Oregon Department of Transportation

US97 BEND NORTH CORRIDOR SOLUTIONS

The Dalles - California #4 (US97)

TRAFFIC ANALYSIS
MP 130.00 to 136.50

December 2010

Transportation Planning Analysis Unit

Transportation Development Division, Salem, Oregon

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Oregon Department of Transportation
Transportation Development Division
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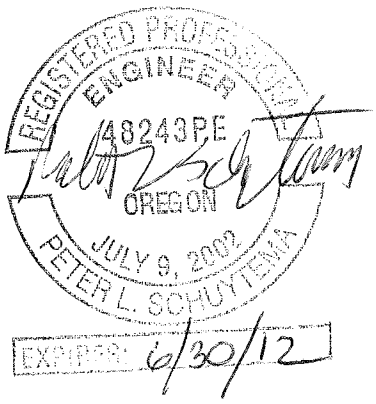

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EXECUTIVE SUMMARY

The purpose of the proposed action is to improve safety and freight mobility for trucks and autos on US97 by implementing a practical design solution that is affordable within the 20-year funding opportunities and that meets the following medium-term and long-term objectives:

- Reduces delay, congestion, and the number and severity of crashes at the US97/Cooley Road and US97/Robal Road intersections within the medium-term planning period as defined by the Bend Metropolitan Planning Organization's 2007-2030 Metropolitan Transportation Plan, and

- Reduces delay, congestion, and improves safety on US97 between the Deschutes Market Road/Tumalo Junction interchange and Empire Avenue interchange within the long-term planning period as defined by the Bend Metropolitan Planning Organization's 2007-2030 Metropolitan Transportation Plan.

This project is located on the northern edge of the City of Bend in Deschutes County in Central Oregon. With a population over 77,000, Bend includes a federally designated Metropolitan Planning Organization (MPO) which coordinates planning between member jurisdictions through a regional transportation plan. Two-thirds of the project area is within the Bend city limits and the MPO boundary while the northern third is in rural Deschutes County. The southern portion of the project area includes a regional mall and big-box commercial west of US97 and light industrial with some retail east of US97. Residential uses border the study area on the west, north, and east sides. Based on the overall range of project alternatives, the traffic analysis study area includes US97 from just north of the Deschutes Market Road Interchange to just south of the Butler Market Road Interchange ramps and US20 from north of Old Bend-Redmond Highway to just south of Empire Avenue. The study area also covers significant local facilities from O.B. Riley Road on the west to Boyd Acres Road on the east.

US97 is the regionally significant north-south four-lane major arterial through central Oregon and the project area currently carrying about 42,200 vehicles a day north of Robal Road. The facility is classified as a statewide expressway, a freight route, and is part of the National Highway System. US97 south of Nels Anderson Place is also a bypass as defined by the Oregon Highway Plan. US20 is a two-lane major arterial and a statewide expressway from the project limits to the junction with 3rd Street. The 2007 (2009 equivalent) average daily traffic (ADT) on US20 is about 27,500 northwest of Robal Road. US20 (a.k.a. US97 Business or 3rd Street) is a north-south five-lane major arterial with a statewide non-freight level of importance.

Within the southern section of the project area, US97 and US20 intersect within a partial interchange with Empire Avenue serving as the link between them. Expressways are meant to favor through traffic with access provided at wide-spaced intersections or

interchanges with private accesses discouraged. However, because of increasing congestion, slowing traffic flow, and crashes on US97 (and US20) in the project area, the highways are no longer meeting the intent of the expressway designation.
Over the past six years most crashes within the project area are rear-end and turning collisions (typical for an urban area) at intersections typically occurring in dry, daylight conditions. On US97, while the number of crashes has generally remained constant over time from 2004 to 2009, the number of severe injury or fatal crashes has increased. The US97 crash data for the past six years yields an average segment crash rate of 30-70% below comparable statewide facilities. On US20, the number of crashes has increased over time from 2004 to 2009. The average segment crash rates exceed statewide comparable rates only west of Cooley Road. There are four 2010 Top 5% or 10% SPIS (Safety Priority Index System) sites on US97 and one on US20 in the study area. Top 5% SPIS sites require investigation and plans for correction.

The 2007 30th Highest Hour Volumes used in this analysis were developed mostly using a combination of classification and turning movement intersection counts taken in 2007. The raw counts were seasonally adjusted to obtain the 30th Highest Hour Volumes. The 30th Highest Hour Volume occurs on a Friday in August around 4:00 to 5:00 PM. Because of recent economic events, employment and population losses have caused current traffic volumes to fall at least 10% from 2007 levels. Because of little or no growth in the traffic volumes since 2007, the 2007 counts are functionally equivalent to 2010 counts.

In 2007, all of the free-flow mainline segments of US97 are under the volume-to-capacity standards except for the northbound section between the Butler Market Road on-ramp and the Empire Avenue off-ramp. The signalized US97 intersections of Cooley and Robal Roads are at or approaching capacity. Along US20, most of the unsignalized intersections along US20 west of the US97/3rd Street connections are at or over capacity for the stopped side-street approaches. The high traffic volumes on US20 (3rd Street) and Empire Avenue have the US20 & Empire Avenue intersection over standard. In addition, the volumes along Empire Avenue between US20 (3rd Street) and US97 are high enough that turning from unsignalized intersections is difficult with high levels of delay.

Queuing problems are mainly left turn lanes being blocked by adjacent through queues. Most of the long-lasting queuing problems are on US97 between Cooley Road and Butler Market Road and along Empire Avenue. Many closely spaced intersections along Empire Avenue show significant blocking times such as between US20 (3rd St) and Jamison Street on the west and Industrial Park Boulevard on the east; between the ramp terminals at the Empire Avenue interchange; and between the closely spaced US20 and Butler Market on-ramps on northbound US97. The effects of the congestion and signals on US97 and the 3rd Street portion of US20 are illustrated with a 10 mph reduction in average speed from the posted 45 mph.

On US97, the existing street, ramp and interchange spacing is substantially under the applicable standards. The interchange spacing is only about a third of the 1.9 mile standard with interchanges spaced approximately one-half mile apart from Empire Avenue to Butler Market Road. Interchange ramp-to ramp spacing is generally only about a quarter-mile

apart instead of the one mile standard which will likely lead to congestion issues with higher volumes.

On US20, the street spacing is just under the standard between Cooley and Robal Roads but is less than a third of the required spacing between at-grade intersections and the US97/US20/3rd Street interchange connections. The ramp terminal spacing standard is not met at the US97/Empire Avenue interchange as there are full access intersections 300' away on the west and about 800' on the east. The signalized US20 (3rd Street) & Empire Avenue intersection is only about 850' away from the southbound ramp terminal, so meeting the spacing standard is unlikely even under ideal conditions.

To create future year 2015 and 2035 volumes, the Bend Metropolitan Planning Organization (BMPO) travel demand model was used. The model is based on the current comprehensive land use plans of Deschutes County and the City of Bend. The Metropolitan Transportation Plan (MTP) financially constrained model scenario was used to develop the future volumes. The volumes were post-processed using procedures from the National Cooperative Highway Research Council (NCHRP) Report 255 to create the future no-build and alternative design hour volumes.

In 2035, the rural sections of US 97 are at or over the v/c standards. In the urban sections, northbound mainline US97 is over or near capacity from south of Butler Market Road to north of Empire Avenue. The southbound direction is over or near the v/c standard from the Empire Avenue interchange south to the project limits.

Most intersections on US97 and US20 are at or over capacity by 2035, leading to extensive queuing and delays on the north end of US97 and US20 likely spreading across multiple hours. The worst signalized bottlenecks in the project area are the US97 & Cooley Road and the US20 & Empire Avenue intersections. The US97 & Nels Anderson Place/Cascade Village Mall intersection is the worst unsignalized bottleneck. The northbound left has no safe gaps in southbound traffic, so vehicles attempting this risk a serious crash. Exiting the mall will be difficult because gaps are limited, so long delays and queues are expected.

By 2035, the queuing is extensive throughout the project area. The US97 & Cooley Road intersection has queues that extend north of Bowery Lane southbound and almost back to Robal Road northbound. Queuing on Cooley Road from this intersection backs into US20 on the west and to Boyd Acres on the east. The queues from the US20 (3rd St) & Empire Avenue intersection extends almost all the way to Cooley Road and over 1000' south of the intersection for the northbound direction. Cooley Road, Robal Road, and Empire Avenue have extensive queuing over their entire length in the project area. Long queues exist on most side-street approaches. The effect of the increasing future congestion can be seen as speeds continue to drop as the overall network speed operates at a crawl speed.

Twenty alternatives and many more concepts were considered in the alternative development phase. These alternatives and concepts were tested first on the purpose and need criteria and then later against the goals and objectives. These alternatives and concepts considered alignments to the west of US97 and the commercial area, along

existing US97 (3rd Street), and to the east of US97 adjacent to the railroad tracks. Near the end of the alternative refinement process, the alternatives were "down-scaled" using a practical design approach, resulting in alternatives with reduced scope and complexity to better address future funding and phasing. The final build alternatives are known as East DS-1 and DS-2.

Both East DS-1 and DS-2 realign US97 to the east of the current alignment next to the railroad tracks. The current US97 would become an extension of 3rd Street from the US20 connections to a new US97 interchange north of Grandview Drive. Both build alternatives share a common design from Cooley Road south, but have different northern interchange types and local road connections.

Both alternatives generally do not affect the existing pedestrian, bike or transit facilities. The largest change will be the extension of Robal Road west to O.B. Riley Road. This allows for easier and quicker pedestrian and biking access from local neighborhoods along Britta Street or O.B. Riley Road to the commercial area east of US20. Pedestrian and bike travel on 3rd Street may be more attractive since traffic volumes dropped with the highway through traffic removed.

In the East DS-1 alternative, north of Cooley Road, US97 returns to its current alignment. US97 has a full diamond service interchange with the extension of 3rd Street located just north of Bowery Lane. Between the 3rd Street interchange and the south project limits, US97 is completely access-controlled. North of Cooley Road, 3rd Street is built on a new four/five lane alignment west of the current alignment. North of Grandview Drive, 3rd Street narrows to a two/three-lane cross-section. Third Street continues east as a two-lane roadway to a new north-south frontage road adjacent to the railroad tracks. This frontage road will serve residences and businesses that used to access US97 directly in this section.

In the East DS-2 alternative, north of Cooley Road, US97 returns to its current alignment. US97 has a system-type partial interchange with the extension of 3rd Street located just north of Grandview Drive. Movements would only be allowed to US97 from 3rd Street northbound and from US97 to 3rd Street southbound. Between the 3rd Street interchange and the south project limits, US97 is completely access-controlled. Third Street north of Cooley is a five-lane cross-section generally on the current alignment. With no direct connection to the west side of US97, Hunnell Road (north section) will be improved north of Loco Road to Fort Thompson Road. Bowery Lane will be improved, formally connected to Hunnell Road, and extended over US97 to a frontage road adjacent to the railroad tracks that serves residences and businesses that had direct US97 access in this section.

Overall, East DS-1 and DS-2 have similar volumes and results and both are substantially better than the no-build in all respects. The number of locations over standard or over capacity is only a third to a half of the no-build. Overall, network and US97 segment speeds and US97 speeds are double the no-build values. By eliminating the Cooley and Robal Road signals and other accesses, the future US97 travel times are about 75% of the 2007 existing condition values. Both of the alternatives have peak operating speeds

reasonably close to the posted speeds, and have improved the access spacing on US97 to exceed spacing standards north of the US20 connections.

US97 is free of congestion in both alternatives except for localized slowing in the weaving section south of Empire Avenue. This section is a “transition” section between the improved new alignment north of Empire Avenue and the unchanged near-capacity section south of Butler Market Road. In this transition section, the improvements are primarily to improve and smooth the traffic flows and not attract additional traffic which would result in a more severe bottleneck south of Butler Market. On the northern side of the project area, the alternatives will preserve the good operations and the overall feel that drivers are used to on the north side of Bend.

There are a number of US20 or local street intersections at or over the v/c standards with some still over capacity with reasonable improvements (US20 intersections represent 80% of the locations over capacity). The US20 improvements offer some capacity enhancements by keeping congestion at a manageable level which keeps operations consistent and balanced with the rest of surrounding system. Otherwise, without separating the highway and local street functions, the project area would have much worse operations than the rest of the system as the local road network is not very well developed.

Overall, the alternatives create a good match or balance between the existing and project areas unlike early more comprehensive alternatives which attracted so much additional local traffic onto US97 that the congestion problem became unmanageable. The alternatives have lower system capacities and less connection points than previous alternatives which will keep most of the short local trips off US97.

Both alternatives function much better than the no-build alternative and will allow free-flow operations on US97 through the 2035 design year. The alternatives will allow US97 to operate consistently with its expressway and freight route designations by maximizing the flow of long distance and regional trips while minimizing access points. Both alternatives meet the project purpose of improving safety and freight mobility on US97. Both alternatives are consistent and balanced in size and operations with the existing facility north and south of the project area while keeping local traffic (short trips) on the local system. Because East DS-1 and DS-2 have very similar networks and a small difference in volumes, either of these are viable based on traffic operations. Although East DS-2 seems to operate much poorer on a system basis, the actual volume difference between East DS-1 and DS-2 is very small and well within the typical 10% weekly volume fluctuations, so both alternatives will function similarly.

BACKGROUND INFORMATION

The purpose of the proposed action is to improve safety and freight mobility for trucks and autos on US97 by implementing a practical design solution that is affordable within the 20-year funding opportunities and that meets the following medium-term and long-term objectives:

- Reduces delay, congestion, and the number and severity of crashes at the US97/Cooley Road and US97/Robal Road intersections within the medium-term planning period as defined by the Bend Metropolitan Planning Organization's 2007-2030 Metropolitan Transportation Plan, and

- Reduces delay, congestion, and improves safety on US97 between the Deschutes Market Road/Tumalo Junction interchange and Empire Avenue interchange within the long-term planning period as defined by the Bend Metropolitan Planning Organization's 2007-2030 Metropolitan Transportation Plan.

This project is located on the northern edge of the City of Bend in Deschutes County in Central Oregon (Figure 1). With a population over 77,000, Bend includes a federally designated Metropolitan Planning Organization (MPO) which coordinates planning between member jurisdictions through a RTP. Two-thirds of the project area is within the Bend city limits and the MPO boundary while the northern third is in rural Deschutes County. The southern portion of the project area includes a regional mall and big-box commercial west of US97 and light industrial with some retail east of US97. Residential uses border the study area on the west, north, and east sides. Because of the overall range of the project alternatives, the study area for traffic analysis purposes includes US97 from just north of the Deschutes Market Road Interchange to just south of the Butler Market Road Interchange ramps and US20 from north of Old Bend-Redmond Highway to just south of Empire Avenue. The study area also covers local facilities from O.B. Riley Road on the west to Boyd Acres Road on the east (Figure 2).

US97 is the regionally significant north-south four-lane major arterial through central Oregon and the project area carrying about 42,200 vehicles a day northwest of Robal Road. The facility is classified as a statewide expressway, a freight route, and is part of the National Highway System. US97 south of Nels Anderson Place is also a bypass as defined by the Oregon Highway Plan. US20 is a two-lane major arterial and a statewide expressway from the project limits to the junction with 3rd Street. The average daily traffic (ADT) on US20 is about 27,500 west of Robal Road. From the start of 3rd Street south through the project area, US20 (a.k.a. US97 Business or 3rd Street) is a north-south five-lane major arterial with a statewide non-freight level of importance.

Figure 1: Vicinity Map

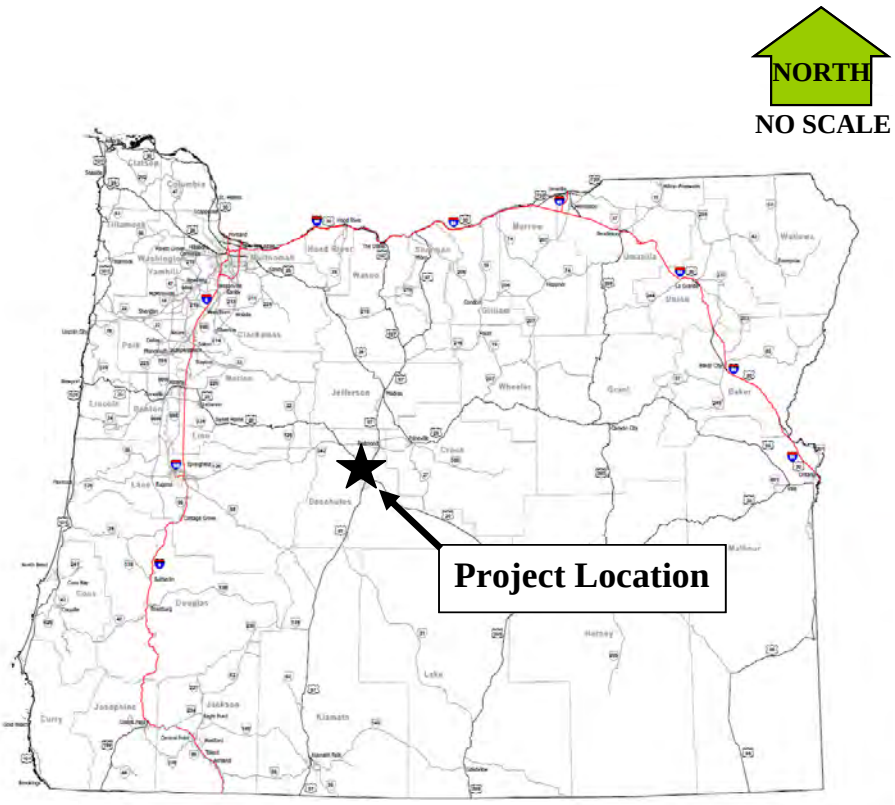
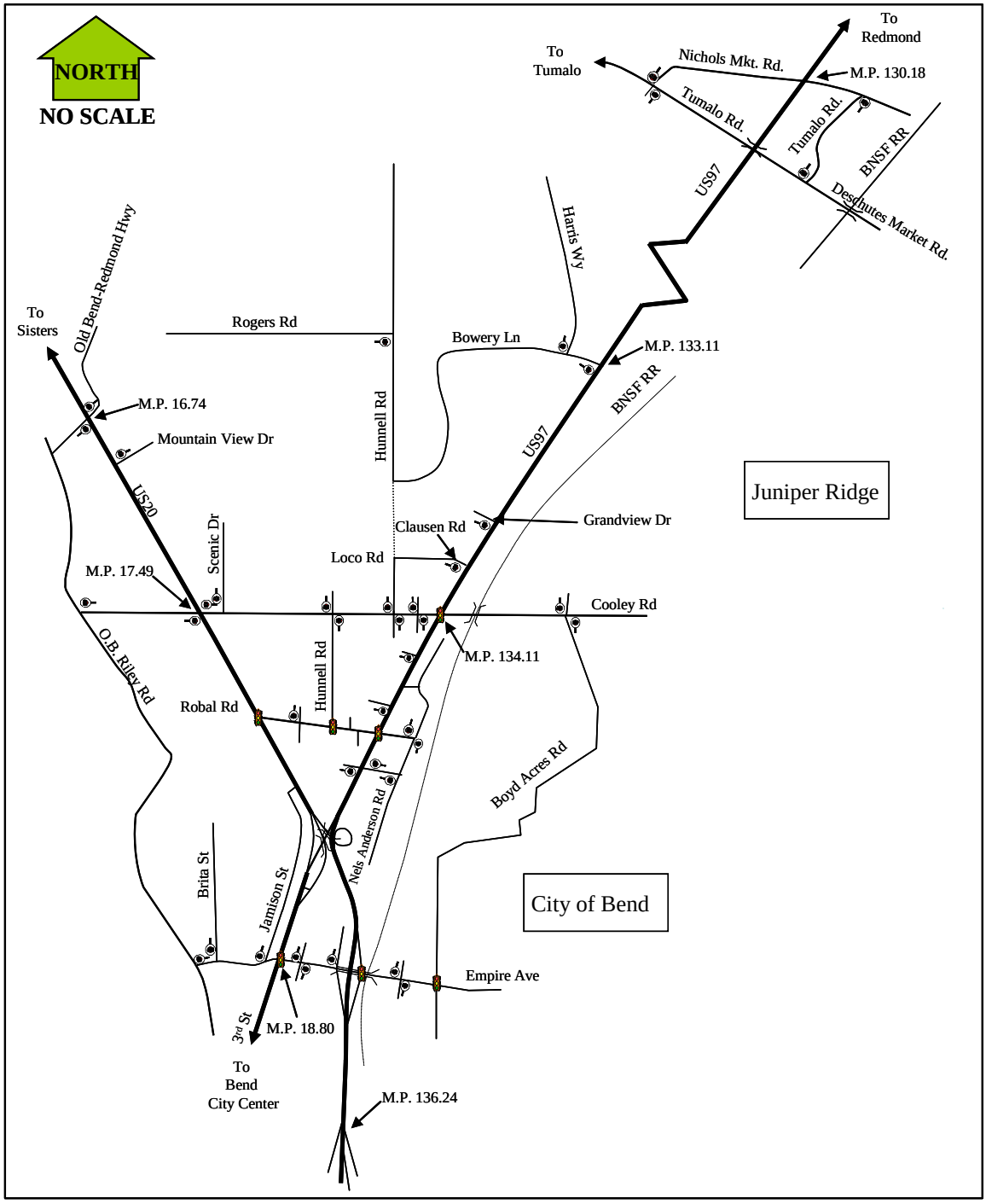


Figure 2: Project Area



Within the southern section of the project area, US97 and US20 intersect together in a partial interchange with Empire Avenue serving as the link between them. Expressways are meant to favor through traffic with access provided at wide-spaced intersections or interchanges with private accesses discouraged. However, because of increasing congestion, slowing traffic flow, and crashes on US97 (and US20) in the project area, the highway is no longer meeting the intent of the expressway designation.

Portions of O.B. Riley, Cooley, Deschutes Market, Nichols Market and Tumalo Roads and Old Bend-Redmond Highway in the study area are Deschutes County two-lane rural major collectors. Empire Avenue is a City of Bend two and four-lane major arterial from 3rd Street east (18,300 ADT) and a two-lane minor arterial from O.B. Riley Road to 3rd Street. Other City two-lane minor arterials include Cooley, Robal, O.B. Riley, and Boyd Acres Roads. Hunnell Road is a minor arterial south of Cooley Road and a City collector north of Cooley Road. All other roads like Nels Anderson Place and Grandview Drive are City local streets.

Sidewalks on US97 are generally limited to the west side of the highway from Grandview Drive south to the US20/US97 interchange. There is partial sidewalk section on the east side of US97 that starts at Cooley Road, then jogs eastward a bit and travels along the east side of Nels Anderson Road south to Robal Road. This sidewalk continues about two-thirds of the way to Nels Anderson Place and then connects to a commercial parking lot. South of the US97/US20 interchange, US97 is a grade-separated facility with no pedestrian facilities. There is a six-foot colored bike lane available for bicyclists.

US20 has no pedestrian facilities west of the US20/US97 interchange. At the interchange, the US97 west-side sidewalk crosses the US20 eastbound ramp to 3rd Street and leads to Jamison Street. Jamison Street only has a west side sidewalk for half the distance to Empire Avenue. South of Empire Avenue, sidewalks are limited to the west side of the roadway. On US20, there are no marked bicycle lanes from the project limits to Empire Avenue, but there are wide paved shoulders available. South of Empire Avenue there are marked bicycle lanes in both directions.

For the City street network in the study area, sidewalks are generally limited to between Hunnell Road and US97 on Robal and Cooley Roads and Clausen Drive. Empire Avenue only has a sidewalk and a paved shoulder on the north side of the street between O.B. Riley Road and US20 (3rd St). Sidewalk and marked bicycle lanes are discontinuous east of 3rd to Boyd Acres Road.

Transit service in the project area is limited to a single route (#4 North 3rd St) that uses US20 (3rd St) to Robal Road then turns around at the Cascade Village Mall and travels back south to downtown. Service is at 40 minute intervals on the weekdays and 80 min on Saturday (no Sunday service). The only stops in the project area are the ODOT park-n-ride south of Empire Avenue, on the US20 connection to 3rd Street (for the Jamison Street industrial area), and the Cascade Village Mall.

Operational Standards

When evaluating maximum acceptable Volume to Capacity (v/c) Ratios for the existing and future no-build conditions, the 1999 Oregon Highway Plan (OHP) mobility standards for a Metropolitan Planning Organization (MPO) area were used. The maximum acceptable v/c ratio for the expressway portions of US97 and US20 is 0.80. The rural sections north of Grandview Drive on US97 and Cooley Road on US20 have a v/c ratio of 0.70. The section of US20 from the US97/US20 interchange south to the southern study area boundary has a maximum v/c ratio of 0.85. The v/c ratio at the ramp terminals on Empire Avenue should not exceed 0.85. For unsignalized intersections, stopped approaches should have a maximum v/c ratio of 0.80 for rural areas and 0.90 in urban areas (based from District-level highways in a MPO area). A v/c ratio of 1.0 represents an intersection that is at capacity.

For the alternatives, the 2003 Highway Design Manual (HDM) v/c's for a MPO are used. Unlike the OHP v/c's the HDM values are not standards, but design guidelines. Design exceptions can be obtained where it is not practical to achieve the HDM v/c's. The design v/c's for US97 and US20 are 0.75 except for 0.60 outside of the MPO boundary. Ramp terminal v/c's are the same as the mainline roadway at 0.75. Because of the differences between the OHP and the HDM v/c's, there may be un-changed areas in the alternatives that meet OHP but do not meet the HDM v/c's. These areas will need design exceptions, however, they should be easily obtainable.

The City of Bend has a three-hour v/c standard in which the v/c must be less than or equal to 1.0 in the shoulder hours on each side of the peak hour for two-way stop-controlled, roundabouts, and signalized intersections. Three separate analysis hours were outside the scope of this project, however, the 4-5 PM and 5-6 PM peak hours are within 10% of each other, so the 4-5 PM peak hour (30th highest hour) will be used to approximate the City standard. Additionally, unsignalized two-way stop-controlled intersections must have less than or equal to 50 seconds of average delay for the critical lane group on approaches with more than 100 peak hour trips and signalized intersections must have no more than 80 seconds of total delay. Deschutes County uses Level of Service (LOS) D for existing facilities and LOS C for new facilities.

In addition to v/c ratios, 95th percentile queue lengths were also obtained to better understand the operation of the system. The v/c calculation methods do not generally take the full impact of adjacent intersections into account, so it is possible to have queues that back through upstream intersections without having reported high v/c ratios. Excessively long queues are often seen in areas where v/c ratios exceed standards. ODOT does not have a queuing standard, but areas in which the 95th percentile queue exists for more than 5% of the 30th highest hour will likely negatively impact operations and are noted in the results. The City of Bend stipulates that the 95th percentile queue needs to be less or equal to the storage provided for unsignalized and signalized intersections.

YEAR 2007 NO-BUILD EXISTING CONDITIONS

Crash Analysis

The purpose of the crash analysis is to document existing safety issues in the project area that might be further impacted by project traffic. Crash deficiencies should be addressed within the build alternatives. The crash analysis is based off on official reported crashes submitted to ODOT's Crash Analysis and Reporting Unit for the study area roadways from 2004 to 2009. The full crash table for the project area are is summarized in Appendix A with the state highway crash characteristic summary listings in Appendix B and the local roadway crash characteristic summary listings shown in Appendix C.

Crash Types

The crashes in the project area are typical for an urban area with most being rear-end, turning (from streets or accesses) or angle types. Rear-end collisions are generally caused by motorists following too close or traveling too fast for conditions, or being inattentive and often colliding into the last vehicle in the queue stopped at an intersection. Limiting street and/or access spacing, adding turn lanes, or constructing medians might reduce these collisions. Turning and angle collisions are caused by motorists taking improper gaps in traffic and failing to yield the right-of-way. Many times the traffic main street volume is high enough so that there are a limited number of available gaps, so the motorist ends up taking a smaller gap which has a higher crash risk.
Increasing sight distance, lowering speed limits, adding illumination, and improving intersection controls (adding all-way stops, roundabouts, signals, grade separation, etc.) may reduce these kinds of crashes.

Higher speed roadways such as US97, US20 and O.B. Riley Road have a high number of head-on, fixed object and sideswipe collisions. Head-on collisions and fixed object collisions are generally caused by motorists driving too fast for conditions, losing control of the vehicle and either hitting another vehicle or object (tree, abutment, ditch, etc). Driving under the influence or fatigue can be a factor in these kinds of collisions and these also have the greatest chance of a fatality or Injury A (internal injuries) severity because of the high speeds. There is generally no pattern for the fixed object collisions, so the only options are to keep the roadways shoulders (clear zone) free of objects or provide protective guardrails or other measures. Head-on collisions are mitigated with median barriers to prevent cross-over type movements. Sideswipe collisions are caused by driver error and result from improper passing movements (sideswipe-meeting) or trying to avoid a stopped vehicle (sideswipe-overtaking) in the roadway. Adding no-passing zones or turn lanes may reduce these collisions.

Crash Analysis Summary

The following sections show the summarized crash analysis statistics for US97, US20 and significant roadways in the study area for the period between January 1, 2004 and December 31, 2009. There were 292 crashes on US97 and 79 on US20 highway segments in the project area. Typically over two-thirds of crashes occurred in dry, daylight conditions. The crash types are typical for the urban and rural portions of this project with numerous intersection crashes in the urban segments. Along US97 the segment crash rates are lower than comparable statewide rates although there are two 2010 SPIS top five percent sites identified on this roadway. The rural segment along US20 (north of Cooley Road) has experienced segment crash rates higher than comparable statewide rates for the last three years. The urban section of US20 is well below the comparable statewide rates. There were no reported top five percent 2010 SPIS sites on US20.

The lower volume local streets (Boyd Acres, Deschutes Market Road, Hunnell Road (south), Nels Anderson Road, Old-Bend Redmond Highway, and Tumalo Road) typically have property damage only crashes that occur in daylight conditions. The typical crash types were turning and angle movements at the local street intersections. Cooley Road and O.B. Riley Road both had about two-thirds of their crashes being fatal or injury crashes. They were typically daylight crashes involving turning and angle movements. An unusual occurrence that shows up in the crash summary is that most every local street had at least one motorcycle crash listed. Boyd Acres and O.B. Riley Roads are parallel facilities to US97 and US20 and serve as alternate routes.

State Highways

US97

The majority of the crashes were rear end collisions at intersections. Table 1 shows the crash and year summary for US97 between 2004 and 2009. The crashes on US 97 were mainly rear-end, turning or fixed object type. These crashes mainly occurred in dry, daytime conditions. About 43% of the crashes occurred at one of three intersections: Cooley Road (MP 134.07 to MP 134.39), Robal Road (MP 134.48 to MP 134.70) and Empire Avenue (MP 135.03 to 135.76). Crashes were highest on this roadway in 2005 with 63 being reported. The six year average is 49 crashes per year.

Table 1: US 97 Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	1	4	2	0	1	0	**8**
Backing	2	0	2	0	0	1	**5**
Fixed Object	2	6	12	6	3	3	**32**
Head-on	0	5	1	0	6	0	**12**
Misc. / Other	1	5	1	2	2	2	**13**
Non-Collision	0	0	1	1	2	2	**6**
Rear-end	22	32	26	24	21	23	**148**
Sideswipe-Meeting	0	2	0	0	1	3	**6**
Sideswipe-Overtaking	3	5	7	1	3	4	**23**
Turning	8	4	2	8	12	5	**39**
Total	**39**	**63**	**54**	**42**	**51**	**43**	**292**
Fatal - Injury A Crashes[1]	0	0	1	7	2	10	**20**
Intersection / Related	16	19	13	13	24	16	**101**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 292 crashes in this area between 2004 and 2009:

- Four fatal crashes
- 5% (15) Injury A crashes
- 50% (147) injury crashes (including A)
- 48% (141) Property Damage Only (PDO) crashes
- 74% (215) occurred in daylight conditions
- 51% (148) were rear-end collisions
- 13% (39) were turn movement related
- 11% (32) were fixed object collisions
- 10% (29) were side-swipe collisions
- 19% (56) were located at or near Cooley Road
- 18% (52) were located at or near Robal Road
- 5% (16) were located at or near Empire Avenue

There were four fatal crashes in this section during the six year period. In October 2006, there was a fatal rear-end collision located at the US97 and Robal Road traffic signal. The crash occurred in clear dry illuminated conditions in the early evening. A southbound vehicle was traveling too fast for conditions (but not exceeding the posted speed) and failed to avoid a vehicle stopped in a queue at the light. The second vehicle was forced into a third vehicle in front of it. The driver of the errant vehicle was the fatality. There were two fatal crashes in December 2008. The first was a southbound vehicle that was speeding and over the centerline just after noon on a clear dry Monday. This errant vehicle struck another vehicle head-on killing both the driver and passenger of the second vehicle. The second crash about three weeks later about 8 AM on a snowy day when a southbound vehicle, exceeding the posted speed, failed to stay in the lane. It ended up overturning and skidding down the pavement. The driver died attempting to escape from the vehicle. The

last crash happened in 2009 a few days before Thanksgiving on a clear, dry Tuesday afternoon. A southbound vehicle failed to stay in the lane on a straightaway, side-swiped a northbound vehicle and then overturned. The fatality was a passenger in the struck vehicle.

The number of crashes has generally remained constant over time from 2004 to 2009 with a spike in 2005 because of an increase in angle, head-on, and rear-end collisions. The number of severe injury or fatal crashes has increased over the past six years. The crash rates were reviewed based on three segments. The first which runs from Deschutes Market Road near milepoint 130.00 to the Bend north urban growth boundary (UGB) at 132.19, has a 2009 crash rate of 0.35 crashes per million vehicle miles (MVM) compared to the statewide rate for rural expressways and rural principal arterials of 0.68 crashes per MVM. The second segment, from the UGB to Robal Road has an overall 2009 crash rate of 0.88 crashes per million vehicle miles as compared to the comparable statewide rate of 2.02 for urban principal arterials. The last segment from Robal Road to the south end of the project has a 2009 segment crash rate of 0.38 crashes per million vehicle miles compared to 0.61 for comparable urban expressways statewide. A review of the past six years of crash data show that the average crash rates for the three segments are 30-70% less than rates for statewide comparable rates.

The 2009 intersection crash rates at Cooley Road and Robal Road are 0.39 and 0.31 crashes per million entering vehicles respectively. These intersections are substantially below the 1.0 crashes per million entering vehicles rule of thumb for indicating a need for further investigation. However, a rule of thumb is just that and depending on the individual intersection crash patterns or severity a safety issue may be indicated without meeting the 1.0 value. Both of these intersections have had enough crashes in past years to put them in the top 5% of the most serious crash locations in Region 4, so cost-effective safety improvements still need to be identified for these intersections.

US20

Rear-end and turning crashes accounted for 59% of the crashes on US20. Table 2 shows the crash type and year summary from 2004 to 2009. These crashes mainly occurred in dry, daytime conditions. There were concentrations of crashes at four intersections within the project area: Cooley Road (MP 17.48-17.49), Robal Road (MP 17.86-18.16), Empire Avenue (MP 18.30 – 18.82), and Nels Anderson Road (MP 19.01- 19.03).

There were two fatal crashes on this roadway segment in the study period. The first crash was an angle collision located at the stop-controlled Cooley Road intersection in November 2006. A westbound vehicle ran the stop sign striking a northbound vehicle killing its driver on a cloudy dry mid-afternoon on a Friday. The second fatal crash occurred early on a Thursday morning in May 2007. An eastbound vehicle failed to maintain its lane, crashing and killing the passenger.

The one pedestrian crash in this section occurred in November 2004 late one afternoon. The collision was near the US20 /Nels Anderson Road intersection (MP 19.01) under dark,

but lighted conditions. The driver was traveling northbound, in fog, on wet pavement. The driver tried to avoid the pedestrian, but the pedestrian was standing or lying in the roadway. The pedestrian suffered a severe injury (Injury A).

Table 2: US20 Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	2	1	3	2	0	0	**8**
Fixed Object	0	1	1	1	3	1	**7**
Head-on	2	0	0	0	0	1	**3**
Misc. / Other	0	0	1	3	2	2	**8**
Pedestrian	1	0	0	0	0	0	**1**
Parking	0	0	0	0	1	0	**1**
Rear-end	3	4	6	4	5	4	**26**
Sideswipe-Meeting	0	0	1	1	0	0	**2**
Sideswipe-Overtaking	0	0	0	2	0	0	**2**
Turning	1	3	4	4	4	5	**21**
Total	**9**	**9**	**16**	**17**	**15**	**13**	**79**
Fatal - Injury A Crashes[1]	1	1	2	1	2	0	**7**
Intersection / Related	4	6	11	5	11	9	**46**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 79 crashes in this area between 2004 and 2009:

- Two fatal crashes
- One pedestrian crash
- 6% (5) Injury A crashes
- 53% (42) injury crashes (including A)
- 44% (35)Property Damage Only (PDO) crashes
- 80% (63) occurred in daylight conditions
- 33% (26) were rear-end collisions
- 27% (21) were turn movement related
- 10% (8) were angle collisions
- 52% (41) were located at or near Empire Avenue, Robal Road and Cooley Road

The number of crashes has increased over time from 2004 to 2009. Crashes were highest on this roadway in 2007 with a six year average of about 13 crashes per year.

The crash rates were reviewed based on two segments, The first segment from Old Bend-Redmond Highway to Cooley Road (MP 17.48) has a 2009 crash rate of 0.89 crashes per million vehicle miles compared to the statewide rate of 0.68 crashes per MVM for rural other principal arterials. This is highest crash rate in the project area. This section has a number of intersection related crashes such as angle, turning, and rear-ends. Very few crashes are the typical rural crashes (i.e. fixed-object, sideswipe, and head-on). This section is transitioning from an urban to a rural character, or has an urban crash pattern with a rural crash rate comparison. This section would not have an issue if it was classified as urban.

The second segment, from Cooley Road to Empire Avenue has an overall crash rate of 0.77 crashes per million vehicle miles as compared to the comparable statewide rate of 2.08 for urban other principal arterials. A review of the past six years of crash rates shows that the average crash rate is comparable to other rural principal arterials at 0.68 crashes per million vehicle miles. The segment rate has been trending higher since 2007 with the last three years more than 15% higher than the average.

The 2009 intersection crash rates at Cooley Road, Robal Road and Empire Avenue are 0.10, 0.35, and 0.18 crashes per million entering vehicle, respectively. These intersections are substantially below the 1.0 crashes per million entering vehicles rule of thumb for indicating a safety issue. However, a rule of thumb is just that and depending on the individual intersection crash patterns or severity, a safety issue may be indicated without meeting the 1.0 value. The Empire Avenue intersection has experienced enough crashes in past years to put it in the top 10% of the most serious crash locations in Region 4 even with the low intersection crash rate. Cost-effective safety improvements should still be identified for these intersections even though the crash rates are below statewide averages.

SPIS Reporting

There are several 2010 SPIS (Safety Priority Index System) sites in the study area. Table 3 lists the top five and ten percent of the 2010 SPIS sites located within the study area on US97 from Cooley Road to Robal Road and US20 from O.B. Riley Road to Empire Avenue. The data in Table 3 is based on a three-year average of the recorded SPIS sites. Every year the top 10% of SPIS sites are listed and the top 5% require investigations. The 2010 5% SPIS cutoff value is 53.30 therefore only two of the sites listed in Table 3 are Top 5% SPIS sites, both of which are on US97. One location is at Cooley Road and the other is at Robal Road.

Table 3: 2010 (2007-2009 data) Top 5 % and 10% SPIS Sites

Route No.	BMP	EMP	Intersection (if appropriate)	# of Crashes	Fatal Crashes	SPIS Value
US97	130.10	130.27	Deschutes Market Road	7	1	51.69
	134.02	134.20	Cooley Road	22	0	54.78[1]
	134.47	134.57	n/a	5	0	45.86
	134.51	134.65	Robal Road	19	0	54.81[1]
US20	18.71	18.89	Empire Avenue	13	0	46.36

[1]Top 5% SPIS site

Local Roads

Boyd Acres Road

There have been a total of 26 crashes on this road segment between 2004 and 2009 with the majority being turning, angle, and rear-end. These crashes mainly occurred in dry, daytime conditions. Less than one-third have been injury crashes. The number of crashes per year has remained moderately constant with the last three years averaging only three crashes per year with no fatal or severe injury crashes. The crash rate for this roadway was not calculated since the short section would skew the calculation.

Half of the collisions are at or near the Empire Avenue intersection. The Empire Avenue intersection was signalized in late 2007, so a number of the earlier related Empire Avenue crashes may be mitigated.

Cooley Road

The majority crash types were angle collisions (Table 4). These crashes mainly occurred in dry, daytime conditions. There were two crashes with either a fatality or severe injury (Injury A). Almost all crashes on this roadway are intersection related.

The number of crashes per year has been relatively low, and has declined over the last three years. The crash rate for this roadway was 0.36 crashes per million vehicle miles which is about half the 2009 statewide crash rate for urban other principal arterials at 0.68 crashes per million vehicle miles.

Table 4: Cooley Road Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	1	4	2	0	0	0	**7**
Fixed Object	2	0	0	0	1	0	**3**
Non-Collision/Miscellaneous	0	0	0	1	0	0	**1**
Rear-end	1	0	1	0	1	0	**3**
Turning	0	0	0	0	0	1	**1**
Total	**4**	**4**	**3**	**1**	**2**	**1**	**15**
Fatal – Injury A Crashes[1]	1	0	1	0	0	0	**2**
Intersection / Related	4	4	2	0	1	1	**12**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 15 crashes in this area between 2004 and 2009:

- There was 1 fatal crash
- 53% (8) injury crashes
- 40% (6) Property Damage Only (PDO) crashes
- 73% (11) occurred in clear weather conditions
- 67% (10) occurred in daylight conditions
- All but one occurred on dry pavement
- 53% (8) were turning or angle collisions
- 47% (7) were located at or near the Bend Parkway

There was one fatal crash on Cooley Road during the six year reported period. It occurred on the Veteran's Day holiday in 2006 Friday at about 3 pm. A northbound vehicle ran a stop sign in cloudy but dry conditions, striking a westbound vehicle. The driver and two passengers were injured in the errant vehicle, while the elder driver of the struck vehicle was the fatality.

There was also one crash that incurred a severe injury (Injury A) was a rear end collision at the US97 intersection. The southbound driver was following too close and failed to stop in time, striking a vehicle stopped but not waiting to turn. The severe injury was in the stopped vehicle. The crash occurred on a Monday evening in July 2004 in clear, dry conditions.

Deschutes Market Road

There have been 14 crashes on this road segment between 2004 and 2009. The major types were non-collision crashes as almost half have involved striking an animal. These crashes mainly occurred in dry, daytime conditions. Less than one-third are injury crashes. For the past six years, crashes average about two per year with a high of six in 2006 and a low of none in 2007. The crash rate for this roadway was not calculated since the short section would skew the calculation.

Empire Avenue

The majority of the 32 crashes that occurred in the six year period were turning or rear end collisions, occurring at intersections (Table 5). These crashes mainly occurred in dry, daytime conditions.

The number of crashes has been increasing between 2004 and 2009, with a spike in 2008. The 2009 crash rate for this roadway was 1.08 crashes per million vehicle miles compared to a statewide crash rate of 0.68 for urban other principal arterials. The segment rate is somewhat inflated since this is a short section, however the trend is increasing as the last three years are almost twice the six year average of crashes.

Table 5: Empire Avenue Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	0	0	1	3	1	**0**	5
Fixed Object	0	0	0	0	0	**1**	1
Non-Collision/Miscellaneous	0	0	0	0	1	**0**	1
Rear-end	0	3	1	1	3	**1**	9
Turning	2	2	0	4	5	**3**	16
Total	**2**	**5**	**2**	**8**	**10**	**5**	**32**
Fatal –Injury A Crashes[1]	0	1	0	0	1	**0**	2
Intersection / Related	2	5	2	8	7	**4**	28

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 32 crashes in this area between 2004 and 2009:

- 44% (14) injury crashes (including two Injury A)
- 56% (18) Property Damage Only (PDO) crashes
- 88% (28) occurred in daylight conditions
- 50% (16) were turn movement related
- 28% (9) were rear-end collisions
- 88% (28) were intersection related crashes

Two crashes incurred a severe injury (Injury A) in this reporting period. The first occurred on a cloudy, dry Thursday afternoon in May 2005. It involved a motorcycle making an improper lane change, driving in the wrong lane to pass a second vehicle which was turning left. The second crash occurred on a clear, dry April morning in 2008. A vehicle turning left did not yield right of way to a motorcycle.

Hunnell Road (South)

The six year crash listing (2004-2009) only reports one crash on this roadway segment. It was a property damage only (PDO) backing accident on a Thursday afternoon in April 2005. A northbound vehicle backed into a southbound vehicle in clear dry conditions.

Nels Anderson Road

The majority crash types were turning or angle collisions and rear-end crashes. These crashes mainly occurred in dry, daytime conditions. Three of the five crashes that have occurred on this road between 2004 and 2009 are at or near the Empire Avenue intersection. The number of crashes per year has remained moderately constant with no crashes in 2009 therefore no crash rate was calculated for this roadway.

O.B. Riley Road

The 24 crashes reported during the study period were almost equally split between angle, fixed object, rear-end, and turning collisions (Table 6). Three separate fatal crashes occurred during this period. Just over half of these crashes occurred in the daytime, a larger majority in dry conditions.

The number of crashes per year has remained moderately constant averaging about six per year. The crash rate for this roadway was 0.58 crashes per million vehicle miles which is almost half the comparable 2009 statewide crash rate for rural major collector at 1.11 crashes per million vehicle miles.

Table 6: O.B. Riley Road Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	1	0	1	1	2	0	5
Fixed Object	0	2	2	0	2	1	7
Miscellaneous / Other	0	0	1	0	0	0	1
Rear-end	2	0	1	1	1	0	5
Turning	0	0	2	1	1	2	6
Total	**3**	**2**	**7**	**3**	**6**	**3**	24
Fatal – Injury A Crashes[1]	0	1	1	0	1	1	4
Intersection / Related	3	0	4	2	5	3	17

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 24 crashes on this road segment between 2004 and 2009:

- Three fatal crashes
- 50% (12) injury crashes (including 1 severe Injury A)
- 38% (9) Property Damage Only (PDO) crashes
- 63% (15) occurred in daylight conditions or in clear weather conditions
- 46% (11) were turning or angle related
- 29% (7) were fixed object collisions
- 21% (5) were rear-end collisions

The first fatality was a fixed object collision which occurred on a Monday evening in April 2005 on a cloudy but dry evening located at the signalized US 20 intersection. The driver failed to maintain his lane and ran off the road a struck a tree.

A second fatality was also a fixed object collision on a Thursday evening in March 2008. A southbound motorcycle that was driving too fast for conditions failed to stay in his lane. The cyclist lost control hitting the ditch, fell off, and struck a fixed object. The crash occurred on a clear dry night.

The third fatality occurred on a Monday evening in July 2009 in unknown conditions. A northbound motorcycle struck a westbound moped that did not yield right of way and was obscured from view.

The crash that resulted in a severe injury (Injury A) occurred on a Friday in July 2006. A southbound motorcycle struck a left turning vehicle that did not yield right-of-way. The crash occurred in the afternoon of a clear, dry day.

Old Bend-Redmond Highway

There were ten crashes in the six year reporting period on the Old Bend-Redmond Highway, seven of which were turn movement related. These crashes are occurring generally at or near Rickard Road, but in clear, dry daylight conditions. Half of the crashes are injury crashes although none are severe (Injury A). The number of crashes per year has remained moderately constant at about two per year. The crash rate for this roadway was not calculated since the short section would skew the calculation.

Robal Road

The majority of the 16 crashes on this road segment between 2004 and 2009 were turning, angle, or rear-end collisions. These crashes mainly occurred in dry, daytime conditions. Almost two-thirds of the crashes are injury crashes. Over two-thirds of the collisions occurred at or near the Hunnell Road intersection. The number of crashes per year has remained moderately constant except for 2007 with about three crashes per year. The crash rate for this roadway was not calculated since the short section would skew the calculation.

Tumalo Road

There have been five crashes reported on this road segment between 2004 and 2009 which were rear end, turning and other (animal). The crashes were all property damage only and occurred in clear, dry conditions. The number of crashes per year has remained moderately constant with only one or so non-fatal or severe injury crashes. The crash rate for this roadway was not calculated since the short section would skew the calculation.

Other Roadways

There have not been any crashes reported in the six years covered in this analysis on the following roadway segments:

- Chavre Way from US97 to Nels Anderson Road,
- Hunnell Road (north) from Cooley Road to Loco Road
- Nels Anderson Place from US97 to Nels Anderson Road
- Nichols Market Road east from Tumalo Road to US97
- Rogers Road from Old Bend-Redmond Hwy to Hunnell Rd

Traffic Development

The 2007 30th Highest Hour Volumes used in this analysis were developed mostly using a combination of 16-hour classification and 3-hour turning movement intersection counts and 48-hour hose tube counts taken in 2007. A peak hour count was obtained to determine lane flows within the northbound weaving section between the Empire Avenue on-ramp and the US20 loop off-ramp (commonly known as the Sister's Loop). Potential alternative impacts necessitated obtaining 3-hour classification counts at certain local street intersections in 2009. Table D1 in Appendix D shows the location, duration, and time obtained for each count. The peak hour for the study area was found to be 4:00 to 5:00 pm. The 30th Highest Hour Volume occurs on a Friday in August.

The counts were seasonally adjusted to 30th Highest Hour Volumes using three local Automatic Traffic Recorders (ATR). ATR's #09-007 Bend-Empire and #09-009 Bend-Revere were averaged together for the Bend Parkway portion of US97. ATR #09-007 Bend-Empire and #09-020 Redmond were averaged together for the rest of US97.

There were no matches in the ATR Characteristic Table for US20 because the subject site volumes were more than 10% of the values shown in the table, so the Seasonal Trends Table was used. The average of the Commuter and Summer trends were used for the expressway portion of US20. Third Street and other local roads used the Commuter trend. Interchange ramps used an average of the Bend Parkway seasonal factors and the local road seasonal factors as ramps are a hybrid between the crossroad and the mainline. The 2007 30th highest hour volumes and lane configurations are shown in Appendix E.

Because of the elapsed time between the traffic counts and the current year, the volumes were reviewed to address concerns that they were out-of-date. Current traffic counts were reviewed and found that the 2007 counts are at least 10% higher than 2009 or 2010 values. In addition, economic events since 2008 have caused employment to drop about 20%, and population has leveled out or decreased in the study area. Because of little or no growth in the traffic volumes beyond 2007, the 2007 counts are functionally equivalent to 2010 counts.

Analysis Results

Mainline & Merge/Diverge/Weave Segments

In 2007, all of the free-flow mainline segments of US97 are under the OHP 0.70 v/c rural standard or the 0.80 v/c urban standard except for the northbound section between the Butler Market Road on-ramp and the Empire Avenue off-ramp (Table 7). The v/c is relatively high on US97 between Butler Market Road and the US20 loop ramp connection to US20 which likely indicates a future congested area.

Table 7: Year 2007 US20 & US97 Mainline Segment and Merge/Diverge/Weave V/C Ratios[1]

Section[2]	OHP v/c Std.	Direction	
		NB	SB
Mainline north of Deschutes Market Rd	0.70	0.52	0.37
Nichols Market Rd/Deschutes Market Rd Off-ramp diverges	0.70	0.49	0.36
Nichols Market Rd/Deschutes Market Rd On-ramp merges	0.70	0.49	0.35
Mainline south of Deschutes Market Rd	0.70	0.49	0.37
US97 Business Off-ramp diverge	0.80		0.53
Mainline US20 NB Flyover ramp from 3rd St	0.85	0.34	
Mainline US20 SB ramp to 3rd St	0.85		0.53
Sister's Loop ramp to US20	0.85	0.33	
Mainline north of Empire Ave[3]	0.80	0.70	0.39
Mainline between Empire Ave ramps	0.80	0.68	0.39
Empire Ave On-ramp merge	0.80		0.54
Empire Ave Off-ramp diverge	0.80	0.72	
Mainline south of Empire Ave	0.80	**0.81**	0.62
Butler Market Rd Off-ramp diverge	0.80		0.55
Butler Market Rd On-ramp merge	0.80	0.70	
Mainline south of Butler Market Rd ramps	0.80	0.72	0.52
US20 (3rd St) NB On-Ramp to US97 merge	0.80	0.62	

[1]Blackened cells indicate that the applicable OHP v/c standard has been exceeded.
[2]NB= Northbound, SB= Southbound
[3]The northbound mainline segment is a weaving section, so the weaving v/c ratio controls the operation of the segment.

Preliminary Signal Warrants

Preliminary Signal Warrant (PSW) criteria were analyzed for all of the unsignalized intersections included in the study area. PSW's are from the Manual of Uniform Traffic Control Devices (MUTCD) Warrant #1 Case A and B. Case A and B deal primarily with high volumes on the minor street and high volumes on the major street respectively.

Meeting PSW's does not guarantee that a traffic signal will be installed. Region Traffic staff will need to perform a intersection traffic control study in which the Region Traffic Engineer will forward the recommendation to the State Traffic Engineer's office. Traffic signal warrants must be met and the State Traffic Engineer's approval obtained before a traffic signal will be installed on a state highway.

Table 8 shows the 2007 PSW status for the unsignalized intersections in the project area. All of the unsignalized intersections in the project area do not meet PSW's except for the US20 & Old Bend-Redmond Highway intersection. This intersection is outside of the urban growth boundary and has a rural nature, so signalizing is not desirable. In addition, Region 4 Traffic does not support a signal at this location.

Table 8: Year 2007 Preliminary Signal Warrants[1]

Intersection	PSW Met?
Tumalo Rd & Nichols Market Rd	No
Tumalo Road & Deschutes Market Rd	No
US97 & Grandview Dr	No
US97 & Clausen Rd	No
Old Bend-Redmond Hwy & O.B. Riley Rd	No
US20 & Old Bend-Redmond Hwy	**Yes**
Cooley Rd & O.B. Riley Rd	No
US20 & Cooley Rd	No
Cooley Rd & Hunnell Rd (south)	No
Cooley Rd & Hunnell Rd (north)	No
Cooley Rd & Boyd Acres Rd	No
US20 & Jamison St	No
Robal Rd & Nels Anderson Dr	No
Nels Anderson Dr & Nels Anderson Pl	No
US97 & Nels Anderson Pl/Cascade Village	No
O.B. Riley Rd & Empire Ave	No
Empire Ave & Britta St	No
Empire Ave & Jamison St	No
Empire Ave & Sherman Rd/Industrial Park Blvd	No
Empire Ave & Nels Anderson Rd/SB US 97 Ramp Terminal	No

[1]Black shaded cells indicate that preliminary signal warrants (PSW's) have been met. Meeting PSW's does not guarantee that a traffic signal will be installed. Region Traffic staff will need to perform an intersection traffic control study in which the Region Traffic Engineer will forward the recommendation to the State Traffic Engineer's office. Traffic signal warrants must be met and the State Traffic Engineer's approval obtained before a traffic signal will be installed on a state highway.

Unsignalized Intersections

In 2007, congestion problems at unsignalized intersections are concentrated in a few areas. Volume to capacity ratios, level of service, and approach delay are well under standards in most of the project area. Table 9 shows the state-jurisdiction unsignalized intersections, while Table 10 and Table 11 show the city and county locations, respectively.

Most of the unsignalized intersections along US20 west of the US97/3rd Street connections are at or over capacity for the stopped side-street approaches. Volume-to-capacity ratios in excess of 1.0 indicate that sufficient gaps in traffic are limited. Ratios in excess of 2.0 indicate that no sufficient gaps are available and vehicles must use a shorter gap to turn onto or travel across a roadway, risking a crash.

Table 9: Year 2007 State Highway Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	OHP v/c Std.	v/c Ratio[1]	Critical Movement[2]
US97 & Bowery Ln	0.70/0.80	0.58/0.03	NBT/EBLR
US97 & Grandview Dr	0.80/0.90	0.55/0.31	SBTR/EBLR
US97 & Clausen Rd	0.80/0.90	0.59/0.09	SBTR/EBR
US97 & Lowe's Dwy	0.80/0.90	0.44/0.12	SBTR/EBR
US97 & Chavre Wy	0.80/0.90	0.59/0.04	NBTR/WBR
US97 & Target Dwy	0.80/0.90	0.42/0.59	SBTR/EBR
US20 & Old Bend-Redmond Hwy	0.70/0.80	**0.32/1.0+**	NBT/WBLTR
US20 & Mountainview Dr	0.70/0.80	0.39/0.11	NBT/WBLR
US20 & Cooley Rd	0.80/0.90	**0.57/1.0+**	SBT/WBTR
US20 & Jamison St	0.80/0.90	**0.59/0.92**	SBTR/EBLR
US97 & Nels Anderson Pl/ Cascade Village Dwy	0.80/0.90	0.79/0.48	NBTR/EBR
Empire Ave & Nels Anderson Rd/ SB US 97 Ramp Terminal	0.85/0.90	**0.66/1.0+**	EBTR/SBLTR

[1]Black shaded cells indicate the applicable OHP mainline/stopped approach v/c standard has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

Other problem areas include Empire Avenue from US20 to the northbound US97 (Bend Parkway) ramp terminal. Volumes are high enough along Empire Avenue to make turns from unsignalized intersections difficult with high levels of delay. The Nels Anderson approach at the SB US97 ramp terminal is at capacity, however the eastbound through-right and westbound left movements onto the ramp are significantly under standard at 0.66 and 0.54, respectively.

Table 10: Year 2007 City Street Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	v/c Ratio[1]	Delay (s)	Critical Movement[2]
Cooley Rd & Scenic Dr	0.13/0.01	0.0/10.8	WBTR/SBLR
Cooley Rd & Hunnell Rd (south)	0.10/0.01	0.0/13.3	WBTR/SBLTR
Cooley Rd & Hunnell Rd (north)	0.22/0.19	0.0/16.9	EBTR/SBLTR
Cooley Rd & Loop Rd/Lowe's Dwy	0.22/0.04	0.0/11.3	EBTR/NBLTR
Cooley Rd & Boyd Acres Rd	0.01/0.20	0.3/16.5	EBLTR/NBLTR
Robal Rd & Auto Mall Dwy	0.22/0.07	0.0/12.0	EBTR/NBLTR
Robal Rd & Target Dwy	0.14/0.14	0.0/10.2	WBT/SBR
Robal Rd & Cascade Village Dwy	0.22/0.13	0.0/11.6	EBTR/NBR
Robal Rd & Nels Anderson Dr	0.38/0.17	10.5/8.4	NBLT/EBLR
Nels Anderson Dr & Chavre Wy	0.06/0.0	9.4/5.2	NBLT/EBLR
Nels Anderson Dr & Nels Anderson Pl	0.07/0.11	0.0/11.4	SBTR/EBLR
O.B. Riley Rd & Empire Ave	0.10/0.31	5.5/16.6	SBLTR/WBLT
Empire Ave & Britta St	0.13/0.13	0.0/12.2	WBT/SBL
Empire Ave & Jamison St	0.24/0.54	0.0/22.2	WBTR/SBLR
Empire Ave & Sherman Rd/Industrial Park Blvd	**0.60/1.0+**	**0.0/120+**	EBTR/SBLTR
Empire Ave & Blenheim/Corporate Pl	0.31/0.27	0.0/27.2	WBTR/NBLTR

[1]Black shaded cells indicate the City v/c of 1.0 and/or the 50 second delay standard for unsignalized intersection has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

Table 11: Year 2007 County Road Unsignalized Intersection Operations for Critical Major and Minor Approaches[1]

Intersection	LOS	Critical Movement[2]
Tumalo Rd & Nichols Market Rd	A/B	EBL/SBLTR
Tumalo Road & Deschutes Market Rd	A/B	WBTL/NBLR
Old Bend-Redmond Hwy & O.B. Riley Rd	A/A	SBTL/WBLR
Cooley Rd & O.B. Riley Rd	A/A	SBTL/WBLR
Rogers Rd & Hunnell Rd	A/A	NBTL/EBLR
Bowery Ln & Harris Wy	A/A	EBTL/SBLR

[1]County operational standards are LOS D for existing facilities.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

Signalized Intersections

The signalized intersections along US97 are at or approaching capacity. Like with the unsignalized intersections, the high volumes of traffic on US20 (3rd Street) and Empire Avenue have the US20 & Empire Avenue intersection over standard (Table 12). The City-controlled signalized intersections on Empire and Robal shown in Table 13 are well under standards.

Table 12: Year 2007 State Highway Signalized Intersection Operations

Intersection	OHP v/c Std.	v/c Ratio[1]
US97 & Cooley Rd	0.80	**1.10**
US97 & Robal Rd	0.80	**0.91**
US20 & Robal Rd	0.80	0.70
US20 (3rd St) & Empire Ave	0.85	**0.89**
Empire Ave & NB US97 Ramp Terminal	0.85	0.74

[1]Black shaded cells indicate the applicable OHP v/c has been exceeded.

Table 13: Year 2007 City Street Signalized Intersection Operations[1]

Intersection	v/c Ratio	Delay (s)
Robal Rd & Hunnell Rd	0.38	20.2
Empire Avenue & Boyd Acres Rd	0.54	26.8

[1]City operational standards are a v/c of 1.0 and/or 80 seconds of intersection delay.

Queuing

The queues and other measures of effectiveness (MOE) were created by averaging at least five random SimTraffic micro-simulation runs together. Field collected headway, driver reaction time, turning speeds, and spot speed data in addition to visual observation and Region 4 local knowledge was used to calibrate the SimTraffic model as best as possible to 30th highest hour conditions. Appendix P gives more detail on the simulation calibration. Queues shown on the figures are a combination of stopped vehicles and vehicles traveling at seven or less miles per hour.

Appendix F shows the 95th percentile queues for the 2007 existing conditions. Along US97, the high level of commuter through traffic between Redmond and Bend is causing the majority of the queuing as vehicles bunch up between relatively free-flow sections north and south of the Cooley-Robal area.

In 2007, there is significant queuing on US97 between Clausen Road and Nels Anderson Place, on Cooley and Robal Roads around the US97 intersections, and along Empire Avenue from Jamison Street to the US97 interchange. Closely spaced intersection and commercial driveway approaches are being blocked by the queues radiating from the US97

intersections with Cooley and Robal Roads. In addition, northbound US97 traffic slows substantially north of Butler Market Road because of high through volumes mixing with traffic coming and going on closely spaced on and off ramps in this section. The slowdown section tapers out as vehicles accelerate away from the Empire Avenue area. Some of this congestion is caused by the Empire Avenue northbound off-ramp backing into the US97 mainline.

An additional measure for queuing is the percent time blocked for turn storage bays and intersections. The queuing figures show the extent of the queuing and the percent time blocked shows how much of the peak hour that these queues block significant transportation elements. Blocking percentages of five percent or greater are considered significant as these levels can have a measurable effect on an intersection's operation.

Table 14 shows the percent time a turn lane or an intersection is blocked for the 2007 existing conditions. Significant queue blocking is substantial throughout the study area with most problems being left turn lanes blocked by adjacent through queues from 10% to 50% of the peak hour. Most of the long-lasting queuing problems are on US97 between Cooley Road to Butler Market Road and along Empire Avenue. Many closely spaced intersections also are showing significant blocking times such as between US20 (3rd St) and Jamison Street on the west and Industrial Park Boulevard on the east on Empire Avenue; between the ramp terminals at the Empire Avenue interchange; and between the closely spaced US20 and Butler Market on-ramps on northbound US97. In addition, queues are filling up the northbound Empire Avenue off-ramp and affecting northbound US97 traffic over a quarter of the peak hour.

Table 14: Year 2007 No-build Significant Queue Blocking[1]

Intersection	Approach[1]	Blocked Lane	Blocked Intersection	Average Percent Time Blocked
US97 & Cooley Rd	EB	L		35
			Loop Rd/ Lowe's Dwy	13
	WB	L		11
	NB	L		12
	SB	L		18
			Clausen Dr	8
US97 & Robal Rd	WB	TR		32
	NB	L		14
	SB	L		18
			Target Dwy	28
US97 & Butler Market Rd NB On-ramp	NB		US20 (3rd St) NB On-ramp	13
US20 & Cooley Rd	WB	L		23
US20 & Robal Rd	WB	L		8
US20 (3rd St) & Empire Ave	EB		Jamison St	51
	WB	L		28
			Industrial Park Blvd/Sherman Rd	9
	NB	L		36
	SB	L		17
Robal Rd & Hunnell Rd S	SB	L		13
Empire Ave & Industrial Park Blvd/Sherman Rd	WB	L		6
Empire Ave & Nels Anderson Rd/US97 SB On-ramp	WB	L		54
			US97 NB Ramps	17
Empire Ave & US97 NB Ramps	WB		Corporate Pl/Blenhiem Pl	21
	NB		US97	28
Empire Ave & Boyd Acres Rd	NB	L		12

[1]NB = Northbound, SB = Southbound, EB= eastbound, WB = Westbound, L= exclusive left turn lane, TR = shared through-left-right lane.

Other Operational Performance Measures

Tables 15 and 16 show additional MOE's for the project area which includes all modeled roadways (see Appendix E). The micro-simulation runs used for the queuing analysis were also used so the results would be consistent. MOE's allow comparisons to be made on a

system-wide basis. Generally, lower delays, lower number of stops, lower travel time and higher average speed show a more efficient system.

Table 15 shows the system-level MOE's. The Average Speed MOE is the speed of all vehicles completely or partially traveling this path averaged over each segment between intersections. The Total Stops MOE shows how many times, on the average, the total number of vehicles would stop either at an intersection or substantially slowed down enough in a queue. The Delay MOE is the total delay for all of the vehicles in the project roadway network for the peak hour whether stopped or not. The Travel Time MOE is accumulated travel time of all vehicles completely or partially the project area roadways in the design hour.

Table 15: Year 2007 No-build Overall Simulation Measures of Effectiveness

Measure of Effectiveness
Average Speed = 22 mph
Total Stops[1] = 25,800
Delay = 740 hr
Travel Time =1,485 hr

[1]A stop is recorded every time a vehicle drops below 7 mph (crawl speed). A vehicle might have multiple stops on a single intersection approach.

Table 16 shows specific per-vehicle MOE's for travel time and average speed for specific roadway segments. The effects of the congestion and signals on US97 and the 3rd Street portion of US20 can be seen with a 10 mph reduction in average speed from the posted 45 mph. The congestion on city roadways is evident because of the low average speeds (less than half of the posted speed limit). An exception is O.B. Riley Road as it is substantially unaffected with a 43 mph average speed compared to its 45 mph posted speed.

Table 16: Year 2007 No-build Segment Travel Time and Speed

Segment	Travel Time per vehicle (min:s)	Average Speed (mph)
US97 (Deschutes Pleasant Ridge Rd – Butler Market Rd)	11:15	32
US20 (Old Bend-Redmond Hwy – Empire Ave)	3:30	35
O.B. Riley Rd (Old Bend-Redmond Hwy –Empire Ave)	2:25	43
Empire Ave (O.B. Riley Rd – Boyd Acres Rd)	3:20	14
Cooley Rd (O.B. Riley Rd – Boyd Acres Rd)	5:00	15
Robal Rd (US20 – Nels Anderson Rd)	2:20	12

Spacing Standards

Appendix C in the OHP has spacing standards for public road approaches and private accesses to be used in the planning process. The following spacing standards apply to the US 97 Bend North Corridor Solutions project:

- Interchange-to-interchange: three miles for a rural expressway and 1.9 miles for an urban expressway or statewide highway based on cross-road spacing. This standard is for the planning of new interchanges on the state system.
- Ramp-to-ramp/intersection: one mile between two interchanges in access-controlled freeway sections or between an interchange and an at-grade intersection.
- Ramp-to-Ramp: one-half mile between the taper sections of intersections or adjacent on and off-ramps.
- Next intersection adjacent to ramp terminal: 1320 feet for a two or multi-lane crossroad in an urban area to the next full or right-in/right-out intersection.
- Street spacing: One mile at 55 mph for a rural expressway; 2640 feet for streets at 45 mph on a urban expressway; and 990 feet for a urban statewide highway. There is no standard for private accesses as they are discouraged on statewide highways and expressways.

Table 17 shows the comparison between major road segments and their appropriate spacing standard. On US97, the existing street, ramp and interchange spacing is substantially under the applicable standards. The interchange spacing is only about a third of the 1.9 mile standard with interchanges spaced approximately one-half mile apart from Empire Avenue to Butler Market Road. Interchange ramp-to ramp spacing is generally only about a quarter-mile apart instead of the one mile standard which will likely lead to congestion issues with higher volumes. Street spacing is also a third to half of the required levels.

On US20, the street spacing is just under the standard between Cooley and Robal Roads but is less than a third of the required spacing between at-grade intersections and the US97/US20/3rd Street interchange connections. Along Empire Avenue at the US97 interchange, the ramp terminal spacing standard is not met as there are nearby full access intersections 300’ away on the west and about 800’ on the east. The signalized US20 (3rd Street) & Empire Avenue intersection is only about 850’ away from the southbound ramp terminal, so meeting the spacing standard will not be possible even under the best conditions.

There are relatively few private accesses on US97 north of Cooley Road, with only the Lowe’s, Target, and Cascade Village Mall right-in/right-out driveways between Cooley and the US97 Business Southbound off-ramp. US97 from the Cascade Village Mall access south through Butler Market Road is access-controlled with the only connections being interchanges. Like US97, the northern section of US20 has very few accesses north of Empire Avenue. From Empire Avenue south, US20 is an uncontrolled five-lane section with many driveways.

Table 17: Spacing Standards Comparison

Roadway	Segment	Spacing Standard	Existing Conditions[1]
	Deschutes Market Rd – Fort Thompson Ln	1 mi	**<2500 ft[2]**
US97	Fort Thompson Ln – Grandview Dr	1 mi	**200- 600 ft[2]**
	Grandview Dr – Clausen Rd	2640 ft	**1000 ft**
	Clausen Rd – Cooley Rd	2640 ft	**1110 ft**
	Cooley Rd - Robal Road	2640 ft	**400 - 600 ft[2]**
	Robal Road – Nels Anderson Pl	2640 ft	**800 ft**
	Nels Anderson Pl – US97 BUS/US20 Ramps	1 mi	**950 ft**
	US97 BUS/US20 Ramps – Empire Ave Ramps	1 mi	**1060 ft**
	US97 BUS/US20 Overcrossing – Empire Ave Overcrossing	1.9 mi	**2590 ft**
	Empire Avenue Ramps – Butler Market Rd Ramps	1 mi	**1270 ft**
	Empire Ave Overcrossing – Butler Market Rd Undercrossing	1.9 mi	**4490 ft**
US20	Old Bend-Redmond Highway – Cooley Rd	1 mi	**300 - 1700 ft[2]**
	Cooley Rd – Robal Rd	2640 ft	**2220 ft**
	Robal Rd – Jamison St	2640 ft	**1530 ft**
	Jamison St – 3rd St Connections	1 mi	**1640 ft**
	3rd St Connections – Empire Ave	1 mi	**1530 ft**
	Empire Ave – project limits	990 ft	**<300 ft[2]**
Empire Ave	Sherman Rd – Nels Anderson Rd/SB US97 On-ramp	1320 ft	**300 ft**
	US97 NB Off-ramp – Corporate/Blenhiem Pl	1320 ft	**780 ft**

[1]Black-shaded cells mean that the interchange/ramp/street spacing is less than the corresponding standard.
[2]Approximate approach (road or driveway) spacing over segment

YEAR 2015 & 2035 NO-BUILD FUTURE CONDITIONS

Future Travel Trends

An analysis was undertaken to determine the future general travel trends throughout the project area using the Bend MPO travel demand model. These travel trends illustrate the traffic patterns on a regional scale both in distribution across areas in Bend as well as identifying the longer distance through trips versus the short local trips.

The 2030 Metropolitan Transportation Plan (MTP) fiscally constrained model scenario was not completed at the time of this analysis, so the 2030 Committed (No-build) scenario was used in combination with the 2003 existing road network which created a true future no-build scenario. Given no changes to the road system, this is what is projected. The major findings are shown below and more detailed travel patterns and results are in Appendix G.

- Through the project study area, 10% of trips on US 20 and 25% on US 97 are through trips. This low through trip percentage indicates that there will be a high amount of trip ends in the project area which may cause intersection/interchange design issues regardless of alternative.
- Around 33% of the local trips are “short hops” on the Parkway (US97) between one or two interchanges.
- At least 50% of the trips on US 97 between Empire Avenue and Cooley Road are “short-hop” (local) trips.
- Over 50% of the trips using Empire Avenue are local trips beginning or ending in adjacent neighborhoods that do not access the Parkway.
- Trips using US 97 are much more likely to originate or terminate in Bend as they are primarily local or commuter-based, while trips that use US 20 are more likely to be long-distance trips.

A large portion of trips use US97 for short distances mainly because US97 is the most attractive route given the overall time savings when compared to the local system. These short-hops cause significant congestion issues at intersections and interchanges with US97. Generally, if capacity was never an issue, traffic would favor the major routes in the project area: US97, US20, 3rd Street, and Empire Avenue. Traffic congestion causes bottlenecks and traffic flows respond by diverting to longer, slower routes. The need to restrict access to US97 to the most important connections and to have sufficient parallel local facilities was determined in part from this trend information. These trends/patterns are also implicitly included in all of the future traffic development as the MTP model scenario will have similar results.

Traffic Development

To create future year 2015 and 2035 volumes, the Bend Metropolitan Planning Organization (BMPO) travel demand model was used. Travel demand models are a combination of mathematical equations and relationships using locally-provided existing and future housing and employment information to project future traffic conditions. These future conditions are placed on a network which is similar to the actual roadway network. The model is based on the current comprehensive land use plans of Deschutes County and the City of Bend. Growth beyond the current comprehensive plans will result in higher impacts than what is shown here.

Significant approved developments were reviewed to see if the population and employment assumptions were consistent with the model assumptions. The only significant approved development in the area is the Les Schwab headquarters development which is part of the first phase of the Juniper Ridge area northeast of the US97 & Cooley Road intersection. The development is consistent with the future model assumptions so no new trips are needed to be added to the network. There is a potential Wal-Mart development in the northwest quadrant of the US 97 & Cooley Road intersection; however, that development is also consistent with the model, so if that development gets approved in the short-term, the future volumes will not need to be revised.

The model application effort used the MTP scenario to develop the future no-build volumes. The MTP scenario is financially constrained which means that all the city, county and state projects (outside of the US97 Bend North Corridor Solutions project) in and around the Bend metropolitan area that can be funded within the next 20 years are included. These projects are assumed to occur regardless of what happens in the US97 Bend North Corridor project area. The Bend Comprehensive (General) Plan map and the MTP project list are included in Appendix D.

The volumes were post-processed using procedures from the National Cooperative Highway Research Council (NCHRP) Report 255. Model base and future year volumes are compared to develop a relative difference between scenarios. This difference was applied to the existing 2007 30th highest hour volumes to arrive at the 2035 no-build volumes used in the analysis. The 2015 no-build volumes were interpolated using straight-line growth from the 2007 existing conditions and the 2035 no-build volumes. Appendix D details the future volumes development. The 2015 Future No-build volumes are shown in Appendix H and the 2035 Future No-Build Volumes are shown in Appendix I.

There is a very large amount of new employment and housing in and around the Cooley Road area (not including any new Juniper Ridge urban growth boundary expansions). The amount of projected growth in the study area is reflected by the large change in volumes. US97 north of Robal Road jumps 32% from 44,500 ADT in 2007 to 58,700 ADT in 2035. Average daily traffic approaching 60,000 on US97 will likely spread the peak period across multiple hours. A 50% increase occurs on US20 west of Robal Road where it increases from 27,500 in 2007 to 41,200 ADT in 2035.

Cooley Road and Empire Avenue are carrying a much larger share of the east-west traffic in 2035 as the volume demand shifts north over time as significant road improvements are completed. Cooley Road is extended to Deschutes Market Road while Empire Avenue is completed and widened to 27th Street. The volumes on Cooley Road on both sides of US97 increase about three times over the 2007 existing conditions which will overwhelm the existing two-lane roadway. Cooley Road west of US97 goes from 7,100 ADT in 2007 to 23,800 in 2035. Similarly, Cooley Road east of US97 increases from 8,200 ADT in 2007 to 23,100 ADT in 2035. Volumes on Empire Avenue also increase substantially resulting in a potentially congested corridor by 2035. For example, Empire Avenue ADT between the US97 ramp terminals almost doubles from 18,200 to 35,900.

Analysis Results

Mainline & Merge/Diverge/Weave Segments

Table 18 shows the volume-capacity ratios for the mainline free-flow segments, ramps, and merge/diverge/weave sections in the study area. In 2015, all sections of US 97 are operating acceptably except for the northbound section between the Butler Market Road on-ramp and the Empire Avenue off-ramp. The section from US20 to Butler Market Road is just below the OHP 0.80 v/c standard as well.

In 2035, the rural sections of US 97 in the Deschutes Market Road area are acceptable in the southbound direction. Higher outbound (northbound) commuter flows in the afternoon push the section north of Deschutes Market Road to over the OHP 0.70 v/c standard and the rest of the section is at the standard. In the urban sections, northbound US97 is over or near capacity from the south of Butler Market Road to north of Empire Avenue. The southbound direction is over or near the OHP standard from the Empire Avenue interchange south.

The over standard mainline sections of US97, especially south of the project limits, will increase congestion for traffic entering and leaving the project area. Any substantial improvements within the project results in traffic reaching the limits faster, thus increasing congestion at these points until subsequent no-build mainline sections are improved. The section south of Empire Avenue would act as a transition section between the at-capacity sections south of Butler Market Road and the improved sections north of Empire Avenue.

Table 18: Year 2015 and 2035 No-build US97 Mainline and Merge/Diverge/Weave V/C Ratios[1,2]

Section	OHP v/c Std.	Direction			
		2015		2035	
		NB	SB	NB	SB
Mainline north of Deschutes Market Rd	0.70	0.57	0.40	**0.72**	0.50
Nichols Market Rd/ Deschutes Market Rd Off-ramp diverges	0.70	0.53	0.39	0.67	0.43
Nichols Market Rd/ Deschutes Market Rd On-ramp merges	0.70	0.53	0.37	0.69	0.46
Mainline south of Deschutes Market Rd	0.70	0.54	0.39	0.69	0.49
US97 Business Off-ramp diverge	0.80		0.54		0.61
Mainline US20 NB Flyover ramp from 3rd St	0.85	0.37		**0.97**	
Mainline US20 SB ramp to 3rd St	0.85		0.59		**0.83**
Sister's Loop ramp to US20	0.85	0.37		0.49	
Mainline north of Empire Ave[3]	0.80	0.76	0.40	**0.93**	0.50
Mainline between Empire Ave ramps	0.80	0.72	0.40	**0.92**	0.50
Empire Ave On-ramp merge	0.80		0.58		0.77
Empire Ave Off-ramp diverge	0.80	0.78		**1.02**	
Mainline south of Empire Ave	0.80	**0.88**	0.67	**1.16**	**0.88**
Butler Market Rd Off-ramp diverge	0.80		0.59		0.78
Butler Market Rd On-ramp merge	0.80	0.76		**1.00**	
Mainline south of Butler Market Rd ramps	0.80	0.79	0.56	**1.06**	0.78
US20 (3rd St) NB On-Ramp (on US97) merge	0.80	0.68	0.67	**0.93**	

[1]Blackened cells indicate that the v/c standard has been exceeded.
[2]NB=Northbound, SB=Southbound
[3]The northbound mainline segment is a weaving section, so the weaving v/c ratio controls the operation of the segment. Because of the high weaving flows, the operation of the weaving section will likely be worse than predicted.

Preliminary Signal Warrants

Table 19 shows the results from the 2015 and 2035 preliminary signal warrant (PSW) analysis. In 2015, three intersections meet the PSW criteria: US20 & Old Redmond-Bend Hwy, US20 & Cooley Road, and O.B. Riley Road & Empire Avenue. Although the US20 & Old Bend-Redmond Highway intersection is over the OHP v/c standard, its rural location makes it an undesirable for a signal because of safety concerns with the potential for high-speed crashes. In addition, Region 4 is not supportive of a signal at this intersection.

The US20 & Cooley Road intersection is likely still too rural in character to be signalized until development changes the surrounding area. Region 4 is supportive of a signal here combined with speed and access changes (for example, closing the south side of the Old Bend-Redmond intersection) along US20 as part of future development mitigation. Development is likely to occur before 2015 in the Cooley Road vicinity and is part of the overall future growth assumptions, so this intersection was assumed to be signalized for 2015 and 2035. Without this assumption, the intersection v/c and delays are too high which

causes unrealistic analysis and simulation results along Cooley Road and the northern project area.

Additional development after 2015 will likely drive the O.B. Riley Road & Empire Avenue intersection signalization, so this likely improvement (signalization) is shown in the 2015 and 2035 analyses. The future volumes here are too high for a single lane roundabout. Assuming widening would occur here in the project horizon (not in the MTP) to accommodate a multiple-lane roundabout is not likely, so only a traffic signal was assumed. The City does have future plans to improve this intersection. Northbound and southbound left turn lanes were added to O.B Riley Road in both 2015 and 2035 with permissive-protected phasing as a companion improvement with signalization.

