (2)	meets standards		does not meet standards

Table 2.1 continued
Design Criteria

<table>
<tr><th colspan="7">Ramp Spacing Criteria</th></tr>
<tr><th>Scenario</th><th colspan="2">Good</th><th colspan="2">Fair</th><th colspan="2">Poor</th></tr>
<tr><td>Distance Between Ramps (2) (#)</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Entry – Entry</td><td colspan="2">>= 1000 ft</td><td colspan="2">800-1000 ft</td><td colspan="2"><= 800 ft</td></tr>
<tr><td>Exit – Exit</td><td colspan="2">>= 1000 ft</td><td colspan="2">800-1000 ft</td><td colspan="2"><= 800 ft</td></tr>
<tr><td>Exit – Entry</td><td colspan="2">>= 500 ft</td><td colspan="2">400-500 ft</td><td colspan="2"><= 400 ft</td></tr>
<tr><td>Entry – Exit</td><td colspan="2">>= 2000 ft</td><td colspan="2">1600-2000 ft</td><td colspan="2"><= 1600 ft</td></tr>
<tr><th colspan="7">Ramp Terminal Conditions</th></tr>
<tr><th>Scenario</th><th colspan="2">Good</th><th colspan="2">Fair</th><th colspan="2">Poor</th></tr>
<tr><td>Stopping Sight Distance (@ cross rd.) (3)</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Stop Controlled-Turn From Minor Rd</td><td colspan="2">(45 mph)</td><td colspan="2">(40 mph)</td><td colspan="2">(35 mph)</td></tr>
<tr><td>Passenger Car</td><td colspan="2">500 ft</td><td colspan="2">391-499 ft</td><td colspan="2">390 ft</td></tr>
<tr><td>Tractor/Semitrailers</td><td colspan="2">765 ft</td><td colspan="2">596-764 ft</td><td colspan="2">595 ft</td></tr>
<tr><td>Main Road Left Turn to Side Road</td><td colspan="2">(45 mph)</td><td colspan="2">(40 mph)</td><td colspan="2">(35 mph)</td></tr>
<tr><td>Passenger Car</td><td>1-lane
365 ft</td><td>2-lane
400 ft</td><td>1-lane
286-365’</td><td>2-lane
311-401’</td><td>1-lane
285 ft</td><td>2-lane
310 ft</td></tr>
<tr><td>Tractor/Semitrailers</td><td>1-lane
500 ft</td><td>2-lane
545 ft</td><td>1-lane
391-499’</td><td>2-lane
426-544’</td><td>1-lane
390 ft</td><td>2-lane
425 ft</td></tr>
</table>

References:
(1) – MDT Roadway Design Manual
(2) – AASHTO “A Policy on Geometric Design of Highways and Streets” 2004
(3) – MDT Traffic Engineering Manual – Part IV – Geometrics
(4) – AASHTO Roadside Design Guide
(#) – Compare against HCM methodology and larger value controls

Geometric assessment spreadsheets in Appendix A contain tabulated information on each geometric feature and element and rankings based on the criteria. The following sections highlight identified deficiencies in each geometric element category. Appendix A contains additional plan sheet figures that illustrate deficiencies.

2.1.1 Cross Section Elements

Cross section elements include the number of lanes, lane dimensions, clear zone (roadside slopes), structure dimensions and pedestrian facilities. Each of these elements was assessed to determine if the interstate meets current standards. The following deficiencies were identified:

Typical Section

For the most part the interstate mainline typical sections meet current design guidelines. The I-15/90 interstate typical section within the study area consists of 4- to 12-foot travel lanes, 4 feet inside shoulders, and 10 feet outside shoulders except at structures where many of the shoulder dimensions are 2 feet. The median width varies at several locations. There are numerous sections of roadway with guardrail on the mainline interstate within the study area because of the high number of structures (bridges and overhead sign structures) and many sections with steep sideslopes. All of the guardrail appears to meet current MDT design standards for type and terminal sections. The following elements do not meet current design guidelines for typical sections.

- **Shoulder Widths:** The I-15 north segment has a typical section with 1-foot inside shoulder and 6-foot outside shoulders. The I-115 interstate segment as it transitions to the local route Iron Street has 2-foot inside shoulders. These two segments are relatively short and in the case of I-15 is a combination mainline and ramp typical section.
- **Median Width:** MDT guidelines call for a 36-foot wide median on interstate facilities with flat to rolling terrain. The I-15/90 interstate segment from just west of the Montana Street interchange to the East Butte interchange has a 28-foot wide median. Also, the I-15 north segment discussed above in regard to the shoulder widths has a raised concrete 6-foot wide median. The curb type raised median is not well suited for a high speed interstate facility based on safety for two way travel.
- **Guardrail:** Length of need calculations were made on all guardrail sections that were protecting obstacles (i.e. bridges and signs). Length of need calculations for guardrail protecting non-recoverable sideslopes were not completed, but the sideslopes at the end terminals were measured. The calculations revealed that most of the guardrail meets the current standards for a 70 mph design speed. I-115 had several sections that do not meet current standards including the eastbound bridge over westbound I-15/90 and at a drainage structure just west of the Excelsior Avenue interchange (both lanes in both directions). Mainline I-15/90 sections that do not meet current standards include: Rocker interchange bridge inside approaches; westbound outside lane approaching Lexington Avenue overpass; eastbound outside lane approaching Oregon Avenue overpass; westbound inside lane approaching Harrison Avenue bridge; westbound outside lane approaching a drainage crossing east of the Harrison Avenue interchange; westbound inside and outside lanes approaching Sheridan overpass; westbound outside lane approaching Continental Drive overpass; and the westbound inside and outside lanes approaching Burlington Avenue overpass.
- **Clear Zone:** Guidelines in the AASHTO *Roadside Design Manual* indicate that based on the design speed and traffic volumes at least 30 feet of recoverable sideslope (greater than 3:1) is required for this facility. 30 feet is a standard clearzone distance for interstate facilities, however, based on the backslopes at the edge of asphalt more than 30 feet may be required. For this planning level study a constant 30 feet was used for analysis. There are several sections on I-15/90 where the roadside slopes do not provide the 30 feet of recoverable slopes. In particular several sideslopes that do not have guardrail within the rolling topography areas between the Rocker and Montana Street interchanges and between Harrison Avenue and the East Butte interchange do not meet standards for clear zone. It is worth noting that many of the deficiencies are related to a non-recoverable back slope (mostly in cut sections) within the 30-foot clear zone.
- **Sideslopes:** In addition to the clear zone measurements and analysis, existing sideslopes were measured to identify areas adjacent to the mainline that exceed a 4:1 slope. Using GIS contours the existing sideslopes were measured. Based on the accuracy of the GIS data most of the backslopes that do not have guardrail within the study corridor range

between 4:1 and 6:1 within the clear zone, although there are a few slopes steeper than 4:1 in short stretches. The majority of backslopes have a 4:1 slope from the edge of pavement down to a ditch section or toe of slope. The backslopes between Montana Street and Harrison Avenue flatten out a little to the 6:1 range. For the most part the typical sections have a constant backslope to a point of slope selection unlike current design standards that use a "barn roof" approach with a gradual slope that increases in steepness at set points away from the asphalt based on clear zone requirements and depth of cut or fill. Although the 4:1 backslopes are recoverable they are steeper than current design practices and require larger clearzone areas. The foreslopes vary from near vertical on the west end to some recoverable slopes on the east end of the corridor. In the West Butte area where the existing roadway is in a significant cut the foreslopes are 2:1 and near the East Butte cut area (west of the Continental overpass) the foreslopes are 3:1. As previously mentioned, the steepness of the foreslopes is the contributing factor on many of the clearzone deficiencies.

Structures

There are 18 structures totaling nearly 3,240 linear feet (~5 percent of total project length) of the interstate system in this study area and all but two (East Butte and Rocker interchanges) are functionally obsolete. Fourteen of the structures are functionally obsolete because the inside and outside shoulders do not meet current criteria. Most of the shoulders on these structures are 2-feet or less. MDT is currently developing a project to replace two railroad structures to current AASHTO standards, just west of the Montana Street interchange. Additional discussion on the impacts of the structure shoulder widths is included in the safety analysis section.

Vertical clearances at all structures were inventoried and analyzed. All mainline overpass structures meet current standards. Most of the local street cross roads are overpasses above I-15/90. Of the underpass crossings the Montana Street and Harrison Avenue interchanges have structures that do not meet current standards for vertical clearances, both are below 16.5 feet. In fact the Montana Street interchange bridge had to be rebuilt a few years ago because a trailer hit the bridge severely damaging the bridge carrying eastbound I-15/90 traffic.

Pedestrian Facilities

Of the five service interchanges that access local cross roads only the Montana Street and Harrison Avenue interchanges have existing pedestrian facilities. The Rocker, Excelsior Avenue and Continental interchanges do not have any sidewalks, pedestrian crossings or curb ramps. Field observations revealed almost no pedestrian activities at and around the Excelsior Avenue and Continental Interchanges. The Rocker Interchange sees pedestrian activities in the form of hitch-hikers and travelers from the adjacent truck stops. It is worth noting that all local cross road overpasses (Lexington, Oregon, Sheridan, Continental) meet the minimum requirements for sidewalk (5' width on one side) except the Burlington overpass, which does not have any pedestrian facilities.

Montana Street and Harrison Avenue have sidewalks and curb ramps on both sides of the roadway. The sidewalk can be characterized as mostly five feet wide in various conditions from newly replaced segments to broken up and in need of replacement. Curb ramps along both roadways are not consistent with a few newer ramps that have colored concrete panels and many older curb ramps that do not meet current ADA guidelines. None of the existing curb ramps in the study area meet ADA requirements of truncated dome detectable warning surfaces.

From a pedestrian safety aspect the greatest deficiency is the limited number and general location of marked or signalized crossings that traverse Montana Street and Harrison Avenue. Harrison Avenue only has pedestrian crossings at the Amherst, Westbound on/off-ramp, and Dewey Boulevard intersections. Montana Street does not have any marked crossings at the ramp terminal intersections. The only marked and signalized crossing is south of the interchange at Rowe Road and the next closest crossing is over a quarter mile north of the interchange.

2.1.2 Horizontal and Vertical Alignment

Horizontal and vertical alignment analysis included the review of the mainline information and each interchange ramp. Alignments were reviewed against design guidelines for a design speed of 70 mph.

Horizontal Alignment

I-15/90 snakes through the Butte Urban area along a rather stretched out S-curve alignment. With this type of alignment there are a few curves that have curvature of close to 90 degrees. Based on the established design criteria the horizontal alignment curvature and cross slope (superelevation) at each curve was reviewed and rated. The curves shown in table 2.2 were found to be deficient with either a “Poor” or “Fair” rating.

Horizontal alignment features have an impact on many other geometric and operational features such as ramp operations, cross section elements and safety. The loop ramps identified as deficient can cause significant safety issues because of their extremely low design speeds. Each mainline horizontal curve and controlling ramp curve is labeled with a corresponding design speed on the geometric figures in Appendix A.

Table 2.2
Horizontal Alignment Deficiencies

Segment	Direction / Location	Radius	Rating	Design Speed / Notes
West Butte I/C	Westbound at I-115 Off-Ramp (left hand)	1637'	Fair	60 MPH, also has poor superelevation
M-2	Eastbound, near milepost 125.1	1910'	Fair	65 MPH, see note
M-2	Westbound, near milepost 125.1	1910'	Fair	65 MPH, see note
M-4	Eastbound & Westbound, near milepost 128.5	1910'	Fair	65 MPH, see note
East Butte I/C	Eastbound & Westbound, at East Butte Interchange	1910'	Fair	65 MPH, see note
I-115	Eastbound, just past I-15/90 Overpass	1432'	Fair	60 MPH, design speed based on radius and super elevation
I-115	Eastbound, near milepost 0.5	1146'	Fair	55 MPH, design speed based on radius and super elevation
I-115	Eastbound, approaching Excelsior Avenue I/C	1146'	Fair	55 MPH, design speed based on radius & super elevation
Harrison Ave. I/C	Eastbound Off-Ramp (Loop Ramp)	200' (controlling)	Poor	25 MPH, compound curve tightening in direction of travel
Harrison Ave. I/C	Westbound On-Ramp (Loop Ramp)	148' (controlling)	Poor	20 MPH, compound curve tightening in direction of travel
East Butte I/C	I-15 Southbound to I-90 Eastbound Ramp	227' (controlling)	Poor	25 MPH, compound curve tightening in direction of travel

Note: Radius alone would get a "Good" rating based on design criteria. Radius in coordination with existing superelevation was analyzed to determine design speed and rating.

Vertical Alignment

For the vertical alignment component the existing grades and vertical curves were reviewed and analyzed. The rolling terrain on the west side of Butte causes I-15/90 to climb and fall as the alignment enters the urban limits. Specifically the grade from the Rocker Interchange to the West Butte Interchange has a considerable grade for a transitioning rural to urban area. Descriptions of the affects of this grade and other vertical alignment deficiencies with a "Poor" rating follow:

- **I-15/90 east of Rocker Interchange Grades (MP 122.75-123.25)** – This segment of I-15/90 has a 4.1 percent (1200-foot) increasing to 5.5 percent (1650-foot) grade going up (eastbound) from the Rocker interchange. This grade has impacts on both the westbound and eastbound travel lanes and the operation of the interchange ramps. In particular this grade causes significant operational issues for heavy trucks. Many trucks exit at Rocker for fuel and lodging and re-enter the interstate.

- **I-15 North Grades (MP 129.7+)** – As I-15 diverges from the I-90 alignment at the East Butte interchange and heads north to Helena the mainline grades are close to 5 percent. This vertical alignment continues for several miles as the interstate climbs towards Elk Park Pass.
- **I-115 Westbound approaching I-15/90 (MP 0.2)** – I-115 westbound as it transitions from a interstate mainline segment to an on-ramp has a 4.3 percent downgrade towards I-15/90.
- **I-15/90 Vertical Curves** - No vertical curves on I-15/90 received a Poor rating and only three received Fair ratings. The series of vertical curves at the Montana Street interchange proceeding west have design speeds of 60, 55 and 60 (heading west). Two of these curves will be improved through the Butte Area Structures project. After that project is constructed the only vertical curve with a design speed below 70 mph will be the vertical curve over Montana Street.
- **I-115 Vertical Curves** – A crest vertical curve on westbound I-115 (at 4.3 percent grade location) approaching I-15/90 has a design speed of 45 mph with a stopping sight distance of 315 feet.

The most significant of these deficiencies is the mainline vertical grade and the effect on heavy vehicles, such as interstate tractor-semitrailer trucks. According to AASHTO trucks experience an increase in speed of up to five percent on downgrades and a decrease of up to seven percent on upgrades. On upgrades the maximum speed a truck is able to maintain is primarily dependent on the entry speed, length and steepness of the grade and the specific truck attributes. Using AASHTO guidelines and procedures it can be determined that a typical heavy truck traveling 70 mph on eastbound I-15/90 approaching the hill east of Rocker will gradually lose speed and reach the top of the hill traveling around 40-45 mph. This reduction in speed can lead to safety and operation problems due to a differential in vehicle traveling speeds.

2.1.3 Ramp Features

Adequately designed ramp features including safe diverge and merge angles and appropriate lengths to accelerate and decelerate at entrance and exit ramps is critical for the traveling public's safety and overall interstate operations. Because the I-15/90 corridor operates relatively free of congestion and the travel speeds approach the 75 mph speed limit, ramp merge and diverge areas that meet current standards are important. The existing ramp features including type (parallel vs. taper), diverge angle, taper length and most importantly acceleration and deceleration lengths were measured and rated based on the design criteria. Table 2.3 shows the interchange ramps that had deficient acceleration or deceleration lengths.

Horizontal alignment features have an impact on many other geometric and operational features such as ramp operations, cross section elements and safety. The loop ramps identified as deficient can cause significant safety issues because of their extremely low design speeds. Each mainline horizontal curve and controlling ramp curve is labeled with a corresponding design speed on the geometric figures in Appendix A.

Table 2.3
Deficient Ramp Features

Interchange	Ramp	Existing La or Ld (ft)	Required La or Ld (ft)
Rocker I/C	EB on-ramp	300	2250 (1)
Montana I/C	EB off-ramp	276	390
	EB on-ramp	300	580
Harrison I/C	WB on-ramp (loop)	237	1520
	WB off-ramp	262	390
	EB on-ramp	512	1350
	EB off-ramp (loop)	~50	550
East Butte I/C	I-15/90 EB to I-15 N	293	390
	I-15 SB to I-90 EB (loop)	300	2201 (2)
Continental I/C	EB on-ramp	300	820
Excelsior I/C	WB on-ramp	300	1000
	WB off-ramp	312	550
	EB on-ramp	300	1429
	EB off-ramp	321	520

Notes: (1) Includes a 1.5 Grade Factor for 3-4 percent uphill and assumed a 20 mph starting speed, (2) Includes a 1.55 Grade Factor for 3-4 percent uphill). La –Acceleration Length, Ld – Deceleration Length

As table 2.3 shows, the three loop ramps and the eastbound Rocker interchange ramp have the largest discrepancy between the existing and required values. The existing geometry of the interchange and structures provide physical limitations to lengthening the acceleration and deceleration lengths. The Excelsior Avenue interchange has poor geometrics and based on the mainline design criteria none of the ramps meet current guidelines for acceleration and deceleration.

As previously discussed, grades have a pronounced impact on heavy truck/semitrailer truck operations on the mainline. Similarly the effects are even more pronounced on ramps and acceleration/deceleration lengths. The eastbound on-ramp at the Rocker interchange has a grade in excess of 5 percent and it ties into the mainline grade previously discussed. Following AASHTO guidelines and procedures it is found that a typical truck will only be able to accelerate from a starting speed of 20 mph to a top speed of 25-30 mph at the end of the 5.5 percent grade on I-15/90 based on the steepness and length of the grade. Further analysis of speed differentials and truck operations on this grade should be completed in phase 2 to assist in developing alternatives for this area.

2.1.4 Interchange/Ramp Spacing

The distances between each interchange, individual ramp and ramp terminal intersections were measured for use in analysis. AASHTO guidelines specify that in urban areas interchanges should be spaced a minimum distance of 1.0 mile. The interchanges in this study all meet this spacing requirement. The absolute distance between successive ramps is determined by analysis of weaving operations. AASHTO provides minimum distances for consideration between each type of ramp (entry to entry, exit to entry, entry to exit, exit to exit). From a geometric feature standpoint the interchange ramps meet current guidelines for spacing. It is important to note that if all of the ramps met current standards for acceleration and deceleration lengths there would be deficiencies in interchange spacing. Specifically at the Harrison Avenue interchange where required acceleration and deceleration lengths for the loop ramps would require auxiliary lanes for a substantial distance west of the interchange to accommodate all of the current interchange movements. Additional analysis on weaving operations is discussed later in this section.