Table 19: Year 2015 & 2035 No-Build Preliminary Signal Warrants[1]

Intersection	PSW Met?	
	2015	2035
Tumalo Rd & Nichols Market Rd	No	No
Tumalo Road & Deschutes Market Rd	No	No
US97 & Grandview Dr	No	No
US97 & Clausen Rd	No	No
Old Bend-Redmond Hwy & O.B. Riley Rd	No	**Yes**
US20 & Old Bend-Redmond Hwy	**Yes**	**Yes**
Cooley Rd & O.B. Riley Rd	No	**Yes**
US20 & Cooley Rd	**Yes**	**Yes**
Cooley Rd & Hunnell Rd (south)	No	**Yes**
Cooley Rd & Hunnell Rd (north)	No	**Yes**
Cooley Rd & Boyd Acres Rd	No	No
US20 & Jamison St	No	**Yes**
Robal Rd & Nels Anderson Dr	No	No
Nels Anderson Dr & Nels Anderson Pl	No	No
US97 & Nels Anderson Pl/Cascade Village	No	No
O.B. Riley Rd & Empire Ave	**Yes**	n/a[2]
Empire Ave & Britta St	No	No
Empire Ave & Jamison St	No	**Yes**
Empire Ave & Sherman Rd/Industrial Park Blvd	No	**Yes**
Empire Ave & Nels Anderson Rd/SB US 97 Ramp Terminal	No	No

[1]Black shaded cells indicate that preliminary signal warrants (PSW's) have been met. Region Traffic staff will need to perform a intersection traffic control study in which the Region Traffic Engineer will forward the recommendation to the State Traffic Engineer's office. Traffic signal warrants must be met and the State Traffic Engineer's approval obtained before a traffic signal will be installed on a state highway.
[2]This intersection will be signalized (or a roundabout installed) before 2035.

By 2035, many of the high volume corridors such as Empire Avenue and Cooley Road cause the significant unsignalized intersections to meet PSW's. Many of these intersections are in urban enough areas to be signalized. However, too many signals on a given roadway lowers the progression bandwidth (makes it harder to progress traffic through the system

quickly), increases travel time and decreases capacity (throughput) of the main roadway. Seven additional intersections met PSW's for 2035.

The US20 & Jamison Street intersection is not a desirable location because its close proximity to the US97/US20/3rd Street interchange connections. This intersection was originally built for emergency services access, never intending to act as a full intersection. The build alternatives will modify the roadways in this area and will close this approach.

Improving the Cooley Road intersections with the north and south portions of Hunnell Road will be driven by development. By 2035, this area is projected to be well developed, so signals were assumed at these two locations by then. If the Cooley Road intersection with Loop Rd/Lowe's is closed anytime in the future, development agreements state that the Cooley Road & Hunnell Road N/Lowe's intersection will be signalized.

The intersections of Old Bend-Redmond Highway and Cooley Road with O.B. Riley Road also are projected to meet PSW's. For 2035, a roundabout was assumed for the Old Bend-Redmond location as operations can affect the adjacent US20 intersection; while the Cooley Road location was left unchanged. The Jamison Street and Industrial Boulevard intersections on Empire were assumed to be unsignalized in the analysis as they are too close to the US20 (3rd Street) intersection, are directly affected by the project, and would not be a good choice for signalization.

Unsignalized Intersections

In 2015, the unsignalized minor roadway and private approaches along US97 operate well under standards (Table 20). Along US20, the mainline unsignalized approaches are under standards, but limited gaps in traffic for turning vehicles cause the intersections with Old Bend-Redmond Hwy and Jamison Street to exceed capacity. Vehicles may use much smaller gaps than standard, risking a crash by doing so.

Congestion of the city intersections (Table 21) is limited to Empire Avenue from Jamison Street to the US97 interchange. Delays exceed two minutes at many approaches and some movements have a v/c of greater than 2.0 (no safe gaps available). Long queues extending through most of the peak hour block nearby intersections increasing the congestion. Most of this congestion radiates from the US20 (3rd Street) & Empire Avenue intersection which is over capacity. Outside of the urban growth boundary, no congestion issues exist (Table 22).

Table 20: Year 2015 State Highway No-Build Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	OHP v/c Std.	v/c Ratio[1]	Critical Movement[2]
US97 & Bowery Ln	0.70	0.61/0.03	NBT/EBLR
US97 & Grandview Dr	0.80	0.62/0.34/	NBT/EBLR
US97 & Clausen Rd	0.80	0.62/0.10	SBTR/EBR
US97 & Lowe's Dwy	0.80	0.47/0.12	SBT/EBR
US97 & Chavre Wy	0.80	0.63/0.05	NBTR/WBR
US97 & Target Dwy	0.80	0.63/0.43	EBR/SBT
US20 & Old Bend-Redmond Hwy	0.70	**0.31/2.0+**	NBT/WBLTR
US20 & Mountainview Dr	0.70	0.44/0.15	NBT/WBLR
US20 & Jamison St	0.80	**0.66/1.43**	SBTR/EBLR
US97 & Nels Anderson Pl/Cascade Village Dwy	0.80	0.84/0.55	NBTR/EBR
Empire Ave & Nels Anderson Rd/ SB US 97 Ramp Terminal	0.85	**0.88/2.0+**	WBL/SBLTR

[1]Black shaded cells indicate the applicable OHP v/c standard has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

By 2035, US97 volumes have increased enough to have the unsignalized intersection mainline approaches reach or exceed the OHP v/c standards (Table 23). These minor intersections start exceeding standards in 2026. The US97 & Nels Anderson Place/Cascade Village Mall intersection is the worst unsignalized bottleneck. The northbound left has no safe gaps in southbound traffic, so vehicles that try it will be risking a serious crash. Exiting the mall will be difficult because of limited gaps; so long delays and queues are expected. Most of the intersections along US20 are approaching or over capacity, so poor side-street operation will be expected.

Table 21: Year 2015 City Street No-Build Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	v/c Ratio[1]	Delay (s)	Critical Movement[2]
Cooley Rd & Scenic Dr	0.20/0.02	0.0/12.6	WBTR/SBLR
Cooley Rd & Hunnell Rd (north)	0.23/0.63	0.0/27.0	EBTR/SBLTR
Cooley Rd & Hunnell Rd (south)	0.18/0.36	0.0/22.8	WBTR/NBTR
Cooley Rd & Loop Rd/Lowe's Dwy	0.28/0.16	0.0/19.9	EBTR/SBLTR
Cooley Rd & Boyd Acres Rd	0.04/0.36	1.2/29.9	WBLTR/NBLTR
Robal Rd & Auto Mall Dwy	0.27/0.08	0.0/13.2	EBTR/WBL
Robal Rd & Target Dwy	0.15/0.15	0.0/10.4	WBT/SBR
Robal Rd & Cascade Village Dwy	0.24/0.14	0.0/11.6	EBTR/NBR
Robal Rd & Nels Anderson Dr	0.18/0.42	8.6/11.3	EBLT/NBLT
Nels Anderson Dr & Chavre Wy	0.07/0.00	9.4/5.2	NBLT/EBLR
Nels Anderson Dr & Nels Anderson Pl	0.07/0.20	0.0/12.4	SBTR/EBLR
Empire Ave & Britta St	0.16/0.20	0.0/14.1	WBT/SBL
Empire Ave & Jamison St	0.27/0.72	**0.0/120+**	WBTR/SBLR
Empire Ave & Sherman Rd/Industrial Park Blvd	**0.68/2.0+**	**0.0/120+**	EBTR/SBLTR
Empire Ave & Blenheim/Corporate Pl	0.36/0.30	0.0/29.9	WBTR/NBLTR

[1]Black shaded cells indicate the applicable City v/c of 1.0 and/or the 50 second delay standard for unsignalized intersection has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

Table 22: Year 2015 County Road No-Build Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	LOS[1]	Critical Movement[2]
Tumalo Rd & Nichols Market Rd	A/B	EBL/SBLTR
Tumalo Rd & Deschutes Pleasant Ridge Rd	A/B	WBLT/NBLR
Tumalo Road & Deschutes Market Rd	A/C	EBL/NBLR
Old Bend-Redmond Hwy & O.B. Riley Rd	A/B	SBLT/WBLR
Cooley Rd & O.B. Riley Rd	A/B	SBLT/WBLR
Rogers Rd & Hunnell Rd	A/A	NBLT/EBLR
Bowery Ln & Harris Wy	A/A	EBLT/SBLR

[1]County operational standards are LOS D for existing facilities.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

Table 23: Year 2035 State Highway No-Build Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	OHP v/c Std.	v/c Ratio[1]	Critical Movement	Year Exceeded	
				Std.	Cap.
US97 & Bowery Ln	0.70	**0.78/0.07**	SBTR/EBLR	2026	2040+
US97 & Grandview Dr	0.80	0.77/0.43	SBTR/EBLR	2040+	2040+
US97 & Clausen Rd	0.80	**0.82/0.19**	SBTR/EBR	2034	2040+
US97 & Lowe's Dwy	0.80	0.60/0.12	SBT/EBR	2040+	2040+
US97 & Chavre Wy	0.80	0.80/0.09	NBTR	2036	2040+
US97 & Target Dwy	0.80	**0.53/0.91**	SBT/EBR	2035	2040+
US20 & Old Bend-Redmond Hwy	0.70	**0.49/2.0+**	NBL/WBLTR	<2007	<2007
US20 & Mountainview Dr	0.70	0.61/0.62	NBT/WBLR	2040+	2040+
US20 & Jamison St	0.80	**0.93/2.0+**	SBTR/EBLR	<2007	2009
US97 & Nels Anderson Pl/ Cascade Village	0.80	**2.0+/1.06**	NBL/EBR	2017	2020
Empire Ave & Nels Anderson Rd/SB US 97 Ramp Terminal	0.85	**2.0+/2.0+**	WBL/SBLTR	<2007	<2007

[1]Black shaded cells indicate the OHP 0.70 rural or 0.80 urban v/c for expressways, the 0.80 rural or 0.90 urban v/c for unsignalized stopped approaches or 0.85 for 3rd Street/US20 and ramp terminals has been exceeded.

[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

The Cooley Road intersections with Boyd Acres Road and Loop Road (Lowe's) experience minor approach delays over two minutes by 2018 depending on development (Table 24). Empire Avenue through the study area exceeds the delay and capacity City operational standards by 2015. Long delays and queues are expected around the US97 Empire interchange area. There is a need for Empire Avenue traffic control and lane capacity improvements before 2015 and Cooley Road improvements before 2020.

The County road system is under standard in 2035 with good operations predicted beyond 2040 (Table 25), except at the O.B. Riley Road & Cooley Road intersection. This intersection is predicted to reach LOS E by 2017 and LOS F by 2018 depending on development in the Cooley Road area.

Table 24: Year 2035 City Street No-Build Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	v/c Ratio[1]	Delay (s)	Critical Movement	Year Std. Exceeded
Cooley Rd & Scenic Dr	0.42/0.05	0.0/26.5	WBTR/SBLR	2040+
Cooley Rd & Loop Rd/Lowe's Dwy	0.54/2.0+	**0.0/120+**	EBTR/SBLTR	2021
Cooley Rd & Boyd Acres Rd	0.27/2.0+	**8.3/120+**	WBLTR/NBLTR	2018
Robal Rd & Auto Mall Dwy	0.43/0.26	0.0/22.9	EBTR/SBLTR	2040+
Robal Rd & Target Dwy	0.19/0.18	0.0/11.2	WBT/SBR	2040+
Robal Rd & Cascade Village Dwy	0.16/0.17	0.0/12.9	EBTR/NBR	2040+
Robal Rd & Nels Anderson Dr	0.27/0.64	10.1/16.2	EBLR/NBLT	2040+
Nels Anderson Dr & Chavre Way	0.10/0.00	9.7/3.7	NBLT/EBLR	2040+
Nels Anderson Dr & Nels Anderson Pl	0.08/0.64	0.0/22.0	SBTR/EBLR	2040+
Empire Ave & Britta St	0.29/0.90	**0.0/80.0**	WBT/SBL	2026
Empire Ave & Jamison St	**0.44/2.0+**	**0.0/120+**	WBTR/SBLR	2013
Empire Ave & Sherman Rd/Industrial Park Blvd	**1.03/2.0+**	**0.0/120+**	EBTR/SBLTR	<2007
Empire Ave & Blenheim/Corporate Pl	**0.64/1.96**	**0.0/120+**	WBTR/NBLTR	2016

[1]Black shaded cells indicate the applicable City v/c of 1.0 and/or the 50 second delay standard for unsignalized intersection has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

Table 25: Year 2035 County Road No-Build Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	LOS[1]	Critical Movement[2]	Year Exceeded	
			Std.	Cap.
Tumalo Rd & Nichols Market Rd	A/B	EBL/SBLTR	2040+	2040+
Tumalo Rd & Deschutes Pleasant Ridge Rd	A/B	WBLT/NBLR	2040+	2040+
Tumalo Road & Deschutes Market Rd	A/C	EBL/NBLR	2040+	2040+
Old Bend-Redmond Hwy & O.B. Riley Rd	C/A[3]	NBTR/WBLR	2040+	2040+
Cooley Rd & O.B. Riley Rd	**A/F**	SBLT/WBLR	2017	2018
Roger Rd & Hunnell Rd	A/A	NBLT/EBLR	2040+	2040+
Bowery Ln & Harris Wy	A/A	EBLT/SBLR	2040+	2040+

[1]Black shaded cells indicate that the County LOS D standard for existing intersections has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.
[3]Single-lane roundabout

Signalized Intersections

Tables 26 and 27 present signalized intersection operations for the future no-build conditions for state and city facilities. The signalized analysis is based on fully optimized signal timing including cycle lengths. Region 4 has indicated that protected left turns will be added in the near future to the Empire Avenue approaches at the US20 & Empire Avenue intersection, so this is included in the 2015 and 2035 results.

Most of the signalized intersections on US97 and US20 are over standard in 2015 and all are over capacity by 2034 (Table 26). This will lead to extensive queuing and delays on the north end of the Bend Parkway and US20 likely spreading across multiple hours. The worst bottlenecks in the project area are the US97 & Cooley Road and the US20 & Empire Avenue intersections which have v/c's around 1.80. The northbound Empire Avenue off-ramp reaches capacity around 2022 and is substantially over capacity in 2035. This level of congestion at the ramp terminal will cause ramp queues to block the right northbound US97 (mainline) lane.

Table 26: Year 2015 & 2035 State Highway No-build Signalized Intersection Operations

Intersection	OHP v/c Std.	v/c Ratio[1]		Year Exceeded	
		2015	2035	Std.	Cap.
US97 & Cooley Rd	0.80	**1.14**	**1.79**	<2007	<2007
US97 & Robal Rd	0.80	**0.97**	**1.23**	<2007	2018
US20 & Cooley Rd	0.80	**0.81**	**1.28**	2015	2023
US20 & Robal Rd	0.80	0.75	**1.02**	2019	2034
US20 & Empire Ave	0.85	**1.14**	**1.85**	<2007	2011
Empire Ave & NB US97 Ramp Terminal	0.85	**0.85**	**1.33**	2016	2022

[1]Black shaded cells indicate that the OHP v/c has been exceeded.

Signalized intersections on the City facilities (Table 27) are all under standard in 2015. In 2027, the Cooley Road & Hunnell (north) intersection is projected to reach capacity and will be substantially over capacity by 2035 without any additional lanes. All other City signalized intersections are under standards, but the intersections of the south leg of Hunnell Road with Cooley Avenue and Empire Avenue at Boyd Acres Rd are approaching capacity.

Table 27: Year 2015 & 2035 City Street No-build Signalized Intersection Operations

Intersection	v/c Ratio[1]/ Delay (s)		Year Std. Exceeded
	2015	2035	
Cooley Rd & Hunnell Rd S	n/a	0.90/41.4	2039
Cooley Rd & Hunnell Rd N	n/a	**1.34/120+**	2027
Robal Rd & Hunnell Rd	0.55/15.9	0.83/38.3	2040+
O.B. Riley Rd & Empire Ave	0.34/10.6	0.86/23.5	2040+
Empire Avenue & Boyd Acres Rd	0.64/24.7	0.96/61.8	2038

[1]Black shaded cells indicate the City v/c of 1.0 and/or the 80 second overall delay standard has been exceeded.

Queuing

Appendix I contains the 2015 and 2035 95th percentile queuing figures for the project area. The 2015 and 2035 queues were created by averaging at least five random SimTraffic micro-simulations together. Because of the extreme congestion on the road network in 2035, the simulation was only run for 30 minutes instead of the normal 60 minutes for all other scenarios and years. Beyond 30 minutes, the queuing backs into adjacent intersections blocking turn bays in a cascading fashion which causes the simulation to eventually report unrealistic results (actual drivers would reroute instead of sitting at a left turn bay for 20 minutes). The 2035 queues are presented as approximate values as the actual 2035 values would be much longer than the 2015. Queues shown on the figures are a combination of stopped vehicles and vehicles traveling at seven or less miles per hour.

By 2015, congestion on US97 northbound extends from the south project limits at Butler Market all the way to Grandview Drive. Southbound, queuing starts at Grandview Drive and continues until the US97 Business exit (to 3rd St). The Cooley and Robal intersections have long queues that radiate out in all directions. Many minor intersections such as Nels Anderson Place, Chavre Way, and Clausen Road are blocked. The US97 northbound ramp terminal backs onto US97 creating congestion between Butler Market Road and the Sister's Loop (US20) exit ramp.

On US20, the Empire Avenue intersection backs up traffic almost to Robal Road and onto the US97 mainline south of the Cascade Village Mall access. Long queues (over 500') exist for southbound approaches at the Cooley and Robal Road intersections.

On the local system, queuing is limited to spots on Cooley and Robal Roads. However, both direction of Empire Avenue are congested entirely within the project area. Long queues exist for almost all side-street approaches.

By 2035, the queuing is extensive project-area wide. The US97 & Cooley Road intersection has queues that extend north of Bowery Lane southbound and almost to Robal Road northbound. Queuing along Cooley Road from this intersection backs west into US20 and east to Boyd Acres Road. The queues from the US20 (3rd St) & Empire Avenue

intersection has queues extending almost to Cooley Road and over 1000' for the northbound direction. Cooley Road, Robal Road, and Empire Avenue have extensive queuing over their entire length in the project area. Long queues exist on most side-street approaches.

Table 28 shows the significant queue blocking sites and percentages in the project area in 2015. Many turn bays on US97 are blocked for over 33% of the peak hour with many smaller intersections blocked up to almost 25% of the hour. Ramp blockages on US97 south of Empire Avenue extend to about 35% of the peak hour. On US20, blocking is limited to turn bays around 15-20% of the peak hour. At Empire Avenue, the southbound left turn bay is blocked almost 69% of the peak hour, the northbound left over 50%, and the closely spaced intersection of Jamison Street is at 70%.

Most turn bays along Empire Avenue are blocked during some of the peak hour from 5% to 70%. The largest times are around the US97 interchange. The westbound left onto the southbound on-ramp is blocked almost 70% of the time, the southbound ramp queues block the northbound ramp terminal over 30% of the time, and the northbound ramp queues backs onto the US97 mainline over 40% of the time.

Table 29 shows the significant queue blocking sites and percentages in the project area in 2035. By 2035, the queue blocking areas have spread from the major arterials and intersections to most routes. Because of the shorter 30 minute run times for the 2035 simulations, these times are likely underestimated in Table 29 and are presented as approximate values. Many turn bays and intersections are blocked on US97 from 20% to over 80% of the peak hour. Ramp blockages on US97 south of Empire Avenue extend to at least 75% of the peak hour. On US20, blocking occurs at all intersections up to almost 50% of the peak hour. At Empire Avenue, the southbound and northbound left turn bays are blocked about 75% of the peak hour and the closely spaced intersection of Jamison Street is almost 65%.

Table 28: Year 2015 No-build Significant Queue Blocking[1]

Intersection	Approach	Blocked Lane	Blocked Intersection	Average Percent Time Blocked
US97 & Cooley Rd	EB	L		28
			Loop Rd/ Lowe's Dwy	5
	WB	L		37
	NB	L		18
	SB	L		37
			Clausen Dr	22
US97 & Chavre Wy	WB		Nels Anderson Rd	17
US97 & Robal Rd	EB	L		7
			CV Mall Dwy	7
	WB	L		37
	NB	L		26
	SB	L		10
			Target Dwy	17
US97 & CV Mall Dwy /Nels Anderson Pl	NB	L		32
US97 & Sister's Loop (US20 Conn)	NB		Empire Ave NB On-ramp	9
US97 & Empire Ave NB Off-ramp	NB		Butler Market Rd NB On-ramp	24
US97 & Butler Market Rd NB On-ramp	NB		US20 (3rd St) NB On-ramp	35
US20 & Cooley Rd	WB	L		16
	NB	R		13
	SB	L		14
US20 & Robal Rd	WB	L		21
	SB	L		5
US20 (3rd St) & Empire Ave	EB		Jamison St	70
	WB	L		15
	NB	L		51
		R		15
	SB	L		65
Robal Rd & Hunnell Rd S	SB	L		8
Empire Ave & OB Riley Rd	NB	L		6
	SB	L		5
Empire Ave & Britta St	EB		OB Riley Rd	8
Empire Ave &	EB		Britta St	9

Jamison St	WB		US20 (3rd St)	14
Empire Ave & Industrial Park Blvd/Sherman Rd	WB	L		9
Empire Ave & Nels Anderson Rd/US97 SB On-ramp	EB	L		6
	WB	L		69
			US97 NB Ramps	31
Empire Ave & US97 NB Ramps	WB		Corporate Pl/Blenhiem Pl	51
	NB		US97	43
Empire Ave & Corporate Pl/ Blenhiem Pl	WB	L		50
			Boyd Acres Rd	34
Empire Ave & Boyd Acres Rd	EB	L		6
	WB	L		48
	NB	L		42

[1]NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, R = exclusive right turn lane.

Table 29: Year 2035 No-build Significant Queue Blocking[1, 2]

Intersection	Approach	Blocked Lane	Blocked Intersection	Average Percent Time Blocked
US97 & Cooley Rd	EB	L		63
			Loop Rd/ Lowe's Dwy	46
	WB	L		84
			Boyd Acres Rd	35
	NB	L		25
	SB	L		70
			Clausen Dr	56
US97 & Chavre Wy	WB		Nels Anderson Rd	>20
US97 & Robal Rd	EB	L		19
			CV Mall Dwy	19
	WB	L		55
			Nels Anderson Rd	56
	NB	L		>30
	SB	L		>10
			Target Dwy	>20
US97 & CV Mall Dwy /Nels Anderson Pl	NB	L		>35
US97 & Sister's Loop (US20 Conn)	NB		Empire Ave NB On-ramp	>10
US97 & Empire Ave NB Off-ramp	NB		Butler Market Rd NB On-ramp	35

US97 & Butler Market Rd NB On-ramp	NB		US20 (3rd St) NB On-ramp	45
US20 & Old Bend-Redmond Hwy	NB	L		12
	SB	L		45
US20 & Cooley Rd	WB	L		46
			OB Riley Rd	24
	NB	L		15
		R		26
	SB	L		33
			Mountainview Dr	30
US20 & Mountainview Dr	SB	L		39
US20 & Robal Rd	WB	L		67
			CV Mall Dwy	18
	SB	L		22
			Cooley Rd	5
US20 (3rd St) & Empire Ave	EB		Jamison St	>70
	WB	L		17
			Industrial Park Blvd/Sherman Rd	12
	NB	L		75
		R		16
	SB	L		79
Cooley Rd & Scenic Dr	EB		US20	40
Cooley Rd & Hunnell Rd S	EB		Scenic Dr	43
	WB	L		62
			Hunnell Rd N	14
	NB	L		61
Cooley Rd & Hunnell Rd N	EB	L		79
			Hunnell Rd S	49
	WB	L		17
Cooley Rd & Loop Rd/Lowe's Dwy	EB	L		46
			Hunnell Rd N	25
	NB	R		79
Robal Rd & CV Mall Dwy (at old AutoMall site)	EB	L		24
			US20	7
	WB	L		45
			Hunnell Rd S	11
Robal Rd & Hunnell Rd S	EB	L		18
			CV Mall Dwy	7
	SB	L		69
Robal Rd & Nels Anderson Rd	NB		Nels Anderson Pl	24

Empire Ave & OB Riley Rd	NB	L		15
	SB	L		19
Empire Ave & Britta St	EB		OB Riley Rd	37
	SB	L		95
Empire Ave & Jamison St	EB		Britta St	62
	WB		US20 (3rd St)	>15
Empire Ave & Industrial Park Blvd/Sherman Rd	WB	L		10
Empire Ave & Nels Anderson Rd/US97 SB On-ramp	WB	L		77
			US97 NB Ramps	>35
Empire Ave & US97 NB Ramps	WB		Corporate Pl/Blenhiem Pl	57
	NB		US97	75
Empire Ave & Corporate Pl/Blenhiem Pl	WB	L		70
			Boyd Acres Rd	50
Empire Ave & Boyd Acres Rd	EB	L		21
			Corporate Pl/Blenhiem Pl	5
	WB	L		73
	NB	L		83

[1]NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, R = exclusive right turn lane.
[2]The 2035 values in this table are based on a 30-minute simulation run which was the longest reportable time before the network completely filled up because of congestion and other metering effects from bottlenecks. The 2035 values are shown as approximations and actual values are likely much higher than shown.

Most turn bays along Empire Avenue are blocked at least some period in the peak hour from 5% to 95%. The largest times are around the US97 interchange. The westbound left onto the southbound on-ramp is blocked over 75% of the time, the southbound ramp queues block the northbound ramp terminal over 30% of the time, and the northbound ramp queues backs onto the US97 mainline over 75% of the time. Queue blocking along other local roads is significant in 2035. All of the intersections along Cooley Road and Robal Road have turn bays and adjacent intersections and approaches blocked around 75% of the hour.

Other Operational Performance Measures

Tables 30 and 31 show additional operational MOE's for the project area. Compared to the 2007 values, the 2015 speeds have fallen from 22 to 14 mph (33%), the total stops have increased about 60%, the delay has increased 105%, and the overall network travel time increased about 33%. The overall average speed in 2035 has been reduced to a crawl speed. Because of extreme congestion from bottlenecks and other metering effects, the 2035 no-

build simulation could only be run for 30 minutes. Speeds are relatively unaffected, but other values such as delay and number of stops are showed 2035 values equal to or less than 2015 values which is not intuitive. In actuality, the 2035 values would be much higher than 2015, but the actual difference cannot be measured. Based on the 57% reduction in average travel speed, the other network MOE's will increase by at least that much.

Table 30: Year 2015 & 2035 No-build Overall Simulation Measures of Effectiveness

Measure of Effectiveness	Year	
	2015	2035[2]
Average Speed (mph)	14	8
Total Stops[1]	42,000	>66,000
Delay (hr)	1,525	>2,400
Travel Time (hr)	2,290	~3,600

[1]A stop is recorded every time a vehicle drops below 7 mph (crawl speed). A vehicle might have multiple stops on an intersection approach.
[2]The 2035 values are based on a 30-minute simulation run which was the longest reportable time before the network completely filled up because of the congestion and metering effects from bottlenecks. Other than speed, the 2035 values are approximated and actual values are likely much higher than shown.

Table 31 shows some specific per-vehicle MOE's for travel time and average speed for specific roadway segments. The effect of the congestion can be seen as speeds continue to drop on the study area roadways. Empire Avenue is operating at crawl speed conditions from 2015 forward. The queues spreading onto the local system can be seen as travel time and speeds on Cooley and Robal Roads significantly decrease in speed and correspondingly increase in travel times. Other than O.B. Riley Road, the local system is traveling at a crawl speed.

Table 31: Year 2015 & 2035 No-build Segment Travel Time and Speed

Segment	Travel Time per vehicle (min:s)		Average Speed (mph)	
	2015	2035	2015	2035[1]
US97 (Deschutes Pleasant Ridge Rd – Butler Market Rd)	14:05	18:05	27	20
US20 (Old Bend-Redmond Hwy – Empire Ave)	5:25	11:20	26	17
O.B. Riley Rd (Old Bend-Redmond Hwy – Empire Ave)	2:40	3:40	40	31
Empire Ave (O.B. Riley Rd – Boyd Acres Rd)	6:00	7:25	9	7
Cooley Rd (O.B. Riley Rd – Boyd Acres Rd)	4:15	19:10	19	5
Robal Rd (US20 – Nels Anderson Rd)	3:00	6:00	10	5

[1]The 2035 values are based on a 30-minute simulation run which was the longest reportable time before the network completely filled up.

BUILD ALTERNATIVE DESCRIPTIONS

Twenty alternatives and many more concepts were considered in the alternative development phase. These alternatives and concepts were tested first on the purpose and need criteria and then later against goals and objectives. These alternatives and concepts considered alignments to the west of US97 and the commercial area, along existing US97 (3rd Street), and to the east of US97 adjacent to the railroad tracks. Near the end of the alternative refinement process, the alternatives were "down-scaled" using a practical design approach, resulting in alternatives with reduced scope and complexity to better address future funding and phasing. The final build alternatives are known as East DS-1 and DS-2. For additional detail on the considered alternatives, please refer to Appendix J and the Alternatives Development Report. Appendix K contains the detailed lane configurations for segments, interchanges and intersections for the two alternatives. Appendix O contains the design storage lengths for the two alternatives.

Both build alternatives realign US97 east of the current alignment next to the railroad tracks. The current alignment would become an extension of 3rd Street from the US20 connections north to a new US97 interchange. The East DS-1 and DS-2 alternatives share a common design from Cooley Road south. The two alternatives have different northern interchange types and local road connections (see Figures 3 and 4).

Both alternatives generally do not affect the existing pedestrian, bike or transit facilities. The largest change will be the extension of Robal Road west from US20 to O.B. Riley Road. This will allow for easier, quicker pedestrian and bicycle access from local neighborhoods along Britta Street or O.B. Riley Road to the commercial area east of US20. Because the highway through traffic has been removed from 3rd Street, volumes are less, making pedestrian and bike travel on 3rd Street more attractive.

The new or modified roadways will match into the existing facilities. On US97, the six foot bike lane will be continued while on US20, the six foot shoulders will be extended. No sidewalks will be built for either roadway. Project segments on County facilities will match into the current roadway. Segments on City facilities will have sidewalks and bike lanes as appropriate. The alternatives do not affect the current transit route in the project area other than the 3rd Street ODOT Region 4 Headquarters driveway will be closed. Vehicles will need to use Mervin Samples Road on the south edge of the ODOT Region 4 campus to access the park and ride lot.

Cooley Road to South Project Limits – Common for Both Alternatives

US97 would be a four–lane access-controlled facility through the project area. At the south project limits (Butler Market Road), the northbound ramp connection from 3rd Street would add a third northbound lane. The northbound on-ramp connection from Butler Market Road would merge into it. The northbound three lanes would continue past the single-lane Empire Avenue northbound off-ramp then split into two two-lane roadways via a left exit

(a 3-2-2 split). The western two-lane connection would have one lane connecting through the existing US20 loop ramp to US20 westbound and one lane connecting to northbound 3rd Street. The eastern two lane roadway is the US97 mainline lanes. US97 southbound would have no connections to US20 or 3rd Street at this location and simply "flyover" the westerly connections. The Empire Avenue southbound on-ramp creates a weaving section with a single auxiliary lane which would drop at the Butler Market off-ramp.

US20 is four lanes through the project area with signalized intersections at Cooley Road, Robal Road and Empire Avenue. At 3rd Street, the two eastbound lanes turn south and create a four-lane section with the two southbound 3rd Street lanes. The inside two lanes become eastbound dual left turn lanes onto Empire Avenue and the other two lanes continue south to the project limits. In the northbound direction, the two 3rd Street northbound lanes are joined at Empire Avenue by a third lane from the westbound to northbound right turn at Empire Avenue. The right lane drops at the ramp to northbound 3rd Street and the two remaining US20 lanes continue west.

Third Street remains in its five-lane cross-section north to Cooley Road. The Cascade Village Mall/Nels Anderson Place intersection is restricted to a right-in-right-out configuration.. The eastern Lowe's driveway is closed because of the 3rd Street & Cooley Road intersection being realigned to the west to accommodate the new US97 alignment. All other approaches and intersections remain.

O.B. Riley Road is relatively unchanged other than a new single-lane roundabout at the extended Robal Road intersection and a signal at Empire Avenue. For 2035, a roundabout at Old Bend-Redmond Highway was assumed in the future no-build. Cooley Road is unchanged from O.B. Riley Road to US20. From US20 to east of Boyd Acres Road, Cooley Road has a four/five lane cross-section with signals at both the Hunnell Road north and south intersections.

Robal Road has been extended west from the existing signal at US20 to O.B. Riley Road. Britta Street is extended north to connect to Robal Road to allow for quicker access to the state system for the emergency services complex located between Britta Street and US20. Robal Road is a two/three lane cross-section from O.B. Riley Road to Hunnell Road with extended storage bays and single/dual turn lanes as needed. Because of the need for dual left turn lanes at the Robal Road & Hunnell Road intersection, Robal is expanded to a four-lane cross-section to 3rd Street. Robal Road east of 3rd Street is unchanged as are the commercial accesses along Robal Road into Target, the old AutoMall site, and into the Cascade Village Mall. Hunnell Road is expanded to four-lanes to the north of Robal Road to allow for the development of the south to east dual left turn and to allow run-out room for the west to north dual left turn.

Empire Avenue has a signal added at O.B. Riley Road as part of the project. Empire Avenue is a three lane cross-section from O.B. Riley Road west to the business park access west of Jamison Street. From the business park access east, Empire Avenue is widened to two travel lanes in each direction to match into the existing five-lane section

at the US97 northbound ramp terminal. The Jamison Street approach is restricted to a right-in-right-out. At US20 (3rd Street), dual left and right turn lanes are provided for the westbound direction. Industrial Park Boulevard is a right-in-right-out with the opposite Sherman Avenue/Nels Anderson Road approach closed. The Nels Anderson/US97 southbound ramp terminal is signalized and coordinated with the existing US20 and southbound US97 ramp terminal signals.

North of Cooley Road – East DS-1

In the East DS-1 alternative, north of Cooley Road, US97 returns to its current alignment. US97 has a full diamond service interchange with the extension of 3rd Street located just north of Bowery Lane. US97 between the 3rd Street interchange and the southern project limits is completely access-controlled. North of the 3rd Street interchange, a median barrier may be added in a future phase or as part of a future safety project to the Deschutes Junction interchange.

Third Street north of Cooley is built on a new four/five lane alignment west of the current alignment. Clausen Drive/Loco Road and Grandview Drive will have full-movement, stop-controlled intersections with 3rd Street. North of Grandview Drive, 3rd Street narrows to a two/three-lane cross-section with new intersections and connections to Bowery Lane and Harris Way. At the US97 interchange, the bridge structure will have a single lane in each direction plus left turn lanes at the ramp terminals. Third Street will continue east as a two-lane roadway to a new north-south frontage road adjacent to the railroad tracks which will serve residences and businesses that used to access US97 directly in this section.

Other local street improvements would include connecting Fort Thompson Lane directly to Harris Way and Hunnell Road. Hunnell Road would also be improved from Loco Road north to Fort Thompson Lane. Additional road/access connections would also be built for any properties currently only served by US97.

Figure 3: Alternative East DS-1

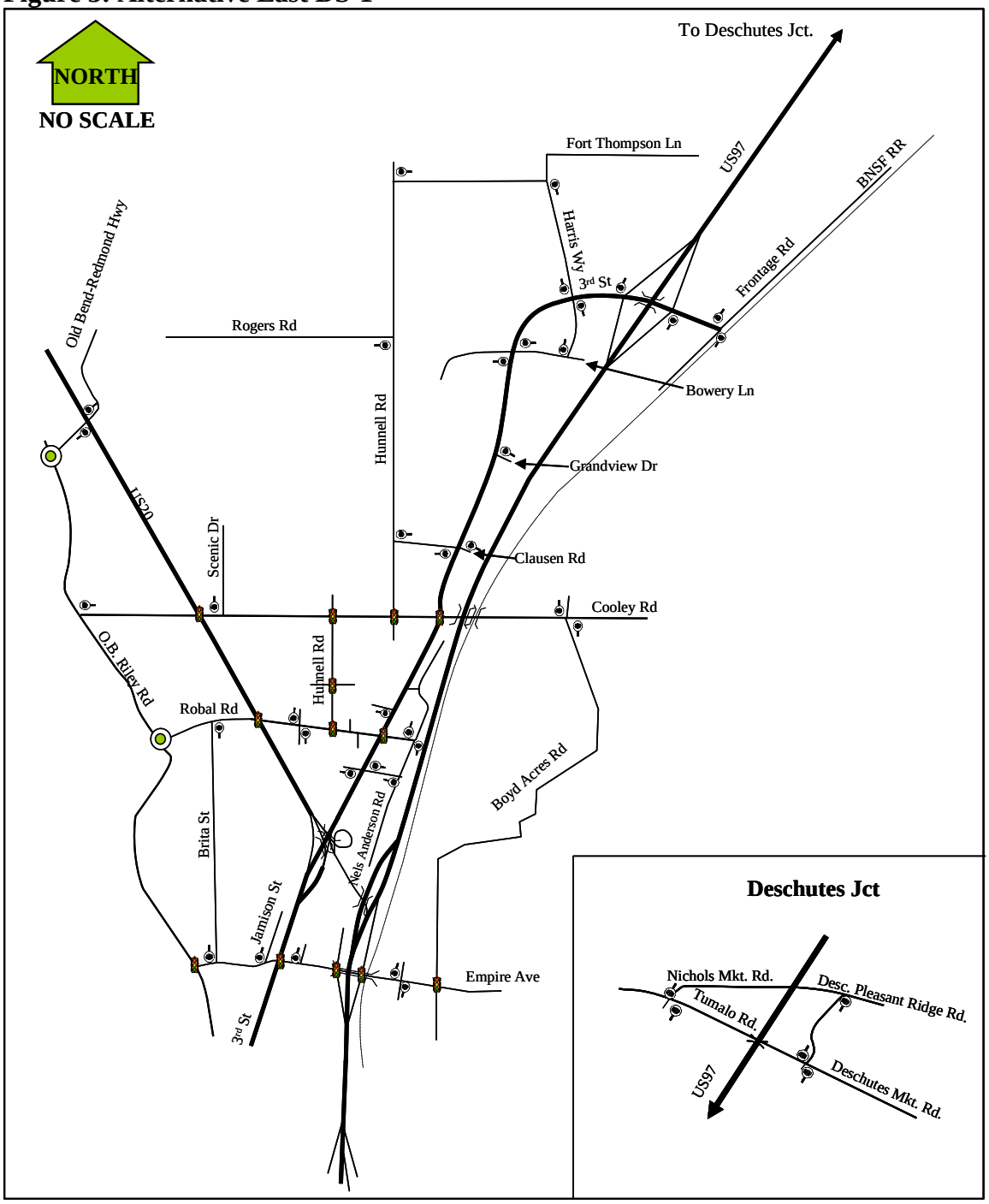
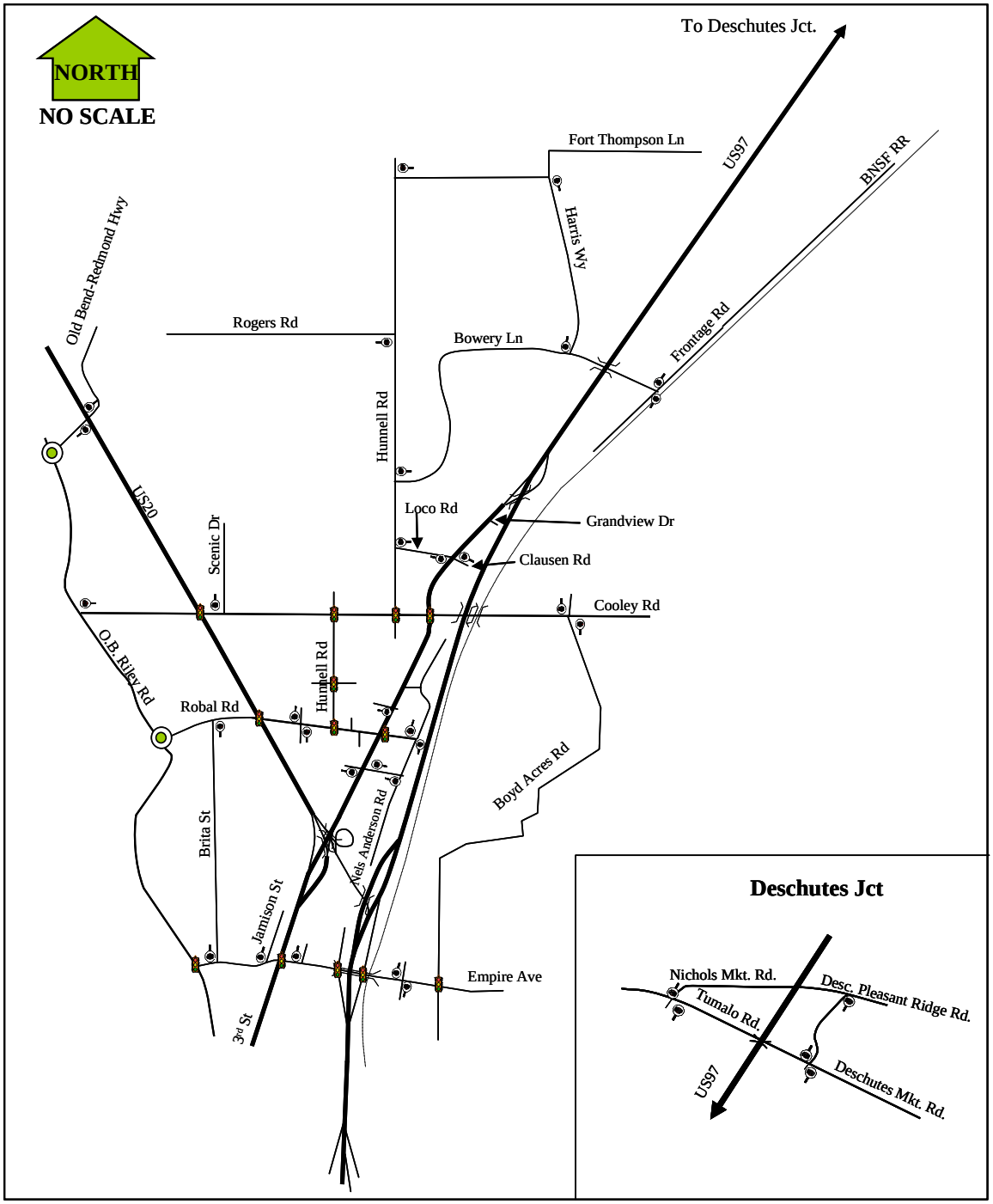


Figure 4: Alternative East DS-2



North of Cooley Road – East DS-2

In the East DS-2 alternative, north of Cooley Road, US97 returns to its current alignment. US97 has a system-type partial interchange with the extension of 3rd Street located just north of Grandview Drive. Movements would only be allowed to US97 from 3rd Street northbound and from US97 to 3rd Street southbound. "Turnaround" movements would need to be performed at the Deschutes Junction interchange on the north edge of the project area and at the Butler Market Road interchange on the south edge of the project area (no southbound off-ramp at Empire Avenue). US97 between the 3rd Street interchange and the southern project limits is completely access-controlled. North of the 3rd Street interchange, a median barrier may be added in a future phase or as part of a future safety project to the Deschutes Junction interchange.

Third Street north of Cooley Road is a five-lane cross-section generally on the current alignment. Clausen Drive/Loco Road and Grandview Drive will have full-movement, stop-controlled intersections with 3rd Street. At the US97 interchange, the bridge structure and ramps will be single lanes.

Since there is no direct connection to the west side of US97, Hunnell Road will be improved north of Loco Road to Fort Thompson Lane. Bowery Lane will be improved, formally connected to Hunnell Road, and extended over US97 to a frontage road adjacent to the railroad tracks. This frontage road will serve residences and businesses that used to access US97 directly in this section. Other local street improvements would include connecting Fort Thompson Lane directly to Harris Way and Hunnell Road. Additional road/access connections would be built for any properties currently only served by US97.

ALTERNATIVE ANALYSIS

Traffic Development

To create the build year (2015) and the design year (2035) volumes, the Bend Metropolitan Planning Organization (BMPO) travel demand model was used. The build alternatives used the Metro Transportation Plan (MTP) scenario to develop the future alternative volumes. The MTP scenario is financially constrained which means that all the city, county and state projects (outside of the US97 North Corridor project) that can be funded within the next 20 years in and around the Bend metropolitan area are included. These projects are assumed to occur regardless of what happens in the US 97 Bend North Corridor project area. The Bend Comprehensive (General) Plan map and the MTP project list is included in Appendix D. The alternative scenarios assumed ramp metering on US97 from the 3rd Street to the Butler Market interchanges by limiting capacities on the ramps to mimic a metered flow.

The volumes were post-processed using procedures from the National Cooperative Highway Research Council (NCHRP) Report 255. The 2035 future year no-build volumes and the 2035 alternative volumes were compared to develop relative differences (link-based ratios) between scenarios. These differences were applied to the 2035 no-build design year volumes to determine the 2035 design year volumes for each alternative. Then the 2015 alternative model scenarios were compared to the 2035 alternative model scenarios to determine another set of differences. This second set of differences was used adjust the 2035 design year volumes down to the 2015 build year volumes. Appendix D gives more details on the future volume development. The East DS-1 alternative 2015 and 2035 volumes are shown in Appendix K and East DS-2 alternative 2015 and 2035 volumes are shown in Appendix M.

East DS-1 Analysis Results

Mainline & Merge/Diverge/Weave Segments

Tables 31 and 32 show the v/c ratio results for the free-flow highway mainline, ramp connections, interchange merge/diverges and weaving sections. In 2015, all sections operate well under the 0.60 rural and the 0.75 urban Highway Design Manual (HDM) v/c's. By 2035, the only problems on East DS-1 are on northbound US97 at the project's edges. The higher commuter flows in the afternoon peak hour are northbound (outbound toward Redmond), so it is more critical than the southbound. Other than the northbound weaving section between Butler Market Road and Empire Avenue, the sections are unchanged from the no-build and represent conditions north and south of the project area.

The section between the Empire Avenue and Butler Market Road interchanges can act as a transition section between the improved new alignment north of Empire and the unchanged near-capacity section south of Butler Market. In this transition, the improvements are primarily limited to improving the traffic flow rather than capacity. Because of high volumes and weaving movements, speeds will be less than the section north of Empire Avenue but greater than south of Butler Market Road. This allows southbound traffic traveling at relatively high speeds to slow down without coming immediately into near-capacity flows. It also allows traffic from Empire Avenue the maximum distance to merge into US97 traffic. Northbound traffic can increase speeds north of Butler Market Road but not too fast allowing room for vehicles to maneuver. This creates the geometric lane and operational balance (three lanes are needed south of the diverge) required at the major diverge to US20 and northbound 3rd Street.

Table 32: Year 2015 and 2035 East DS-1 US97 Mainline and Merge/Diverge/Weave V/C Ratios[1]

Section	HDM v/c	Direction[2] 2015 NB	2015 SB	2035 NB	2035 SB
Mainline north of Deschutes Market Rd	0.60	0.54	0.37	**0.72**	0.50
Nichols Market Rd/ Deschutes Market Rd Off-ramp diverges	0.60	0.47	0.36	0.59	0.49
Nichols Market Rd/ Deschutes Market Rd On-ramp merges	0.60	0.51	0.31	**0.69**	0.42
Mainline south of Deschutes Market Rd	0.60	0.47	0.32	0.58	0.44
3rd St Off-ramp diverges	0.75	0.43	0.33	0.50	0.45
3rd St On-ramp merges	0.75	0.46	0.27	0.56	0.36
Mainline between 3rd St ramps	0.75	0.41	0.27	0.47	0.36
Mainline south of 3rd St	0.75	0.42	0.27	0.49	0.37
Empire Ave NB On-ramp merge	0.75	0.42		0.48	
NB Mainline south of Empire Ave NB On-ramp	0.75	0.34		0.41	
3rd St /US20 NB diverge	0.75	0.50		0.64	
Mainline south of NB ramp to 3rd St/US20	0.75	0.50	0.30	0.64	0.42
Empire Ave – Butler Market Rd SB weaving section[3]	0.75		0.54		0.65
US20 Connection – Empire Ave NB weaving section[3]	0.75	0.67		**0.84**	
Butler Market Rd NB On-ramp merge	0.75	0.55		0.68	
Mainline south of Butler Market Rd (SB) and US20 (NB) ramps	0.75	0.71	0.34	**0.93**	0.43

[1]Blackened cells indicate that the HDM design v/c guideline has been exceeded.
[2]NB=Northbound, SB = Southbound
[3]This mainline segment is a weaving section, so the weaving v/c ratio controls the operation of the segment. Because of the high weaving flows, the operation of the weaving section will likely be worse than predicted.

Table 33: Year 2015 and 2035 East DS-1 US20/3rd St Connections V/C Ratios

Section[1]	HDM v/c	2015	2035
US20 Connection to NB 3rd St	0.75	0.34	0.37
Connection to WB US20 & NB 3rd St	0.75	0.45	0.58
US97 (Sister's Loop) Connection & WB US20 On-ramp merge	0.75	0.31	0.51

[1]NB=Northbound, WB = Westbound

Auxiliary lanes will be needed before 2015 in the northbound direction and by 2027 in the southbound direction between the Empire Avenue and Butler Market Road interchanges. Auxiliary lanes allow vehicles to easily merge or diverge out of high traffic flows. They also allow local traffic traveling between interchanges to stay out the mainline lanes. With the limited on-ramp to off-ramp traffic between these two interchanges, the primary function of the auxiliary lanes will be to smooth out conflicting mainline and ramp flows.

The closely-spaced successive US20 and Butler Market Road on-ramps plus a relatively short weaving section can make northbound weaving problematic. The best combination between geometry and operations was to make this a Type B weaving section where vehicles in the right lane can either exit at Empire Avenue or continue north on US97. The auxiliary lane would originate with the higher volume US20 on-ramp and have the Butler Market Road on-ramp merge into it thus keeping the majority of the on-off movements out of the through lanes. This also keeps the northbound cross–section to three total lanes. The v/c for the northbound weaving section is 0.84 which is over the HDM v/c of 0.75 but the distance between the ramps is too short to have a lower v/c four-lane section with a two-lane off ramp at Empire Avenue. Some local congestion/slowing between weaving vehicles is possible in this section.

The southbound Empire Avenue- Butler Market Road is a Type A weaving section where vehicles in the right auxiliary lane must exit at Butler Market if a lane change is not made and forces US97 traffic to make a lane change to exit at Butler Market. This weaving section is not over the HDM v/c; however, because of the high weaving volumes operations will be subject to slowdowns and localized congestion. A Type B weave would be preferable, but the additional length beyond the Butler Market off-ramp would interfere with the Butler Market Road overcrossing and a nearby canal.

The two lanes in each direction on US20 between 3rd Street and the project limits east of the Old Bend-Redmond Highway is driven by the intersections on the project. Widening of US20 between the project limits and Robal Road will be necessary once the US20 & Cooley intersection is signalized (approximately 2020). Stopping previously free traffic on the mainline will approximately cut the capacity in half so additional lanes are necessary to keep the same flow of traffic constant.

Between the Robal Road and Empire Avenue the project need is trying to keep congestion at a practical level without clogging up a good portion of the nearby system. Around 2019, the Robal Road intersection will exceed the OHP v/c which indicates a need for an improvement. Robal Road improvements such as adding a dual left turn lane on Robal will

require two eastbound lanes or adding the westerly extension will take signal phase time away from the mainline thus accelerating the need for widening if done before 2019. By 2019, the v/c at the Empire Avenue intersection is predicted to be around 1.20 without any improvements. The 1.20 v/c level is well over capacity. Long queues in all directions can be expected especially through the 3rd/US20 section making it difficult to maneuver with long travel times and delays.

Preliminary Signal Warrants

Table 34 shows the preliminary signal warrant (PSW) results. Meeting a preliminary signal warrant does not mean an improvement will be installed. The region will have to do a intersection traffic control study and get approval of the State Traffic Engineer's office before a signal will be approved on state highways.

In 2015, only the US20 & Old Bend-Redmond Highway and the O.B. Riley Road & Empire Avenue intersections meet PSW's. The US20 & Old Bend-Redmond Highway intersection is a poor location for a signal as it is located in a rural high-speed area and Region 4 does not support a signal at this location. Since this intersection has the same operation with or without this project, it was removed to limit the scope of the alternatives to mainly focus on US97 issues. The East DS-1 alternative adds significantly more traffic to O.B. Riley Road and Empire Avenue which makes the O.B. Riley Road & Empire Avenue intersection part of the project improvements, so this intersection is assumed to be signalized in the analysis. The intersection has too much traffic for a roundabout to work properly so a signal is shown as the most practical option.

Depending on timing of project elements many other intersections were assumed to have improved traffic control in 2015. The intersections along Cooley Road at US20, Hunnell Road S and Hunnell Road N intersections were signalized assuming development growth in the Cooley Road area by then. This assumption smoothed out the simulation results by removing the queue from an over–capacity Cooley Road, especially from the US20 intersection that jams up the system unrealistically. Around 2020, PSW's start being met at these intersections from assumed traffic growth. Also, because of existing development agreements, when the Loop Road/Lowe's driveway is closed to accommodate the new 3rd Street alignment, the Cooley Road & Hunnell Road N intersection will be signalized. This 3rd Street realignment will likely be in one of the first constructed phases in order to gain measureable capacity relief and to allow development in the immediate area.

The additional traffic along O.B. Riley Road triggers a PSW in 2022 at the new Robal Road intersection. The analysis assumed that the intersection would be constructed as a single-lane roundabout when the western Robal Road extension is built since it works well and fits the suburban character of the area.

Table 34: Year 2015 & 2035 East DS-1 Preliminary Signal Warrants[1]

Intersection	PSW Met?		Year Met
	2015	2035	
Tumalo Rd & Nichols Market Rd	No	No	
Tumalo Road & Deschutes Market Rd	No	No	
3rd St & US97 NB Ramps	No	No	
3rd St & US97 SB Ramps	No	No	
3rd St & Grandview Dr	No	No	
3rd St & Clausen Rd	No	No	
3rd St & Nels Anderson Pl/Cascade Village	No	No	
Old Bend-Redmond Hwy & O.B. Riley Rd	No	**Yes**	2030
Old Bend-Redmond Hwy & US20	**Yes**	**Yes**	Now
Cooley Rd & O.B. Riley Rd	No	No	
Cooley Rd & US20	No[2]	**Yes**	2020
Cooley Rd & Hunnell Rd (south)	No[2]	**Yes**	2025
Cooley Rd & Hunnell Rd (north)	No[2]	**Yes**	2035
Cooley Rd & Boyd Acres Rd	No	No	
Robal Rd & O.B. Riley Rd	No[3]	**Yes**	2022
Robal Rd & Britta St	No	No	
Robal Rd & Nels Anderson Dr	No	No	
Nels Anderson Dr & Nels Anderson Pl	No	No	
Empire Ave & O.B. Riley Rd	**Yes**	**Yes**	Now
Empire Ave & Britta St	No	No	
Empire Ave & Jamison St	No	No	
Empire Ave & Industrial Park Blvd	No	No	
Empire Ave & Nels Anderson Rd/SB US97 Ramp Terminal	No[4]	**Yes**	2035
Empire Ave & Corporate/Blenhiem Pl	No	No	
Hunnell Rd & Shopping Center Access	No	No	

[1]Black shaded cells indicate that preliminary signal warrants (PSW's) have been met. Region Traffic staff will need to perform an intersection traffic control study in which the Region Traffic Engineer will forward the recommendation to the State Traffic Engineer's office. Traffic signal warrants must be met and the State Traffic Engineer's approval obtained before a traffic signal will be installed on a state highway.
[2]The 2015 analysis assumed signals at these locations as these are likely mitigations for near-term developments along Cooley Road.
[3]This intersection when constructed as part of the project will likely be a roundabout regardless of when the PSW is met.
[4]This intersection will be substantially widened as part of the project and would need to be signalized for Empire Avenue to operate efficiently.

Technically, the Empire Avenue & US97 Southbound Ramp Terminal/ Nels Anderson Road intersection does not meet PSW's until at or beyond the design year, since the Nels Anderson approach volume is relatively low and the on-ramp has traffic moving away from the intersection. However, for the southbound left turn movement, the interchange and this section of Empire Avenue between US97 and US20 (3rd Street) to work acceptably, this intersection needs to be signalized. Otherwise, queues from this intersection will affect the adjacent one and will severely limit exits from the relatively isolated Nels Anderson industrial area. With the above assumptions, the only additional intersection to meet PSW's

by 2035 is the O.B. Riley Road & Old Bend-Redmond Highway in 2030 because of increased traffic flows on O. B. Riley Road (some from new development and some from diverting US20 traffic). This intersection is in rural Deschutes County and was assumed to be a single-lane roundabout.

Unsignalized Intersections

In 2015, all unsignalized intersections in the project area are under standards except for the US20 & Old Bend-Redmond Highway intersection (Tables 35 – 37). The US20 & Old Bend-Redmond Highway intersection has a v/c of over 2.0 indicating that there are no safe gaps available to turn into. Vehicles will select smaller gaps which creates more risk for a crash.

Table 35: Year 2015 East DS-1 State Highway Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	HDM v/c	v/c Ratio[1]	Critical Movement[2]
3rd St & NB Ramps	0.75	0.17/0.16	EBL/NBL
3rd St & SB Ramps	0.75	0.18/0.21	EBTL/SBL
US20 & Old Bend-Redmond Hwy	0.75	**0.28/2.0+**	WBL/NBL

[1]Blackened cells means that the HDM v/c design guideline has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

Table 36: Year 2015 East DS-1 City Street Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	v/c Ratio	Delay (s)	Critical Movement[1]
3rd St & Frontage Rd	0.00/0.02	7.3/8.9	EBL/NBTL
3rd St & Grandview Dr	0.01/0.02	8.0/12.9	SBL /WBL
3rd St & Clausen Rd	0.16/0.05	8.4/44.2	NBL/WBL
3rd St & Chavre Wy	0.28/0.03	0.0/9.4	NBT/WBR
3rd St & Target Dwy	0.20/0.38	0.0/14.0	SBT/EBR
3rd St & Nels Anderson Pl/Cascade Village	0.47/0.37	0.0/15.1	NBT/WBR
Cooley Rd & Scenic Dr	0.10/0.02	0.5/10.6	EBTL/SBLR
Cooley Rd & Boyd Acres Rd	0.03/0.46	9.5/45.7	WBL/NBTR
O.B. Riley Rd & Robal Rd[2]	0.33/0.30	6.3/5.0	SBTL/WBLR
Robal Rd & Britta St	0.02/0.15	1.0/9.6	WBTL/NBLR
Robal Rd & Auto Mall Dwy	0.02/0.08	8.5/17.5	EBL/NBTL
Robal Rd & Target Dwy	0.10/0.10	0.0/9.9	WBT/SBR
Robal Rd & Cascade Village Dwy	0.04/0.06	0.0/9.1	EBT/NBR
Robal Rd & Nels Anderson Dr	0.37/0.03	12.9/2.3	NBTL/EBLR
Nels Anderson Dr & Chavre Wy	0.01/0.01	2.3/8.9	NBTL/EBLR
Nels Anderson Dr & Nels Anderson Pl	0.01/0.13	0.4/11.1	NBTL/EBLR
Empire Ave & Britta St	0.01/0.01	8.2/12.5	EBL/SBL
Empire Ave & Jamison St	0.15/0.06	0.0/10.1	WBT/SBR
Empire Ave & Industrial Park Blvd	0.36/0.07	0.0/10.2	WBT/SBR
Empire Ave & Corporate/Blenhiem Pl	0.02/0.42	10.4/52.9	EBL/NBLTR
Hunnell Rd & Loco Rd	0.00/0.17	1.3/10.4	SBTL/WBLR

[1]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.
[2]Intersection is a roundabout.

Table 37: Year 2015 East DS-1 County Road Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	LOS	Critical Movement[1]
Tumalo Rd & Deschutes Pleasant Ridge Rd	A/B	WBTL/NBLR
Tumalo Road & Nichols Market Rd	A/B	EBL/SBLTR
Tumalo Rd & Deschutes Market Rd	A/C	EBL/NBLTR
3rd St & Harris Wy	A/B	WBL/NBLTR
3rd St & Bowery Ln	A/B	SBL/EBLTR
O.B. Riley Rd & Old Bend-Redmond Hwy	A/B	SBTL/WBLR
O.B. Riley Rd & Cooley Rd	A/B	SBL/WBL
Hunnell Rd & Rogers Rd	A/A	NBTL/EBLR
Hunnell Rd & Fort Thompson Ln	A/A	SBTL/WBLR
Fort Thompson Ln & Harris Wy	A/A	WBTL/NBLR
Bowery Ln & Harris Wy	A/A	EBTL/SBLR

[1]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

By 2035 the mainline left turns are having difficulty finding gaps as the US20 v/c ratio is over standards at the US20 & Old Bend-Redmond intersection (Table 38). Traffic diversion to other local facilities such as Robal and Cooley Roads is likely in the peak periods of the day. On the local system, only the Cooley Road & Boyd Acres Road intersection exceeds standard (Tables 39-40) around 2016 which likely indicates a traffic control improvement.

Table 38: Year 2035 East DS-1 State Highway Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	HDM v/c	v/c Ratio[1]	Critical Movement[2]	Year Exceeded	
				Std.	Cap.
3rd St & NB Ramps	0.75	0.30/0.36	EBL/NBL	2040+	2040+
3rd St & SB Ramps	0.75	0.33/0.36	EBTR/SBTR	2040+	2040+
US20 & Old Bend-Redmond Hwy	**0.75**	**0.81/2.0+**	WBL/NBL	<2007	<2007

[1]Blackened cells means that the HDM design v/c guideline has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

Table 39: Year 2035 East DS-1 City Street Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	v/c Ratio	Delay[1] (s)	Critical Movement[2]	Year Std. Exceeded
3rd St & Frontage Rd	0.02/0.04	7.3/9.4	EBL/NBTL	2040+
3rd St & Grandview Dr	0.01/0.11	8.8/17.7	SBL/WBL	2040+
3rd St & Clausen Rd	0.26/0.77	9.4/120+	NBL/EBL	2017
3rd St & Chavre Wy	0.36/0.05	0.0/9.9	NBT/WBR	2040+
3rd St & Target Dwy	0.22/0.41	0.0/15.9	SBT/EBR	2040+
3rd St & Nels Anderson Pl/Cascade Village	0.37/0.15	0.0/19.9	NBT/WBR	2040+
Cooley Rd & Scenic Dr	0.25/0.03	0.3/17.3	EBTL/SBLR	2040+
Cooley Rd & Boyd Acres Rd	**0.21/2.0+**	**1.7/120+**	WBL/NBL	2016
O.B. Riley Rd & Robal Rd[3]	0.89/0.53	29.8/9.6	SBTL/WBLR	2039
Robal Rd & Britta St	0.05/0.30	1.9/11.2	WBTL/NBLR	2040+
Robal Rd & Auto Mall Dwy	0.04/0.36	9.9/47.3	EBL/NBTL	2040+
Robal Rd & Target Dwy	0.13/0.17	0.0/10.7	WBT/SBR	2040+
Robal Rd & Cascade Village Dwy	0.00/0.12	0.0/9.7	EBT/NBR	2040+
Robal Rd & Nels Anderson Dr	0.42/0.04	14.9/2.4	NBTL/EBLR	2040+
Nels Anderson Dr & Chavre Wy	0.02/0.01	3.1/9.2	NBTL/EBLR	2040+
Nels Anderson Dr & Nels Anderson Pl	0.02/0.16	0.9/11.3	NBT/ EBLR	2040+
Empire Ave & Britta St	0.01/0.04	9.2/20.3	EBL/SBL	2040+
Empire Ave & Jamison St	0.25/0.10	0.0/11.6	WBT/SBR	2040+
Empire Ave & Industrial Park Blvd	0.55/0.10	0.0/10.2	WBT/SBR	2040+
Empire Ave & Corporate/Pl	0.03/0.72	13.1/120+	EBL/NBLTR	2040+
Hunnell Rd & Loco Rd	0.00/0.02	0.6/11.2	SBTL/WBLR	2040+

[1]Blackened cells mean that the City 50 second delay standard for unsignalized intersections with the subject approach having more than 100 peak hour trips or the v/c of 1.0 standard has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.
[3]Intersection is a roundabout.

Table 40: Year 2035 East DS-1 County Road Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	LOS	Critical Movement[1]	Year Std. Exceeded
Tumalo Rd & Deschutes Pleasant Ridge Rd	A/C	WBTL/NBLR	2040+
Tumalo Road & Nichols Market Rd	A/D	EBL/SBLTR	2040+
Tumalo Rd & Deschutes Market Rd	A/C	EBL/SBLTR	2040+
3rd St & Harris Wy	A/C	WBL/SBLTR	2040+
3rd St & Bowery Ln	A/C	NBL/EBLTR	2040+
O.B. Riley Rd & Old Bend-Redmond Hwy[1]	B/C	SBTL/WBLR	2038
O.B. Riley Rd & Cooley Rd	A/D	SBL/WBLR	2040+
Hunnell Rd & Rogers Rd	A/A	SBTR/EBLR	2040+
Hunnell Rd & Fort Thompson Ln	A/A	SBTR/WBLR	2040+
Fort Thompson Ln & Harris Wy	A/A	WBTL/NBLR	2040+
Bowery Ln & Harris Wy	A/A	EBTL/SBLR	2040+

[1]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.
[2]Intersection is a roundabout.

Signalized Intersections

Most of the state highway signalized intersections exceed the HDM v/c's and are approaching or exceeding capacity by the design year (Table 41). Even with two lanes in each direction on US20 with dual turn lanes as appropriate, the US20 intersections at Cooley and Robal Roads are about at capacity with 0.93 and 1.0 v/c respectively. The US20 (3rd Street) & Empire Avenue intersection is substantially over capacity at a v/c of 1.10. Four southbound lanes (two through and long dual left turns) are needed to allow for lane changing along 3rd Street between the US20 connection and Empire Avenue. The large volume at this intersection would typically be handled with a grade separation rather than at-grade. However, because of the close proximity to US97, grade separations are not practical.

Table 41: Year 2015 & 2035 State Highway East DS-1 Signalized Intersection V/C Ratios

Intersection[1]	HDM v/c	v/c Ratio[2]		Year Exceeded	
		2015	2035	Std.	Cap.
US20 & Cooley Rd	0.75	0.50	**0.93**	2027	2039
US20 & Robal Rd	0.75	0.61	**1.00**	2022	2035
US20 & Empire Ave	0.75	**0.83**	**1.10**	2015	2028
Empire Ave & NB US97 Ramps	0.75	0.57	**0.79**	2032	2040+
Empire Ave & SB US97 On-ramp	0.75	0.48	0.68	2040+	2040+

[1]NB = Northbound, SB = Southbound
[2]Black shaded cells indicate the HDM design v/c guideline has been exceeded.

All City signalized intersections are under standards in 2015. All meet standards in 2035 except for the O.B. Riley Road & Empire Avenue intersection (Table 42). This intersection is over the City standards (and the highest in the project area) mainly because of high northbound and southbound through movements from the increased volumes. This shows the need to widen O.B. Riley Road to two travel lanes in each direction by 2027.

Table 42: Year 2015 & 2035 City Street East DS-1 Signalized Intersection V/C Ratios

Intersection	v/c Ratio[1]		Delay (s)		Year Std. Exceeded
	2015	2035	2015	2035	
3rd St & Cooley Rd	0.44	0.84	47.2	59.2	2040+
3rd St & Robal Rd	0.65	0.73	42.3	44.1	2040+
Cooley Rd & Hunnell Rd S	0.12	0.38	12.3	16.3	2040+
Cooley Rd & Hunnell Rd N	0.19	0.41	17.9	18.8	2040+
Robal Rd & Hunnell Rd	0.33	0.56	16.7	21.9	2040+
O.B. Riley Rd & Empire Ave	0.62	**1.26**	20.4	**106.9**	2027
Empire Avenue & Boyd Acres Rd	0.64	0.93	26.3	47.1	2040+

[1]Black shaded cells indicate the City v/c of 1.0 and 80 second delay standard for signalized intersections has been exceeded.

Queuing

Appendix L contains the 2015 and 2035 95th percentile queuing figures for the project area. The 2015 and 2035 queues were created by averaging at least five random SimTraffic micro-simulations together. Queues shown on the figures are a combination of stopped vehicles and vehicles traveling at seven or less miles per hour.

In 2015, the main queuing issue on US97 is a significant slowdown section (rolling queue) for northbound US97 from the southern US20 connection north to Empire Avenue because of the extensive weaving. North of Empire Avenue, US97 is free-flow to the northern project limits at the Deschutes Market Interchange. Problems on US20 are generally limited to long northbound and southbound queues at the 3rd Street & Empire Avenue intersection. Queues northbound exceed a quarter-mile while the southbound queue reaches the 3rd Street/US20 interchange. On the local system, long queues exist at the 3rd Street &

Robal Road intersection, but they do not block approaches except for the eastern Cascade Village Mall driveway. Queuing is predominant on Empire Avenue with occasional blockages of minor roads such as Britta Street, Jamison Street, and Industrial Park Boulevard.

Table 43 shows the significant (greater than 5% of the peak hour) blocking areas in 2015 with blocking issues limited to intersection turn bays. The most significant durations occur at the US20 & Old Bend-Redmond Highway intersection mainly from the long delays incurred by side-street traffic trying to cross or turn. Over half of the blocking problems are along Empire Avenue with most taking up almost10% of the peak hour. Congestion is expected in the highest traveled portions in the peak hour around the US97 interchange.

Table 43: Year 2015 East DS-1 Significant Queue Blocking[1]

Intersection	Approach	Blocked Lane	Average Percent Time Blocked
US20 & Old Bend-Redmond Hwy	SB	L	81
	NB	L	66
US20 & Robal Rd	EB	L	10
	WB	T	15
US20 & Empire Ave	NB	R	11
3rd St & Robal Rd	WB	TR	15
	SB	R	7
Empire Ave & Nels Anderson Rd/ US97 SB On-ramp	EB	R	5
Empire Ave & US97 NB Off-ramps	NB	TR	9
Empire Ave & Boyd Acres Rd	EB	T	6
	WB	L	8
	NB	L	33

[1]NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, TR = shared through-right lane.

Through 2035, the constant queuing issue on US97 shows significant slowdown on northbound US97 between the southern US20 connection and the Empire Avenue northbound off-ramp because of extensive weaving. No issues are evident on the rest of US97 in the project area. Long queues exist on US20 approaching Robal Road westbound and significant slowing occurs approaching the Old Bend-Redmond Highway intersection because of left-turning vehicles blocking the westbound through lanes. The northbound queue at the US20 & Empire Avenue exceeds a quarter mile and the southbound queue extends through the 3rd Street/US20 interchange.
Significant queuing occurs on Robal and Empire Avenue with many driveways and streets blocked.

Table 44 shows the significant (greater than 5%) blocking areas in 2035. The queues now have expanded to block turn bays and extend into adjacent intersections and approaches. Most of the blocked roadways are minor except for the eastbound US20 connection to 3rd Street southbound that is blocked 30% of the peak hour. Over 50% of the peak hour

blocking occurs at the US20 & Old Bend-Redmond Highway, US20 & Empire, 3rd Street & Cooley Road, Cooley Road & Boyd Acres Road, and Empire Avenue & O.B Riley Road and Boyd Acres Road intersections.

Table 44: Year 2035 East DS-1 Significant Queue Blocking[1]

Intersection	Approach	Blocked Lane	Blocked Intersection	Average Percent Time Blocked
US20 & Old Bend-Redmond Hwy	SB	L		100
	NB	L		100
	WB	L		14
US20 & Cooley Rd	WB	L		5
			Scenic Dr	7
	NB	L		14
		R		14
	SB	L		7
US20 & Robal Rd	EB	L		39
	WB	L		24
		R		30
	NB	L		31
		R		31
US20 & Empire Ave	WB	L		14
			Industrial Park Blvd	14
		R		14
	NB	L		66
		R		69
			Sherman Ave	56
	SB		EB US20/SB 3rd St	30
3rd St & Clausen Dr	EB	L		40
	SB	L		7
3rd St & Cooley Rd	EB	L		17
	WB	L		6
	NB	R		25
	SB	L		66
			Clausen Dr	24
3rd St & Robal Rd	EB		Cascade Village Dwy	19
	WB	TR		18
			Nels Anderson Dr	5
	NB	T		10
	SB	R		7
Cooley Rd & Hunnell Rd N	NB	L		6
Cooley Rd & Boyd Acres Rd	NB	L		65
	SB	L		72
Robal Rd & Hunnell Rd	WB	R		5

Empire Ave & O.B. Riley Rd	WB	R		58
	NB	L		36
	SB	L		6
Empire Ave & Nels Anderson/US97 SB On-ramp	EB	L		11
		R		11
Empire Ave & US97 NB Ramps	WB	R		6
	NB	TR		8
Empire Ave & Boyd Acres Rd	EB	L		14
		R		11
	WB	L		24
	NB	L		15
		R		62
	SB	R		80

[1]NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, TR = shared through-right lane.

Other Operational Performance Measures

Tables 45 and 46 show additional operational MOE's for the project area over the 20-year analysis period. The tables show increasing congestion by dropping overall average speed and increasing delay. However, impacts to US97 are minimal as travel times only increase about 10% from 2015 to 2035. In comparison, on US20 which has numerous over-capacity intersections, travel times more than double. Local system impacts vary from little change on O.B. Riley Road to significant (increase of 40%) on 3rd Street. Roadways with the most affected travel times have the lowest segment speeds. Only US97 and O.B. Riley Road have peak hour speeds close to the posted speeds.

Table 45: Year 2015 & 2035 East DS-1 Overall Simulation Measures of Effectiveness

Measure of Effectiveness	Year	
	2015	2035
Average Speed (mph)	32	18
Total Stops[1]	18,700	47,900
Delay (hr)	330	1,550
Travel Time (hr)	1,130	2,630

[1]A stop is recorded every time a vehicle drops below 7 mph (crawl speed). A vehicle might have multiple stops on an intersection approach.

Table 46: Year 2015 & 2035 East DS-1 Segment Travel Time and Speed

Segment	Travel Time per vehicle (min:s)		Average Speed (mph)	
	2015	2035	2015	2035
US97 (Deschutes Market Rd – Butler Market Rd)	7:25	8:10	47	43
US20 (Old Bend-Redmond Hwy – Sherman Ave)	4:20	9:40	29	14
3rd St (US97 – US20)	5:20	7:40	30	22
O.B. Riley Rd (Old Bend-Redmond Hwy – Empire Ave)	3:15	3:30	35	31
Empire Ave (O.B. Riley Rd – Boyd Acres Rd)	2:30	4:15	17	11
Cooley Rd (O.B. Riley Rd – Boyd Acres Rd)	4:25	4:35	19	18
Robal Rd (O.B. Riley Rd – Nels Anderson Rd)	3:25	4:15	14	11

Spacing Standards

Appendix C in the OHP has spacing standards for public road approaches and private accesses to be used in the planning process. The following spacing standards apply to the US 97 Bend North Corridor Solutions project:

- Interchange-to-interchange: three miles for a rural expressway and 1.9 miles for an urban expressway or statewide highway based on cross-road spacing. This standard is for the planning of new interchanges on the state system.
- Ramp-to-ramp/intersection: one mile between two interchanges in access-controlled freeway sections or between an interchange and an at-grade intersection.
- Ramp-to-Ramp: one-half mile between the taper sections of intersections or adjacent on and off-ramps.
- Next intersection adjacent to ramp terminal: 1320 feet for a two or multi-lane crossroad in an urban area to the next full intersection or right-in-right-out.
- Street spacing: One mile at 55 mph for a rural expressway; 2640 feet for streets at 45 mph on a urban expressway; and 990 feet for a urban statewide highway. There is no standard for private accesses as they are discouraged on statewide highways and expressways.

North of the 3rd Street interchange, US97 has a few accesses up to Deschutes Junction. A future median may be added between the two interchanges to limit conflict points as creating full frontage /backage roads for a few isolated properties was not cost-effective. US97 south of the 3rd Street interchange is access-controlled with the only connections being interchanges. Like US97, the northern section of US20 has very few accesses north of Empire Avenue. From Empire Avenue south, US20 is an uncontrolled five-lane section with many driveways.

Table 47 compares the major road segments and their appropriate spacing standard. On US97 north of the US20 connections to the 3rd Street interchange, the highway exceeds the

interchange and ramp-to-ramp spacing standards. Most existing accesses north of the 3rd Street interchange remain but might be restricted with a future extension of the median barrier north to Deschutes Market Road. The distance from the US20 connections and the Empire Avenue interchange is only about 10% of the standard, however this is only one connection in the northbound direction for a partial interchange. The interchange spacing between Empire Avenue and Butler Market is less than half of the 1.9 mile standard remaining unchanged from the no-build.

On US20, the street spacing is only about a third of the standard north of Cooley Road and Empire Avenue. US20 approaches the standard between 3rd Street and Robal Road northbound and is close to the standards between Cooley and Robal Roads. South of Empire Avenue, the spacing is improved with some driveway closures, but still does n not meet the the spacing standards.

Table 47: Spacing Standards Comparison

Roadway	Segment	Spacing Standard	Alternative Spacing[1]
US97	Deschutes Market Rd - 3rd Street Interchange	1 mi	**<2500 ft[2]**
	3rd Street Interchange – US20 Connections	1.9 mi	3.2 mi
	US20 Connections – Empire Avenue Interchange	1.9 mi	**1030 ft**
	Empire Avenue Interchange- Butler Market Interchange	1.9 mi	**4490 ft**
	3rd Street Ramps – US20 Connection	2640 ft	1.9 mi NB 3.2 mi SB[3]
	US20 Connection – Empire Avenue Ramps	2640 ft	**1580 ft[4]**
	Empire Avenue Ramps – Butler Market Ramps	2640 ft	**1270 ft**
US20	Old Bend-Redmond Highway – Cooley Rd	1 mi	**300 - 1700 ft[2]**
	Cooley Rd – Robal Rd	2640 ft	**2220 ft**
	Robal Rd – 3rd St Connections	1 mi	**3010 ft EB 4380 ft WB**
	3rd St Connections– Empire Ave	1 mi	**1530 ft**
	Empire Ave – project limits	990 ft	**<400** ft[2]
Empire Ave	Industrial Park Blvd – Nels Anderson Rd/SB US97 On-ramp	1320 ft	**370 ft[5]**
	US97 NB Off-ramp – Corporate/Blenhiem Pl	1320 ft	**780 ft**
3rd Street	US20 Connections – Nels Anderson Rd	1 mi	**950 ft**
	Harris Way – 3rd St SB Ramps	1320 ft	**1060 ft**
	3rd St NB Ramps – Frontage Road	1320 ft	**950 ft**

[1]Black-shaded cells mean the spacing is less than the corresponding standard.
[2]Approximate road/driveway spacing over segment
[3]This is the distance to the next ramp which is the Empire Avenue southbound on-ramp.
[4]Northbound only
[5]Appoximately 850 feet to the signalized US20/3rd Street intersection

The ramp terminal spacing standard is not met on Empire Avenue with sections one- third to a half of the requirement. At the 3rd Street interchange, the ramp terminal spacing is about 75% of standard. The interchange has minimized the ramp terminal spread (to limit property impacts) thus maximizing the distance to the next intersection, but existing road geometry at Harris Way and the railroad tracks prevent fully reaching the standards.

East DS-2 Analysis Results

Mainline & Merge/Diverge/Weave Segments

Tables 48 and 49 show the v/c ratio results for the free-flow highway mainline, ramp connections, interchange merge/diverges and weaving sections. In 2015, all sections are operating under the 0.60 rural and the 0.75 urban Highway Design Manual (HDM) v/c's. By 2035, the only problems in East DS-2 are on northbound US97 at the edges of the project. Higher commuter flows in the afternoon peak hour are northbound (outbound toward Redmond), making it more critical than the southbound. Except for the northbound weaving section between Butler Market Road and Empire Avenue, the other sections remain unchanged from the no-build, representing conditions north and south of the project area.

The section between the Empire Avenue and Butler Market Road interchanges is a transition section between the improved new alignment north of Empire and the unchanged near-capacity section south of Butler Market. In this section, the improvements are limited primarily to improving traffic flow rather than improving capacity. Because of high volumes and weaving movements, speeds will be less than north of Empire Avenue but likely greater than south of Butler Market Road. This will allow relatively high speed southbound traffic to slow before reaching near-capacity conditions. Also, it allows traffic from Empire Avenue the maximum room to merge into US97 traffic. Northbound traffic will do the opposite by gradually increasing speed north of Butler Market Road while allowing room for vehicles to maneuver. This creates the geometric lane and operational balance (three lanes are needed south of the diverge) required at the major diverge to US20 and northbound 3rd Street.

Before 2015 in the northbound direction and by 2027 in the southbound direction, auxiliary lanes will be needed between the Empire Avenue and Butler Market Road interchanges. Auxiliary lanes make it easier for vehicles to move into or out of high traffic flows and allow local traffic traveling between interchanges to stay out the mainline lanes. There is limited interchange to interchange traffic so the primary function of the auxiliary lanes here will be to smooth out the conflicting traffic flows.

The short section plus the turbulence between the closely-spaced successive US20 and Butler Market Road on-ramps makes northbound weaving problematic. The best geometric and operational combination is a Type B weaving section where vehicles in the right lane can either exit at Empire Avenue or continue north on US97. The auxiliary lane originates

with the higher volume US20 on-ramp and has the Butler Market Road on-ramp merge into it, keeping most of the on-off movements out of the through lanes. This also keeps the northbound cross–section to three total lanes. The v/c for the northbound weaving section is 0.84 which is over the HDM v/c of 0.75 but the distance between the ramps is too short to have a four-lane section with a two-lane off ramp at Empire Avenue. Some local congestion/slowing between weaving vehicles is possible in this section.

Table 48: Year 2015 and 2035 East DS-2 US97 Mainline and Merge/Diverge/Weave V/C Ratios[1, 2]

Section	Direction				
	HDM	2015		2035	
	v/c	NB	SB	NB	SB
Mainline north of Deschutes Market Rd	0.60	0.54	0.37	**0.72**	0.50
Nichols Market Rd/ Deschutes Market Rd Off-ramp diverges	0.60	0.47	0.36	0.59	0.49
Nichols Market Rd/ Deschutes Market Rd On-ramp merges	0.60	0.51	0.31	**0.69**	0.42
Mainline south of Deschutes Market Rd	0.60	0.47	0.32	0.58	0.44
3rd St NB On-ramp merge/ SB Off-ramp diverge	0.75	0.46	0.33	0.56	0.45
Mainline south of 3rd St	0.75	0.39	0.27	0.46	0.36
Empire Ave NB On-ramp merge	0.75	0.39		0.45	
NB Mainline south of Empire Ave NB On-ramp	0.75	0.34		0.41	
3rd St /US20 NB diverge	0.75	0.50		0.64	
Mainline south of NB ramp to 3rd St/US20	0.75	0.50	0.30	0.64	0.40
Empire Ave – Butler Market Rd SB weaving section	0.75		0.54		0.67
US20 Connection – Empire Ave NB weaving section[3]	0.75	0.66		**0.84**	
Butler Market Rd NB On-ramp merge	0.75	0.51		0.68	
Mainline south of Butler Market Rd (SB) and US20 (NB) ramps	0.75	0.71	0.34	**0.93**	0.43

[1]Blackened cells indicate that HDM design v/c guideline has been exceeded.
[2]NB = Northbound, SB = Southbound
[3]This is a weaving section, so the weaving v/c ratio controls the operation of the segment. Because of the high weaving flows, the operation of the weaving section will likely be worse than predicted.

Table 49: Year 2015 and 2035 East DS-2 US20/3rd St Connections V/C Ratios

Section[1]	HDM v/c	2015	2035
US20 Connection to NB 3rd St	0.75	0.40	0.40
Connection to WB US20 & NB 3rd St	0.75	0.45	0.58
US97 (Sister's Loop) Connection & WB US20 On-ramp merge	0.75	0.31	0.52

[1]NB = Northbound, WB = Westbound

The southbound Empire Avenue- Butler Market Road weaving section is a Type A where vehicles in the right auxiliary lane must exit at Butler Market if a lane change is not made

and forces US97 traffic to make a lane change to exit at Butler Market. This weaving section is not over the HDM v/c, however, because of the high weaving volumes operations will be subject to slowdowns and localized congestion. A Type B weave here would be preferable, but the additional length beyond the Butler Market off-ramp interferes with the Butler Market Road overcrossing and a nearby canal.

The need for two lanes in each direction on US20 between 3rd Street and the project limits east of the Old Bend-Redmond Highway is driven by the intersections on the project. Widening of US20 between the project limits and Robal Road will be necessary once the US20 & Cooley intersection is signalized (approximately 2020) as stopping previously free traffic on the mainline will approximately cut the capacity in half so additional lanes are necessary to keep the same flow of traffic constant.

Between the Robal Road and Empire Avenue intersections of US20 the project need is trying to keep congestion at a practical level without clogging up a good portion of the nearby system. Around 2019, the Robal Road intersection will exceed the OHP v/c which indicates a need for an improvement. Robal Road improvements such as adding a dual left turn lane on Robal needs two eastbound lanes or adding the westerly extension requires taking signal phase time away from the mainline thus accelerating the need for widening if done before 2019. By 2019, the Empire Avenue intersection v/c ratio is predicted to be around 1.20 without any improvements, which is well over capacity. Long queues in all directions can be expected especially through the 3rd/US20 section making it difficult to maneuver with long travel times and delays.

Preliminary Signal Warrants

Table 50 shows the preliminary signal warrant (PSW) results. Meeting a preliminary signal warrant does not mean an improvement will be installed. The region will have to do an intersection traffic control study and get approval of the State Traffic Engineer's office before a signal will be approved on state highways.

In 2015, only the US20 & Old Bend-Redmond Highway and the O.B. Riley Road & Empire Avenue intersections meet PSW's. The US20 & Old Bend-Redmond Highway intersection is a poor location for signal as it is located in a rural high-speed area and Region 4 does not support a signal at this location. Since this intersection has the same operation with or without this project, it was removed from the project to limit the scope to mainly focus on US97 issues. The East DS-2 alternative adds significantly more traffic to O.B. Riley Road and Empire Avenue which makes the O.B. Riley Road & Empire Avenue intersection part of the project improvements, so this intersection is assumed to be signalized in the analysis. The intersection has too much traffic for a roundabout to work properly so a signal is shown as the most practical option.

Table 50: Year 2015 & 2035 East DS-2 Preliminary Signal Warrants[1]

Intersection	PSW Met?		Year Met
	2015	2035	
Tumalo Rd & Nichols Market Rd	No	No	
Tumalo Road & Deschutes Market Rd	No	No	
3rd St & Grandview Dr	No	No	
3rd St & Clausen Rd	No	No	
3rd St & Nels Anderson Pl/Cascade Village	No	No	
Old Bend-Redmond Hwy & O.B. Riley Rd	No	**Yes**	2030
Old Bend-Redmond Hwy & US20	**Yes**	**Yes**	
Cooley Rd & O.B. Riley Rd	No	No	
Cooley Rd & US20	No	**Yes**	2023
Cooley Rd & Hunnell Rd (south)	No[2]	**Yes**	2035
Cooley Rd & Hunnell Rd (north)	No[2]	**Yes**	2021
Cooley Rd & Boyd Acres Rd	No[2]	No	
Robal Rd & O.B. Riley Rd[3]	No	**Yes**	2022
Robal Rd & Britta St	No	No	
Robal Rd & Nels Anderson Dr	No	No	
Nels Anderson Dr & Nels Anderson Pl	No	No	
Empire Ave & O.B. Riley Rd	**Yes**	**Yes**	
Empire Ave & Britta St	No	No	
Empire Ave & Jamison St	No	No	
Empire Ave & Industrial Park Blvd	No	No	
Empire Ave & Nels Anderson Rd/SB US97 Ramp Terminal	No[4]	**Yes**	2040+
Empire Ave & Corporate/Blenhiem Pl	No	No	
Hunnell Rd & Shopping Center Access	No	No	

[1]Black shaded cells indicate that preliminary signal warrants (PSW's) have been met. Region Traffic staff will need to perform an intersection traffic control study in which the Region Traffic Engineer will forward the recommendation to the State Traffic Engineer's office. Traffic signal warrants must be met and the State Traffic Engineer's approval obtained before a traffic signal will be installed on a state highway.
[2]The 2015 analysis assumed signals at these locations as these are likely mitigations for near-term developments along Cooley Road.
[3]This intersection when constructed as part of the project will likely be a roundabout regardless of when the PSW is met.
[4]This intersection will be substantially widened as part of the project and would need to be signalized for Empire Avenue to operate efficiently.

Depending on timing of project elements numerous other intersections were assumed to have improved traffic control in 2015. The intersections along Cooley Road at US20, Hunnell Road S and Hunnell Road N were signalized assuming development growth in the Cooley Road area by that time. This smoothed out the simulation results, otherwise queuing from an over–capacity Cooley Road, especially from the US20 intersection, would jam the system unrealistically. Around 2021, PSW's start being met at the Cooley Road intersections from assumed traffic growth. Also, because of existing development agreements, when the Loop Road/Lowe's driveway is closed to accommodate the new 3rd Street alignment, the Cooley Road & Hunnell Road N intersection will be signalized. This

3rd Street realignment will likely be in an early construction phase to gain measureable capacity relief and allow development in the immediate area. The Cooley Road & Hunnell Road N intersection also is the primary access to Bowery Lane and the eastside frontage road connections in East DS-2.

The additional traffic along O.B. Riley Road triggers a PSW in 2022 at the new intersection at Robal Road. The analysis assumed that the intersection would be constructed as a single-lane roundabout upon construction of the western Robal Road extension as a single-lane roundabout works well here and fits in with the suburban character of the area.

Technically, the Empire Avenue & US97 Southbound Ramp Terminal/ Nels Anderson Road intersection does not meet PSW's until at or beyond the design year, since the Nels Anderson approach volume is relatively low and the on-ramp has traffic moving away from the intersection. However, for the southbound left turn movement, the interchange and this section of Empire Avenue between US97 and US20 (3rd Street) to work acceptably, this intersection needs to be signalized. Otherwise, queues from this intersection will affect the adjacent one and will severely exits from the relatively isolated Nels Anderson industrial area.

With the above assumptions, the only additional intersection to meet PSW's by 2035 is the O.B. Riley Road & Old Bend-Redmond Highway in 2030 because of increased traffic flows on O. B. Riley Road (some from new development and some from diverting US20 traffic). This intersection is in rural Deschutes County and was assumed to be a single-lane roundabout.

Unsignalized Intersections

In 2015, all unsignalized intersections in the project area are under standards except for the US20 & Old Bend-Redmond Highway intersection (Tables 51-53). This intersection has a v/c of over 2.0 for the side-street indicating that there are no safe gaps available to turn into. Traffic will likely divert to Robal or Cooley Roads to avoid turning left or crossing this intersection in or near the peak hours. Otherwise, vehicles will select smaller gaps in the traffic stream creating more risk for a crash.

Table 51: Year 2015 East DS-2 State Highway Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	HDM v/c	v/c Ratio[1]	Critical Movement[2]
US20 & Old Bend-Redmond Hwy	0.60	**0.28/2.0+**	WBTR/SBL

[1]Blackened cells means that the HDM design v/c guideline has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. SB = Southbound, WB = Westbound, L= exclusive left turn lane, TR = shared left-though lane.

Table 52: Year 2015 East DS-2 City Street Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	v/c Ratio	Delay (s)	Critical Movement[1]
3rd St & Grandview Dr	0.00/0.03	8.2/11.4	SBL/WBLR
3rd St & Clausen Rd	0.18/0.06	8.2/52.0	NBL/WBL
3rd St & Chavre Wy	0.33/0.03	0.0/9.6	NBT/WBR
3rd St & Target Dwy	0.19/0.37	0.0/13.6	SBT/EBR
3rd St & Nels Anderson Pl/Cascade Village	0.32/0.08	0.0/16.5	NBT/WBR
Cooley Rd & Scenic Dr	0.10/0.02	0.5/10.6	EBTL/SBLR
Cooley Rd & Boyd Acres Rd	0.03/0.56	9.8/63.1	WBL/NBL
O.B. Riley Rd & Robal Rd[1]	0.33/0.30	6.3/5.0	NBTL/WBLR
Robal Rd & Britta St	0.02/0.15	1.0/9.6	WBTL/NBLR
Robal Rd & Auto Mall Dwy	0.02/0.08	8.5/17.5	EBL/NBTL
Robal Rd & Target Dwy	0.10/0.10	0.0/9.9	WBT/SBR
Robal Rd & Cascade Village Dwy	0.04/0.06	0.0/9.1	EBT/NBR
Robal Rd & Nels Anderson Dr	0.35/0.03	12.7/2.3	NBTL/EBLR
Nels Anderson Dr & Chavre Wy	0.01/0.01	2.3/8.9	NBTL/EBLR
Nels Anderson Dr & Nels Anderson Pl	0.01/0.12	0.4/10.6	NBTL/EBLR
Empire Ave & Britta St	0.01/0.01	8.2/13.2	EBL/SBL
Empire Ave & Jamison St	0.15/0.06	0.0/10.1	WBT/SBR
Empire Ave & Industrial Park Blvd	0.40/0.07	0.0/10.1	WBT/SBR
Empire Ave & Corporate/Blenhiem Pl	0.02/0.38	10.4/46.8	EBL/NBLTR
Hunnell Rd & Loco Rd	0.02/0.19	2.2/11.2	SBTL/WBLR
Bowery Ln & Frontage Rd	0.01/0.00	9.0/2.4	NBTL/EBLR

[1]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, TL= shared through-left lane, LTR= shared left-through-right turn lane.
[2]Intersection is a roundabout.

Table 53: Year 2015 East DS-2 County Road Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	LOS	Critical Movement[1]
Tumalo Rd & Deschutes Pleasant Ridge Rd	A/B	WBTL/NBLR
Tumalo Road & Nichols Market Rd	A/B	EBL/SBLTR
Tumalo Rd & Deschutes Market Rd	A/C	EBL/NBLTR
O.B. Riley Rd & Old Bend-Redmond Hwy	A/B	SBTL/WBLR
O.B. Riley Rd & Cooley Rd	A/B	SBL/WBL
Hunnell Rd & Rogers Rd	A/A	NBTL/EBLR
Hunnell Rd & Bowery Ln	A/A	SBTL/WBLR
Hunnell Rd & Fort Thompson Ln	A/A	NBTR/WBLR
Fort Thompson Ln & Harris Wy	A/A	WBTL/NBLR
Bowery Ln & Harris Wy	A/A	EBTL/SBLR

[1]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, LTR= shared left-through-right turn lane.

By 2035, the mainline left turns are having difficulty finding gaps as the US20 v/c ratio is over standards at the US20 & Old Bend-Redmond intersection (Table 54). Traffic diversion to other local facilities such as Robal and Cooley Roads is likely in the peak periods. On the local system, only the Cooley Road & Boyd Acres Road intersection exceeds standard (Tables 55-56) around 2016 which likely indicates a traffic control improvement.

Table 54: Year 2035 East DS-2 State Highway Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	HDM v/c	v/c Ratio[1]	Critical Movement	Year Exceeded	
				Std.	Cap.
US20 & Old Bend-Redmond Hwy	0.60	**0.81/2.0+**	WBL/NBL	<2007	<2007

[1]Blackened cells means that the HDM design v/c guideline has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, WB = Westbound, L= exclusive left turn lane.

Table 55: Year 2035 East DS-2 City Street Unsignalized Intersection Operations for Critical Major and Minor Approaches[1]

Intersection	v/c Ratio	Delay (s)	Critical Movement[2]	Year Std. Exceeded
3rd St & Grandview Dr	0.10/0.11	8.8/15.2	SBL/WBLR	2040+
3rd St & Clausen Rd	0.24/0.62	8.9/80.0	NBL/EBL	2040+
3rd St & Chavre Wy	0.38/0.05	0.0/10.0	NBT/WBR	2040+
3rd St & Target Dwy	0.24/0.44	0.0/15.9	SBT/EBR	2040+
3rd St & Nels Anderson Pl/Cascade Village	0.63/0.15	0.0/20.6	NBT/WBR	2040+
Cooley Rd & Scenic Dr	0.25/0.03	0.3/16.4	EBTL/SBLR	2040+
Cooley Rd & Boyd Acres Rd	**0.21/2.0+**	**15.0/120+**	WBL/NBL	2016
O.B. Riley Rd & Robal Rd[2]	0.89/0.53	29.8/9.6	SBTL/WBLR	2039
Robal Rd & Britta St	0.06/0.31	2.0/11.3	WBTL/NBLR	2040+
Robal Rd & Auto Mall Dwy	0.04/0.38	9.9/49.7	EBL/NBTL	2040+
Robal Rd & Target Dwy	0.13/0.17	0.0/10.7	WBT/SBR	2040+
Robal Rd & Cascade Village Dwy	0.07/0.12	0.0/9.7	EBT/NBR	2040+
Robal Rd & Nels Anderson Dr	0.42/0.04	14.9/2.4	NBTL/EBLR	2040+
Nels Anderson Dr & Chavre Wy	0.02/0.01	3.1/9.2	NBTL/EBLR	2040+
Nels Anderson Dr & Nels Anderson Pl	0.02/0.16	1.1/11.4	NBTL/EBLR	2040+
Empire Ave & Britta St	0.01/0.04	9.2/20.8	EBL/SBL	2040+
Empire Ave & Jamison St	0.25/0.10	0.0/11.6	WBT/SBR	2040+
Empire Ave & Industrial Park Blvd	0.43/0.10	0.0/10.1	WBT/SBR	2040+
Empire Ave & Corporate/Blenhiem Pl	0.03/0.63	12.7/96.0	EBL/NBLTR	2040+
Hunnell Rd & Loco Rd	0.03/0.48	1.8/18.9	SBTL/WBLR	2040+
Bowery Ln & Frontage Rd	0.04/0.02	9.5/4.1	NBTL/EBLR	2040+

[1]Blackened cells mean that the City 50 second delay standard for unsignalized intersections with the subject approach having more than 100 peak hour trips or the v/c of 1.0 standard has been exceeded.
[2]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, TL= shared through-left lane, LTR= shared left-through-right turn lane.
[3]Intersection is a roundabout.

Table 56: Year 2035 East DS-2 County Road Unsignalized Intersection Operations for Critical Major and Minor Approaches

Intersection	LOS	Critical Movement	Year Std. Exceeded
Tumalo Rd & Deschutes Pleasant Ridge Rd	A/C	WBTL/NBLR	2040+
Tumalo Road & Nichols Market Rd	A/C	EBL/SBLTR	2040+
Tumalo Rd & Deschutes Market Rd	A/D	EBL/NBLTR	2040+
O.B. Riley Rd & Old Bend-Redmond Hwy	B/C	SBTL/WBLR	2038
O.B. Riley Rd & Cooley Rd	A/D	SBL/WBL	2040+
Hunnell Rd & Rogers Rd	A/A	NBTL/EBLR	2040+
Hunnell Rd & Bowery Ln	A/B	SBTL/WBLR	2040+
Hunnell Rd & Fort Thompson Ln	A/B	SBTL/WBLR	2040+
Fort Thompson Ln & Harris Wy	A/A	WBTL/NBLR	2040+
Bowery Ln & Harris Wy	A/A	EBTL/SBLR	2040+

[1]This is the critical (mainline/side-street) approach by direction and lane configuration for exclusive or shared turn lanes. NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, LR = shared left-right lane, TL= shared through-left lane, LTR= shared left-through-right turn lane.

Signalized Intersections

Most of the state highway signalized intersections exceed the HDM v/c's and are approaching or exceeding capacity by the design year (Table 57). Even with two lanes in each direction on US20 with dual turn lanes as appropriate, the US20 intersections at Cooley and Robal Roads are about at capacity with 0.91 and 1.0 v/c respectively. The US20 (3rd Street) & Empire Avenue intersection is substantially over capacity at a v/c of 1.20. Four southbound lanes (two through and long dual left turn) are needed to allow for lane changing along 3rd Street between the US20 connection and Empire Avenue. The large volume at this intersection would typically be handled with a grade separation rather than at-grade. However, because of the close proximity to US97, grade separations are not practical.

Table 57: Year 2015 & 2035 State Highway East DS-2 Signalized Intersection V/C Ratios

Intersection	HDM v/c	v/c Ratio[1]		Year Exceeded	
		2015	2035	Std.	Cap.
US20 & Cooley Rd	0.75	0.53	**0.91**	2027	2040
US20 & Robal Rd	0.75	0.63	**1.00**	2022	2036
US20 & Empire Ave	0.75	**0.82**	**1.20**	2015	2025
Empire Ave & NB US97 Ramps	0.75	0.59	0.75	2036	2040+
Empire Ave & SB US97 On-ramp	0.75	0.47	0.66	2040+	2040+

[1]Black shaded cells indicate the HDM design v/c guideline has been exceeded.

All City signalized intersections are under standards in 2015 and except for the O.B. Riley Road & Empire Avenue intersection meet standards in 2035 (Table 58). This intersection is just over the City standards mainly because of high southbound through volumes. This shows a likely need to widen O.B. Riley Road to two travel lanes in each direction around the 2035 design year.

Table 58: Year 2015 & 2035 City Street East DS-2 Signalized Intersection V/C Ratios[1]

Intersection	v/c Ratio		Delay (s)		Year Std. Exceeded
	2015	2035	2015	2035	
3rd St & Cooley Rd	0.45	0.78	38.3	50.3	2040+
3rd St & Robal Rd	0.68	0.81	37.5	51.2	2040+
Cooley Rd & Hunnell Rd S	0.14	0.39	14.6	27.7	2040+
Cooley Rd & Hunnell Rd N	0.29	0.57	20.3	29.8	2040+
Robal Rd & Hunnell Rd	0.35	0.57	16.4	21.6	2040+
O.B. Riley Rd & Empire Ave	0.57	**1.01**	18.5	60.4	2035
Empire Ave & Boyd Acres Rd	0.65	0.89	26.1	43.8	2040+

[1]Black shaded cells indicate the City v/c of 1.0 or 80 second delay standard for signalized intersections has been exceeded.

Queuing

Appendix N contains the 2015 and 2035 95th percentile queuing figures for the project area. The 2015 and 2035 queues were created by averaging at least five random SimTraffic micro-simulations together. Queues shown on the figures are a combination of stopped vehicles and vehicles traveling at seven or less miles per hour.

US97 in 2015 is free-flowing through the project area. Problems on US20 are generally limited to lengthy northbound and southbound queues at the 3rd Street and Empire Avenue intersection. Queues are about 425’ northbound and 700’ southbound, but no adjacent streets or connections are blocked. On the local system, the longest queues are at the 3rd Street & Robal Road intersection. Only the queues on Robal Road block significant adjacent driveways (Cascade Village Mall) and intersections (Nels Anderson Rd). Empire Avenue queuing does not extend between intersections except with closely spaced ones like 3rd Street and Jamison Street or O.B. Riley Road and Britta Street.

Table 59 shows the significant (greater than 5%) blocking areas in 2015 with blocking issues limited to turn bays. The most significant durations occur at the US20 & Old Bend-Redmond Highway intersection mainly from the long delays incurred by side-street traffic trying to cross or turn. Over half of the blocking problems are along Empire Avenue so congestion is expected in the highest traveled portions during the peak hour around the US97 interchange. The highest blocking in the local system is on the east end of Robal Road where queues block through the Nels Anderson Road intersection almost 10% of the peak hour which will mean localized difficulty for vehicles turning on and off this roadway segment.

By 2035, substantial queuing problems exist within the project area. Significant slowdowns (rolling queues) exist on northbound US97 from the southern US20 connection north to Empire Avenue because of the extensive lane changes (weaving). A second slowdown area exists north of the Empire Avenue northbound off-ramp up to the major diverge area for the connections to US20 and 3rd Street as vehicles position themselves in the proper lanes before the junction.

Congestion on northbound 3rd Street propagates down to the 3rd Street/US20 interchange as significant slowing exists on both the 3rd Street connection from US20 and the connection from US97. Long queues exist on US20 approaching Robal Road westbound and significant slowing occurs approaching the Old Bend-Redmond Highway intersection from intersections at or over capacity in this section. The southbound queue at US20 & Empire Avenue extends into the US20/3rd/US97 connections. Robal Road and Empire Avenue are essentially queued over their entire length because the over-capacity intersections block many accesses and streets.

Table 59: Year 2015 East DS-2 Significant Queue Blocking[1]

Intersection	Approach	Blocked Lane	Blocked Intersection	Average Percent Time Blocked
US20 & Old Bend-Redmond Hwy	SB	L		99
	NB	L		50
US20 & Robal Rd	WB	L		18
	NB	R		5
US20 & Empire Ave	NB	L		9
		R		20
3rd St & Robal Rd	WB	L		38
			Nels Anderson Dr	8
	NB	L		5
Empire Ave & O.B. Riley Rd	WB	R		8
Empire Ave & Nels Anderson/US97 SB On-ramp	EB	L		6
		R		9
Empire Ave & US97 NB Ramps	NB	L		6
Empire Ave & Boyd Acres Rd	EB	L		11
		R		7
	WB	L		14
	NB	R		29

[1]NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, R = exclusive right turn lane.

There are over 20 street intersections and significant driveway approaches that have blocking issues (Table 60). Blocking of adjacent streets and intersection turn lanes over half the time occurs at US20 & Old Bend-Redmond Highway, US20 & Empire, 3rd Street

& Robal and Cooley Roads, Cooley Road & Boyd Acres Road, and Empire Avenue & O.B Riley and Boyd Acres Roads.

Table 60: Year 2035 East DS-2 Significant Queue Blocking[1]

Intersection	Approach	Blocked Lane	Blocked Intersection	Average Percent Time Blocked
US20 & Old Bend-Redmond Hwy	SB	L		99
	NB	L		91
	WB	L		48
US20 & Cooley Rd	EB	L		13
	WB	L		42
			Scenic Dr	6
	SB	L		12
US20 & Robal Rd	EB	L		25
			Britta St	9
	WB	L		39
		R		49
			AutoMall/CV Dwy	20
	NB	L		25
		R		28
	SB	L		5
US20 & Empire Ave	WB	L		18
			Industrial Park Blvd	18
		R		24
	NB	L		75
		R		76
			Sherman Ave	66
	SB		EB US20/SB 3rd St	13
3rd St & Cooley Rd	EB	L		14
		R		14
	WB	L		7
	NB	R		25
	SB	L		55
			Clausen Dr	5
3rd St & Robal Rd	EB		Cascade Village Dwy	29
	WB	L		68
			Nels Anderson Dr	43
	NB	L		28
	SB	L		18
		R		31
			Target Dwy	15

3rd St & Nels Anderson Rd/Cascade Village	NB		Connection from US97	13
	SB		Robal Rd	10
Cooley Rd & Hunnell Rd S	EB	L		22
Cooley Rd & Hunnell Rd N	EB	T		8
	NB	L		25
Cooley Rd & Boyd Acres Rd	NB	L		88
	SB	L		68
Robal Rd & AutoMall/ Cascade Village Dwy	EB	L		12
			US20	10
	WB	L		21
			Hunnell Rd S	12
	NB	L		38
Robal Rd & Hunnell Rd	EB	R		17
			AutoMall/ Cascade Village Dwy	13
	WB	L		22
			Target Dwy	10
	NB	L		33
	SB	L		14
Robal Rd & Target Dwy	WB	R		5
			3rd St	17
Hunnell Rd & Shopping Center Access E-W	SB	L		11
Empire Ave & O.B. Riley Rd	WB	R		58
			Britta St	50
	NB	R		33
	SB	L		16
Empire Ave & Britta St	EB	L		18
			O.B. Riley Rd	13
	WB		Jamison St	14
Empire Ave & Jamison St	WB		3rd St	7
Empire Ave & Industrial Park Blvd	WB		Nels Anderson/SB US97 SB On-ramp	12
Empire Ave & Nels Anderson/US97 SB On-ramp	EB	L		13
	WB	L		13
			US97 NB Ramps	11
Empire Ave & US97 NB Ramps	WB	R		16
			Corporate/ Blenhiem Pl	10
	NB	TR		14
Empire Ave & Corporate/Blenhiem Pl	WB	L		9
			Boyd Acres Rd	6

Empire Ave & Boyd Acres Rd	EB	L		8
		R		18
	WB	L		40
	NB	L		8
		R		46
	SB	R		50

[1]NB = Northbound, SB = Southbound, EB= Eastbound, WB = Westbound, L= exclusive left turn lane, T= through lane, R = exclusive right turn lane, TR = shared through-right lane.

Other Operational Performance Measures

Tables 61 and 62 show additional operational MOE's for the project area over the 20-year analysis period. The tables show increasing congestion as overall average speed drops by 50% and delay increases sevenfold. However, impacts to US97 are minimal as travel times only increase about 10% from 2015 to 2035. In comparison, on US20 with its numerous over-capacity intersections, travel times more than double. Impacts from the high amount of queuing on Robal Road and Empire Avenue are reflected in the segment speeds as they drop to crawl speeds. Local system impacts have about a 40% increase in travel time. Only US97 has peak hour speeds close to the posted speeds.

Table 61: Year 2015 & 2035 East DS-2 Overall Simulation Measures of Effectiveness

Measure of Effectiveness	Year	
	2015	2035
Average Speed (mph)	32	15
Total Stops[1]	18,800	56,300
Delay (hr)	320	2,140
Travel Time (hr)	1,140	3,190

[1]A stop is recorded every time a vehicle drops below 7 mph (crawl speed). A vehicle might have multiple stops on an intersection approach.

Table 62: Year 2015 & 2035 East DS-2 Segment Travel Time and Speed

Segment	Travel Time per vehicle (min:s)		Average Speed (mph)	
	2015	2035	2015	2035
US97 (Deschutes Market Rd – Butler Market Rd)	7:20	8:15	48	43
US20 (Old Bend-Redmond Hwy – Sherman Ave)	4:25	10:05	31	14
3rd St (US97 – US20)	3:45	6:55	29	18
O.B. Riley Rd (Old Bend-Redmond Hwy – Empire Ave)	2:50	8:30	36	19
Empire Ave (O.B. Riley Rd – Boyd Acres Rd)	2:40	8:35	16	6
Cooley Rd (O.B. Riley Rd – Boyd Acres Rd)	3:50	5:20	22	16
Robal Rd (O.B. Riley Rd – Nels Anderson Rd)	3:05	5:05	15	10

Spacing Standards

Appendix C in the OHP has spacing standards for public road approaches and private accesses to be used in the planning process. The following spacing standards apply to the US 97 Bend North Corridor Solutions project:

- Interchange-to-interchange: three miles for a rural expressway and 1.9 miles for an urban expressway or statewide highway based on cross-road spacing. This standard is for the planning of new interchanges on the state system.
- Ramp-to-ramp/intersection: one mile between two interchanges in access-controlled freeway sections or between an interchange and an at-grade intersection.
- Ramp-to-Ramp: one-half mile between the taper sections of intersections or adjacent on and off-ramps.
- Next intersection adjacent to ramp terminal: 1320 feet for a two or multi-lane crossroad in an urban area to the next full intersection or right-in-right-out.
- Street spacing: One mile at 55 mph for a rural expressway; 2640 feet for streets at 45 mph on a urban expressway; and 990 feet for a urban statewide highway. There is no standard for private accesses as they are discouraged on statewide highways and expressways.

North of the 3rd Street interchange, US97 has a few accesses up to Deschutes Junction. A future median may be added between the two interchanges to limit conflict points as creating full frontage /backage roads for a few isolated properties was not cost-effective. US97 south of the 3rd Street interchange is access-controlled with the only connections being interchanges. Like US97, the northern section of US20 has very few accesses north of Empire Avenue. From Empire Avenue south, US20 is an uncontrolled five-lane section with many driveways.

Table 63 compares the between major road segments to their appropriate spacing standard. On US97, north of the US20 connections to the 3rd Street interchange, the highway exceeds the interchange and ramp-to-ramp spacing standards. Most existing accesses north of the 3rd Street interchange remain but might be restricted with a future extension of the median barrier north to Deschutes Market Road. The distance from the US20 connections and the Empire Avenue interchange is only about 10% of the standard, however this is only one connection in the northbound direction for a partial interchange. The interchange spacing between Empire Avenue and Butler Market is less than half of the 1.9 mile standard remaining unchanged from the no-build.

Table 63: Spacing Standards Comparison

Roadway	Segment	Spacing Standard	Alternative Spacing[1]
US97	Deschutes Market Rd - 3rd Street Interchange	1 mi	**<2500 ft[2]**
	3rd Street Interchange – US20 Connections	1.9 mi	2.2 mi
	US20 Connections – Empire Avenue Interchange	1.9 mi	**1030 ft**
	Empire Avenue Interchange- Butler Market Interchange	1.9 mi	**4490 ft**
	3rd Street Ramps – US20 Connection	2640 ft	1.9 mi NB 1.7 mi SB[3]
	US20 Connection – Empire Avenue Ramps	2640 ft	**1580 ft[4]**
	Empire Avenue Ramps – Butler Market Ramps	2640 ft	**1270 ft**
US20	Old Bend-Redmond Highway – Cooley Rd	1 mi	**300 - 1700 ft[2]**
	Cooley Rd – Robal Rd	2640 ft	**2220 ft**
	Robal Rd – 3rd St Connections	1 mi	**3010 ft EB 4380 ft WB**
	3rd St Connections– Empire Ave	1 mi	**1530 ft**
	Empire Ave – project limits	990 ft	**<400 ft[2]**
Empire Ave	Industrial Park Blvd – Nels Anderson Rd/SB US97 On-ramp	1320 ft	**370 ft[5]**
	US97 NB Off-ramp – Corporate/Blenhiem Pl	1320 ft	**780 ft**
3rd Street	US20 Connections – Nels Anderson Rd	1 mi	**950 ft**

[1]Black-shaded cells mean the spacing is less than the corresponding standard.
[2]Approximate road/driveway spacing over segment
[3]This is the distance to the next ramp which is the Empire Avenue southbound on-ramp.
[4]Northbound only
[5]Appoximately 850 feet to the signalized US20/3rd Street intersection

On US20, the street spacing is only about a third of the standard north of Cooley Road and Empire Avenue. US20 approaches the standard between 3rd Street and Robal Road northbound and is close to the standards between Cooley and Robal Roads. South of Empire Avenue, the spacing is improved with some driveway closures, but still does n not meet the the spacing standards. The ramp terminal spacing standard is not met on Empire Avenue with sections a third to a half of the required level.

ALTERNATIVE SUMMARY & COMPARISON

Overall, East DS-1 and DS-2 have similar volumes and results. Both are substantially better than the no-build in all respects (Table 64). The number of locations over standard or over capacity is only a third to a half of the no-build. The US97 segment and the overall network speed are double the no-build values. Conversely, alternative travel times are less than half of the no-build. The US97 travel times are about 75% of the 2007 existing condition values because of the elimination of the Cooley and Robal Road signals and other access points. Both of the alternatives have peak operating speeds reasonably close to the posted speeds. Both alternatives improved the access spacing on US97 to exceed spacing standards north of the US20 connections to the new 3rd Street interchange. South of the US20 connections and north of the new 3rd Street interchange on US97 and along US20 the spacing does not meet standards as it is relatively unchanged from the no-build alternative.

Table 64: Alternative Comparison for 2035 Results

Measure	No-build	East DS-1	East DS-2
Number of locations over standards	21	12	11
Number of locations over capacity	15	5	5
Number of turn storage bays blocked more than 50% of the peak hour	17[1]	10	10
Number of intersections blocked by queues	24[1]	7	19
Overall average network speed (mph)	8[1]	18	15
Overall network total stops	>66,000[1]	47,900	56,300
Overall network delay (hr)	>2,400[1]	1,550	2,140
Overall network travel time (hr)	~3,600[1]	2,630	3,190
US97 (Deschutes Jct- Butler Market Rd) Segment Speed (mph)	20[1]	43	43
US97 (Deschutes Jct- Butler Market Rd) Segment Travel Time (min:sec)	18:05[1]	8:10	8:15
Sections where spacing standards exceeded or met	0	2	2

[1]Data based on a 30-minute simulation run versus 60 minutes for others. Actual 60 minute values are likely much higher or slower than shown.

US97 is free of congestion in both alternatives except for localized slowing in the weaving section south of Empire Avenue. This weaving section is a “transition” section between the improved new alignment north of Empire Avenue and the unchanged near-capacity section south of Butler Market Road. Within this transition section, improvement is limited to smoothing the traffic flows between the old and new sections without attracting additional traffic which would cause a severe bottleneck south of Butler Market. In the north portion of the project area, alternatives preserve the good operations.

There are a number of US20 or local intersections at or over the HDM design v/c guidelines with some still over capacity even with reasonable improvements. Four of the five intersections along US20 from Old Bend-Redmond Highway to Empire Avenue are

over capacity by 2035. The improvements on US20 offer some capacity enhancements to keep congestion at a manageable level but do not keep it free-flowing like on US97 which will keep operations consistent and balanced with the surrounding system because constructing a large amount of capacity improvements would attract too much traffic off the local system to be manageable. Without at least the level of improvements offered in the build alternatives, the project area would be much worse than the rest of the system as the current network is not very well developed (lacks parallel local facilities). Both alternatives degrade the O.B. Riley & Empire Avenue intersection by pushing higher volumes though the intersection than in the future no-build. In addition, queuing is an issue at the westbound approach because the alternatives reduce the US20 (3rd Street) & Empire Avenue bottleneck which allows more traffic to reach O.B. Riley Road.

The alternatives will allow US97 to operate consistently with its expressway and freight route designations by maximizing the flow of long distance and regional trips while minimizing access points. Overall, the alternatives create a good match or balance between the existing and project areas unlike earlier, more comprehensive alternatives which attracted so much additional local traffic onto US97 that congestion became unmanageable. The alternatives have lower system capacities and less connection points than previous alternatives keeping most of the short local trips off US97.

The full interchange in East DS-1 will be more sensitive to future land use changes. Increased growth (i.e. future connection to the Juniper Ridge area east of the railroad tracks) will increase the local traffic on the ramps to/from the south. The success of East DS-1 (and DS-2) relies on having a full parallel city arterial street connection from Empire Avenue to Juniper Ridge in place. This local connection needs to be competitive in travel time with US97 so local users will use it rather than state facilities.

The major difference between the two build alternatives is that East DS-2 does not have the southerly connections from 3rd Street to/from US97. This volume difference is only about 70 vph which results in v/c ratios not varying by more than a few points to a tenth at the most. However, this increase is significant at the system level and East DS-2 acts as a sensitivity analysis for East DS-1. East DS-2 has substantially more total stops (18%) more delay (38%) and more travel time (21%) than DS-1 in 2035 with a very small increase in volumes. Both alternatives are similar for 2015. For most places in East DS-1, an increase of 10% in volume generates results similar to East DS-2. More than 10% causes substantial congestion above and beyond East DS-2 meaning these alternatives are very sensitive to changes in flows. This means that they do represent the maximum flow that can use the alternatives without complete system congestion. In other words, these alternatives represent the minimum level of improvements necessary to handle the expected future volumes. While the volumes used the in the analysis are peak 30th highest hour values (Fridays), volumes can easily fluctuate 10% during the week. Because of the numerous intersections at or over capacity this causes significant impacts to the system to the point that East DS1 could easily have results similar to East DS-2 on any given day.

CONCLUSIONS

Both alternatives function much better than the no-build alternative and will allow US97 to achieve free-flow operations through the 2035 design year. The alternatives will allow US97 to operate consistently with its expressway and freight route designations by maximizing the flow of long distance and regional trips while minimizing access points. Both alternatives meet the project purpose of improving safety and freight mobility on US97. Both alternatives are consistent and balanced in size and operations with the existing facility north and south of the project area while keeping local traffic on the local system.

Because East DS-1 and DS-2 have very similar networks and a small difference in volumes, either of these are viable based on traffic operations. Even though East DS-2 seems to operate much poorer for the overall network, the actual volume difference between East DS-1 and DS-2 is very small and well within the typical 10% weekly fluctuations, so either alternative can act similarly to the other on any given day.

Oregon Department of Transportation

US97 BEND NORTH CORRIDOR SOLUTIONS

The Dalles - California #4 (US97)

TRAFFIC ANALYSIS APPENDICES
MP 130.00 to 136.50

December 2010

Transportation Planning Analysis Unit

Transportation Development Division, Salem, Oregon

US97 BEND NORTH CORRIDOR SOLUTIONS

TRAFFIC ANALYSIS APPENDICES
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APPENDIX A: CRASH ANALYSIS

Crash Analysis Summary

The following sections show the summarized crash analysis statistics for US97, US20 and significant roadways in the study area for the period between January 1, 2004 and December 31, 2009. There were nearly 292 crashes on US97 and 79 on US20 highway segments in the project area. Typically over two-third of crashes occurred in dry, daylight conditions. The crash types are typical for the urban and rural portions of this project with numerous intersection crashes in the urban segments. Along US97 the segment crash rates are lower than comparable statewide rates although there are two 2010 SPIS top five percent sites identified on this roadway. Along US20 the rural segment (north of Cooley Road) has experienced segment crash rates higher than comparable statewide rates for the last three years. The urban section of US20 is well below the comparable statewide rates. There were no reported top five percent 2010 SPIS sites on US20.

The lower volume local streets (Boyd Acres, Deschutes Market Road, Hunnell Road (south) Nels Anderson Road, Old-Bend Redmond Highway and Tumalo Road) typically have property damage only crashes that occur in daylight conditions. The typical crash types were turning and angle movements at the local street intersections. Cooley Road and O.B. Riley Road both had about two-thirds of their crashes being fatal or injury crashes. They were typically daylight crashes involving turning and angle movements. An unusual occurrence that shows up in the crash summary is that most every local street had at least one motorcycle crash listed. Boyd Acres and O.B. Riley Roads are parallel facilities to US97 and US20 and serve as alternate routes.

State Highways

US97

The majority of the crashes were rear end collisions at intersections. Table A-1 shows the crash and year summary for US97 between 2004 and 2009. The crashes on US 97 were mainly rear-end, turning or fixed object type. These crashes mainly occurred in dry, daytime conditions. About 43% of the crashes occurred at the Cooley Road (MP 134.07 to MP 134.39) and Robal Road (MP 134.48 to MP 134.70) intersections and the US97/Empire Avenue (MP 135.03 to 135.76) Interchange. Crashes were highest on this roadway in 2005 with 63 being reported. The six year average is about 49 crashes per year.

Table A-1 US 97 Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	1	4	2	0	1	0	**8**
Backing	2	0	2	0	0	1	**5**
Fixed Object	2	6	12	6	3	3	**32**
Head-on	0	5	1	0	6	0	**12**
Misc. / Other	1	5	1	2	2	2	**13**
Non-Collision	0	0	1	1	2	2	**6**
Rear-end	22	32	26	24	21	23	**148**
Sideswipe-Meeting	0	2	0	0	1	3	**6**
Sideswipe-Overtaking	3	5	7	1	3	4	**23**
Turning	8	4	2	8	12	5	**39**
Total	**39**	**63**	**54**	**42**	**51**	**43**	**292**
Fatal - Injury A Crashes[1]	0	0	1	7	2	10	**20**
Intersection / Related	16	19	13	13	24	16	**101**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 292 crashes in this area between 2004 and 2009:

- Four fatal crashes
- 5% (15) injury A crashes
- 50% (147) injury crashes (including A)
- 48% (141) Property Damage Only (PDO) crashes
- 74% (215) occurred in daylight conditions
- 51% (148) were rear-end collisions
- 13% (39) were turn movement related
- 11% (32) were fixed object collisions
- 10% (29) were side-swipe collisions
- 19% (56) were located at or near Cooley Road
- 18% (52) were located at or near Robal Road
- 5% (16) were located at or near Empire Avenue (on US97 ramp connections)

There were four fatal crashes in this section during the six year period. In October 2006, there was a fatal rear-end collision located at the US97 and Robal Road traffic signal. The crash occurred in clear dry illuminated conditions in the early evening. A southbound vehicle was traveling too fast for conditions (but not exceeding the posted speed) failed to avoid a vehicle stopped in a queue at the light. The second vehicle was forced into a third vehicle in front of it. The driver of the errant vehicle was the fatality. There were two fatal crashes in December 2008. The first was a southbound vehicle that was speeding and over the centerline just after noon on a clear dry Monday. This errant vehicle struck another vehicle head-on killing both the driver and passenger of the second vehicle. The second crash about three weeks later about 8 am on a snowy day when a southbound vehicle, exceeding the posted speed, failed to stay in the lane. It ended up overturning and skidding down the pavement with the driver who died attempting to

escape from the vehicle. The last crash happened in 2009 a few days before Thanksgiving on a clear, dry Tuesday afternoon. A southbound vehicle failed to stay in the lane on a straightaway, side-swiped a northbound vehicle and then overturned. The fatality was a passenger in the struck vehicle.

The number of crashes has generally remained constant over time from 2004 to 2009 with a spike in 2005 because of an increase in angle, head-on, and rear-end collisions. The number of severe injury or fatal crashes has increased over the past six years. The crash rates were reviewed based on three segments. The first which runs from Deschutes Market Road near mile point 130.00 to the Bend north urban growth boundary (UGB) at 132.19, has a 2009 crash rate 0.35 crashes per million vehicle miles (MVM) compared to the statewide rate for rural expressways and rural principal arterials of 0.68 crashes per MVM. The second segment, from the UGB to Robal Road has an overall 2009 crash rate of 0.88 crashes per million vehicle miles as compared to the comparable statewide rate of 2.02 for urban principal arterials. The last segment from Robal Road to the south end of the project has a 2009 segment crash rate of 0.38 crashes per million vehicle miles compared to 0.61 for comparable urban expressways statewide. A review of the past six years of crash data show that the average crash rates for the three segments are 30-70% less than rates for statewide comparable rates.

The 2009 intersection crash rates at Cooley Road and Robal Road are 0.39 and 0.31 crashes per million entering vehicles, respectively. These intersections are substantially below the 1.0 crashes per million entering vehicles rule of thumb for indicating a need for further investigation. However, a rule of thumb is just that and depending on the individual intersection crash patterns or severity a safety issue may be indicated without meeting the 1.0 value. Both of these intersections have had enough crashes in past years to put them in the top 5% of the most serious crash locations in Region 4, so cost-effective safety improvements still need to be identified for these intersections.

US20

Rear-end and turning crashes accounted for 59% of the crashes on US20. Table A-2 shows the crash type and year summary from 2004 to 2009. These crashes mainly occurred in dry, daytime conditions. There were concentrations of crashes at four intersections within the project area: Cooley Road (17.48-17.49), Robal Road (MP 17.86-18.16), Empire Avenue (MP 18.30 – 18.82), and Nels Anderson Road (MP 19.01-19.03).

There were two fatal crashes on this roadway segment in the study period. The first crash was an angle collision located at the stop-controlled Cooley Road intersection in November 2006. A westbound vehicle ran the stop sign striking a northbound vehicle killing its driver on a cloudy dry mid-afternoon on a Friday. The second fatal crash occurred early on a Thursday morning in May 2007. An eastbound vehicle failed to maintain its lane, crashing and killing the passenger.

The one pedestrian crash in this section occurred in November 2004 late one afternoon. The collision was near the US20 /Nels Anderson Road intersection (MP 19.01) under dark, but lighted conditions. The driver was traveling northbound, in fog, on wet pavement. The driver tried to avoid the pedestrian, but the pedestrian was standing or lying in the roadway. The pedestrian suffered a severe injury (Injury A).

Table A-2 US20 Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	2	1	3	2	0	0	**8**
Fixed Object	0	1	1	1	3	1	**7**
Head-on	2	0	0	0	0	1	**3**
Misc. / Other	0	0	1	3	2	2	**8**
Pedestrian	1	0	0	0	0	0	**1**
Parking	0	0	0	0	1	0	**1**
Rear-end	3	4	6	4	5	4	**26**
Sideswipe-Meeting	0	0	1	1	0	0	**2**
Sideswipe-Overtaking	0	0	0	2	0	0	**2**
Turning	1	3	4	4	4	5	**21**
Total	**9**	**9**	**16**	**17**	**15**	**13**	**79**
Fatal - Injury A Crashes[1]	1	1	2	1	2	0	**7**
Intersection / Related	4	6	11	5	11	9	**46**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 79 crashes in this area between 2004 and 2009:

- Two fatal crashes
- One pedestrian crash
- 6% (5) injury A crashes
- 53% (42) injury crashes (including A)
- 44% (35)Property Damage Only (PDO) crashes
- 80% (63) occurred in daylight conditions
- 33% (26) were rear-end collisions
- 27% (21) were turn movement related
- 10% (8) were angle collisions
- 6% (5) were located at or near Cooley Road
- 159% (12) were located at or near Robal Road
- 30% (24) were located at or near Empire Avenue

The number of crashes has increased over time from 2004 to 2009. Crashes were highest on this roadway in 2007 with a six year average of about 13 crashes per year.

The crash rates were reviewed based on two segments, The first segment from Old Bend-Redmond Highway to Cooley Road (MP 17.48) has a 2009 crash rate of 0.89 crashes per million vehicle miles compared to the statewide rate of 0.68 crashes per million vehicle mile for rural other principal arterials. This is highest crash rate in the project area. This

section has a number of intersection related crashes such as angle, turning, and rear-ends. Very few crashes are the typical rural crashes (i.e. fixed-object, sideswipe, and head-on). This section is transitioning from an urban to a rural character, or has an urban crash pattern with a rural crash rate comparison. This section would not have an issue if it was classified as urban. The second segment, from Cooley Road to Empire Avenue has an overall crash rate of 0.77 crashes per million vehicle miles as compared to the comparable statewide rate of 2.08 for urban other principal arterials. A review of the past six years of crash rates shows that the average crash rate is comparable to other rural principal arterials at 0.68 crashes per MVM. The segment rate has been trending higher since 2007 with the last three years more than 15% higher than the average.

The 2009 intersection crash rates at Cooley Road, Robal Road and Empire Avenue are 0.10, 0.35, and 0.18 crashes per million entering vehicle, respectively. These intersections are substantially below the 1.0 crashes per million entering vehicles rule of thumb for indicating a safety issue. However, a rule of thumb is just that and depending on the individual intersection crash patterns or severity, a safety issue may be indicated without meeting the 1.0 value. The Empire Avenue intersection has experienced enough crashes in past years to put it in the top 10% of the most serious crash locations in Region 4 even with the low intersection crash rate. Cost-effective safety improvements should still be identified for these intersections even though the crash rates are below statewide averages.

SPIS Reporting

There are several 2010 SPIS (Safety Priority Index System) sites in the study area. Table A-3 lists the top five and ten percent of the 2010 SPIS sites located within the study area on US97 from Cooley Road to Robal Road and US20 from O.B. Riley Road to Empire Avenue. The data in Table A3 is based on a three-year average of the recorded SPIS sites. Every year the top 10% of SPIS sites are listed and the top 5% require investigations. The 2010 5% SPIS cutoff value is 53.30 therefore only two of the sites listed in Table A-3 are Top 5% SPIS sites, both of which are on US97. One location is at Cooley Road and the other is at Robal Road.

Table A-3 2010 (2007-2009 data) Top 5 % and 10% SPIS Sites

Route No.	BMP	EMP	Intersection (if appropriate)	# of Crashes	Fatal Crashes	SPIS Value
US97	130.10	130.27	Deschutes Market Road	7	1	51.69
	134.02	134.20	Cooley Road	22	0	54.78[1]
	134.47	134.57	n/a	5	0	45.86
	134.51	134.65	Robal Road	19	0	54.81[1]
US20	18.71	18.89	Empire Avenue	13	0	46.36

[1]Top 5% SPIS site

Local Roads

Boyd Acres Road

The majority crash types were turning or angle collisions and rear-end crashes (Table A-4). These crashes mainly occurred in dry, daytime conditions. A large concentration of collisions at or near the intersections of Empire Avenue is reported. The Empire Avenue intersection was signalized in late 2007, so a number of the related Empire Avenue crashes may be mitigated.

The number of crashes per year has remained moderately constant with the last three years averaging only three crashes per year with no fatal or sever injury crashes. The crash rate for this roadway was not calculated since the short section would skew the calculation

Table A-4 Boyd Acres Road Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	0	1	1	1	0	1	**4**
Fixed Object	1	1	0	0	0	0	**3**
Head-on	0	1	0	0	1	0	**2**
Non-Collision	0	0	1	0	0	0	**1**
Rear-end	1	0	5	1	0	0	**7**
Sideswipe-Meeting	0	0	0	0	0	1	**1**
Turning	1	3	1	2	1	0	**8**
Total	**3**	**6**	**8**	**4**	**2**	**3**	**26**
Fatal - Injury A Crashes[1]	0	1	0	0	0	0	**1**
Intersection / Related	1	4	2	4	2	1	**14**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 26 crashes in this area between 2004 and 2009:

- 31% (8) injury crashes
- 69% (18) Property Damage Only (PDO) crashes
- 62% (16) occurred in clear weather conditions
- 58% (15) occurred in day conditions
- 58% (15) occurred on dry pavement
- 46% (12) were turning or angle collisions
- 50% (13) were located at or near Empire Avenue
- 15% (4) were located near Fred Meyer Road

One crash that incurred a severe injury (Injury A) was a head-on collision located at the Fred Meyer Road intersection. The northbound driver lost control of the vehicle and crossed centerline striking a southbound vehicle. The errant driver and his passenger were injured, failed to maintain his lane, and drove left of the center of the road. The

vehicle was traveling too fast for conditions, but was not exceeding the posted speed. The crash occurred late one Saturday night in June in dark, rainy conditions.

There was one motorcycle crash that incurred two injuries (both Injury B) when it hit an unknown fixed object. The distracted driver was traveling too fast for conditions, but was not exceeding the posted speed. The crash occurred on a clear, but icy Saturday morning in November.

Cooley Road

The majority crash types were angle collisions (Table A-5). These crashes mainly occurred in dry, daytime conditions. There were two crashes with either a fatality or severe injury (Injury A). Almost all crashes on this roadway are intersection related.

The number of crashes per year has been relatively low over the last three years, but has declined over the last three years. The crash rate for this roadway was 0.36 crashes per million vehicle miles which is about half the 2009 statewide crash rate for urban other principal arterials at 0.68 crashes per million vehicle miles.

Table A-5 Cooley Road Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	1	4	2	0	0	0	**7**
Fixed Object	2	0	0	0	1	0	**3**
Non-Collision/Miscellaneous	0	0	0	1	0	0	**1**
Rear-end	1	0	1	0	1	0	**3**
Turning	0	0	0	0	0	1	**1**
Total	**4**	**4**	**3**	**1**	**2**	**1**	**15**
Fatal – Injury A Crashes[1]	1	0	1	0	0	0	**2**
Intersection / Related	4	4	2	0	1	1	**12**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 15 crashes in this area between 2004 and 2009:

- There was 1 fatal crash
- 53% (8) injury crashes
- 40% (6) Property Damage Only (PDO) crashes
- 73% (11) occurred in clear weather conditions
- 67% (10) occurred in daylight conditions
- All but one occurred on dry pavement
- 53% (8) were turning or angle collisions
- 47% (7) were located at or near the Bend Parkway

There was one fatal crash on Cooley Road in 2006 during the six year reported period. It occurred on the Veteran's Day holiday Friday at about 3 pm. A northbound vehicle ran a stop sign in cloudy but dry conditions, striking a westbound vehicle. The driver and two passengers were injured in the errant vehicle, while the elder driver of the struck vehicle was the fatality.

There was also one crash that incurred a severe injury (Injury A) was a rear end collision at the US97 intersection. The southbound driver was following too close and failed to stop in time, striking a vehicle stopped but not waiting to turn. The severe injury was in the stopped vehicle. The crash occurred on a Monday evening in July of 2004 in clear, dry conditions.

Deschutes Market Road

The major types were non-collision crashes (Table A-6) many involved striking an animal. These crashes mainly occurred in dry, daytime conditions. Almost two-thirds of the crashes are property damage only.

For the past six years averages crashes average about two per year with a high of six in 2006 and a low of none in 2007. The crash rate for this roadway was not calculated since the short section would skew the calculation.

Table A-6 Deschutes Market Road Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	0	0	0	0	0	1	**1**
Fixed Object	1	1	1	0	0	0	**3**
Head-on	1	0	2	0	0	0	**3**
Non-Collision/Miscellaneous	0	0	2	0	3	1	**6**
Turning	0	0	1	0	0	0	**1**
Total	**2**	**1**	**6**	**0**	**3**	**2**	**14**
Fatal – Injury A Crashes[1]	0	0	2	0	0	1	**2**
Intersection / Related	0	0	2	0	0	1	**3**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 14 crashes in this area between 2004 and 2009:

- There was 1 fatal crash
- 29% (4) injury crashes
- 64% (9) Property Damage Only (PDO) crashes
- 79% (7) occurred in clear weather conditions
- 67% (11) occurred in day conditions
- 50% (7) occurred on dry pavement
- 43% (6) were other, non-collision type crashes, many involving animals (4) involved striking animals

There were three crashes with fatalities or severe injury (Injury A) on Deschutes Market Road in this 6 year reporting period. The fatal crash occurred on a Tuesday evening in October when a southbound vehicle was killed when her vehicle failed to stay in the lane and crossed over striking a northbound vehicle in clear, dry conditions.

The two severe injury crashes occurred in different years. The first happened late on a Friday night in October of 2006. A southbound vehicle struck an animal on the crest of a hill in clear dry conditions. The second collision occurred on a Wednesday morning in June of 2009 when a northbound motorcycle also struck an animal on the crest of a hill in clear dry conditions.

Empire Avenue

The majority of the 32 crashes that have occurred in the six year period were turning or rear end collisions, occurring at intersections (Table A-7). These crashes mainly occurred in dry, daytime conditions.

The number of the crashes has been increasing between 2004 and 2009, with a spike in 2008. The 2009 crash rate for this roadway was 1.08 crashes per million vehicle miles compared to a statewide crash rate of 0.68 for urban other principal arterials. The segment rate is somewhat inflated since this is a short section. However trend is definitely increasing as the last three years are almost twice the six year average of five crashes.

Table A-7 Empire Avenue Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	0	0	1	3	1	**0**	5
Fixed Object	0	0	0	0	0	**1**	1
Non-Collision/Miscellaneous	0	0	0	0	1	**0**	1
Rear-end	0	3	1	1	3	**1**	9
Turning	2	2	0	4	5	**3**	16
Total	**2**	**5**	**2**	**8**	**10**	**5**	**32**
Fatal –Injury A Crashes[1]	0	1	0	0	1	**0**	2
Intersection / Related	2	5	2	8	7	**4**	28

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 32 crashes in this area between 2004 and 2009:

- 44% (14) injury crashes (including two Injury A)
- 56% (18) Property Damage Only (PDO) crashes
- 88% (28) occurred in daylight conditions
- 50% (16) were turn movement related
- 28% (9) were rear-end collisions
- 88% (28) were intersection related crashes

Two crashes incurred a severe injury (Injury A) in this reporting period. The first occurred on a cloudy, dry Thursday afternoon in May 2005. It involved a motorcycle making an improper lane change, driving in the wrong lane to pass a second vehicle which was turning left. The second crash occurred on a clear, dry April morning in 2008. A vehicle turning left did not yield right of way to a motorcycle.

Hunnell Road (South)

The six year crash listing (2004-2009) only reports one crash on this roadway segment. It was a property damage only (PDO) backing accident on a Thursday afternoon in April 2005. A northbound vehicle backed into a southbound vehicle in clear dry conditions.

Nels Anderson Road

The majority crash types were turning or angle collisions and rear-end crashes (Table A-8). These crashes mainly occurred in dry, daytime conditions. A large concentration of collisions at or near the intersections of Empire Avenue is reported. The number of crashes per year has remained moderately constant with no crashes in 2009 therefore no crash rate was calculated for this roadway.

Table A-8 Nels Anderson Road Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	1	0	0	0	0	0	**1**
Rear-end	0	0	0	1	0	0	**1**
Turning	0	0	1	1	1	0	**3**
Total	**1**	**0**	**1**	**2**	**1**	**0**	**5**
Fatal – Injury A Crashes[1]	0	0	0	0	1	0	**1**
Intersection / Related	1	0	1	1	1	0	**4**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were only 5 crashes on this roadway segment between 2004 and 2009:

- There were 2 injury crashes, one of which was severe (Injury A)
- Only one crash was not intersection related.
- All crashes daylight conditions
- All but one crash occurred in dry conditions.

There was only one fatal or severe injury (Injury A) crash on Nels Anderson Road in this six year reporting period. This crash occurred on a Monday morning in April 2008 when a left-turning vehicle turned in front of a westbound motorcycle in clear dry conditions. The motorcyclist was the severely injured person.

O.B. Riley Road

Of the 24 crashes reported during the study period, they were almost equally split between angle, fixed object, rear-end and turning collisions (Table A-9). Three separate fatal crashes occurred during this period. Just over half of these crashes occurred in the daytime, a larger majority in dry conditions.

The number of crashes per year has remained moderately constant averaging about four per year. The crash rate for this roadway was 0.58 crashes per million vehicle miles which is almost half the comparable 2009 statewide crash rate for rural major collector at 1.11 crashes per million vehicle miles.

Table A-9 O.B. Riley Road Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	1	0	1	1	2	0	**5**
Fixed Object	0	2	2	0	2	1	**7**
Miscellaneous / Other	0	0	1	0	0	0	**1**
Rear-end	2	0	1	1	1	0	**5**
Turning	0	0	2	1	1	2	**6**
Total	**3**	**2**	**7**	**3**	**6**	**3**	**24**
Fatal – Injury A Crashes[1]	0	1	1	0	1	1	**4**
Intersection / Related	3	0	4	2	5	3	**17**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 24 crashes on this road segment between 2004 and 2009:

- Three fatal crashes
- 50% (12) injury crashes (including 1 severe Injury A)
- 38% (9) Property Damage Only (PDO) crashes
- 63% (15) occurred in daylight conditions or in clear weather conditions
- 46% (11) were turning or angle related
- 29% (7) were fixed object collisions
- 21% (5) were rear-end collisions

The first fatality was a fixed object collision which occurred on a Monday evening in April 2005 on a cloudy but dry evening located at the signalized US 20 intersection. The driver failed to maintain his lane and ran off the road striking a tree.

A second fatality was also a fixed object collision on a Thursday evening in March 2008. A southbound motorcycle that was driving too fast for conditions failed to stay in the lane. The cyclist lost control hitting the ditch, fell off, and struck a fixed object. The crash occurred on a clear dry night.

The third fatality occurred on a Monday evening in July 2009 in unknown conditions. A northbound motorcycle struck a westbound moped that did not yield right of way and was obscured from view.

The crash that resulted in a severe injury (Injury A) occurred on a Friday in July 2006. A southbound motorcycle struck a left turning vehicle that did not yield right-of-way. The crash occurred in the afternoon of a clear, dry day.

Old Bend-Redmond Highway

There were ten crashes in the six year reporting period on the Old Bend-Redmond Highway, seven of which were turn movement related (Table A-10). These crashes are occurring generally at or near Rickard Road, but in clear, dry daylight conditions.

The number of crashes per year has remained moderately constant at about two per year. The crash rate for this roadway was not calculated since the short section would skew the calculation.

Table A-10 Old-Bend Redmond Highway Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	0	0	1	0	0	0	**1**
Miscellaneous/ Other	0	1	0	0	0	0	**1**
Rear-end	0	0	0	0	0	1	**1**
Turning	0	1	1	1	2	2	**7**
Total	**0**	**2**	**2**	**1**	**2**	**3**	**10**
Fatal – Injury A Crashes[1]	0	0	0	0	0	0	**0**
Intersection / Related	0	1	1	1	2	2	**7**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 10 crashes in this area between 2004 and 2009:

- 50% (5) injury crashes (no Injury A)
- 90% (9) occurred in daylight conditions
- 80% (8) occurred in clear, dry conditions
- All but two crashes were angle or turn movement related

Robal Road

The majority crash types were turning or angle collisions and rear-end crashes (Table A-11). These crashes mainly occurred in dry, daytime conditions. A large share of collisions occurred at or near the Hunnell Road intersection.

The number of crashes per year has remained moderately constant except for 2007 with about three crashes per year. The crash rate for this roadway was not calculated since the short section would skew the calculation.

Table A-11 Robal Road Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Angle	0	0	0	1	0	0	**1**
Head-On	0	1	0	0	0	0	**1**
Rear-end	0	0	0	1	0	0	**1**
Turning	0	2	2	5	2	2	**13**
Total	**0**	**3**	**2**	**7**	**2**	**2**	**16**
Fatal – Injury A Crashes[1]	0	0	1	0	0	0	**1**
Intersection / Related	0	2	2	5	2	1	**12**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

There were a total of 16 crashes in this area between 2004 and 2009:

- 63% (10) injury crashes (including A)
- 37% (6) Property Damage Only (PDO) crashes
- 81% (13) occurred in dry conditions
- All but 2 crashes were in daylight conditions
- 81% (13) were turn movement related
- 69% (11) were located at or near the Hunnell Road intersection

The one severe injury (Injury A) crash occurred on a clear, dry Friday afternoon in August of 2006 when a westbound motorcycle struck a left turning vehicle that did not yield right of way to it. The cyclist was injured when they were forced off the motorcycle.

Tumalo Road

There were three types of crashes reported on this roadway for the six year reporting period – Rear end, turning and other (animal) (Table A-12). The crashes were all property damage only and occurred in clear, dry conditions. Four of the five crashes occurred mid-week.

The number of crashes per year has remained moderately constant with only one or so non-fatal or severe injury crashes. The crash rate for this roadway was not calculated since the short section would skew the calculation.

There were a total of 5 crashes in this area between 2004 and 2009:

- There were no fatal or injury crashes
- All crashes were Property Damage Only (PDO)
- All crashes occurred in clear dry conditions.
- 4 of the 5 crashes occurred mid-week (Wednesday or Thursday)

Table A-12 Tumalo Road Crash Type and Year Table

Crash Type	2004	2005	2006	2007	2008	2009	Total
Miscellaneous / Other	0	0	1	0	0	0	**1**
Rear-end	1	1	0	0	0	0	**2**
Turning	0	0	0	0	0	2	**2**
Total	**1**	**1**	**1**	**0**	**0**	**2**	**5**
Fatal – Injury A Crashes[1]	0	0	0	0	0	0	**0**
Intersection / Related	1	1	0	0	0	2	**3**

[1]Injury A is an incapacitating non-fatal injury (i.e. broken bones, severe/internal bleeding, unconsciousness, etc) that prevents a person from continuing normal activities that they were capable of before the injury.

Other Roadways

There have not been any crashes reported in the six years covered in this analysis on the following roadway segments:

- Chavre Way from US97 to Nels Anderson Road,
- Hunnell Road (north) from Cooley Road to Loco Road
- Nels Anderson Place from US97 to Nels Anderson Road
- Nichols Market Road east from Tumalo Road to US97
- Rogers Road from Old Bend-Redmond Hwy to Hunnell Rd

APPENDIX B. STATE HIGHWAY CRASH CHARACTERISTIC SUMMARIES

Figure B-1 Single Crash Characteristics List Report
09/27/2010

OREGON DEPARTMENT OF TRANSPORTATION - TRANSPORTATION DEVELOPMENT DIVISION
TRANSPORTATION DATA SECTION - CRASH ANALYSIS AND REPORTING UNIT
SINGLE CRASH CHARACTERISTICS LIST REPORT

Highway 004 MP 130.00 to 136.50, Both Add and Non-Add mileage 01/01/2004 to 12/31/2009

1 - 292 of 292 rows shown.

#	RDWY	CONM P	CON #	MLG TYP	MILE POINT	CRASH DATE	STRIKE DIR	NO OF DEATHS	NO OF INJ	NO OF VEH	PED	BIC	LIGHT	SUR-FACE	EVENTS	ROAD CHAR	OFF RDWY	COLLISION TYPE	CAUSES	ALCOH	DRUG	SPEED
1	MN		0		130.00	07/02/2004	S	0	4	2	0	0	DAY	DRY		2	N	TURN	02	N	N	N
1	MN		0		130.00	10/08/2005	S	0	0	1	0	0	DARK	DRY	035	3	N	OTH	12	N	N	N
1	MN		0		130.00	11/28/2006	S	0	0	1	0	0	DAY	ICE	079,062	3	Y	FIX	01	N	N	Y
1	MN		0		130.00	06/30/2007	S	0	1	1	0	0	DAY	DRY	079,058	3	Y	FIX	01,16	N	N	Y
1	MN		0		130.00	12/13/2008	N	0	1	2	0	0	DAWN	ICE		3	N	HEAD	01	N	N	Y
1	MN		0		130.06	11/28/2006	S	0	1	1	0	0	DAY	ICE	079,010	3	Y	FIX	32,30	N	N	Y
1	MN		0		130.08	07/14/2006	N	0	0	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN		0		130.09	11/28/2005	S	0	1	2	0	0	DAY	ICE		3	N	SS-M	01,05	N	N	Y
1	MN		0		130.09	02/03/2008	N	0	0	2	0	0	DARK	ICE	124	3	N	SS-M	01	N	N	Y
1	MN		0		130.10	09/03/2005	S	0	1	2	0	0	DARK	DRY		3	N	SS-O	13	N	N	N
1	MN		0		130.11	07/03/2005	S	0	2	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN		0		130.12	11/22/2007	S	0	0	1	0	0	DARK	ICE	124,020,079	3	Y	FIX	01	N	N	Y
1	MN		0		130.16	07/21/2005	S	0	1	1	0	0	DARK	DRY	044	3	Y	FIX	27	N	N	N
1	MN		0		130.16	08/31/2005	S	0	1	1	0	0	DARK	DRY	044	3	Y	FIX	27	N	N	N
1	MN		0		130.16	12/01/2008	S	0	1	2	0	0	DAY	DRY	089	3	N	REAR	27	N	N	N
1	MN		0		130.17	12/18/2008	S	0	0	1	0	0	DAY	SNO	044	3	Y	FIX	01	N	N	Y
1	MN		0		130.18	06/14/2004	S	0	3	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	MN		0		130.18	05/21/2005	S	0	1	3	0	0	DAY	DRY	013,012,010	1	N	ANGL	02	N	N	N
1	MN		0		130.18	04/25/2006	E	0	2	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN		0		130.18	06/27/2006	E	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN		0		130.18	01/07/2008	N	0	1	2	0	0	DAY	DRY		1	N	ANGL	02	N	N	N
1	MN		0		130.18	11/30/2008	SW	0	1	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	MN		0		130.18	02/26/2009	N	0	1	2	0	0	DAWN	ICE	124	1	N	TURN	01	N	N	Y

1	MN	0	130.19	12/01/2008	N	2	2	2	0	0	DAY	DRY	092	3	N	HEAD	13,26	N	Y	Y
1	MN	0	130.37	01/27/2008	S	0	7	2	0	0	DAY	ICE	124	3	N	HEAD	01,10	N	N	Y
1	MN	0	130.38	07/14/2006	S	0	0	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN	0	130.60	07/13/2008	N	0	1	1	0	0	DAY	DRY		3	N	NCOL	16,27	N	N	N
1	MN	0	130.68	12/18/2008	N	1	0	1	0	0	DAY	SNO	124,001,099	3	Y	NCOL	01	N	N	Y
1	MN	0	130.98	12/25/2009	S	0	0	1	0	0	DARK	ICE	124	3	Y	NCOL	10	N	N	N
1	MN	0	131.00	12/07/2005	S	0	0	1	0	0	DAY	ICE	079,010	3	Y	FIX	01	N	N	Y
1	MN	0	131.00	12/27/2007	S	0	0	1	0	0	DAY	ICE	079,010	3	Y	FIX	01	N	N	Y
1	MN	0	131.00	01/29/2008	S	0	1	2	0	0	DAY	ICE	124	3	N	HEAD	01,10	N	N	Y
1	MN	0	131.00	10/05/2009	S	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	131.00	11/24/2009	N	1	2	3	0	0	DAY	DRY	010	3	N	SS-M	05	N	N	N
1	MN	0	131.11	01/15/2005	S	0	3	2	0	0	DAY	ICE	092	3	N	HEAD	01,06	N	N	Y
1	MN	0	131.18	01/03/2005	N	0	1	2	0	0	DLIT	ICE		3	N	REAR	01,07	N	N	Y
1	MN	0	131.18	11/21/2007	N	0	0	2	0	0	DAY	DRY	068	3	N	REAR	07	N	N	N
1	MN	0	131.18	09/28/2009	N	0	0	1	0	0	DUSK	DRY	035	3	N	OTH	12	N	N	N
1	MN	0	131.20	01/10/2008	N	0	2	2	0	0	DARK	WET		2	N	REAR	16,07	N	N	N
1	MN	0	131.44	10/20/2007	S	0	1	1	0	0	DAY	ICE	079,010	3	Y	FIX	01	N	N	Y
1	MN	0	131.94	04/27/2007	N	0	2	2	0	0	DARK	DRY		2	N	REAR	07	N	N	N
1	MN	0	132.00	01/30/2004	N	0	1	1	0	0	DAY	ICE	053,088	3	Y	FIX	01	N	N	Y
1	MN	0	132.00	03/09/2006	S	0	2	1	0	0	DAY	ICE	079,062	3	Y	FIX	01	N	N	Y
1	MN	0	132.00	11/04/2006	S	0	1	1	0	0	DARK	ICE	079,010	3	Y	FIX	01	N	N	Y
1	MN	0	132.00	04/15/2008	N	0	0	2	0	0	DAY	DRY	025	3	N	OTH	11	N	N	N
1	MN	0	132.00	02/19/2009	N	0	0	2	0	0	DAY	DRY	028	3	N	NCOL	12	N	N	N
1	MN	0	132.06	07/26/2006	S	0	3	3	0	0	DAY	DRY		3	N	HEAD	10,07	N	N	N
1	MN	0	132.14	12/01/2005	N	0	2	3	0	0	DAY	SNO	013	3	N	OTH	01	N	N	Y
1	MN	0	132.18	03/24/2005	S	0	0	2	0	0	DAY	SNO		3	N	TURN	01	N	N	Y
1	MN	0	132.18	01/15/2006	S	0	1	1	0	0	DAY	DRY	035,062	3	N	OTH	12	N	N	N
1	MN	0	132.18	10/16/2009	S	0	1	2	0	0	DAY	DRY		3	N	TURN	08	N	N	N
1	MN	0	132.19	01/14/2007	N	0	0	1	0	0	DARK	DRY	035	3	N	OTH	12	N	N	N
1	MN	0	132.50	12/29/2009	N	0	0	2	0	0	DUSK	SNO	124	3	N	SS-O	06,01	N	N	Y
1	MN	0	132.64	01/15/2009	N	0	0	2	0	0	DARK	DRY		3	N	SS-O	13	N	N	N
1	MN	0	132.76	02/26/2009	N	0	1	2	0	0	DAY	SNO	124,061	3	Y	SS-M	01	N	N	Y
1	MN	0	133.00	03/11/2004	S	0	1	2	0	0	DAY	DRY		2	N	BACK	02	N	N	N
1	MN	0	133.00	01/31/2008	S	0	1	1	0	0	DARK	ICE	124,079,072	3	Y	FIX	01,10	N	N	Y
1	MN	0	133.00	12/25/2008	S	0	6	2	0	0	DAY	ICE	061	3	N	HEAD	01	N	N	Y

1	MN	0	133.05	01/28/2008	N	0	0	2	0	0	DAY	ICE	124	3	N	REAR	01,10,07	N	N	Y
1	MN	0	133.05	03/31/2008	N	0	0	2	0	0	DAY	DRY	026	3	N	REAR	07,30	N	N	Y
1	MN	0	133.05	10/13/2009	N	0	0	1	0	0	DARK	ICE	124	3	Y	OTH	01	N	N	Y
1	MN	0	133.07	10/25/2005	S	0	0	2	0	0	DAY	DRY		2	N	HEAD	27,13	N	N	N
1	MN	0	133.08	12/19/2005	N	0	0	2	0	0	DAY	WET		3	N	HEAD	01,05	N	N	Y
1	MN	0	133.08	03/01/2006	N	0	0	2	0	0	DAY	DRY		3	N	SS-O	33,13,10	N	N	N
1	MN	0	133.09	09/12/2005	S	0	0	1	0	0	DAY	DRY	035	3	N	OTH	12	N	N	N
1	MN	0	133.11	06/21/2006	W	0	1	1	0	0	DAY	DRY	079	1	Y	FIX	01	N	N	Y
1	MN	0	133.12	05/18/2005	N	0	0	2	0	0	DAY	DRY		3	N	SS-O	26,07	N	N	N
1	MN	0	133.13	12/19/2005	N	0	1	1	0	0	DAY	SNO	010	3	Y	OTH	01	N	N	Y
1	MN	0	133.14	08/15/2008	S	0	0	1	0	0	DAY	DRY	035	3	N	OTH	12	N	N	N
1	MN	0	133.21	01/03/2005	N	0	1	1	0	0	DAY	ICE	072,010	3	Y	FIX	01	N	N	Y
1	MN	0	133.21	03/28/2007	N	0	1	3	0	0	DAY	DRY	072	2	N	TURN	02,07	N	N	N
1	MN	0	133.61	06/21/2004	N	0	1	1	0	0	DAY	DRY	079,010	3	Y	FIX	01	N	N	Y
1	MN	0	133.63	04/17/2006	S	0	1	1	0	0	DAY	ICE	093,072,010	3	Y	FIX	27	N	N	N
1	MN	0	133.69	01/31/2004	S	0	1	1	0	0	DARK	ICE	079,067	3	Y	OTH	01	N	N	Y
1	MN	0	133.69	11/30/2008	SW	0	1	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN	0	133.70	06/29/2005	S	0	2	2	0	0	DAY	DRY	022	3	N	SS-M	05	N	N	N
1	MN	0	133.70	10/16/2009	S	0	1	2	0	0	DAY	DRY		3	N	REAR	32,07,27	N	N	N
1	MN	0	133.71	05/13/2004	S	0	2	2	0	0	DAY	DRY	082	1	N	TURN	04	N	N	N
1	MN	0	133.71	05/22/2004	S	0	3	2	0	0	DAY	DRY	092	1	N	TURN	02	N	N	N
1	MN	0	133.71	11/10/2004	NW	0	0	2	0	0	DLIT	DRY		1	N	BACK	10	N	N	N
1	MN	0	133.71	01/18/2008	S	0	3	2	0	0	DAY	DRY		1	N	REAR	30,33,07	N	N	Y
1	MN	0	133.72	05/02/2005	S	0	0	2	0	0	DAY	DRY		3	N	SS-O	27	N	N	N
1	MN	0	133.73	10/19/2005	S	0	0	3	0	0	DAY	DRY		3	N	REAR	01	N	N	Y
1	MN	0	133.73	08/27/2009	N	0	1	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	133.75	06/28/2004	S	0	1	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	133.85	07/29/2008	S	0	0	3	0	0	DAY	DRY	013	3	N	REAR	07	N	N	N
1	MN	0	133.87	08/13/2004	S	0	2	3	0	0	DAY	DRY	013	3	N	REAR	07	N	N	N
1	MN	0	133.91	08/08/2005	S	0	3	4	0	0	DAY	DRY	013,012	3	N	REAR	01	N	N	Y
1	MN	0	134.05	07/08/2005	S	0	1	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.07	10/16/2004	S	0	3	3	0	0	DAY	DRY	013	3	N	REAR	01,27	N	N	Y
1	MN	0	134.07	03/27/2007	SW	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.08	05/20/2004	S	0	1	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.08	11/29/2005	S	0	2	3	0	0	DAY	ICE	013	3	N	REAR	01	N	N	Y

1	MN	0	134.08	09/20/2007	S	0	0	2	0	0	DAY	DRY		3	N	REAR	01	N	N	Y
1	MN	0	134.09	05/06/2004	S	0	0	2	0	0	DAY	DRY	092	3	N	TURN	02	N	N	N
1	MN	0	134.09	04/11/2006	S	0	0	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN	0	134.09	06/22/2006	N	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.09	11/01/2008	NE	0	0	2	0	0	DARK	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.10	07/09/2004	SW	0	2	2	0	0	DAY	DRY		3	N	REAR	01,07,27	N	N	Y
1	MN	0	134.10	07/11/2006	S	0	2	3	0	0	DAY	DRY	013	3	N	REAR	27,32	N	N	N
1	MN	0	134.11	06/22/2004	N	0	0	2	0	0	DAY	DRY		1	N	REAR	01,27	N	N	Y
1	MN	0	134.11	06/27/2004	N	0	2	2	0	0	DAY	DRY		1	N	ANGL	04,27	N	N	N
1	MN	0	134.11	07/05/2004	N	0	1	2	0	0	DAY	DRY		1	N	REAR	01	N	N	Y
1	MN	0	134.11	07/09/2004	NE	0	2	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.11	07/26/2004	S	0	1	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.11	11/02/2004	N	0	0	2	0	0	DLIT	WET		1	N	REAR	07,10	N	N	N
1	MN	0	134.11	12/02/2004	SW	0	1	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.11	03/03/2005	N	0	1	2	0	0	DARK	DRY		1	N	ANGL	04	N	N	N
1	MN	0	134.11	03/06/2005	S	0	1	2	0	0	DAY	DRY		1	N	REAR	10,04	Y	N	N
1	MN	0	134.11	04/25/2005	NE	0	0	2	0	0	DAY	WET		1	N	REAR	27	N	N	N
1	MN	0	134.11	10/31/2005	S	0	0	2	0	0	DAWN	DRY		1	N	ANGL	27,04	N	N	N
1	MN	0	134.11	11/28/2005	S	0	3	3	0	0	DAY	SNO	013,050	1	N	REAR	01	N	N	Y
1	MN	0	134.11	11/28/2005	N	0	0	2	0	0	DAY	DRY	093	1	N	ANGL	04,27	N	N	N
1	MN	0	134.11	05/22/2006	N	0	1	2	0	0	DAY	DRY		1	N	REAR	27	N	N	N
1	MN	0	134.11	01/05/2007	N	0	0	2	0	0	DLIT	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.11	02/21/2007	S	0	0	2	0	0	DAY	WET		1	N	REAR	10	N	Y	N
1	MN	0	134.11	04/08/2007	N	0	2	2	0	0	DLIT	WET		1	N	REAR	27,07	N	N	N
1	MN	0	134.11	01/27/2008	S	0	0	2	0	0	DAY	ICE	124	1	N	TURN	01,08	N	N	Y
1	MN	0	134.11	01/27/2008	N	0	1	2	0	0	DAY	ICE	124	1	N	REAR	01,07	N	N	Y
1	MN	0	134.11	03/14/2008	S	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.11	01/27/2009	N	0	0	2	0	0	DUSK	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.11	02/21/2009	N	0	2	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.11	04/04/2009	N	0	1	2	0	0	DAY	DRY		1	N	TURN	04	N	N	N
1	MN	0	134.11	05/08/2009	N	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.11	08/15/2009	N	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.11	09/10/2009	S	0	1	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.11	10/23/2009	S	0	1	2	0	0	DAY	DRY		1	N	REAR	32	N	N	N
1	MN	0	134.12	05/27/2005	S	0	1	2	0	0	DAY	DRY		3	N	REAR	27	N	N	N