Spacing between ramp terminal intersections and adjacent frontage and local road intersections is important for operations because this spacing provides a buffer between the local road traffic and the traffic entering and exiting from the interchange. MDT guidelines specify a distance of 65' in urban areas and 100' in rural areas between ramp terminals and frontage roads. Because of the high number of heavy trucks at many interchanges and based on experience that even a 100' spacing between intersections is not sufficient operationally, the 100' spacing was used as the design criteria. Table 2.4 shows the ramp terminal intersections that are deficient.

Table 2.4
Deficient Ramp Terminal Intersection Spacing

Interchange	Ramp Terminal Intersection	Required Spacing (ft)	Existing Spacing (ft)
Rocker I/C	EB off/on-ramp & South Frontage Rd.	100	~40
Rocker I/C	WB off/on-ramp & North Frontage Rd.	100	~40
Montana St I/C	EB off-ramp shared ramp & Montana St.	377	310
Montana St I/C	Montana St. & EB on-ramp shared ramp	500(1)	310
Montana St I/C	Montana St. & WB shared-on ramp	500(1)	380
Montana St I/C	WB on/off ramp & Oxford St.	100	85
Harrison Ave I/C	EB off-ramp & Dewey Blvd.	100	~40
Continental I/C	WB on/off-ramp & Saddle Rock Dr.	100	55

Notes: (1) Ramp/continuous frontage road combination.

Significant operation issues can occur when ramp terminal intersections and frontage or local road intersections are placed to closely together. Field observations show that the spacing of the intersections at the Rocker interchange has a significant effect on the truck turning movements. The spacing of the eastbound off-ramp at Harrison Avenue in relation to Dewey Boulevard effects the traffic operations of the off-ramp. The traffic signal at Dewey often causes queues of vehicles that block the eastbound off-ramp intersection. In peak hours this can cause the queues on the eastbound off-ramp to increase as vehicles wait for gaps in traffic. Field observations revealed that the longest backups occurred when a semitrailer truck was waiting for a gap to pull out onto Harrison Avenue and then take a right on Dewey Blvd. Because a semitrailer truck needs to pull into the center lane to make the nearly 180 turn degree it can take several minutes for a large enough gap in traffic. The longest observed queue on the eastbound off-ramp was 11 cars, which gets close to backing up onto the interstate mainline. Traffic counts show that anywhere from 20-30 percent of the vehicles in a given peak hour on the eastbound off-ramp make the movement to Dewey Blvd. Figure 2.2 shows a semitrailer truck making the right turn from the eastbound off-ramp south towards the Harrison Avenue and Dewey Blvd. intersection.

Figure 2.2
Harrison Eastbound Off-Ramp near Dewey Blvd.

2.1.5 Adjacent Access

Adjacent access locations for each interchange were inventoried. MDT and FHWA guidelines identify an access control line adjacent to freeway interchanges. Generally this is 100 feet past the ramp terminal intersection in urban areas. There should not be any accesses within this access control line. The access control line along with labels for each access near the ramp terminal is shown in the geometric figures in Appendix A. Encroachment on this access line happens at the Rocker, Montana Street and Harrison Avenue interchanges. Encroachments vary from gas station entrances to major street intersections such as Dewey Blvd.

The Montana Street ramps are unique in their configuration and operation. They merge into a continuous frontage road configuration with adjacent local roads. The unique aspect is that in the two-lane shared ramp frontage road sections there are local access and parking is allowed on the shared ramps. The concern with this design is the potential for wrong way travel or uncontrolled access to the through lanes from the adjacent properties. The existing advisory signing correctly restricts illegal movements; however, signing alone is inadequate to restrict wrong way travel, as relatively brief observations showed. On three different occasions a wrong way movement was observed on the eastbound on-ramp. Crash data does not provide any evidence that this illegal movement has resulted in a crash, but the potential for a serious crash exists.

2.1.6 Turning Movements

Turning movements were analyzed at all ramp terminal and cross road intersections within the study area. A WB-67 design vehicle was used for all turning movements except on Harrison Avenue at Cornell Avenue and Amherst Avenue where a WB-50 was used. Turning movement paths and points of conflicting movements are shown in Appendix A. The following intersections had significant turning movement conflicts:

- Rocker I/C – Eastbound on/off-ramps and South Frontage road intersection
- Rocker I/C – Westbound on/off-ramps and North Frontage road intersection
- Montana Street Interchange – Eastbound on/off-ramps
- Harrison Avenue Interchange – Eastbound off-ramp and Harrison Ave./Dewey Blvd.
- Harrison Avenue Interchange – Eastbound on/off-ramps

It is worth noting that at the Rocker eastbound on/off-ramps MDT has installed temporary concrete barrier on the south west corner because an existing light standard had been hit so many times by tractor trailers. Evidence of the turning movement issues can be seen by the numerous tire marks on this concrete barrier.

2.1.7 Intersection Sight Distance

Existing intersection sight distance (ISD) was measured based on a cross road design speed of 45 mph. At this design speed many ISD issues were identified. Table 2.5 summarizes the deficiencies and sight distance dimension triangles are shown on figures in Appendix A.

Table 2.5
Intersection Sight Distance Issues

Interchange	Ramp Terminal Intersection	Existing ISD	Rating	Obstructions
Rocker I/C	EB off/on-ramps	290’	Poor	Bridge Pier
Rocker I/C	WB off/on-ramps	250’	Poor	Bridge Pier
Montana St. I/C	EB off/on-ramps	300’	Poor	Bridge Pier
Montana St. I/C	WB off/on-ramps	300’	Poor	Bridge Pier
Harrison I/C	EB off-ramp	280’	Poor	Bridge Pier, Bush
Harrison I/C	EB off –ramp (loop)	330’	Poor	Harrison Ave & Dewey Blvd. Intersection
Harrison I/C	Amherst Ave - Right Turn	250’	Poor	Adjacent Property, Cornell Ave. Intersection

Note: Required ISD – 45 mph = 500 ft; 35 mph = 390 ft

2.2 SAFETY ANALYSIS

The safety analysis consisted of reviewing and summarizing historical crash information and inventorying existing highway lighting, signs and striping for conformance to current standards.

2.2.1 Crash Analysis

Vehicle crash data was provided by MDT for the entire study area for a five-year period from January 1, 2001 to December 31, 2005. Information was available for all three interstate segments and each of the study cross roads, however the majority of the information is for the I-15/90 corridor. The data contained information related to time, type of crash, general location, number of vehicles, roadway conditions, traffic controls, contributing factors and severity in terms of injuries/fatalities. This information was inventoried, reviewed and analyzed, to identify trends and problem areas that may be correctable through potential improvements. It was found that many of the crashes coded to the interstate mainline near interchanges were incorrectly coded to the interstate system when the crash actually took place on the cross road. These crashes were moved to the correct cross road for analyses. Crash trends were identified from the summary analyses.

2.2.1.1 Mainline Interstate Crash Summary

The mainline interstate segments consist of two segments for analysis, which include all segments of the I-15 and I-90 corridors within the study area and the I-115 interstate segment. There were 423 crashes along I-15/90 resulting in 3 fatalities and 116 injuries (in 89 crashes). On I-115 there were 19 crashes resulting in 1 fatality and 12 injuries (in 7 crashes). There was an additional crash involving a fourth fatality on I-15/90, but it was determined to not be attributed to the roadway. A brief summary of each fatal accident follows:

- 1/15/01 – MP 128.5: Coded as Other (driver); driver was cut off by semi-truck and swerved to avoid collision, lost control and rolled, driver was ejected. Driver was not wearing seatbelt.
- 12/31/03 – MP 124.1: Coded as Alcohol; driver was eastbound near the West Butte I/C lost control on curve, rolled and was ejected. Driver was not wearing seatbelt. Slushy road conditions.
- 03/23/03 – MP 228.9: Coded as Too Fast for Conditions; driver lost control on icy road and rolled on embankment pinned by vehicle. Driver was not wearing seatbelt.
- 09/04/04 – MP 228.0: Coded as Careless Driving; fatality not shown in MDT provided tabulation; driver apparently had a heart attack while driving and vehicle rolled. Heart attack was cause of death.
- 07/29/02 – MP 0.8 (I-115): Coded as Inattentive Driving; driver lost control and the vehicle rolled and hit guardrail, driver was ejected, 2 others injured. Driver was not wearing seatbelt.

Table 2.6 summarizes the mainline interstate segment crash analysis. It should be noted that the crash rate for both I-15/90 and I-115 is significantly higher than the statewide average. However, the statewide average is for rural interstates. MDT has not compiled statewide averages for urban interstate segments. It may still be concluded that the mainline crash rates are high in relation to Montana interstates and highways.

Table 2.6
Interstate Mainline 2001-2005 Crash Summary

Criteria	I-15/90	I-115	Statewide Average
Number of Crashes	423	19	N/A
Number of Crashes per year	84.6	3.8	N/A
Crashes per Mile	39.1	13.9	N/A
Crash Rate	1.40	1.32	1.07
Severity Index	1.47	3.68	1.96
Severity Rate	2.06	4.85	2.08

Notes: Crash and Severity Rates are for all vehicles. Statewide Average is for rural interstates. Severity Index assigns a weighted value (8 for fatality, 3 for injury) to the crashes for use with the crash rates to determine the severity rate. The severity rate better represents the danger of crashes within the corridor.

Spreadsheets summarizing all of the crash data for the mainline I-15/90 and I-115 crashes are included in Appendix B. This includes summaries by crash type, year of crash, number of vehicles, time of day, day of week, direction of travel, road condition, lighting, driver age, vehicle type, and contributing factors. The following statistics are worth noting:

- 81 percent of crashes involved a single vehicle (high rate indicates potential geometric deficiencies)
- 58 percent of crashes occurred on icy/snow/slushy road conditions
- 60 percent of crashes occurred during daylight conditions
- Nearly 50 percent of crashes were caused by inattentive and careless driving or driving to fast for conditions (high rate indicates potential geometric deficiencies)
- 31 percent of the crashes involved drivers under 25 years of age

Additional data relative to seatbelt use was obtained from MDT to try and identify seatbelt use in fatal and injury crashes. In all four of the fatal crashes on the interstate the driver was not wearing a seatbelt. Results on the use of seatbelts in injury crashes were inconclusive because of the uncertainty and incompleteness of the data on seatbelt use.

2.2.1.2 Interstate Crash Summary by Segment

To further investigate crashes and look for trends the crash data was broken into the interchange and mainline segments shown in Figure 2.1. Crashes were summarized for each segment and compared to the corridor average. Individual crash rates for each segment and crashes per mile were reviewed to identify trends. Both analysis methods revealed the same trends. Figures 2.3 and 2.4 show that the West Butte Interchange, mainline segment 2 (M-2), Harrison Avenue Interchange, East Butte Interchange, and the Continental Interchange all had crash averages significantly higher than the corridor average. Further investigation into crash types and contributing factors was completed on these high crash segments and mainline segment 1 (M-1).

Figure 2.3
Crashes/mile per Segment

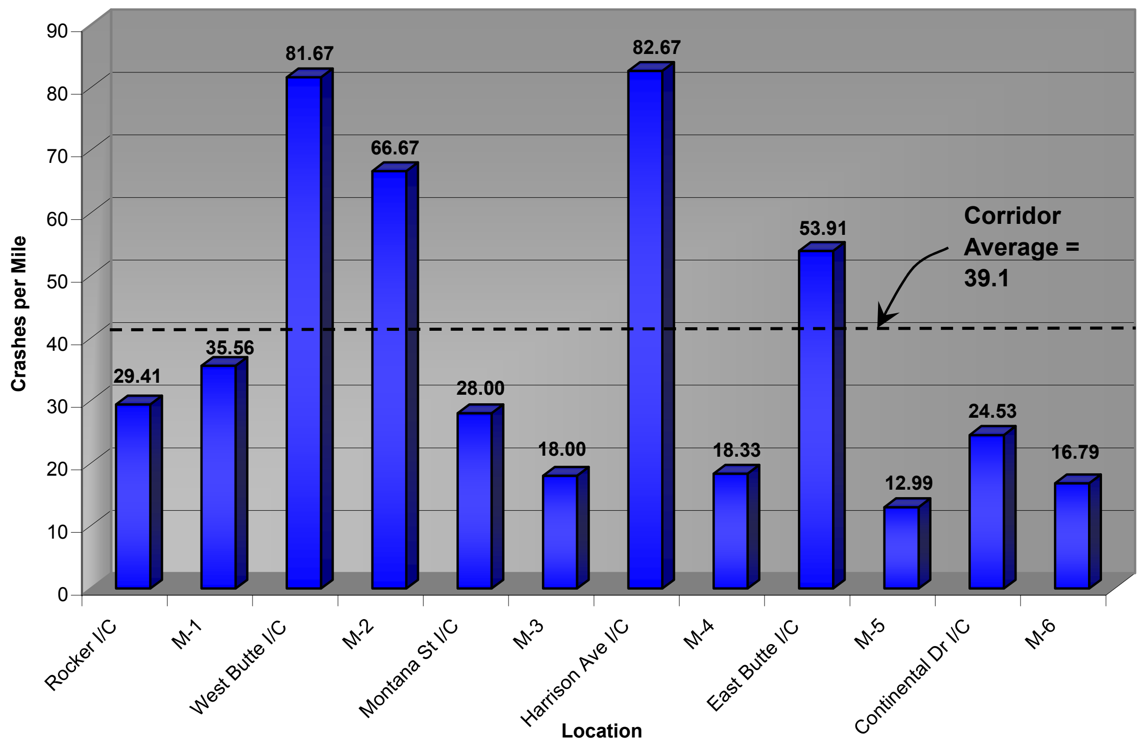
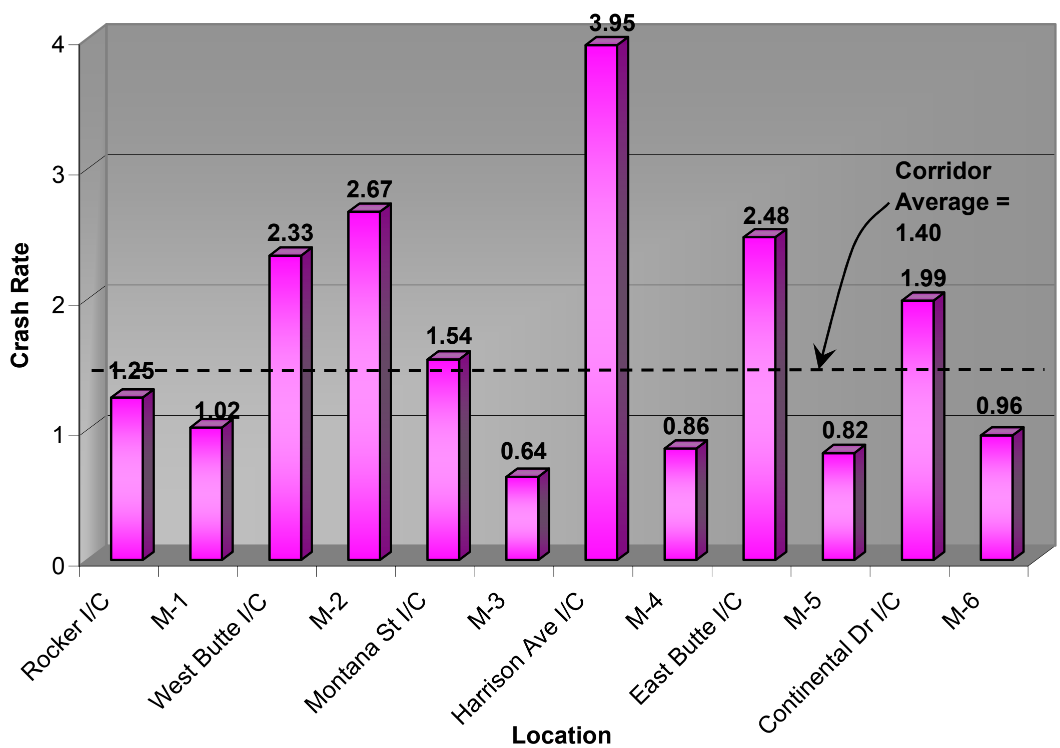


Figure 2.4
Crash Rates per Segment



Higher crash rates can be expected at interchanges because of the required weaving, exiting and entering movements by vehicles. The intent of the analysis was to identify specific trends within each segment that may be contributing to crashes. Many of the crash records were not specific to exact crash location or contributing factors in terms of the roadway features so conclusive results were not obtained for each interchange location in terms of direct relations to ramp operations and geometrics. Based on the data available in the crash reports and with an understanding of the operations and geometric conditions trends on the high crash segments is summarized in the following paragraphs.

Mainline Segment 1: As discussed earlier this segment includes the section of interstate with the significant grades east of the Rocker Interchange. It is worth noting that 65 percent of the crashes in this segment occurred in the eastbound direction (up the hill) and 54 percent of the crashes occurred at night. These factors may be related to the potential for differential speeds of traffic in this area related to truck speeds on the grade.

West Butte Interchange: This segment includes the left-hand off-ramp and tight mainline curvature. 65 percent of the crashes occurred during poor road conditions (icy/slushy/snow) and nearly 60 percent of crashes occurred at night.

Mainline Segment 2: This segment is characterized by the two sets of long structures and the guardrail on both sides of the interstate for the majority of this segment. These characteristics most likely contributed to 77.5 percent of the crashes occurring during poor road conditions. Additionally, approximately 35-40 percent of the crashes involved a bridge. Field observations reveal that the guardrail in this area has been hit numerous times. Figure 2.5 shows a typical bridge cross section and guardrail application found in this section.

Figure 2.5
Typical Functionally Obsolete Structure

Harrison Avenue Interchange: This interchange handles the highest volume of traffic on the ramps and as previously discussed there are considerable geometric deficiencies on these ramps. It is worth noting that approximately 20% of the injury crashes for the entire I-15/90 corridor occurred in this segment.

2.2.1.3 Cross Road Intersection Crash Summary

Crash data for the ramp terminal and cross road intersections was analyzed to identify intersections with high crash rates (CR) and type of crashes. Summary spreadsheets are included in Appendix B, which show the crash rate per million vehicles entering and the crash types. The intersections with the highest crash rates and the most common crash type are:

- Harrison Avenue and Dewey Boulevard (1.07 CR) – 43 percent right angle crashes and 33 percent rear-end crashes
- Harrison Avenue and Amherst Avenue (0.88 CR) – 64 percent rear end crashes
- Harrison Avenue and East bound On/Off-Ramps (0.82 CR) – 54 percent sideswipe crashes in the northbound direction.
- Eastbound Off/On-Ramps at Rocker (0.86 CR) – Six crashes, two involving fixed object relating to turning movements
- North Frontage Road Intersection at Rocker (0.86 CR) – Three crashes total

It is worth noting that field observations show that there is a significant lane balance issue on Harrison approaching Amherst Avenue because of the third lane drop at Cornell Avenue. This causes a speed differential between the inside and outside lanes, which combined with weaving from the dropped outside third lane could contribute to a higher percentage of rear-end crashes. Field observations of the Harrison and Eastbound On/Off-ramps reveal that the existing hotel sign in combination with the accesses immediately south of the intersection cause a visual block of the physical on-ramp (see figure 2.6). Additionally, the restaurant and casino south of the gas station on the east side of Harrison has overgrown shrubs which restrict sight distance at the access to the hotel. This causes vehicles to pull slightly into the through lane in order to see oncoming traffic. These factors may contribute to the high number of crashes at this intersection.