1	MN	0	134.12	07/21/2005	N	0	2	3	0	0	DAY	DRY	013	3	N	REAR	27	N	N	N
1	MN	0	134.12	03/12/2006	N	0	0	2	0	0	DAY	ICE		3	N	REAR	07	N	N	N
1	MN	0	134.12	03/12/2006	N	0	0	2	0	0	DAY	ICE		3	N	REAR	07	N	N	N
1	MN	0	134.12	04/03/2009	N	0	2	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.12	09/21/2009	N	0	8	2	0	0	DLIT	DRY		3	N	SS-O	13	N	N	N
1	MN	0	134.13	02/14/2005	N	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.13	10/01/2007	N	0	0	3	0	0	DAY	DRY	013	3	N	REAR	27	N	N	N
1	MN	0	134.13	11/04/2009	S	0	1	2	0	0	DAWN	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.15	10/20/2005	S	0	1	2	0	0	DAY	DRY		3	N	REAR	26,13	N	N	N
1	MN	0	134.15	03/12/2006	N	0	0	2	0	0	DAY	ICE	124,040	3	N	REAR	07	N	N	N
1	MN	0	134.15	09/27/2007	N	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.16	08/10/2007	N	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.17	06/10/2006	N	0	4	2	0	0	DAY	DRY		3	N	REAR	27,07	N	N	N
1	MN	0	134.20	09/30/2004	S	0	0	2	0	0	DUSK	DRY	010,040	3	N	SS-O	01,05	N	N	Y
1	MN	0	134.20	01/06/2007	N	0	0	2	0	0	DLIT	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.21	11/17/2004	N	0	1	2	0	0	DARK	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.39	03/10/2005	N	0	2	2	0	0	DAY	DRY	079	3	N	REAR	01	N	N	Y
1	MN	0	134.48	01/20/2008	E	0	2	2	0	0	DLIT	ICE	124	2	N	TURN	01,03	N	N	Y
1	MN	0	134.48	09/22/2009	N	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.49	05/26/2009	S	0	0	2	0	0	DAY	DRY		3	N	TURN	02	N	N	N
1	MN	0	134.50	07/07/2006	E	0	1	2	0	0	DAY	DRY		2	Y	REAR	07	N	N	N
1	MN	0	134.54	08/19/2004	N	0	3	4	0	0	DAY	DRY	013	3	N	REAR	01,27	N	N	Y
1	MN	0	134.54	08/25/2004	S	0	1	2	0	0	DAY	DRY		3	Y	REAR	07	N	N	N
1	MN	0	134.54	06/13/2006	W	0	0	2	0	0	DAY	DRY		2	Y	BACK	10	N	N	N
1	MN	0	134.56	06/08/2005	S	0	1	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.56	06/24/2009	S	0	1	2	0	0	DAY	DRY	040	3	Y	SS-M	05	N	N	N
1	MN	0	134.56	11/15/2009	S	0	1	2	0	0	DLIT	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.57	07/26/2004	SW	0	1	2	0	0	DAY	DRY		3	N	REAR	07,27	N	N	N
1	MN	0	134.58	04/24/2006	S	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.58	12/28/2006	S	0	0	2	0	0	DLIT	DRY		2	N	TURN	02	N	N	N
1	MN	0	134.59	11/04/2004	S	0	3	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.59	02/19/2005	S	0	4	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.59	08/06/2005	S	0	2	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.59	08/15/2005	S	0	1	2	0	0	DAY	DRY		3	N	REAR	27,07	N	N	N
1	MN	0	134.59	08/16/2006	N	0	1	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N

1	MN	0	134.59	10/12/2006	N	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.59	10/21/2009	S	0	1	3	0	0	DAY	DRY	013,001	3	N	REAR	07,00	N	N	N
1	MN	0	134.60	01/05/2004	E	0	0	2	0	0	UNK	WET		1	N	TURN	01,08	N	N	Y
1	MN	0	134.60	05/28/2004	S	0	0	2	0	0	DAY	UNK		1	N	REAR	07,27	N	N	N
1	MN	0	134.60	01/17/2005	NE	0	0	2	0	0	DARK	WET	080,092	3	N	REAR	07,10	N	N	N
1	MN	0	134.60	03/22/2005	NE	0	2	2	0	0	DAY	SNO		1	N	REAR	01	N	N	Y
1	MN	0	134.60	08/05/2005	S	0	2	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.60	12/30/2005	S	0	0	2	0	0	DLIT	WET		1	N	REAR	07	N	N	N
1	MN	0	134.60	06/01/2006	S	0	0	2	0	0	DAY	DRY		1	N	BACK	10	N	N	N
1	MN	0	134.60	09/30/2006	N	0	1	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.60	11/01/2006	S	1	2	3	0	0	DLIT	DRY	013	1	N	REAR	01	N	N	Y
1	MN	0	134.60	10/01/2007	W	0	1	2	0	0	DLIT	DRY		1	N	TURN	13,08	N	N	N
1	MN	0	134.60	10/15/2007	N	0	1	3	0	0	DUSK	WET	013	1	N	REAR	07	N	N	N
1	MN	0	134.60	01/28/2008	N	0	0	2	0	0	DAY	ICE	124	1	N	HEAD	01,10	N	N	Y
1	MN	0	134.60	06/04/2008	N	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.60	07/14/2008	N	0	3	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.60	08/11/2008	S	0	1	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.60	08/13/2008	E	0	2	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	MN	0	134.60	11/24/2008	NE	0	1	3	0	0	DAY	DRY	013	1	N	TURN	02	N	N	N
1	MN	0	134.60	12/27/2008	SW	0	0	1	0	0	DLIT	ICE	040,055	1	Y	FIX	01	N	N	Y
1	MN	0	134.60	05/18/2009	N	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.60	11/13/2009	N	0	1	2	0	0	DAY	SNO		1	N	REAR	07	N	N	N
1	MN	0	134.61	07/28/2004	NE	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.61	03/14/2005	N	0	0	3	0	0	DAY	DRY	013	3	N	REAR	07,26	N	N	N
1	MN	0	134.61	12/20/2005	N	0	1	2	0	0	DAY	WET		3	N	REAR	07	N	N	N
1	MN	0	134.61	01/10/2006	N	0	1	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.61	02/06/2006	N	0	0	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN	0	134.61	09/22/2006	N	0	0	3	0	0	DAY	DRY	013	3	N	REAR	07	N	N	N
1	MN	0	134.61	03/13/2007	NE	0	1	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.61	04/24/2007	N	0	0	2	0	0	DAY	DRY	004	3	N	REAR	07	N	N	N
1	MN	0	134.62	10/26/2007	N	0	0	2	0	0	DUSK	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.63	09/26/2007	N	0	0	2	0	0	DAY	DRY		2	N	TURN	02	N	N	N
1	MN	0	134.64	01/11/2008	N	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.65	11/12/2005	N	0	0	1	0	0	DARK	SNO	079	3	Y	FIX	01	N	N	Y
1	MN	0	134.65	01/20/2006	NE	0	2	2	0	0	DAY	ICE	044	3	Y	FIX	01	N	N	Y

1	MN	0	134.70	02/22/2006	S	0	1	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.70	09/22/2009	N	0	0	2	0	0	DAY	DRY		3	N	REAR	26,07	N	N	N
1	MN	0	134.73	09/15/2008	NE	0	2	4	0	0	DAY	DRY	013	3	N	REAR	07	N	N	N
1	MN	0	134.74	10/02/2006	N	0	1	3	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	134.75	02/17/2006	E	0	1	2	0	0	DLIT	ICE	093	1	N	ANGL	27,10,01	N	N	Y
1	MN	0	134.75	01/12/2007	S	0	1	2	0	0	DLIT	DRY		1	N	TURN	02	N	N	N
1	MN	0	134.75	10/11/2008	E	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	134.75	12/05/2008	NE	0	0	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	MN	0	134.75	06/05/2009	N	0	0	3	0	0	DAY	DRY		1	N	REAR	26,07	N	N	N
1	MN	0	134.75	07/31/2009	E	0	0	2	0	0	DAY	DRY		1	N	BACK	10	N	N	N
1	MN	0	134.77	10/16/2007	N	0	0	2	0	0	DAY	DRY		2	N	TURN	02	N	N	N
1	MN	0	134.85	12/23/2009	N	0	0	3	0	0	DAY	DRY	013	3	N	REAR	07	N	N	N
1	MN	0	134.94	12/05/2006	S	0	0	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN	0	135.00	12/23/2009	N	0	0	2	0	0	DARK	DRY		3	N	REAR	07	N	N	N
1	MN	0	135.01	07/04/2007	N	0	0	1	0	0	DAY	DRY		3	N	NCOL	01	N	N	Y
1	MN	0	135.01	12/22/2007	N	0	1	2	0	0	DAY	WET		4	N	REAR	01,07	N	N	Y
1	MN	0	135.03	10/25/2007	N	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	135.04	04/05/2006	S	0	1	1	0	1	DAY	DRY		3	N	SS-O	27,13	N	N	N
1	MN	0	135.04	10/26/2006	N	0	1	2	0	0	DLIT	DRY		3	N	REAR	01	N	N	Y
1	MN	0	135.05	11/18/2007	N	0	1	1	0	0	DAY	WET	053	7	Y	FIX	01	N	N	Y
1	MN	0	135.19	03/03/2006	N	0	0	2	0	0	DAY	DRY		3	N	REAR	13	N	N	N
1	MN	0	135.20	03/08/2006	N	0	3	1	0	0	DARK	ICE	044,010	3	Y	FIX	01	N	N	Y
1	MN	0	135.20	12/22/2006	N	0	1	2	0	0	DUSK	DRY		3	N	REAR	01	N	N	Y
1	MN	0	135.30	01/16/2004	N	0	1	2	0	0	DLIT	DRY	079	3	N	SS-O	13	N	N	N
1	MN	0	135.38	10/13/2009	N	0	0	2	0	0	DAY	ICE	124,044	3	N	SS-O	13,01,06	N	N	Y
1	MN	0	135.41	01/21/2004	S	0	0	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN	0	135.43	11/22/2006	N	0	1	3	0	0	DAY	WET	013	3	N	REAR	01	N	N	Y
1	MN	0	135.44	07/16/2008	N	0	0	2	0	0	DAY	DRY		3	N	REAR	27,07	N	N	N
1	MN	0	135.50	06/19/2008	N	0	1	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	MN	0	135.64	12/18/2008	S	0	0	2	0	0	DAY	ICE	124	3	N	REAR	01	N	N	Y
1	MN	0	135.74	09/14/2005	S	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	135.75	04/23/2007	N	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	135.77	05/23/2006	N	0	0	1	0	0	DAY	WET	043	3	Y	FIX	26	N	N	N
1	MN	0	135.77	09/12/2008	S	0	0	2	0	0	DAY	DRY	043	3	N	SS-O	13	N	N	N
1	MN	0	135.77	10/25/2008	SW	0	3	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N

1	MN	0	135.78	11/10/2006	N	0	6	3	0	0	DUSK	WET		3	N	REAR	01	N	N	Y
1	MN	0	135.78	08/26/2007	N	0	0	1	0	0	DUSK	DRY	079	3	Y	FIX	01	N	N	Y
1	MN	0	135.79	04/07/2004	S	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	135.79	10/13/2005	S	0	1	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	135.79	09/18/2007	N	0	0	5	0	0	DAY	DRY	013	3	N	REAR	01,27	N	N	Y
1	MN	0	135.79	06/07/2009	N	0	0	1	0	0	DAY	DRY	043	3	Y	FIX	32	N	Y	N
1	MN	0	135.80	09/25/2005	N	0	1	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN	0	135.80	11/09/2005	N	0	0	1	0	0	DUSK	DRY	035	3	N	OTH	12	N	N	N
1	MN	0	135.80	06/12/2007	N	0	0	1	0	0	DAY	DRY	035	3	N	OTH	12	N	N	N
1	MN	0	135.97	03/08/2006	S	0	1	1	0	0	DLIT	ICE	043	3	Y	FIX	01	N	N	Y
1	MN	0	135.98	05/03/2009	S	0	0	2	0	0	DAY	WET		1	N	REAR	07	N	N	N
1	MN	0	136.03	04/20/2004	N	0	1	3	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	136.22	08/21/2009	N	0	0	1	0	0	DARK	DRY	101,043,010	3	N	FIX	25,26	N	N	N
1	MN	0	136.27	11/23/2006	N	0	0	1	0	0	DAY	WET	040,010	5	Y	FIX	30,32	N	N	Y
1	MN	0	136.32	08/12/2005	S	0	0	1	0	0	DAY	DRY	040,043	3	Y	FIX	27	N	N	N
1	MN	0	136.35	04/08/2008	S	0	0	2	0	0	DAY	DRY		3	N	SS-O	13	Y	N	N
1	MN	0	136.44	03/19/2007	S	0	0	4	0	0	DAY	DRY	044,013	7	N	SS-O	13	N	N	N
1	MN	0	136.45	01/08/2005	N	0	1	2	0	0	DARK	ICE		3	N	HEAD	01,05	N	N	Y
1	MN	0	136.47	03/19/2005	N	0	2	2	0	0	DLIT	DRY	040	8	N	HEAD	13,05	N	N	N
1	MN	0	136.48	01/02/2005	N	0	1	2	0	0	DLIT	ICE		1	N	REAR	01	N	N	Y
1	MN	0	136.48	08/15/2005	N	0	1	3	0	0	DAY	DRY	013	1	N	REAR	07	N	N	N
1	MN	0	136.49	06/01/2005	NE	0	0	2	0	0	DAY	DRY		3	N	REAR	01,27	N	N	Y
1	CN 2	0	135.09	03/02/2007	N	0	0	2	0	0	DAY	WET		5	N	REAR	01,10	N	N	Y
1	CN 4	0	135.23	01/14/2006	N	0	0	1	0	0	DLIT	ICE	043	3	Y	FIX	01	N	N	Y
1	CN 1	0	135.37	04/28/2008	W	0	1	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	CN 1	0	135.37	01/02/2009	W	0	0	2	0	0	DARK	DRY		1	N	TURN	02	N	N	N
1	CN 1	0	135.41	05/15/2007	E	0	1	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	CN 1	0	135.42	06/07/2005	W	0	1	2	0	0	DAY	WET		1	N	REAR	01,27	N	N	Y
1	CN 1	0	135.42	01/20/2006	E	0	0	2	0	0	DAY	DRY		1	N	REAR	27	N	N	N
1	CN 2	0	135.42	01/15/2005	S	0	0	2	0	0	DLIT	ICE		1	N	TURN	02	N	N	N
1	CN 1	0	135.45	03/21/2005	E	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	CN 2	0	135.45	10/03/2006	S	0	0	1	0	0	DAY	DRY	028	1	N	NCOL	24	N	N	N
1	CN 1	0	135.47	02/27/2008	W	0	0	2	0	0	DAY	DRY		7	N	REAR	07	N	N	N
1	CN 1	0	135.48	08/26/2009	W	0	0	2	0	0	DAY	DRY		8	N	REAR	07	N	N	N
1	CN 1	0	135.50	03/08/2004	W	0	0	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N

1	CN	1	0	135.50	10/11/2004	W	0	2	2	0	0	DAY	DRY		1	N	TURN	04	N	N	N
1	CN	1	0	135.50	05/12/2005	W	0	1	2	0	0	DAY	DRY		1	N	TURN	04,13	N	N	N
1	CN	1	0	135.50	07/03/2006	N	0	1	2	0	0	DAY	WET		1	N	ANGL	02	N	N	N
1	CN	1	0	135.50	02/13/2007	S	0	0	2	0	0	UNK	DRY		1	N	TURN	02	N	N	N
1	CN	1	0	135.50	02/17/2008	W	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	CN	1	0	135.50	03/12/2008	NW	0	1	1	0	1	DAY	DRY		1	N	TURN	04	N	N	N
1	CN	1	0	135.50	09/13/2008	W	0	1	2	0	0	DLIT	DRY		1	N	TURN	02	N	N	N
1	CN	1	0	135.51	01/21/2009	W	0	0	1	0	0	DAY	DRY	043	1	Y	FIX	10	N	N	N
1	CN	2	0	135.64	08/28/2007	E	0	0	2	0	0	DAY	DRY		1	N	TURN	04	N	N	N
1	CN	2	0	135.64	12/12/2007	W	0	0	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	CN	2	0	135.64	06/16/2008	E	0	0	2	0	0	DAWN	DRY		1	N	TURN	02	N	N	N
1	CN	3	0	135.76	06/28/2006	NE	0	1	1	0	1	DAY	DRY		1	N	TURN	02	N	N	N
1	CN	1	0	136.01	07/12/2007	NW	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	CN	1	0	136.01	11/09/2007	S	0	1	3	0	0	DARK	DRY	013	1	N	REAR	01	Y	N	Y
1	CN	3	0	136.06	08/02/2004	NE	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	CN	3	0	136.06	07/29/2005	N	0	2	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	CN	3	0	136.06	08/21/2005	N	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	CN	3	0	136.06	03/20/2006	NE	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	CN	3	0	136.06	10/25/2008	NE	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	CN	3	0	136.06	09/27/2009	NE	0	2	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	CN	1	0	136.29	12/14/2007	N	0	0	2	0	0	DAY	DRY		4	N	REAR	07	N	N	N
1	CN	1	0	136.30	06/02/2005	E	0	1	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	CN	1	0	136.30	09/09/2008	SW	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
2	MN		0	135.79	06/21/2004	N	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
					TOTAL		5	241	573												

The information contained in this report is compiled from individual driver and police crash reports submitted to the Oregon Department of Transportation as required in ORS 811.720. The Crash Analysis and Reporting Unit is committed to providing the highest quality crash data to customers. However, because submittal of crash report forms is the responsibility of the individual driver, the Crash Analysis and Reporting Unit can not guarantee that all qualifying crashes are represented nor can assurances be made that all details pertaining to a single crash are accurate.

OREGON DEPARTMENT OF TRANSPORTATION - TRANSPORTATION DEVELOPMENT DIVISION
TRANSPORTATION DATA SECTION - CRASH ANALYSIS AND REPORTING UNIT
SINGLE CRASH CHARACTERISTICS LIST REPORT

Highway 017 MP 16.50 to 19.05, Both Add and Non-Add mileage 01/01/2004 to 12/31/2009

1 - 79 of 79 rows shown.

RDWY #	COM P	CON #	MLG TYP	MILE POINT	CRASH DATE	STRIKE DIR	NO OF DEATHS	NO OF INJ	NO OF VEH	PED	BIC	LIGHT	SUR-FACE	EVENTS	ROAD CHAR	OFF RDWY	COLLISION TYPE	CAUSES	ALCOH	DRUG	SPEED
1	MN		0	16.50	03/25/2009	S	0	0	1	0	0	DARK	DRY	035	3	N	OTH	12	N	N	N
1	MN		0	16.64	10/31/2006	W	0	0	1	0	0	DAY	DRY	035	3	N	OTH	12	N	N	N
1	MN		0	16.73	01/03/2007	W	0	0	1	0	0	DARK	ICE	124,010,079	3	Y	FIX	01	N	N	Y
1	MN		0	16.74	03/18/2005	SE	0	0	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	MN		0	16.74	04/26/2006	NE	0	0	3	0	0	DAY	DRY		1	N	ANGL	02	N	N	N
1	MN		0	16.74	09/11/2007	W	0	5	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	MN		0	16.74	03/28/2008	N	0	0	2	0	0	DAY	SNO		1	N	TURN	02	N	N	N
1	MN		0	16.74	11/30/2008	NE	0	1	1	0	0	DARK	DRY	057	1	Y	FIX	01	N	N	Y
1	MN		0	16.74	12/18/2008	NE	0	0	1	0	0	DAY	ICE	079,010	1	Y	FIX	01	N	N	Y
1	MN		0	16.74	12/02/2009	S	0	1	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	MN		0	16.75	06/28/2008	N	0	1	2	0	0	DAY	DRY		1	N	TURN	32,02	N	N	N
1	MN		0	16.75	08/22/2009	SE	0	3	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN		0	16.76	12/06/2004	W	0	1	2	0	0	DAY	ICE		3	N	HEAD	01,05	N	N	Y
1	MN		0	16.86	02/04/2009	S	0	0	2	0	0	DARK	DRY		1	N	TURN	03	N	N	N
1	MN		0	16.95	03/16/2008	N	0	1	1	0	0	DAY	DRY	035	3	N	OTH	12	N	N	N
1	MN		0	17.25	07/22/2007	E	0	1	2	0	0	DAY	DRY		3	N	SS-M	01,05,16	N	N	Y
1	MN		0	17.25	08/27/2007	N	0	0	2	0	0	DAY	DRY		3	N	REAR	01	N	N	Y
1	MN		0	17.41	02/01/2007	W	0	0	1	0	0	DARK	WET	035	3	N	OTH	12	N	N	N
1	MN		0	17.41	11/21/2008	E	0	0	1	0	0	DUSK	DRY	035	3	N	OTH	12	N	N	N
1	MN		0	17.44	03/31/2006	N	0	1	1	0	0	DAY	DRY	093,079,010	3	Y	FIX	27	N	N	N
1	MN		0	17.45	02/19/2004	W	0	2	2	0	0	DAY	DRY		3	N	REAR	01	N	N	Y
1	MN		0	17.48	08/29/2007	NW	0	2	3	0	0	DAY	DRY	013	3	N	REAR	01	N	N	Y
1	MN		0	17.48	05/27/2009	SE	0	0	1	0	0	DAY	DRY	035	3	N	OTH	12	N	N	N
1	MN		0	17.49	04/10/2006	E	0	3	2	0	0	DAY	DRY		1	N	ANGL	02	N	N	N

1	MN	0	17.49	11/10/2006	NW	1	3	2	0	0	DAY	DRY		1	N	ANGL	03	N	N	N
1	MN	0	17.49	02/08/2008	E	0	1	1	0	0	DARK	ICE	072,124	1	Y	FIX	01	N	N	Y
1	MN	0	17.86	05/31/2007	E	1	0	1	0	0	UNK	DRY	001	3	Y	NCOL	12	N	N	N
1	MN	0	17.90	01/26/2005	SE	0	0	2	0	0	DLIT	WET		3	N	REAR	27	N	N	N
1	MN	0	17.91	05/16/2004	S	0	2	2	0	0	DAY	DRY	044	1	N	HEAD	10	N	N	N
1	MN	0	17.91	11/19/2004	NW	0	3	2	0	0	DLIT	DRY		1	N	REAR	10	Y	N	N
1	MN	0	17.91	04/12/2005	SE	0	3	3	0	0	DAY	DRY	013	1	N	REAR	07	N	N	N
1	MN	0	17.91	08/10/2005	S	0	2	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	17.91	07/12/2006	S	0	2	3	0	0	DAY	DRY	013	1	N	REAR	30,32	N	N	Y
1	MN	0	17.91	12/05/2006	E	0	0	2	0	0	DAY	DRY		1	N	TURN	08,10	N	N	N
1	MN	0	17.91	07/09/2007	SE	0	1	2	0	0	DAY	DRY	010	1	N	TURN	04,27	N	N	N
1	MN	0	17.91	11/19/2007	N	0	1	2	0	0	DAY	DRY		1	N	ANGL	27	N	N	N
1	MN	0	17.91	01/10/2008	N	0	0	2	0	0	DAY	ICE	124	1	N	REAR	30,07	N	N	Y
1	MN	0	17.91	02/19/2009	S	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1	MN	0	17.91	08/28/2009	E	0	1	2	0	0	DAY	DRY		1	N	TURN	08	N	N	N
1	MN	0	18.15	12/09/2007	NW	0	3	2	0	0	DAY	SNO		4	N	TURN	08,32	N	N	N
1	MN	0	18.16	06/29/2006	S	0	1	1	0	1	DAY	DRY		3	N	TURN	02	N	N	N
1	MN	0	18.30	01/27/2008	N	0	3	2	0	0	DAY	ICE	124	3	N	PARK	10,13	N	N	N
1	MN	0	18.40	03/11/2005	S	0	2	1	0	0	DAY	DRY	067,037,010	5	Y	FIX	10	N	N	N
1	MN	0	18.55	07/24/2007	S	0	0	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN	0	18.72	06/02/2007	S	0	1	1	0	0	DAY	DRY		3	N	NCOL	01	N	N	Y
1	MN	0	18.76	08/10/2007	S	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	18.78	04/16/2004	SW	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	18.78	02/06/2007	S	0	0	2	0	0	DAY	DRY		3	N	SS-O	13	N	N	N
1	MN	0	18.79	09/18/2006	S	0	1	2	0	0	DAY	DRY	092	3	N	REAR	07	N	N	N
1	MN	0	18.79	09/19/2006	S	0	0	2	0	0	DAY	DRY		3	N	REAR	07	N	N	N
1	MN	0	18.80	12/21/2004	N	0	0	2	0	0	DAY	DRY		1	N	ANGL	04	N	N	N
1	MN	0	18.80	01/26/2005	E	0	0	2	0	0	DAY	DRY		1	N	ANGL	04	N	N	N
1	MN	0	18.80	02/11/2005	E	0	2	3	0	0	DAY	DRY	013	1	N	REAR	27,07,10	N	N	N
1	MN	0	18.80	05/27/2005	E	0	0	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1	MN	0	18.80	05/08/2006	N	0	1	2	0	0	DAY	DRY		1	N	REAR	27	N	N	N
1	MN	0	18.80	06/01/2006	W	0	1	3	0	0	DAY	WET	093,013	1	N	REAR	07	N	N	N
1	MN	0	18.80	09/12/2006	N	0	0	3	0	0	DAY	DRY	092,013	1	N	REAR	26,07	N	N	N
1	MN	0	18.80	11/14/2006	E	0	0	2	0	0	DLIT	DRY		1	N	TURN	02	N	N	N
1	MN	0	18.80	11/14/2006	E	0	0	2	0	0	DLIT	WET		1	N	TURN	04,01,02	N	N	Y

1 MN	0	18.80	02/12/2007	S	0	0	2	0	0	DLIT	DRY		1	N	ANGL	04	N	N	N
1 MN	0	18.80	06/18/2007	E	0	1	2	0	0	DAY	DRY		1	N	TURN	02	N	N	N
1 MN	0	18.80	04/04/2008	S	0	0	3	0	0	DAY	DRY	013	1	N	REAR	07	N	N	N
1 MN	0	18.80	04/07/2008	N	0	0	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1 MN	0	18.80	06/14/2008	S	0	1	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1 MN	0	18.80	08/01/2008	S	0	2	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1 MN	0	18.80	08/15/2008	E	0	1	2	0	0	DAY	DRY		1	N	TURN	04	N	N	N
1 MN	0	18.80	02/02/2009	S	0	1	2	0	0	DAY	DRY		1	N	TURN	04	N	N	N
1 MN	0	18.80	08/25/2009	S	0	0	2	0	0	DAY	DRY		1	N	REAR	07,22	N	N	N
1 MN	0	18.80	12/16/2009	S	0	1	2	0	0	DAY	DRY		1	N	REAR	07	N	N	N
1 MN	0	18.82	09/25/2007	N	0	2	2	0	0	DAY	DRY		3	N	REAR	01	N	N	Y
1 MN	0	19.01	10/13/2004	N	0	0	2	0	0	DAY	DRY		2	N	TURN	02	N	N	N
1 MN	0	19.01	11/10/2004	N	0	1	1	1	0	DLIT	WET		3	N	PED	12	Y	N	N
1 MN	0	19.03	12/06/2004	SW	0	0	3	0	0	DAY	ICE	013	1	N	ANGL	03	N	N	N
1 MN	0	19.03	03/16/2009	W	0	1	2	0	0	DAWN	SNO		1	N	TURN	08	N	N	N
1 MN	0	19.04	06/21/2008	N	0	0	2	0	0	DAY	DRY		3	N	TURN	08,02	N	N	N
1 MN	0	19.05	09/01/2005	N	0	2	2	0	0	DAY	DRY		2	N	TURN	02	N	N	N
1 MN	0	19.05	12/30/2009	S	0	1	2	0	0	DAWN	ICE	124	3	N	HEAD	01	N	N	Y
1 CN 1	0	18.51	08/28/2006	S	0	0	2	0	0	DAY	DRY	022,023	1	N	SS-M	10	N	N	N
1 CN 1	0	18.56	08/27/2009	W	0	1	1	0	0	DAY	DRY	044	3	Y	FIX	21,01,11	N	N	Y
			TOTAL		2	71	150												

The information contained in this report is compiled from individual driver and police crash reports submitted to the Oregon Department of Transportation as required in ORS 811.720. The Crash Analysis and Reporting Unit is committed to providing the highest quality crash data to customers. However, because submittal of crash report forms is the responsibility of the individual driver, the Crash Analysis and Reporting Unit can not guarantee that all qualifying crashes are represented nor can assurances be made that all details pertaining to a single crash are accurate.

APPENDIX C. LOCAL STREET CRASH CHARACTERISTIC SUMMARIES

Table C-1 Boyd Acres Road Crash Summary

Date	At or Near Intersecting Street	Weather Surface Light[1]	Crash Type[2]	Severity[3]	Cause
2/4/2004	Painter St	CLR ICE DAWN	REAR	PDO	Driving too fast
2/11/2004	Empire Blvd	FOG WET DAY	ANGL	INJ-B	Running stop sign; Inattentive driver
9/6/2004	Empire Blvd	CLR DRY DARK	FIX	INJ-B	Other improper driving
3/24/2005	Empire Blvd	CLD WET DAY	ANGL	INJ-C	Failure to yield ROW
5/26/2005	Ross Dr	CLR DRY DAY	TURN	PDO	Failure to yield ROW
6/11/2005	Fred Meyer Rd	RAIN WET DARK	HEAD	INJ-A	Driving too fast; Driving left of center; Alcohol involved
6/21/2005	Empire Blvd	CLR DRY DAY	TURN	PDO	Failure to yield ROW
7/9/2005	Builders St	CLR DRY DLIT	ANGL	PDO	Failure to yield ROW
8/2/2005	Lamoine Ln	CLD DRY DARK	FIX	INJ-C	Other improper driving
2/4/2006	Empire Blvd	SNOW SNOW DAY	REAR	PDO	Following too close
2/8/2006	Butler Market Rd	CLR DRY DAY	TURN	PDO	Failure to yield ROW
4/5/2006	Empire Blvd	CLR DRY DAY	REAR	INJ-C	Inattentive driver
5/22/2006	Empire Blvd	RAIN WET DAY	REAR	PDO	Following too close

6/15/2006	Empire Blvd	CLR DRY DAY	ANGL	PDO	Failure to yield ROW
8/22/2006	Empire Blvd	CLR DRY DAY	REAR	PDO	Following too close
11/3/2006	Empire Blvd	CLD WET DUSK	REAR	INJ-C	Driving too fast; Inattentive driver
11/11/2006	Fred Meyer Rd	CLR ICE DAY	NCOL	INJ-B	Driving too fast
03/28/2007	Snow Peaks Dr	CLR DRY DAY	ANGL	PDO	Failure to yield ROW
05/06/2007	Empire Avenue	CLR DRY DARK	ANGL	PDO	Running Stop Sign
07/13/2007	Shaniko Ln	CLR DRY DAY	PDO	TURN	Failure to yield ROW
09/07/2007	Empire Avenue	CLR DRY DAY	PDO	REAR	Following too close
01/07/2008	Fred Meyer Rd	SNOW ICE DARK	PDO	HEAD	Driving left of center
02/14/2008	Sierra Dr	CLD DRY DAWN	TURN	INJ-B	Failure to yield ROW
02/26/2009	Fred Meyer Rd	CLD ICE DAY	SS-M	PDO	Driving left of center
03/13/2009	Cooley Rd	SLT WET DARK	FIX	PDO	Careless driving
04/23/2009	Empire Avenue	CLR DRY DAY	ANGL	PDO	Failure to yield ROW

[1] CLR – Clear; CLD – Cloudy; DUNL – Dark-Unlit; SLT – Sleet
2 ANGL – Angle Collision; REAR – Rear-End Collision; NCOL – Non-Collision; FIX – Fixed Object; SS-O – Side-Swipe Overtaking; TURN – Turning Collision; PED – Pedestrian; OTH – Other
[3] PDO –Property Damage Only; INJ-C –minor injury; INJ-B –moderate injury; INJ-A – severe injury; FATAL – Fatality

Table C-2 Cooley Road Crash Summary

Date	At or Near Intersecting Street	Weather Surface Light[1]	Crash Type[2]	Severity[3]	Cause
6/13/2004	18th Street	CLD DRY DARK	FIX	INJ-B	Loss of Control
6/25/2004	18th Street	CLR DRY DARK	FIX	INJ-B	Loss of Control
6/27/2004	Bend Pky	CLR DRY DAY	ANGL	INJ-B	Inattentive driver; Disregarding traffic signal
07/26/2004	Cooley Rd	CLR DRY DAY	REAR	INJ-A	Following too close
03/03/2005	Cooley Rd	CLR DRY DARK	ANGL	INJ-C	Disregarding traffic signal
07/08/2005	Boyd Acres Rd	CLR DRY DAY	ANGL	PDO	Running Stop Sign
10/31/2005	Bend Pky	CLD DRY DAY	ANGL	PDO	Inattentive driver; Disregarding traffic signal
11/28/2005	Bend Pky	CLR DRY DAY	ANGL	PDO	Inattentive driver; Disregarding traffic signal
11/10/2006	McKenzie-Bend Hwy	CLD DRY DAY	ANGL	FATAL	Running Stop Sign
04/10/2006	McKenzie-Bend Hwy	CLR DRY DAY	ANGL	INJ-C	Failure to yield ROW
09/18/2006	Boyd Acres Rd	CLD DRY DAY	REAR	PDO	Following too close; Inattentive driver
01/26/2007	Boyd Acres Rd	CLR DRY DAY	OTHER	PDO	Hit animal
02/08/2008	McKenzie-Bend Hwy	CLR ICE DARK	FIX	INJ-B	Slide/Swerve in wet conditions
10/09/2008	Bend Pky	CLR DRY DAY	REAR	PDO	Following too close

04/04/2009	Bend Pky	CLR DRY DAY	TURN	INJ-B	Disregarding traffic signal

[1] CLR – Clear; CLD – Cloudy; DUNL – Dark-Unlit; SLT – Sleet
[2] ANGL – Angle Collision; REAR – Rear-End Collision; NCOL – Non-Collision; FIX – Fixed Object; SS-O – Side-Swipe Overtaking; TURN – Turning Collision; PED – Pedestrian; OTH – Other
[3] PDO –Property Damage Only; INJ-C –minor injury; INJ-B –moderate injury; INJ-A – severe injury; FATAL – Fatality

Table C-3 Deschutes Market Road Crash Summary

Date	At or Near Intersecting Street	Weather Surface Light[1]	Crash Type[2]	Severity[3]	Cause
02/03/2004	Rd 3169	SNOW SNO DAY	FIX	PDO	Hit ditch
02/17/2004	US 97	SNOW ICE DAY	HEAD	PDO	Driving left of center
11/28/2005	US 97	SNOW ICE DAY	FIX	PDO	Hit ditch then tree
03/25/2006	Rd 3169	CLD WET DAY	OTHER	PDO	Avoiding rock/debris in road
04/09/2006	Rd 3176	RAIN WET DAY	FIX	PDO	Hit ditch then pole
07/07/2006	Rd 3347	CLR DRY DAY	HEAD	PDO	Driving left of center
10/13/2006	Rd 3169	CLR DRY DAY	OTHER	INJ-A	Hit deer/elk
10/24/2006	Rd 3347	CLR DRY DARK	HEAD	FATAL	Driving left of center
12/03/2006	Rd 3176	CLR DRY DAY	TURN	PDO	Driving too fast for conditions
05/30/2008	Dale Rd	CLD WET DUSK	OTHER	PDO	Hit deer/elk
07/10/2008	Dale Rd	CKR DRY DAY	OTHER	INJ-B	Driving left of center
08/22/2008	Rd 3347	CLR DRY DAY	OTHER	INJ-C	Hit deer/elk
02/26/2009	Rd 3176	CLD ICE DAY	ANGL	PDO	Running Stop Sign
06/24/2009	Rd 3347	CLR DRY DAY	OTHER	INJ-A	Hit deer/elk

[1] CLR – Clear; CLD – Cloudy; DUNL – Dark-Unlit; SLT – Sleet
[2] ANGL – Angle Collision; REAR – Rear-End Collision; NCOL – Non-Collision; FIX – Fixed Object; SS-O – Side-Swipe Overtaking; TURN – Turning Collision; PED – Pedestrian; OTH – Other
[3] PDO –Property Damage Only; INJ-C –minor injury; INJ-B –moderate injury; INJ-A – severe injury; FATAL – Fatality

Table C-4 Empire Avenue Crash Summary

Date	At or Near Intersecting Street	Weather Surface Light[1]	Crash Type[2]	Severity[3]	Cause
03/08/2004	US97	CLR DRY DAY	TURN	PDO	Failure to yield ROW
10/11/2004	US97	CLR DRY DAY	TURN	INJ-B	Disregarding signal
01/15/2005	US97	RAIN ICE DLIT	TURN	PDO	Failure to yield ROW
02/11/2005	US20	CLD DRY DAY	REAR	INJ-B	Inattentive driver; Following too close; Other improper driving
03/21/2005	US97	CLR DRY DAY	REAR	PDO	Following too close
05/12/2005	US97	CLD DRY DAY	TURN	INJ-A	Disregarded signal; Improper lane change
06/07/2005	US97	RAIN WET DAY	REAR	INJ-C	Driving too fast; Inattentive driver
06/01/2006	US20	RAIN WET DAY	REAR	INJ-C	Following too close
07/03/2006	Empire Ave	RAIN WET DAY	ANGL	INJ-B	Failure to yield ROW
02/12/2007	McKenzie-Bend Hwy	CLR DRY DLIT	ANGL	PDO	Disregarding traffic signal
02/13/2007	NB Exit to Empire	CLR DRY UNK	TURN	PDO	Driving to fast for conditions
04/27/2007	Clayton Ave	CLR DRY DAY	ANGL	PDO	Driving too fast for conditions
05/06/2007	Boyd Acres Rd	CLR DRY DARK	ANGL	PDO	Running Stop Sign

05/15/2007	Nels Anderson Rd	CLR DRY DAY	REAR	INJ-C	Following too close
05/15/2007	Nels Anderson Rd	CLR DRY DAY	TURN	PDO	Driving too fast for conditions
6/18/2007	McKenzie-Bend Hwy	CLR DRY DAY	TURN	INJ-C	Driving too fast for conditions
09/18/2007	Clayton Ave	CLR DRY DAY	TURN	PDO	Driving too fast for conditions
02/17/2008	NB Entrance	CLR DRY DAY	REAR	PDO	Following too close
03/12/2008	NB Entrance	CLD DRY DAY	TURN	INJ-B	Disregarding traffic signal
06/19/2008	NB Entrance	CLD DRY DAY	TURN	INJ-B	Driving too fast for conditions
04/28/2008	Sherman Rd	CLR DRY DAY	TURN	INJ-A	Driving too fast for conditions
02/15/2008	18th Street	CLR DRY DAY	REAR	PDO	Following too close; Improper turn
02/27/2008	SB Entrance	CLR DRY DAY	REAR	PDO	Following too close
08/15/2008	McKenzie-Bend Hwy	CLR DRY DAY	TURN	INJ-C	Disregarding traffic signal
09/13/2008	NB Exit	CLR DRY DLIT	TURN	INJ-C	Driving too fast for conditions
12/18/2008	High Desert Ln	SNOW ICE DARK	ANGL	PDO	Failure to yield ROW
12/19/2008	18th Street	SNOW ICE DAY	OTHER	PDO	Following too close

01/02/2009	Sherman Rd	DLR DRY DARK	TURN	PDO	Driving too fast for conditions
01/21/2009	NB Entrance	CLR DRY DAY	FIX	PDO	Hit guardrail
02/02/2009	McKenzie-Bend Hwy	CLR DRY DAY	TURN	INJ-C	Disregarding traffic signal
04/22/2009	Jamieson St	CLR DRY DAY	TURN	PDO	Running Stop Sign
08/26/2009	NB Entrance	CLR DRY DAY	REAR	PDO	Following too close

[1] CLR – Clear; CLD – Cloudy; DUNL – Dark-Unlit; SLT – Sleet
[2] ANGL – Angle Collision; REAR – Rear-End Collision; NCOL – Non-Collision; FIX – Fixed Object; SS-O – Side-Swipe Overtaking; TURN – Turning Collision; PED – Pedestrian; OTH – Other
[3] PDO –Property Damage Only; INJ-C –minor injury; INJ-B –moderate injury; INJ-A – severe injury; FATAL – Fatality

Table C-5 Nels Anderson Road Crash Summary

Date	At or Near Intersecting Street	Weather Surface Light[1]	Crash Type[2]	Severity[3]	Cause
12/06/2004	McKenzie-Bend Hwy	SNOW ICE DAY	ANGL	PDO	Running Stop Sign
12/29/2006	Empire Ave	CLR DRY DAY	TURN	PDO	Driving too fast for conditions
05/15/2007	Empire Ave	CLR DRY DAY	TURN	PDO	Driving too fast for conditions
10/14/2007	Nels Anderson Pl	CLR DRY DAY	REAR	PDO	Tire failure
04/28/2008	Sherman/Empire	CLR DRY DAY	TURN	INJ-A	Driving too fast for conditions

[1] CLR – Clear; CLD – Cloudy; DUNL – Dark-Unlit; SLT – Sleet
[2] ANGL – Angle Collision; REAR – Rear-End Collision; NCOL – Non-Collision; FIX – Fixed Object; SS-O – Side-Swipe Overtaking; TURN – Turning Collision; PED – Pedestrian; OTH – Other
[3] PDO –Property Damage Only; INJ-C –minor injury; INJ-B –moderate injury; INJ-A – severe injury; FATAL – Fatality

Table C-6 OB Riley Road Crash Summary

Date	At or Near Intersecting Street	Weather Surface Light[1]	Crash Type[2]	Severity[3]	Cause
03/01/2004	US20	CLD DRY DLIT	REAR	INJ-B	Driving too fast for conditions
05/10/2004	US20	CLR DRY DAY	ANGL	INJ-C	Failure to yield ROW; Disregarding traffic signal
05/18/2004	Empire Ave	CLR DRY DAY	REAR	INJ-C	Following too close; Inattentive driver
04/04/2005	Rd 3107	CLD DRY DUSK	FIX	FATAL	Driving too fast; Alcohol involved
12/31/2005	Empire Ave	RAIN ICE DARK	FIX	PDO	Driving too fast
04/30/2006	Rd 215	CLR DRY DARK	FIX	PDO	Driving too fast; Alcohol involved
06/13/2006	US20	RAIN WET DAY	TURN	INJ-B	Disregarding signal
07/07/2006	Archie Briggs Road	CLR DRY DAY	TURN	INJ-A	Failure to yield ROW
09/07/2006	Rd 3508	CLR DRY DAY	FIX	INJ-B	Fatigue
10/02/2006	Empire Ave	CLR DRY DAY	OTH	PDO	Other
11/22/2006	US20	CLR DRY DAY	REAR	PDO	Driving too fast for conditions
12/14/2006	US20	RAIN WET DLIT	ANGL	INJ-C	Disregarding traffic signal
08/08/2007	McKenzie – Bend Hwy	CLR DRY DAY	REAR	PDO	Following too close
08/16/2007	McKenzie – Bend Hwy	CLR DRY DLIT	TURN	PDO	Disregarding traffic signal

09/23/2007	McKenzie – Bend Hwy	CLR DRY DAY	ANGL	INJ-B	Disregarding traffic signal
01/29/2008	Archie Briggs Rd	CLR ICE DLIT	ANGL	PDO	Failure to yield ROW
03/20/2008	Firerock Rd	CLR DRY DLIT	FIX	FATAL	Loss of Control
03/28/2008	Rd 2156	SNOW WET DAY	FIX	INJ-C	Exceeding posted speed
07/07/2008	McKenzie – Bend Hwy	CLR DRY DAY	REAR	PDO	Following too close
12/10/2008	Mervin Samples Rd	CLR DRY DAY	ANGL	INJ-B	Failure to yield ROW
12/18/2008	Empire Ave	SNOW ICE DAY	TURN	PDO	Failure to yield ROW
01/06/2009	Roper Ln	CLD CE DARK	FIX	INJ-B	Slid/Swerve into pole
07/13/2009	Empire Ave	UNK UNK DAY	TURN	FATAL	Driving too fast for conditions
09/11/2009	Empire Ave	CLR DRY DAY	TURN	INJ-B	Driving too fast for conditions

[1] CLR – Clear; CLD – Cloudy; DUNL – Dark-Unlit; SLT – Sleet
[2] ANGL – Angle Collision; REAR – Rear-End Collision; NCOL – Non-Collision; FIX – Fixed Object; SS-O – Side-Swipe Overtaking; TURN – Turning Collision; PED – Pedestrian; OTH – Other
[3] PDO –Property Damage Only; INJ-C –minor injury; INJ-B –moderate injury; INJ-A – severe injury; FATAL – Fatality

Table C-7 Old Bend-Redmond Highway Crash Summary

Date	At or Near Intersecting Street	Weather Surface Light[1]	Crash Type[2]	Severity[3]	Cause
03/18/2005	At MP 16.74	CLR DRY DAY	TURN	PDO	Driving too fast for conditions
12/22/2005	At US20	CLD WET DAY	OTHER	PDO	Hit deer/elk
04/26/2006	At MP 16.74	CLR DRY DAY	ANGL	PDO	Driving too fast for conditions
05/12/2006	At US20	CLR DRY DAY	TURN	PDO	Improper turn; Driving too fast for conditions
09/11/2007	At MP 16.74	CLR DRY DAY	TURN	INJ-B	Driving too fast for conditions
03/28/2008	At MP 16.74	SNOW SNO DAY	TURN	PDO	Driving too fast for conditions
06/28/2008	At MP 16.75	CLR DRY DAY	TURN	INJ-B	Reckless Driving; Driving too fast for conditions
03/25/2009	Rd 3139	CLR DRY DAY	REAR	INJ-B	Reckless Driving; Driving too fast for conditions
08/22/2009	At MP 16.75	CLR DRY DAY	REAR	INJ-C	Following too close
12/02/2009	At MP 16.74	CLR DRY DAY	TURN	INJ-C	Driving too fast for conditions

[1] CLR – Clear; CLD – Cloudy; DUNL – Dark-Unlit; SLT – Sleet
[2] ANGL – Angle Collision; REAR – Rear-End Collision; NCOL – Non-Collision; FIX – Fixed Object; SS-O – Side-Swipe Overtaking; TURN – Turning Collision; PED – Pedestrian; OTH – Other
[3] PDO –Property Damage Only; INJ-C –minor injury; INJ-B –moderate injury; INJ-A – severe injury; FATAL – Fatality

Table C-8 Robal Road Crash Summary

Date	At or Near Intersecting Street	Weather Surface Light[1]	Crash Type[2]	Severity[3]	Cause
09/04/2005	Hunnell Rd	CLR DRY DAY	TURN	INJ-C	Driving too fast for conditions
11/12/2005	Hunnell Rd	CLR DRY DAY	TURN	PDO	Driving too fast for conditions
12/18/2005	Hunnell Rd	CLR ICE DAY	HEAD	PDO	Driving left of center
06/13/2006	Hunnell Rd	CLR DRY DAY	TURN	PDO	Driving too fast for conditions
08/04/2006	Hunnell Rd	CLR DRY DAY	TURN	INJ-A	Driving too fast for conditions
02/15/2007	Hunnell Rd	CLR DRY DAY	ANGL	INJ-C	Disregarding traffic signal
05/04/2007	Bend Pky	CLR DRY DAY	TURN	PDO	Improper turn
08/24/2007	Hunnell Rd	CLR DRY DAY	TURN	INJ-C	Disregarding traffic signal
09/05/2007	Bend Pky	CLR DRY DAY	TURN	PDO	Improper driving
10/01/2007	Bend Pky	CLR DRY DLIT	TURN	INJ-C	Improper lane change; Improper turn
10/15/2007	Bend Pky	RAIN WET DUSK	REAR	INJ-C	Following too close
11/24/2007	Hunnell Rd	CLR DRY DAY	TURN	INJ-C	Driving too fast for conditions
08/13/2008	Bend Pky	CLR DRY DAY	TURN	INJ-B	Failure to yield ROW
12/24/2008	Bend Pky	CLR DRY DAY	TURN	INJ-C	Failure to yield ROW

03/06/2009	Hunnell Rd	CLR ICE DAY	TURN	PDO	Driving too fast for conditions
12/09/2009	Hunnell Rd	CLD WET DAY	TURN	INJ-C	Driving too fast for conditions

[1] CLR – Clear; CLD – Cloudy; DUNL – Dark-Unlit; SLT – Sleet
[2] ANGL – Angle Collision; REAR – Rear-End Collision; NCOL – Non-Collision; FIX – Fixed Object; SS-O – Side-Swipe Overtaking; TURN – Turning Collision; PED – Pedestrian; OTH – Other
[3] PDO –Property Damage Only; INJ-C –minor injury; INJ-B –moderate injury; INJ-A – severe injury; FATAL – Fatality

Table C-9 Tumalo Road Crash Summary

Date	At or Near Intersecting Street	Weather Surface Light[1]	Crash Type[2]	Severity[3]	Cause
2/18/2004	US97	CLR DRY DLIT	REAR	PDO	Following too close
10/20/2005	Half Mile Ln	CLR DRY DAY	REAR	PDO	Following too close
11/30/2006	Half Mile Ln	CLR DRY DARK	OTH	PDO	Other
07/04/2009	78th Street	CLR DRY DAY	TURN	PDO	Failure to yield ROW
11/04/2009	Half Mile Ln	CLR DRY DAWN	TURN	PDO	Driving too fast for conditions

[1] CLR – Clear; CLD – Cloudy; DUNL – Dark-Unlit; SLT – Sleet
[2] ANGL – Angle Collision; REAR – Rear-End Collision; NCOL – Non-Collision; FIX – Fixed Object; SS-O – Side-Swipe Overtaking; TURN – Turning Collision; PED – Pedestrian; OTH – Other
[3] PDO –Property Damage Only; INJ-C –minor injury; INJ-B –moderate injury; INJ-A – severe injury; FATAL – Fatality

APPENDIX D: TRAFFIC DEVELOPMENT

30th Highest Hour Traffic Development

The 2007 30th Highest Hour Volumes used in this analysis were developed using combination of 16-hour and 3-hour manual intersection counts and 48-hour hose tube counts taken in 2007. A peak hour count was obtained to determine lane flows within the northbound weaving section between the Empire Avenue on-ramp and the Sister's Loop off-ramp. Potential alternative impacts necessitated obtaining 3-hour classification counts at certain local street intersections in 2009. Table D-1 shows the location, duration, and time obtained for each count. The peak hour for the study area was found to be 4:00 to 5:00 PM and the peak truck hour is from 8:00 to 9:00 AM. The 30th highest hour volumes occur on a mid-August Friday.

Table D-1 Count Locations

Location	Duration	Date
US97 & Deschutes Market/Nichols Market Rd	16 hours	5/30/2007 & 6/13/2007
US97 & Bowery Ln	3 hours	03/17/2009
US97 & Grandview Dr	16 hours	05/24/2007
US97 & Clausen Rd	3 hours	06/12/2007
US97 & Cooley Rd	16 hours	07/19/2007
US97 & Lowe's Driveway	3 hours	06/26/2007
US97 & Chavre Wy	3 hours	06/26/2007
US97 & Target Driveway	16 hours	06/06/2007
US97 & Robal Rd	16 hours	07/19/2007
US97 & Nels Anderson Pl/Cascade Village Driveway	16 hours	6/27/2007
US97 Business (3rd Street) SB Ramp at US 20 Interchange	48 hours	06/11-13/2007
Sisters Loop Ramp (US97 NB to US20 WB)	48 hours	06/11-13/2007
US97 Empire Ave – Sister's Loop NB weaving section	1 hour	6/26/2007
US97 NB and SB (between Empire Ave & Butler Market Rd Ramps)	16 hours	05/31/2007
US20 & Old Bend-Redmond Highway	16 hours	05/23/2007
US20 & Mountain View Dr	3 hours	03/18/2009
US20 & Cooley Rd	16 hours	05/23/2007
US20 & Robal Rd	16 hours	05/23/2007
US20 & Jamison St	3 hours	05/22/2007
US20 SB On-ramp to Parkway SB	48 hours	06/12-14/2007
US20 turnaround connection (from US97 Business SB ramp to US20 West)	48 hours	06/11-13/2007
US20 & Empire Ave	16 hours	05/24/2007
US20 NB Off-ramp to Parkway NB	48 hours	06/12-14/2007

Location	Duration	Date
Tumalo Rd & Nichols Market Rd	16 hours	05/30/2007
Deschutes Market Rd & NB Interchange Ramps	16 hours	05/30/2007
Cooley Rd & Scenic Dr	3 hours	03/19/2009
Cooley Rd & Hunnell Rd (north)/Main Lowe's Driveway	3 hours	06/05/2007
Cooley Rd & Loop Rd/(eastern) Lowe's Driveway	3 hours	05/23/2007
Cooley Rd & Boyd Acres Rd	16 hours	06/13/2007
Robal Rd & Auto Mall Driveway	3 hours	05/17/2007
Robal Rd & Target Driveway	3 hours	06/07/2007
Robal Rd & Cascade Village Driveway (opposite Target)	3 hours	06/07/2007
Bowery Ln & Harris Wy	3 hours	03/24/2009
Rogers Rd & Hunnell Rd	3 hours	03/10/2009
Hunnell Rd/Berg Ln & Cooley Rd	16 hours	5/31/2007
Hunnell Rd & Robal Rd	16 hours	06/08/2007
O.B. Riley Rd & Old Redmond-Bend Highway	16 hours	06/13/2007
O.B. Riley Rd & Cooley Rd	16 hours	06/13/2007
Nels Anderson Rd & Chavre Wy	3 hours	06/06/2007
Nels Anderson Rd & Robal Rd	16 hours	06/08/2007
Nels Anderson Rd & Nels Anderson Pl	16 hours	06/08/2007
Empire Ave & O.B. Riley Rd	16 hours	06/08/2007
Empire Ave & Britta St	16 hours	06/08/2007
Empire Ave & Jamison St	16 hours	06/08/2007
Empire Ave & Cady Wy/Sherman Rd	16 hours	06/13/2007
Empire Ave & Nels Anderson Rd/ SB On-Ramp	16 hours	06/14/2007
Empire Ave & NB Ramps	16 hours	09/11/2007
Empire Ave & Blenheim/Corporate Pl	3 hours	03/19/2009
Empire Ave & Boyd Acres Rd	16 hours	6/29/2007
Butler Market Rd & SB Off-ramp	16 hours	06/07/2007
Butler Market Rd & 2nd Street/NB On-ramp	16 hours	06/06/2007

The counts were seasonally adjusted to 30th Highest Hour Volumes using three local Automatic Traffic Recorders (ATR). ATR's #09-007 Bend-Empire and #09-009 Bend-Revere were averaged together for the Bend Parkway portion of US97. ATR #09-007 Bend-Empire and #09-020 Redmond were averaged together for the rest of US97.

There were no matches in the ATR Characteristic Table because the subject site volumes were more than 10% of the values shown in the table, so the Seasonal Trends Table was

used. The average of the Commuter and Summer trends were used for the expressway portion of US20. Third Street and other local roads used the Commuter trend. Interchange ramps used an average of the Bend Parkway seasonal factors and the local road seasonal factors as ramps are a hybrid between the crossroad and the mainline. The 2007 30th highest hour volumes and lane configurations are shown in Appendix F.

Future Volume Development

In order to create future year 2015 and 2035 volumes, the Bend Metropolitan Planning Organization (BMPO) travel demand model was used. Travel demand models are a combination of mathematical equations and relationships using locally-provided existing and future housing and employment information to project future traffic conditions. These future traffic conditions are placed on a network which is similar to the actual roadway network.

Originally, future volumes were created for 2012 and 2032 based on the 2012 build year and a 20-year design life. There were recent concerns that since the project has been in progress for a number of years the likelihood of having anything constructed by 2012 is very small. In addition, economic events since 2008 have depressed the traffic volumes about 10% lower than the 2007 values, employment has dropped around 20%, and population has leveled out or decreased in the study area. The MPO considers these decreases significant enough that the current 2030 population/employment forecasts are at least representative of 2035. Therefore, the 2012 and 2032 project volumes are representative of 2015 and 2035 conditions and have been renumbered (no actual changes to the volumes) in this report. Please see the March 22, 2010 letter from Joel McCarroll (Region 4 Traffic Manager) at the end of this appendix.

The model is based on the current comprehensive plans of Deschutes County and Bend. Growth beyond the current comprehensive plans will result in higher impacts than what is shown here. Figure D-1 shows a subset of Bend's comprehensive plan (General Plan) which covers the majority of the study area.

This model application effort used the Metro Transportation Plan (MTP) scenario to develop the future no-build and build alternative volumes. The MTP scenario is financially constrained which means that these model application volumes included all the city, county and state projects (outside of the US 97 North Corridor project) that can be funded within the next 20 years in and around the Bend metropolitan area. These projects are assumed to occur regardless of what happens in the US 97 Bend North Corridor project study area. Any projects assumed at the US97 & Cooley Road intersection were removed from the no-build model runs, so the true unimproved impacts could be properly measured. The remaining unconstructed MTP projects are shown in Table D-2.

Table D-2 MTP Projects

Name	Improvement	From	To
Cooley Rd	New 3-lane roadway	18th St	Deschutes Market Rd
Cooley Rd Loop	Road Extension	OB Riley Rd	OB Riley Rd
Empire Ave	New 3-lane roadway	Purcell Blvd	27th St
Empire Ave	Widen to 5 lanes	3rd St	27th St
Empire Ave	Add US97 SB off-ramp and widen NB off-ramp	US97 SB Ramps	US97 NB Ramps
Reed Market Rd	Widen to 3-lanes	15th St	27th St
Reed Market Rd	Multi-lane roundabout	15th St	n/a
Reed Market Rd	Traffic Signal	American Lane	n/a
Reed Market Rd	Widen to 5 lanes	US97	27th St
Reed Market Rd	Realignment	27th St	n/a
27th St	Widen to 5 lanes	Reed Market Rd	Neff Rd
Murphy Rd	Road Extension	Brookswood Blvd	3rd St
Murphy Rd	Road Extension	Brosterhous Rd	27th St
US97	New interchanges including access restrictions to south end of Parkway.	Powers Rd	3rd St
Putnam Rd	New Roadway	UGB	Johnson Market Rd
Summit Dr	New Roadway	Mt. Washington Dr	Skyline Ranch Rd
Skyline Ranch Rd	New Roadway	Shevin Park Rd	Century Dr
Skyline Ranch Rd	New Roadway	Shevlin Park Rd	Tumalo Creek Rd
New E-W Collector	New Roadway	Skyline Ranch Rd	Mt. Washington Dr
New E-W Collector	New Roadway	Mt. Washington Dr	Shevlin Park Rd
New N-S Collector	New Roadway	New N-S Collector	Galveston St
Brita St	New Roadway	Robal Rd	Cooley Rd
Brita St	New Roadway	Robal Rd	Empire Ave
Hunnell Rd	New Roadway	Cooley Rd	UGB
Yeoman Rd	Road Extension	18th St	Existing section
Yeoman Rd	Road Extension	Existing section	Butler Market Rd
18th St	Road Extension	Empire Ave	Brinson Blvd
New E-W Collector	New Roadway	27th St	Hamby Rd
New E-W Collector	New Roadway	Brosterhous Rd	American Ln
9th St	Road Extension	Existing section	Awbrey Rd
Purcell Blvd	Road Extension	Existing section	Existing section
Chase Rd	Road Extension	Existing section	Brosterhous Rd
American Lane	Realignment	n/a	Reed Market Rd
Bear Creek Rd	New Roadway	12th St	Bear Creek Rd

Significant approved developments were reviewed to see if the population and employment assumptions were consistent with the model assumptions. The only significant approved development in the area is the Les Schwab headquarters development which is part of the first phase of the Juniper Ridge area northeast of the US 97 & Cooley Road intersection. The development is consistent with the future model assumptions so no new trips are needed to be added to the network. There is a potential Wal-Mart development in the northwest quadrant of the US 97 & Cooley Road intersection. Because that development is also consistent with the model, if that development is approved in the short-term, future volumes will not need to be revised.

The volumes were post-processed using procedures from the National Cooperative Highway Research Council (NCHRP) Report 255. Model base and future year volumes on a link basis are compared to develop a relative difference between scenarios. This difference was applied to the existing 2007 30th highest hour volumes to arrive at the 2035 no-build volumes used in the analysis. Attempts to grow the model volumes by a percentage did not work well because of the high amount of future growth assumed in the study area. The 2015 no-build volumes were interpolated using straight-line growth from the 2007 *existing* conditions and the 2035 no-build volumes. Once all the link volumes were created, select link analyses were run to determine turn movement percentages at intersections. These percentages were applied to the link volumes to determine turning movements. Lastly, the intersections were balanced between intersections as appropriate (within interchanges and along roadways with access control or where all driveways were counted). The 2015 and 2035 Future No-build volumes are shown in Appendix H.

Both the East DS-1 and DS-2 build alternatives had specific model scenarios created by modifying the road network in the MTP scenario. The 2035 build scenario volumes were compared to the 2035 no-build scenario in order to create the post-processed 2035 build volumes. Then the 2035 build model scenarios were compared with the 2015 build model scenarios to create link-based ratios in order to convert the 2035 post-processed build volumes into 2015 post-processed volumes. Ratios were then created between the 2015 and 2035 build model scenarios to convert the 2035 alternative volumes into 2015 volumes. Turning movements were then were created and the network balanced. The East DS-1 and DS-2 volumes are shown in Appendences L and N, respectively.

Figure D-1 Bend General Plan Map Subset

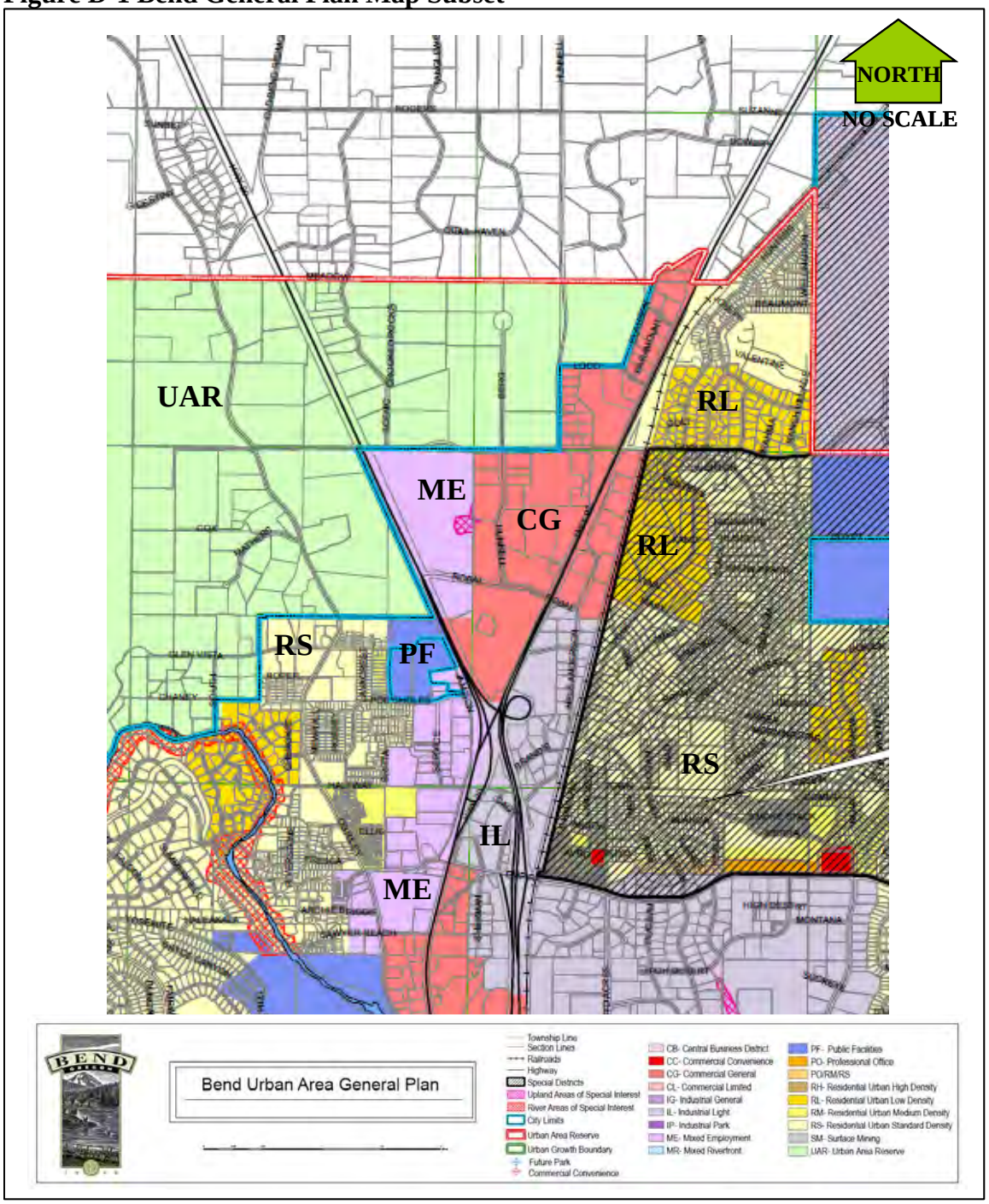


Figure D-2 Memo - Design Year Traffic Volumes

Oregon

Oregon Department of Transportation
Region 4 Office
19008 North Hwy 97
PO Box 5309
Bend, OR 97708
Telephone (541) 388-6100
FAX (541) 388-6223

Date: March 22, 2010

To: Jon Heacock
Region 4 Technical Center Manager

From: Joel McCarroll
Region 4 Traffic Manager

Subject: US 97 Bend North Corridor Project
Design Year Traffic Volumes

Originally the US 97 Bend North Corridor projected traffic volumes were based on a 2012 build year and a 2032 design year. With the current status of the project and projected funding it appears that a 2015 build year and 2035 design year are more reasonable. We have evaluated the likely impacts to projected traffic volumes with a 2015 build year and a 2035 design year and are recommending that the current projected volumes for a 2012 build year and a 2032 design year are representative of conditions of a 2015 build year and 2035 design year for the following reasons:

- Actual traffic in the project area has decreased. The original traffic counts were completed in the summer and fall of 2007. Year 2008 counts completed by the City of Bend at similar locations and Automatic Traffic Recorders (ATR) in and around the project showed declines in traffic volumes of approximately 8 to 10%. ATR data from 2008 to 2009 was either flat or showed slight declines. Current traffic volumes are approximately 8 to 10% lower than the counts taken in 2007.

- The seasonally adjusted unemployment rate for the Bend Metropolitan Statistical Area (Deschutes County) in January 2010 was 13.4%. The unemployment rate spiked at 16.4% in May 2009. With the collapse of the local real estate market and the loss of several manufacturers, all expectations are that the economic recovery in Deschutes County will lag the national recovery. In addition, many workers commute into Deschutes County and the Bend area from adjacent counties. Unemployment rates in these counties are even higher than that of Deschutes County. The seasonally adjusted unemployment rate in Crook County (east) in January 2010 was 15.9%. The unemployment rate in Crook County spiked at 22.4% in June 2009. The seasonally adjusted unemployment rate in Jefferson County (north) in January 2010 was 13.4%. The unemployment rate in Jefferson County spiked at 16.2% in May 2009.

  Total non-farm employment in the Bend MSA peaked at 73,510 in June 2007. Total non-farm employment decreased to 59,300 in January 2010. That represents a loss of 14,210 jobs (a 19% decrease). According to staff at the Bend Metropolitan Planning Organization (MPO), these decreases in employment are

significant enough that the 2030 Regional Transportation Plan forecast may be more representative of 2035.

- The number of notices of default on home mortgages in the Bend MSA has soared over the past few years. Two hundred twenty-one (221) notices of default were filed in calendar year 2006. The number of default notices soared to 3,507 in calendar year 2009.

  In addition, residential rental vacancy rates have increased in the past few years. The vacancy rate in 2005 stood at 8.54% and increased to 11.47% in 2009. That represents a vacancy rate increase of 34%. According to staff at the MPO, the large increase in the number of default notices and the large increase in rental vacancy rates may indicate that population growth has stagnated and the 2030 Regional Transportation Plan forecast may be more representative of 2035.

- Growth rates in the project area are expected to be unchanged from those used to develop the 2012 and 2032 numbers.

APPENDIX E: 2007 30TH HIGHEST HOUR VOLUMES

Figure E-1 2007 30th Highest Hour Volumes & Lane Configurations

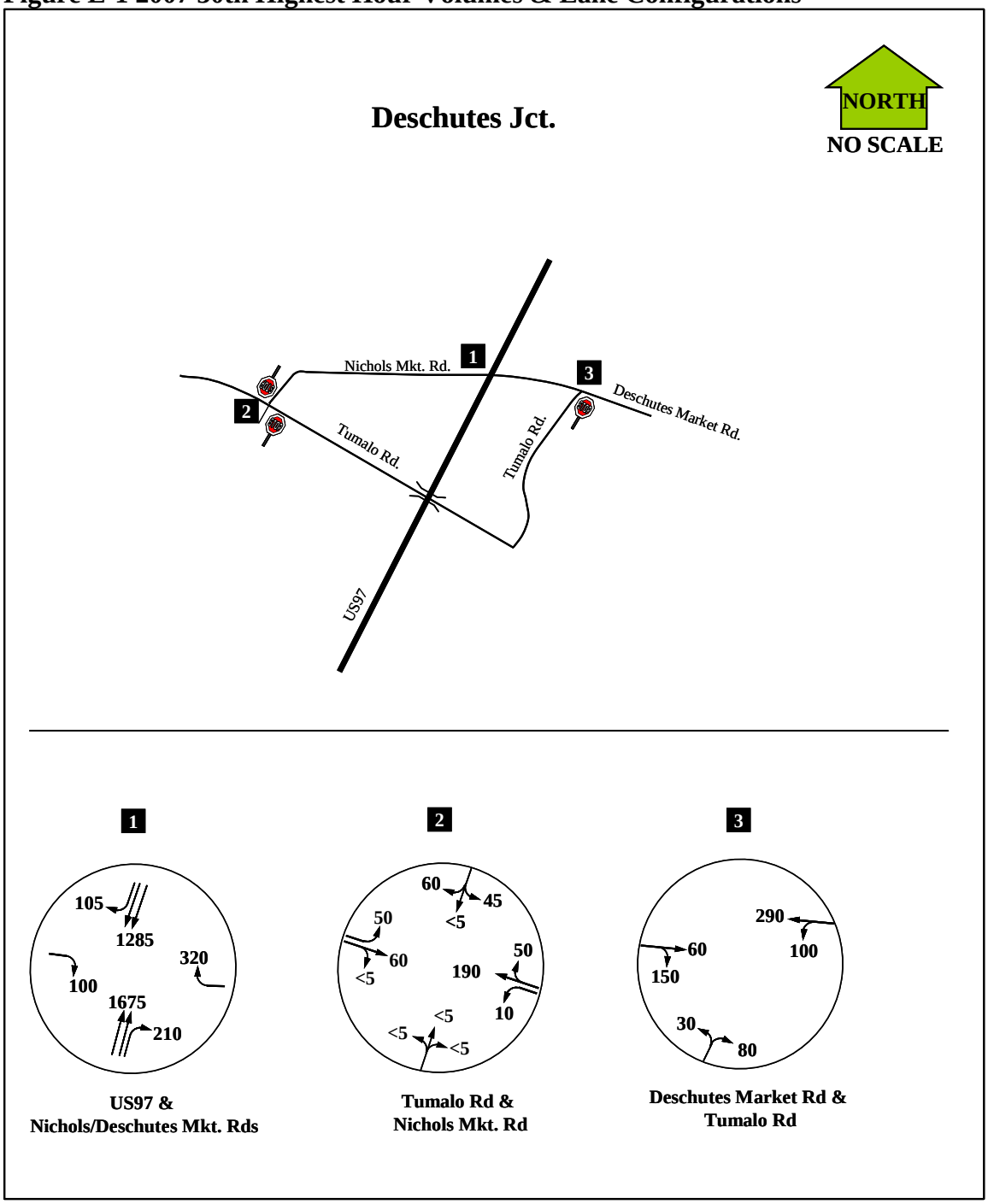


Figure E-2 2007 30th Highest Hour Volumes Intersection Key

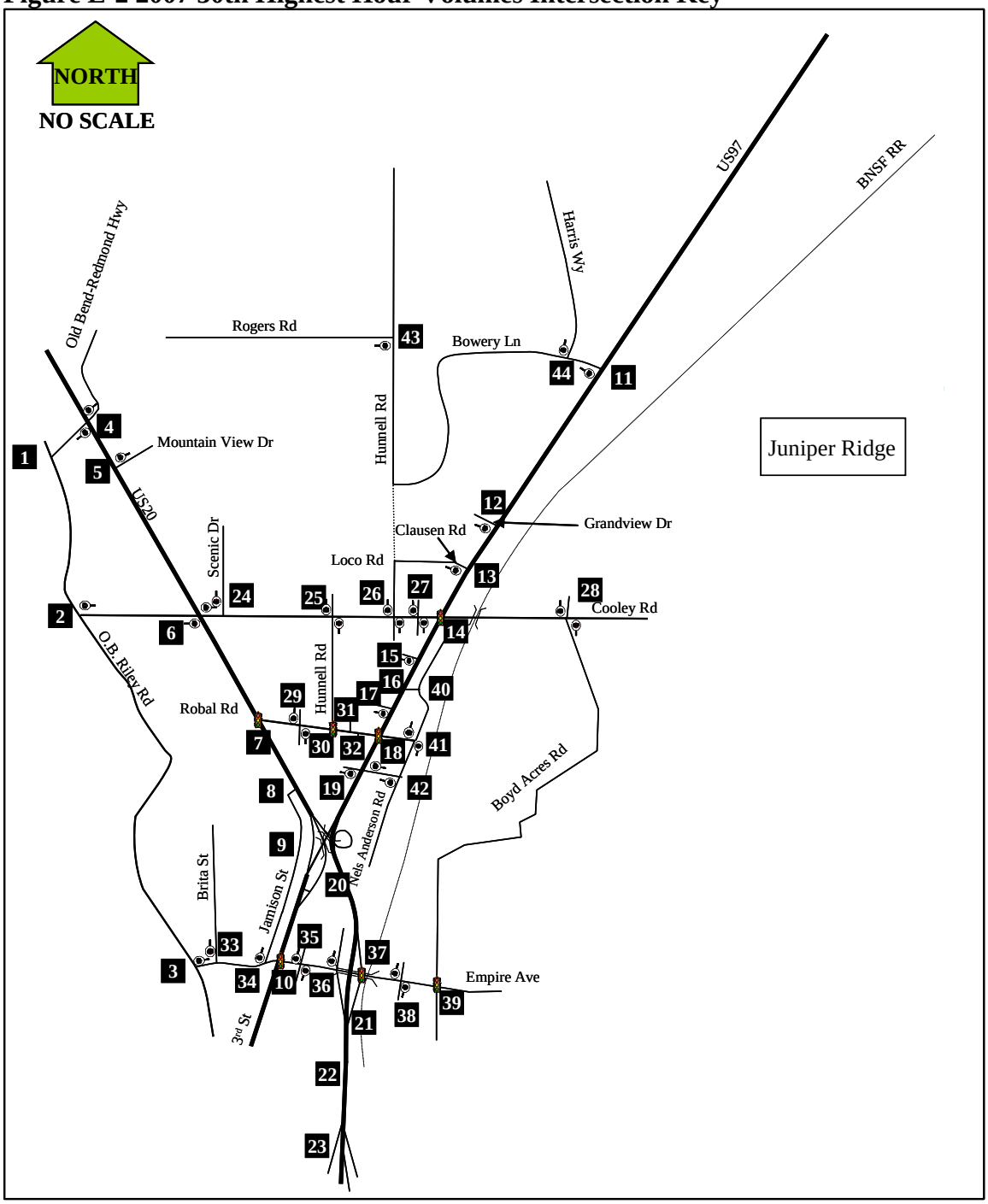


Figure E-3 2007 30th Highest Hour Volumes & Lane Configuration

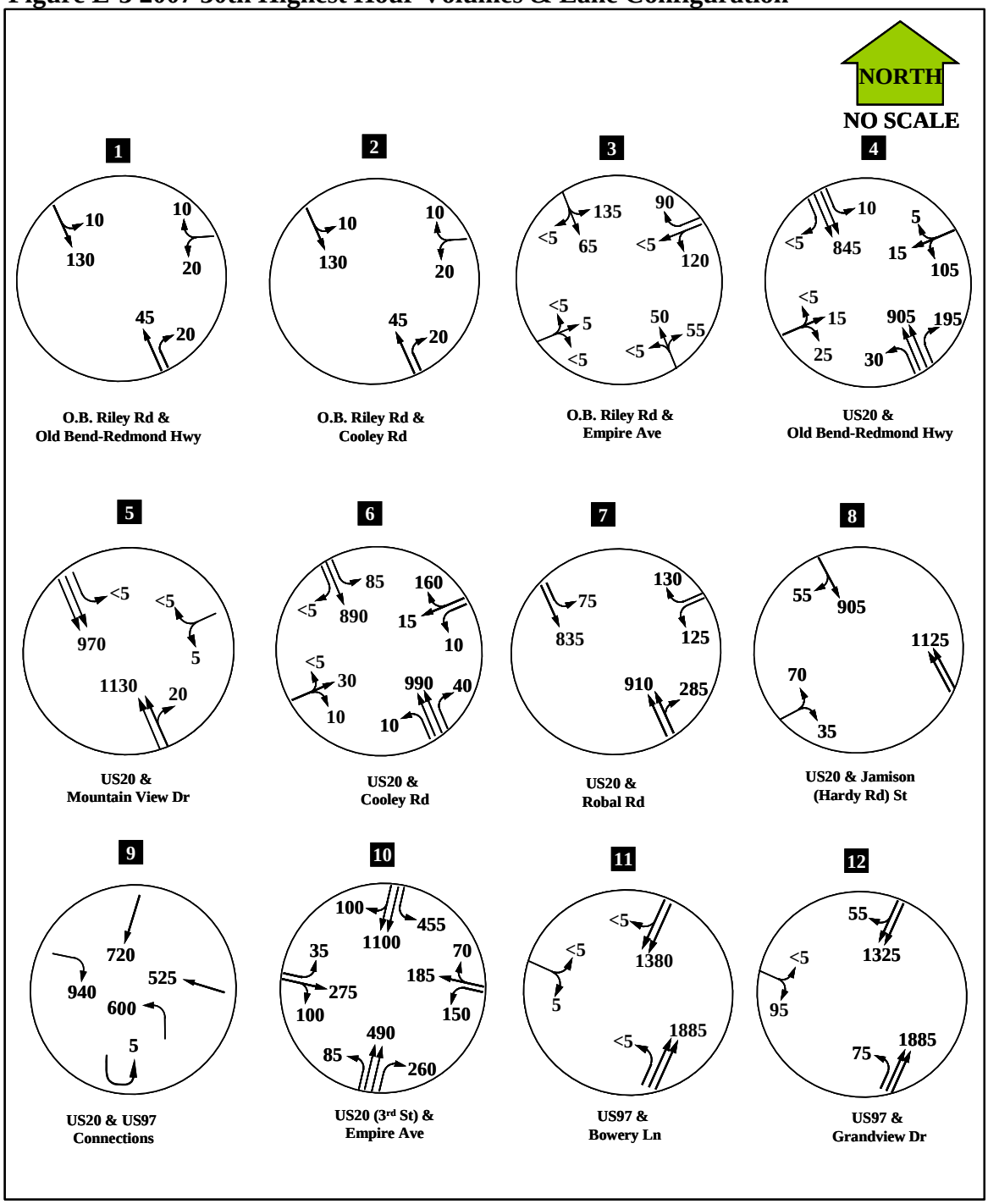


Figure E-4 2007 30th Highest Hour Volumes & Lane Configurations

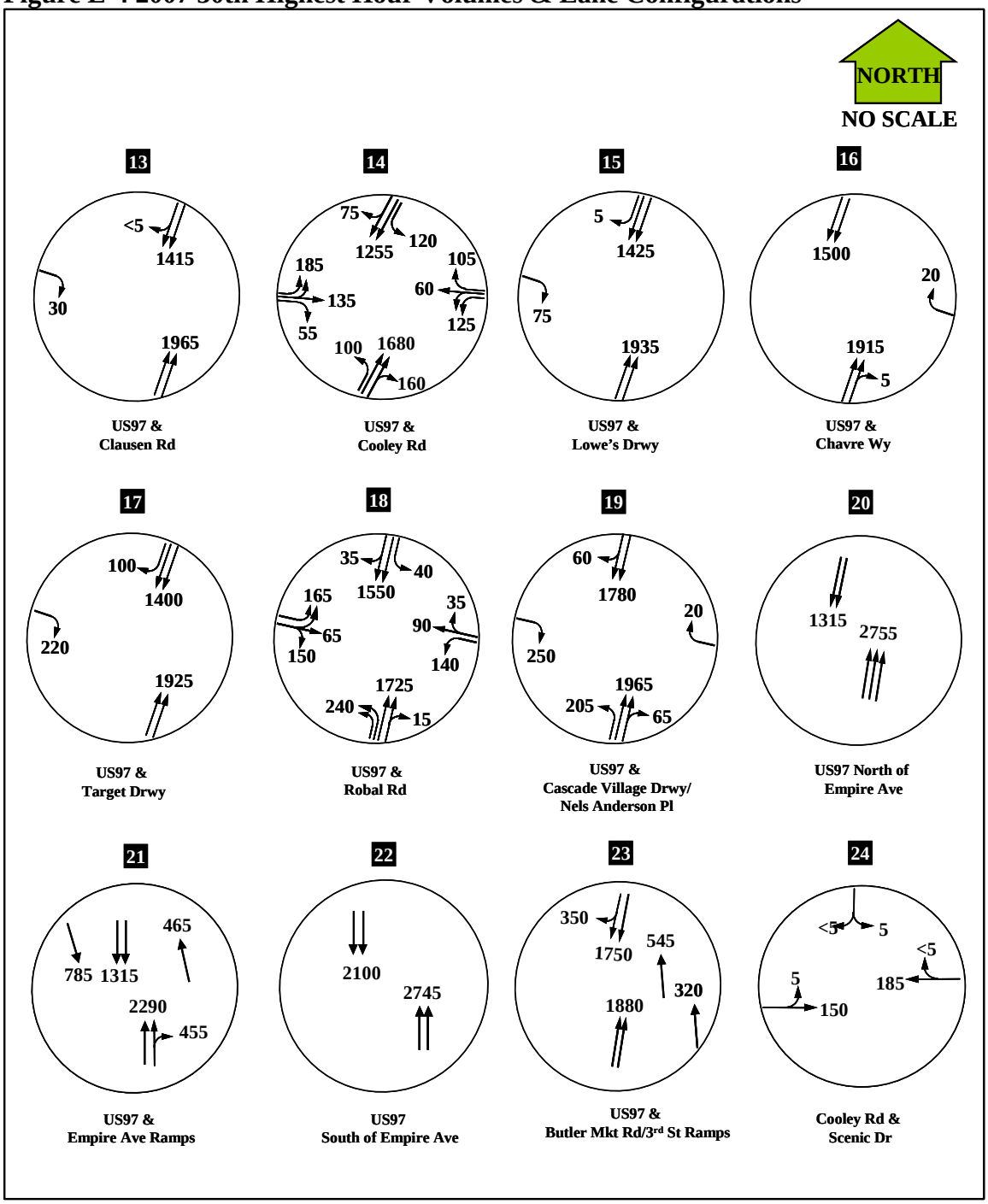


Figure E-5 2007 30th Highest Hour Volumes & Lane Configurations

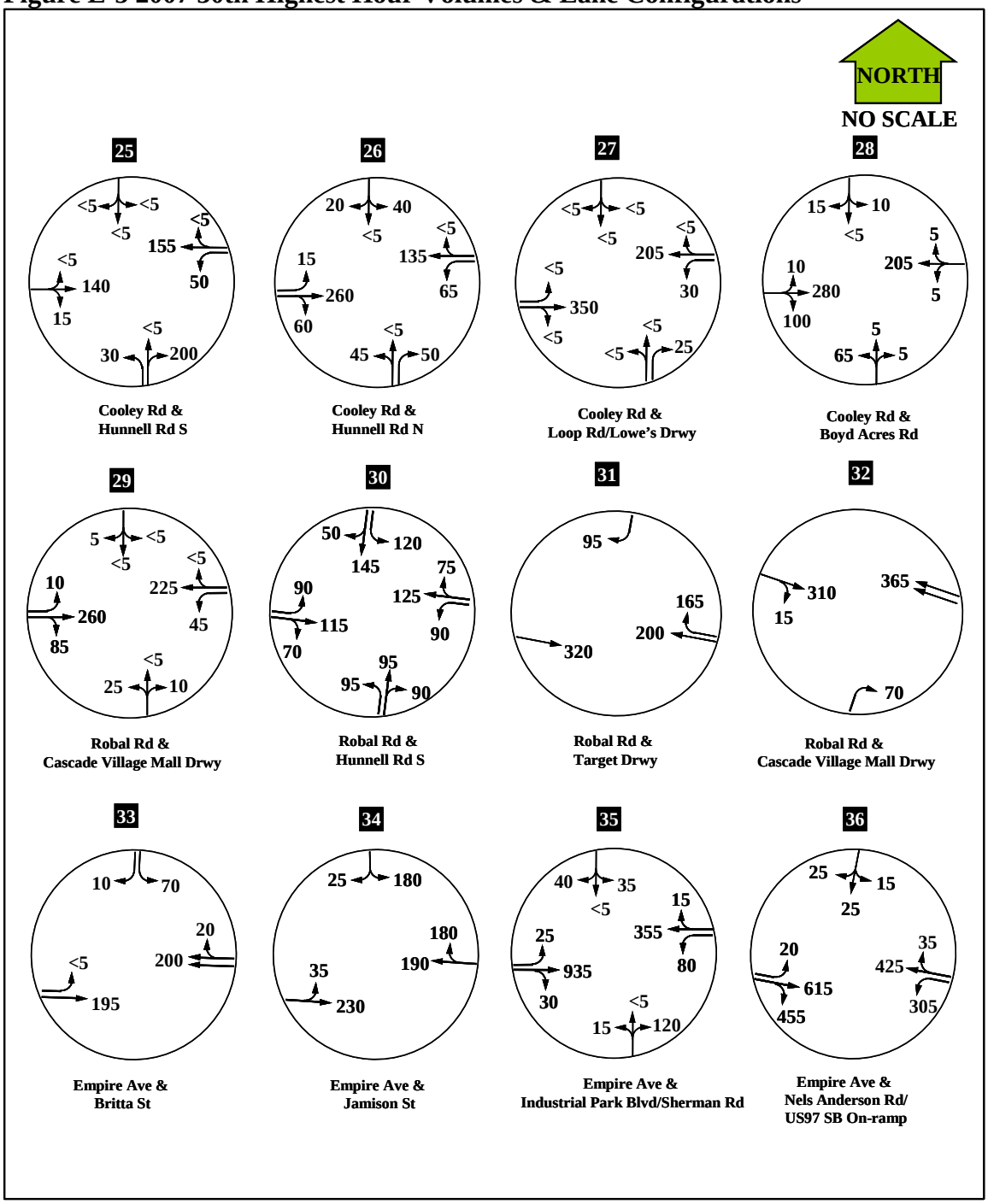
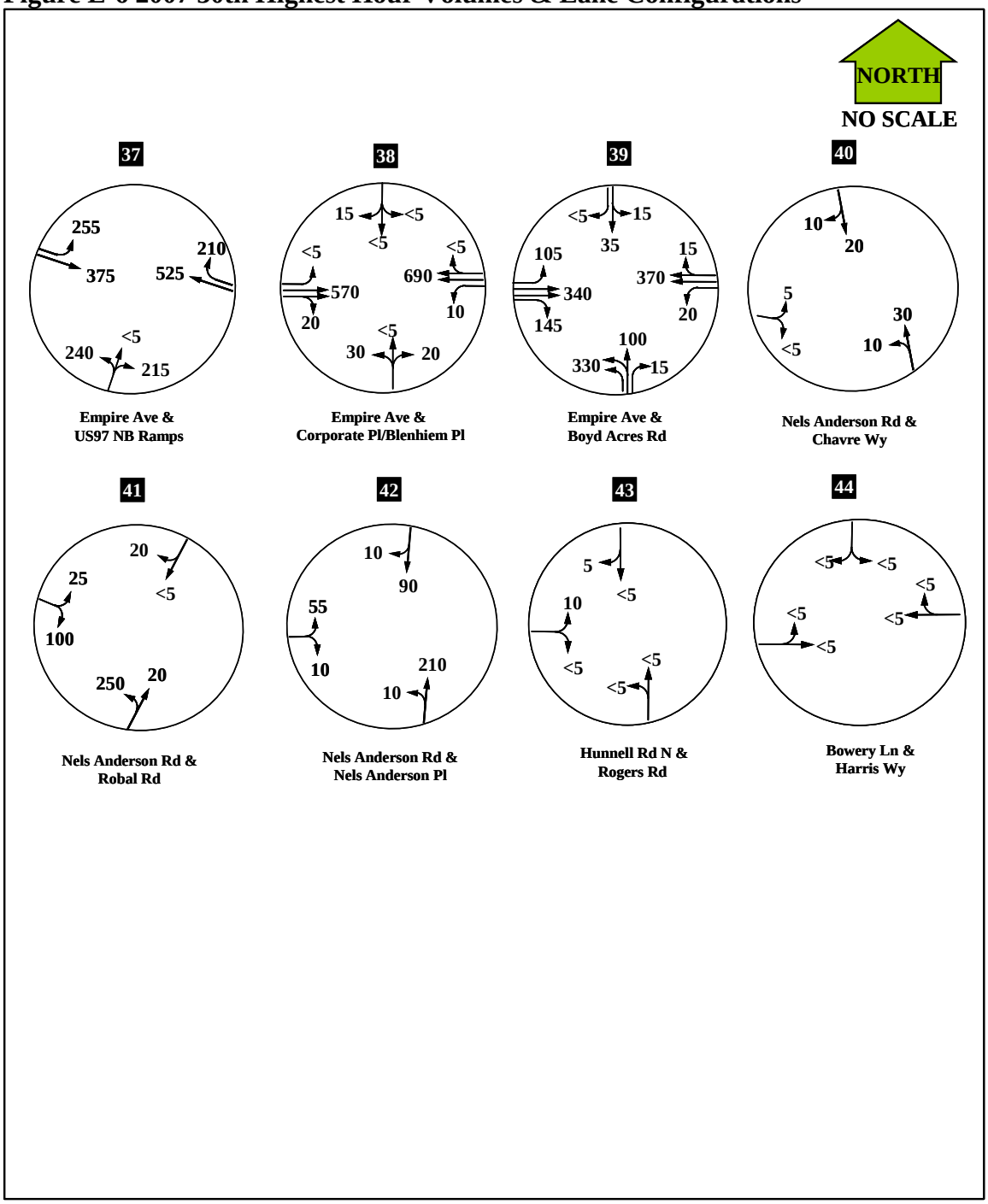


Figure E-6 2007 30th Highest Hour Volumes & Lane Configurations



APPENDIX F: 2007 NO-BUILD 95TH PERCENTILE QUEUES

Figure F-1 2007 Existing Conditions 95th Percentile Queues

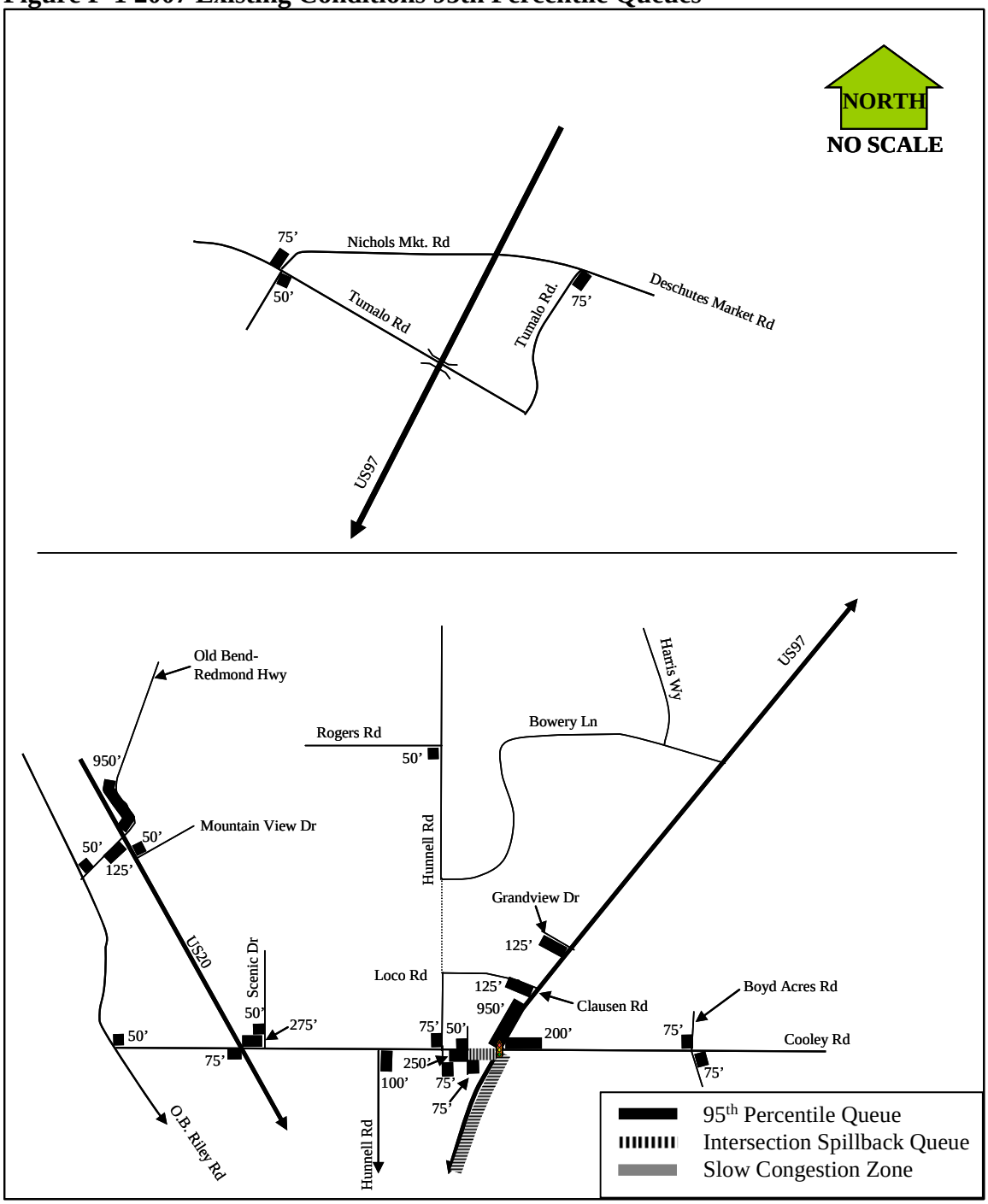


Figure F-2 2007 Existing Conditions 95th Percentile Queues

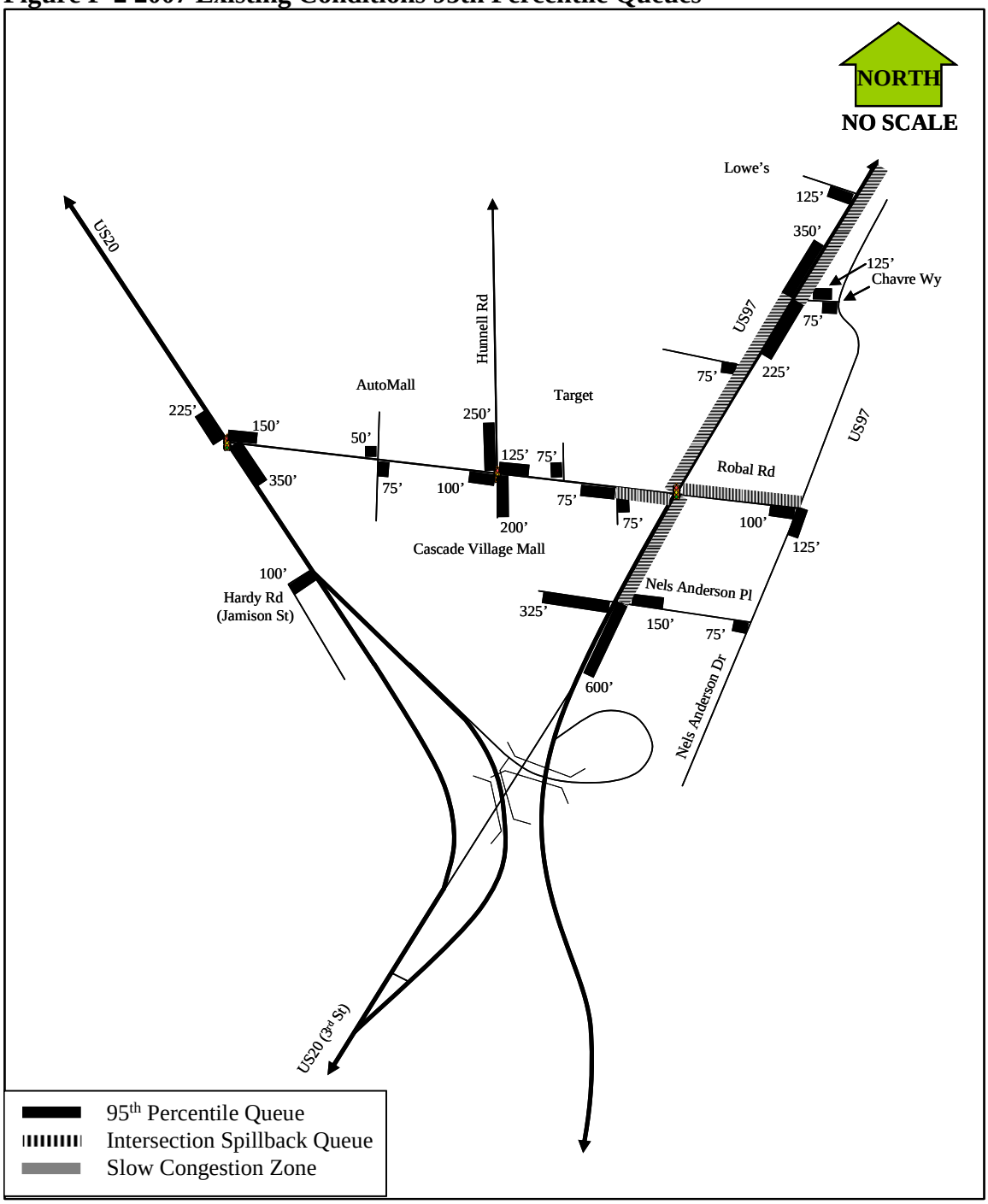
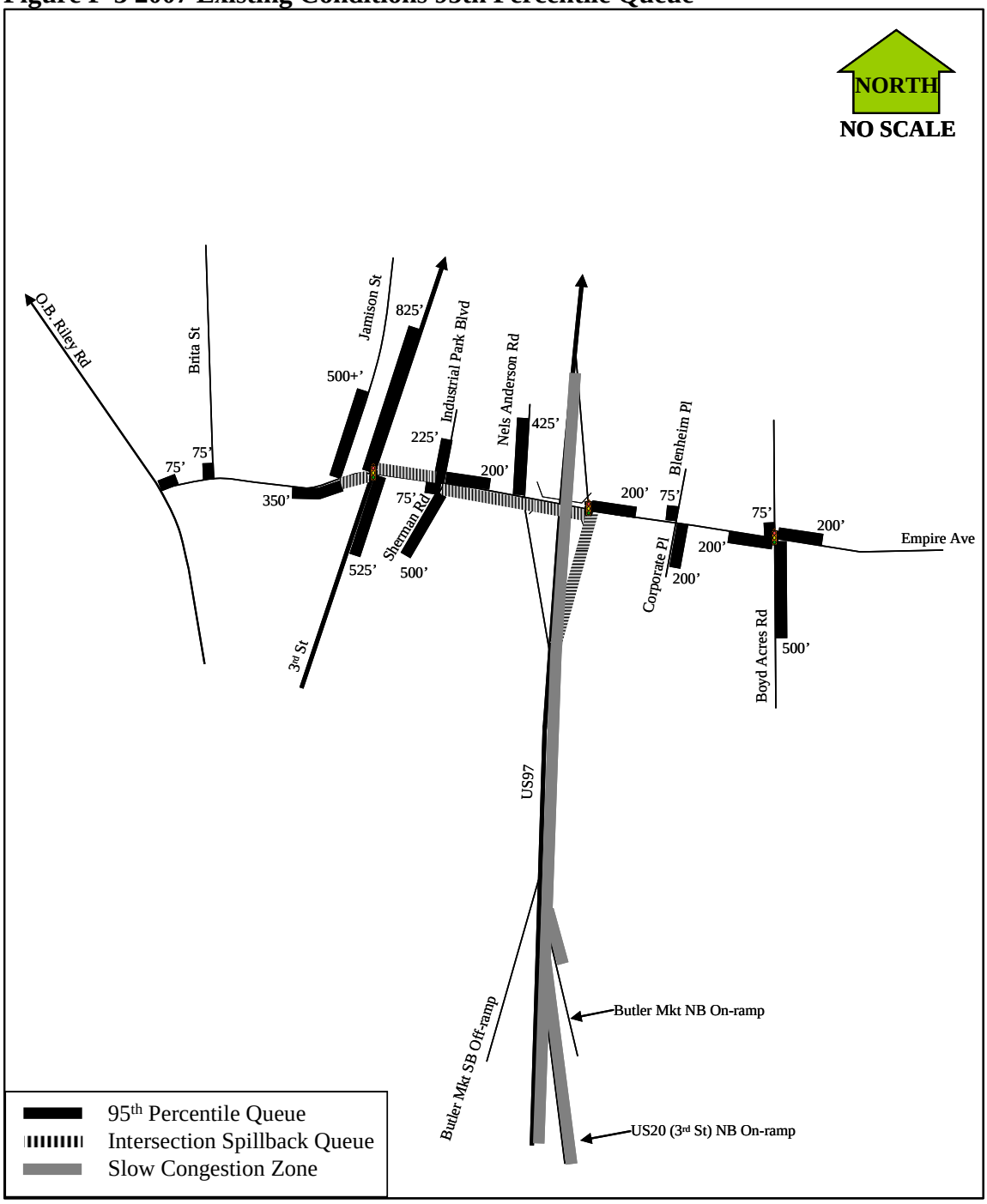


Figure F-3 2007 Existing Conditions 95th Percentile Queue



APPENDIX G: FUTURE TRAVEL PATTERNS

STATE OF OREGON **INTEROFFICE MEMO**

Department of Transportation
Transportation Development Division
Mill Creek Office Park
555 13th Street NE Suite 2
Salem, Oregon 97301-4178
(503) 986-4112 FAX (503) 986-4174

File Code:

Date: April 6, 2007

TO: **Jon Heacock,**
US 97 Bend North Corridor Project Manager

FROM: **Peter Schuytema, P.E., Senior Transportation Analyst**
Transportation Planning Analysis Unit

SUBJECT: **Technical Memo #1: US 97 Bend North Corridor Future Travel Trends**

The purpose of this memo is to provide a summary of the future general travel trends throughout the US 97 Bend North Corridor Project study area using the Bend MPO model. These travel trends illustrate the traffic patterns on a regional scale both in distribution across areas in Bend as well as identifying the longer distance through trips versus the short local trips. These patterns can give guidance on shaping the future alternatives for this project. The project study area extends on US 97 from the Deschutes Market – Tumalo Road interchange at MP 130.18 south through the Butler Market Road/Division Avenue interchange at approximately MP 136.77. In addition, the project study area includes US 20 from the Old Redmond-Bend Highway at MP 16.74 south to the US 20/Division Avenue interchange at MP 19.80.

Ideally, the 2030 Metro Transportation Plan (MTP) fiscally constrained model scenario would be used, however the MTP is not scheduled to be finished until June 2007. As a substitute, the 2030 Committed (No-build) scenario was used in combination with the 2003 road network which makes this a true future no-build scenario. There are no large significant projects in the local area so the large-scale travel trends should be close to the upcoming MTP scenario. Summary findings are shown below and more detailed travel patterns are shown on Figures A1-A9 and listed in Appendix A.

- The study area is heavily local-trip oriented with the Bend Parkway as the major focus for local trip usage.
- Through the project study area, 10% of trips on US 20 are through trips and 25% on US 97. These low through trip numbers indicate that there will be a high

amount of trip ends in the project area which may cause intersection/interchange design issues regardless of alternative.

- Around 33% of the local trips are “short hops” on the Parkway for an interchange or two.
- At least 50% of the trips on US 97 between Empire Avenue and Cooley Road are “short-hop” local trips.
- Almost 75% of local trips on the Parkway travel at least one part of the Empire Avenue - Powers Road section.
- Over 50% of the trips using Empire Avenue are local trips beginning or ending in adjacent neighborhoods that do not access the Parkway.
- Trips using US 97 are much more likely to originate or terminate in Bend as they are primarily local or commuter-based, while trips that use US 20 are more likely to be long-distance trips.
- Keeping the US 97/US 20 direct connections is more important than keeping the Empire Avenue interchange ramps as the direct connections serve a much larger proportion of longer distance trips. The Oregon Transportation Commission has expressed a desire to remove, as much as possible, short local trips from the state system.

If you have any questions, please call me at (503) 986-4110.

---

cc: Thanh Nguyen, TPAU
Dorothy Upton, TPAU
File

Appendix A – Summary Findings from General Travel Trends

Note: All trips shown below are relative to the "Analysis Point" location described and shown on the figures. All trips are daily trips to capture the overall traffic patterns, rather than using a specific peak hour. Trips are shown passing through the "Analysis Point" and ending up (or beginning from) a specific Bend district or an external point (shown as circles on the figures) outside the model area. Trips that are shown traveling to or from an external point go directly there without stopping. Trips that stop along the way would be counted as a district trip.

US 97 Northbound - South of Empire Avenue – Figure A1 (northbound direction shown; southbound is opposite)

Travel Patterns

- 70% of trips originate from central or southern Bend
- 20% of trips originate from Awbrey Butte/Empire Avenue/Boyd Acres area neighborhoods
- 10% of trips arrive into the area from south of Bend via US 97
- 40% of trips terminate in northern Bend
- 35% of trips depart the area via US 20 or US 97 north of Bend
- 25% of trips terminate in Awbrey Butte/Empire Avenue area neighborhoods

Travel Summary

- 20-25% of trips are "short hops" which is a trip that begins and ends between downtown and Empire Avenue.
- About 65% are short trips that start and end between Revere Avenue and Cooley Road.
- Only 3.5% of the trips are pure through trips which travel through Bend; the remaining 96.5% are trips that begin or end in Bend or are local trips.
- Through the study area, 10% of trips on US 20 are through trips and 25% on US 97.

US 97 Northbound - North of Cooley Road – Figure A2 (northbound direction shown; southbound is opposite)

Travel Patterns

- 50% of trips originate from central or southern Bend
- 40% of trips originate from Awbrey Butte/Empire Avenue/Boyd Acres area neighborhoods
- 10% of trips originate from northern Bend
- 70% of trips depart the area via US 97 north of Bend
- 30% of trips terminate in northern Bend

Travel Summary

- Over 95% of the trips either end or begin in Bend.
- No trips come from US 20 outside of the modeled area

US 20 Southbound - North of Cooley Road – Figure A3 (southbound direction shown; northbound is opposite)

Travel Patterns

- 50% of trips arrive in the area via US 20 north of Bend
- 20% of trips originate on Deschutes County roadways (i.e. Old Bend-Redmond Hwy) north of Bend
- 15% of trips originate from the Awbrey Butte/Tumalo area
- 15% of trips originate from northern Bend
- 35% of trips terminate in central or southern Bend
- 35% of trips terminate in Awbrey Butte/Empire Avenue/Boyd Acres area neighborhoods
- 15% of trips terminate in northern Bend
- 15% of trips depart the area via US 97 south of Bend

Travel Summary

- 50 % of trips start or end north of Bend on US 20
- 30% of trips are short traveling between local northern Bend destinations

Northbound US 97 Off-ramp at Empire Avenue – Figure A4

Travel Patterns

- 80% of trips originate from central or southern Bend
- 10% of trips originate from Awbrey Butte neighborhoods
- 10% of trips arrive into the area via US 97 south of Bend
- 100% of trips terminate in Awbrey Butte/Empire Avenue area neighborhoods

Travel Summary

- 90% of trips using the northbound Empire Avenue off-ramp are local.
- All of the trips begin or end in Bend.

Southbound US 97 On-ramp at Empire Avenue – Figure A5

Travel Patterns

- 50% of trips originate from Awbrey Butte/Empire Avenue/Boyd Acres neighborhoods
- 30% of trips arrive into the area via US 20 north of Bend
- 10% of trips originate from northern Bend
- 10% of trips arrive into the area via Deschutes County roadways (i.e. Old Bend-Redmond Hwy) north of Bend
- 70% of trips terminate in central or southern Bend
- 20% of trips depart the area via US 20 south of Bend
- 10% of trips terminate in Awbrey Butte/Empire Avenue area neighborhoods

Travel Summary

- About 6% of trips go to/from US 20 north of Bend through to the south of Bend.
- Over 50% of the trips just travel the Bend Parkway portion of US 97 (between Empire Avenue and Powers Road).

Northbound US 97 On-ramp at Empire Avenue – Figure A6

Travel Patterns

- 90% of trips originate from Awbrey Butte/Empire Avenue/Boyd Acres neighborhoods
- 10% of trips originate from northern Bend
- 65% of trips terminate in northern Bend
- 35% of trips depart the area via US 97 north of Bend

Travel Summary

- None of the trips using the Empire Avenue northbound on-ramp use the "Sisters Loop" or US 20.
- 60% of the total trips are "short hops" between Empire Avenue and Cooley Road

Northbound US 20 On-ramp "Sisters Loop" – Figure A7

Travel Patterns

- 70% of trips originate from central or southern Bend
- 30% of trips arrive into the area from US 97 south of Bend
- 50% of trips depart the area via US 20 north of Bend

- 35% of trips terminate in northern Bend
- 15% of trips terminate in county roads north of Bend

Travel Summary

- 15% of trips on the loop ramp are traveling from the south of Bend on US 97 to the north of Bend on US 20.

Eastbound Empire Avenue between 3rd Street and US 97 – Figure A8

Travel Patterns

- 45% of trips originate from Awbrey Butte/Empire Avenue/Boyd Acres neighborhoods
- 25% of trips arrive into the area via US 20 north of Bend
- 20% of trips originate in northern Bend
- 10% of trips originate on county roads north of Bend
- 5% of trips arrive into the area via US 97 north of Bend
- 45% of trips terminate in Awbrey Butte/Empire Avenue/Boyd Acres neighborhoods
- 25% of trips terminate in central/southern Bend
- 10% of trips terminate in northern Bend
- 10% of trips depart the area via US 97 north and south of Bend

Travel Summary

- About 65% of the trips are local trips starting or ending in adjacent neighborhoods.
- About 50% of trips are east-west local trips

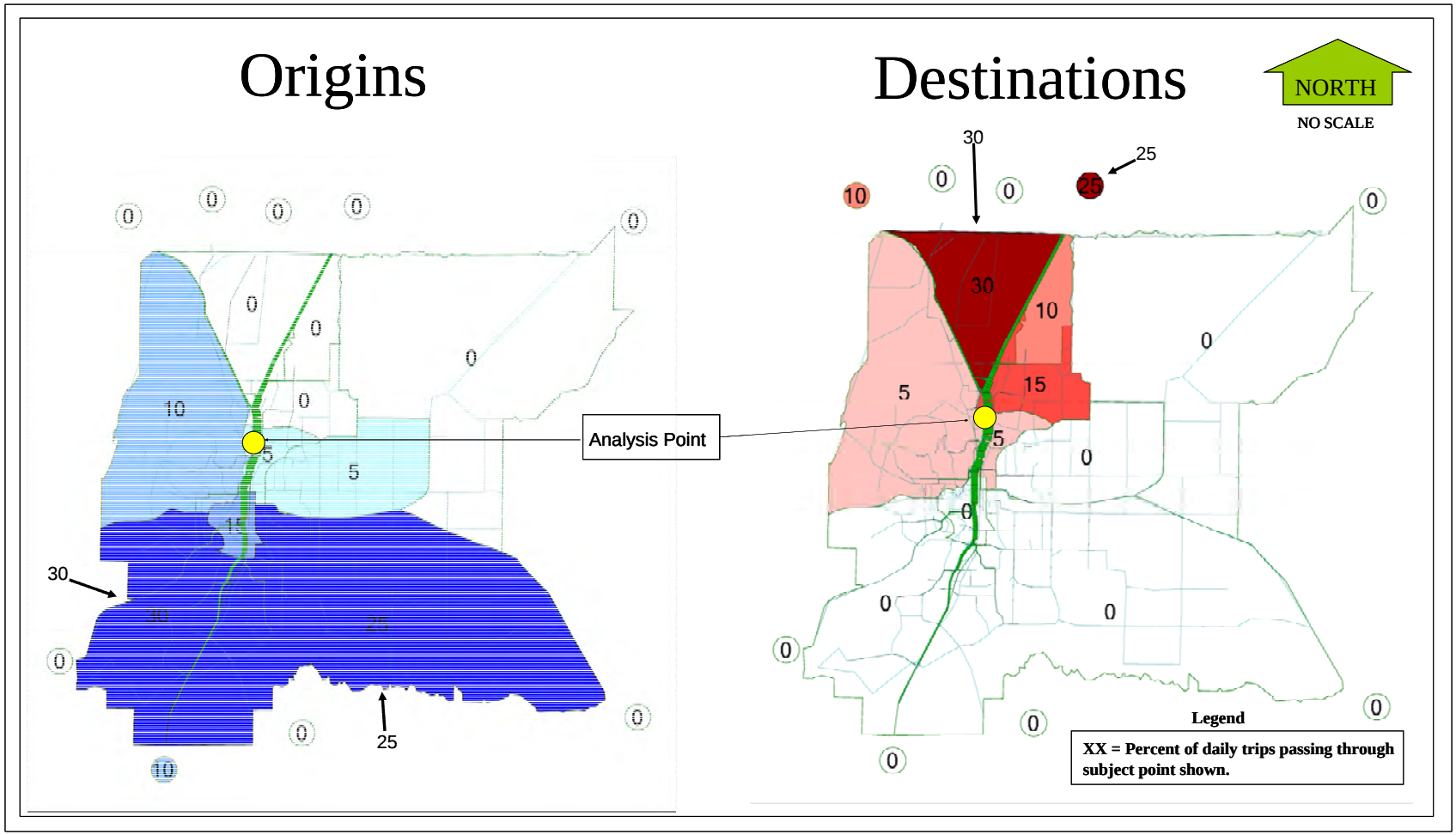
Westbound Empire Avenue between 3rd Street and US 97 – Figure A9

Travel Patterns

- 70% of trips originate from Empire Avenue/Boyd Acres neighborhoods
- 20% of trips originate in central/southern Bend
- 10% of trips originate in northern Bend
- 65% of trips terminate in Awbrey Butte/Empire Avenue neighborhoods
- 15% of trips terminate in northern Bend
- 15% of trips depart the area via US 20 north of Bend
- 5% of trips depart the area via county roads north of Bend

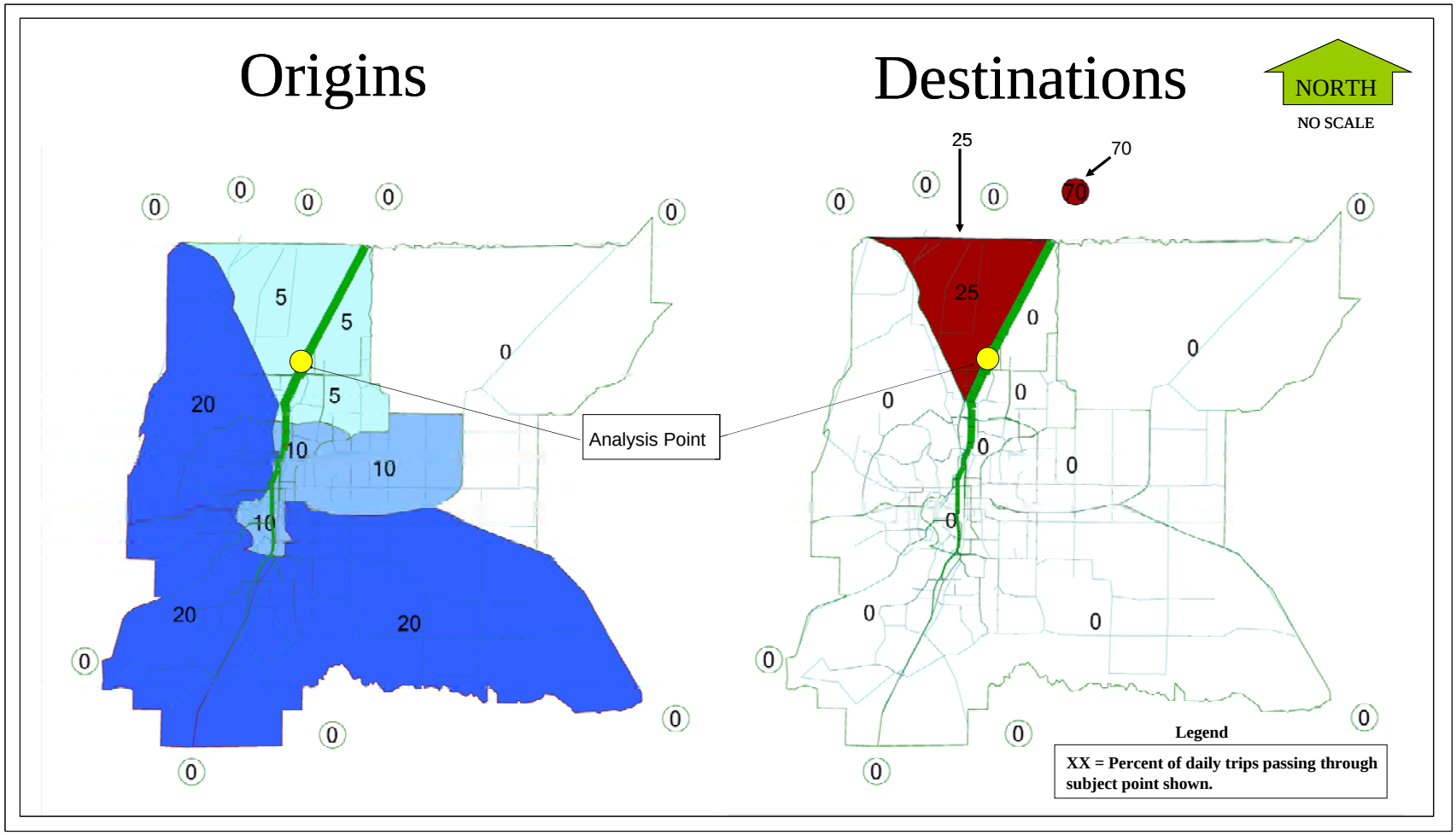
Travel Summary

- About 65% of the trips are local trips starting or ending in adjacent neighborhoods.
- About 50% of trips are east-west local trips



OREGON DEPARTMENT OF TRANSPORTATION T P A U TRANSPORTATION PLANNING ANALYSIS UNIT

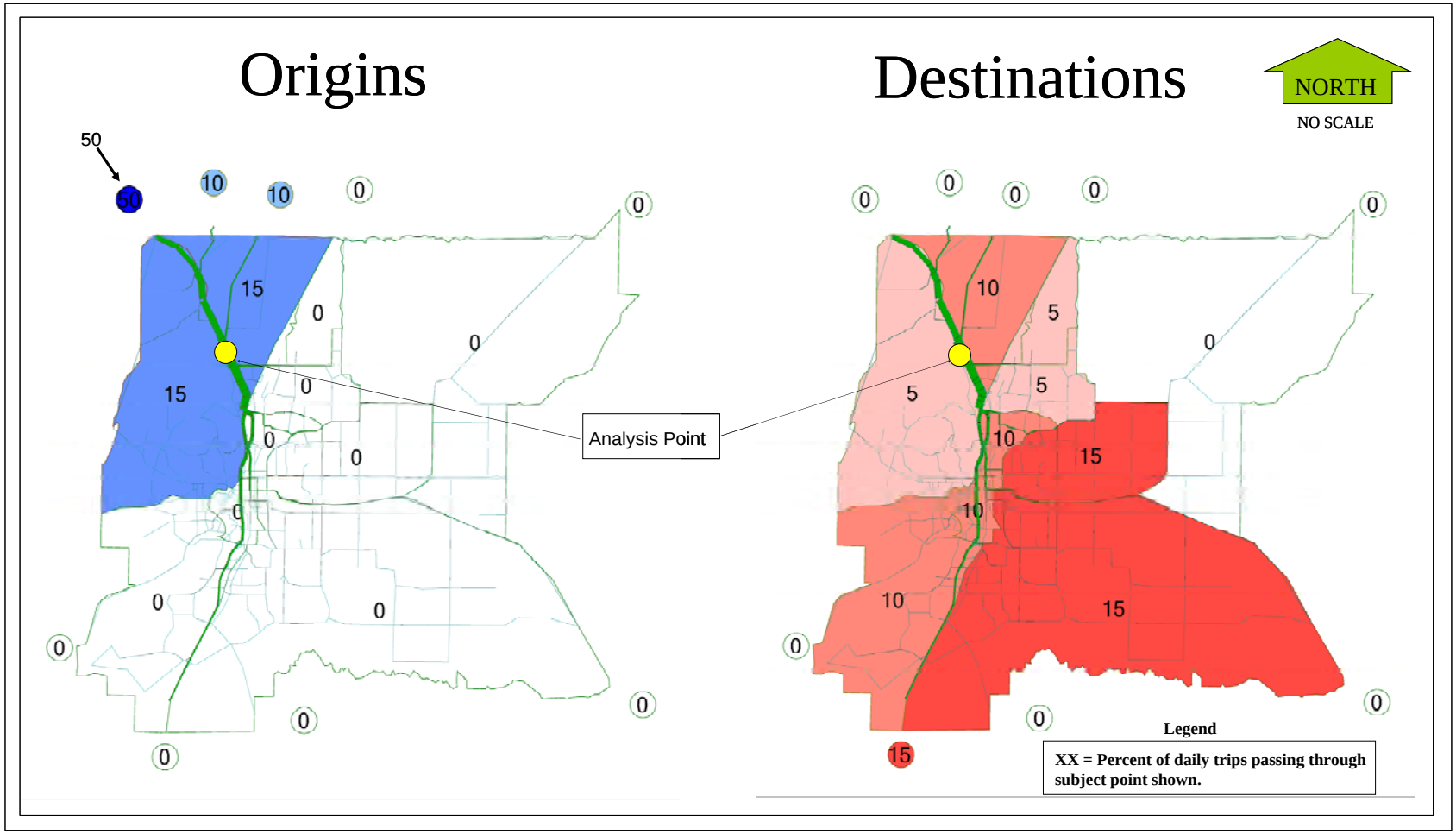
US 97 Northbound – South of Empire Avenue US 97/20 Bend North Corridor Project	File : TM_figures.ppt Date : 03/29/07	Prep. By: Peter Schuytema, P.E. Rev. By: Doug Norval, P.E.	FIGURE A1



OREGON DEPARTMENT OF TRANSPORTATION

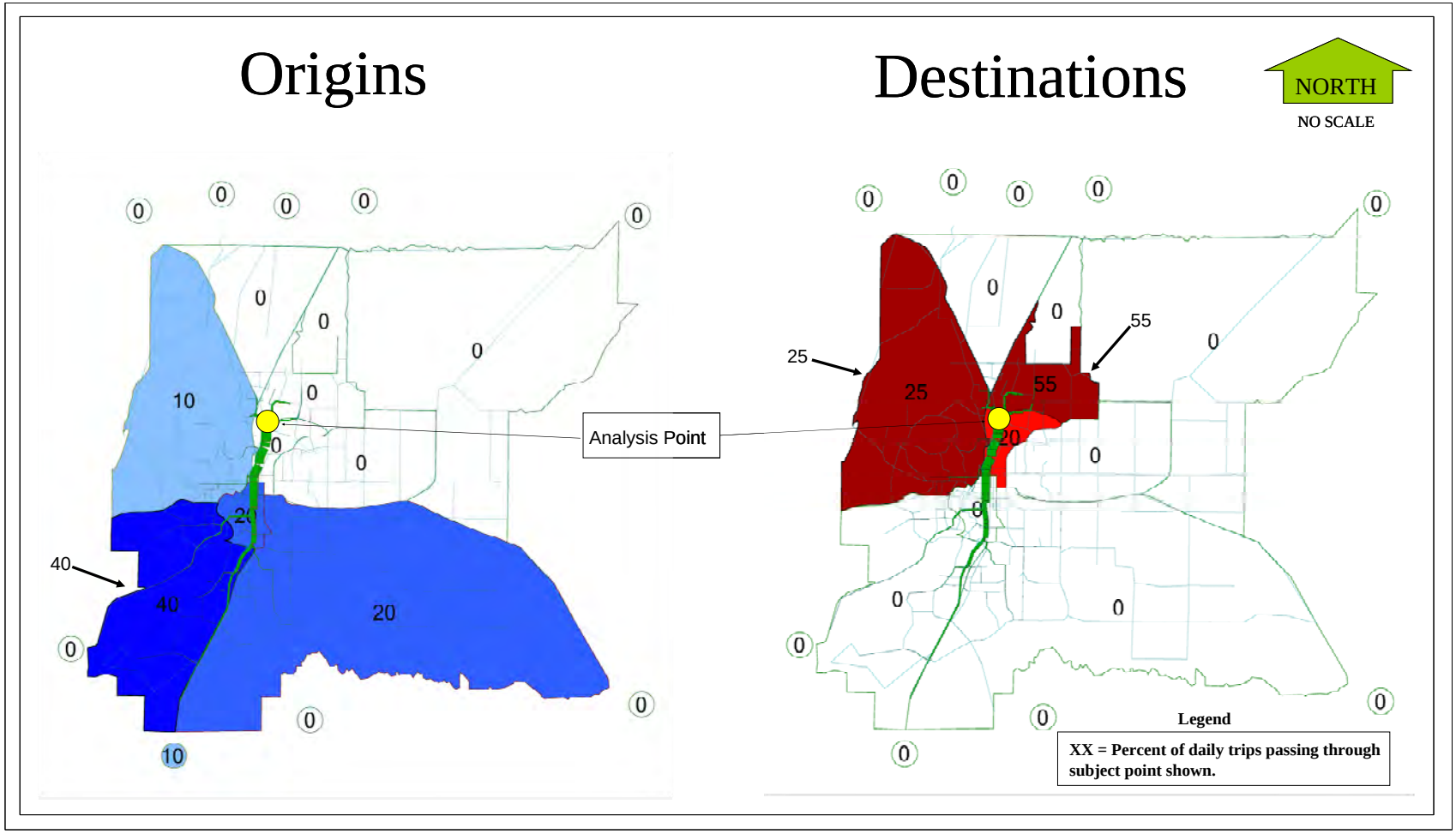
T P A U TRANSPORTATION PLANNING ANALYSIS UNIT

US 97 Northbound - North of Cooley Road US 97/20 Bend North Corridor Project	File : TM_figures.ppt Date : 03/29/07	Prep. By: Peter Schuytema, P.E. Rev. By: Doug Norval, P.E.	FIGURE A2



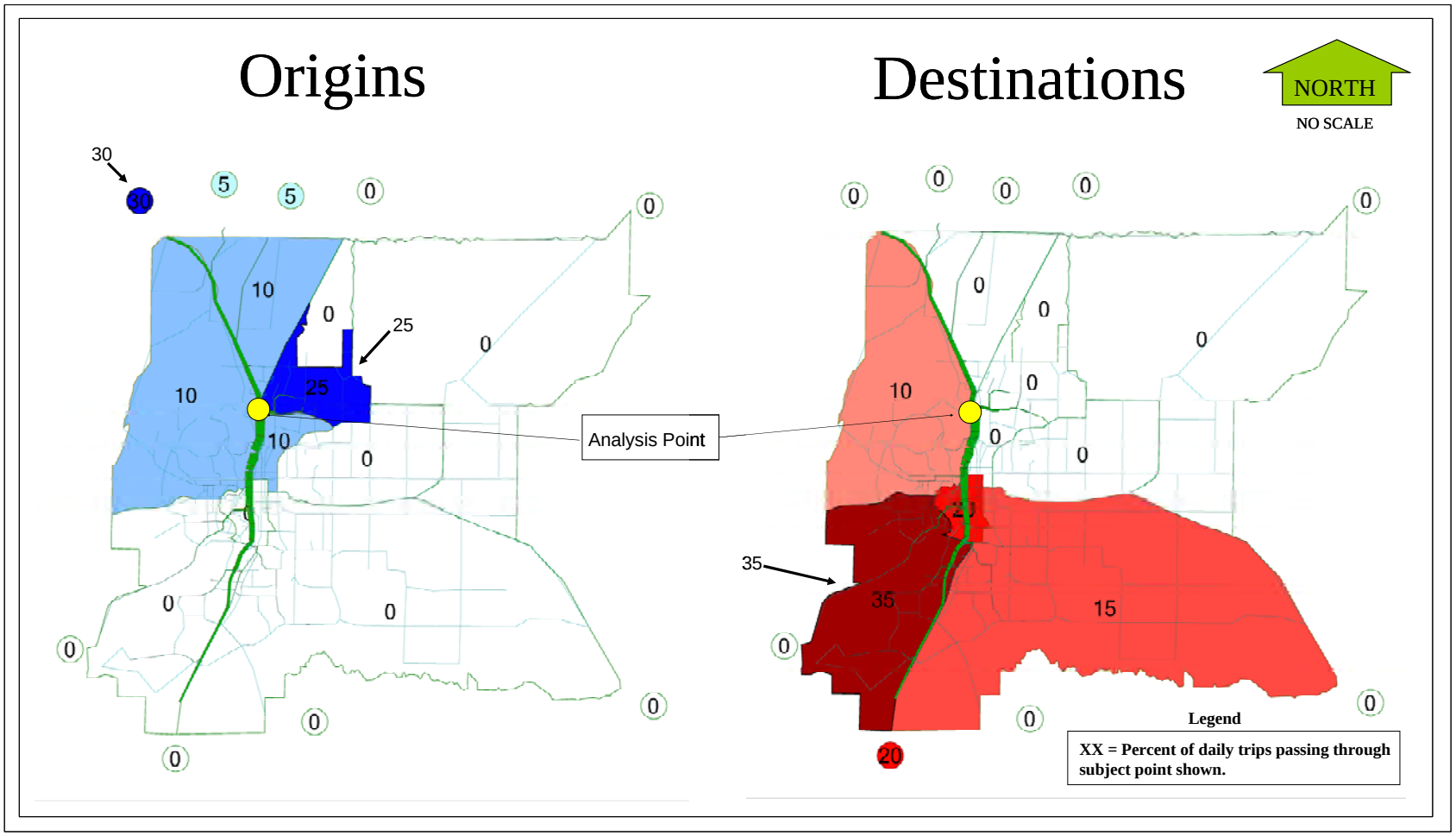
OREGON DEPARTMENT OF TRANSPORTATION T P A U TRANSPORTATION PLANNING ANALYSIS UNIT

US 20 Southbound - North of Cooley Road US 97/20 Bend North Corridor Project	File : TM_figures.ppt Date : 03/29/07	Prep. By: Peter Schuytema, P.E. Rev. By: Doug Norval, P.E.	FIGURE A3



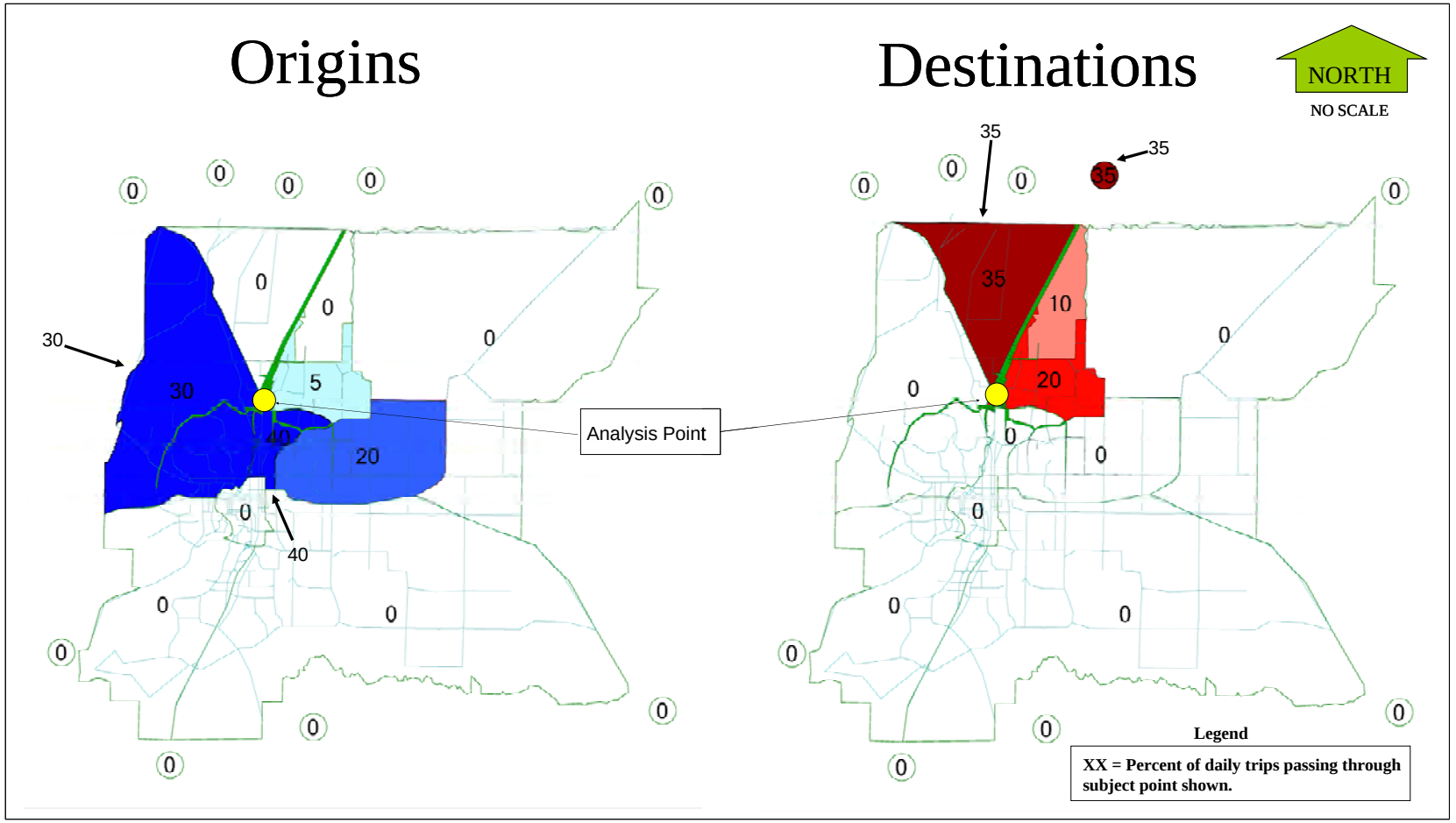
OREGON DEPARTMENT OF TRANSPORTATION T P A U TRANSPORTATION PLANNING ANALYSIS UNIT

Northbound US 97 Off-ramp at Empire Avenue **US 97/20 Bend North Corridor Project**	**File : TM_figures.ppt** **Date : 03/29/07**	**Prep. By: Peter Schuytema, P.E.** **Rev. By: Doug Norval, P.E.**	FIGURE A4



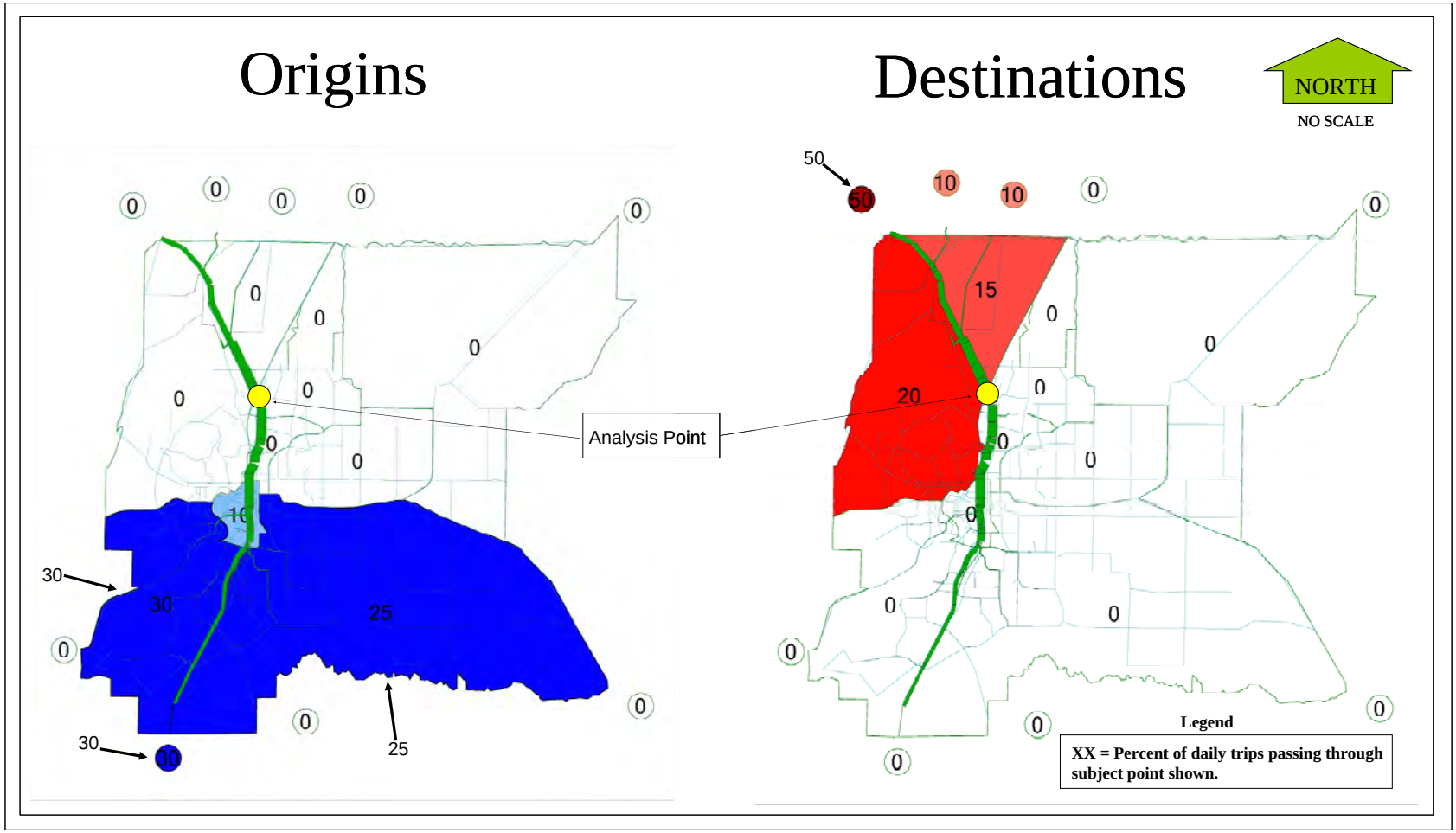
OREGON DEPARTMENT OF TRANSPORTATION T P A U **TRANSPORTATION PLANNING ANALYSIS UNIT**

Southbound US 97 On-ramp at Empire Avenue **US 97/20 Bend North Corridor Project**	**File : TM_figures.ppt** **Date : 03/29/07**	**Prep. By: Peter Schuytema, P.E.** **Rev. By: Doug Norval, P.E.**	FIGURE A5



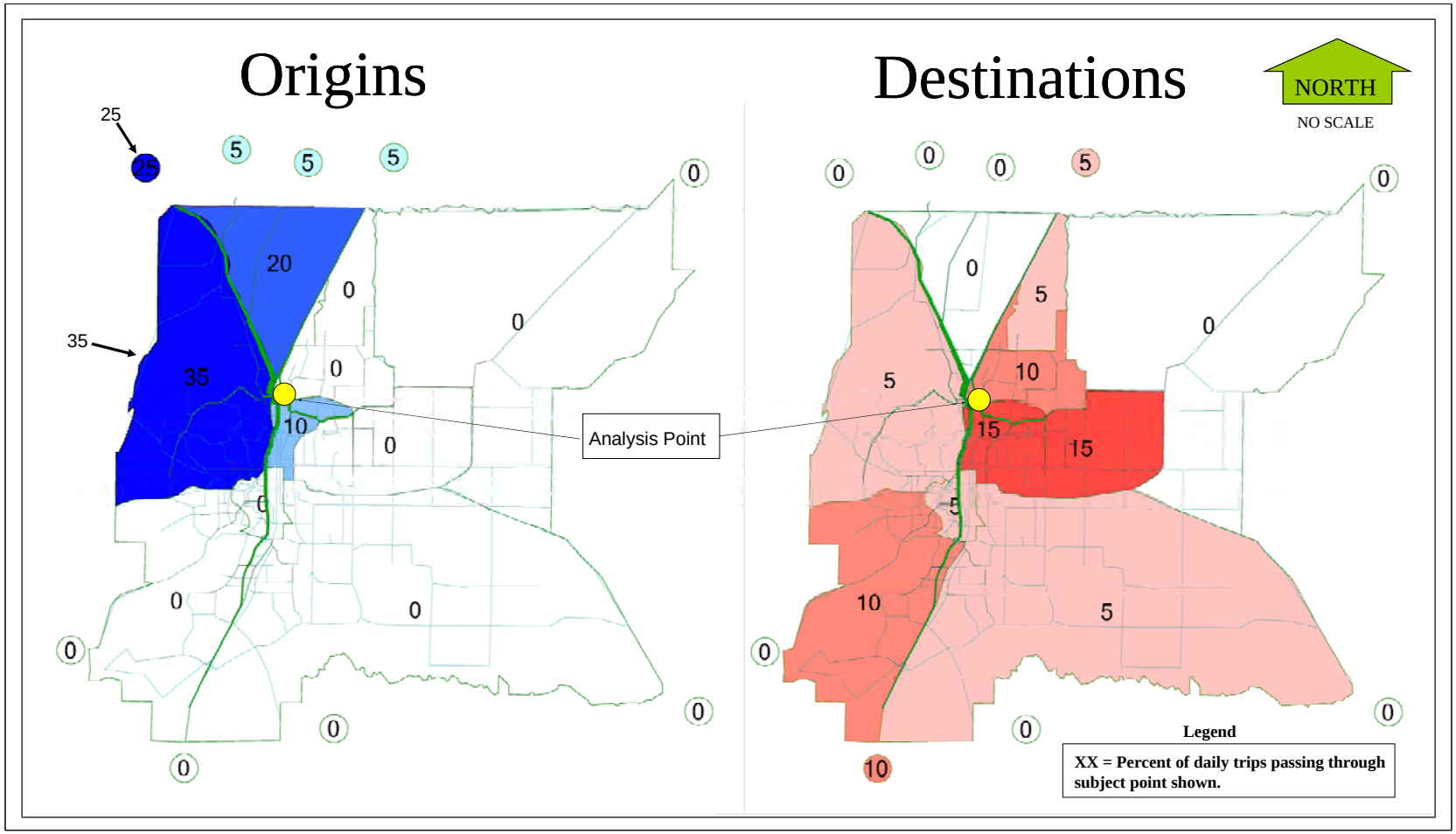
OREGON DEPARTMENT OF TRANSPORTATION T P A U **TRANSPORTATION PLANNING ANALYSIS UNIT**

Northbound US 97 On-ramp at Empire Avenue **US 97/20 Bend North Corridor Project**	**File : TM_figures.ppt** **Date : 03/29/07**	**Prep. By: Peter Schuytema, P.E.** **Rev. By: Doug Norval, P.E.**	FIGURE A6



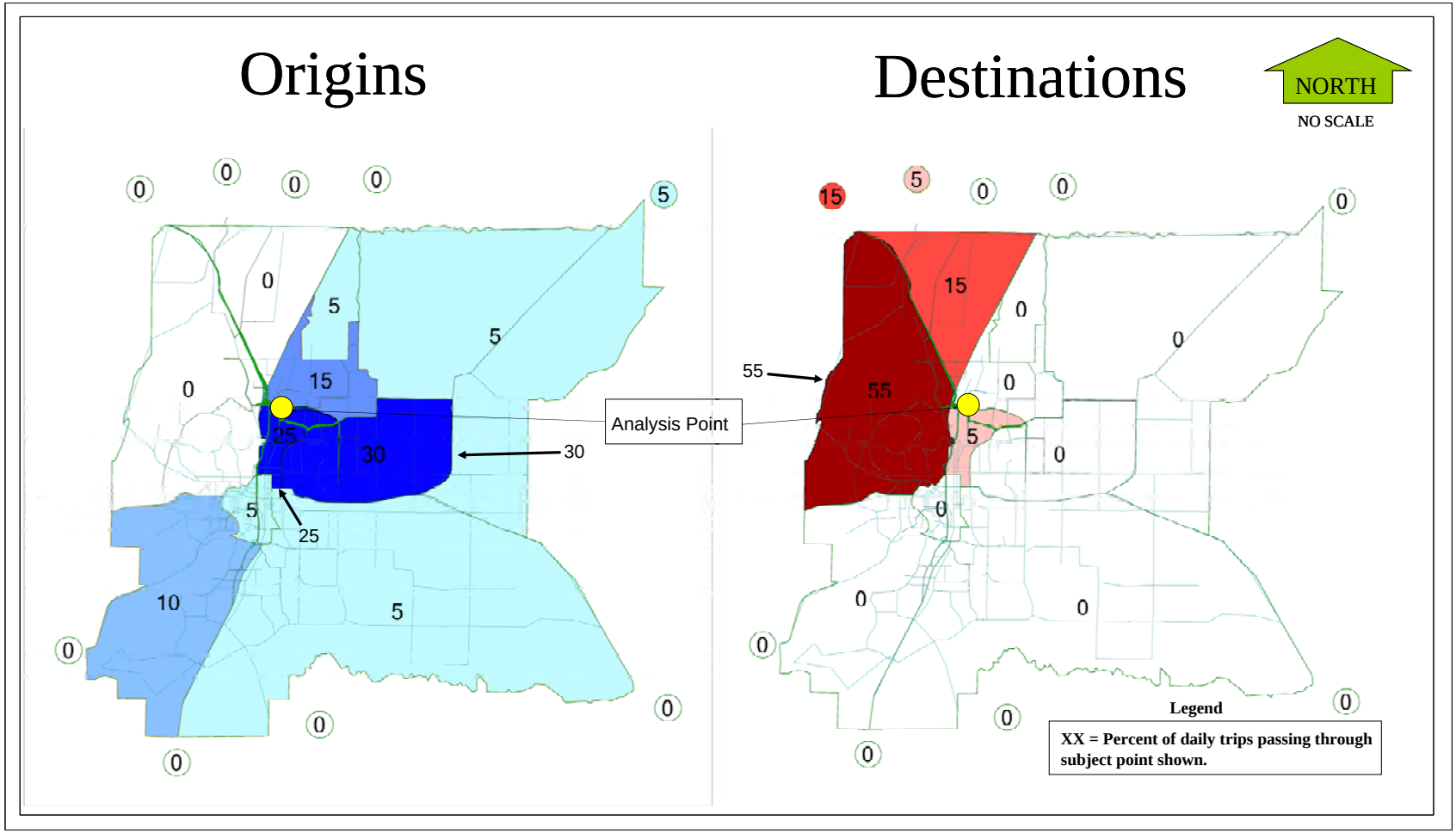
OREGON DEPARTMENT OF TRANSPORTATION T P A U **TRANSPORTATION PLANNING ANALYSIS UNIT**

Northbound US 20 On-ramp "Sister's Loop" **US 97/20 Bend North Corridor Project**	**File : TM_figures.ppt** **Date : 03/29/07**	**Prep. By: Peter Schuytema, P.E.** **Rev. By: Doug Norval, P.E.**	FIGURE A7



OREGON DEPARTMENT OF TRANSPORTATION T P A U TRANSPORTATION PLANNING ANALYSIS UNIT

Eastbound Empire Avenue between 3rd Street and US 97 **US 97/20 Bend North Corridor Project**	**File : TM_figures.ppt** **Date : 03/29/07**	**Prep. By: Peter Schuytema, P.E.** **Rev. By: Doug Norval, P.E.**	FIGURE A8



OREGON DEPARTMENT OF TRANSPORTATION T P A U TRANSPORTATION PLANNING ANALYSIS UNIT

Westbound Empire Avenue between 3rd Street and US 97 **US 97/20 Bend North Corridor Project**	**File : TM_figures.ppt** **Date : 03/29/07**	**Prep. By: Peter Schuytema, P.E.** **Rev. By: Doug Norval, P.E.**	FIGURE A9