Figure 2.6
Harrison & EB On/Off-Ramp Intersection

2.2.2 Lighting Assessment

An inventory and assessment of the existing lighting against current MDT lighting guidelines was performed. MDT guidelines identify three lighting layouts, partial interchange lighting (PIL), complete interchange lighting (CIL), and continuous interchange lighting. Currently every interchange except the Excelsior Avenue interchange has some level of lighting. The Harrison Avenue Interchange and Montana Street Interchanges have complete interchange lighting (CIL) and the other interchanges have partial interchange lighting (PIL). The Rocker and Continental interchanges have PIL that closely meets current MDT standards for layout. East Butte and West Butte both have a few lights at a couple for the merge/diverge points. At the East Butte interchange there are only lights at the diverge point for southbound I-15 on the north side of the interchange. The loop ramp and I-15 northbound ramps do not have any lights. The West Butte Interchange has three lights in the gore area of the I-115 eastbound left-hand off ramp from I-15/90. There are also two lights at the merge point of the I-115 westbound ramp to I-15/90 westbound. All of the existing overhead signs within the corridor do not have lighting.

Existing and future traffic data was analyzed against lighting warrants to identify needs for lighting. The lighting assessment spreadsheet located in Appendix B shows that Montana Street and Harrison Avenue interchanges meet the requirements for CIL, while the Rocker interchange meets the requirements for the ramp volumes, but not the cross road volumes. It is worth noting that the recently completed westbound weigh station has continuous lighting from the weigh station to the Rocker interchange in the westbound direction.

Night-to-day crash ratios show that the West Butte (1.45) and Continental (1.12) interchanges have more nighttime crashes than during the day. The Rocker and Harrison Avenue interchanges had ratios around 0.5. The high night-to-day crash ratio at the West Butte interchange along with the curvature and left-hand exit may indicate that the lighting is inadequate. Many system-to-system interchanges use high mast lighting because of the high speed winding movements on the ramps. Considering both the East Butte and West Butte interchanges are system-to-system interchanges the current lighting is extremely limited. Lighting deficiencies and potential improvements should be investigated during Phase 2 for most of the interchanges. Additionally the overhead signs should be further analyzed for potential lighting needs. Although newer sign panel technology can provide efficient reflection so that lighting is not needed, it is important to analyze the sign panel reflection in relation to adjacent ambient light sources, which can reduce effectiveness of sign panel reflection.

2.2.3 Signing and Pavement Marking Assessment

Existing signing and pavement markings were reviewed and compared to current guidelines in the *Manual of Uniform Traffic Control Devices*. A summary inventory spreadsheet identifying signage for each interchange and interstate segment is included in Appendix B. Regulatory, guide, route markers, and other signs were inventoried. General service and general direction signs were not inventoried. The intersection traffic control signage and all overhead signs are shown in the geometric plan figures in Appendix A. Overall the signing appears to be in good shape throughout the corridor. The following signing and pavement marking issues or deficiencies were identified:

- I-115 Eastbound – Signing could be improved with either a gradual decrease in speed to 35 mph or advisory signs for the curves. There are not currently any speed limit signs on I-115 before the reduced speed sign.
- As mentioned previously, the left-hand off-ramp on the horizontal mainline curve can be confusing and drivers can unintentionally take the exit. If this happens there is not signing to guide the driver back to I-90 other than to follow the business route signs through the City. Because of the business route it may not be possible to add guide signs without causing confusion. Further, drivers looking for I-15 may mistake the 115 shield for I-15.
- The overhead signing approaching the eastbound I-115 off-ramp exit ramp is confusing because the mainline lanes show Montana Street and Harrison Avenue rather than the next regional city (Helena or Billings) as most system level interchange guide signs do (see figure 2.7).
- There is inadequate pedestrian crossing signage on the north leg of the intersection of Harrison Avenue and Dewey Blvd. Crossing is restricted in this area. However, there are insufficient signing directing pedestrians to or restricting them from crossing at certain locations.
- Trees obscure the eastbound Harrison off-ramp exit direction sign.
- There are no advisory speed signs for the eastbound and westbound off-ramps at Excelsior Avenue. Both of these loop ramps have tight curvature may justify an advisory sign.
- Several signs on I-115 are faded and in need of replacement.

- Pavement markings are in good condition throughout the corridor with the exception of the Rocker Interchange cross road striping, which is worn away due the high number of trucks crossing the centerlines and shoulder lines around the intersections.
- The pavement markings on the eastbound I-115 ramp from I-15/90 do not adequately guide vehicles through the interchange and compromise its' operation and safety. The original design and construction provided a double left-hand off-ramp at this location. As shown in figure 2.7 the current off-ramp is marked with one lane 24' wide, which causes some uncertainty because of the wide roadway and the curvature that causes the mainline to go the right, while the ramp continues straight.

Figure 2.7
EB I-115 Ramp Gore Area

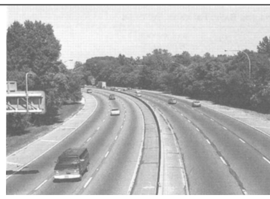
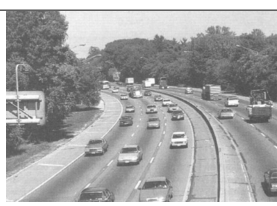
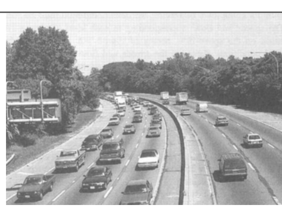
2.3 TRAFFIC ANALYSIS

Traffic analysis was performed to assess the quality of traffic operations along the study corridor. The aim of this analysis was to identify deficiencies in the transportation system for existing and future traffic conditions. Roadways in the study area were divided into smaller components comprising of mainline segments, ramp junctions and surface street intersections. These roadway components were analyzed separately and in relation to each other to quantify traffic operations through the study area. Adequacy of traffic operations was assessed based on several measures of effectiveness (MOEs) compiled as a result of this analysis. The following sections describe the procedures, metrics and results of the traffic operational analysis for the study corridor.

2.3.1 Traffic Operational Analysis

Traffic engineers commonly use level of service (LOS) to measure traffic operations of freeways, freeway ramp junctions, arterials, and intersections. LOS is an operational analysis rating system defined in the *2000 Highway Capacity Manual* (HCM). Operations are affected by several variables including speed, delay, travel time, and the freedom to maneuver. There are six LOS (refer to Table 2.7) ranging from "A" to "F". LOS A is defined as being ideal flow conditions with little or no delays. Conversely, LOS "F" is defined as conditions where extreme delays are encountered. Each LOS describes traffic flow in terms of delay, travel time, and/or speed experienced by motorists.

Table 2.7
Basic Level of Service Descriptions

	**LOS A.** Represents the best operating conditions and is considered free flow. Individual users are virtually unaffected by the presence of others in the traffic stream.
	**LOS B.** Represents reasonably free flowing conditions with some influence by others.
	**LOS C.** Represents a constrained constant flow below speed limits, with additional attention required by drivers to maintain safe operations. Comfort level of the driver noticeably declines.
	**LOS D.** Represents traffic operations approaching unstable flow with high passing demand and limited passing capacity. Maneuverability of the driver is severely restricted. LOS D is an acceptable condition for arterial and collector roadways in the community.
	**LOS E.** Represents unstable flow near capacity. LOS E often quickly changes to LOS F because of disturbances (road conditions, accidents, etc.) in traffic flow.
	**LOS F.** Represents the worst conditions with heavily congested flow and traffic demand exceeding capacity. LOS F is characterized by stop-and-go traffic, poor travel time, low comfort and convenience, and increased accident exposure.

2.3.1.1 Basic Freeway Segment/Ramp Junction/Weaving Section

The LOS analysis of basic freeway sections and ramp junctions is based on the density of vehicles expressed as passenger cars per mile per lane (pcpmpl) on the facility during the peak hour. Low traffic densities allow drivers to easily maneuver their vehicles and drivers can easily select their travel speed. Vehicles entering or exiting the freeway using interchange ramps are relatively non-intrusive to the mainstream traffic flow as they merge or diverge from the freeway. As the traffic density increases, drivers have a more difficult time maneuvering and are restricted in the speed at which they can travel. Merging and diverging vehicles at ramp junctions become intrusive to vehicles in the mainstream traffic flow. *CORSIM* software and *Highway Capacity Software (HCS)* was used to determine the LOS for all basic freeway segments, ramp junctions, and weaving sections.

2.3.1.2 Signalized Intersection

LOS at signalized intersections is based on the overall stop delay of the intersection. Each approach to the intersection experiences delay based on the amount of time provided for that approach. The delay for each approach is averaged to provide an overall delay. As delay increases the LOS decreases. Individual movements may experience a worse LOS than the overall LOS. However, the HCM recommends that if the volume to capacity (v/c) ratio is less than 0.85 to 0.90 then there should not be concern for an unacceptable, delay-based LOS for the given approach. *Synchro* software was used to determine the LOS for signalized intersections.

2.3.1.3 Unsignalized Intersection

Unsignalized intersections are broken into two categories, all-way stop controlled (AWSC) and two-way stop controlled (TWSC). AWSC intersections use the average total delay of the intersection to determine LOS. TWSC intersection LOS analysis does not report an overall delay; rather it reports the delay and LOS for each approach separately. The reason the LOS analysis of TWSC intersections does not report overall delay is that the uncontrolled movements experience very little delay and an average of uncontrolled delays with controlled delays does not provide an accurate depiction of intersection operations. *HCS* was used to determine the LOS for unsignalized intersections.

2.3.2 Existing Conditions

Existing conditions were evaluated for I-15/90 as well as the surrounding local roadway network. Existing condition operational analysis is performed to provide an understanding of the conditions that existing traffic is experiencing. These conditions include congestion, delay at intersections and any other friction encountered in the form of merge, diverge or weaving maneuvers. This section discusses the methodologies used in the analysis of the existing operations and the results of the analysis.

2.3.2.1 Roadway Geometry

Existing roadway geometry was collected for the interstate, interchanges, and local street system to help determine the constraints of the system. Roadway geometry along with traffic volumes is essential for the determination of level-of-service (LOS).

2.3.2.2 Roadway Corridor Travel Volumes

Existing roadway traffic volume data was collected along I-15/90. Traffic volume data was also collected on the local street system throughout the study area. The volume data includes daily vehicle classification volumes and peak hour turning movement volumes at key intersections within the study area.

2.3.2.2.1 Average Daily Traffic and Vehicle Classification

Average daily traffic (ADT) volumes were collected in June of 2006. ADT volumes were collected on I-15/90, the I-15/90 ramps, and the local roadway network. Figures 2.7 through 2.11 display the existing ADT volumes along I-15/90 and the local roadway system.

The percentage of heavy vehicles that travel along a roadway affects traffic operations along the corridor. Heavy vehicles typically travel at slower speeds than passenger vehicles. Heavy vehicles also require longer acceleration and deceleration distances. As the percentage of heavy vehicles in the traffic stream increases, passenger vehicle movement becomes restricted and traffic operations deteriorate. Vehicle classification counts were collected at the same time as the ADT volumes. A typical percentage of heavy vehicles is 6 percent, but along I-15/90 heavy vehicle percentages ranged from approximately 5 to 14 percent. Heavy vehicle percentages are included in Appendix C.

2.3.2.2.2 Peak Hour Turning Movement Volumes

Peak hour turning movement counts were collected in the summer of 2006. The counts were conducted during the AM Peak (7:00-9:00 AM), noon peak (11:00 AM-2:00 PM) and the PM Peak (3:00-6:00 PM) periods of a typical weekday (Tuesday, Wednesday, or Thursday). Peak hour turning movement counts are included in the Appendix.

2.3.2.3 Results of Existing Conditions Analysis

The LOS analysis of existing roadway conditions includes I-15/90 mainline, I-15/90 ramps, and I-15/90 interchange intersections. Figures 2.8 through 2.12 display existing volumes and LOS along I-15/90 and the local roadway system.

2.3.2.3.1 I-15/90 Mainline

I-15/90 mainline sections, including both basic freeway segments, merge/diverge area and weaving sections, operate at a very good LOS. As seen in Table 2.8 and Figure 2.13, mainline I-15/90 operates at LOS A for all peak periods.