APPENDIX H: 2015 & 2035 NO-BUILD VOLUMES

Figure H-1 2015 DHV & Lane Configurations

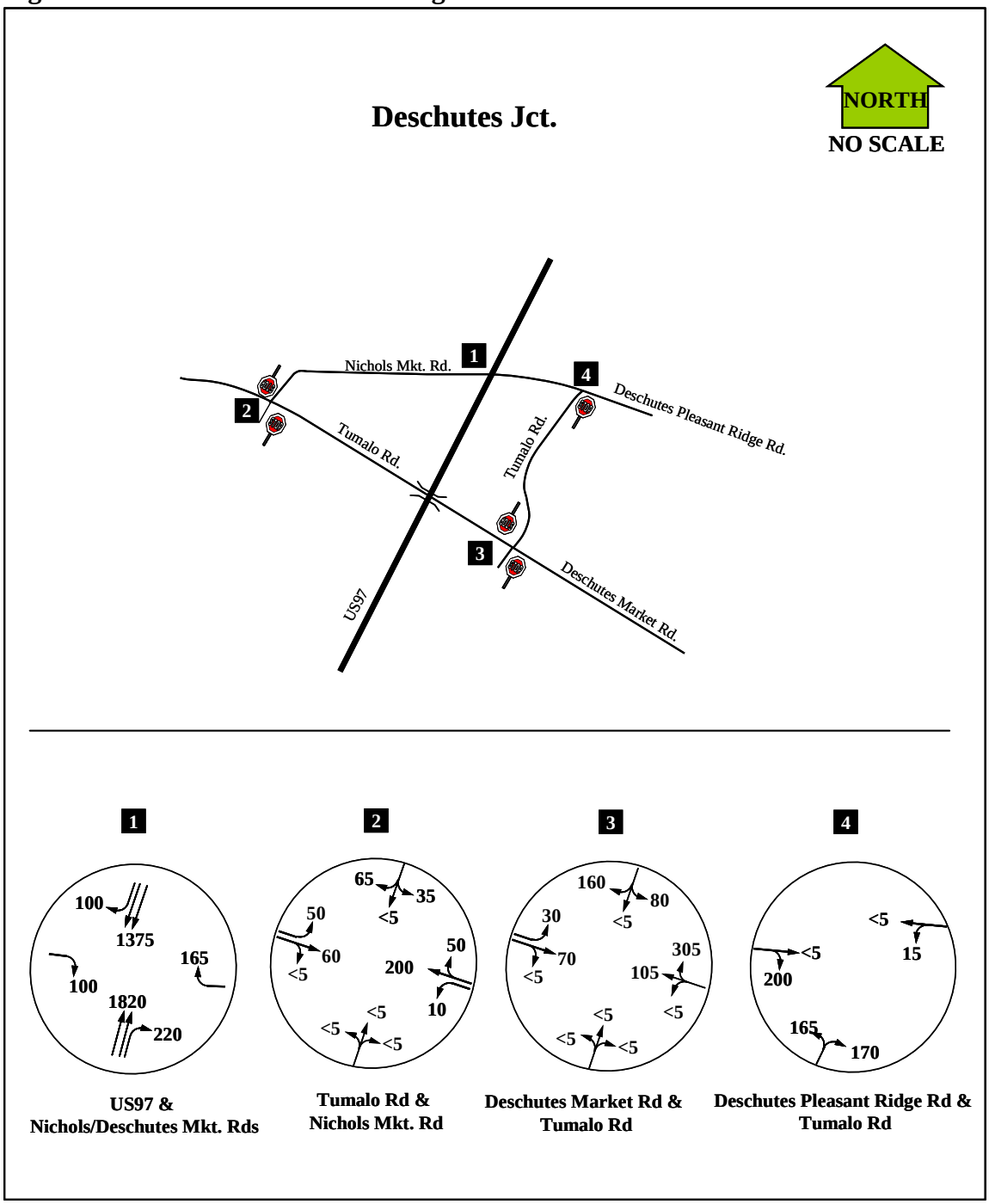


Figure H-2 2015 DHV Intersection Key

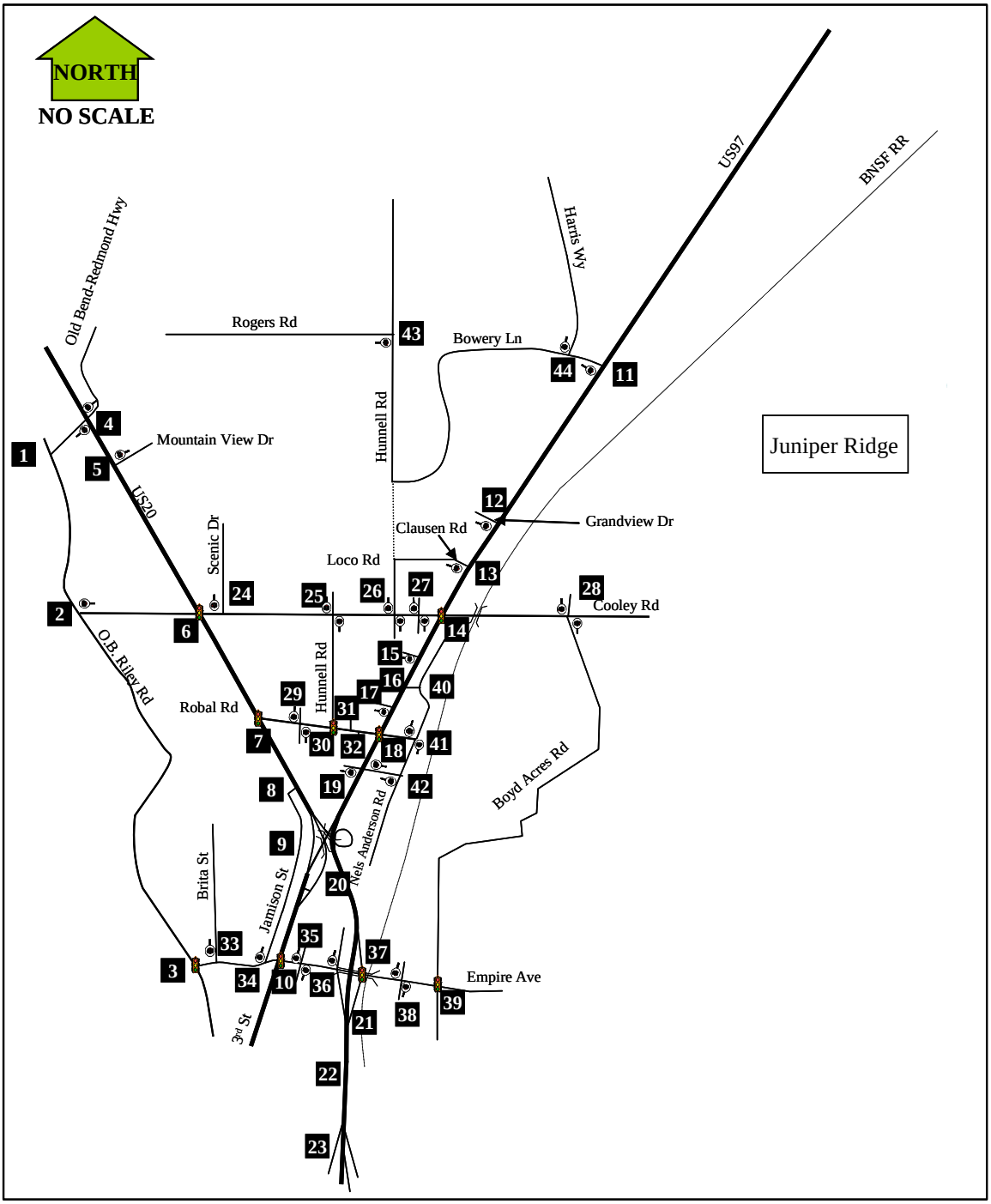


Figure H-3 2015 DHV & Lane Configurations

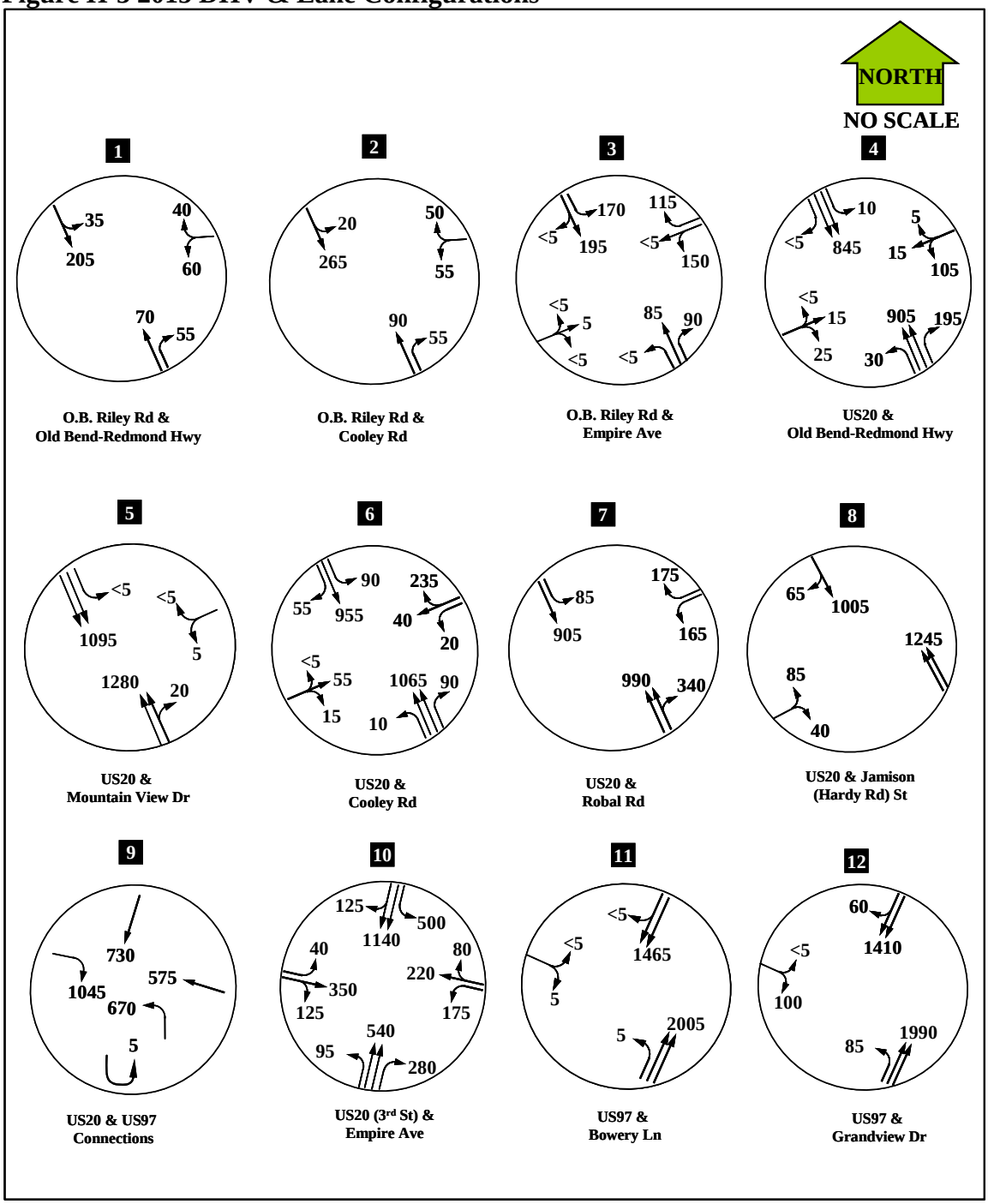


Figure H-4 2015 DHV & Lane Configurations

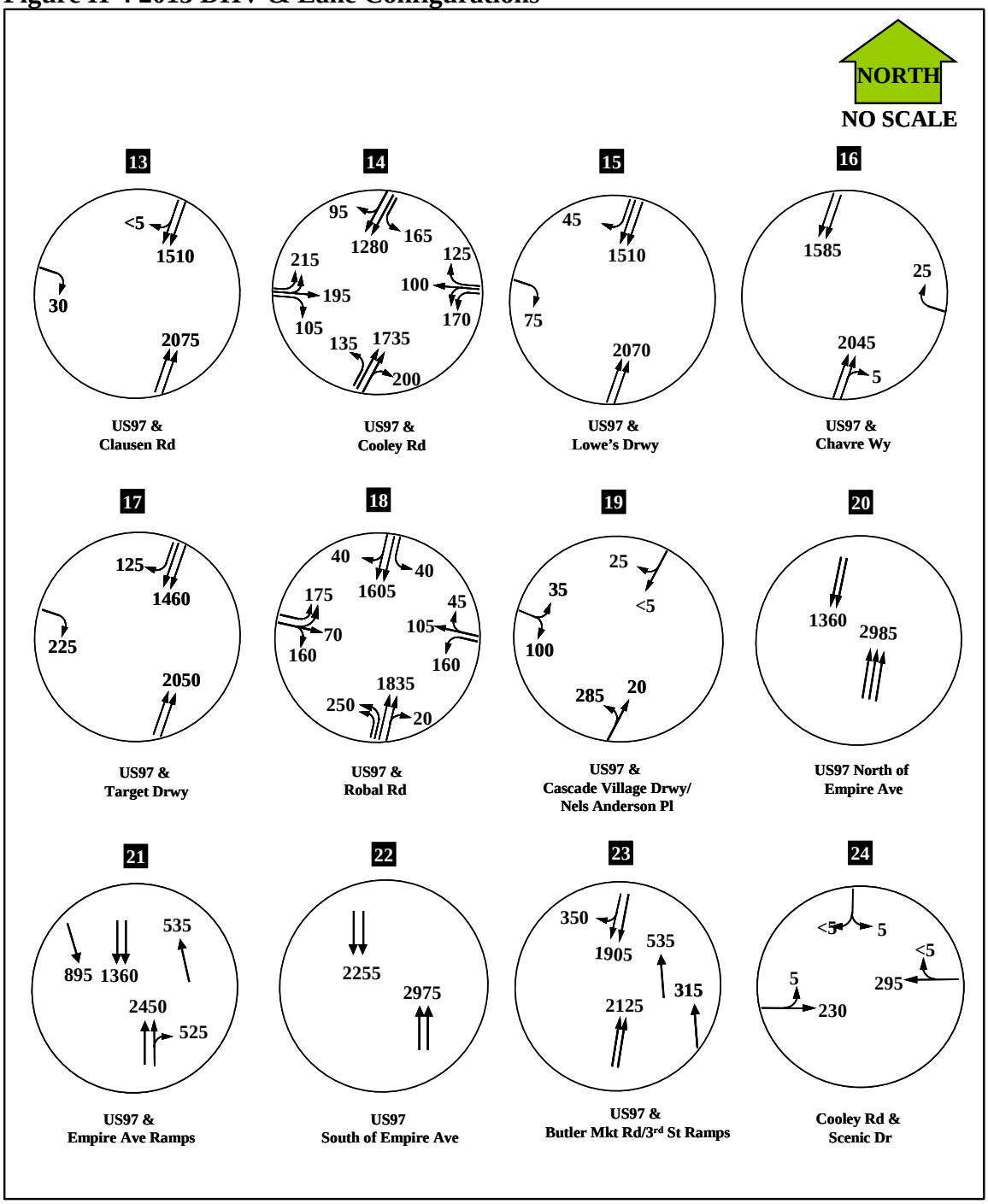


Figure H-5 2015 DHV & Lane Configurations

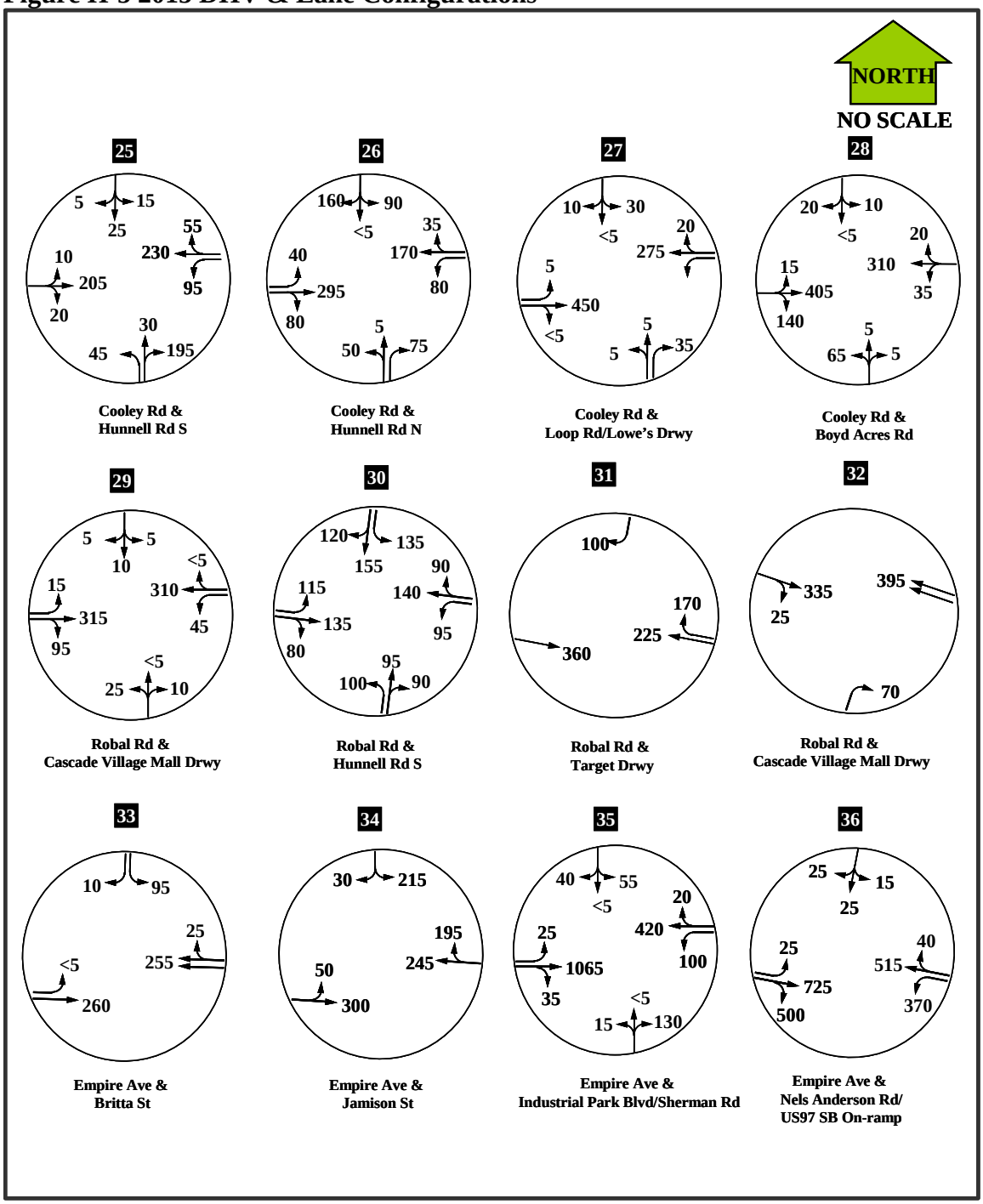


Figure H-6 2015 DHV & Lane Configurations

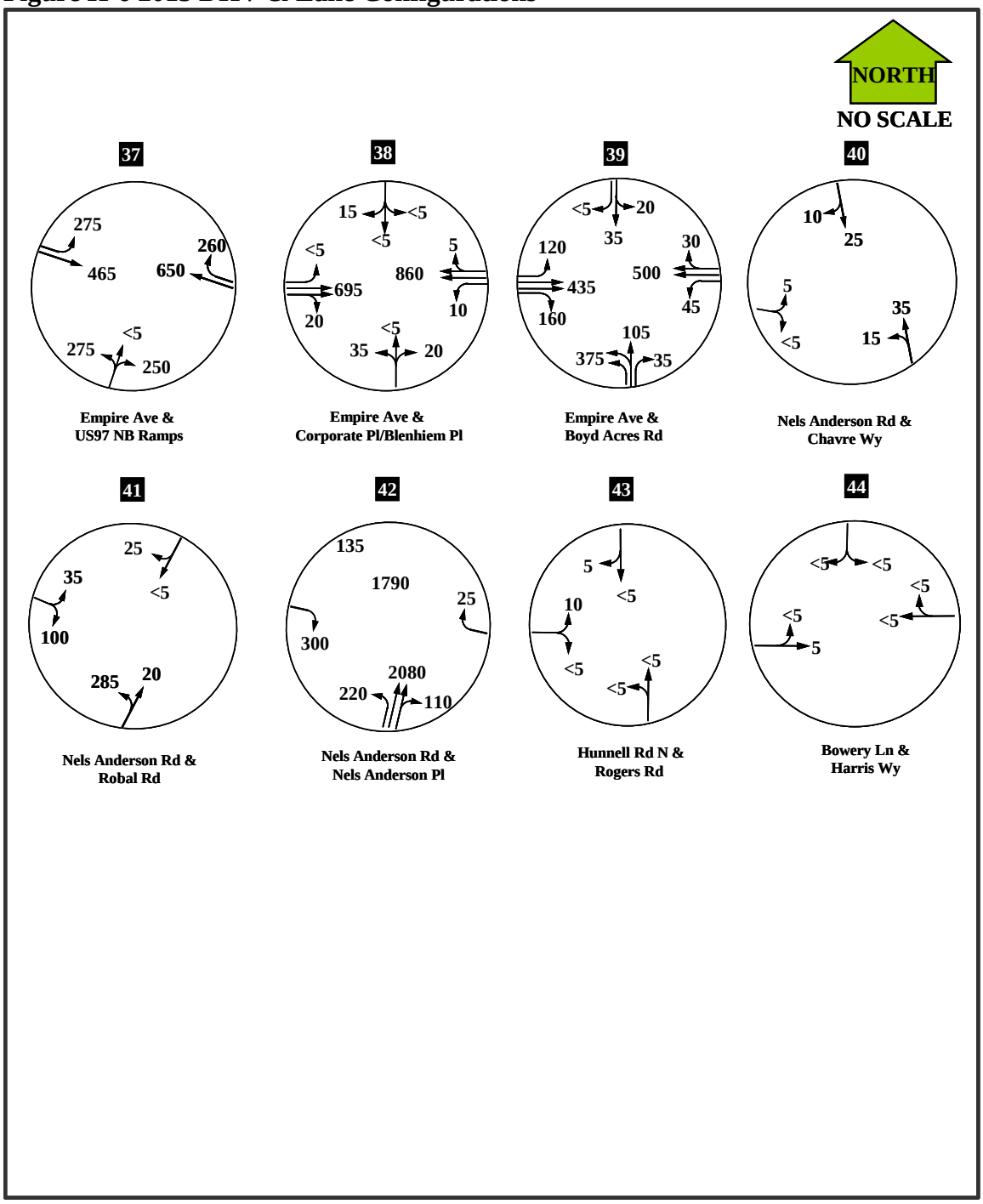


Figure H-7 2035 DHV Intersection Key

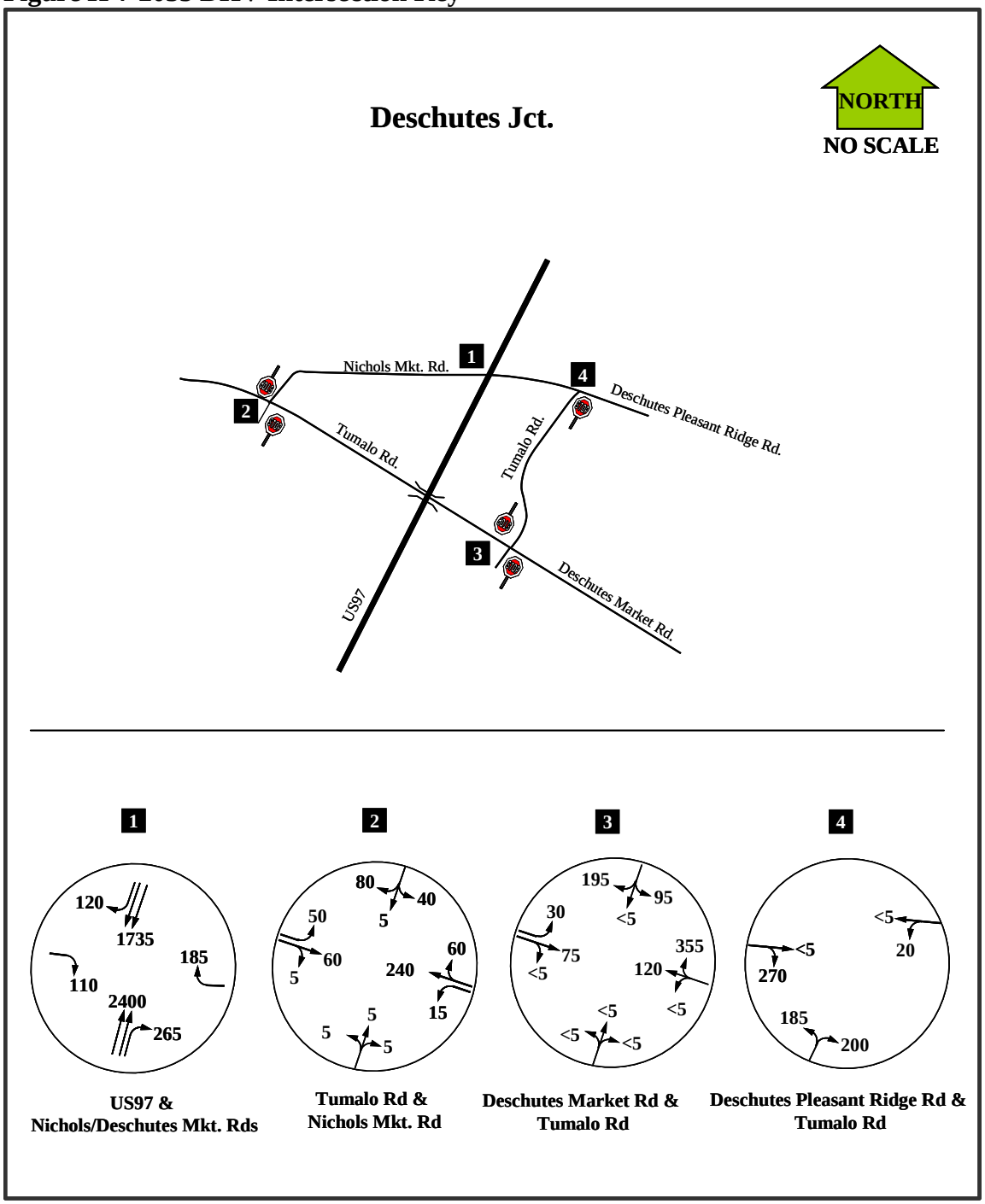


Figure H-8 2035 DHV Intersection Key

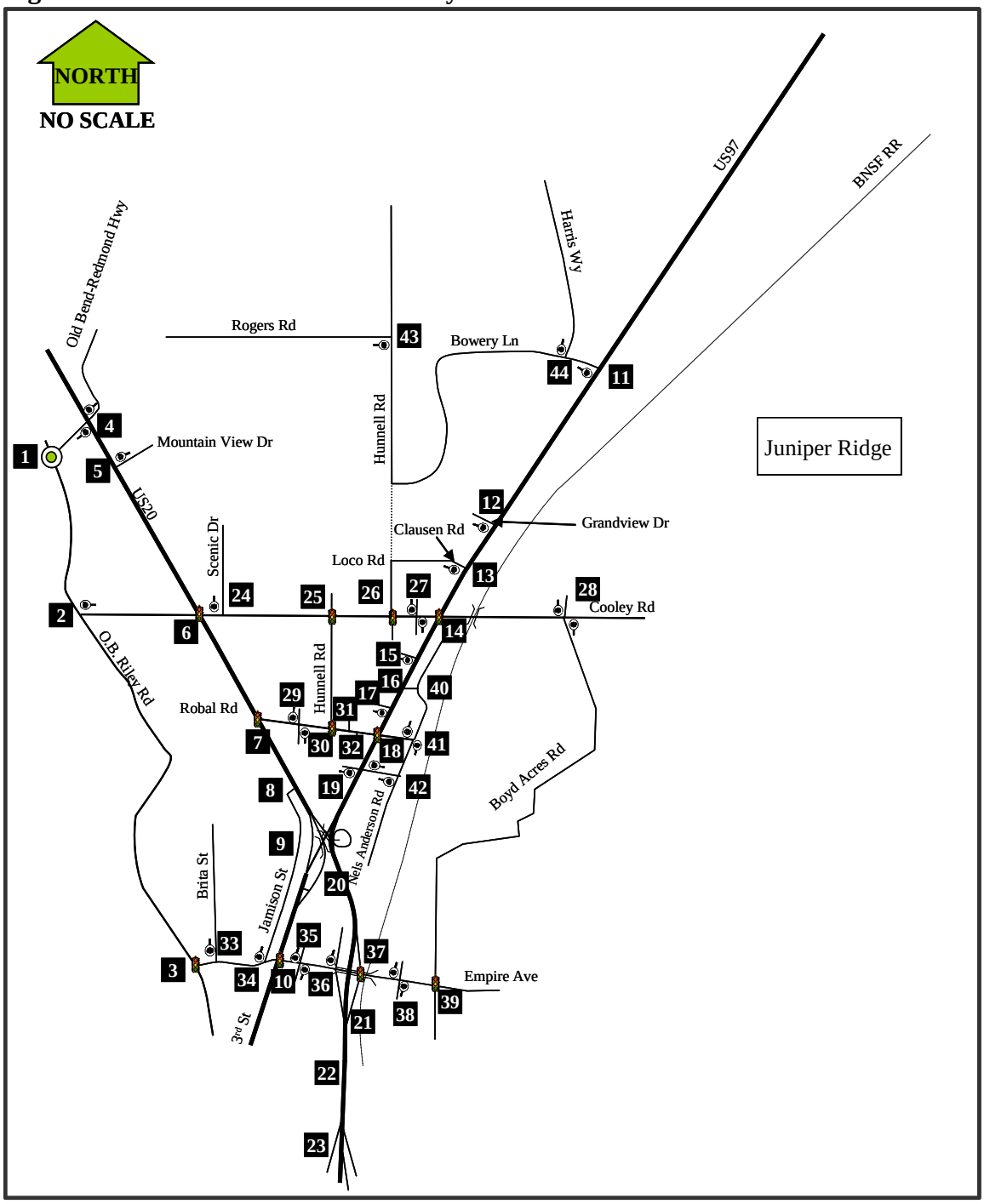


Figure H-9 2035 DHV & Lane Configurations

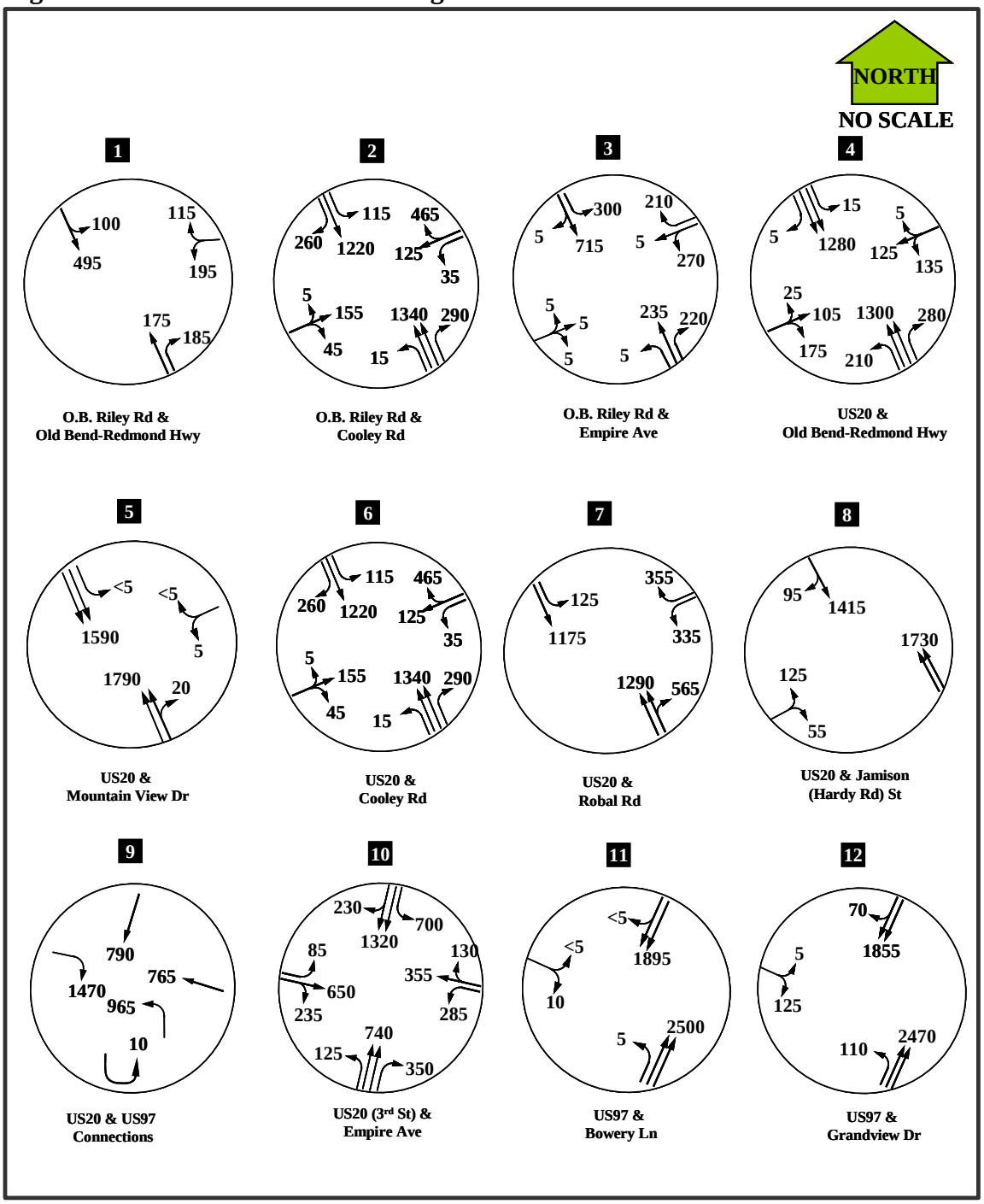


Figure H-10 2035 DHV & Lane Configurations

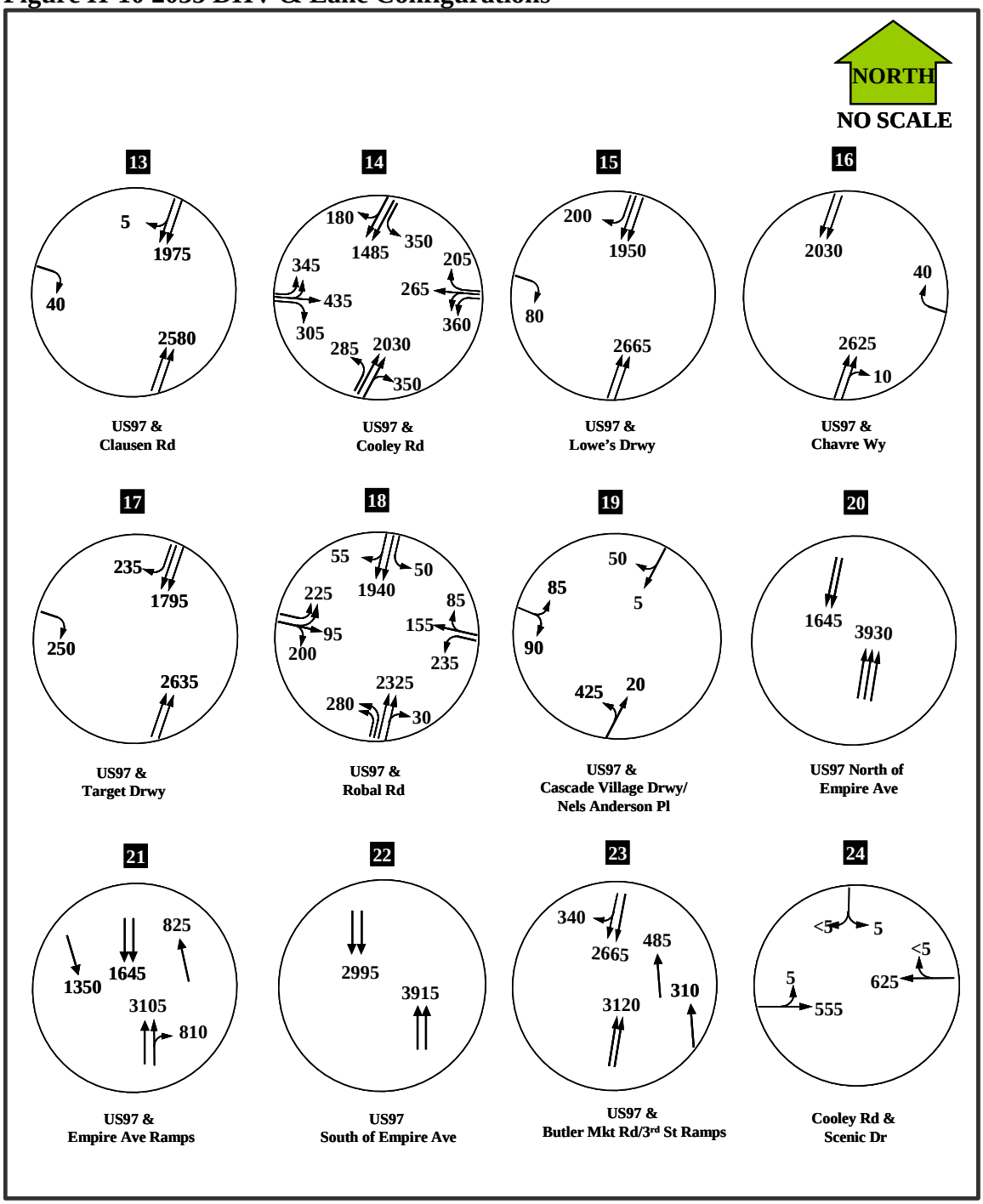


Figure H-11 2035 DHV & Lane Configurations

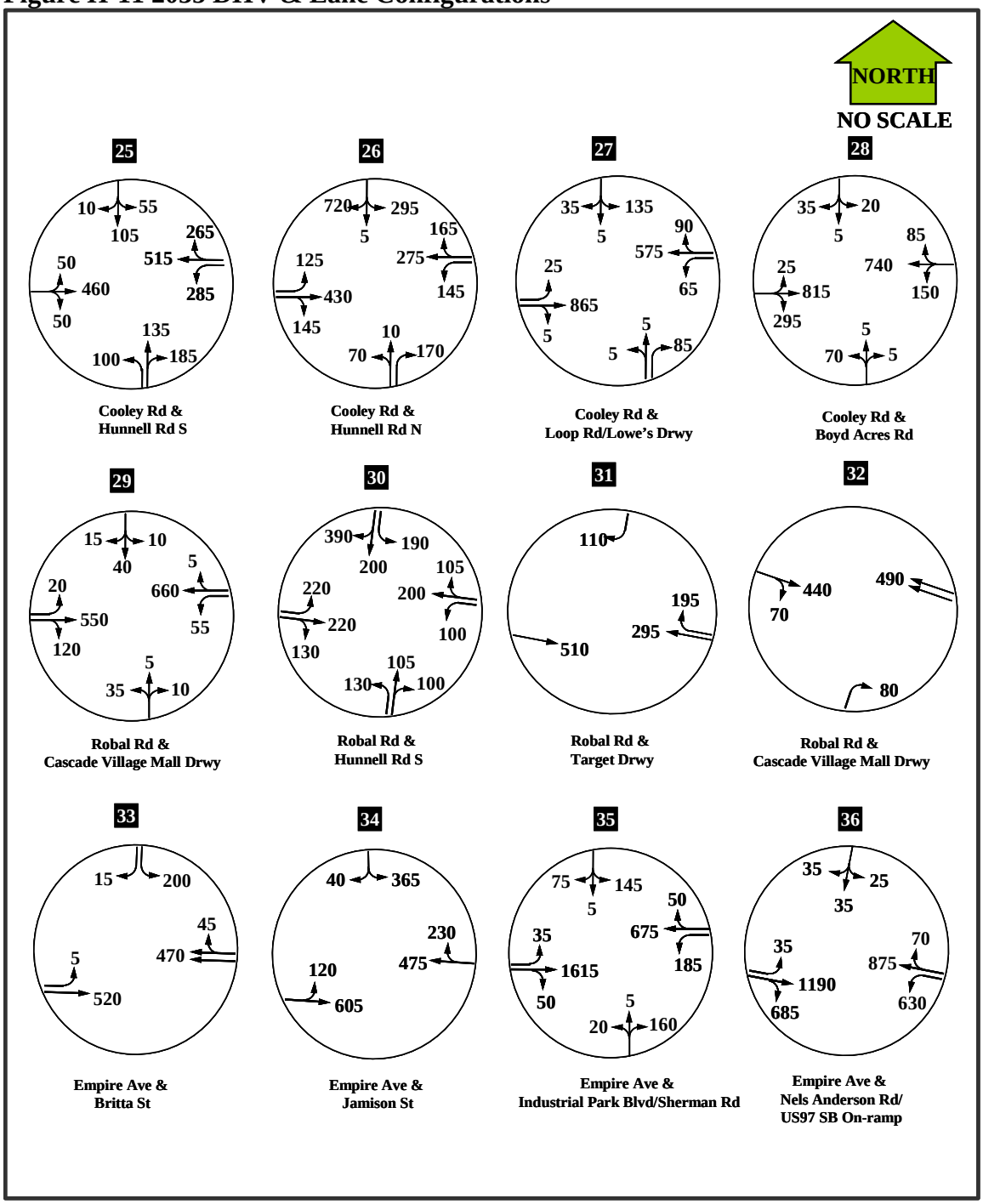
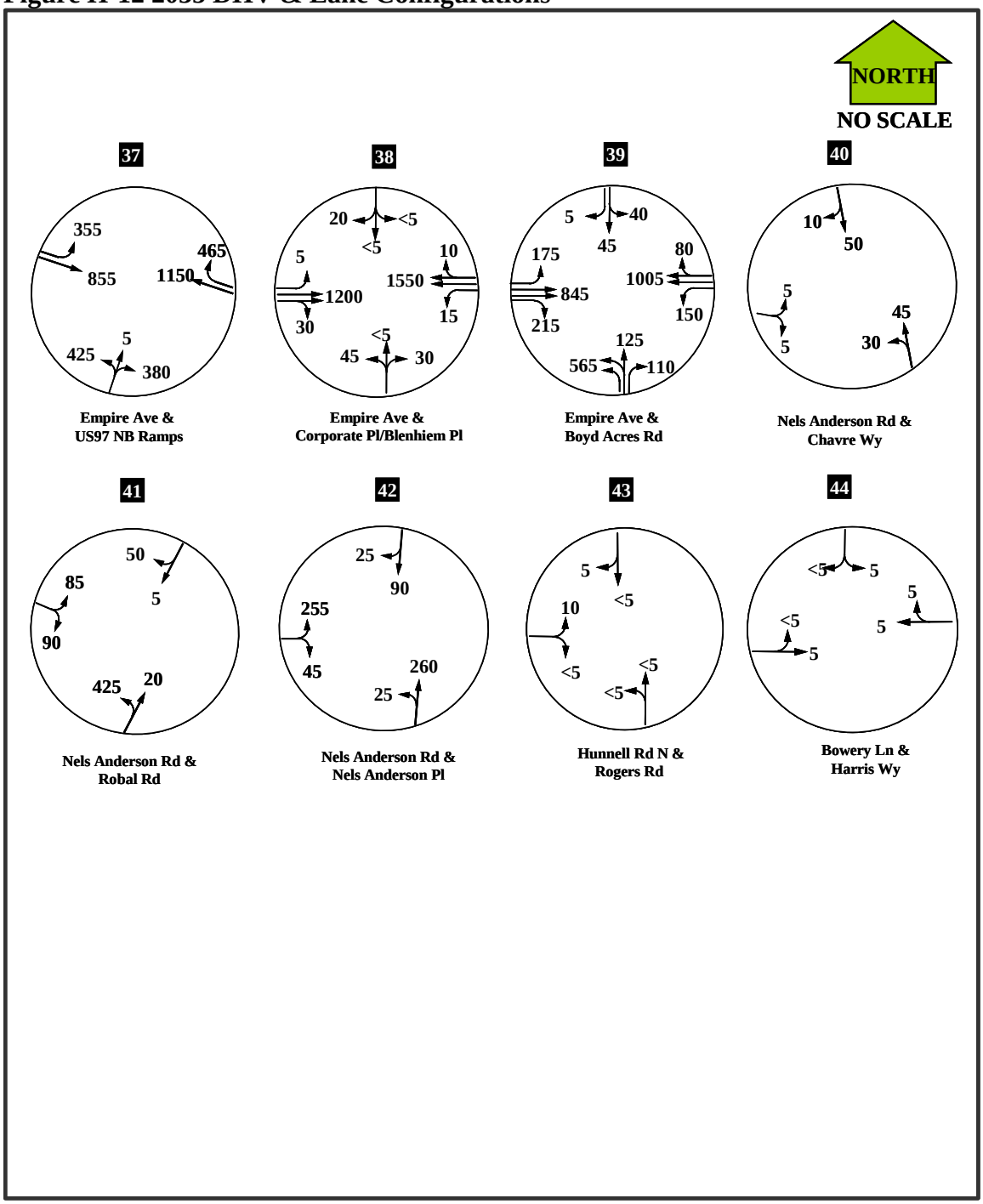


Figure H-12 2035 DHV & Lane Configurations



APPENDIX I: 2015 & 2035 NO-BUILD 95TH PERCENTILE QUEUES

Figure I-1 2015 No-build 95th Percentile Queues

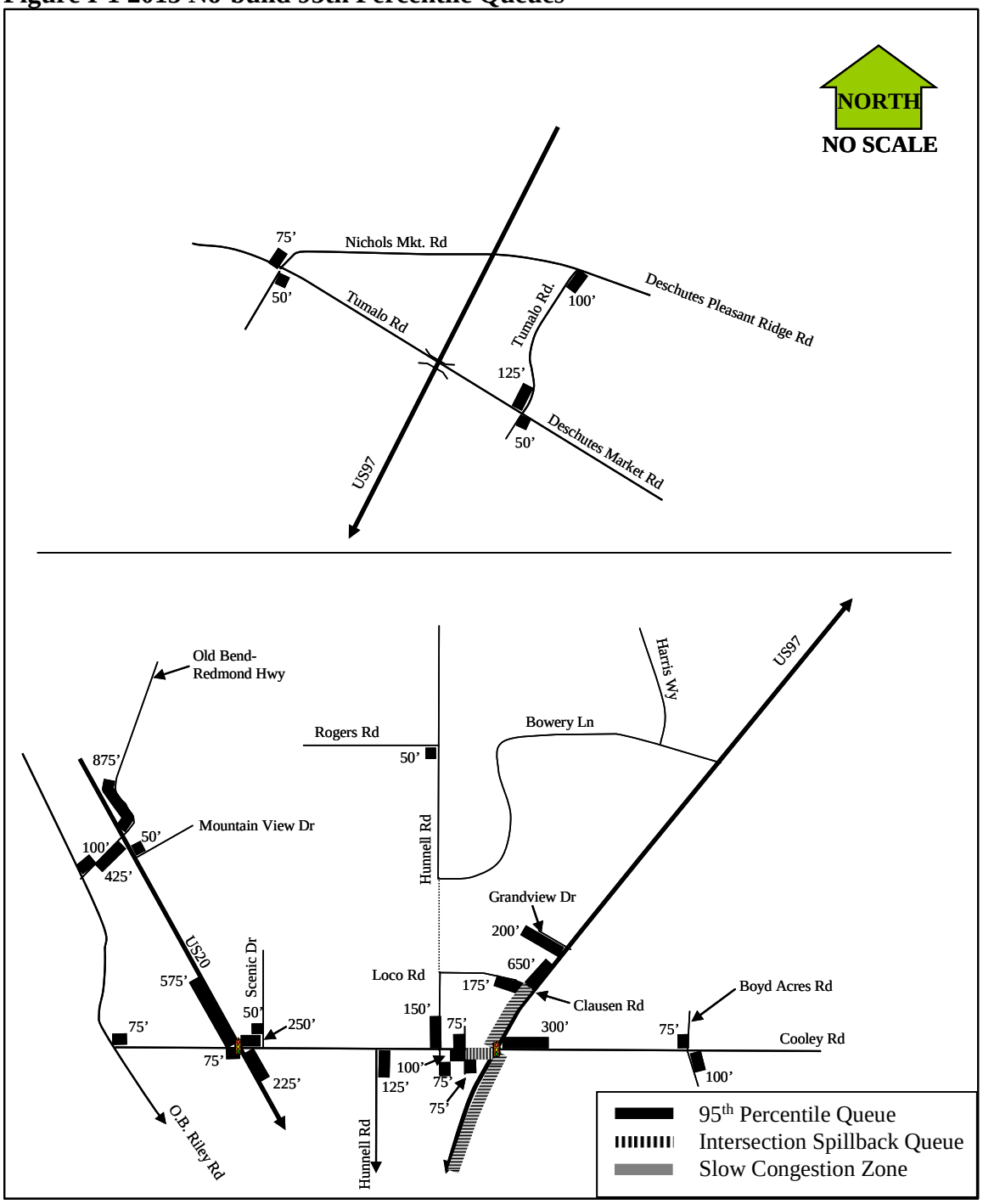


Figure I-2 2015 No-build 95th Percentile Queues

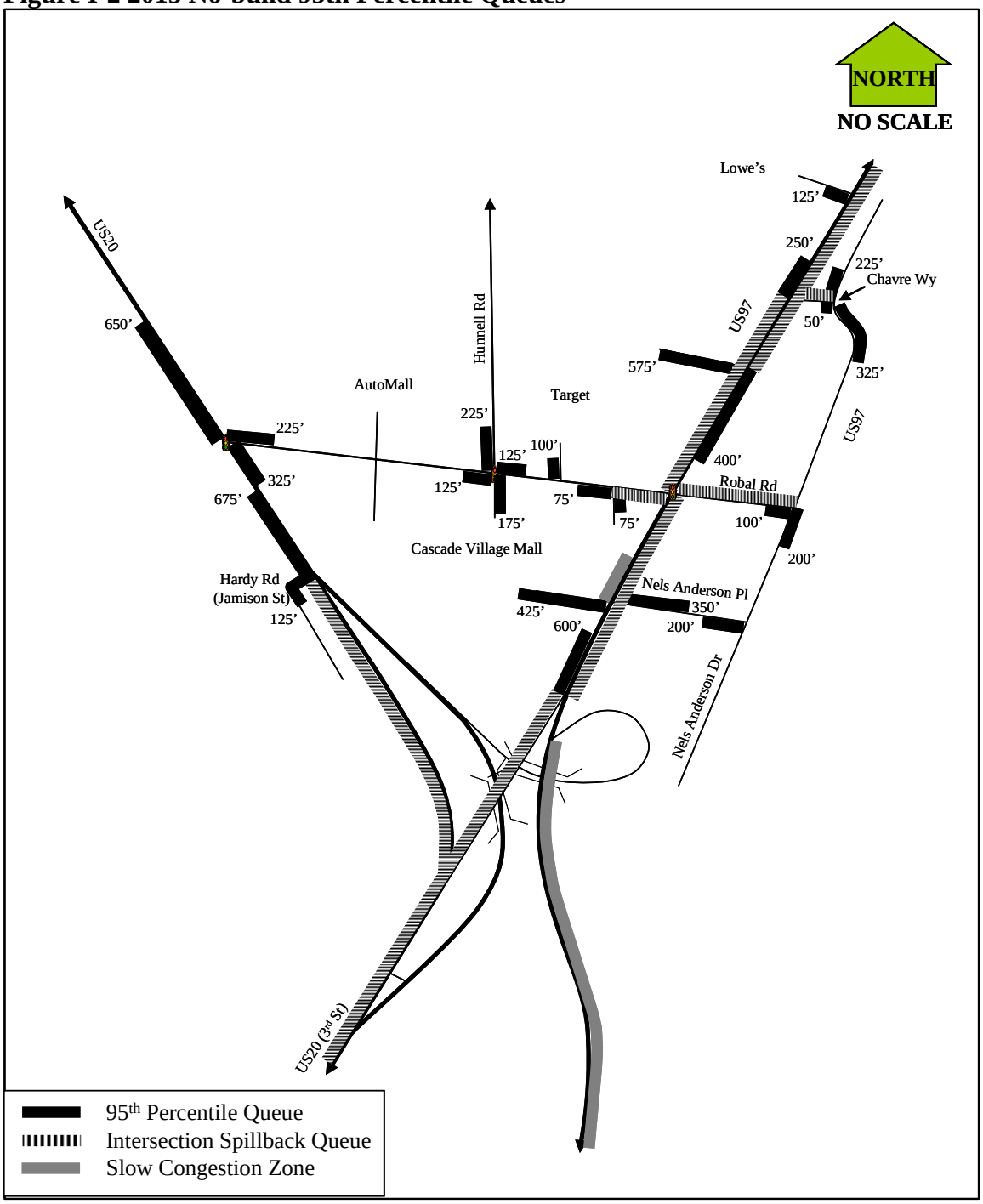


Figure I-3 2015 No-build 95th Percentile Queues

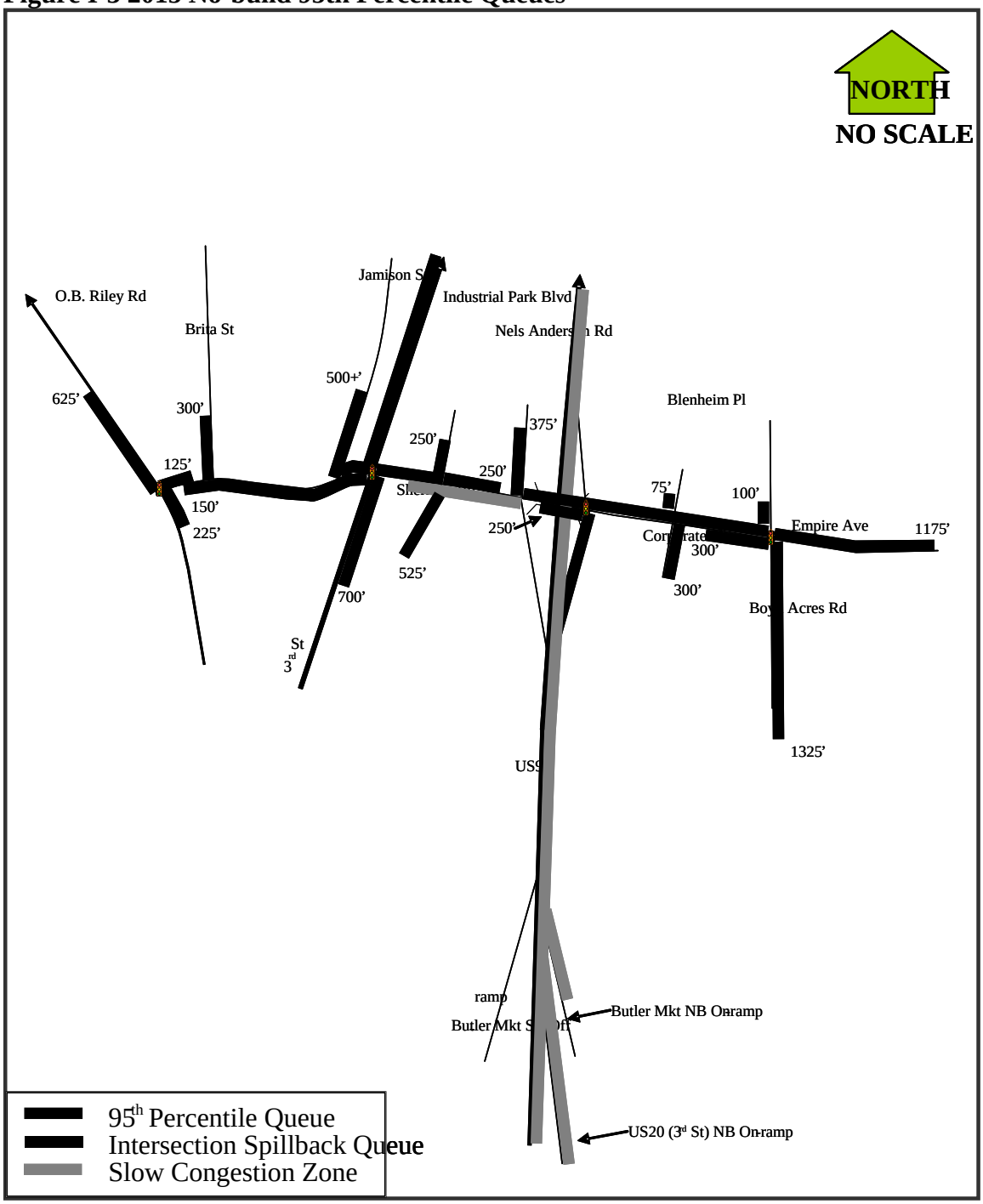


Figure I-4 2035 No-build 95th Percentile Queues

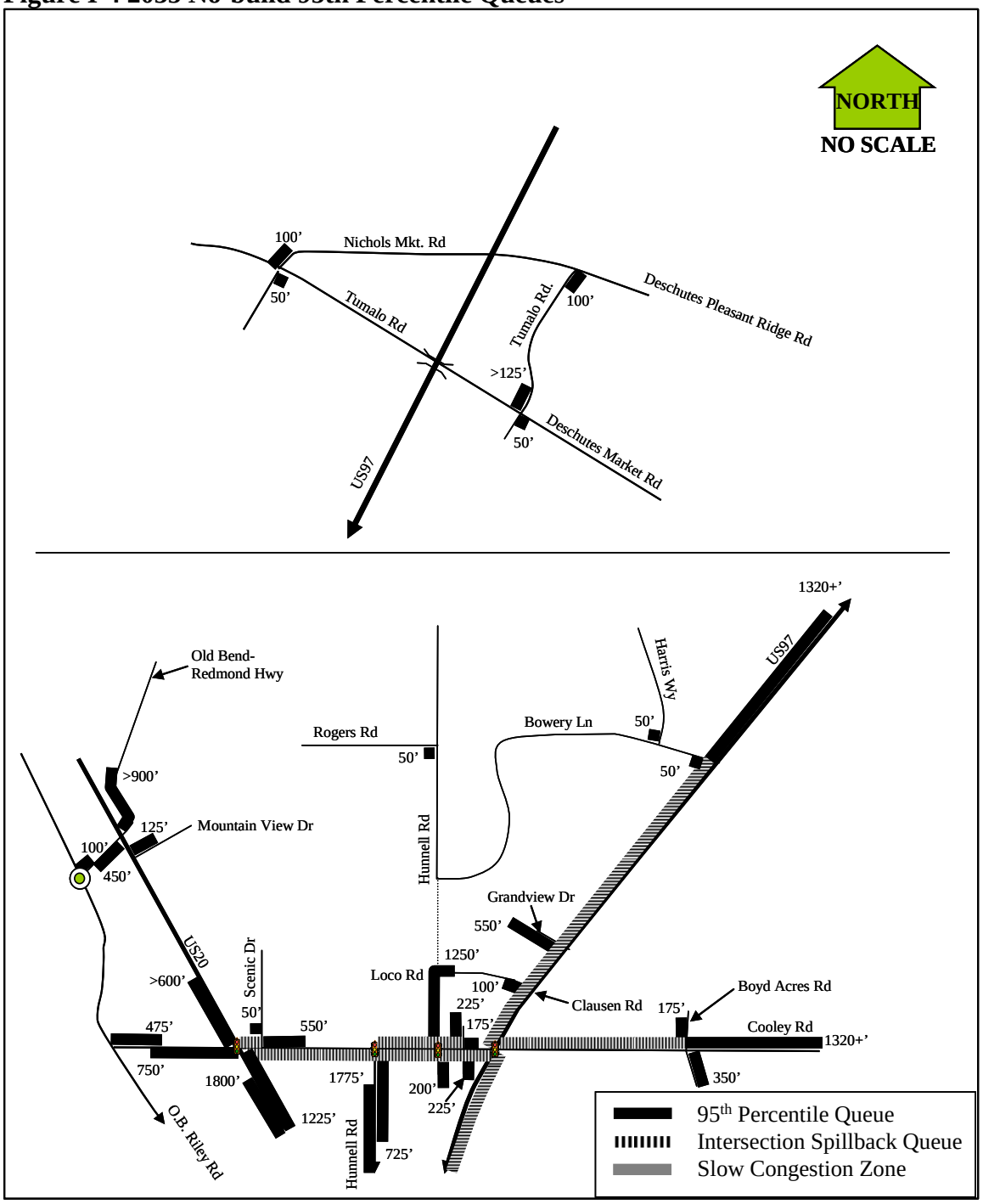


Figure I-5 2035 No-build 95th Percentile Queues

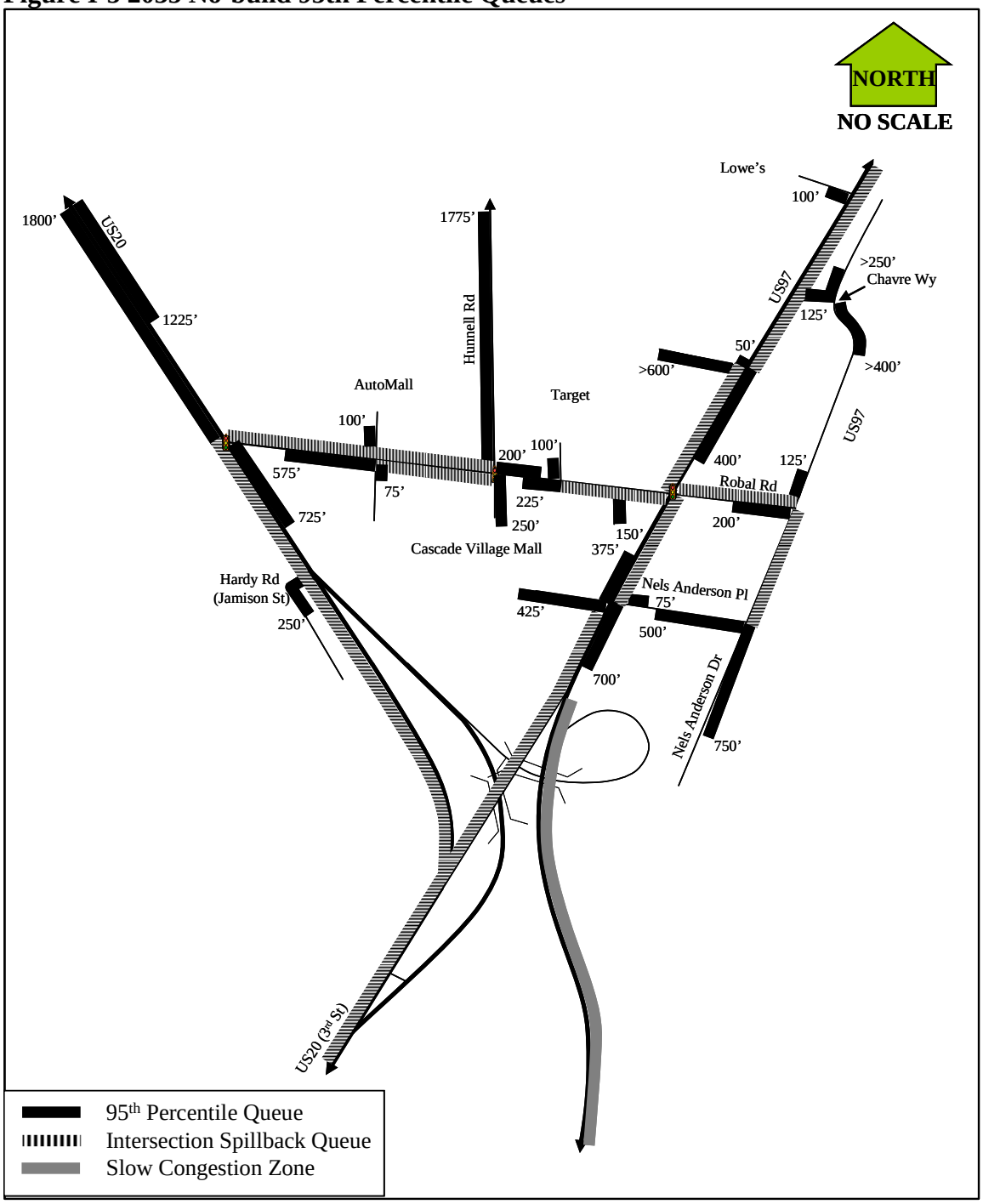
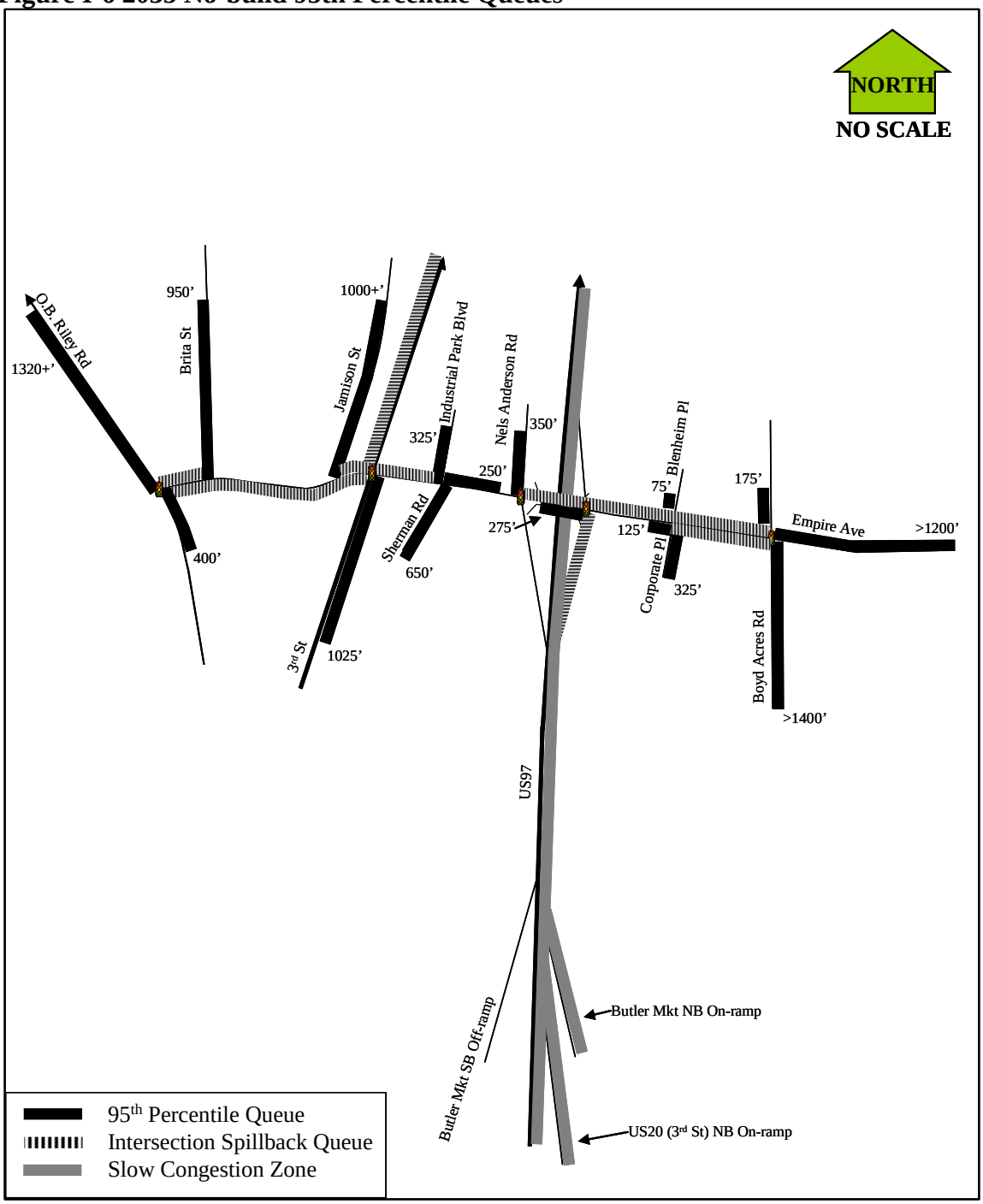


Figure I-6 2035 No-build 95th Percentile Queues



APPENDIX J: ALTERNATIVES CONSIDERED BUT DISMISSED

Alternative Screening Overview

The US97 Bend North Corridor Solutions Project used a multi-tiered screening process to determine the final alternatives to be studied in the environmental document. Concepts were identified and developed that had potential to meet the project purpose and need. These concepts were then screened against the purpose and need to determine if the concept could meet minimum project requirements (four lanes and no signals on US97, comparison to basic interchange and facility design standards, a system-level traffic model analysis, and funding limitation criteria).

The official considered project alternatives are discussed in the Alternatives Development Report (ADR) Refer to the ADR for descriptions of each alternative and how an alternative fared through the development process including any reasons for not forwarding an alternative to the next stage. Following this overview section, are the four technical memorandums that show the system-level traffic model analysis of alternative scenarios and options.

Since the project started in 2007, many concepts were developed by ODOT, local jurisdictions, stakeholders, and the public. Many concepts did not pass basic feasibility and reasonable tests were dropped early on and are not included in the ADR or in the technical memos. Through the screening process many concepts duplicated elements of other concepts or were eliminated when better concepts were found. These duplicate or lesser concepts are also not in the ADR, but may be included in the technical memorandums as part of the continuous screening process.

Table J-1 shows the locations of the ADR alternatives in the technical memorandums and the final outcomes of the alternatives including dismissal reasons or if an alternative was forwarded into the Draft Environmental Impact Statement (DEIS). Some alternatives listed in the memorandums are under different names in the ADR. Table J-2 shows the concepts included in the technical memorandums but are not listed in the ADR and their dismissal reasons.

Table J-1 ADR Alternatives

ADR Alternative[1]	Technical Memorandum	Dismissal Reasons	
		Technical Impracticality	Economic Infeasibility
No-build	2, 5, 6, 7	Final Alternative in DEIS	
RWA-1	2	Ramp terminal spacing	n/a
DL-1	n/a[2]	Violates OAR 734-051-0295 Grant of Access and ramp terminal spacing	n/a
WS West (Modified)	6	Violates OAR 734-051-0295 Grant of Access	n/a
WS West E (Modified)	n/a[2]	Ramp and ramp terminal spacing	n/a
West A	2, 5, 6[3]	Barrier to developable lands	Total project cost and construction phasing funding

West A-2B	n/a[4]	Barrier to developable lands	Total project cost and construction phasing funding
West B	5	Dual highway corridor and barrier to developable lands	Total project cost and construction phasing funding
West C	6	Barrier to developable lands	Total project cost and construction phasing funding
West 1	6	Dual highway corridor and barrier to developable lands	Total project cost and construction phasing funding
West DS-1	7	Dual highway corridor and barrier to developable lands	Construction phasing funding
GM-2	n/a[2]	Ramp and ramp terminal spacing	n/a
Existing A	5	n/a	Total project cost
Existing DS-1	7	Project purpose –congestion	n/a
WS East A	n/a[2]	Ramp and ramp terminal spacing	n/a
RRA-2B	2	Project purpose –congestion	n/a
East 1	2, 5 ,6[3]	n/a	Total project cost
East 2	2, 5, 6[3]	n/a	Total project cost
East 3	2, 5, 6[3]	n/a	Total project cost
East DS-1	7	Final Alternative in DEIS	
East DS-2	7	Final Alternative in DEIS	

[1] The alternatives generally fall into one of three geographic corridors. “West” alternatives (including RWA-1 and DL-1) re-route US97 west of its existing alignment and closer to US20. “Existing” alternatives (including GM-2 and DL-1) retain US97 on its existing alignment, “East” alternatives (including RRA-2B) re-route US97 to the east of its existing alignment and closer to the railroad. Note that Alternative DL-1 is a hybrid so it has both west and existing characteristics.

[2]Alternative was dropped after the first purpose and need-based geometric evaluation, so was not included in pool of alternatives to be tested.

[3] Alternative had multiple names and variations so memorandums referenced go back to the earliest origins of this alternative.

[4] Not explicitly modeled as would have made little difference in the results compared to West A.

Table J-2 Dismissed Concepts in Technical Memorandums[1]

Concept	Technical Memorandum	Dismissal Reason
RWA-1-2	2, 5	Redundant concept to West B
RRA-1B	2, 5	Redundant concept to East A
RRA-1C	2	Prior iteration of East 1, replaced by East DS-1
RRA-2-2	2, 5	Prior iteration of East 1-3, replaced by East DS-1
TSM-TDM	6	Does not function as standalone alternative
West D	6	Failed basic feasibility/reasonableness criteria
West D-Slip	6	Failed basic feasibility/reasonableness criteria
East A	6	Prior iteration of East 1-3, replaced by East DS-1
East B	6	Moves congestion problems instead of addressing
East DS-1 w/18th St Ext	7	Not significantly different from East DS-1

[1]The concepts in this table were dismissed within the screening process and are not included in the Alternative Development Report.

System-Level Screening Analysis Overview (Purpose & Need Screen Step 2)

If a concept passed the first step of the purpose and need screen, then it was tested using the Bend MPO travel demand model to give a preliminary operational assessment. This system-level screening analysis (Purpose & Need Screen #2 in the ADR) was based on the potential for the concept to reduce congestion and improve traffic operations on US97 and other study area roadways.

Besides the basic concepts, numerous design options or land use scenarios were tested. Some of these tests included larger versions of the Juniper Ridge development, full versus partial interchanges, and new roadway and ramp connections. Many of these new options became elements included in future concepts. At a minimum, concepts were evaluated using relative comparisons of link volumes at pre-defined screenline locations and/or critical link demand-to-capacity ratios (highest in a given segment). Technical Memorandums #2 and #5 also investigated model link travel time. The results were summarized and compared then keep or drop recommendations were made.

Alternatives that passed the first two steps of the purpose and need screens were then measured for their ability to meet the funding limitations. If an alternative failed to meet one or more of the screening criteria, it was withdrawn from further consideration.

Around the time Technical Memorandum #7 was written, the project team discussed redoing alternatives because of costs to more practical and fundable levels. For illustration and pilot purposes, TPAU performed an planning-level analysis on the basic project area using the Highway Economic Requirement System (HERS-ST) program to see how much benefit different funding thresholds affected the project area. The report looked at a no-build, an existing corridor scenario, and an eastern corridor scenario. HERS-ST is a segment analysis program that looks at needs but can produce benefit-cost ratios and other high-level system performance measures. Appendix T has the full final report.

Figure J-1 Technical Memorandum #2: Model Evaluation of Existing Alternatives

STATE OF OREGON

INTEROFFICE MEMO

Department of Transportation
Transportation Development Division
Mill Creek Office Park
555 13th Street NE Suite 2
Salem, Oregon 97301-4178
(503) 986-4110 FAX (503) 986-4174

File Code:

Date: July 2, 2007

TO: **Jon Heacock,**
US 97 North Corridor Project Manager

FROM: **Peter L. Schuytema, P.E., Senior Transportation Analyst**
Transportation Planning Analysis Unit

SUBJECT: **Technical Memorandum #2: Model Evaluation of Existing Alternatives**

This technical memorandum contains the results from the first level of analysis of the US 97 Bend North Corridor project area including the US 97/20 Refinement Plan preferred alternatives.. This screening level analysis is intended to determine the impact of major elements in various scenarios (e.g., what is the impact of Juniper Ridge).

Summary

None of these alternatives are perfect. Because the roadway network in 2030 is mostly at or over capacity, the alternatives are mostly just shifting traffic from one roadway to another without significant study area changes. All of the alternatives contain multiple serious overcapacity problems. Not all of the issues in the Committed scenario are addressed, some are created by the alternative itself, and some alternatives just push a problem to another location. Most of the alternatives have improved travel times on US 97 but degraded times on US 20 and the local system.

The direct US 20-97 connection alternatives, RRA-2-2 and RWA-3B-2, are the best overall alternatives resulting from this analysis. Alternative RWA-1-2 should also be considered for further analysis as it was recommended as one of the best alternatives in many of the evaluation sections.

The Alternative RRA-1/2 family does not fare very well overall especially considering that they are the most sensitive overall to the Juniper Ridge development. Alternative RRA-1C and Alternative RRA-2B (the original US 97/20 Refinement Plan alternative)

have much larger scale impacts on the study area system to the point that the problems that they create may be more troublesome than the problems that they fix. Other than Alternative RRA-1B, which has some benefits to US 97, and the direct connection RRA-2-2 alternative, the other Alternative RRA-1/2 alternatives should be dropped from further consideration.

Alternative RWA-1 fails to differentiate itself from the other westerly alignment alternatives. Alternative RWA-1-2 and Alternative RWA-3B-2 perform better, so analyzing Alternative RWA-1 further is not necessary as the other two will always outperform it.

Background

The BMPO (Bend Metropolitan Planning Organization) regional transportation model was used for this first-level analysis for the US 97 Bend North Corridor project. Transportation models are a combination of mathematical equations and relationships using locally-provided existing housing and employment information to project future traffic conditions. These future traffic conditions are placed on a network which is similar to the actual roadway network. An individual scenario was created for each conceptual alternative. These scenarios were compared together on a relative basis (proportions and percents) rather than using the actual volumes reported on each segment or "link" to find the differences between them. The actual model volumes cannot be directly used because the model is just mathematical relationships and needs to be tied to actual traffic volumes.

The following example from the Fern Valley Interchange project in Phoenix, Oregon illustrates why models are used to report the relative change rather than absolute actual volumes.

Example:

> Northbound Fern Valley Interchange off-ramp: model volume in 2005: 353 vehicles per hour (vph)
> Northbound Fern Valley Interchange off-ramp: model volume in 2030: 716 vph
>
> The relative change in model volumes on the northbound off-ramp between 2005 and 2030 = 716 / 353 = 2.03 (103% increase). The actual 2005 volume on the northbound off ramp is 479 vph. The actual 2030 volume on the northbound off-ramp would be 479 x 2.03 = 972 vph.

The example shows that the actual model volumes are rather meaningless however the important part is the 103% increase over the next 25 years. These types of relative comparisons were used throughout the analysis and will be used for the upcoming higher detailed analysis steps.

Scenario Parameters

The future 2030 Committed PM peak hour model volumes were used. The "Committed" designation means that these volumes include all the city, county and state projects that are listed in a funding committed construction program (i.e. ODOT's Statewide Transportation Improvement Plan; STIP) in the Bend metro area. These projects are assumed to occur regardless of what happens in the US 97/20 project area. Bend's regional transportation plan (RTP) is still in development which would add in all projects that could be funded over a 20-year period. This RTP scenario will be needed to be used in the future for further rounds of alternative screening and for creating the design hour volumes and operational results.

Additionally, volumes can easily fluctuate 10% over a given week, so this analysis uses a 10% threshold for determining if a change makes a difference (i.e. significant). It should be noted that not every detail is large enough for a model to see relative differences between (e.g., signals, residential street alignments, or whether an interchange ramp is straight or a loop). All of the scenarios were evaluated on a volume, capacity, and travel time basis. The scenarios were compared on a relative basis for each of the three evaluations with the committed scenario.

Scenario Descriptions

Three different general system scenarios and eleven alternative scenarios were identified by the project team, the project traffic/design sub-team, and TPAU, and were evaluated in this first-level analysis. General descriptions of each scenario follow:

Committed

The Committed scenario was used as the comparison for other scenarios; however, it does not have a consistent comparison of its own. It can only be compared to the existing conditions, but to make this an "apples-to-apples" comparison, all of the scenarios would also need to be compared to the existing conditions. All of the results would then be muddied up with the committed improvements from the existing conditions to the committed conditions. It is best if initial analysis only compares one variable, for example, such as whether an interchange is there or not rather than trying to figure out the overlapping effects of multiple variables. This scenario includes all of the city, county and state projects that are listed in a funding committed construction program (i.e. ODOT's Statewide Transportation Improvement Plan; STIP) in the Bend metro area (Figure 1).

Juniper Ridge

This scenario adds in the additional 1,000 acre Juniper Ridge development urban growth boundary (UGB) expansion as of April 2007. Five hundred acres are already currently included in the UGB. Connections to the Juniper Ridge area are via existing roads, namely Cooley Road and Deschutes Market Road.

Juniper Ridge plus UGB Expansions

In addition to the Juniper Ridge UGB expansion detailed above, other UGB expansions being considered by the City of Bend were added. The significant UGB expansions include the west side of Bend in the Skyliners Road area, the south side of Bend in the Rocking Horse Lane area, and the southeast side of Bend in the Knott Road area. The Gopher Gulch expansion area to the northwest of Bend in the O.B. Riley Road area is already included in the Committed scenario.

Unlike the work that the City of Bend is performing which reallocates the future population around for each UGB expansion area separately so the official future population control totals are not exceeded, this scenario looked at the total effect of all UGB expansions along with Juniper Ridge. This combination does exceed the future population control totals as a result and therefore can only be used for this analysis.

Juniper Ridge with US 97 Interchange

This scenario adds in the additional 1,000 acre Juniper Ridge development urban growth boundary (UGB) expansion as of April 2007. Connections to Juniper Ridge are through a full-movement interchange on US 97 between Cooley Road and Deschutes Market Road in addition to local roadways (Figure 2).

Alternative RWA-1

The Alternative RWA-1 scenario moves US 97 to the west paralleling US 20 and goes around the west side of the "Golden Triangle" area connecting back into the original US 97 alignment north of Cooley Road with a partial interchange (Figure 3). A full-movement interchange with Cooley Road is provided, however there is no direct US 97 – US 20 connection. The southbound off-ramp for Empire Avenue is also added. This alternative was one of the two final alternatives from the US 97/20 Refinement Plan (a.k.a. Alternative 1B).

Alternative RWA-1 with Juniper Ridge

This scenario is the same as the above except with the Juniper Ridge land uses added.

Alternative RWA-1-2

This scenario is the same as the above except that the Empire Avenue Interchange ramps have been removed, leaving Empire Avenue as just an overcrossing of US 97/Bend Parkway (Figure 4).

Alternative RRA-1B

The Alternative RRA-1B scenario moves US 97 to the east to parallel the west side of the BNSF railroad tracks (Figure 5). There is no direct connection to US 97 from US 20 and US 97 overcrosses Cooley Road. Third Street (original US 97 alignment) connects with Cooley Road and connects back into US 97 north of Cooley Road in a partial interchange.

Alternative RRA-1B with Juniper Ridge

This scenario adds the 1,000 acre UGB expansion of Juniper Ridge to the regular Alternative RRA-1B scenario. Connections to the Juniper Ridge area are via existing roads, namely Cooley Road and Deschutes Market Road.

Alternative RRA-1C

This scenario is the same as the above except that the Empire Avenue Interchange ramps have been removed, leaving Empire Avenue as just an overcrossing of US 97/Bend Parkway (Figure 6).

Alternative RRA-2B

This scenario is the same as the regular Alternative RRA-1B scenario, but grade separates the US 20 /Cooley Road intersection with a diamond-style interchange (Figure 7). This reflects the final Alternative 3B as shown in the US 97/20 Refinement Plan.

Alternative RRA-2-2

The Alternative RRA-2-2 (Revised Rail Alignment) scenario builds upon the Alternative RRA-1B scenario by adding new northbound and southbound direct connection ramps between US 20 and US 97 (Figure 8). The existing US 20/3rd Street ramps and the Sister's Loop ramp would remain. In this case the Sister's Loop ramp would now connect to 3rd Street instead of US 97. A new southbound off-ramp would be added to the Empire Avenue interchange making it a full diamond interchange. Third Street would be extended underneath the US 20 connections in both directions to connect with the old US 97 alignment.

Third Street would continue northward, crossing under the new alignment of US 97 in the vicinity of the Deschutes Memorial Gardens cemetery paralleling US 97 and the BNSF railroad tracks. Third Street will eventually connect back into US 97 via a partial interchange allowing free-flow access to and from the north. The main Juniper Ridge access would connect to the 3rd Street extension about halfway between the US 97/3rd Street partial interchange and the US 97 overcrossing (Figure 8).

Alternative RRA-2-2 with Juniper Ridge

This scenario is the same as the above except with the Juniper Ridge land uses added.

Alternative RWA-3B-2

The Alternative RWA-3B-2 (Revised Westerly Alignment) scenario builds upon the Alternative RWA-1 scenario. US 97 would be completely disconnected from Third Street and simply overcross it in this location (Figure 9). A new southbound off-ramp would be added to the Empire Avenue interchange making it a full diamond interchange.

US 97 would also overcross Robal, Cooley, and Hunnell Roads. Robal Road would be extended southwesterly to connect with the north end of Brita Street and to a frontage road connecting with Cooley Road. Rogers Road would be extended westward to directly connect with US 20 and O.B. Riley Road. Rogers Road would be extended eastward over US 97 and the railroad to connect with the northern extension of 3rd Street. US 20 would directly connect to US 97 north of Cooley Road with a directional trumpet-style interchange.

Third Street would continue northward, paralleling US 97 and the BNSF railroad tracks. Third Street will eventually connect back into US 97 via a partial interchange allowing free-flow access to and from the north. The main Juniper Ridge access would connect to the 3rd Street extension at the Rogers Road intersection.

Alternative RWA-3B-2 with Juniper Ridge

This scenario is the same as the above except with the Juniper Ridge land uses added.

Scenario Results

Volume Evaluation

The volume evaluation indicates how much extra traffic is attracted to or diverted away for a given scenario when compared to the Committed no-build scenario. The scenarios were evaluated along screenlines cutting across the major facilities in the study area north of Cooley Road, south of Empire Avenue, and east of US 97 (Figure 10). Scenario model volumes on each major facility were summed up for each screenline and compared to the Committed scenario. The percent differences were averaged across all three screenlines. Table 1 shows the screenline overall average percent difference in model volume for each model scenario when compared to the Committed scenario.

Table 1. Overall Average Volume Percent Difference

Scenario	Average Percent Difference from Committed Scenario[1]
Committed	0
Juniper Ridge	**22**
Juniper Ridge plus UGB Expansions	**21**
Juniper Ridge w/ US 97 Interchange	**31**
Alternative RWA-1	-2
Alternative RWA-1 w/ Juniper Ridge	**23**
Alternative RWA-1-2 w/o Empire Ave Interchange	-3
Alternative RRA-1B	-1
Alternative RRA-1B w/ Juniper Ridge	**20**
Alternative RRA-1C	-4
Alternative RRA-2B	2
Alternative RRA-2-2	-1
Alternative RRA-2-2 w/ Juniper Ridge	**31**
Alternative RWA-3B-2	-2
Alternative RWA-3B-2 w/ Juniper Ridge	**34**

[1] Black shaded cells indicate a significant (+/- 10%) difference from the Committed scenario.

As shown in Table 1, the only scenarios that have a significant difference overall are the Juniper Ridge scenarios. While the project cannot directly consider the Juniper Ridge UGB expansion impacts as it is not in the current comprehensive plan, a sensitivity analysis can be undertaken to evaluate the possible impacts to the final alternatives. A sensitivity analysis using +20% and +33% volume thresholds will be incorporated into the detailed analysis phase of this project.

The results also show that the smaller UGB expansions on the west and south portions of Bend do not have any significant effect. Adding Juniper Ridge is the significant effect on the system. Adding a full interchange to US 97 for Juniper Ridge results in an additional 9% impact to the system over just Juniper Ridge alone. Adding an interchange may improve the section of US 97 north of the new interchange to Deschutes Market Road as volume is reduced there, but the interchange keeps the local Juniper Ridge trips on US 97. The full interchange makes it much easier for local trips to access the Juniper Ridge area as US 97 is the fastest route.

The RRA-2-2 and RWA-3B-2 alternative scenarios with Juniper Ridge have a similar impact with the full interchange Juniper Ridge scenario. The RRA-2-2 with Juniper Ridge scenario has the same impact and the RWA-3B-2 one has slightly more impact. This means that a combination of a partial flyover-style interchange (using ramps to and from the north) combined with a parallel 3rd Street extension has the same impact on rerouting traffic as does a full interchange. The partial interchange keeps the vast majority (80%) of Juniper Ridge trips on 3rd Street while a full interchange will move these trips to US 97.

A direct US 20-US 97 connection in Alternatives RRA-2-2 and RWA-3B-2 has no apparent overall improvement over the original Alternatives RWA-1 and RRA-1B because overall relative volume shifts are small, however for Alternative RRA-2-2, there are significant shifts of traffic in the immediate interchange area. In Alternative RRA-1B, most US 20 volume is on 3rd Street but in Alternative RRA-2-2, 80% of US 20 west-bound traffic shifts to US 97 from 3rd Street and 98% of US 20 eastbound traffic. Interaction between 3rd Street and US 20 is relatively small so the existing connections to and from US 20 to 3rd Street are of questionable value. In contrast, Alternative RWA-1 has most US 20 traffic on US 97 and in Alternative RWA-3B-2, over 99% of US 20 traffic is coming from and going to the south on US 97.

The Alternative RWA-3B-2 ramps from US 97 southbound to US 20 northbound and vice versa are not necessary unless a full interchange form is desired. Most of this traffic that would use this movement is relatively local as longer distance trips would use less out-of-direction routes such as OR 126, Tumalo Road, or Rogers Road.

While none of the alternative scenarios show a significant level of change, the alternatives without Empire Avenue interchange have the highest level of removing traffic from the study area. In this case, traffic wanting to use the interchange for a likely short trip diverts away from Empire Avenue and US 97 and uses other local roadways such as O.B. Riley Road, Boyd Acres Road and 18th Street.

Capacity Evaluation

The capacity evaluation indicates if certain roadway segments would be likely over capacity and if certain alternative scenarios had less capacity available than the Committed “no-build” scenario. Eleven state segments on US 97 and US 20 were evaluated along with ten segments on local roadways from Deschutes Market Road south to Reed Market Road. Model demand-to-capacity (d/c) ratios are mid-block or segment based and they can only be relatively compared on a large-scale basis such as below, at, or over capacity. They cannot be compared with the Oregon Highway Plan or Highway Design Manual volume-to-capacity ratios as these require that volumes are based on the 30th highest hour from actual ground counts.

Tables 2 and 3 show the 2030 d/c ratio-based capacity ranges for US 20 and US 97. Tables 4 and 5 show the capacity ranges for the local system. The tables are broken out in three tiers which are under capacity (d/c’s less than 0.90), at capacity (0.90 to 1.10 d/c), and over capacity (over 1.10 d/c). Below capacity links are relatively free of issues; at capacity links likely have significant problems but are probably solvable; and over capacity links indicate a serious issue that will require a large amount of improvements or will result in outstanding capacity issues.

The Committed network is showing the significant state and non-state facilities generally at or over capacity. There are a significant level of trips diverting from the state highways onto parallel local roads such as O.B. Riley Road and Boyd Acres Road. Trouble spots in the project area are US 20 (3rd Street) between Cooley Road and Empire Avenue and

between O.B. Riley Road and the Bend Parkway (US 97) overcrossing at Division Avenue; O.B. Riley Road, and Empire Avenue.

The Committed scenario includes the extension of Empire Avenue to 27th Street and this improvement will attract a very large amount of trips onto Empire as Empire will be the only through east-west facility in the project area. This has the result of many of the study area segments to exceeding capacity in the Committed scenario, which are not addressed by any of the alternative scenarios.

The presence of Juniper Ridge causes at least one additional area in each alternative scenario to go over capacity which will need to be addressed in the sensitivity analysis. The Alternative RRA family is the least sensitive to Juniper Ridge on a capacity basis and the Alternative RWA family is the most sensitive judging by the road segments that change to higher impact d/c ratio ranges.

Table 2. US 20: 2030 Capacity (d/c) Ranges

Scenario	Old Bend-Redmond Hwy to Cooley Rd.	Cooley Rd. to Empire Ave.	Empire Ave. to O.B. Riley Rd.	O.B. Riley Rd, to US 97 Overcrossing
Committed	Under	**Over**	**At**	**Over**
Juniper Ridge	Under	**Over**	**At**	**Over**
Juniper Ridge Plus UGB Expansions	Under	**Over**	**At**	**Over**
Juniper Ridge w/ US 97 Interchange	Under	**Over**	**At**	**Over**
Alternative RWA-1	Under	**Over**	**At**	**Over**
Alternative RWA-1 w/ Juniper Ridge	Under	**Over**	**At**	**Over**
Alternative RWA-1-2	Under	**Over**	**At**	**Over**
Alternative RRA-1B	Under	**Over**	**At**	**Over**
Alternative RRA-1B w/ Juniper Ridge	Under	**Over**	**At**	**Over**
Alternative RRA-1C	Under	**Over**	**Over**	**Over**
Alternative RRA-2B	**Over**	**Over**	Under	**Over**
Alternative RRA-2-2	**At**	**Over**	Under	**Over**
Alternative RRA-2-2 w/ Juniper Ridge	**At**	**Over**	**At**	**Over**
Alternative RWA-3B-2	**At**	**Over**	**At**	**Over**
Alternative RWA-3B-2 w/ Juniper Ridge	**At**	**Over**	**At**	**Over**

None of the alternative scenarios are free of any over-capacity segments. For US 20 in Table 2, Alternative RWA-1, Alternative RWA-1-2, Alternative RRA-1B, and

Alternative RRA-2-2 stand out as the best alternatives. For US 97 in Table 3, either Alternative RWA-1, RRA-1B, or RRA-1C are the best alternatives for US 97 capacity.

For the local system, in Tables 4 and 5, Alternative RRA-2B is the best, however, this alternative's "over capacity" d/c ratios are far higher and in some cases double of other alternatives which causes significant impacts far outside of the study area. The next best is Alternative RWA-1-2.

The best overall, by a good margin, is Alternative RWA-1-2. Other possible middle-tier alternatives are Alternatives RWA-1, RRA-1B, and RRA-2-2.

Table 3. US 97: 2030 Capacity (d/c) Ranges

Scenario	Deschutes Mkt. Rd. to Cooley Rd.	Cooley Rd to Empire Ave.	Empire Ave. to 3rd St. Undercrossing	3rd St. Undercrossing to Colorado Ave.
Committed	At	Over	At	Over
Juniper Ridge	Over	Over	At	Over
Juniper Ridge Plus UGB Expansions	Over	Over	Over	Over
Juniper Ridge w/ US 97 Interchange	Over	Over	At	Over
Alternative RWA-1	Under	Under	At	Over
Alternative RWA-1 w/ Juniper Ridge	Over	At	Over	At
Alternative RWA-1-2	Under	Under	Under	Over
Alternative RRA-1B	Under	Under	At	Over
Alternative RRA-1B w/ Juniper Ridge	Over	Under	At	Over
Alternative RRA-1C	At	Under	Under	At
Alternative RRA-2B	At	Under	Over	Over
Alternative RRA-2-2	Under	Under	At	Over
Alternative RRA-2-2 w/ Juniper Ridge	At	Under	Over	Over
Alternative RWA-3B-2	Under	Under	At	Over
Alternative RWA-3B-2 w/ Juniper Ridge	At	At	At	Over

The worst performing alternatives are Alternative RRA-1C, Alternative RRA-2B, and Alternative RWA-3B-2. These alternatives have significant volume shifts that either increase or decrease traffic volumes in an opposite manner. For example Alternative RWA-3B-2 frees up US 97 but causes significant issues on US 20. US 20, US 97/Bend Parkway, and Empire Avenue are the significant facilities in the project area. These roadways are the desired trip paths for most trips in the study area.

Any improvements on US 20, the US 97/Bend Parkway, and Empire Avenue will not see a large change because as these facilities are improved, trips that are currently diverting on parallel roadways will come back to their "desired" path and such will "fill up" any extra capacity on the roadway. Connections will need to be removed to permanently divert trips from these roadways.

Table 4. 2030 Northern Project Area Non-state Roads Capacity (d/c) Ranges

Scenario	Deschutes Mkt. Rd. from US 97 to Cooley Rd.	O.B. Riley Rd from Old Bend-Redmond Hwy to 3rd St.	Cooley Rd. from O.B. Riley Rd. to US 97	Cooley Rd. from US 97 to 18th St.
Committed	Under	**At**	Under	**Over**
Juniper Ridge	**Over**	**Over**	Under	**Over**
Juniper Ridge Plus UGB Expansions	**Over**	**Over**	Under	**Over**
Juniper Ridge w/ US 97 Interchange	**Over**	**Over**	Under	**At**
Alternative RWA-1	Under	**Over**	**Over**	**At**
Alternative RWA-1 w/ Juniper Ridge	**At**	**Over**	Over	**Over**
Alternative RWA-1-2	Under	**Over**	**Over**	**At**
Alternative RRA-1B	Under	**Over**	**At**	**Over**
Alternative RRA-1B w/ Juniper Ridge	**Over**	**Over**	**At**	**Over**
Alternative RRA-1C	Under	**Over**	**At**	**Over**
Alternative RRA-2B	Under	**At**	Under	**At**
Alternative RRA-2-2	**Over**	**Over**	Under	**At**
Alternative RRA-2-2 w/ Juniper Ridge	**Over**	**Over**	Under	**At**
Alternative RWA-3B-2	**Over**	**Over**	Under	**At**
Alternative RWA-3B-2 w/ Juniper Ridge	**Over**	**Over**	Under	**Over**

Alternative RRA-1C removes a large portion of trips from US 97 causing this section to be relatively free of congestion. However, the trips that once used this section now shift to US 20 and other parallel local roads causing overcapacity areas there. Alternative RWA-3B-2 does not function as well as the above as the direct connection allows smoother flow on US 97 like the other alternatives, but causes over-capacity issues on US 20 in the interchange area.

Alternative RRA-2B improves US 20 which attracts a large amount of trips which ends up causing overcapacity segments on US 20 and US 97. Local roads in the north half of the project area are relatively uncongested in this scenario. However, local roads in the

southern half do not fare as well as this alternative causes Revere Avenue and Reed Market Road to go over capacity as these roadways connect 3rd Street with US 97. The overcapacity sections outside the study area indicate that this alternative has a regional impact which will probably require significant capacity improvements to the state and local system. If capacity was unlimited, this alternative mirrors the desired trip paths considering where people want to go and the routes what they want to take. These impacts will require a regional effort (i.e. Transportation System Plan or RTP level) which is too extensive for a project development project and thus this alternative should be eliminated from consideration.

Table 5. 2030 Southern Project Area Non-state Roads Capacity (d/c) Ranges

Scenario	Empire Ave. from O.B. Riley Rd. to 18th St.	Butler Mkt. Rd. from 3rd St. to Boyd Acres Rd.	Revere Ave. from US 97 to 3rd St.	Reed Mkt. Rd. from Colorado Ave. to 3rd St.
Committed	Over	At	At	At
Juniper Ridge	Over	Over	At	At
Juniper Ridge Plus UGB Expansions	Over	At	At	At
Juniper Ridge w/ US 97 Interchange	Over	At	At	At
Alternative RWA-1	Over	Over	At	At
Alternative RWA-1 w/Juniper Ridge	Over	Over	At	At
Alternative RWA-1-2	Over	At	At	At
Alternative RRA-1B	Over	Over	At	At
Alternative RRA-1B w/ Juniper Ridge	Over	At	At	At
Alternative RRA-1C	Over	Over	Over	At
Alternative RRA-2B	Over	At	Over	Over
Alternative RRA-2-2	Over	Over	At	At
Alternative RRA-2-2 w/ Juniper Ridge	Over	Under	At	At
Alternative RWA-3B-2	Over	Over	At	At
Alternative RWA-3B-2 w/ Juniper Ridge	Over	Over	At	At

Travel Time Evaluation

The travel time evaluation indicates the overall network efficiency of a particular scenario. More congestion on a network equates to longer travel times. The travel times were based on five origin-destination (O-D) pairs. The travel time for each O-D pair was based on the shortest path by time between the two points in both directions. Depending on the congestion in a particular scenario, this might result in different shortest paths for

the opposite direction. For example, a path might use 3rd Street and US 20 to go north but use O.B. Riley Road to return south. The five O-D pairs were between the common 3rd Street and Revere Avenue intersection and the intersections of US 20/Old Bend-Redmond Highway, O.B. Riley Road/Old Bend-Redmond Highway, Robal Road/Hunnell Road, Cooley Road/Boyd Acres Road, and US 97 in the Juniper Ridge area. Table 6 shows the average travel time percent differences on US 20, US 97 and the overall study area between the each scenario and the Committed scenario.

Table 6. Average Travel Time Percent Differences with the Committed Scenario[1]

Scenario	US 20 Percent Difference from Committed Scenario	US 97 Percent Difference from Committed Scenario	Overall Study Area Average Percent Difference from Committed Scenario
Committed	0	0	0
Juniper Ridge	8	**24**	**13**
Juniper Ridge with US 97 Interchange	**10**	**24**	**16**
Juniper Ridge plus UGB Expansions	6	**28**	**12**
Alternative RWA-1	1	-8	-2
Alternative RWA-1-2	6	-8	-2
Alternative RWA-1 w/ Juniper Ridge	5	3	4
Alternative RRA-1B	**22**	**-15**	**11**
Alternative RRA-1B w/ Juniper Ridge	**27**	-9	**18**
Alternative RRA-1C	**37**	**-14**	**25**
Alternative RRA-2B	**-18**	**-19**	**-19**
Alternative RRA-2-2	-1	**-18**	-5
Alternative RRA-2-2 w/ Juniper Ridge	**23**	**-17**	**12**
Alternative RWA-3B-2	4	**-14**	-2
Alternative RWA-3B-2 w/ Juniper Ridge	6	-9	8

[1] Gray shaded cells indicate that travel time is significantly less than the committed scenario and black shaded cells indicate travel times that are significantly greater.

As expected, Juniper Ridge has a significant negative impact on the travel time over the Committed network and most of the alternative scenarios. Adding an interchange to US 97 for Juniper Ridge does not cause an additional significant travel time penalty over Juniper Ridge alone. Juniper Ridge has the most impact to Alternative RRA-2-2 mostly to US 20 and the local road system.

The alternatives with the western alignments (RWA-1 and RWA-3B-2) both do not have significant differences with the Juniper Ridge scenario. The roadway alignment is

significantly out of direction for Juniper Ridge traffic to access US 97 and thus uses 3rd Street instead. For example, only 10% of the Juniper Ridge traffic uses US 20 in Alternative RWA-3B-2 via Rogers Road.

The Alternative RWA-1 and RWA-1-2 scenarios do not have any significant travel time difference over the Committed scenario. Times do drop somewhat on US 97 and increase on US 20. Alternative 3B with or without Empire Avenue significantly drops travel times on US 97, but causes large increases on US 20. This is consistent with them shifting volumes from US 97 to US 20.

The best performer is the Alternative RRA-2B even though there are a number of serious bottlenecks with this alternative, so there are enough better-performing segments to balance the system out. This alternative is the only one to have a significant travel time decrease on US 20. For US 97, the best alternatives are the RRA family and Alternative RWA-3B-2. The best overall alternatives would be ones that significantly improve US 97 while not causing a significant travel time increase on US 20 or, secondarily, the local system. Alternative RRA-2-2 is the best in this regard with the second-largest overall travel time drop on US 97, US 20 and overall.

Alternative Comparison

Table 8 compares the scenarios together given the results from each of the evaluations whether a given scenario had a significant positive, negative or neutral effect. Travel times are the biggest differentiator as most of the other measures either have no significant effect like percent volume difference or are all have the same significant effect like US 20 Capacity.

From the analysis, the Alternative RWA-1-2 outperformed its Alternative RRA counterpart. While RWA-1-2 sometimes had no significant effect, RRA-1C generally had a negative effect on the system as this alternative shifts much more traffic on to US 20 increasing capacity problems on 3rd Street.

As with some of the individual evaluations, the best overall is the flawed Alternative RRA-2B. Because how this alternative changes the traffic patterns, it may significantly improve US 97 in the study area, but it make US 97 much worse outside the study area to the south along with US 20 and most larger local roadways. This alternative pushes problems to the outside of the study area. The impacts are amplified to a regional level so there are a number of them way outside of the study area such as Reed Market Road. The study area would need to be increased to cover most of Bend, which is out of scope for this project, to quantify all of the impacts.

Outside of the above alternative, the direct US 20-97 connection alternatives, RRA-2-2 and RWA-3B-2 are the best overall alternatives for the study area which should be forwarded on for more detailed analysis. Alternative RRA-2-2 performs slightly better than Alternative RWA-3B-2. These both improve the capacity and travel times significantly on US 97 but do not have too much of a negative effect on US 20.

Table 9 shows the overall effect of Juniper Ridge on each alternative family. As with Table 8, the travel time is the only item that varies very much. Juniper Ridge is large enough to have across-the-board negative impact on volumes and capacities. The best overall alternatives are the western alignments, RWA-1 and RWA-3B-2 mainly because that most Juniper Ridge traffic does not use US 20. Alternatives RRA-1B/C does the worst and Alternative RRA-2-2 is in the middle.

Table 8. Alternative Comparisons without Juniper Ridge Impacts[1]

	Alt RWA-1	Alt RWA-1-2	Alt RRA-1B	Alt RRA-1C	Alt RRA-2B	Alt RRA-2-2	Alt RWA-3B-2
Percent Difference -Committed	0	0	0	0	0	0	0
US 20 d/c range	-	-	-	-	-	-	-
US 97 d/c range	+	+	+	+	-	+	+
North Local Roads d/c range	-	-	-	-	+	-	-
South Local Roads d/c range	-	-	-	-	-	-	-
Travel Time - US 20	0	0	-	-	+	0	0
Travel Time – US 97	0	0	+	+	+	+	+
Travel Time - Overall	0	0	-	-	+	0	0

[1] "+" shows that a scenario has a significantly positive impact on the system which is equal to minimum or negative volume differences, d/c ranges and travel times; "0" is no significant change; "-" is a significant negative impact which is equal to high positive percent differences, d/c ranges and travel times.

Table 9. Alternative Family Comparisons with Juniper Ridge Impacts[1]

	Alt RWA-1	Alt RRA-1B/C	Alt RRA-2-2	Alt RWA-3B-2
Percent Difference - Committed	-	-	-	-
US 20 d/c range	-	-	-	-
US 97 d/c range	-	-	-	-
North Local Roads d/c range	-	-	-	-
South Local Roads d/c range	-	-	0	-
Travel Time - US 20	0	-	-	0
Travel Time – US 97	0	0	0	0
Travel Time - Overall	0	-	-	0

[1] "+" shows that a scenario has a significantly positive impact on the system which is equal to minimum or negative volume differences, d/c ranges and travel times; "0" is no significant change; "-" is a significant negative impact which is equal to high positive percent differences, d/c ranges and travel times.

Conclusions

All alternatives are not significantly different in volume differences from the Committed scenario. Because the Committed network is mostly at or over capacity, the alternatives are mostly just shifting traffic from one roadway to another without significant study area changes. All of the alternatives have a number of serious overcapacity problems somewhere on them. Some problems in the Committed scenario are addressed, some are created by the alternative itself, and some just push a problem downstream. Most of the alternatives have improved travel times on US 97 but degraded times on US 20 and the local system.

The direct US 20-97 connection alternatives, RRA-2-2 and RWA-3B-2, are the best overall alternatives resulting from this first-level screening analysis. Alternative RWA-1-2 should also be considered for further analysis as it was recommended as one of the best alternatives in many of the evaluation sections.

The Alternative RRA family does not fare very well overall especially considering that they are the most sensitive to the Juniper Ridge development. Alternative RRA-1C and Alternative RRA-2B (the original US 97/20 Refinement Plan alternative) have much larger scale impacts on the study area system to the point that the problems that they create may be more troublesome than the problems that they fix in the Committed scenario. Other than Alternative RRA-1B, which has some benefits to US 97, and the direct connection RRA-2-2 alternative, the other Alternative RRA alternatives should be dropped from further consideration.

Alternative RWA-1 fails to differentiate itself from the other westerly alignment alternatives. Alternative RWA-1-2 and Alternative RWA-3B-2 perform better, so analyzing Alternative RWA-1 further is not necessary as the other two will always outperform it.
Some other significant summary points from this screening analysis:

- The Committed scenario roadway network is generally at or over capacity in 2030.
- Significantly over capacity areas <u>not</u> addressed in alternatives are:
  - US 20 (Third Street) between O.B. Riley Rd. and Division Ave.
  - Empire Ave. between O.B. Riley Rd. and US 97 (Bend Parkway) northbound ramps
- US 97, US 20 and Empire Avenue are the desired paths for trips in the study area so improvements to these roadways will cause currently diverting trips to return which will end up minimizing any improvement impacts.
- Need to consider Juniper Ridge in the detailed analysis stage with a sensitivity analysis using +20% and +33% volume thresholds.
- Currently considered Bend UGB expansions beyond Juniper Ridge do not have a significant effect on the project area.

- Adding an interchange on US 97 between Cooley Road and Deschutes Market Road will increase volumes significantly on major routes in the study area as Juniper Ridge access becomes easier. A full-movement interchange on US 97 will amplify the effect of Juniper Ridge.

- The only benefit the additional US 97 interchange has to the highway system is to lessen the volume between this new interchange and the Deschutes Market Road interchange. Other local facilities such as Cooley Road, Empire Avenue, and Butler Market Road carry less Juniper Ridge trips if an interchange is in place. The interchange will primarily benefit the local system rather than the highway system.

- A full US 97 interchange for Juniper Ridge is not necessary as the partial interchanges plus local connectivity as shown in Alternatives RRA-2-2 and RWA-3B-2 have a similar benefit.

- The partial interchange with ramps to and from the north in Alternative RRA-2-2 and RWA-3B-2 keeps the vast majority (80%) of Juniper Ridge trips on 3rd Street while a full interchange will move these trips to US 97.

- A direct US 97-US20 connection does not have a significant study area impact.

Recommendation Summary

Table 10 shows the scenario recommendations from the first-level screening analysis. Note that the recommendations to drop from further consideration include the preferred alternatives (Alternative RWA-1 and RRA-2B) from the US 97/20 Refinement Plan.

Table 10. Recommendations

Scenario	Recommendation
Juniper Ridge with US 97 Interchange	Full Interchange not needed for project
Juniper Ridge plus UGB Expansions	Not needed for further analysis
Alternative RWA-1	Drop
Alternative RWA-1-2	Keep
Alternative RRA-1B	Tentatively Keep
Alternative RRA-1C	Drop
Alternative RRA-2B	Drop
Alternative RRA-2-2	Keep
Alternative RWA-3B-2	Keep

Next Steps

When the RTP (Metro Plan) is completed and the model's RTP scenario officially adopted by the MPO this first-level analysis may need to be partially repeated using the RTP scenario. This is only needed if the RTP scenario is found to be significantly

different from the Committed scenario in the project area and if there are more alternatives remaining than can be reasonably handled in the detailed analysis phase.

Upcoming steps involve creation of the 30th highest hour volumes for the existing condition analysis once all the traffic counts and field inventory data is collected this summer. Future 2030 design hour volumes will be created for each remaining alternative based on the adopted RTP model scenario. Analysis will be limited to key intersections only in order to further screen the alternatives down to no more than three (3) for detailed analysis.

If there are any questions or comments, please contact me at 503-986-4110.

---

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Martin Matesek, District 11/Region 4 Roadway
Joel McCarroll, Region 4 Traffic
Mary Lauzon, Region 4 Right-Of-Way
File

Figure J-2 US 97 Bend North Corridor - Committed Scenario

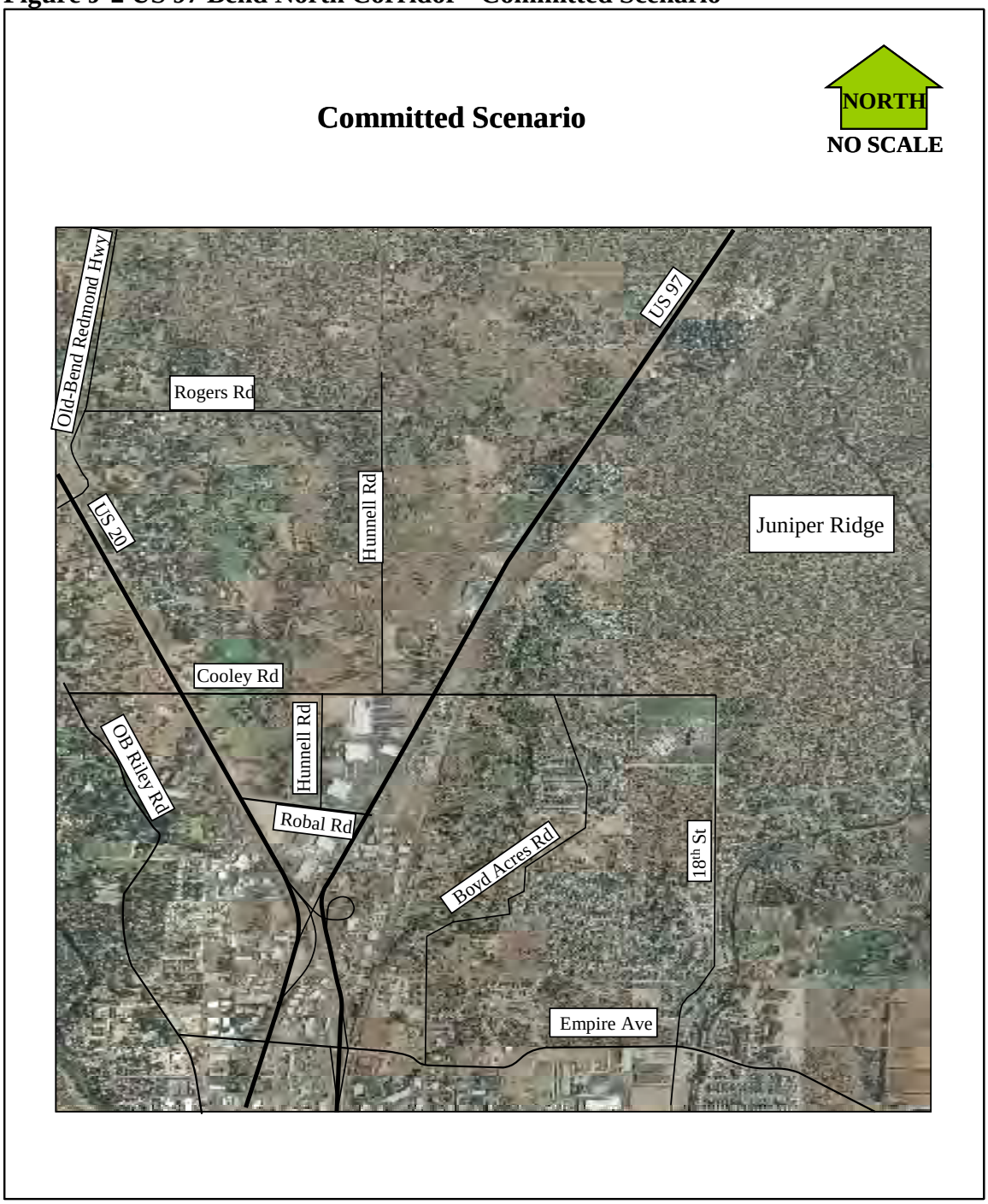

Figure J-3 US 97 Bend North Corridor - Juniper Ridge with US 97 Intch.

Juniper Ridge with US 97 Interchange

NORTH

NO SCALE

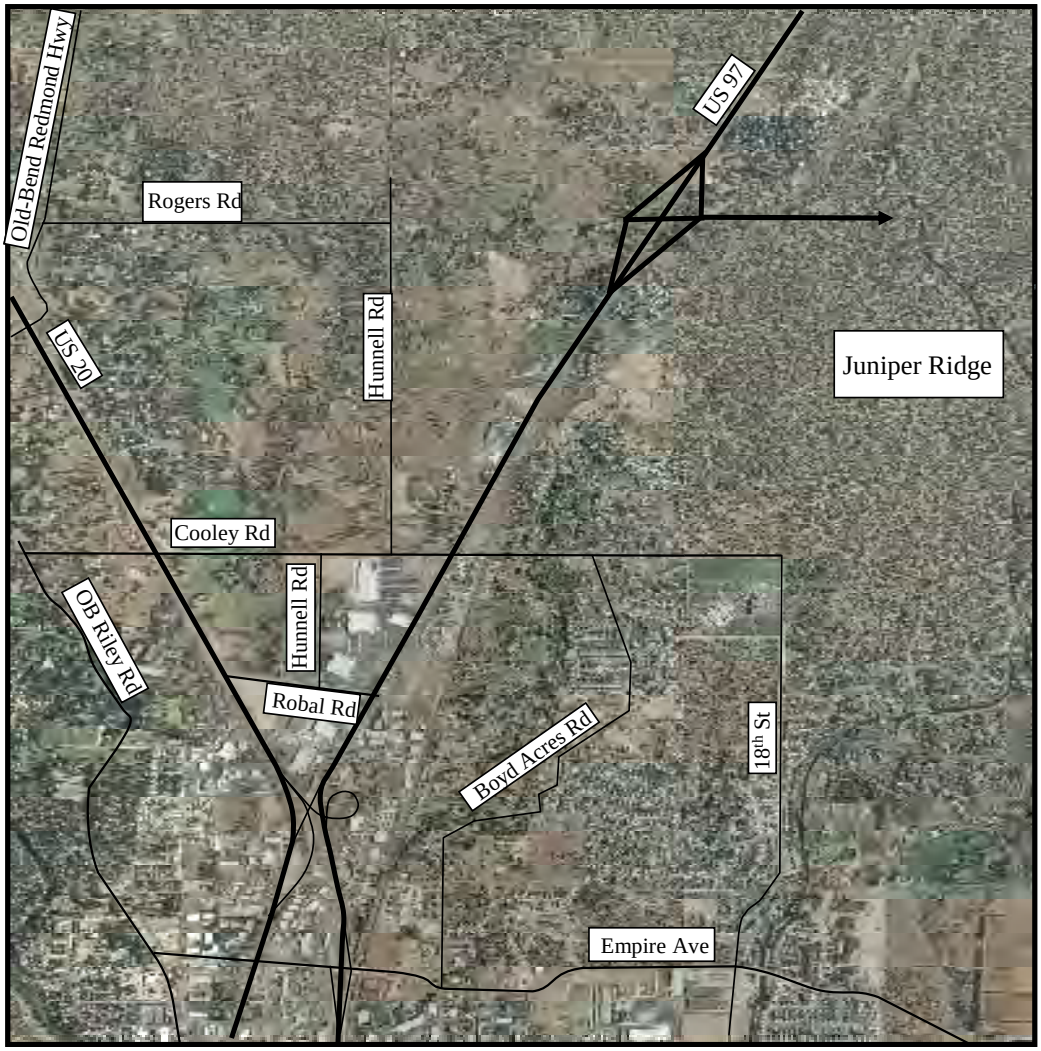

Figure J-4 US 97 Bend North Corridor - Alternative RWA-1

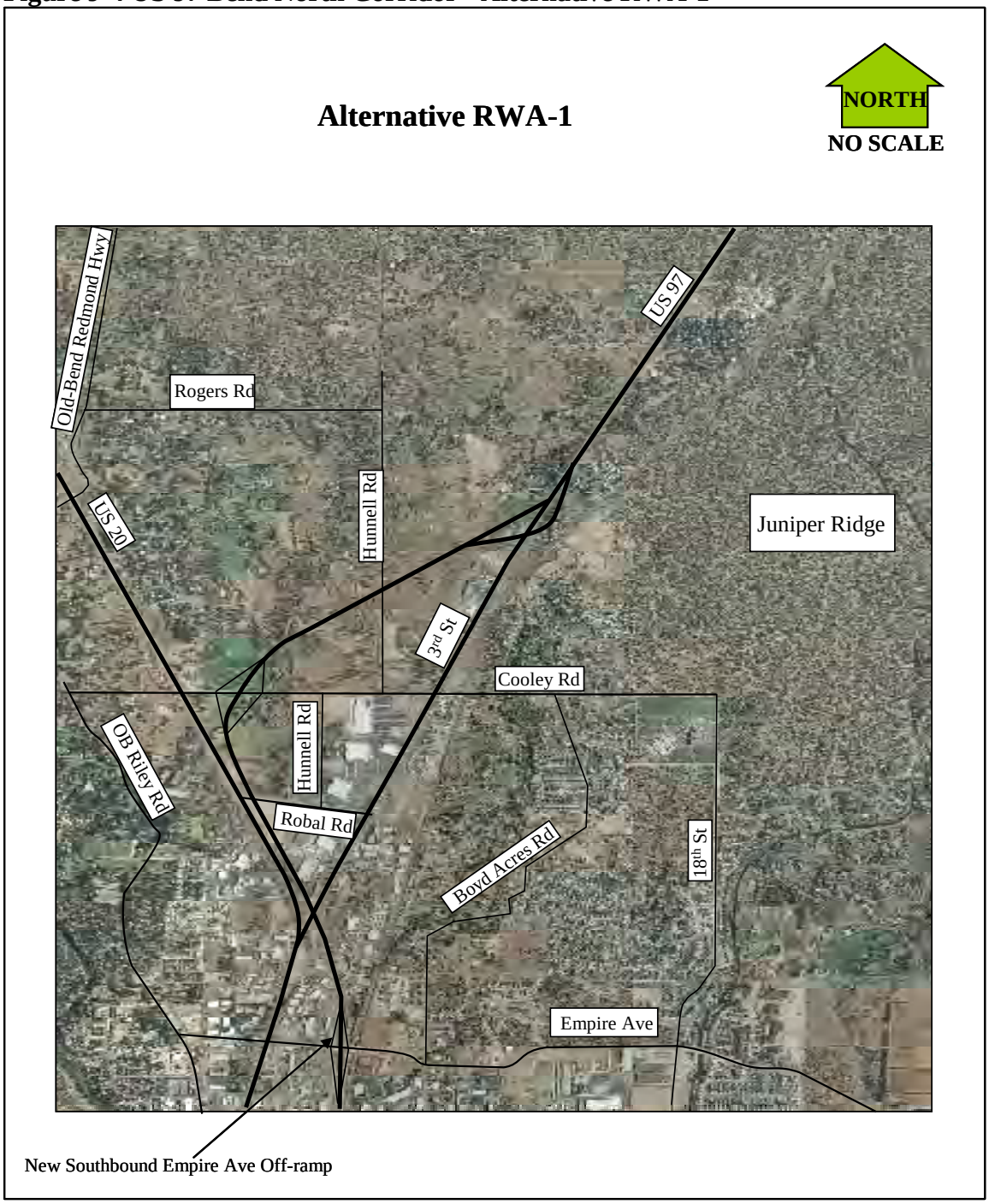

Figure J-5 US 97 Bend North Corridor - Alternative RWA-1

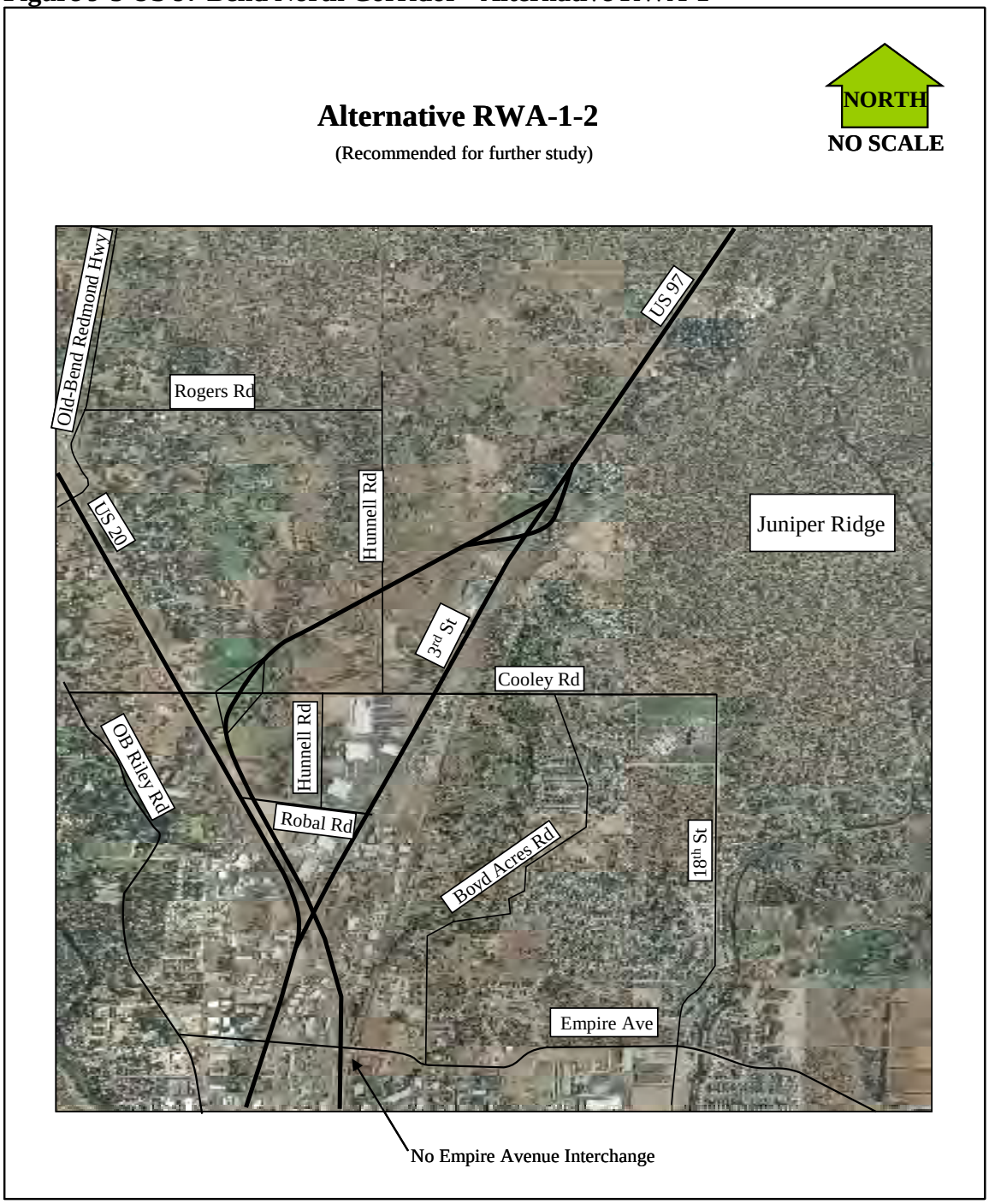

Figure J-6 US 97 Bend North Corridor - Alternative RRA-1B

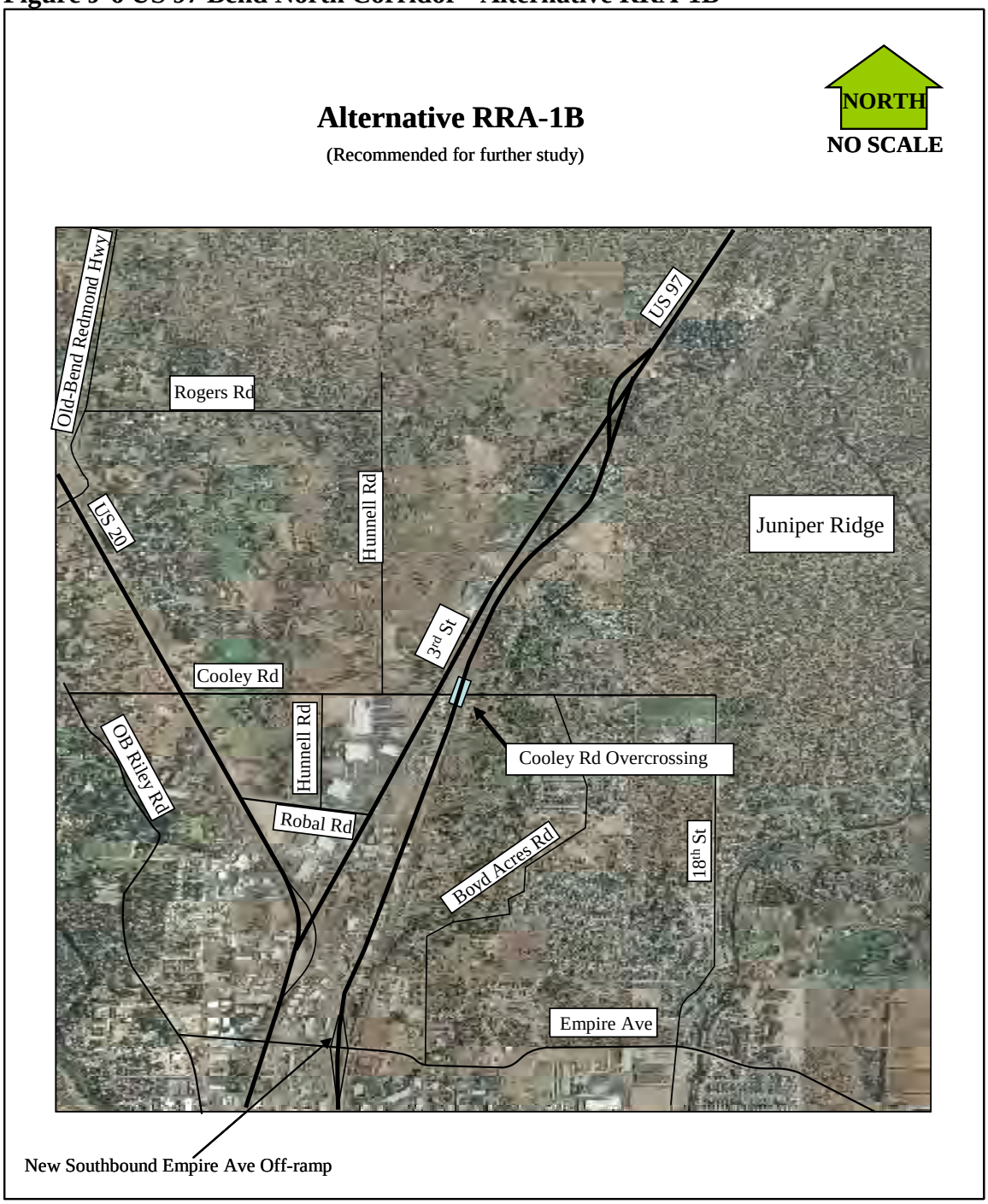

Figure J-7 US 97 Bend North Corridor - Alternative RRA-1C

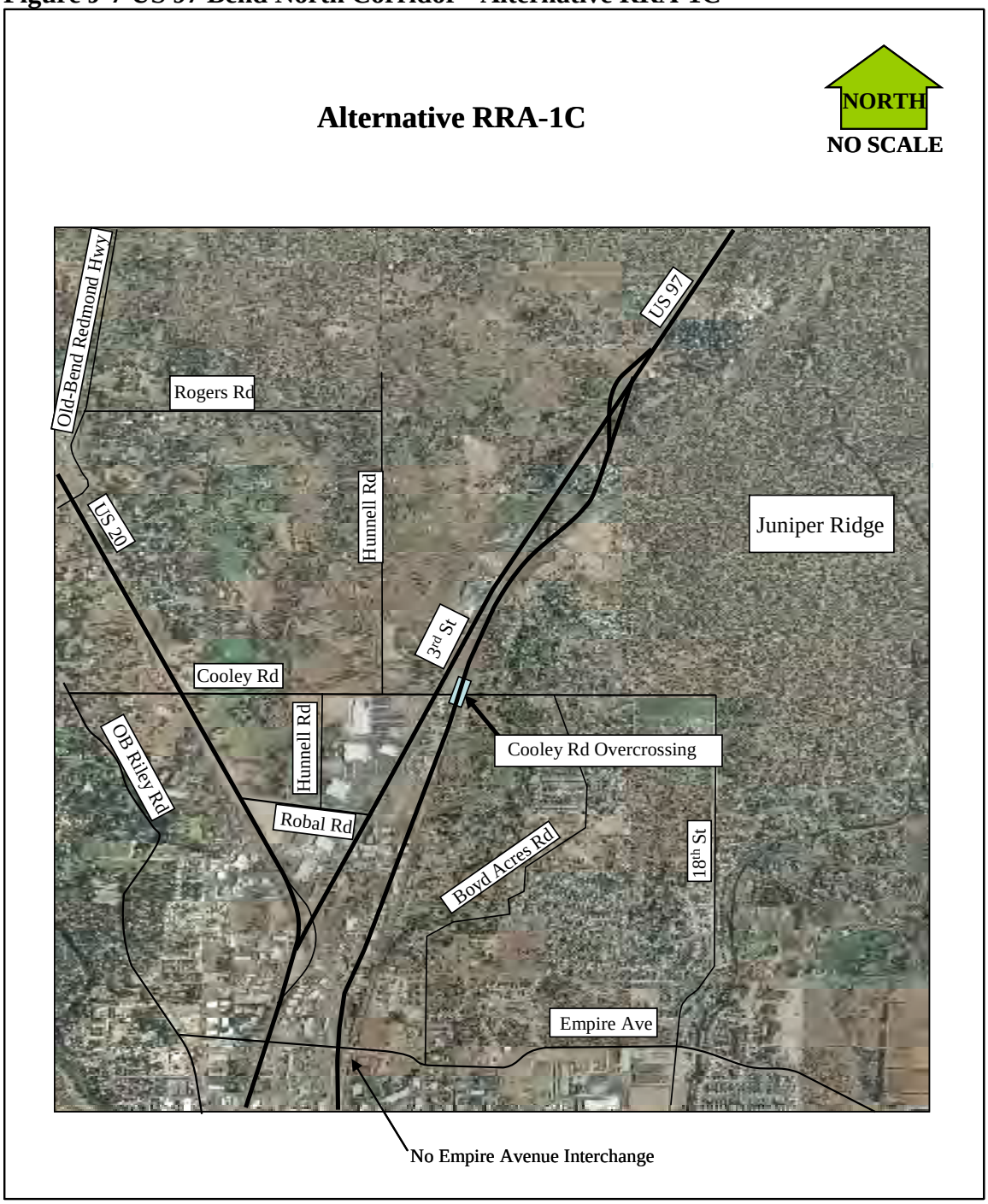

Figure J-8 US 97 Bend North Corridor - Alternative RRA-2B

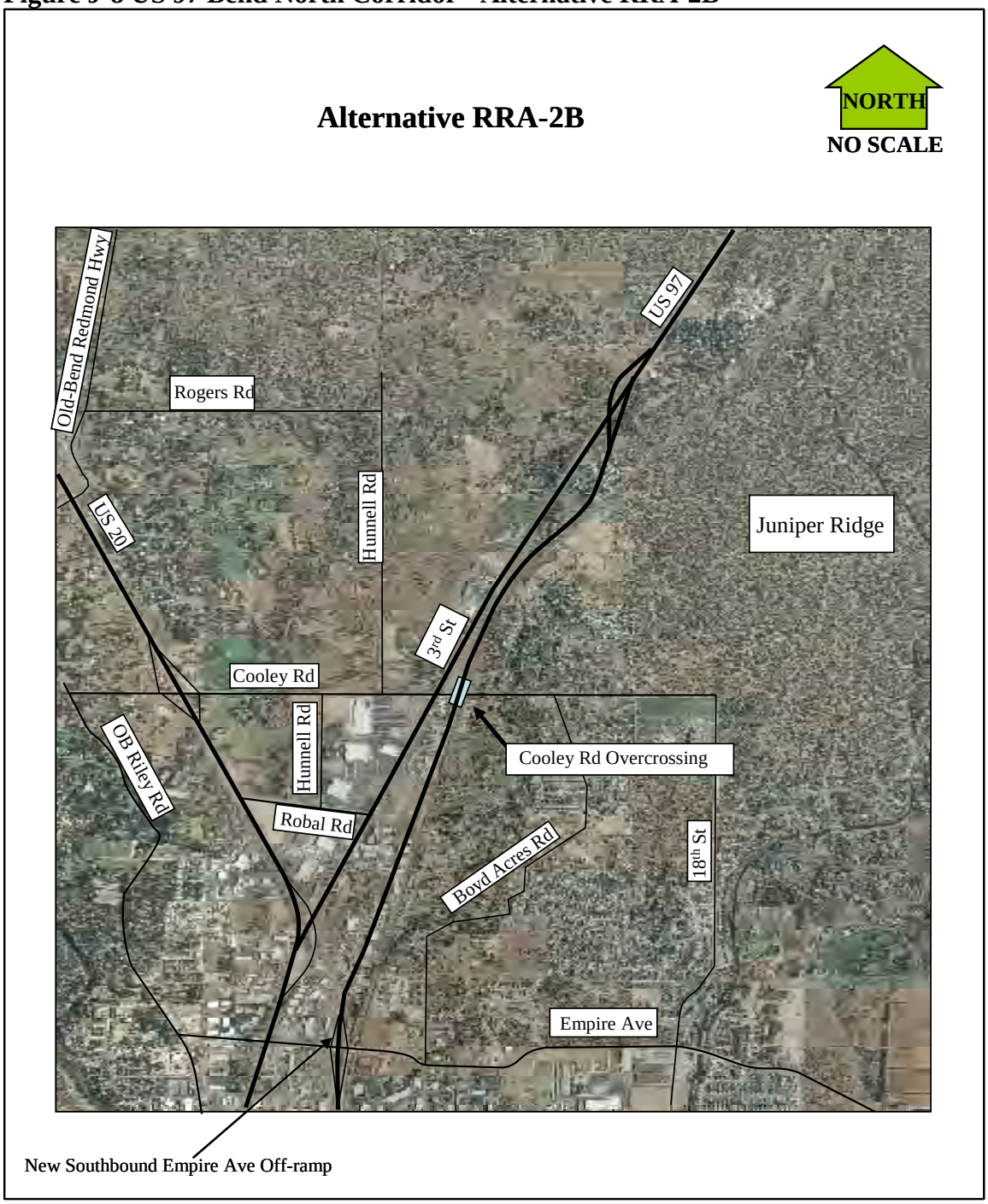

Figure J-9 US 97 Bend North Corridor - Alternative RRA-2-2

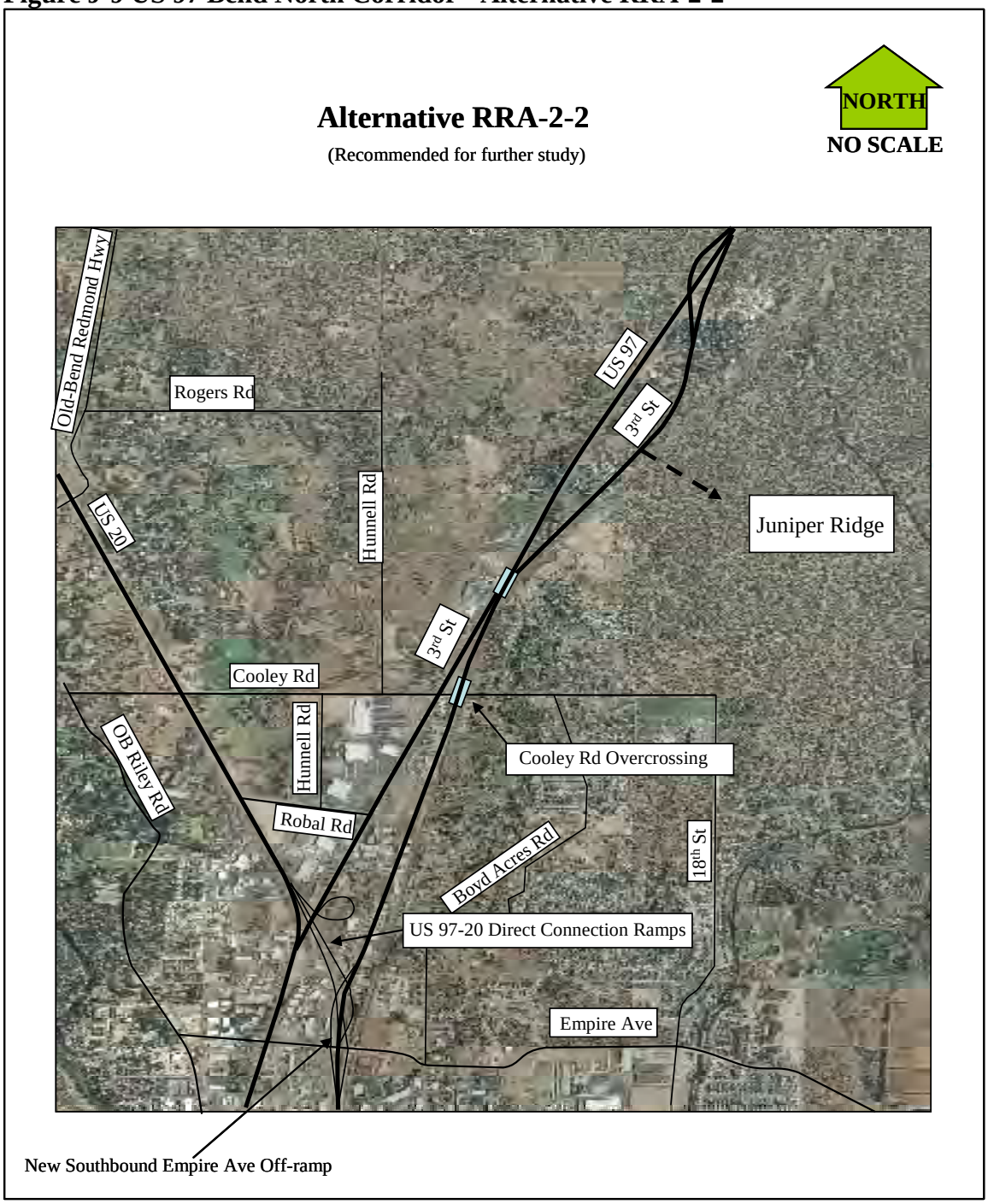

Figure J-10 US 97 Bend North Corridor - Alternative RWA-3B-2

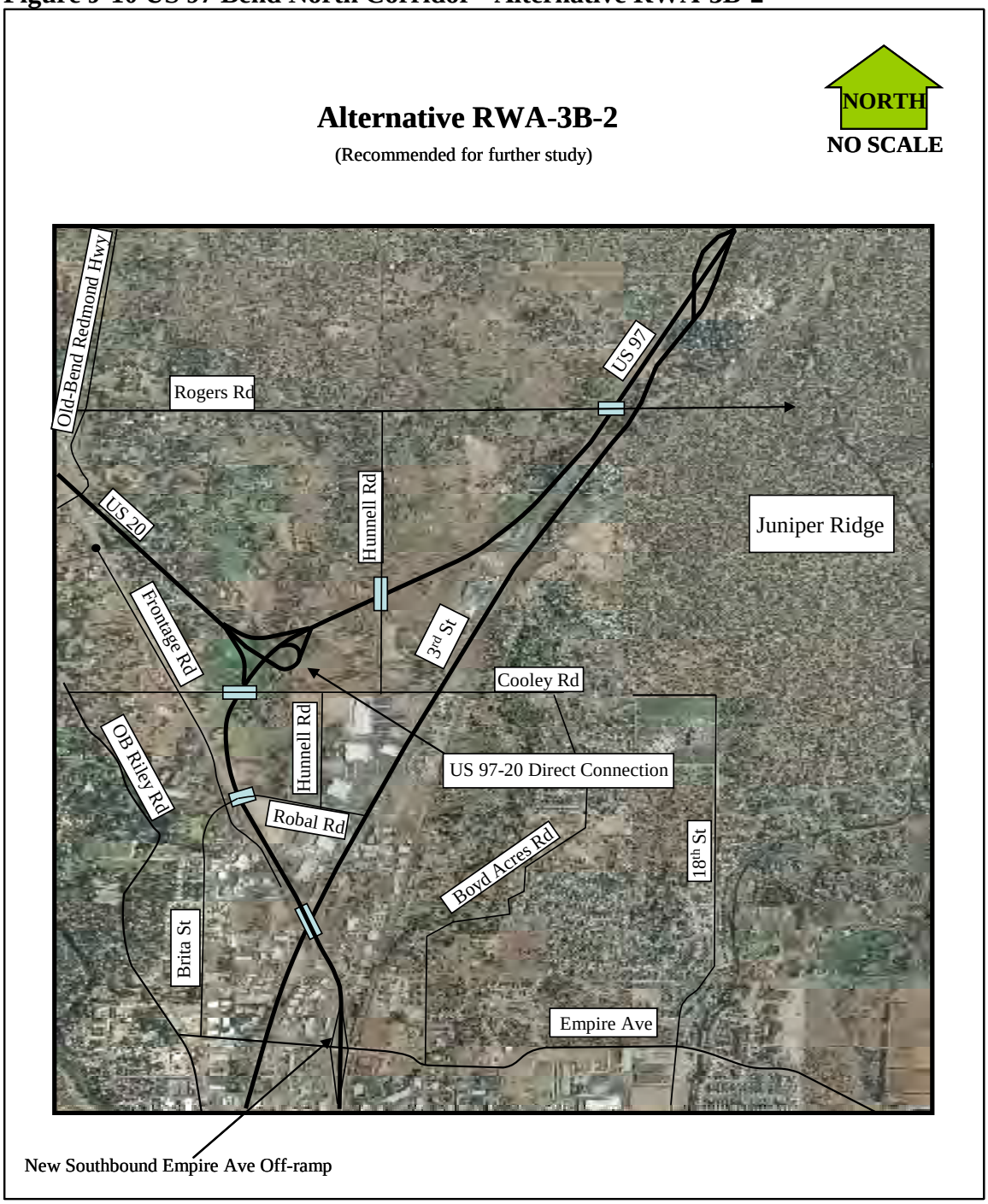

Figure J-11 US 97 Bend North Corridor - Screenline Locations

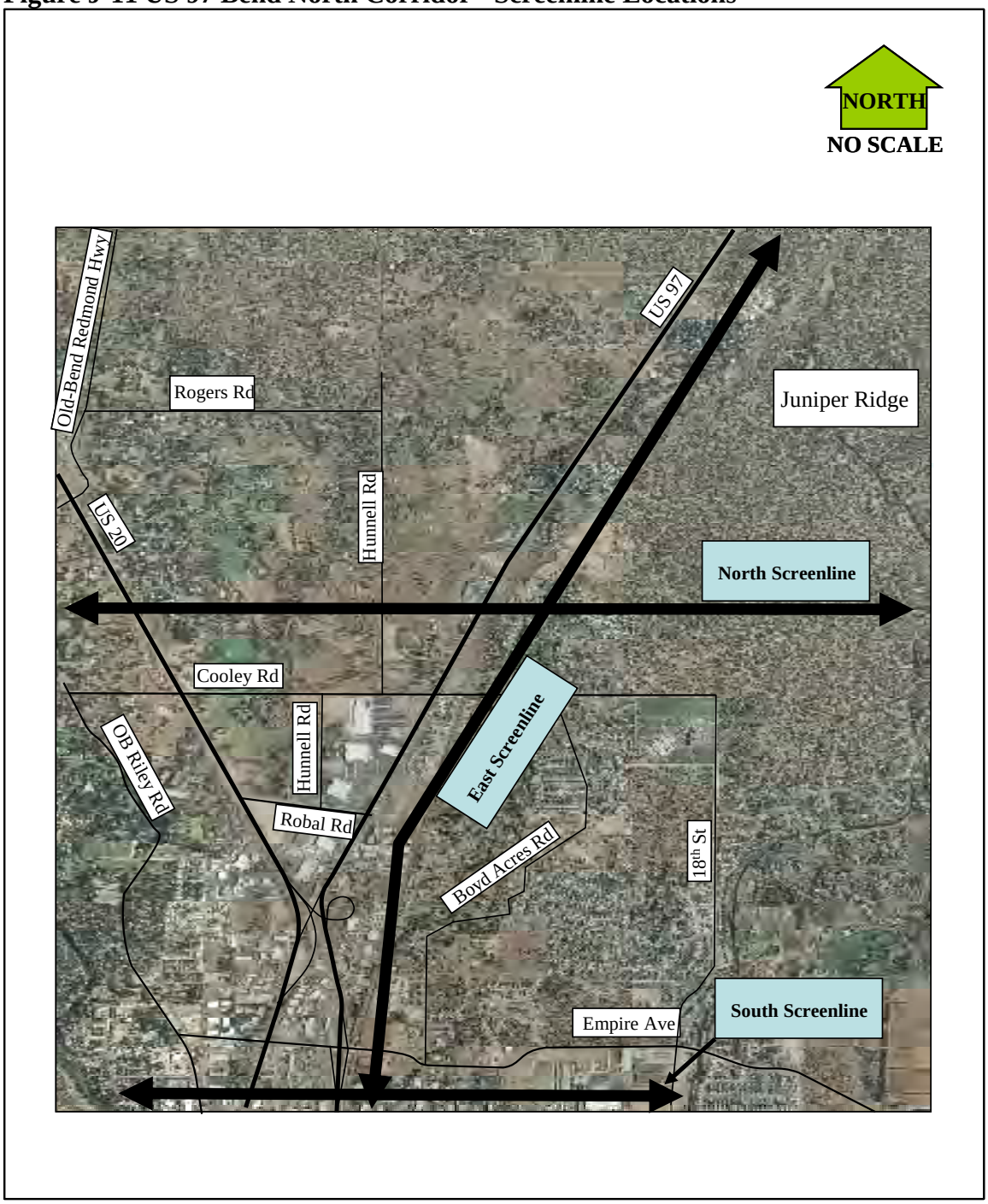

Figure J-12 Final: Technical Memorandum # 5: Purpose & Need Screen #2 Alternative Evaluations

STATE OF OREGON

INTEROFFICE MEMO

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File Code:

Date: May 16, 2008

TO: **Jon Heacock,**
US97 North Corridor Project Manager

FROM: **Peter L. Schuytema, P.E., Senior Transportation Analyst**
Transportation Planning Analysis Unit

SUBJECT: **FINAL: Technical Memorandum #5: Purpose & Need Screen #2 Alternative Evaluations**

This technical memorandum contains the results for the Purpose and Need secondary screening for the US97 Bend North Corridor project area. This screening level analysis is intended to compare and contrast the remaining six alternatives to determine their system-level impacts. Technical Memorandum #2, dated July 2, 2007, had the first round of transportation model-based screening analysis on general system scenarios and alternatives.

Summary

All of the alternatives have the potential to reduce congestion on US97. However, the main differences between the alternatives are how they address US20 and the local roadway system. The best alternatives are the direct connection alternatives RRA-2-2 and RWA-3B-2. It is recommended that RRA-1B and RWA-1-2 be dropped as these are outperformed by others in their class. Alternatives MM-1 and RWA-4 are recommended to be tentatively kept with modifications to the features and alignments.

Background

The BMPO (Bend Metropolitan Planning Organization) regional transportation model was used for this first-level analysis for the US97 Bend North Corridor project. Transportation models are a combination of mathematical equations and relationships using locally-provided existing housing and employment information to project future

traffic conditions. These future traffic conditions are placed on a network which is similar to the actual roadway network. An individual scenario was created for each conceptual alternative. These scenarios were compared together on a relative basis (proportions and percents) rather than using the actual volumes reported on each segment or "link" to find the differences between them. The actual model volumes cannot be directly used because the model is just mathematical relationships and needs to be tied to actual traffic volumes.

The future 2030 Committed network were used in order to stay consistent with Technical Memorandum #2 dated July 2, 2007. The "Committed" designation means that the network included all the city, county and state projects that are listed in a funding committed construction program (i.e. ODOT's Statewide Transportation Improvement Plan; STIP) in the Bend metro area. These projects are assumed to occur regardless of what happens in the US97/20 project area.

Additionally, volumes can easily fluctuate 10% over a given week, so this analysis uses a 10% threshold for determining if a change makes a difference (i.e. significant). It should be noted that not every detail is large enough for a model to see relative differences between (e.g., signals, residential street alignments, or whether an interchange ramp is straight or a loop). All of the scenarios were evaluated on a volume, capacity, and travel time basis. The scenarios were compared on a relative basis for each of the three evaluations with the committed scenario.

Scenario Descriptions

Two new alternatives were identified by the project traffic/design sub-team and are evaluated along with the results of the Committed, Juniper Ridge and the four successful alternatives out of Technical Memo #2 (Alternatives RRA-1B, RRA-2-2, RWA-1-2, and RWA-3B-2).

The Committed network and the alternative scenario networks were additionally tested by adding in the proposed Juniper Ridge development. This scenario adds in the additional 1,000 acre Juniper Ridge development urban growth boundary (UGB) expansion as of April 2007. Five hundred acres are already currently included in the UGB. Connections to the Juniper Ridge area are via existing roads, namely Cooley Road and Deschutes Market Road. A figure and related description of each scenario follow.

Figure 1: Committed Scenario

This scenario includes all of the city, county and state projects that are listed in a funding committed construction program (i.e. ODOT's Statewide Transportation Improvement Plan; STIP) in the Bend metro area. Technical Memorandum #2 explained the issues surrounding the Committed scenario, so it is purely included in this memorandum as a comparison for the alternatives.

Figure 2: Alternative MM-1

The Alternative MM-1 scenario leaves US97 on its existing alignment with all existing at-grade street and driveway connections closed. Cooley Road and Robal Road both overcross US97. Third Street is extended northward behind the Cascade Village Mall approximately following the Hunnell Road alignment to eventually connect back to US97 via a partial directional interchange. Nels Anderson Rd is extended over US97 to give access to the business area north of Empire Avenue. A new southbound off-ramp would be added to the Empire Avenue interchange making it a full diamond interchange.

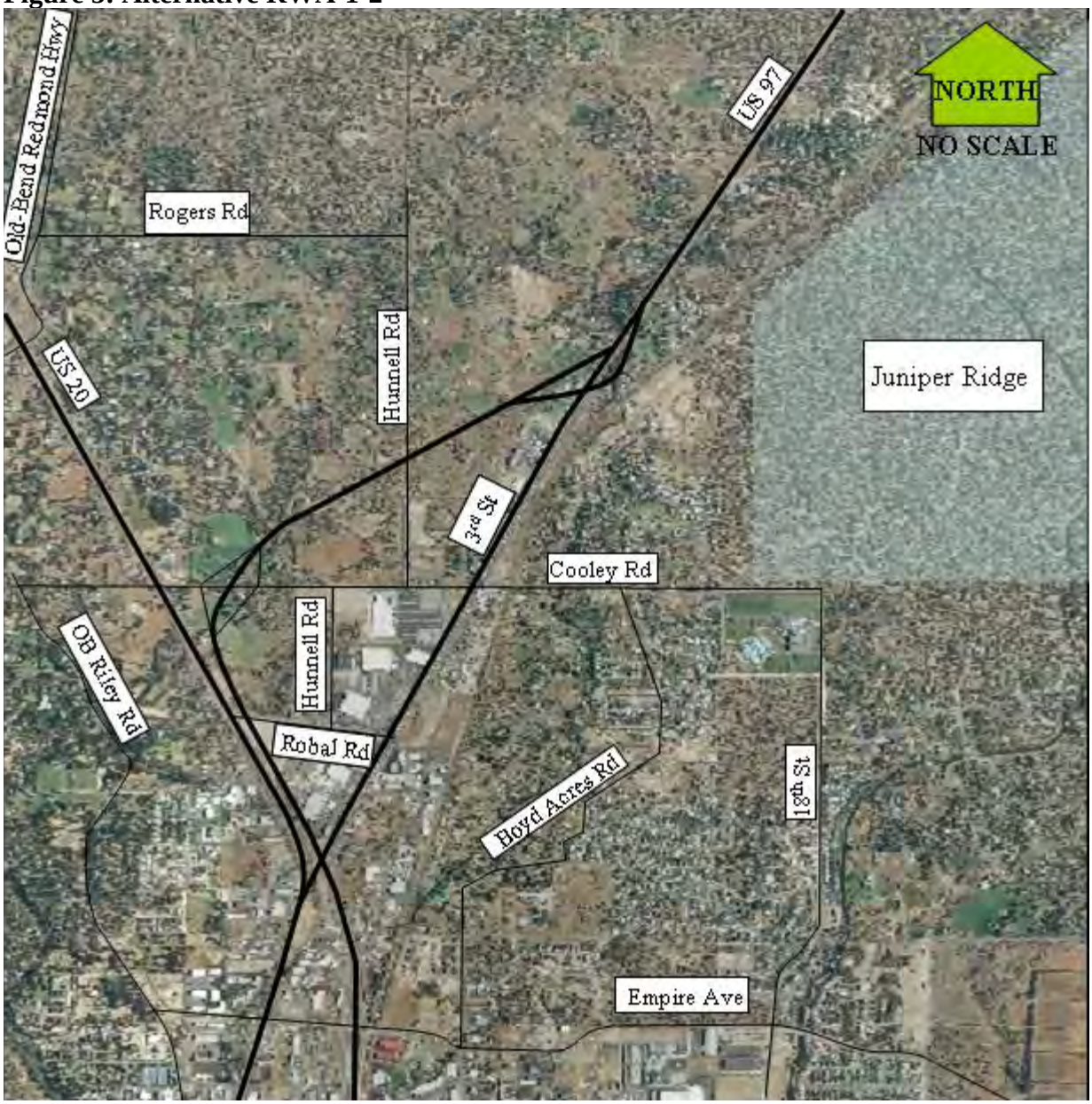
Figure 3: Alternative RRA-1B

The Alternative RRA-1B (Revised Rail Alignment) scenario moves US97 to the east to parallel the west side of the BNSF railroad tracks. There is no direct connection to US97 from US20 and US97 overcrosses Cooley Road. The US20 westbound loop ramp would be removed. Third Street (original US97 alignment) connects with Cooley Road and connects back into US97 north of Cooley Road in a partial interchange. A new southbound off-ramp would be added to the Empire Avenue interchange making it a full diamond interchange.

Figure 4: Alternative RRA-2-2

The Alternative RRA-2-2 adds new northbound and southbound direct connection ramps between US20 and US97. The existing US20/3rd Street ramps and the westbound US20 loop ramp would remain, however, the loop ramp would now connect to 3rd Street instead of US97. A new southbound off-ramp would be added to the Empire Avenue interchange making it a full diamond interchange. Third Street would continue northward, crossing under the new alignment of US97 in the vicinity of the Deschutes Memorial Gardens cemetery paralleling US97 and the BNSF railroad tracks. Third Street will eventually connect back into US97 via a partial interchange allowing free-flow access to and from the north. The main Juniper Ridge access would connect to the 3rd Street extension about halfway between the US97/3rd Street partial interchange and the US97 overcrossing.

Figure 5: Alternative RWA-1-2



The Alternative RWA-1-2 (Revised Westerly Alignment) scenario moves US97 to the west paralleling US20 and goes around the west side of the "Golden Triangle" area connecting back into the original US97 alignment north of Cooley Road with a partial interchange. A full-movement interchange with Cooley Road is provided, however there is no direct US97 – US20 connection. The Empire Avenue Interchange ramps have been removed, leaving Empire Avenue as just an overcrossing of US97/Bend Parkway.

Figure 6: Alternative RWA-3B-2

In the Alternative RWA-3B-2 scenario, US97 would be completely disconnected from Third Street. A new southbound off-ramp would be added to the Empire Avenue interchange making it a full diamond interchange. Robal, Cooley, and Hunnell Roads would overcross US97. Robal Road would be extended to connect with the north end of Brita Street and to a frontage road connecting with Cooley Road. Rogers Road would be extended westward to directly connect with US20 and O.B. Riley Road and extended eastward over US97 and the railroad to connect with the northern extension of 3rd Street. US20 would directly connect to US97 north of Cooley Road with a directional trumpet-style interchange. Third Street would continue northward, paralleling US97 and connecting back into US97 via a partial interchange. The main Juniper Ridge access would connect to the 3rd Street extension at the Rogers Road intersection.

Figure 7: Alternative RWA-4

The Alternative RWA-4 scenario has a similar alignment as the other RWA alternatives. The main difference is that there are no interchanges between the northern partial interchange and the Empire Avenue interchange. A new southbound off-ramp would be added to the Empire Avenue interchange making it a full diamond interchange.

Scenario Results

Volume Evaluation

The volume evaluation indicates how much extra traffic is attracted to or diverted away for a given scenario when compared to the Committed or Committed + Juniper Ridge

scenarios. The scenarios were evaluated along screenlines cutting across the major facilities in the study area north of Cooley Road, south of Empire Avenue, and east of US97 (Figure 8). Scenario model volumes on each major facility were summed up for each screenline and compared to the Committed scenario.

Figure 8: Screenline Locations

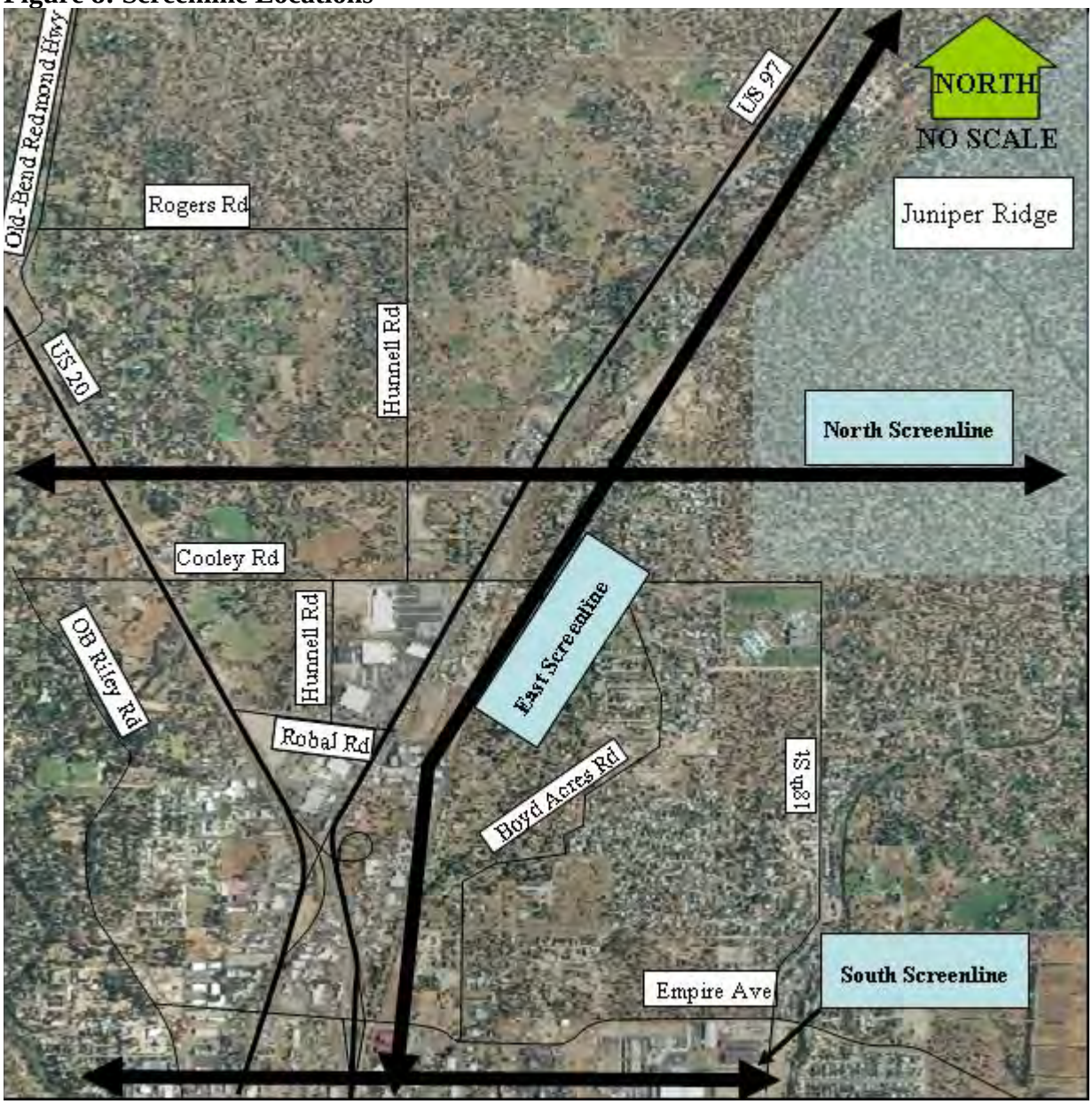


Table 1 shows the north screenline model volume percent difference for each alternative scenario when compared to the Committed with or without the Juniper Ridge development. Table 1 shows the effectiveness of an alternative in removing local trips from the highway system and the alternative's relative sensitivity toward the Juniper Ridge development. All of the alternatives remove greater than 20% of traffic from US97. Alternative RRA-1B pulls the least at 22% while RWA-1-2 and RWA-4 pull off the most at 35%. The direct connection RRA-2-2 will add a small amount of traffic to US20 while its westerly companion RWA-3B-2 removes a significant portion. In Alternative RRA-2-2, US20 is used for access to the local street system in the "triangle" area, while in RWA-3B-2, US20 can only be practically used by longer-distance trips as significant out of direction travel will be required for a local trip to access the "triangle

area." Alternative MM-1 is the only alternative to significantly remove traffic from the local street system which is added to US20/3rd Street.

Table 1. North Screenline Percent Difference from Committed Scenario[1]

	US97		US20		Local Roads[2]	
Scenario	**w/o JR**	**w/JR**	**w/o JR**	**w/JR**	**w/o JR**	**w/JR**
Committed	0	**46**	0	4	0	**59**
Alternative MM-1	**-26**	**23**	-1	6	**-16**	**42**
Alternative RRA-1B	**-22**	**20**	**-21**	**-10**	4	**63**
Alternative RRA-2-2	**-29**	**-18**	4	**-13**	-2	**45**
Alternative RWA-1-2	**-35**	0	-7	0	2	**58**
Alternative RWA-3B-2	**-31**	**-35**	**-16**	**-19**	1	**60**
Alternative RWA-4	**-35**	**12**	**-16**	**-17**	-3	**34**

[1] Black shaded cells indicate a significant negative impact at the screenline because of increased volumes. Gray shaded cells indicate a significant positive impact at the screenline because of decreased volumes.
[2] Local roads include O.B. Riley and Deschutes Market Roads.

The Juniper Ridge development adds 46% more traffic to US97 in the committed scenario. All of the alternatives mute the impact from Juniper Ridge. The RWA-class alternatives have the best performance and Alternative MM-1 and RRA-1B have the worst performance. These two alternatives along with RWA-4 are also the most sensitive to the Juniper Ridge development with 40+% impacts on US97. These alternatives have a large portion of the Juniper Ridge traffic using Deschutes Market Road to access US97 rather than traveling south to access Cooley Road which then can access the "triangle" commercial area and other points south. Alternative MM-1 and RRA-1B have the extension of 3rd Street on the west "wrong" side of US97 which limits or prevents easy access to Juniper Ridge. Alternative RWA-4 has the Rogers Road extension into the Juniper Ridge area but it is not very effective in drawing off much volume as it is relatively slow. Alternatives with a 3rd Street extension on the east side of US97 (i.e. RRA-2-2 and RWA-3B-2) allow for more direct access into Juniper Ridge that quickly gets traffic to the local system with a none or small significant impact to the state system.

The direct connection alternatives RRA-2-2 and RWA-3B-2 still have volumes significantly less than the committed scenario with or without Juniper Ridge. Alternative RWA-3B-2 is the only one not to be significantly affected by Juniper Ridge on the state system because of how US20 is connected which limits short-distance local trips. Alternative RWA-1-2 keeps the systems at the Committed scenario volumes because of the lack of Empire Avenue ramp connections. All of the alternatives and the Committed scenario have large increases on the local system when Juniper Ridge is added.

Table 2 shows the south screenline model volume percent difference for each alternative scenario when compared to the Committed with or without the Juniper Ridge development. This table shows the alternative impacts to the roadway system south of Empire Avenue (southern project limit) to the 3rd Street undercrossing just south of Butler Market Road.

All of the alternatives except for the direct connection alternatives RRA-2-2 and RWA-3B-2 have significant reductions on the Bend Parkway portion of US97. The direct connection alternatives combine US20 and US97 together which puts extra traffic on this section of US97. Depending on the alternative this impact is anywhere from 12 to 18% more traffic. Because of the section of US97 south of the 3rd Street undercrossing is overcapacity, any connections to take US20-bound traffic off of US97 (like a new southbound US97 to eastbound US20/southbound 3rd Street flyover ramp) should occur before this section is reached.

The direct connection alternatives do not add a significant amount of traffic to US20/3rd Street because that traffic will stay on US97 for longer distances. All of the other alternatives have substantial increases on US20/3rd Street because of the extension of 3rd Street which will attract a higher proportion of local trips. Only Alternative RRA-1B and RWA-1-2 have a significant impact to the local street system south of Empire Avenue. Alternative RRA-1B puts more traffic mainly on O.B. Riley Road while RWA-1-2 adds substantial traffic to Boyd Acres Road and 18th Street.

Table 2. South Screenline Percent Difference from Committed Scenario[1]

	US97		US20/3rd St		Local Roads[2]	
Scenario	**w/o JR**	**w/JR**	**w/o JR**	**w/JR**	**w/o JR**	**w/JR**
Committed	0	7	0	5	0	**10**
Alternative MM-1	**-13**	3	**24**	**27**	3	**16**
Alternative RRA-1B	**-18**	-6	**13**	**13**	**14**	**17**
Alternative RRA-2-2	-1	8	1	**11**	0	**16**
Alternative RWA-1-2	**-23**	-2	**18**	**17**	**19**	**22**
Alternative RWA-3B-2	-6	6	5	**17**	3	**19**
Alternative RWA-4	**-24**	-7	**32**	**32**	8	**13**

[1]Black shaded cells indicate a significant negative impact at the screenline because of increased volumes. Gray shaded cells indicate a significant positive impact at the screenline because of decreased volumes.
[2]Local roads include O.B. Riley and Boyd Acres Roads and 18th Street.

Juniper Ridge has no significant impact to US97 south of the project area, but it will to US20/3rd Street as the local trips eventually filter down onto 3rd Street. Juniper Ridge has significant impacts to all alternatives for US20/3rd Street and local roadways.

Table 3 shows the east screenline model volume percent difference for each alternative scenario when compared to the Committed with or without the Juniper Ridge development. This table shows the alternative impacts to the major east-west local roadways in the study area.

Only Alternative MM-1 and RRA-2-2 have significant reductions in traffic on Cooley Road. These are also the only alternatives not to have volumes with Juniper Ridge higher than the Committed scenario. These two alternatives also have similar overall study area volume patterns. Alternative MM-1 shifts more traffic southward to Empire and Butler Market Roads when compared to the other alternatives which lightens the impact on Cooley Road. Alternative RRA-2-2 has substantial traffic from Juniper Ridge accessing the 3rd Street extension which allows it to bypass Cooley Road.

Table 3. East Screenline Percent Difference from Committed Scenario[1]

	Cooley Rd		Empire Ave	
Scenario	**w/o JR**	**w/JR**	**w/o JR**	**w/JR**
Committed	0	**18**	0	5
Alternative MM-1	**-13**	-3	2	9
Alternative RRA-1B	8	**12**	-5	5
Alternative RRA-2-2	**-15**	0	1	2
Alternative RWA-1-2	1	**20**	**-15**	**-12**
Alternative RWA-3B-2	-9	**12**	1	9
Alternative RWA-4	9	**14**	**-13**	1

[1]Black shaded cells indicate a significant negative impact at the screenline because of increased volumes. Gray shaded cells indicate a significant positive impact at the screenline because of decreased volumes.

Only Alternative RWA-1-2 and RWA-4 have significant reductions in traffic on Empire Avenue. The fact that Alternative RWA-4 has similar reductions to Alternative RWA-1-2 means that a single interchange will work just as well at Empire Avenue than at Cooley Road without removing any existing Empire Avenue ramp connections. Only Alternative RWA-1-2 still has a significant reduction on Empire with Juniper Ridge.

Capacity Evaluation

The capacity evaluation indicates if certain roadway segments would be likely over capacity and if certain alternative scenarios had less capacity available than the Committed "no-build" scenario. Eleven state segments on US97 and US20 were evaluated along with ten segments on local roadways from Deschutes Market Road south to Reed Market Road. Model demand-to-capacity (d/c) ratios are mid-block or segment based and they can only be relatively compared on a large-scale basis such as below, at, or over capacity. They cannot be compared with the Oregon Highway Plan or Highway Design Manual volume-to-capacity ratios as these require that volumes are based on the 30th highest hour from actual ground counts.

Tables 4 and 5 show the 2030 d/c ratio-based capacity ranges for US97 and US20. Tables 6 and 7 show the capacity ranges for the local system. The tables are broken out in three tiers which are under capacity (d/c's less than 0.90), at capacity (0.90 to 1.10 d/c), and over capacity (over 1.10 d/c). Because model capacities are generally less than the detailed operational capacities the below capacity links are likely relatively free of issues; at capacity links likely have significant problems but are probably solvable; and over capacity links indicate a serious issue that will require a large amount of improvements or will result in outstanding capacity issues. None of the alternative scenarios are free of any over-capacity segments.

Table 4. US97: 2030 Capacity (d/c) Ranges

Scenario	Deschutes Mkt. Rd. to Cooley Rd.	Cooley Rd to Empire Ave.	Empire Ave. to 3rd St. Undercrossing	3rd St. Undercrossing to Colorado Ave.
Committed	At	**Over**	At	**Over**
Juniper Ridge	**Over**	**Over**	At	**Over**
Alternative MM-1	**Under**	**Under**	At	**Over**
Alternative MM-1 w/ Juniper Ridge	**Over**	At	**Over**	**Over**
Alternative RRA-1B	**Under**	**Under**	At	**Over**
Alternative RRA-1B w/ Juniper Ridge	**Over**	**Under**	At	**Over**
Alternative RRA-2-2	**Under**	**Under**	At	**Over**
Alternative RRA-2-2 w/ Juniper Ridge	At	**Under**	**Over**	**Over**
Alternative RWA-1-2	**Under**	**Under**	**Under**	**Over**
Alternative RWA-1-2 w/ Juniper Ridge	**Over**	At	At	At
Alternative RWA-3B-2	**Under**	**Under**	At	**Over**
Alternative RWA-3B-2 w/ Juniper Ridge	At	At	At	**Over**
Alternative RWA-4	**Under**	**Under**	**Under**	**Over**
Alternative RWA-4 w/ Juniper Ridge	**Over**	**Under**	At	**Over**

Other than the overcapacity section of US97 south of the 3rd Street undercrossing just south of Butler Market Road, the alternatives have a wide variation in d/c ratio as shown in Table 4. All of the alternatives provide a positive significant benefit from Deschutes Market Road south to Empire Avenue. The lack of an Empire Avenue interchange keeps volumes low south of Empire in Alternative RWA-1-2, however, the same benefit in having a single interchange is realized in Alternative RWA-4 without removing the Empire Avenue interchange. In addition, keeping the Empire Avenue interchange in place will keep the project more consistent with Bend's Transportation System Plan (TSP). Having a direct connection between US20 and US97 minimizes the impact of Juniper Ridge on US97 north of Empire Avenue in Alternatives RRA-2-2 and RWA-3B-2 as short-distance trips cannot use US20 effectively.

US20 in the project area has generally the same performance across the alternatives as shown below in Table 5. Juniper Ridge has very little impact as few trips use US20 from the development. US20 from the northern project limit to Cooley Road is generally under capacity as this section is mostly three or four lanes. Between Cooley and Empire, US20 is overcapacity so additional lanes are needed in this section. A good portion of traffic turns onto Empire Avenue, so the section south of Empire Avenue to O.B. Riley Road in the less dense section of 3rd Street, is about at capacity. South of O.B. Riley Road in the

dense commercial section, US20 is overcapacity in this section mainly because of additional traffic added from O.B. Riley and Butler Market Roads. New lanes are unlikely to be added so this section will continue to be a bottleneck.

Table 5. US20: 2030 Capacity (d/c) Ranges

Scenario	Old Bend-Redmond Hwy to Cooley Rd.	Cooley Rd. to Empire Ave.	Empire Ave. to O.B. Riley Rd.	O.B. Riley Rd, to US97 Overcrossing
Committed	**Under**	**Over**	At	**Over**
Juniper Ridge	**Under**	**Over**	At	**Over**
Alternative MM-1	**Under**	**Over**	At	**Over**
Alternative MM-1 w/Juniper Ridge	**Under**	**Over**	At	**Over**
Alternative RRA-1B	**Under**	**Over**	At	**Over**
Alternative RRA-1B w/ Juniper Ridge	**Under**	**Over**	At	**Over**
Alternative RRA-2-2	At	**Over**	**Under**	**Over**
Alternative RRA-2-2 w/ Juniper Ridge	At	**Over**	At	**Over**
Alternative RWA-1-2	**Under**	**Over**	At	**Over**
Alternative RWA-1-2 w/ Juniper Ridge	**Under**	**Over**	At	**Over**
Alternative RWA-3B-2	At	**Over**	At	**Over**
Alternative RWA-3B-2 w/ Juniper Ridge	At	**Over**	At	**Over**
Alternative RWA-4	**Under**	**Over**	At	**Over**
Alternative RWA-4 w/ Juniper Ridge	**Under**	**Over**	At	**Over**

Only the direct connection alternatives RRA-2-2 and RWA-3B-2 have any significant differences. Because both of these alternatives combine US20 and US97 traffic together, d/c ratios are higher on US20 north of Cooley Road as the route is more attractive than using O.B. Riley Road as an alternate. Alternative RRA-2-2 pulls enough traffic off of 3rd Street to drop the section from Empire Avenue to O.B. Riley Road to under capacity.

The major northern project area local roads included in the project area are Deschutes Market, O.B. Riley, Cooley, and Robal Roads as shown in Table 6. Deschutes Market Road is generally under capacity until Juniper Ridge is added which makes it generally over capacity. Alternative RRA-2-2 and RWA-4 are the only ones to have Deschutes Market not significantly overcapacity. Because of congestion on US20, many trips divert to O.B. Riley Road causing is to be over capacity for most of its length. Alternative MM-1 is the only alternative not to have this roadway over capacity because of the close presence of the realigned 3rd Street. Cooley Road is generally under capacity in all alternatives except it is at capacity in Alternative RRA-1B and over capacity in RWA-1-

2. Robal Road is generally well under capacity in all alternatives except for an isolated section in MM-1. Robal Road in Alternative MM-1 from the new alignment of 3rd Street through to the driveways just west of the existing US97 needs to be a four-lane section rather than the two assumed. With four lanes, the section will be under capacity.

The lack of an Empire Avenue interchange in Alternative RWA-1-2 causes Cooley Road to go over capacity, but Empire Avenue is still over capacity without the Empire interchange ramps. In contrast to Alternative RWA-4, which has a single service-type interchange at Empire Avenue, Cooley Road between US20 and US97 is under capacity (Empire is still overcapacity). This means that a single service-type interchange placement is better at Empire Avenue rather than at Cooley Road.

The southern project area includes Empire Avenue, Butler Market Road, Revere Avenue and Reed Market Road. The Committed scenario includes the extension of Empire Avenue to 27th Street and this improvement will attract a very large amount of trips onto Empire as Empire will be the only through east-west facility in the project area. This has the result of many of the study area segments exceeding capacity in the Committed scenario, which are not addressed by any of the alternative scenarios.