Figure 2.8
Existing ADT Volumes at Rocker Interchange and I-15/90

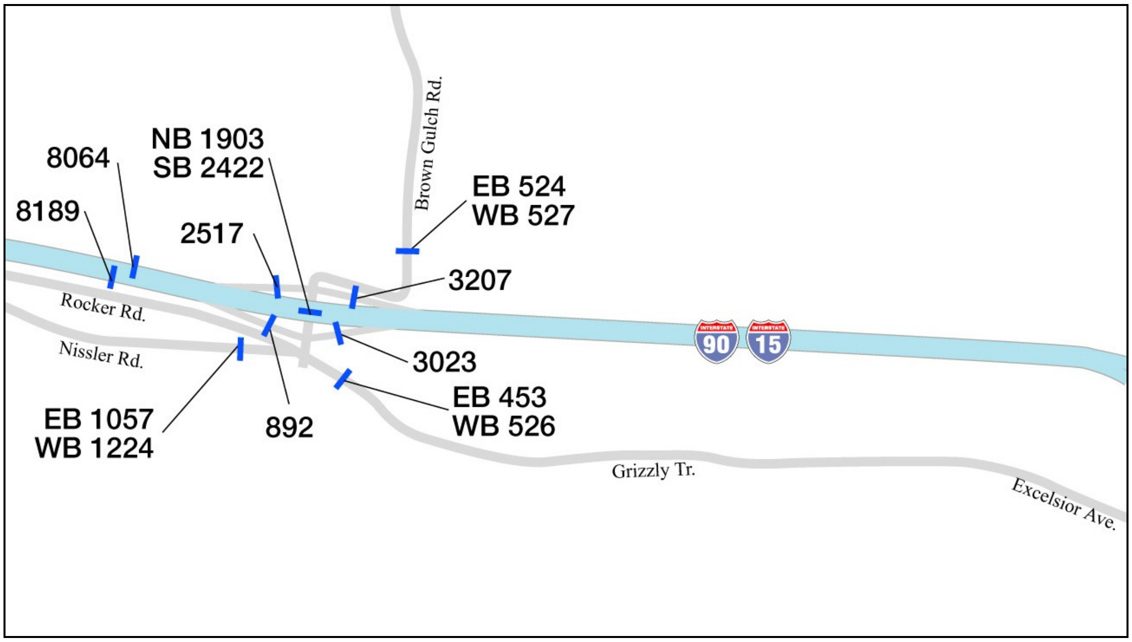


Figure 2.9
Existing ADT Volumes at I-115 Interchange and I-15/90

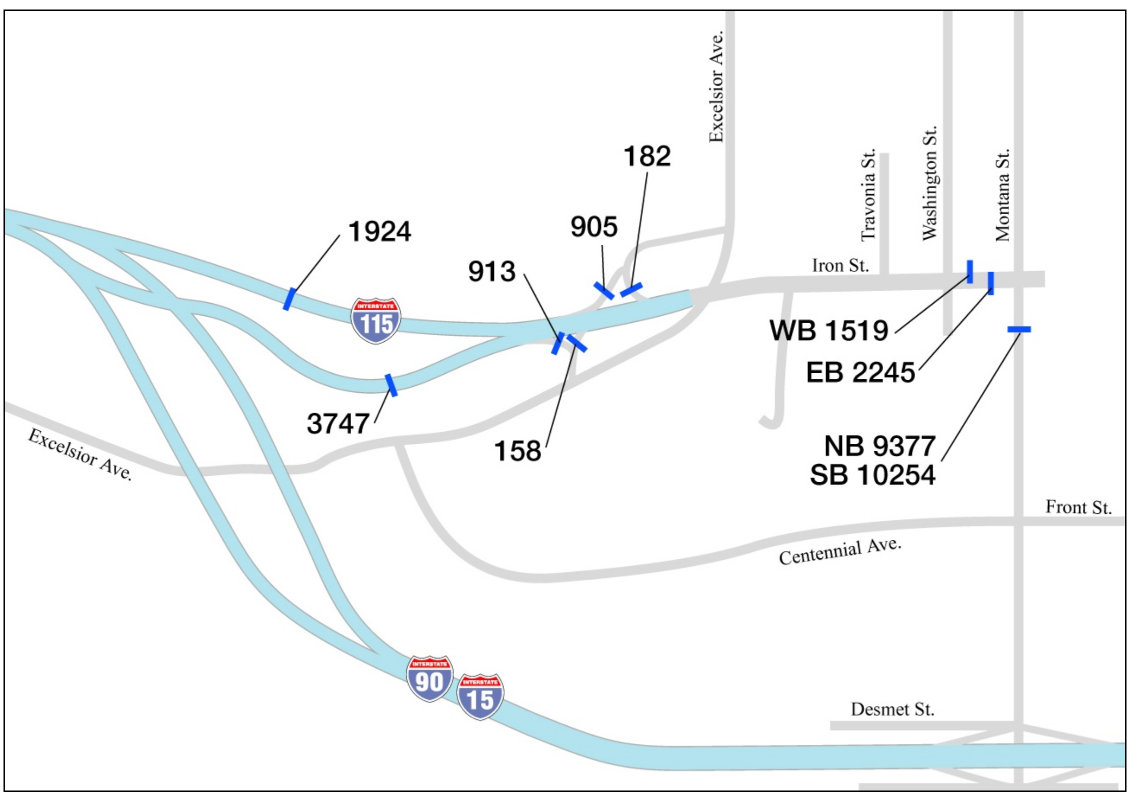


Figure 2.10
Existing ADT Volumes at Montana Street Interchange and I-15/90

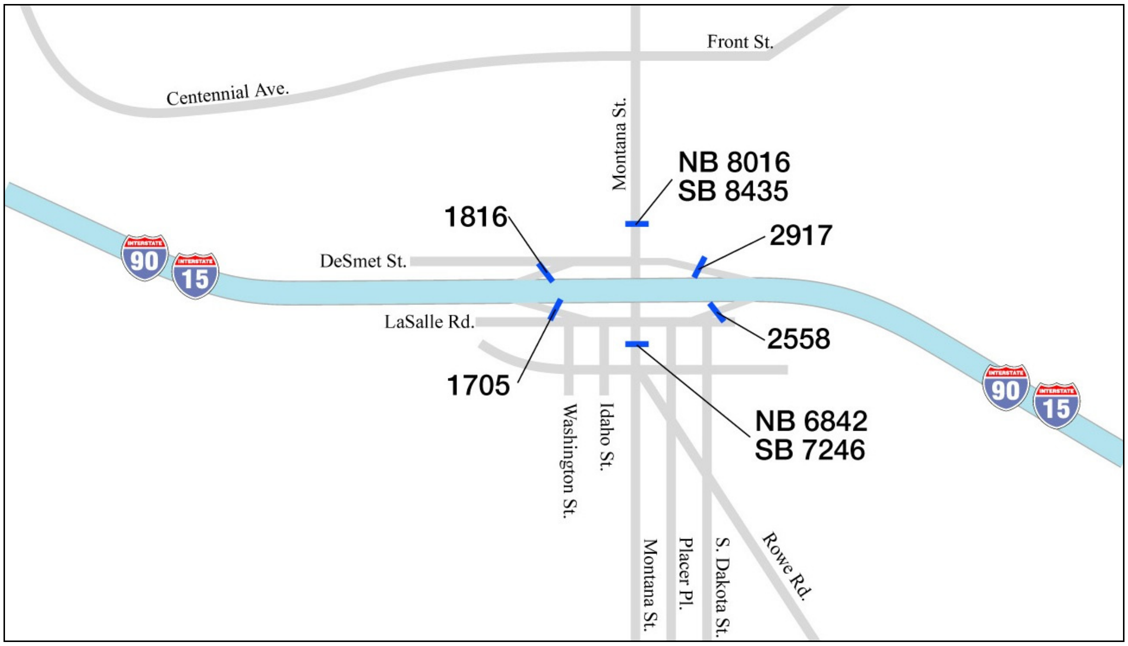


Figure 2.11
Existing ADT Volumes at Harrison Avenue Interchange and I-15/90

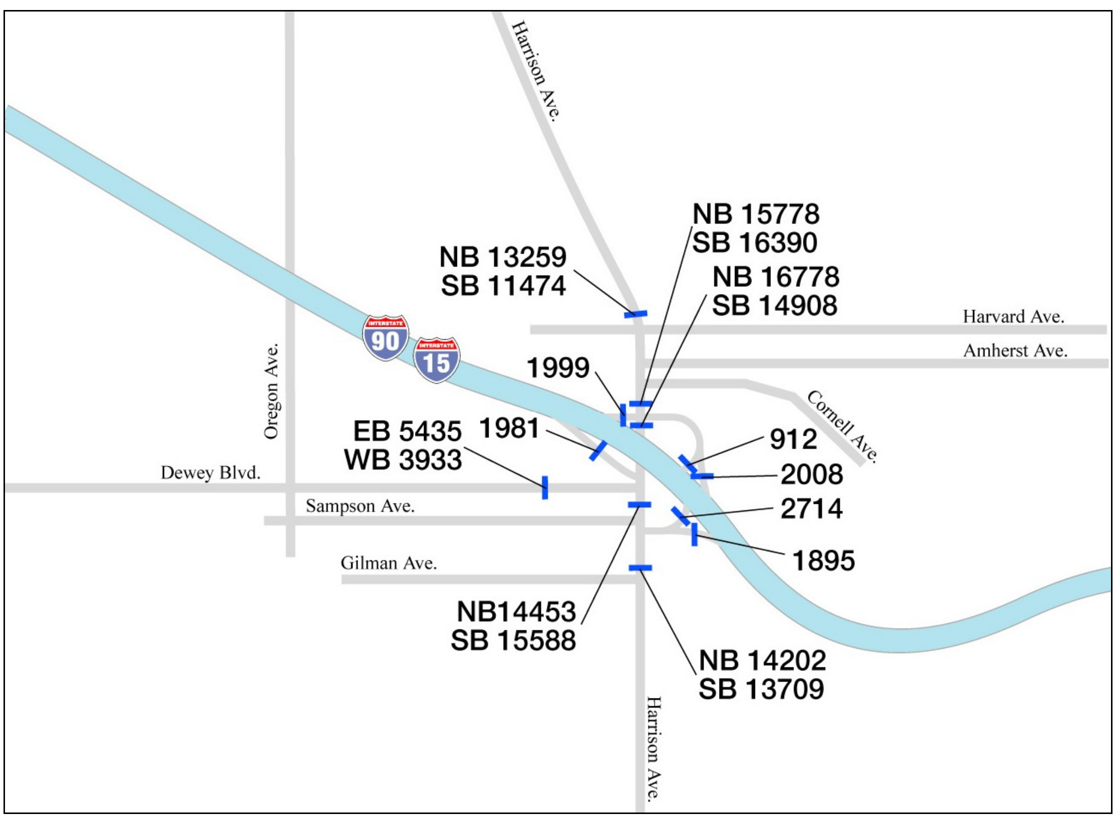


Figure 2.12
Existing ADT Volumes at Continental Drive Interchange and I-15/90

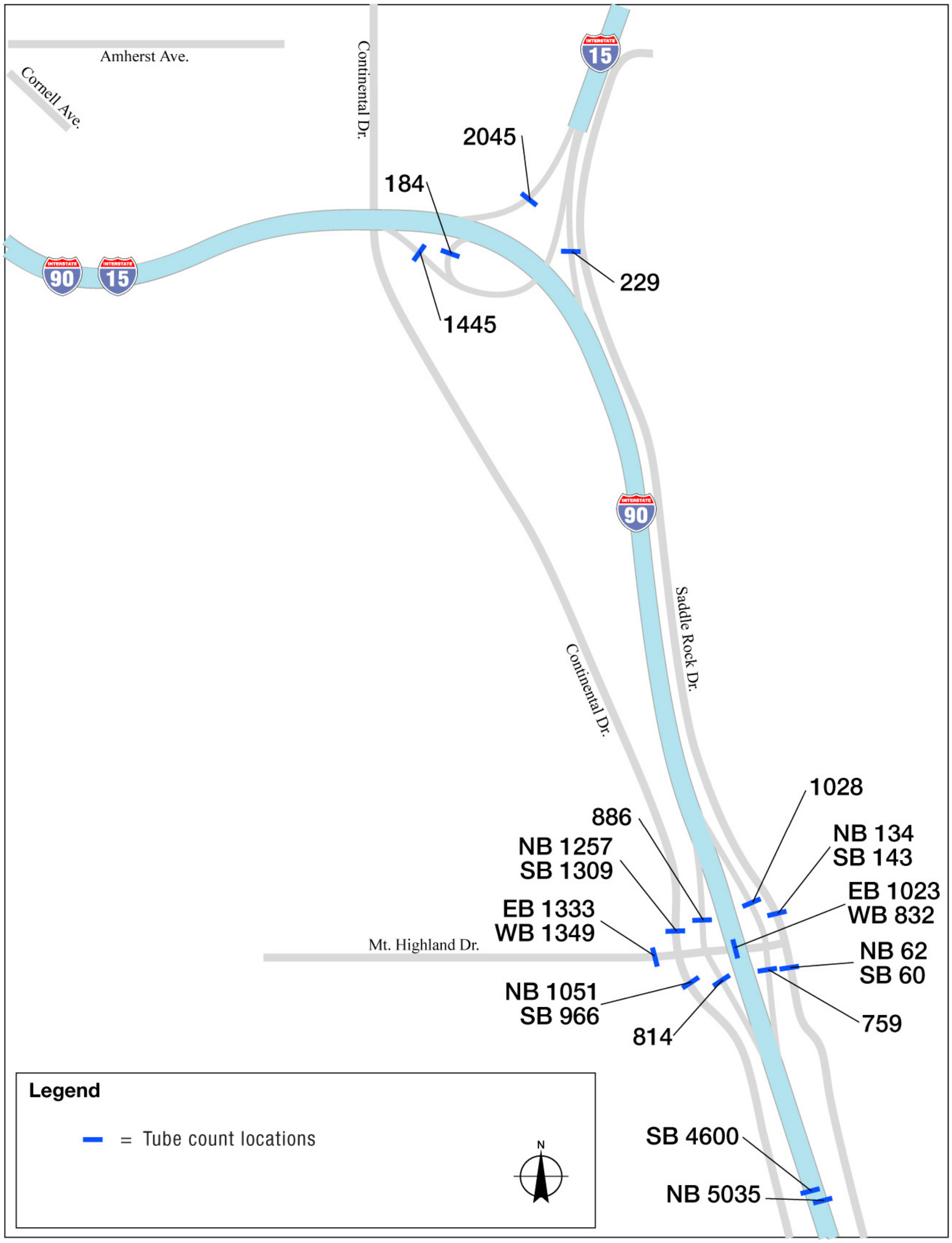


Table 2.8
Existing (Year 2006) Traffic Operations on Mainline I-15/90

Freeway Link			AM			Noon			PM		
Direction	From	To	Volume (vph)	Density (pcpmpl)	LOS	Volume (vph)	Density (pcpmpl)	LOS	Volume (vph)	Density (pcpmpl)	LOS
Eastbound	West end	Rocker Interchange	426	3.2	A	566	4.3	A	652	4.9	A
	Rocker Interchange	I-115	464	3.5	A	604	3.1	A	705	5.4	A
	I-115	Montana Street	187	1.2	A	356	1.6	A	406	2.9	A
	Montana Street	Harrison Avenue	237	2.8	A	435	3	A	527	5.4	A
	Harrison Avenue	I-15	226	1.5	A	378	2.8	A	363	3.3	A
	I-15	Continental Drive	154	1	A	312	2	A	285	1.9	A
	Continental Drive	East End	202	1.2	A	302	1.8	A	300	1.9	A
Westbound	East End	Continental Drive	260	2	A	324	2.4	A	369	2.7	A
	Continental Drive	I-15	335	3	A	346	2.7	A	349	2.7	A
	I-15	Harrison Avenue	433	3.4	A	468	3.7	A	491	3.8	A
	Harrison Avenue	Montana Street	522	4.3	A	592	5.3	A	864	6.5	A
	Montana Street	I-115	363	2.8	A	516	4.1	A	800	5.8	A
	I-115	Rocker Interchange	476	3.8	A	580	4.6	A	994	7.5	A
	Rocker Interchange	West end	456	3.6	A	493	4.8	A	949	7.1	A

2.3.2.3.2I-15/90 Ramp Junctions

Ramp junctions along I-15/90 operate at an acceptable LOS. All merge/diverge areas and the weave area between I-115 and the Rocker Road interchange functions at LOS B or better for all peak periods.

2.3.2.3.3I-15/90 Travel Times

Travel time data was obtained from field visits during the data collection phase of the study. The travel time analysis looked at the time required to travel on I-15/90 from Rocker Road interchange to Continental Drive Interchange. Currently, based on the travel time runs, it takes approximately eight minutes to travel on I-15/90 between Rocker Road interchange to Continental Drive Interchange. Traffic on I-15/90 has the freedom to travel at the posted speed limit for the entire length of the study corridor due to absence of congestion or other operational impedances.

2.3.2.3.4I-15/90 Interchange Intersections

The majority of the intersections at the interchanges along I-15/90 operate at acceptable levels of service with one exception. Montana Street and the I-15/90 eastbound ramp intersection operates at an unacceptable LOS (LOS E) as a two-way stop control intersection. Table 2.9 displays the LOS at each intersection for AM, Noon and PM peak hour conditions. Existing operations at study intersections is displayed in Figures 2.14 to 2.18.

Table 2.9
Existing (Year 2006) Traffic Operations on Surface Streets

Main Street	Cross Street	AM		Noon		PM	
		Delay	LOS	Delay	LOS	Delay	LOS
Rocker Road	Browns Gulch Road*	9.4	A	10.2	B	10.2	B
	Westbound Ramps*	9.1	A	9.4	A	9.7	A
	Eastbound Ramps*	9.4	A	9.5	A	9.6	A
	Nissler Road*	9.7	A	9.7	A	9.7	A
Excelsior Street	Eastbound I-115 Ramps*	9.3	A	9.5	A	10.0	B
	Westbound I-115 Ramps*	9.5	A	9.7	A	10.3	B
Iron Street	Alabama Street*	9.0	A	9.2	A	9.3	A
	Travonia Street*	9.6	A	9.3	A	9.9	A
	Washington Street*	10.3	B	9.7	A	10.2	B
Montana Street	Iron Street	8.0	A	6.0	A	7.3	A
	Front Street	14.8	B	15.5	B	16.9	B
	Westbound Ramps*	12.5	B	12.2	B	12.8	B
	Eastbound Ramps*	14.5	B	15.7	C	35.4	E
	Rowe Road	27.2	C	25.1	C	23.0	C
Harrison Avenue	Amherst Avenue	19.4	B	21.9	C	21.9	C
	Cornell Avenue*	10.4	B	11.9	B	10.7	B
	Westbound Ramps	3.5	A	4.4	A	4.2	A
	Eastbound Off Ramp*	10.6	B	12.4	B	13.4	B
	Dewey Boulevard	8.4	A	10.5	B	9.6	A
	Eastbound Ramps*	10.9	B	11.6	B	11.9	B
Mount Highland Drive	Continental Drive*	12.1	B	10.3	B	12.8	B
	EB/SB Ramps*	8.7	A	8.9	A	9.3	A
	WB/NB Ramps*	11.9	B	10.1	B	10.0	B
	Saddle Rock Drive*	7.2	A	7.2	A	7.2	A

** - Maximum side-street delay reported for unsignalized intersection*

Figure 2.13
Mainline Volumes and LOS for Existing Conditions along I-15/90

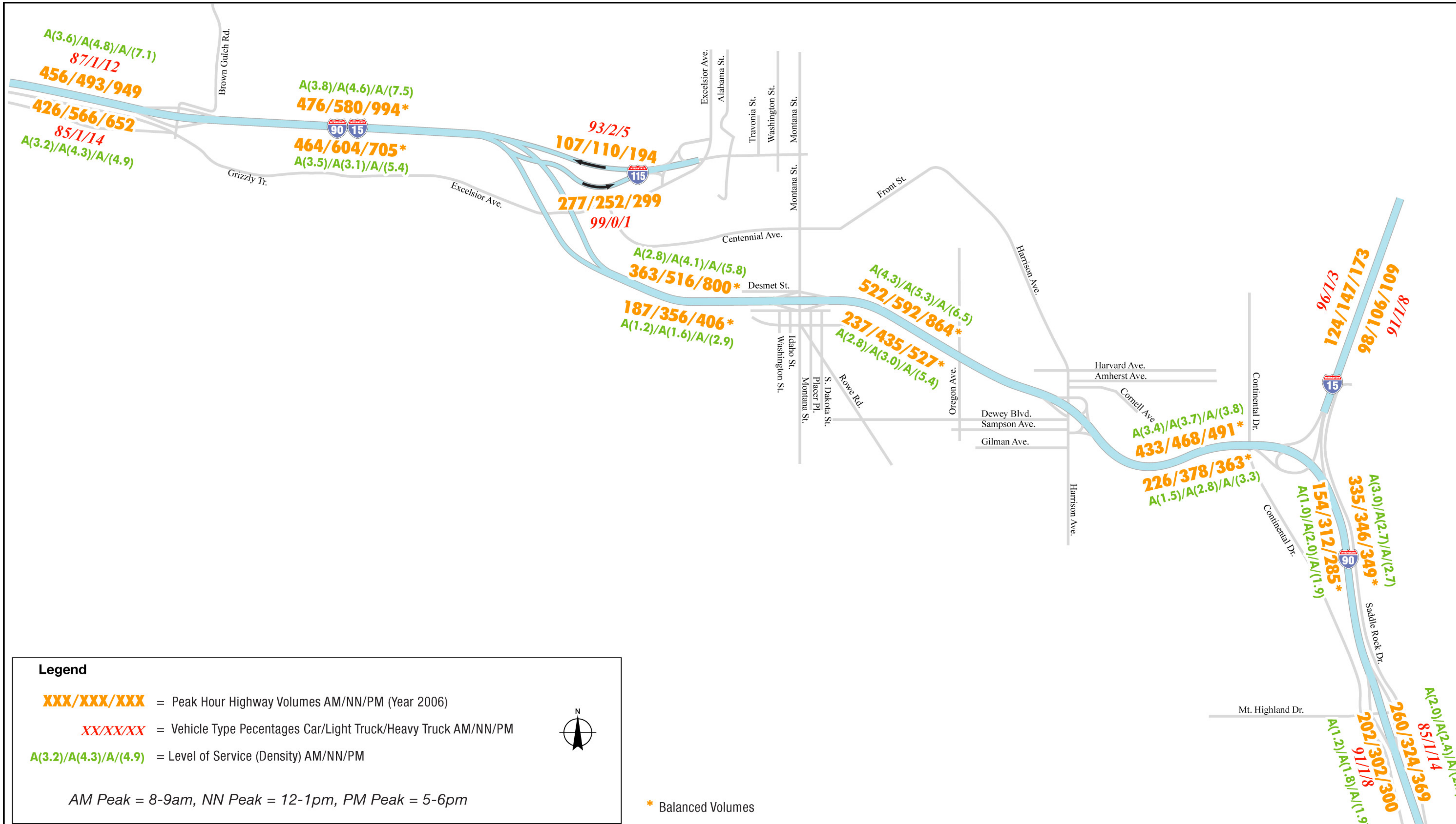


Figure 2.14
Existing Volumes and LOS at Rocker Interchange and I-15/90

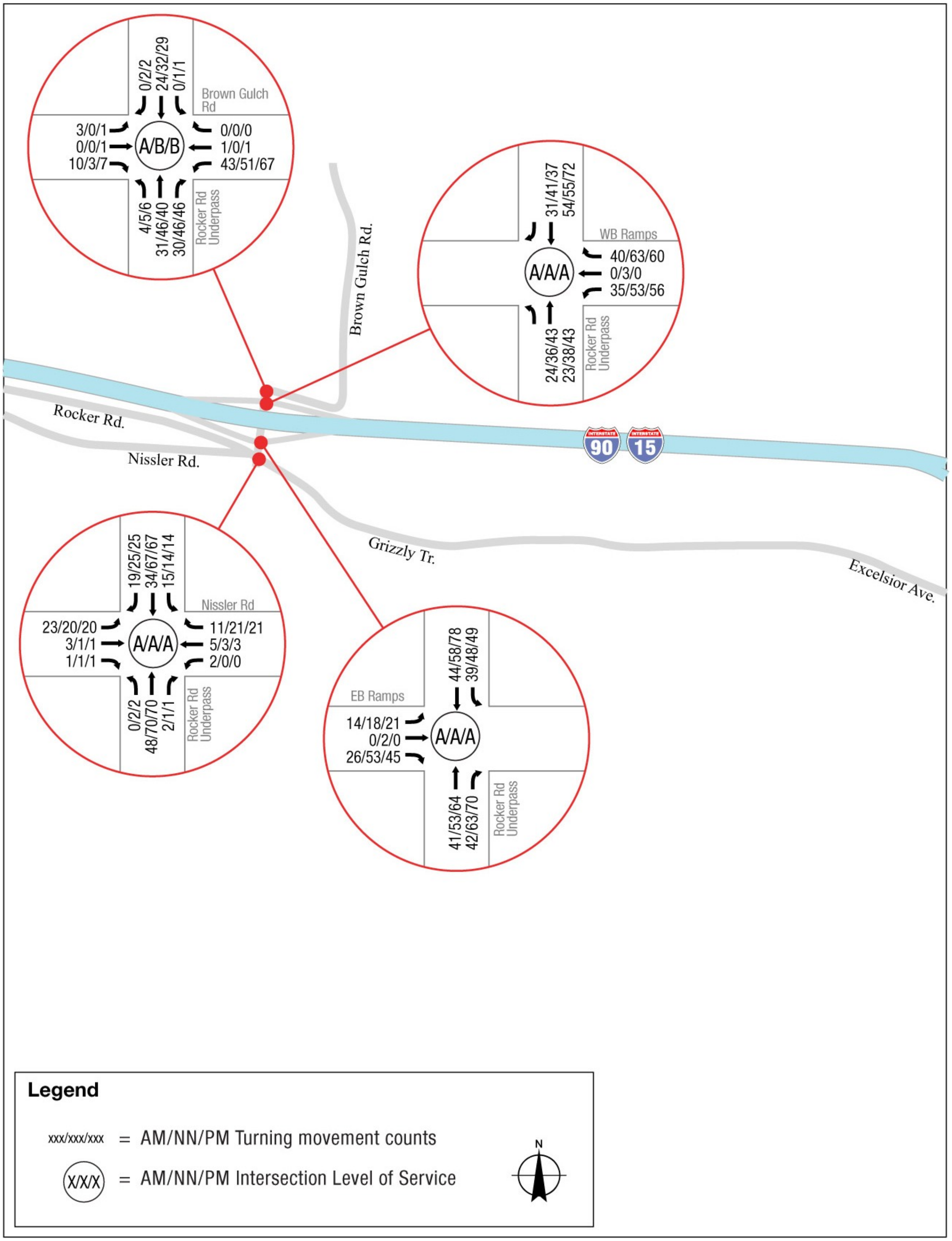


Figure 2.15
Existing Volumes and LOS at I-115 Interchange and I-15/90

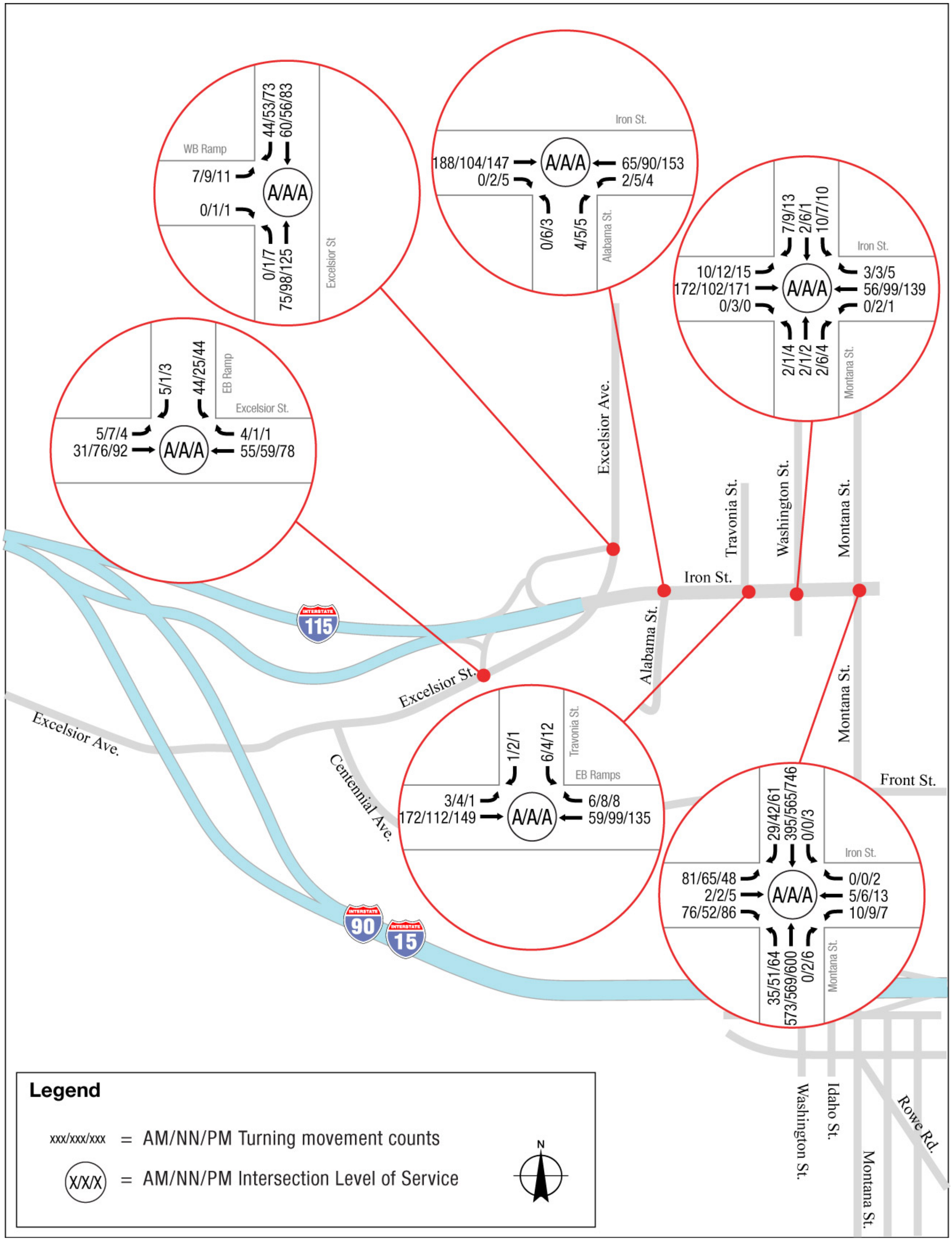


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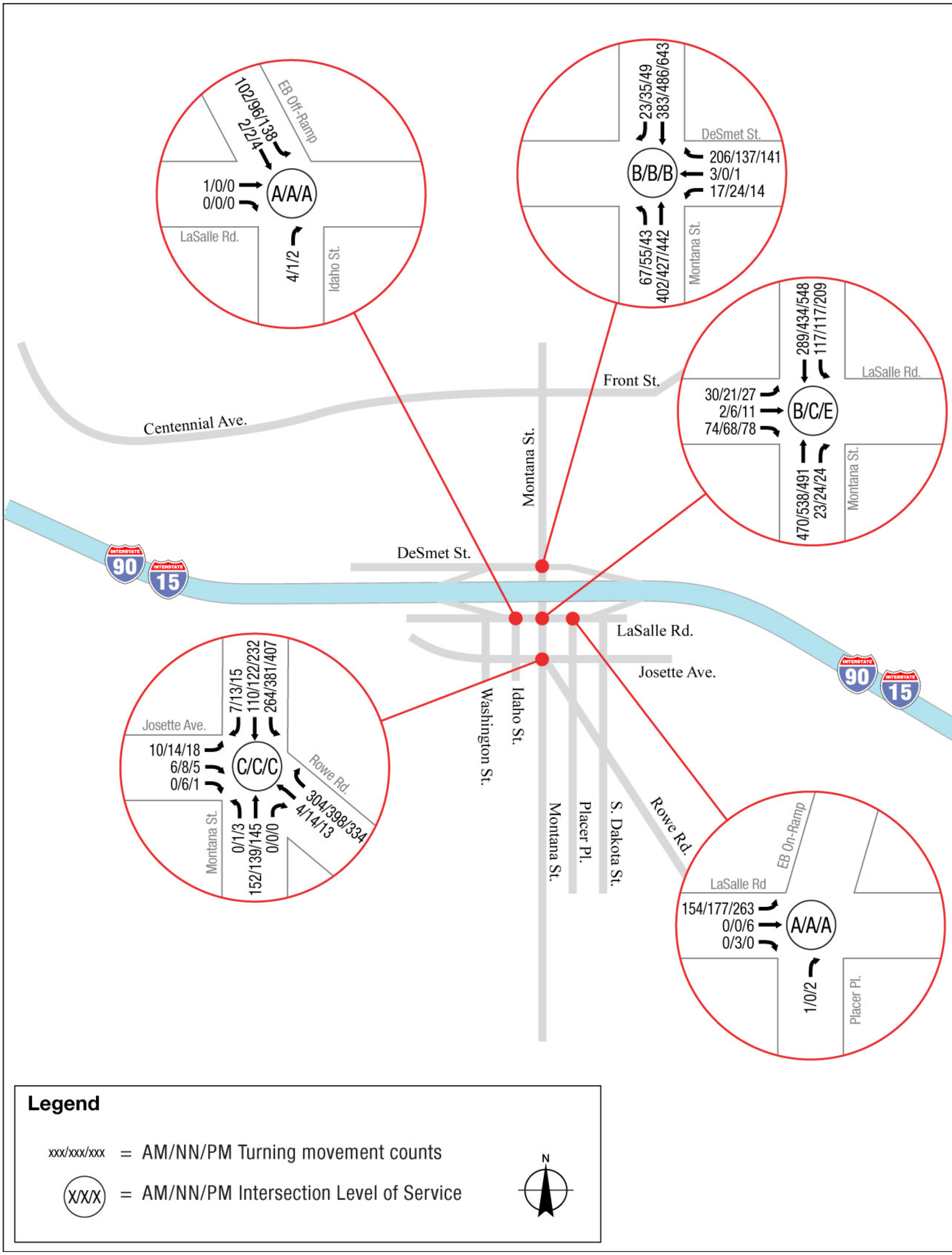
Figure 2.16
Existing Volumes and LOS at Montana Street Interchange and I-15/90



PBS&J
MDT serving you with pride

Figure 2.17
Existing Volumes and LOS at Harrison Avenue Interchange and I-15/90

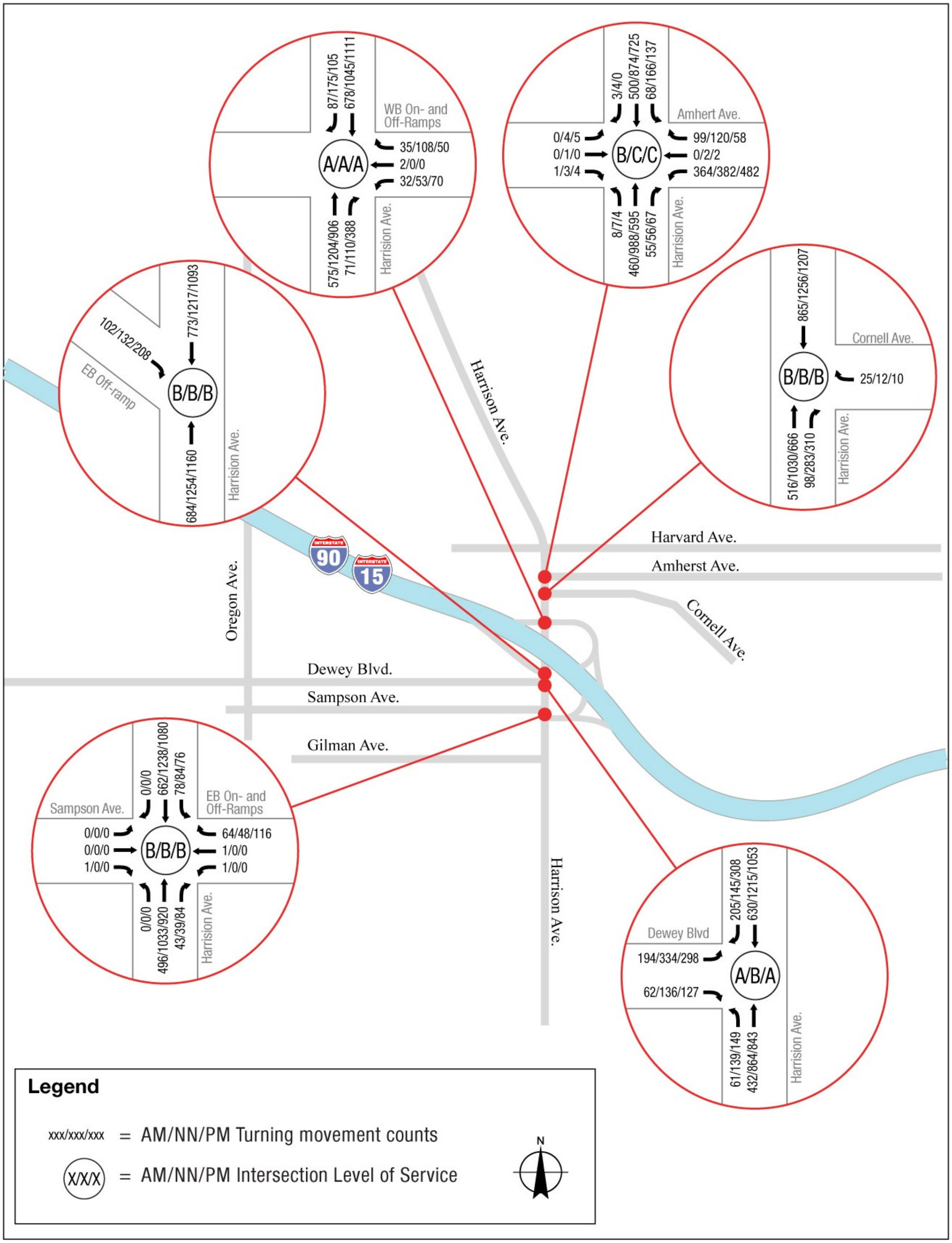
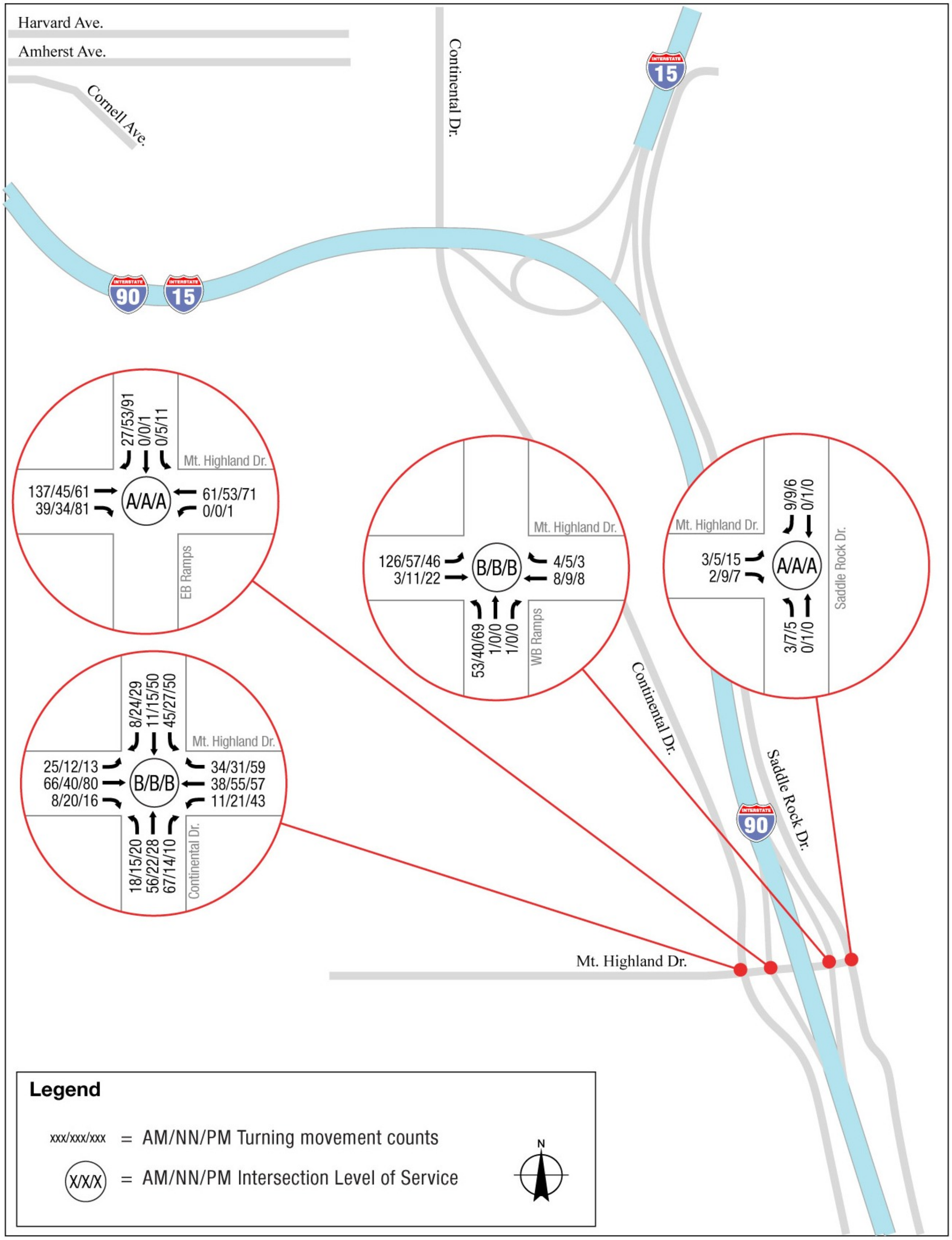


Figure 2.18
Existing Volumes and LOS at Continental Interchange and I-90



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2.3.2.3.5Existing Conditions Summary

The existing condition analysis results for I-15/90 indicate that mainline sections operate at an acceptable LOS (LOS A) during all three peak periods of the day. The majority of the interchange intersections in the study area operate at an acceptable LOS, although the Montana Street and the I-15/90 eastbound ramp intersection operates at an unacceptable LOS during the PM peak hour. Figure 2.13 through 2.17 displays existing volume and LOS conditions for the study area.

2.3.3 Signal Warrant Analysis

Signal warrant analyses were conducted at most of the stop-controlled intersections in the study area to evaluate the potential of signalization of the stop-controlled intersections. Tube counts and turning movement counts conducted in the study area in conjunction with geometric data collected at the study intersections were used as input values for the warrant analysis. Procedures prescribed in the *Manual of Uniform Traffic Control Devices* (MUTCD, 2003) were used to conduct the warrant analysis. A brief description of each of the eight signal warrants follows.

Warrant 1 - Eight-Hour Vehicular Volume

Condition A - Minimum Vehicular Volume
This warrant applies where the volume of intersecting traffic is the principal reason for consideration of a signal. Warrant 1 is satisfied when the volumes on the major and minor-streets are above a certain threshold for any eight hours of an average day. The volume thresholds vary depending on the number of lanes, speed of traffic, and community size.

Condition B - Interruption of Continuous Traffic
This warrant applies where the traffic operating on the major-street is so heavy that the minor-street suffers excessive delay or hazard when entering or crossing the major-street. Warrant 2 is satisfied in the same way as Warrant 1 except the minimum volume thresholds are higher for the major-street approach and lower for the minor-street approach

Condition C. Combination of Warrants
This warrant is applied where an intersection does not meet either Warrant 1A or Warrant 1B but can satisfy Warrants 1A and 1B to the extent of 80 percent or more of the required volumes.

Warrant 2 - Four-Hour Vehicular Volumes

This warrant is applied where, during a minimum of four hours of the day, traffic volumes at the intersection are great enough to cause significant delay to the minor street approach. Warrant 2 is satisfied when for each of any four hours of an average day, the plotted points representing the total of both approaches on the major and the corresponding volumes on the higher-volume minor approach all fall above the curves on figures shown in the MUTCD (Figures 4C-1 and 4C-2 in section of the MUTCD) for the existing combination of approach lanes.

Warrant 3 - Peak Hour Warrant

A. Peak Hour Delay
This warrant is applied where, during one hour of the day, minor-street traffic experiences excessive delay. It is satisfied when the volume on one minor-street approach is at least 100 vph on a single moving lane or at least 150 vph on two moving lanes; the total intersection entering volume is 800 vph or more for a four leg intersection or 650 vph for a three leg intersection; and the total delay on one minor-street approach at a stop sign is at least four vehicle-hours on a single lane approach or five vehicle-hours on a two-lane approach.

B. Peak Hour Volume
This warrant is applied where, during a minimum of one hour of the day, traffic volumes are great enough so that minor-street traffic experiences excessive delay. Warrant 3 is satisfied when the plotted point of the peak hour traffic volume, representing the total of both approaches on the major and the corresponding volume on the higher-volume minor approach, all fall above the curves (Figures 4C-3 and 4C-4 in section 4 of the MUTCD) shown in the MUTCD for the existing combination of approach lanes.

Warrant 4 - Crossing Pedestrian Traffic

This warrant is intended to identify locations where additional gaps are needed to provide safe pedestrian crossing of a major street. It applies where pedestrian crossing volumes on the major street exceeds either 100 or more for any four hours of the day or 190 or more during any one hour.

Warrant 5 - School Crossing

This warrant applies if a school is near the intersection and gaps are needed to facilitate safe crossing for children. Because this intersection is not a designated school crossing and is not located near a school, Warrant 5 is not applicable.

Warrant 6 - Coordinated Signal System

A signal may be warranted where it would encourage concentration and organization of traffic flow on networks. The warrant is satisfied where the traffic control signals on a one-way street or a street that has traffic predominantly in one direction, are so far apart that they do not provide the necessary degree of vehicular platooning. Additional requirements apply.

Warrant 7 - Crash Experience

This warrant applies where a signal could improve traffic operations so that the number of collisions at an intersection is reduced. However, signals may often increase some types of collisions. Four conditions must be met before a signal may be installed solely to reduce collisions.

A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency
B. There have been five or more collisions of types preventable by signals within a 12 month period;

C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of condition A in Table 4C-1 of section 4 of the MUTCD or the vph in both of the 80 percent columns of Condition B in Table 4C-1 of section 4 of the MUTCD exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant.

Warrant 8 - Roadway Network

This warrant applies where grouping of vehicles is required to ensure proper progression. It only applies at intersections of two major roadways.

A brief summary of the warrant analysis is listed in Table 2.10.

Table 2.10
Signal Warrant Analysis

Interchange	Intersection	Warrants							
		1	2	3	4	5	6	7	8
Continental	Continental Dr(Mt. Highland) & Saddle Rock Dr.								
Continental	Westbound Off-Ramp at Continental								
Continental	Eastbound Off-Ramp at Continental								
Continental	Mt. Highland & Continental Drive								
Excelsior	Eastbound Off-Ramp at Excelsior Avenue								
Excelsior	Westbound Off-Ramp at Excelsior Avenue								
Harrison	Eastbound Off-Ramp at Harrison (N of Dewey) (1)	X	X						
Harrison	Eastbound Off-Ramp at Harrison (S of Dewey) (1)	X	X						
Montana	Eastbound Off Ramp at Montana Street								
Montana	Westbound Off Ramp at Montana Street	X	X						
Rocker	Rocker & Nissler/Grizzly Road (S. Frontage)								
Rocker	Eastbound Off Ramp at Rocker Road								
Rocker	Westbound Off Ramp at Rocker Road								
Rocker	Rocker & Browns Gulch Road (N. Frontage)								

X – Warrant Met, Notes: (1) Right turns can be excluded from warrant analysis, included for this analysis.

As can be seen from Table 2.9, a few of the intersections considered for the signal warrant analysis meet the eight hour and four hour vehicular volume warrants. The intersections of the Eastbound off ramps at Harrison Avenue (both north and south of Dewey) and the Westbound Off Ramp at Montana Street meet warrants 1 and 2 along with some portions of Warrant 3. It is anticipated additional warrants for signalization of these three intersections will be met if future growth is considered for the analysis.

3.0 FUTURE TRAFFIC CONDITIONS

Future traffic conditions were evaluated for I-15/90 as well as the surrounding local roadway network. Future condition operational analysis is performed with the existing roadway infrastructure with future year (2025) volumes. Various measures of effectiveness such as delay and density were examined to assess the quality of operations for future year conditions. This section discusses the methods used in the analysis of the future year (2025) operations and the results of the analysis.

3.1 FUTURE VOLUME PROJECTION

Future traffic growth data for the traffic analysis was derived from the Silver Bow-Butte Transportation Plan Update document along with the regional transportation model for Butte. Butte is expected to experience some redistribution of population along with an approximate 25 percent growth in employment. Volume projections contained in the Transportation Plan Update along with the regional transportation model projections for year 2025 indicate that traffic will grow by approximately 20 percent over the next 20 years. It was assumed for this study that future year 2025 volumes will be approximately 25 percent higher than existing volumes. Harrison Avenue is expected to experience the highest growth in traffic volumes in the future due to the projected increase in population and employment in its vicinity north of I-15/90. Future projected volumes along I-15/90 and surface streets in its vicinity are shown in Figures 3.1 through 3.6.

3.2 FUTURE CONDITIONS

Future (2025) traffic volumes were developed and used as input to the CORSIM, SYNCHRO and HCS models to analyze traffic operations. A brief summary of future (2025) volumes and traffic operations along I-15/90 is shown in Figure 3.1 and also listed in Table 3.1 Heavy vehicle percentages are assumed to be the same as the existing conditions. A typical percentage of heavy vehicles is 6 percent, but along I-15/90 heavy vehicle percentages range from 6 to 14 percent. Future volumes along the corridor are included in the Appendix.

3.3 RESULTS OF NO-ACTION ALTERNATIVE ANALYSIS

The LOS analysis of future roadway conditions includes I-15/90 mainline, I-15/90 ramps, and I-15/90 interchange intersections.

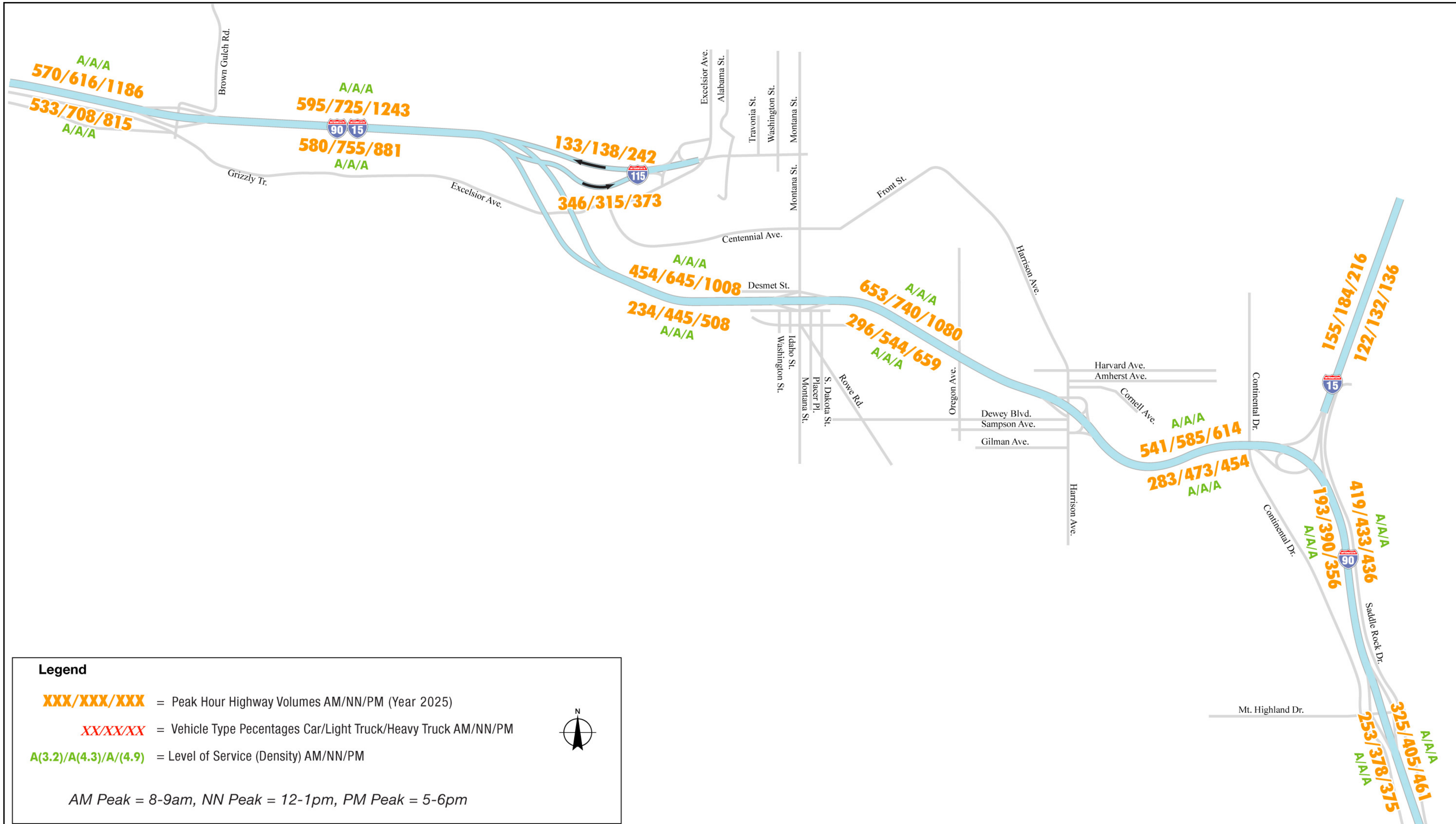
3.3.1 I-15/90 Mainline

I-15/90 mainline sections, including both basic freeway segments and weaving sections, operate at acceptable LOS for AM, Noon and PM peak hours. Unacceptable LOS is defined as LOS C or worse. As seen in Table 3.1 and Figure 3.1, none of the mainline I-15/90 sections experience unacceptable LOS.

Table 3.1
Future (Year 2025) Traffic Operations on Mainline I-15/90

Direction	Freeway Link		AM			Noon			PM		
	From	To	Volume (vph)	Density (pcpmpl)	LOS	Volume (vph)	Density (pcpmpl)	LOS	Volume (vph)	Density (pcpmpl)	LOS
Eastbound	West end	Rocker Interchange	533	4.0	A	708	5.3	A	815	6.2	A
	Rocker Interchange	I-115	580	4.3	A	755	5.3	A	881	6.5	A
	I-115	Montana Street	234	1.8	A	445	3.3	A	508	3.7	A
	Montana Street	Harrison Avenue	296	2.6	A	544	4.2	A	659	5.2	A
	Harrison Avenue	I-15	283	1.8	A	473	3.0	A	454	3.4	A
	I-15	Continental Drive	193	1.1	A	390	2.3	A	356	2.4	A
	Continental Drive	East End	253	1.5	A	378	2.1	A	375	2.3	A
Westbound	East End	Continental Drive	325	2.5	A	405	3.0	A	461	3.4	A
	Continental Drive	I-15	419	3.2	A	433	3.3	A	436	3.4	A
	I-15	Harrison Avenue	541	4.1	A	585	4.4	A	614	4.7	A
	Harrison Avenue	Montana Street	653	5.0	A	740	6.1	A	1080	8.0	A
	Montana Street	I-115	454	3.3	A	645	4.9	A	1000	7.0	A
	I-115	Rocker Interchange	595	4.7	A	725	5.6	A	1243	9.3	A
	Rocker Interchange	West end	570	4.4	A	616	5.3	A	1186	9.1	A

Figure 3.1
Mainline Volumes and LOS for Future (Year 2025) Conditions along I-15/90



3.3.2 I-15/90 Ramp Junctions

Ramp junctions along I-15/90 operate at acceptable LOS as did the mainline segments. All merge/diverge areas and the weave area between I-115 and the Rocker Road interchange functions at LOS B or better for all peak periods.

3.3.3 I-15/90 Interchange Intersections

Most of the intersections along the surface streets in the vicinity of I-15/90 operate at acceptable levels of service (LOS C or better) in 2025. Figures 3.2 through 3.6 show the projected volumes and LOS for future (Year 2025) conditions.

The intersection of Montana Street and Eastbound ramps and Harrison Avenue and Amherst Avenue intersection operates at unacceptable LOS in the PM peak hour. The intersection of Harrison Avenue and Amherst Avenue operates at an unacceptable LOS in the Noon peak hour. Table 3.2 displays the 2025 LOS at each intersection for AM, Noon and PM peak hour conditions.

Table 3.2
Future (Year 2025) Traffic Operations on Surface Streets

Main Street	Cross Street	AM		Noon		PM	
		Delay	LOS	Delay	LOS	Delay	LOS
Rocker Road	Browns Gulch Road*	9.7	A	10.2	B	10.2	B
	Westbound Ramps*	9.3	A	9.8	A	10.1	B
	Eastbound Ramps*	9.7	A	9.8	A	10.1	B
	Nissler Road*	10.1	B	10.7	B	10.7	B
Excelsior Street	Eastbound I-115 Ramps*	9.6	A	9.8	A	10.5	B
	Westbound I-115 Ramps*	9.8	A	10.0	B	10.9	B
Iron Street	Alabama Street*	9.2	A	9.4	A	9.5	A
	Travonia Street*	10.0	B	9.6	A	10.3	B
	Washington Street*	10.9	B	10.1	B	10.8	B
Montana Street	Iron Street	8.7	A	6.4	A	7.9	A
	Front Street	15.4	C	19.5	B	21.0	C
	Westbound Ramps*	15.2	C	14.5	B	15.7	C
	Eastbound Ramps*	20.1	C	22.5	C	>100.0	F
	Rowe Road	27.2	C	27.0	C	25.2	C
Harrison Avenue	Amherst Avenue	25.8	C	>100.0	F	42.9	D
	Cornell Avenue*	10.9	B	13.1	B	11.3	B
	Westbound Ramps	3.8	A	5.3	A	4.3	A
	Eastbound Off Ramp*	11.9	B	13.0	B	15.2	C
	Dewey Boulevard	8.7	A	12.7	B	33.5	C
	Eastbound Ramps*	11.8	B	13.1	B	13.7	B
Mount Highland Drive	Continental Drive*	13.8	B	10.8	B	15.2	C
	EB/SB Ramps*	8.9	A	9.0	A	9.5	A
	WB/NB Ramps*	13.4	B	10.6	B	10.4	B
	Saddle Rock Drive*	7.2	A	7.2	A	7.2	A

** - Maximum side-street delay reported for unsignalized intersection*

Figure 3.2
Future Year (2025) Volumes and LOS at Rocker Interchange and I-15/90

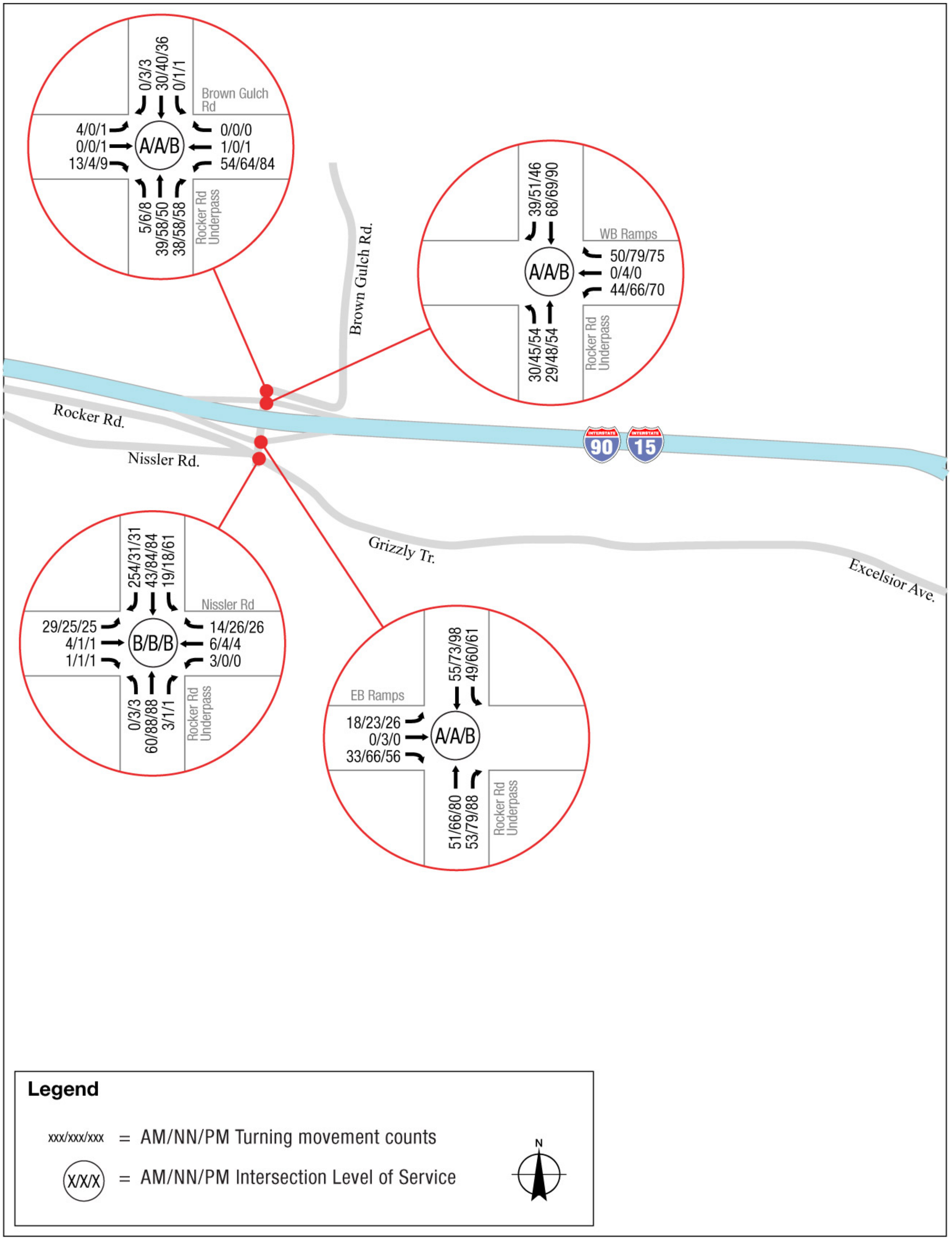


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Figure 3.3
Future Year (2025) Volumes and LOS at I-115 Interchange and I-15/90

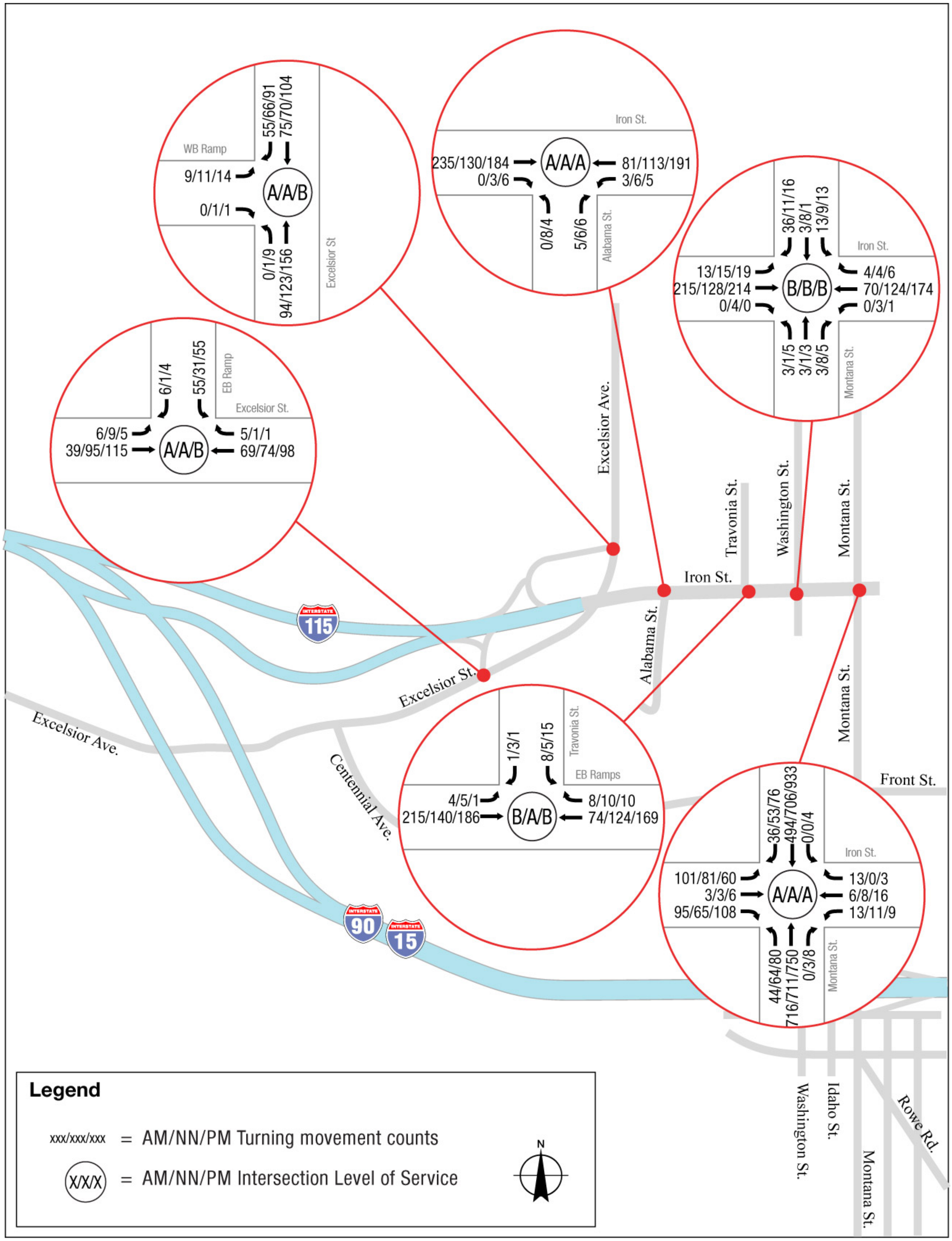

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Figure 3.4
Future Year (2025) Volumes and LOS at Montana Street Interchange and I-15/90

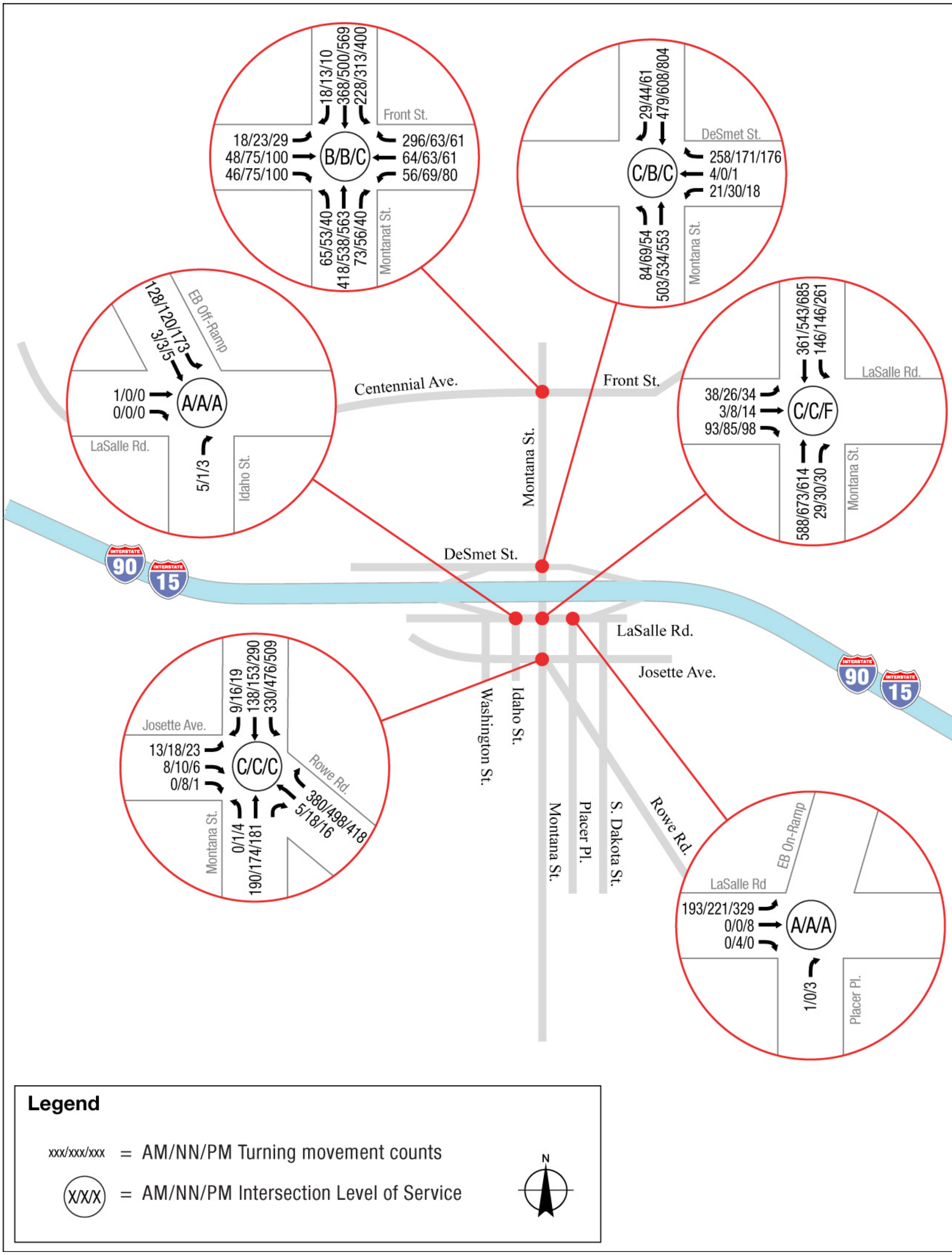


Figure 3.5
Future Year (2025) Volumes and LOS at Harrison Avenue Interchange and I-15/90

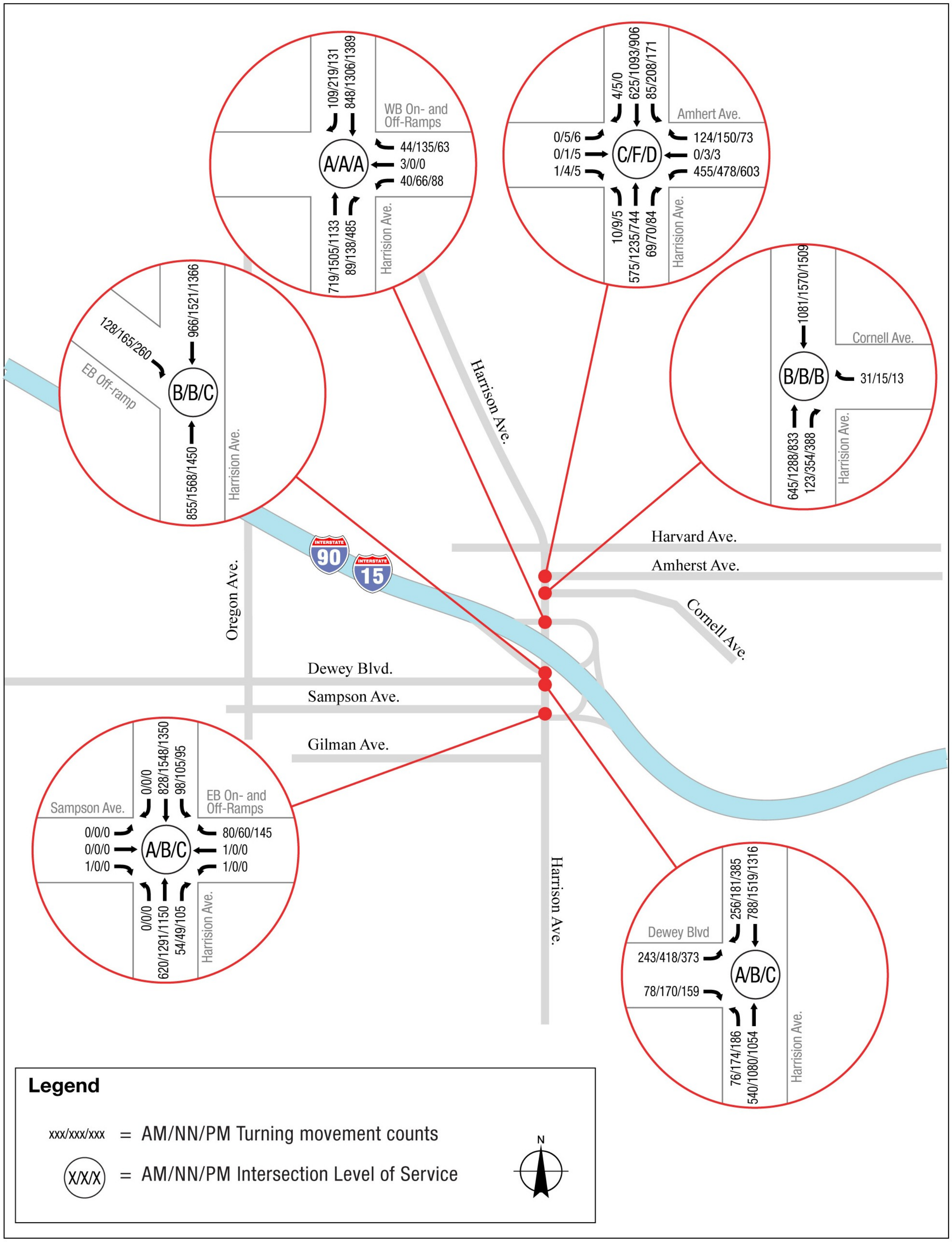
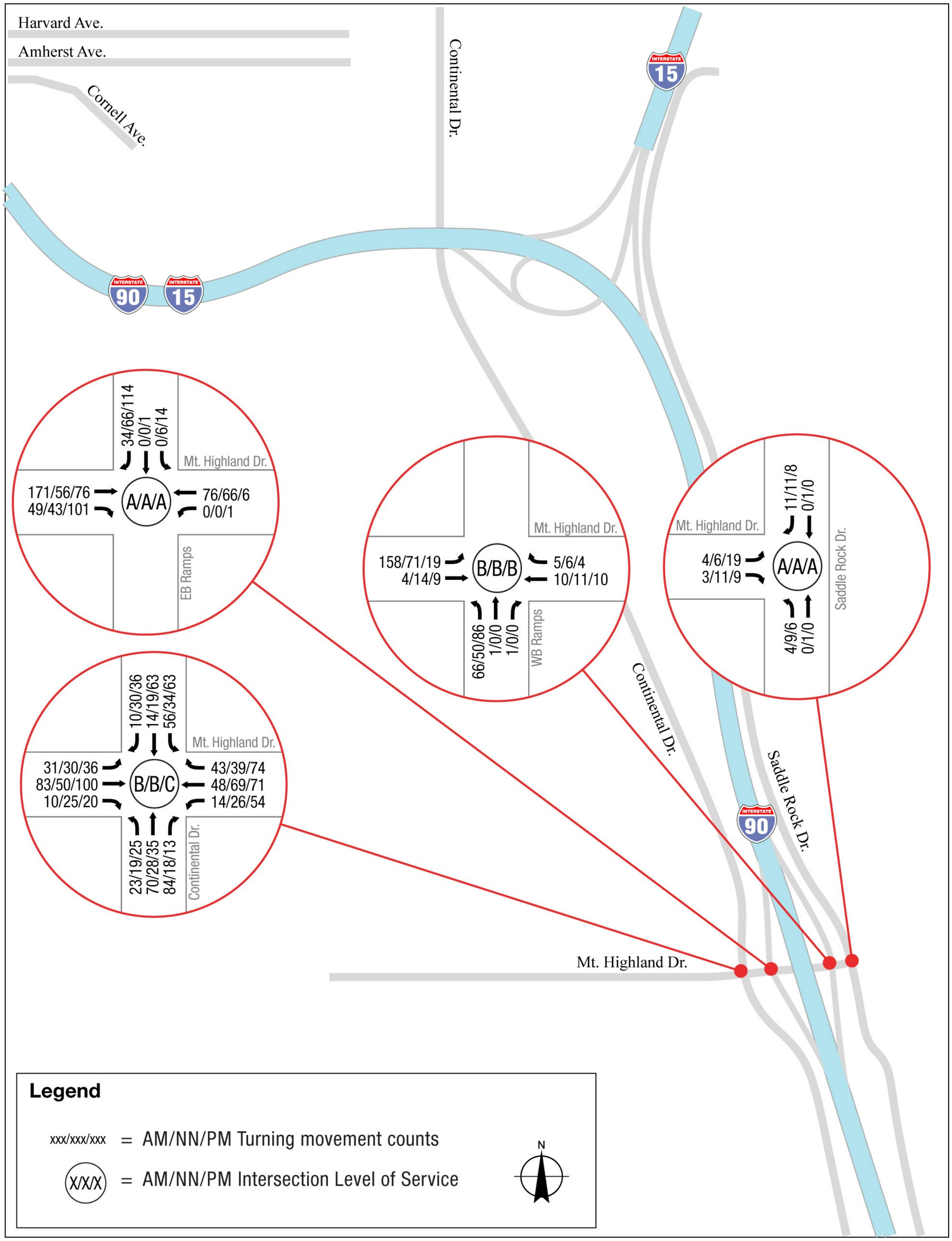


Figure 3.6
Future Year (2025) Volumes and LOS at Continental Drive Interchange and I-15/90



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3.3.4 Future (Year 2025) Conditions Summary

The results of future year analysis show that the majority of the highway transportation system operates at acceptable levels of service in the future. Compared to the existing conditions along I-15/90 the highway transportation system has slightly higher densities and delays in the future. Listed below are some of the future year analysis results for I-15/90.

- All of the mainline sections operate at an acceptable LOS (LOS A) in 2025.
- All ramps entering and exiting I-15/90 operate at an acceptable LOS in 2025.
- Most of the interchange intersections in the project area operate at an acceptable LOS (LOS C or better) in 2025.

3.4 RESERVE CAPACITY ANALYSIS

Reserve capacity analysis was conducted to assess the quality of operations beyond the horizon year of 2025 and determine the longevity of the transportation system. Traffic demand for years beyond year 2025 was obtained by using the annual growth rate from existing conditions to future year (approximately 1.122 percent per year) to extrapolating year 2025 volumes. Traffic operations were evaluated for I-15/90 mainline, ramp merge/diverge conditions and intersections for each year of incremented volume beyond year 2025. A brief summary of the findings of the reserve capacity analysis follows.

3.4.1 I-15/90 Mainline Reserve Capacity

CORSIM software in conjunction with HCS software was used to evaluate basic freeway sections for future reserve capacity. LOS B was considered to be the upper limit of acceptable operations on I-15/90 for determining the reserve capacity. Results of the analysis indicate that mainline I-15/90 can accommodate a maximum volume of approximately 2150 vehicles per hour during the peak hour while operating at LOS B. The section of I-15/90 between I-115 and the Rocker Interchange carries the highest volume on mainline I-15/90. This section of I-15/90 reaches capacity in year 2074 (49 years beyond year 2025) at the current traffic growth rate of 1.122% per year (overall growth factor of 2.16) Other sections of I-15/90 carry lower volumes and would reach capacity at a slower pace than the highest volume section.

3.4.2 I-15/90 Ramp Merge/Diverge and Weave Sections

CORSIM software in conjunction with HCS software was used to evaluate merge/diverge and weave sections for future reserve capacity. LOS B was considered to be the upper limit of acceptable operations on I-15/90 for determining the reserve capacity. Results of the analysis indicate that mainline I-15/90 can accommodate a maximum volume of approximately 1550 vehicles per hour on mainline I-15/90 during the peak hour while operating at LOS B. The section of I-15/90 between I-115 and the Rocker Interchange carries the highest volume on mainline I-15/90. This section of I-15/90 reaches capacity in year 2045 (20 years beyond year 2025) at the current traffic growth rate of 1.122% per year (overall growth factor of 1.56). Other sections of I-15/90 carry lower volumes and would reach capacity at a slower pace than the highest volume section.

3.4.3 Surface Street Intersections

SYNCHRO software in conjunction with HCS software was used to evaluate the intersection operations for the future reserve capacity analyses. LOS C was considered to be the upper limit of acceptable operations on I-15/90 for determining the reserve capacity. Intersection controls were assumed to be the same as those for existing conditions for the reserve capacity analysis. All corridors in the study area were evaluated individually for determination of reserve capacity. The worst approach LOS was considered for intersection performance of unsignalized intersections. Results of the analysis indicate that most of the intersections operate acceptably from a Level of service perspective even if the volumes are doubled (at least for 20 years past year 2025). Note that several of these intersections may need to be signalized due to higher mainline and side-street volumes causing signal warrants to be met. Signals may also be warranted at most of the unsignalized intersections in the vicinity of I-15/90 to provide adequate gaps in main street traffic and service side-street traffic. The following intersections exhibit some operational issues for future volume conditions.

1. LaSalle Road/EB on/off-ramps and Montana Street: This intersection operates at failing LOS for year 2025 volumes. This condition is projected to worsen beyond year 2025 if left un-mitigated.
2. Josette Avenue/Rowe Road and Montana Street: This intersection is projected to operate at unacceptable LOS for year 2050 volumes
3. Amherst Avenue and Harrison Avenue: This intersection operates at failing LOS for year 2025 volumes. This condition is projected to worsen beyond year 2025 if left un-mitigated.

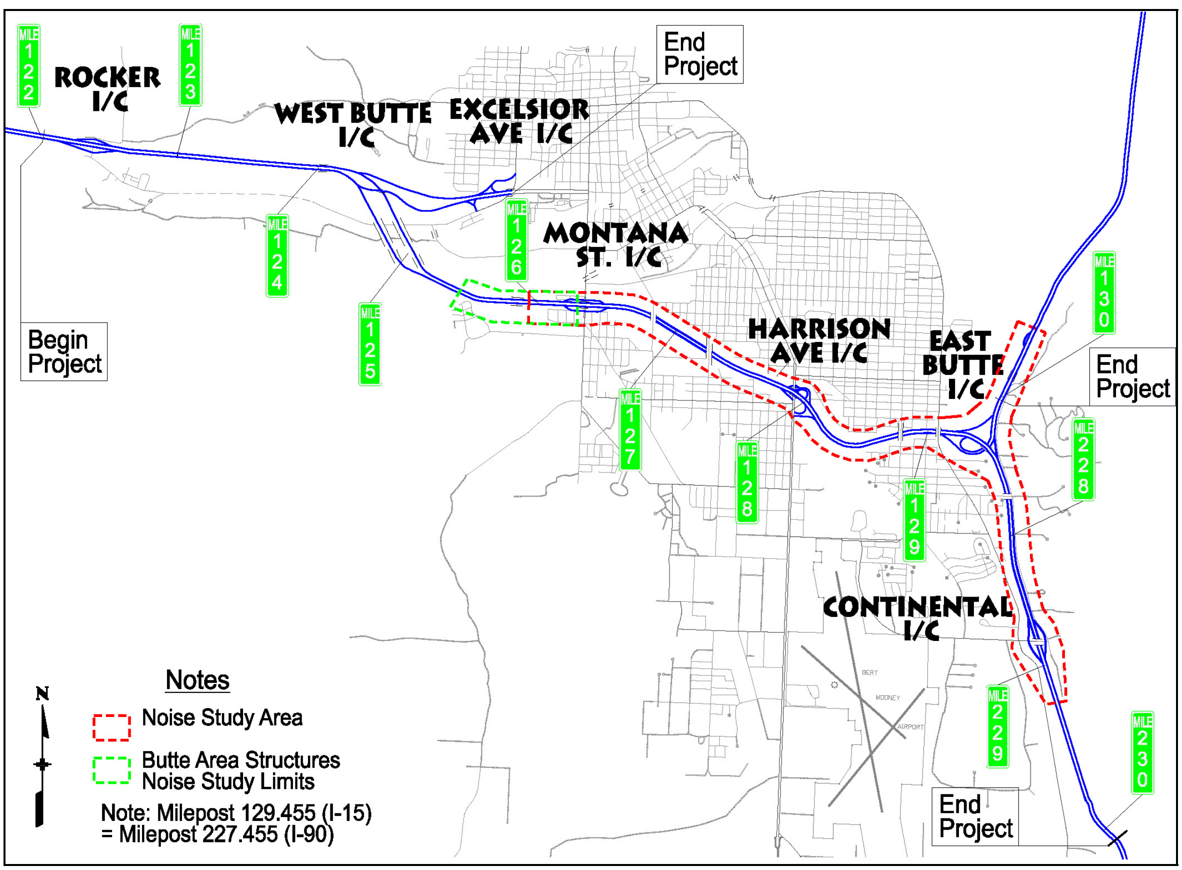
4.0 NOISE ANALYSIS

A noise study was completed as part of the Phase 1 analysis to identify existing noise levels along the interstate system. The noise analysis provides a reference for understanding the potential issues associated with traffic noise in the neighborhoods surrounding I-15/90. As future roadway projects are considered or projects are developed during Phase 2 of this study the noise analysis provides a baseline for comparison.

4.1 STUDY LIMITS

The noise study area does not cover the entire study area of the Butte Interstate Traffic Study. Noise levels were only analyzed for areas where potential noise-sensitive receptors exist. The noise study area as shown in Figure 4.1 generally covers I-15/90 from just west of the Montana Street Interchange (~milepost 126) to just south of the Continental Interchange (~milepost 229 (I-90 reference)) and along I-15 for approximately one mile north (~milepost 130.3) of the East Butte Interchange. The study area extends approximately 500 feet from the interstate centerline with a wider area around interchanges and is approximately 6.5 miles long. This study area overlaps a previously completed noise study done for the bridge replacement project just west of Montana Street (Butte Structures, IM 15-2(75) 124).

Figure 4.1
Noise Study Area



4.2 METHODS

This noise study was conducted in accordance with Montana Department of Transportation's (MDT) *Traffic Noise Analysis and Abatement: Policy and Procedure Manual, June 2001*. The MDT noise guidelines are consistent with the FHWA's 23 CFR 772 *Procedures for Abatement of Highway Traffic Noise and Construction Noise* and have been approved by FHWA. A noise sensitive site is any property (owner occupied, rented, or leased) where frequent exterior human use occurs and where a lowered noise level would be of benefit. FHWA has defined a traffic noise impact as exterior noise levels that "approach or exceed" the Noise Abatement Criteria (NAC), or when noise levels "substantially exceed" existing conditions. MDT has determined that "approach" be defined as within 1 dBA of the NAC (e.g. 66 dBA for Activity Category B – parks, residences, schools, hospitals, libraries, etc.) and that "substantially exceeding existing conditions" be defined as an increase of 13 dBA.

For the purpose of this baseline noise analysis, receptors were chosen that would have the greatest impact from traffic noise on I-15/90. These receptors include predominantly residential sites in addition to a few park sites, mobile homes, apartments, hotels and Hillcrest Elementary School. A total of 68 noise-sensitive receptors representing up to 345 single-family residences, 14 mobile homes, 48 apartments, 3 hotels, 1 school, 1 park and the 4 Blacktail Creek Bike Path locations were identified within the noise study area.

4.3 FINDINGS

Study results indicate that various neighborhoods are currently impacted by traffic noise from the I-15/90 interstate facility. The noise analysis evaluated 83 noise-sensitive receptors, including single-family residences, mobile homes, apartments, parks, hotels and a school that were identified within the study area. A total of 15 receptors in the existing condition and a total of 18 in the future year exceeded the acceptable noise levels as defined by the FHWA and MDT. The 15 receptors in the existing condition represent over 80 individual single-family residence structures. It should be noted that all receptors that exceeded acceptable noise levels did so based on the "approaching and exceeding" criteria and not the "substantially exceeding existing conditions," criteria.

For this baseline study 60 dBA and 66 dBA noise contours were estimated using the TNM computer model for both the existing and future no-build traffic conditions. These contours are a line, roughly parallel with I-15/90, where either a 60 dBA or 66 dBA noise levels is expected. The contours do not consider any shielding of noise provided by structures or topographic features between the receptor and the roadway. Additionally, the noise contours do not account for traffic noise from roadways other than the existing I-15/90 and may fluctuate near the interchanges. The contours for both the Present Year (existing) and Future Year (2025) are shown in the Noise Study Plan Sheets in the appendix. The 66 dBA contour represents an area that exceeds acceptable noise levels as defined by the land use activity category as shown in Table 1. It should be noted that a 66 dBA noise is not acceptable to live with from a quality of life standpoint and represents areas that must consider noise abatement on future Type 1 projects as defined by MDT and FHWA. In general a Type 1 project along I-15/90 would be defined as any Federal or Federal-Aid highway project that would significantly change the horizontal or vertical alignment or increase the number of lanes. The 66 dBA contour can generally be described as:

66 dBA Contour Present Year (existing):

- Montana Street to Harrison Avenue Interchange – 205 to 235 feet from the centerline of I-15/90.
- Harrison Avenue to East Butte Interchange – 180 to 210 feet from the centerline of I-15/90.
- East Butte Interchange to Continental Interchange – 165 to 195 feet from the centerline of I-90, and

66 dBA Contour Future Year (2025):

- Montana Street to Harrison Avenue Interchange – 225 to 255 feet from the centerline of I-15/90.
- Harrison Avenue to East Butte Interchange – 195 to 225 feet from the centerline of I-15/90.
- East Butte Interchange to Continental Interchange – 190 to 220 feet from the centerline of I-90.

The 60 dBA contour represents an area that should be used for planning purposes by local officials and developers to be more protective of the quality of life for residents, school, parklands and the like. Local officials should use these contour limits for the development and implementation of noise compatible land use planning. New developments should be reviewed against the 60 dBA contour to avoid or mitigate noise in new developments in which potential noise-sensitive receptors may be part of the planned development. The 60 dBA contour can generally be described as:

60 dBA Contour Present Year (existing):

- Montana Street to East Butte Interchange – 405 to 435 feet from the centerline of I-15/90.
- Harrison Avenue to East Butte Interchange – 385 to 415 feet from the centerline of I-15/90.
- East Butte Interchange to Continental Interchange – 320 to 350 feet from the centerline of I-90, and

60 dBA Contour Future Year (2025):

- Montana Street to East Butte Interchange – 470 to 500 feet from the centerline of I-15/90.
- Harrison Avenue to East Butte Interchange – 445 to 475 feet from the centerline of I-15/90.
- East Butte Interchange to Continental Interchange – 360 to 390 feet from the centerline of I-90.

Phase 1 of the Butte Interstate Traffic Study involves the identification of existing deficiencies and does not involve developing alternative build scenarios. Without any build scenarios no noise abatement alternatives were developed or analyzed as part of this Noise Study. Potential mitigation strategies that can be considered during Phase 2 of the Butte Interstate Traffic Study or during future Type 1 Projects include: alignment modifications, property acquisition, land use controls, and noise barriers.

5.0 IDENTIFIED DEFICIENCIES

The Phase 1 Butte Interstate Traffic Study has identified numerous deficiencies related to geometry features, safety and traffic (existing and future). The deficiencies have been described in previous sections of this report. A summary of all identified deficiencies is provided in the following paragraphs and shown on summary graphic Figure 5.1.

Rocker Interchange – Exit 122

The Rocker Interchange experiences a high volume of heavy truck traffic and the current interchange has characteristics of a rural low-volume interchange that doesn't accommodate current usage.

- Poor Ramp Geometry (intersection spacing, intersection sight distance, truck turning movement, access control)
- Deficient eastbound On-Ramp acceleration length
- No Pedestrian facilities

Mainline Segment 1 – Rocker to West Butte

This mainline segment has the highest ADT in the study area.

- Steep grade that causes uphill operational issues
- Insufficient clear zone areas

West Butte Interchange – Exit 124 (City Center)

The West Butte Interchange has considerable safety and geometric issues and is characterized as a system level interchange that is not provide full movements and has a left hand off-ramp on a curve.

- Poor Ramp Geometry (left-hand off-ramp, ramp horizontal alignment)
- Deficient mainline horizontal alignment
- Inadequate lighting
- Signing and striping

Mainline Segment 2 –West Butte to Montana

This segment is characterized as having one of the highest crash rates in the study area.

- Four lengthy, functionally obsolete structures (shoulder widths)
- Poor Horizontal alignment
- Clear zone

Montana Street Interchange - Exit 126

The Montana Street Interchange is characterized by the ramp configurations that consist of shared ramp/frontage road/local access.

- Deficient eastbound Off-Ramp deceleration and On-Ramp acceleration length
- Ramp operation issues – shared ramp/frontage roads
- Ramp terminal issues (intersection spacing, intersection sight distance, access control)
- Vertical curve over Montana Street
- Westbound Off-Ramp and Montana Street meets traffic signal Warrants 1 and 2

Mainline Segment 3 – Montana to Harrison

This mainline segment has the second highest ADT, but is relatively straight and flat.

- Narrow median width
- Insufficient clear zone area

Harrison Avenue Interchange – Exit 127

Harrison Avenue is the principal north-south arterial through Butte and this interchange handles the most traffic. This interchange can be characterized as having poor ramp geometry and numerous cross road ramp terminal issues.

- Ramp geometry issues (horizontal curvature - loop ramps, insufficient acceleration/deceleration length)
- Ramp terminal issues (intersection spacing, intersection sight distance, truck turning movement, access control)
- Lane usage imbalance leads to periodic queuing and congestion issues on Harrison Avenue and approach roads Amherst Avenue and Dewey Blvd.

Mainline Segment 4 – Harrison to East Butte

This mainline segment is characterized as having a curving alignment with steep sideslopes.

- Horizontal alignment issues (insufficient horizontal curvature)
- Insufficient clear zone in areas

East Butte Interchange – Exit 129

This system-to-system level interchange is characterized by an extremely tight loop ramp with low operating speeds and steep grades on the I-15 mainline north of the interchange.

- Ramp geometry issues (horizontal curvature – loop ramps, insufficient acceleration length)
- Poor typical section on ramps (median, shoulders)
- Inadequate lighting

Mainline Segment 5 –East Butte to Continental

This segment can be characterized by the low volume of traffic and relative straight alignment.

- Insufficient clear zone areas

Continental Interchange – Exit 228

The Continental Interchange can be characterized as a rural type interchange and the current traffic volumes are relatively low.

- Ramp geometry issues (insufficient eastbound On-Ramp acceleration length)
- Ramp terminal issues (truck turning movement, intersection spacing, and intersection sight distance).

Mainline Segment 6–Continental to East end

This mainline segment is characterized by the independent profiles of eastbound and westbound. This segment is also the last relatively flat section before the ascent to Homestake Pass begins.

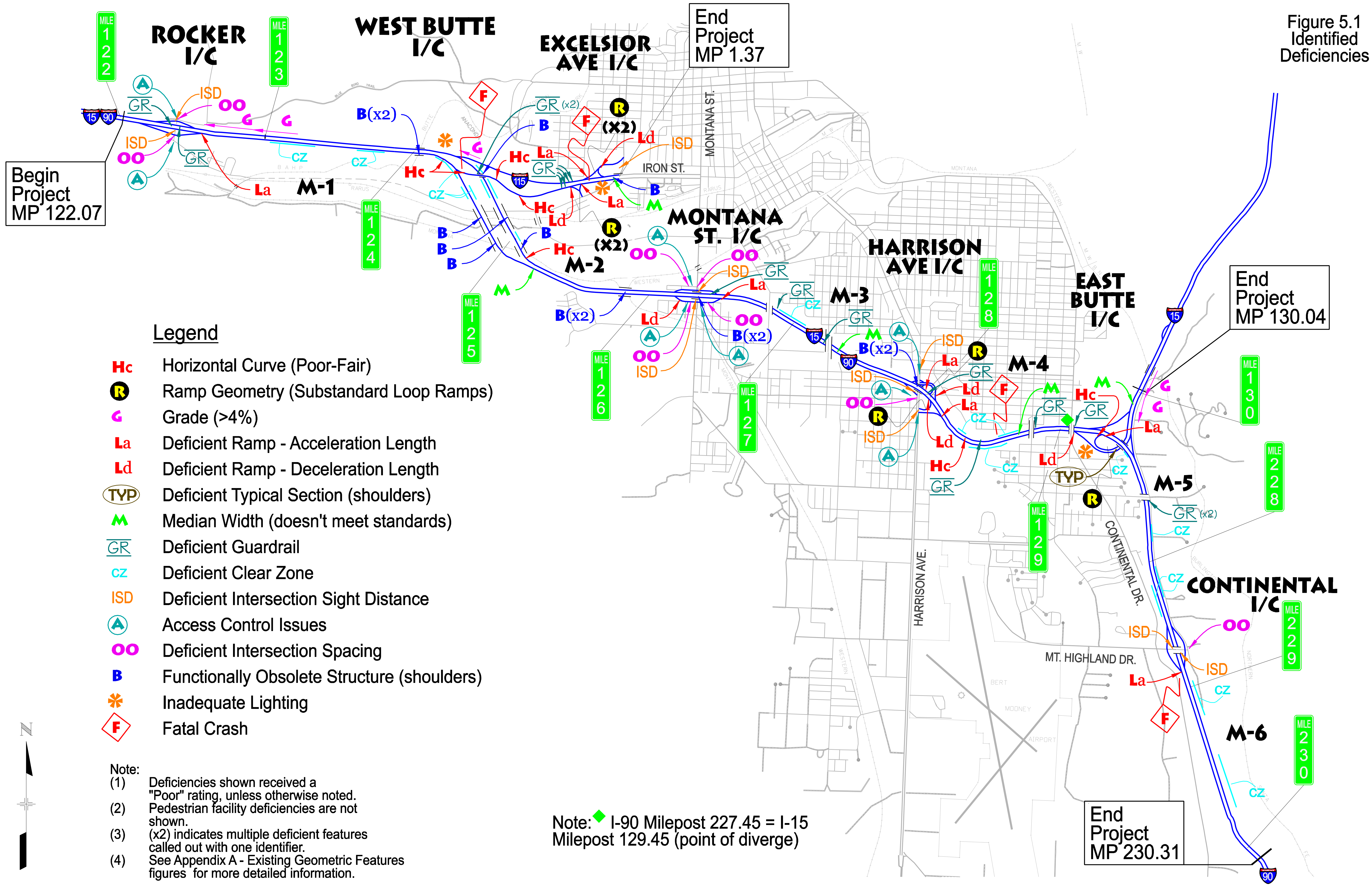
- insufficient clear zone areas

Excelsior Avenue Interchange – Exit 1 (I-115)

Excelsior Avenue is characterized as a low volume interchange located on an interstate that is transitioning to a local road.

- Ramp Geometry (acceleration/deceleration length, horizontal curvature, typical section)
- I-115 Mainline design deficiencies (horizontal, vertical and typical section (median))
- Signing deficiencies
- No lighting at interchange

Figure 5.1
Identified Deficiencies



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6.0 NEXT PHASE

The completion of the Phase 1 Study has developed a comprehensive understanding of existing geometric features, safety issues, and traffic operation and capacity conditions. Future traffic volumes have been developed and potential traffic operational issues have been identified. Deficiencies have been identified for each interchange and interstate segment. The next step is to continue with this momentum and begin to develop solutions to eliminate, minimize, or mitigate deficiencies. Alternative solutions should include both short term and long term improvements.

It is anticipated that during Phase 2 numerous alternative treatments for each interchange and interstate segment will be analyzed to determine cost effective solutions to the identified deficiencies. Examples of obvious potential treatments to be analyzed during Phase 2 include:

- Rocker Interchange – full interchange reconfiguration, short term geometric improvements on cross road or short term ramp improvements
- Mainline Segment 1 - auxiliary/truck climbing lanes
- West Butte - full interchange reconfiguration and short term ramp improvements, lighting improvements
- Mainline Segment 2 - structure improvements (widening, mainline realignment, automatic ant-icing systems)
- Montana Street – interchange reconfiguration, ramp terminal treatments
- Harrison Avenue – full interchange reconfiguration, operational improvements on cross road (signal timing, access management)
- East Butte – full interchange reconfiguration, short term lighting improvements
- Excelsior Avenue Interchange – lighting, signing improvements