All of the alternatives have no significant impact outside of the general project area because d/c ratios along Revere Avenue and Reed Market Road are generally the same as the Committed scenario. Empire Avenue from O.B. Riley Road to 18th Street and Butler Market Road from 3rd Street to Boyd Acres Road are both generally over capacity so none of alternatives have a significant impact on the local road system from Empire Avenue south. Both of these roadways would need additional lanes to handle the increased through traffic.

Table 6. 2030 Northern Project Area Non-state Roads Capacity (d/c) Ranges

Scenario	Deschutes Mkt. Rd from US97 to Cooley Rd	O.B. Riley Rd from Old Bend-Redmond Hwy to 3rd St	Cooley Rd from O.B. Riley Rd to US97	Cooley Rd from US97 to 18th St	Robal Rd
Committed	**Under**	At	**Under**	**Over**	**Under**
Juniper Ridge	**Over**	**Over**	**Under**	**Over**	**Under**
Alternative MM-1	**Under**	**Under**	**Under**	At	**Over**
Alternative MM-1 w/ Juniper Ridge	**Over**	**Over**	**Under**	At	**Over**
Alternative RRA-1B	**Under**	**Over**	At	**Over**	**Under**
Alternative RRA-1B w/ Juniper Ridge	**Over**	**Over**	At	**Over**	**Under**
Alternative RRA-2-2	**Under**	**Over**	**Under**	At	**Under**
Alternative RRA-2-2 w/ Juniper Ridge	At	**Over**	**Under**	At	At
Alternative RWA-1-2	**Under**	**Over**	**Over**	At	At
Alternative RWA-1-2 w/ Juniper Ridge	**Over**	**Over**	**Over**	**Over**	**Under**
Alternative RWA-3B-2	**Under**	**Over**	**Under**	At	**Under**
Alternative RWA-3B-2 w/ Juniper Ridge	**Over**	**Over**	**Under**	**Over**	**Under**
Alternative RWA-4	**Under**	**Over**	**Under**	**Over**	**Under**
Alternative RWA-4 w/ Juniper Ridge	At	**Over**	**Under**	**Over**	**Under**

Travel Time Evaluation

The travel time evaluation indicates the overall network efficiency of a particular scenario. More congestion on a network equates to longer travel times. The travel times were based on five origin-destination (O-D) pairs. The travel time for each O-D pair was based on the shortest path by time between the two points in both directions. Depending on the congestion in a particular scenario, this might result in different shortest paths for the opposite direction. For example, a path might use 3rd Street and US20 to go north but use O.B. Riley Road to return south. The five O-D pairs were between the common 3rd

Street and Revere Avenue intersection and the intersections of US20/Old Bend-Redmond Highway, O.B. Riley Road/Old Bend-Redmond Highway, Robal Road/Hunnell Road, Cooley Road/Boyd Acres Road, and US97 in the Juniper Ridge area. Table 7 shows the average travel time percent differences on US20, US97 and the overall study area between the each scenario and the Committed scenario.

Alternative MM-1 and RRA-2-2 have the fastest travel time on US97. Alternative MM-1 has a travel time identical to the Committed scenario. Alternative RRA-2-2 is the only alternative to have a travel time less than the Committed scenario overall. Alternative RRA-1B is the slowest of all the alternatives overall with or without Juniper Ridge. While it has a significantly faster US97 section, it adds more local traffic and thus travel time increases to US20 which brings the overall performance down. All of the RWA-class alternatives do not have a significant overall difference from the Committed scenario. Alternative MM-1 and RWA-4 are least affected by Juniper Ridge as the percent difference between with and without Juniper Ridge is one percent. The direct connection alternatives, Alternative RRA-2-2 and RWA-3B-2 are the most negatively affected by Juniper Ridge, with 17% and 10% difference, respectively.

Table 7. Average Travel Time Percent Differences with the Committed Scenario[1]

Scenario	US20	US97	Overall Study Area
Committed	0	0	0
Juniper Ridge	8	**24**	**13**
Alternative MM-1	6	**-17**	0
Alternative MM-1 w/ Juniper Ridge	6	**-12**	1
Alternative RRA-1B	**22**	**-15**	**11**
Alternative RRA-1B w/ Juniper Ridge	**27**	-9	**18**
Alternative RRA-2-2	-1	**-18**	-5
Alternative RRA-2-2 w/ Juniper Ridge	**23**	**-17**	**12**
Alternative RWA-1-2	6	-8	2
Alternative RWA-1-2 w/ Juniper Ridge	9	1	7
Alternative RWA-3B-2	4	**-14**	-2
Alternative RWA-3B-2 w/ Juniper Ridge	6	-9	8
Alternative RWA-4	**10**	-9	3
Alternative RWA-4 w/ Juniper Ridge	**10**	-5	4

[1]Gray shaded cells indicate that travel time is significantly less than the committed scenario and black shaded cells indicate travel times that are significantly greater.

Alternative Comparison

Table 8 compares the scenarios together given the results from each of the evaluations whether a given scenario had a significant positive, negative or neutral effect. Table 9 shows the overall effect of Juniper Ridge on each alternative. Juniper Ridge is large enough to have across-the-board negative impact on volumes and capacities.

The best RRA-class alternative is RRA-2-2. The direct connection of US20 to US97 allows for about 30% more local traffic to be removed from US97 over Alternative RRA-1B. This alternative also does not significantly affect local roads in the project area. However, Alternative RRA-2-2 will add about 15-25% more traffic to US97 south of Empire Avenue when compared to other alternatives which equates to the volume levels in the Committed scenario. Alternative RRA-2-2 is also one of the alternatives least sensitive to Juniper Ridge. This is mainly because the Juniper Ridge traffic uses the 3rd Street extension in the alternative which bypasses US97 and Cooley Road. The direct connection and the 3rd Street extension combine to make the best US97 and overall travel time of any alternative. Alternative RRA-1B removes the least amount of traffic off of US97, is one of the most sensitive to Juniper Ridge impacts, has relatively high impacts to US20 and surrounding local roadways, and has the slowest travel time of any alternative.

Table 8. Alternative Comparisons without Juniper Ridge Impacts[1]

	Alt MM-1	**Alt RRA-1B**	**Alt RRA-2-2**	**Alt RWA-1-2**	**Alt RWA-3B-2**	**Alt RWA-4**
Local Trips Removed – US20	0	+	0	0	+	+
Local Trips Removed – US97	+	+	+	+	+	+
Impacts to Parkway	+	+	0	+	0	+
Impacts to 3rd St	-	-	0	-	0	-
Impacts to Local roads[2]	+	-	+	0	0	0
US20 d/c	-	-	-	-	0	-
US97 d/c	+	+	+	+	+	+
North Local Roads d/c	+	0	+	-	+	+
US20 Travel Time	0	-	0	0	0	-
US97 Travel Time	+	+	+	0	+	0
Overall Travel Time	0	-	0	0	0	0

[1]"+" shows that a scenario has a significantly positive impact on the system which is equal to minimum or negative volume differences, d/c ranges and travel times; "0" is no significant change; "-" is a significant negative impact which is equal to high positive percent differences, d/c ranges and travel times.
[2]Based on the local roads shown in Table 2 and 3.

The best RWA-class alternative is RWA-3B-2. Like Alternative RRA-2-2, the direct connection allows for the best efficient operation. The RWA-class alternatives remove more than 30% of local traffic from US97. Alternative RWA-3B-2 is more efficient than

Alternative RRA-2-2 as the US20 direct connection in RRA-2-2 can be used as a local access into the triangle area while it cannot be in RWA-3B-2. Alternative RWA-3B-2 will add about 7% -18% more traffic to US97 south of Empire Avenue because of directly connecting US20. This is about 25-50% of the impact of Alternative RRA-2-2. Alternative RWA-3B-2 pulls a significant amount of traffic from US20 and does not significantly impact local roadways. This difference results in about 20% more traffic removed from the expressway portion of US20 than with Alternative RRA-2-2.

Alternative RWA-1-2 removes the least amount of traffic off of US97 and US20 in the RWA-class and is somewhat hampered by the lack of an Empire Avenue interchange. This alternative loads the local street network significantly south of Empire Avenue. Also, this is the only alternative to add a significant amount of traffic to Cooley Road causing it go over capacity. This alternative does remove 15% of traffic from Empire Avenue because of no ramp connections but Empire Avenue is still over capacity.

Table 9. Alternative Comparisons with Juniper Ridge Impacts[1]

	Alt MM-1	**Alt RRA-1B**	**Alt RRA-2-2**	**Alt RWA-1-2**	**Alt RWA-3B-2**	**Alt RWA-4**
Sensitivity to Juniper Ridge[2]	-	-	+	-	0	-
Local Trips Removed –US20	0	+	+	0	+	+
Local Trips Removed –US97	-	-	+	0	+	-
Impacts to Parkway	0	0	0	0	0	0
Impacts to 3rd St	-	-	-	-	-	-
Impacts to Local roads[3]	-	-	-	-	-	-
US20 d/c	-	-	0	-	0	-
US97 d/c	-	-	-	-	-	-
North Local Roads d/c	-	-	0	-	-	0
US20 Travel Time	0	-	-	0	0	-
US97 Travel Time	+	0	+	0	0	0
Overall Travel Time	0	-	-	0	0	0

[1]"+" shows that a scenario has a significantly positive impact on the system which is equal to minimum or negative volume differences, d/c ranges and travel times; "0" is no significant change; "-" is a significant negative impact which is equal to high positive percent differences, d/c ranges and travel times.
[2]Based on the change in US97 values in Table 1.
[3]Based on the local roads shown in Table 2 and 3.

Alternative RWA-4 gives the same benefit to US97 as RWA-1-2 but keeps the Empire Avenue in place which will help avoid inconsistency issues with the city's TSP. This

means for an alternative that has a single service interchange (MM-1, RWA-1-2 and RWA-4), the best placement is at Empire Avenue. All of these issues result in the travel times being no different from the Committed scenario. Alternative RWA-1-2 is also one of the alternatives most sensitive to Juniper Ridge and is the most sensitive RWA-class alternative.

Alternative RWA-4's performance falls between RWA-3B-2 and RWA-1-2. RWA-4 is generally better than Alternative RWA-1-2 because of the placement of the service interchange occurs at Empire Avenue rather than at Cooley Road. Alternative RWA-4 is one of the best in removing traffic from US97 and US20 and is generally the same as RWA-3B-2 in this regard. However, this alternative is most sensitive RWA-class alternative to Juniper Ridge. This is mainly attributed to the less-than-effective Rogers Road extension, which because of the relative slowness of this route fails to attract much Juniper Ridge traffic to it. Having the main Juniper Ridge connection off of an extension of 3rd Street is preferable as in Alternative RWA-3B-2. Alternative RWA-4 has the highest impacts of any alternative to US20/3rd Street south of Empire Avenue. Alternative MM-1 has a similar form to Alternative RWA-4. Both have an interchange at Empire Avenue and both have a separated US20 route with local access into the triangle commercial area. Alternative MM-1 pulls the second least amount of traffic off of US97 and is one of most sensitive to the Juniper Ridge development. Most of this can be attributed to the lack of a 3rd Street extension to the east of US97 that can be used to easily access the Juniper Ridge development area. Alternative MM-1 is the only alternative to significantly lower traffic on local roads in the project area because of the presence of a "center" 3rd Street alignment. However, this reduction in local road volume is transferred to US20 which does cause significant impacts to the expressway portion of US20 and 3rd Street. Alternative MM-1 is the only alternative to cause the center section of Robal Road to go over capacity and the entire length of O.B. Riley Road (better than the Committed scenario) to stay under capacity, again attributed to the centralized 3rd Street alignment. Alternative MM-1 has one of the lowest travel times on US97 and even given the extra traffic on US20 is not expected to significantly impact the travel time on it.

Conclusions

- The best alternatives are the direct connection alternatives RRA-2-2 and RWA-3B-2. These alternatives remove the most local traffic from US97 and do not have a significant negative impact on US20 and local roadways.
- Alternatives RRA-1B and RWA-1-2 are the lowest performers in each of their classes and will be outperformed by others in their class.
- Alternative RWA-4 does out-perform Alternative MM-1 but the differences are not enough to drop MM-1. Both alternatives need some alterations to stay in the mix:
    - MM-1:
        - The 3rd Street alignment needs to be adjusted to stay between the cemetery and the Grandview Drive area, go underneath

US97, and extend north to the partial interchange to allow for a future Juniper Ridge connection.
        - The central portion of Robal Road from the new 3rd Street extension to the easternmost mall access needs to be widened to four lanes.
    - RWA-4:
        - Remove the Rogers Road extension.
        - Move the partial interchange to the north side of the cemetery to allow extra length for the 3rd Street extension to allow for a future connection into Juniper Ridge.
- Significantly over capacity areas not addressed in the alternatives within the immediate project area are O.B. Riley Road and Empire Avenue between O.B. Riley Road and 18th Street.
- A key point in addressing sensitivity to Juniper Ridge on US97 would be to add an extension of 3rd Street to all alternatives on the east side of US97 and have a roadway connecting directly into Juniper Ridge.
- A Rogers Road extension into Juniper Ridge is ineffective in removing trips from US97 as the route back into the "triangle area" is relatively slow.
- Any connections to reroute US20 traffic off of US97 in the direct connection alternatives of RRA-2-2 and RWA-3B-2 need to occur north of the southbound 3rd Street connection (south of Butler Market Road).
- The preferable location for a single service interchange is Empire Avenue.
- US20 needs to be widened between Cooley Road and Empire Avenue.
- Empire Avenue needs to be widened from O.B. Riley Road east.

Table 10 shows the scenario recommendations from the screening analysis.

Table 10. Recommendations

Scenario	Recommendation
Alternative MM-1	Tentatively keep with modifications
Alternative RRA-1B	Drop
Alternative RRA-2-2	Keep
Alternative RWA-1-2	Drop
Alternative RWA-3B-2	Keep
Alternative RWA-4	Tentatively keep with modifications

If there are any questions or comments, please contact me at 503-986-4110.

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Figure J-13 Final: Tecnical Memorandum #6: Purpose & Need Screen #2 & Goals & Objectives Screen #1 Alternative Evaluations

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File Code:

Date: January 21, 2009

TO: **Jon Heacock**
US97 North Corridor Project Manager

FROM: **Peter L. Schuytema, P.E., Senior Transportation Analyst**
Transportation Planning Analysis Unit

SUBJECT: **FINAL: Technical Memorandum #6: Purpose & Need Screen #2 & Goals & Objectives Screen #1 Alternative Evaluations**

This technical memorandum contains the results for the Purpose and Need secondary screening and the primary screening for the Goals and Objectives screening for the US97 Bend North Corridor project area. The purpose of this screening analysis is to determine which new alternative scenarios offer any improvement over the current West A and East A alternatives. This screening level analysis is intended to compare and contrast the remaining alternatives to determine their system-level impacts.

All of the alternatives included in this memorandum except for the TSM-TDM (Transportation System Management – Transportation Demand Management) alternative pass the purpose and need as they reduce congestion on US97. The TSM-TDM alternative, while having impacts similar to the no-build Committed scenario, contains elements that should be considered as part of the alternatives.

The East B (slip ramp to 3rd Street) benefit to the system is a slight reduction of volumes on Empire Avenue. However, the alternative shifts the capacity issues to 3rd Street, intensifying the problems in the Robal Road area. Of all of the West alternatives, only West E offers an overall solution to the study area congestion issues, without shifting the problem, and offers more local access without negatively impacting the highway system.

Background

The BMPO (Bend Metropolitan Planning Organization) regional transportation model was used for this first-level analysis for the US97 Bend North Corridor project. Transportation models are a combination of mathematical equations and relationships using locally-provided existing housing and employment information to project future traffic conditions. These future traffic conditions are placed on a network which is similar to the actual roadway network. An individual scenario was created for each conceptual alternative. These scenarios were compared together on a relative basis (proportions and percents) rather than using the actual volumes reported on each segment or "link" to find the differences between them. The actual model volumes cannot be directly used because the model is just mathematical relationships and needs to be tied to actual traffic volumes.

The future 2030 Committed network were used in order to stay consistent with previous technical memorandums. The "Committed" designation means that the network included all the city, county and state projects that are listed in a funding committed construction program (i.e. ODOT's Statewide Transportation Improvement Plan; STIP) in the Bend metro area. These projects are assumed to occur regardless of what happens in the US97/20 project area.

Additionally, volumes can easily fluctuate 10% over a given week, so this analysis uses a 10% threshold for determining if a change makes a difference (i.e. significant). It should be noted that not every detail is large enough for a model to see relative differences between (e.g., signals, residential street alignments, or whether an interchange ramp is straight or a loop). The scenarios were compared on a relative basis with segment volume and capacity evaluations.

Scenario Descriptions

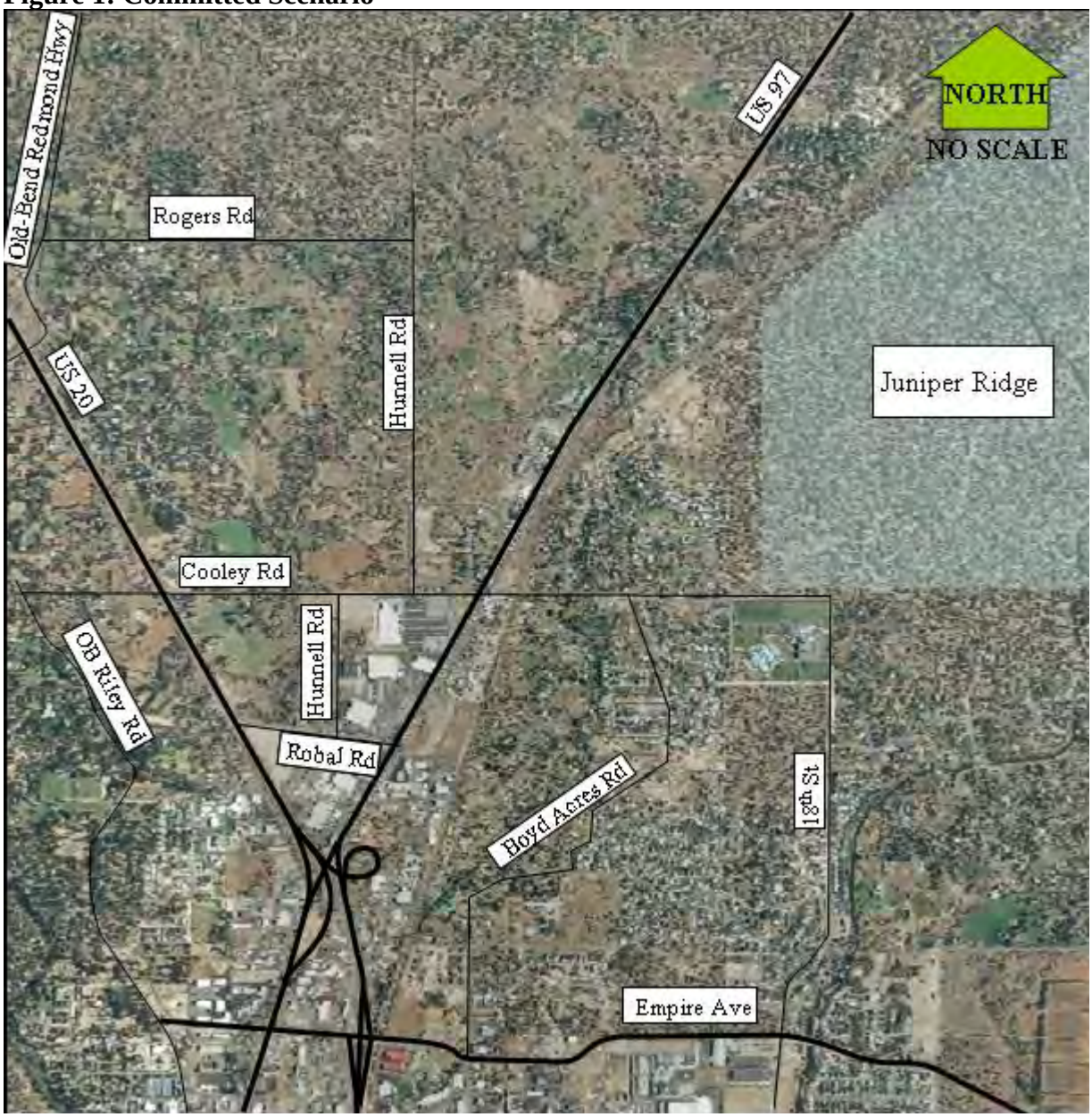
Because of concerns with out-of-direction travel and access with the current West A alternative, a series of new West alternatives were created by internal staff and outside consultants to see if more access could be provided without significantly impacting US97. In response to the new west alternatives, a new East B alternative was created as an increased access alternative to the current East A alternative. The City of Bend also proposed a TSM-TDM alternative to see if this was a standalone alternative.

The alternative scenario networks were sensitivity tested by adding in the proposed full Juniper Ridge development. This scenario adds in the proposed additional 1,000 acre Juniper Ridge development urban growth boundary (UGB) expansion as of April 2007. Five hundred acres are already currently included in the UGB. Connections to the Juniper Ridge area are via existing roads, namely Cooley Road and Deschutes Market Road.

Most of the scenarios were tested with a partial north interchange and with a full north interchange. The partial north interchange would most likely take the form of a half-diamond, so as to not to preclude expansion to a full diamond interchange at a later date.

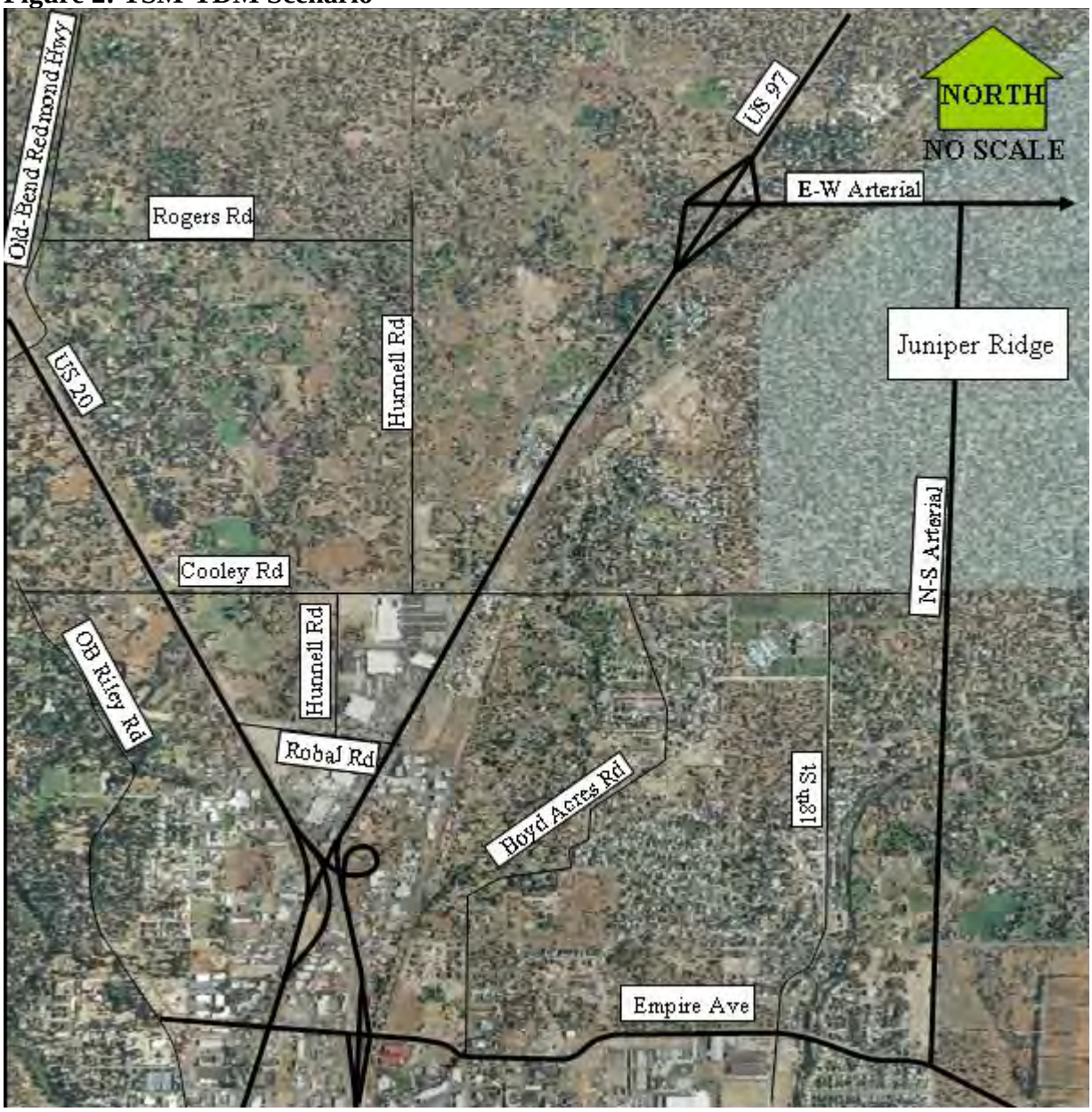
The full interchange scenario also assumed a new east-west four-lane connection into the Juniper Ridge area coupled with a new north-south four-lane arterial east of US97 between the new east-west arterial and Empire Avenue. While not modeled, the partial half-diamond would be compatible with these new arterial roadways. A figure and related description of each scenario follow.

Figure 1: Committed Scenario



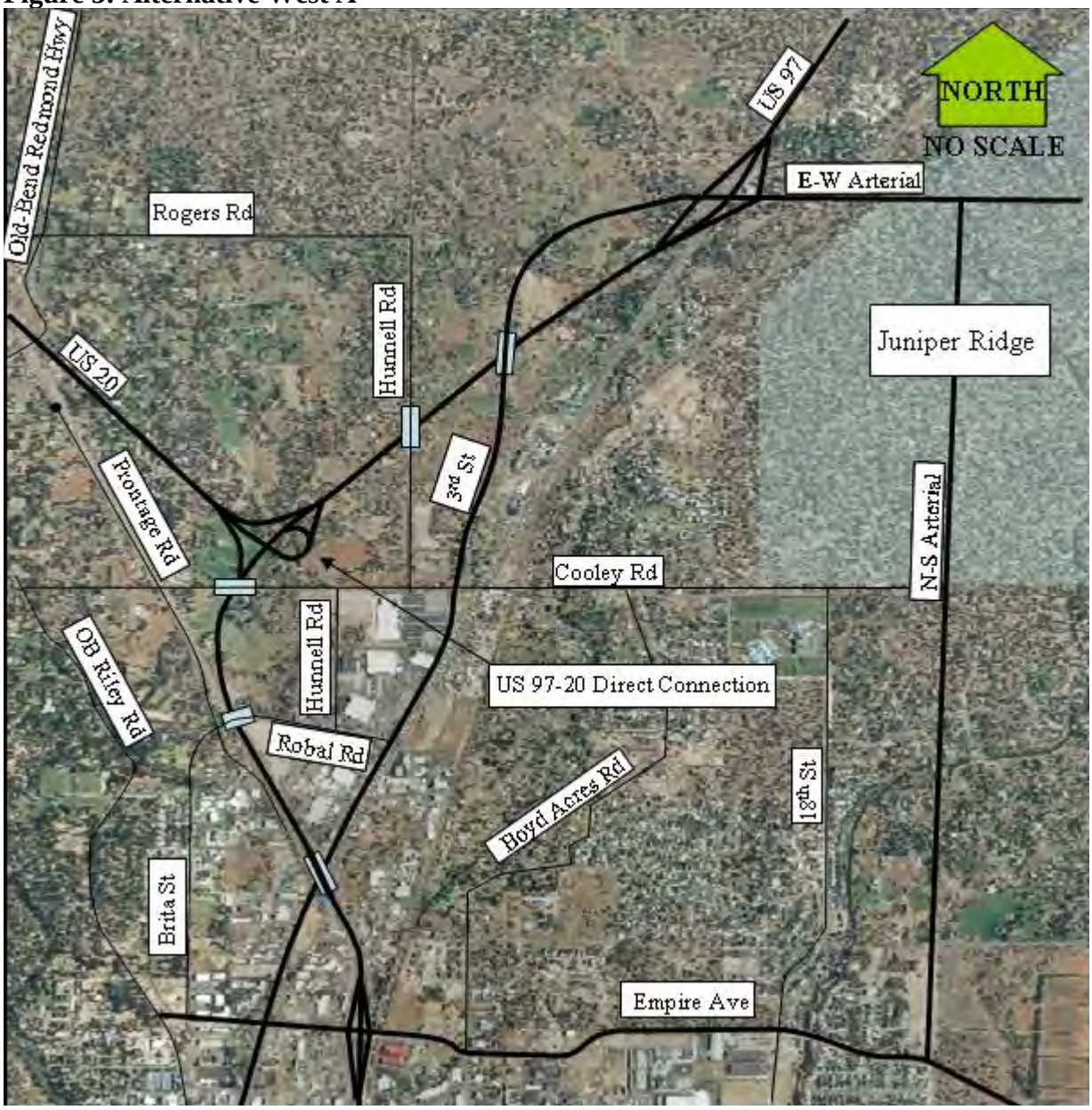
This scenario includes all of the city, county and state projects that are listed in a funding committed construction program (i.e. ODOT's Statewide Transportation Improvement Plan; STIP) in the Bend metro area.

Figure 2: TSM-TDM Scenario



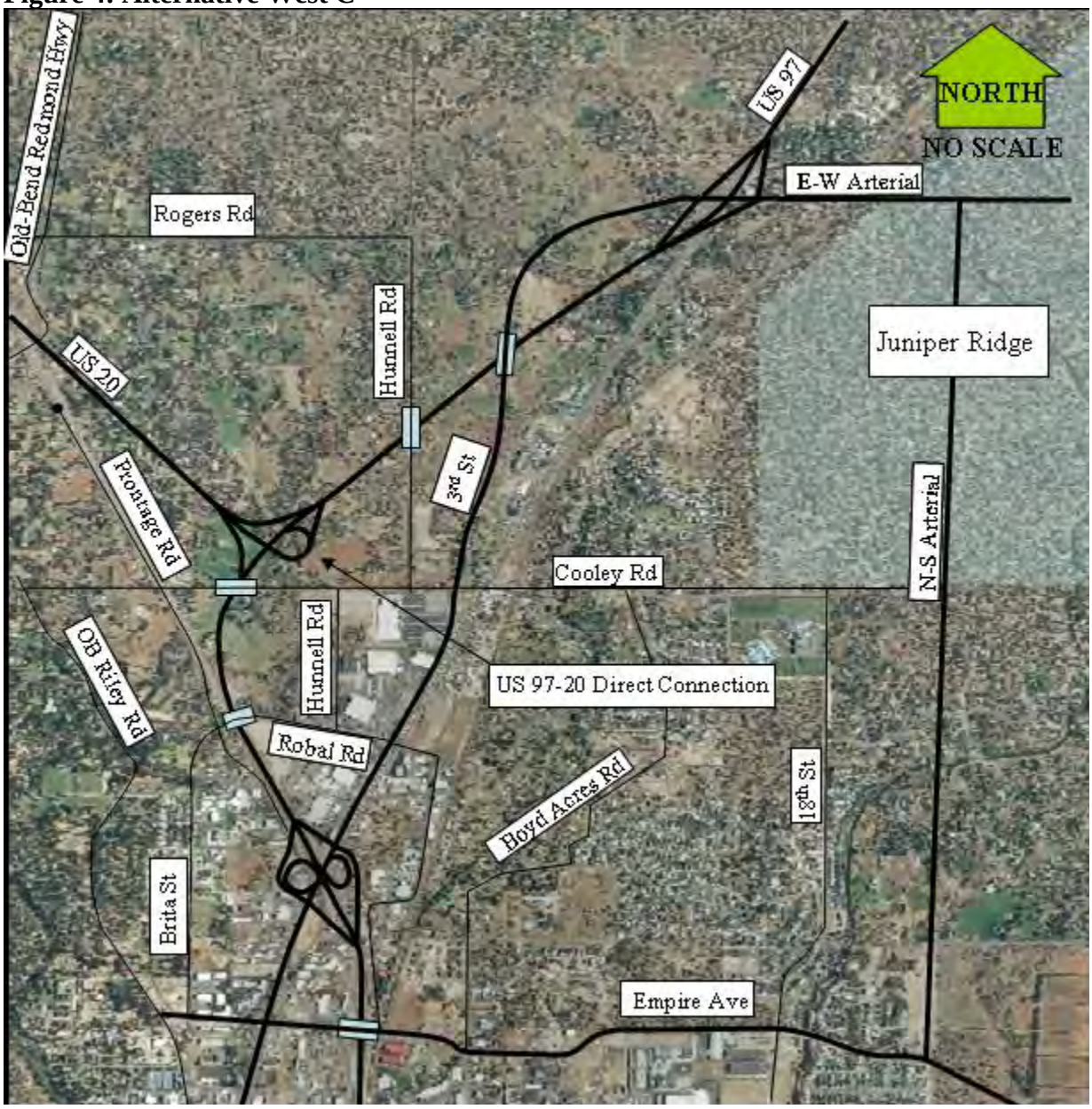
This scenario includes the full north diamond interchange along with the new east-west Juniper Ridge and the new north south arterials. In addition, from the full north interchange south to Colorado Avenue interchange, all of the on-ramps assume ramp metering. Existing signalized and unsignalized right-out connections were not modified.

Figure 3: Alternative West A



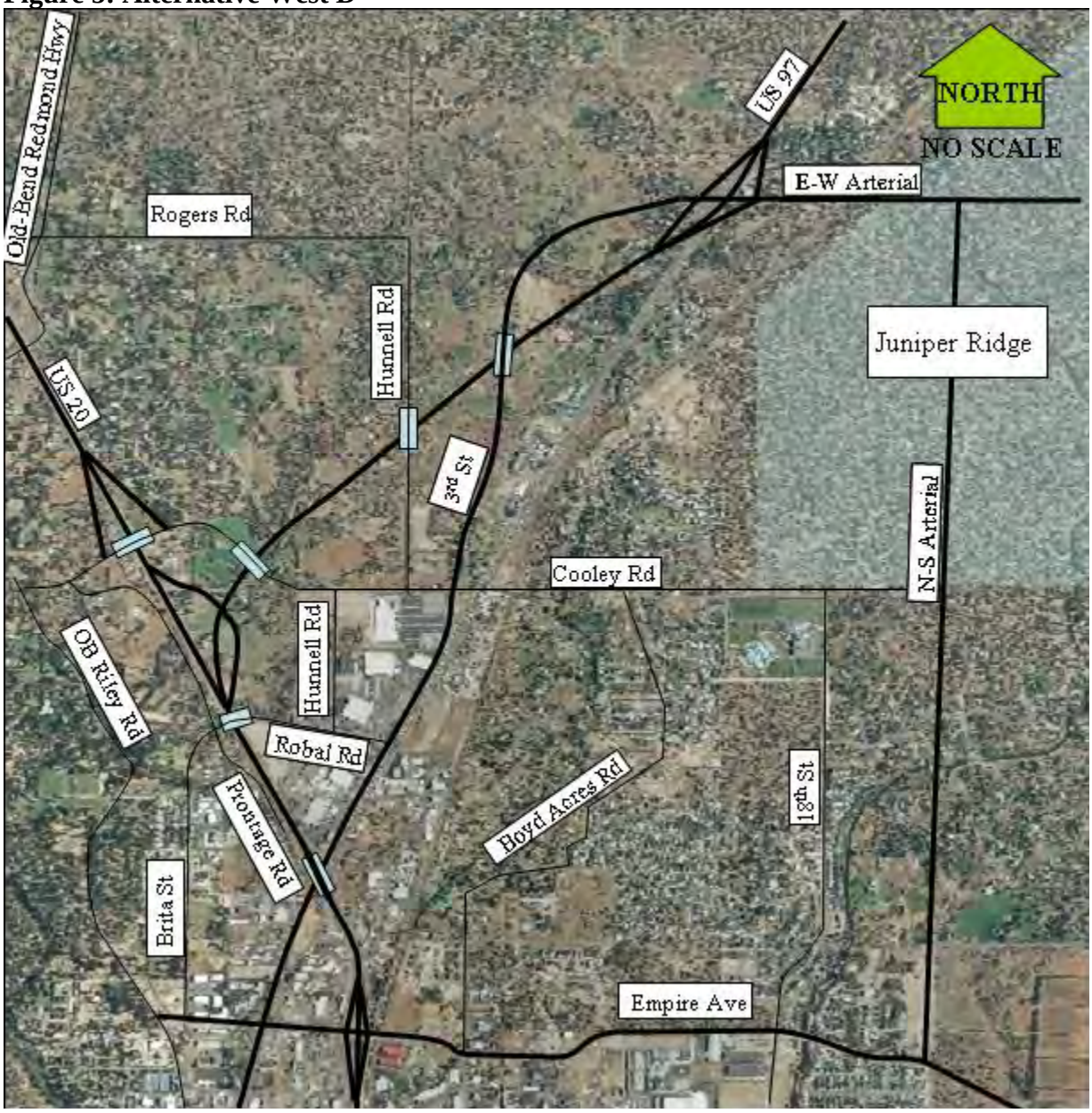
In the Alternative West A scenario, US97 would be completely disconnected from Third Street. A new southbound off-ramp would be added to the Empire Avenue interchange making it a full diamond interchange. Robal, Cooley, and Hunnell Roads would overcross US97. Robal Road would be extended to O.B. Riley Road, connecting with the north end of Brita Street and to a frontage road connecting with Cooley Road. US20 would directly connect to US97 north of Cooley Road with a directional trumpet-style interchange. Third Street would continue northward, paralleling US97 and connecting back into US97 via a service interchange. The main Juniper Ridge access would connect to the 3rd Street extension at the US97 northern interchange.

Figure 4: Alternative West C



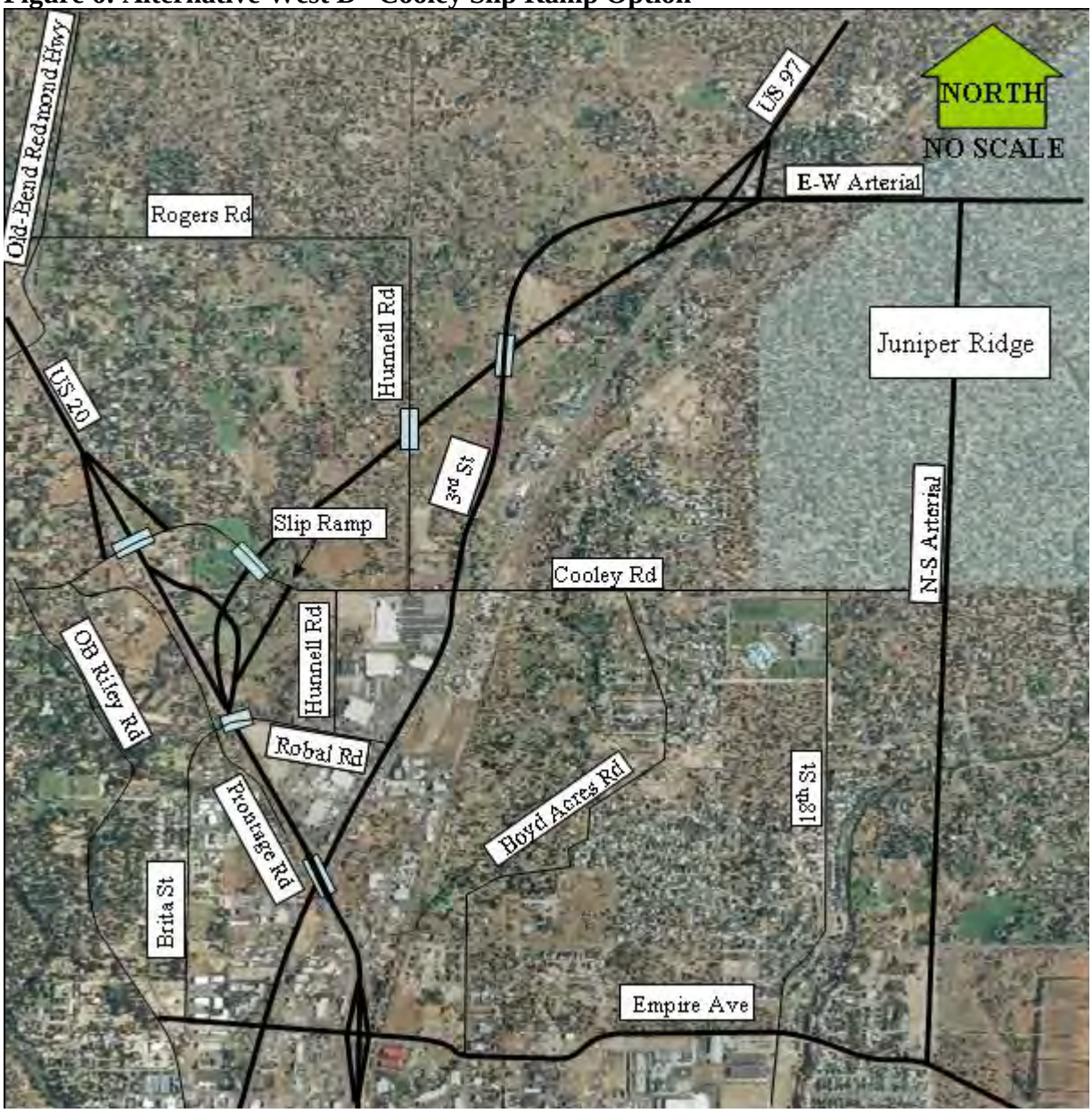
Alternative West C adds a full partial cloverleaf interchange where US97 overcrosses 3rd Street. The Empire Avenue interchange would be removed. All other elements are the same as West A.

Figure 5: Alternative West D



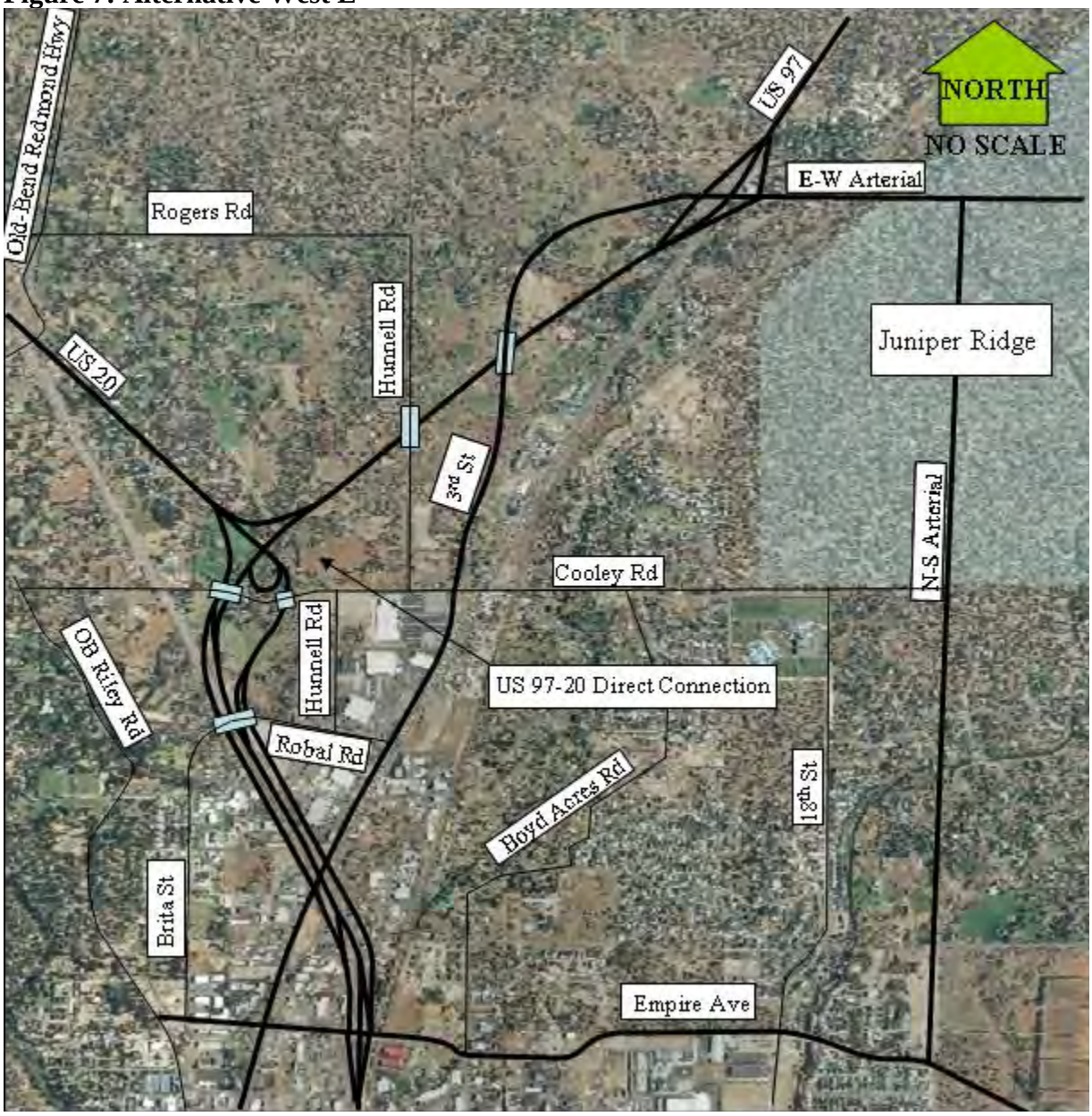
Alternative West D scenario modifies the West A scenario by replacing the full system interchange with US20 with a partial directional interchange. In addition, ramps to and from the west would connect Cooley Road to US20. All other elements are the same as West A.

Figure 6: Alternative West D –Cooley Slip Ramp Option



Alternative West D – Cooley Slip scenario modifies West D by adding a ramp from northbound US97 to Cooley Road. All other elements are the same as West D.

Figure 7: Alternative West E

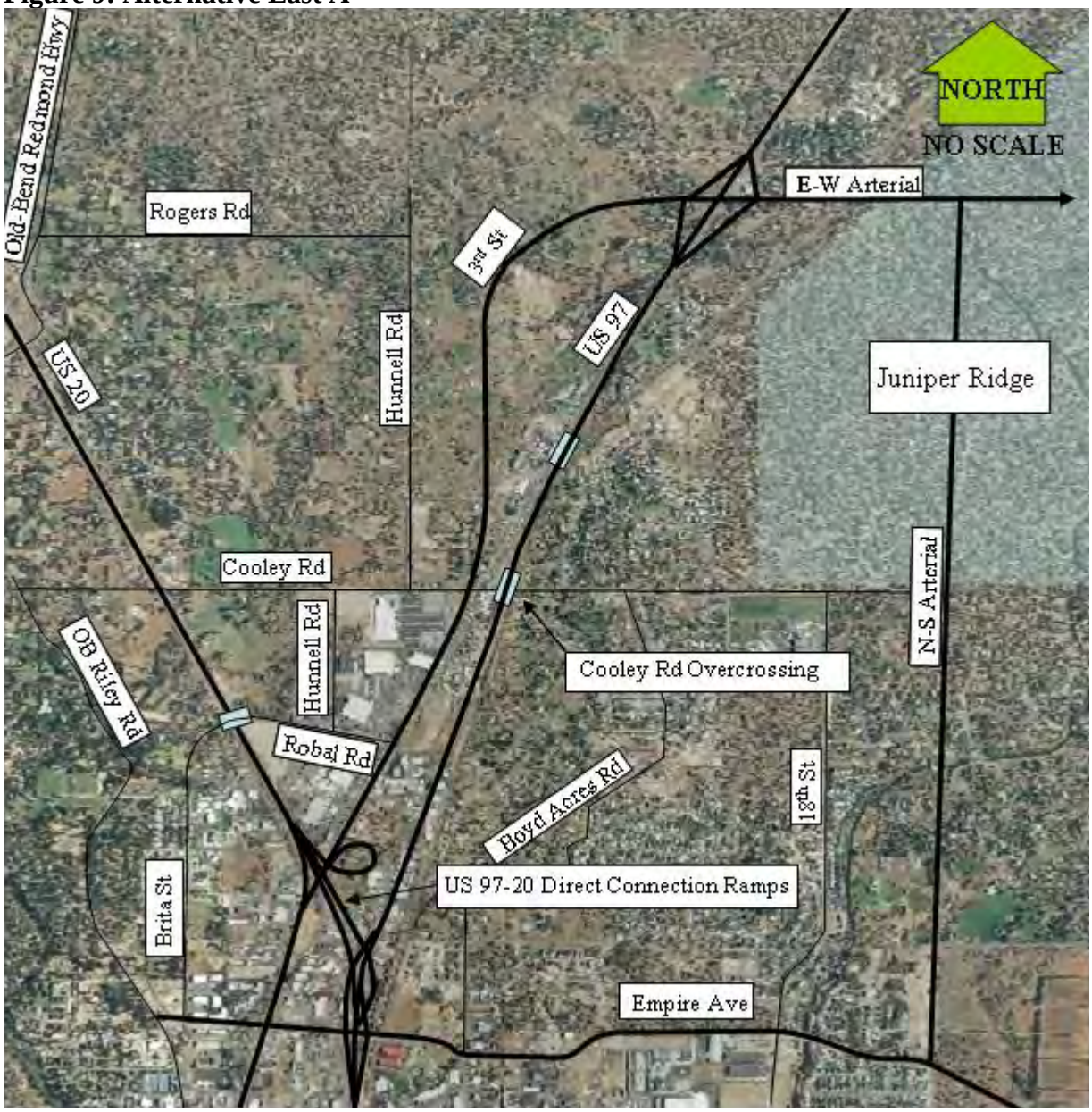


In the Alternative West E scenario, a split-diamond interchange would be added between 3rd Street and Empire Avenue replacing the current Empire Avenue interchange. One-way collector-distributor ramp roadways would connect to the US20 trumpet-style interchange. The trumpet-style interchange is flipped from West A to favor the higher volume movements. All other elements are the same as in West A.

Figure 8: Alternative WS West

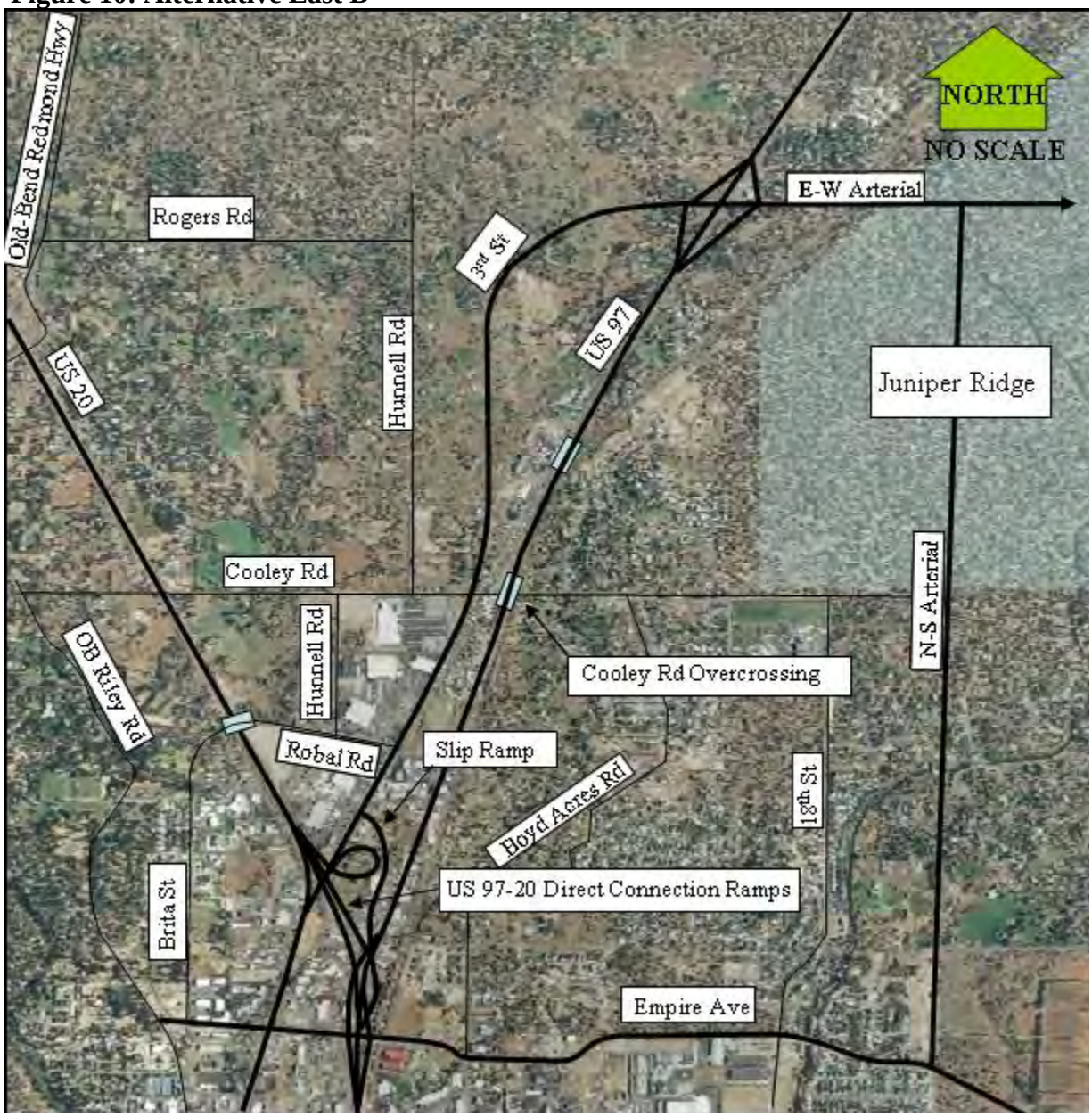
In the Alternative WS West scenario, a full interchange would be added where US97 overcrosses 3rd Street. A southbound ramp would connect this interchange with Empire Avenue. The Empire Avenue interchange would be removed. US20 would be rerouted onto Cooley Road with Cooley Road having a full interchange with US97. Robal and Hunnell Roads would overcross US97. Robal Road would be extended to O.B. Riley Road connecting with the north end of Brita Street and to a frontage road connecting with Cooley Road. Third Street would continue northward and connect back into US97 via a partial interchange.

Figure 9: Alternative East A



The Alternative East A adds new northbound and southbound direct connection ramps between US20 and US97. The existing US20/3rd Street ramps and the westbound US20 loop ramp would remain, however, the loop ramp would now connect to 3rd Street instead of US97. A new southbound off-ramp would be added to the Empire Avenue interchange making it a full diamond interchange. Third Street would continue northward, intersecting with US97 north of Cooley Road in the crossing under the new alignment of US97 in the vicinity of the Deschutes Memorial Gardens cemetery paralleling US97 and the BNSF railroad tracks. Third Street will eventually connect back into US97 via a service interchange. Robal Road would be extended to O.B. Riley Road connecting with the north end of Brita Street. The main Juniper Ridge access would connect to the 3rd Street extension at the US97 interchange.

Figure 10: Alternative East B



Alternative East B has all the elements in East A, but it adds a new northbound connection from the westbound US97-US20 direct connection ramp to 3rd Street.

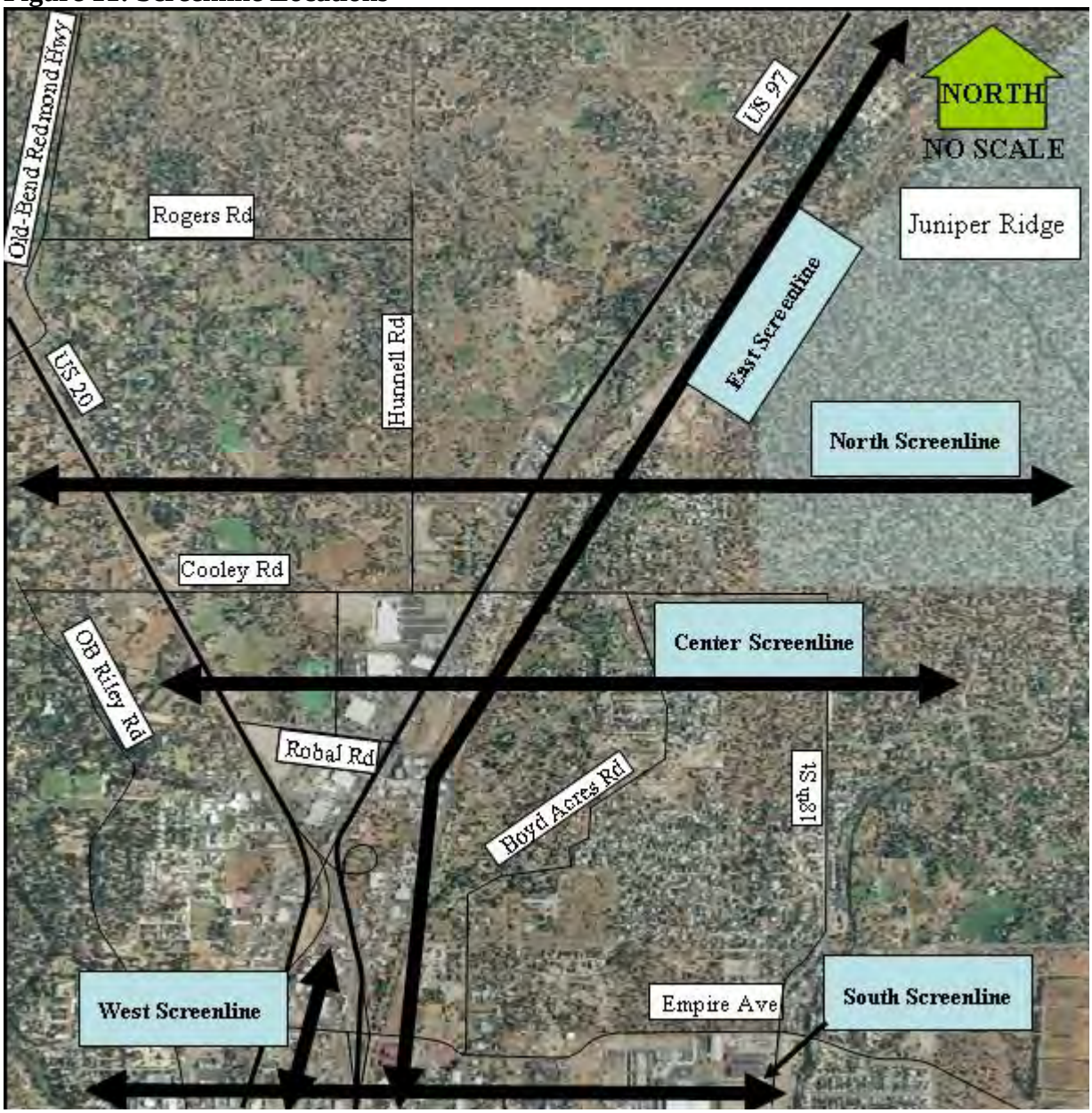
Scenario Results

Volume Evaluation

The volume evaluation was used to indicate how much extra traffic is attracted to or diverted away for a given scenario. Screenlines were created cutting through the study area north and south of Cooley Road, south of Empire Avenue, and east of US97 (Figure

11). In addition, a screenline was used on Empire Avenue west of US97. The scenario volumes were compared where major roadways intersected the screenlines.

Figure 11: Screenline Locations



Unlike the previous technical memorandums, except for the TDM-TSM scenario, the alternatives are compared to the current West A and East A alternatives rather than back to the Committed network. The purpose of this analysis was to see if any new alternative offered significant benefits over the current alternatives. Not all locations showed significant differences between scenarios.

Tables 1 through 3 show the significant (key differentiator) locations and percent differences in screenline volume for the TSM-TDM, West, and East scenarios under the

existing and Juniper Ridge (JR) land use scenarios. Locations not shown in the tables do not have significant impacts. Most of the alternative scenarios were evaluated under the partial and full interchange configurations.

Table 1. TSM-TDM Scenario Screenline Comparison with Committed Scenario[1]

Scenario	Roadway/Screenline Location			
	US97	N-S Arterial	Cooley Rd	Empire Ave
	North (%)	North (%)	East (%)	East (%)
TSM-TDM	-17	**17**	**96**	
TSM-TDM w/JR[2]	**52**	**46**		-10

[1]Black shaded cells indicate a significant negative impact at the screenline because of increased volumes.
[2]The TSM-TDM alternative with Juniper Ridge is compared to the Committed network with Juniper Ridge scenario.

Under the existing land use scenario, the TSM-TDM scenario is successful in removing 17% of traffic from US97 north of Cooley Road. Diverting traffic also causes volumes on Cooley Road east of US97 to almost double. The addition of the new north-south arterial pulls traffic from US97. When the Juniper Ridge land uses are added in and even though the new north-south route gets substantially more volume, there is an almost 70% increase on US97 as most of the new traffic will use US97 to get to their destinations. Under the higher JR volumes, a significant portion of Empire Avenue traffic diverts to other routes to avoid US97. There are no significant differences in other portions of the study area because the scenario benefits are from the additional north-south route rather than the ramp meters.

Table 2. West Scenarios Comparison from West A Partial Interchange Scenario[1]

Scen.	US97		US20		N-S Arterial	3rd St		Cooley Rd	Empire Ave	
	North (%)	Center (%)	North (%)	South (%)	North (%)	North (%)	Center (%)	East (%)	West (%)	East (%)
West A Full Intch					**30**	-14				
West A Full Intch w/ JR[2]	**31**				**59**	-52	-17	-20	**24**	**35**
West C Partial Intch							**38**	**20**	-20	-27
West C Full Intch					**70**	-16	39	**21**	-23	-29
West C Full Intch w/ JR[2]	**32**				**63**	-55				-11
West D Partial Intch			**15**				**14**			
West D Full Intch		**10**	**14**		**31**	-10	**12**			
West D Full Intch w/ JR[2]	**25**	**10**	**19**		**61**	-49	-15	-21	**21**	**35**
West D Slip Partial Intch		**14**	**14**		**32**	-10				
West D Slip Full Intch		**14**	**15**		**32**	-10				

Scen.	US97		US20		N-S Arterial	3rd St		Cooley Rd	Empire Ave	
	North (%)	Center (%)	North (%)	South (%)	North (%)	North (%)	Center (%)	East (%)	West (%)	East (%)
West D Slip Full Intch w/ JR[2]	**24**	**11**	**19**		**62**	-49	-46	-20	**23**	**35**
West E Partial Intch				-12			**20**		-70	
West E Full Intch				-11	**34**	-14	**16**		-69	
West E Full Intch w/ JR[2]	**31**				**58**	-52		-16	-55	**35**
WS West Partial	**10**					-22	**12**	**22**	-29	-59

[1]Black shaded cells indicate a significant negative impact at the screenline because of increased volumes.
[2]Scenarios with Juniper Ridge are compared with the West A Partial with Juniper Ridge scenario.

The West D, West D-Slip, and the WS West alternative were the only ones to add significant trips to US97 over the West A alternative. These alternatives encourage more local trips to use the highway system over local routes. WS West adds significant trips to US97 north of the US20 interchange and the West D alternatives add trips to US20 south of the US20 interchange. The complete or mostly complete access at Cooley Road in these alternatives encourages local trips to use the highway system instead of surface streets.

Only the West D alternatives created significant impacts to US20 north of Cooley Road. The West D alternatives have the highest impacts because of the ramp connections between US20 and Cooley Road. West E is the only alternative to significantly drop traffic on the US20/97 common section because local traffic moves to the collector-distributor roadways between US20 and Empire Avenue.

For Alternatives West A, C and E, the impacts of a full interchange with existing land uses do not have a significant impact. The new north-south arterial picks up a large portion of the volume when compared to the extra trips that a full interchange would put on US97. Under a Juniper Ridge land use, the sensitivity of the full interchange is shown as volumes on US97 increase over 30%. Also, a full interchange causes substantial reductions on 3rd Street north of Cooley Road as traffic shifts to US97.

As it would be expected, the impacts to the new north-south arterial are higher than under the West A alternative with most of the increase occurring under a Juniper Ridge land use. South of Cooley Road, most of the alternatives increase traffic on 3rd because of the more direct connections to 3rd Street. The addition of Juniper Ridge causes a larger proportion to use US97 than 3rd Street, so 3rd Street still sees significant reductions.

Impacts to Cooley Road vary depending on the alternative. West C and WS West put additional traffic on Cooley Road as access to Empire Avenue is restricted. West A and its variants like West D, do not address volume issues on Empire Avenue. Alternatives that modify the interchange location (West E) or move it completely (West C or WS West) reduce the volumes on Empire Avenue substantially. West E has the largest reductions between 3rd Street and US97. West C has smaller reduction but over a larger portion of Empire.

Table 3. East Scenarios Comparison from East A Partial Interchange Scenario[1]

Scenario	Roadway/Screenline Location						
	US97		N-S Arterial	3rd St		Cooley Rd	Empire Ave
	North (%)	Center (%)	North (%)	North (%)	Center (%)	East (%)	West (%)
East A Full Intch			30			14	
East A Full Intch w/ JR[2]	62	62	57	-59	-40		
East B Partial Intch					17	12	-12
East B Full Intch			33		16	27	
East B Full Intch w/ JR[2]	52	52	59	-59	-32		

[1]Black shaded cells indicate a significant negative impact at the screenline because of increased volumes.
[2]Scenarios with Juniper Ridge are compared with the East A Partial with Juniper Ridge scenario.

Alternative East A with a full interchange with the existing land uses does not have any significant impact on the highway system. A sizeable portion of local traffic diverts to the new north-south arterial and Cooley Road rather than using US97 to access destinations no longer served by US97.

Alternative East B with a partial or a full northern interchange does not have any significant effect on the highway system. East B will add more traffic to a congested 3rd Street south of Cooley. Most of the East B ramp traffic is trying to access the mall/commercial area and will need to weave across multiple lanes to turn left at Robal Road. The rest of the East B ramp traffic is going to Cooley Road east of 3rd Street as a direct US97-Cooley movement is not possible under East A. East B does reduce volumes on Empire Avenue between US97 and 3rd, as traffic can reach 3rd quicker. Under a full northern interchange, diverting traffic uses Cooley more extensively.

When Juniper Ridge is added to the full interchange scenarios, there is an approximately 50 - 60% volume increase on US97. This is about double the west alternative value. The East alternative scenarios have a shorter distance between Juniper Ridge and Empire Avenue than the west alternatives so US97 is more attractive. Volumes on the new north-south arterial increase about 25%, but volumes on 3rd Street drop about 60% as traffic shifts to US97. This shows that a full interchange is very sensitive, especially with an East alternative, to Juniper Ridge or other substantial land use change in the nearby area.

Capacity Evaluation

The capacity evaluation indicates if certain roadway segments would be likely over capacity and if certain alternative scenarios had less capacity available than the Committed "no-build" scenario. Eight state segments on US97 and US20 were evaluated along with twelve segments on local roadways from Deschutes Market Road south to Empire Avenue. Model demand-to-capacity (d/c) ratios are mid-block or segment based and they can only be relatively compared on a large-scale basis such as below, at, or over capacity. They cannot be compared with the Oregon Highway Plan or Highway Design Manual volume-to-capacity ratios as these require that volumes are based on the 30th highest hour from actual ground counts.

Tables 4 through 7 show the 2030 d/c ratio-based capacity ranges for US97 and US20 for the alternatives. Tables 8 through 11 show the capacity ranges for the local system. Appendix A contains color-patterned figures illustrating the d/c ratios in the tables for the partial and full northern interchange scenarios with the Juniper Ridge UGB-included 500 acres. The tables are broken out in three tiers which are under capacity (d/c's less than 0.90), at capacity (0.90 to 1.10 d/c), and over capacity (over 1.10 d/c). Because model capacities are generally less than the detailed operational capacities the below capacity links are likely relatively free of issues; at capacity links likely have significant problems but are probably solvable; and over capacity links indicate a serious issue that will require a large amount of improvements or will result in outstanding capacity issues. None of the alternative scenarios are free of any over-capacity segments.

Table 4 shows that Alternatives West A, C, E perform the best on US97 with all segments under capacity in the project area. The West D alternatives and WS West do not perform as well as West A. Under a Juniper Ridge scenario, all of the alternatives perform similarly.

Table 4. US97: West Alternative 2030 Capacity (d/c) Ranges

Scenario	Deschutes Mkt. Rd. to North 3rd St Intch	North 3rd St Intch to US20 Intch	US20 Intch to Empire Ave	Empire Ave to Butler Market Rd
West A Partial Intch	Under	Under	Under	**At**
West A Partial Intch w/ JR	**At**	Under	**At**	**At**
West A Full Intch	Under	Under	Under	**At**
West A Full Intch / JR	**At**	Under	**At**	**At**
West C Partial Intch	Under	Under	**Under/At**[1]	**At**
West C Full Intch	Under	Under	**Under/At**[1]	**At**
West C Full Intch / JR	**At**	Under	**At**	**At**
West D Partial Intch	Under	Under	**At**	**At**
West D Full Intch	**At**	Under	**At**	**At**
West D Full Intch w/ JR	**At**	Under	**At**	**At**
West D-Slip Partial Intch	Under	Under	**At**	**At**
West D-Slip Full Intch	Under	Under	**At**	**At**
West D-Slip Full Intch w/ JR	**At**	Under	**At**	**At**
West E Partial Intch	Under	Under	Under	**At**
West E Full Intch	Under	Under	Under	**At**
West E Full Intch w/ JR	**At**	Under	**At**	**At**
WS West Partial	Under	Under	**Under/At**[1]	**At**

[1]The section is under capacity from the US20 interchange to 3rd Street and at capacity from 3rd Street south to Empire Avenue.

Table 5 shows that the TSM-TDM alternative is no different from the Committed network on US97. Both the East A and B alternatives under partial or full northern interchanges perform similarly on US97. East B seems to work a bit better than East A south of Empire Avenue under Juniper Ridge as the traffic is a bit more spread out between US97 and 3rd Street.

In Table 6, West E performed the best on US20 with or without Juniper Ridge having no overcapacity segments with WS West and West C just behind. The West D alternatives perform worse than West A on the common US20/97 section because of the greater local access to Cooley Road which creates higher volumes. The West D alternatives also have 3rd Street north of Empire Avenue over capacity.

Table 5. US97: East & TSM-TDM Alternative 2030 Capacity (d/c) Ranges

Scenario	Deschutes Mkt. Rd. to North 3rd St Intch	North 3rd St Intch to US20 Connections	US20 Connections to Empire Ave	Empire Ave to Butler Market Rd
Committed	Under	n/a	**At**	**At**
TSM-TDM Full Intch	Under	n/a	**At**	**At**
TSM-TDM Full Intch w/ JR	**At**	n/a	**At**	**At**
East A Partial Intch	Under	Under	Under	**At**
East A Partial Intch w/ JR	**At**	Under	Under	**Over**
East A Full Intch	Under	Under	Under	**At**
East A Full Intch w/JR	**At**	Under	Under	**Over**
East B Partial Intch	Under	Under	Under	**At**
East B Full Intch	Under	Under	Under	**At**
East B Full Intch w/ JR	**At**	Under	Under	**At**

Table 6. US20: West Alternative 2030 Capacity (d/c) Ranges

Scenario	North of Cooley Rd	Common US20/97 Section	US20 Intch to Empire Ave	Empire Ave O.B. Riley Rd
West A Partial Intch	**At**	Under	**Over**	Under
West A Partial Intch w/ JR	**At**	**At**	**Over**	**At**
West A Full Intch	**At**	Under	**Over**	Under
West A Full Intch / JR	Under	**At**	**Over**	**At**
West C Partial Intch	**At**	Under	Under	Under
West C Full Intch	**At**	Under	Under	Under
West C Full Intch / JR	**At**	**At**	**At**	**At**
West D Partial Intch	**At**	**At**	**Over**	Under
West D Full Intch	**At**	**At**	**Over**	Under
West D Full Intch w/ JR	Under	**At**	**Over**	**At**
West D-Slip Partial Intch	**At**	**At**	**Over**	Under
West D-Slip Full Intch	**At**	**At**	**Over**	Under
West D-Slip Full Intch w/ JR	Under	**At**	**Over**	**At**
West E Partial Intch	Under	Under	Under	Under
West E Full Intch	Under	Under	Under	Under
West E Full Intch w/ JR	Under	**At**	Under	Under
WS West Partial	**At**	Under	Under	Under

Table 7 shows that the TSM-TDM alternative does not perform as well on US20 as the Committed scenario because of trips rerouting on US20 to avoid congestion on the 3rd

Street section of US97. Both East A and B perform the same with or without a full northern interchange under existing or Juniper Ridge land uses.

Table 7. US20: East & TSM-TDM Alternative 2030 Capacity (d/c) Ranges

Scenario	North of Cooley Rd	Cooley Rd to US20 Connections	US20 Connections to Empire Ave	Empire Ave O.B. Riley Rd
Committed	Under	**Over**	**At**	**At**
TSM-TDM Full Intch	**At**	**Over**	**At**	**At**
TSM-TDM Full Intch w/ JR	**At**	**Over**	**At**	**At**
East A Partial Intch	Under	Under	**Over**	Under
East A Partial Intch w/ JR	**At**	**Over**	**Over**	**At**
East A Full Intch	Under	Under	**Over**	Under
East A Full Intch w/JR	Under	Under	**Over**	**At**
East B Partial Intch	Under	Under	**Over**	Under
East B Full Intch	Under	Under	**Over**	Under
East B Full Intch w/ JR	Under	Under	**Over**	**At**

Table 8 shows the differentiators for north-south local roadways. In all West alternatives the section of 3rd Street between Cooley Road south to the US97 interchange (or overcrossing) is over capacity. Also, the new north-south arterial is under capacity in all West and East alternatives from Juniper Ridge south to Cooley Road. The West D alternatives and WS West perform the best on O.B. Riley Road because the alternatives offer access from US20 to Cooley Road. Local traffic on O.B. Riley shifts to US20 as US20 is a more attractive (quicker) option.

In Table 9, the TSM-TDM alternative does not address any issues along 3rd Street between Cooley and the US20 overcrossing because of the at-grade accesses and intersections in this section. The other change is the reducing of traffic on O. B. Riley Road as traffic shifts to US20 as the preferred route to avoid the congestion and restrictions on US97.

East A with a partial or full interchange and East B with a partial interchange perform the same. East B with a full interchange increases the congestion on 3rd Street with or without Juniper Ridge because most East B ramp traffic is going to the mall area via Robal Road or to the Cooley Road area east of US97.

Table 8. West Alternatives North-South Non-state Roadways: 2030 Capacity (d/c) Ranges

Scenario	Deschutes Market Rd	O.B. Riley Rd – Old Bend to 3rd St
West A Partial Intch	Under	**Over**
West A Partial Intch w/ JR	**Over**	**Over**
West A Full Intch	Under	**Over**
West A Full Intch / JR	**Over**	**Over**
West C Partial Intch	Under	**Over**
West C Full Intch	Under	**Over**
West C Full Intch / JR	**Over**	**Over**
West D Partial Intch	Under	**Over**
West D Full Intch	Under	**At**
West D Full Intch w/ JR	**Over**	**Over**
West D-Slip Partial Intch	Under	**Over**
West D-Slip Full Intch	Under	**At**
West D-Slip Full Intch w/ JR	**Over**	**Over**
West E Partial Intch	Under	**Over**
West E Full Intch	Under	**Over**
West E Full Intch w/ JR	**Over**	**Over**
WS West Partial	Under	**At**

Table 9. East & TSM-TDM Alternatives North-South Non-state Roadways: 2030 Capacity (d/c) Ranges

Scenario	3rd St – Cooley to US97	Deschutes Market Rd	O.B. Riley Rd – Old Bend to 3rd St
Committed	**Over**	Under	**Over**
TSM-TDM Full Intch	**Over**	Under	**At**
TSM-TDM Full Intch w/ JR	**Over**	**At**	**Over**
East A Partial Intch	Under	Under	**At**
East A Partial Intch w/ JR	**At**	**At**	**Over**
East A Full Intch	Under	Under	**At**
East A Full Intch w/JR	Under	**Over**	**At**
East B Partial Intch	Under	Under	**At**
East B Full Intch	**At**	Under	**At**
East B Full Intch w/ JR	**At**	**Over**	**At**

Table 10. West Alternatives East-West Non-state Roadways: 2030 Capacity (d/c) Ranges

Scenario	Cooley Rd – US20 to 3rd St	Cooley Rd – 3rd St to 18th St	Robal Rd – US20 to 3rd	Empire Ave US20 – NB Ramps	Empire Ave NB Ramps to 18th St
West A Partial Intch	Under	Under	**At**	**At**	Under
West A Partial Intch w/ JR	Under	**Over**	Under	**Over**	**Over**
West A Full Intch	Under	Under	**At**	**At**	**At**
West A Full Intch / JR	Under	**At**	**At**	Under	**At**
West C Partial Intch	Under	**At**	**Over**	Under	Under
West C Full Intch	Under	**At**	**Over**	Under	Under
West C Full Intch / JR	Under	**At**	**Over**	Under	Under
West D Partial Intch	Under	Under	Under	**At**	**At**
West D Full Intch	Under	Under	Under	**At**	**At**
West D Full Intch w/ JR	Under	**At**	Under	Under	**At**
West D Slip Partial Intch	Under	Under	Under	Under	**At**
West D Slip Full Intch	Under	Under	Under	**At**	**At**
West D Slip Full Intch w/ JR	Under	**At**	Under	Under	**At**
West E Partial Intch	Under	Under	**At**	Under	**At**
West E Full Intch	Under	Under	**At**	Under	**At**
West E Full Intch w/ JR	Under	**At**	**At**	**At**	**At**
WS West Partial	**At**	**At**	**At**	**At**	**At**

Table 10 shows the east-west local roadway impacts. Alternative WS West is the only alternative to significantly impact the west portion of Cooley Road because US20 is routed onto Cooley road to access US97. WS West also has more local roadways at capacity than any other alternative. West C causes Robal Road to go over capacity (d/c

ratios increase 120%) because access to Empire Avenue is more restricted than other alternatives. In addition, the extension of Nels Anderson Road to Empire will bring more traffic directly into Robal from Empire. Only West C and E address the Empire capacity issues. West C has less impact spread over a larger portion of Empire, while West E has a more dramatic impact concentrated on the higher volume 3rd Street to US97 segment.

In Table 11, the TSM-TDM alternative does not have any differences over the Committed no-build network except east of US97 on Empire Avenue. The ramp metering on US97 will divert some traffic to other roadways as it may be easier to use surface streets than the highway. As in other locations, there is little difference between East A with or without a full northern interchange. The significant difference between East A and B is seen with Robal Road at capacity in East B because most traffic wishes to access the triangle commercial area from the East B ramp.

Table 11. East & TSM-TDM Alternatives East-West Non-state Roadways: 2030 Capacity (d/c) Ranges

Scenario	Cooley Rd – US20 to 3rd St	Cooley Rd – 3rd St to 18th St	Robal Rd – US20 to 3rd	Empire Ave US20 – NB Ramps	Empire Ave NB Ramps to 18th St
Committed	Under	**At**	Under	**Over**	**Over**
TSM-TDM Full Intch	Under	**At**	Under	**Over**	**At**
TSM-TDM Full Intch w/ JR	Under	**At**	Under	**Over**	**Over**
East A Partial Intch	**Over**	Under	Under	**At**	**At**
East A Partial Intch w/ JR	Under	**At**	**At**	**Over**	**Over**
East A Full Intch	**Over**	Under	Under	**At**	**At**
East A Full Intch w/JR	**At**	**At**	Under	Under	**At**
East B Partial Intch	**Over**	Under	**At**	**At**	**At**
East B Full Intch	**Over**	**At**	**At**	Under	**At**
East B Full Intch w/ JR	**Over**	**At**	**At**	**At**	**At**

Alternative Comparison

Across all of the alternatives, the difference of a partial system or service interchange versus a full service type interchange is minimal on existing land uses. A new north-south arterial between Juniper Ridge and Empire Avenue needs to be constructed to support a new full interchange on US97. The combination will result in a 20 to 25 % decrease of volumes on US97 as some trips will divert to the new arterial. A full interchange is much more sensitive to surrounding land uses and densities than a partial interchange. Under a Juniper Ridge (1,500 acres) proposal, East alternatives are more sensitive with a 60% increase on US97 over a West alternative with 30%. This will result in a net impact to US97 of 10 to 40% over the existing land uses. Construction of a full interchange immediately is very risky because of the unknown volume impact, so the partial half-diamond (ramps to/from the north) should be constructed first. After the local system is expanded including the new north-south arterial, the ramps to/from the south could be constructed. Table 12 shows a summary of the significant positive, neutral and negative alternative impacts.

Table 12. Alternative Summary

	West A	West C	West D	West D-Slip	West E	WS West	East A	East B	TSM-TDM
Impacts to US97	0	0	0	-	0	-	0	0	+
Impacts to US20	0	0	-	-	0	-	0	0	0
Impacts to 3rd St	+	-	-	+	-	0	0	-	0
Impacts to Empire Ave	0	+	0	0	+	+	0	+	-
US97 d/c	+	+	0	0	+	0	+	+	0
US20 d/c	0	+	0	0	+	+	+	+	-
North – South Local d/c	0	0	0	0	0	0	+	+	0
East-West Local d/c	0	+	+	+	+	0	0	0	0

[1]"+" shows that a scenario has a significantly positive impact on the system which is equal to minimum or negative volume differences and d/c ranges; "0" is no significant change; "-" is a significant negative impact which is equal to high positive percent differences and d/c ranges.

The TSM-TDM alternative shows that that the alternative is not a stand-alone on the same level as the others. The addition of ramp metering has the potential to reduce impacts to US97 in the project area and should be considered as an interim solution or inclusion as part of a project phase.

The East B alternative offers little improvement to the project area over East A. While it does reduce Empire Avenue volumes slightly, this traffic is moved directly to a congested 3rd Street location and ends up the moving problem instead of solving it. Most of the East B ramp traffic is destined to the mall/commercial area which will increase the congestion in the Robal Road area.

The current West A alternative has unresolved capacity issues surrounding the US20/97 interchange, on 3rd Street north of Empire Avenue and on Empire itself. The West C alternative addresses the 3rd Street and Empire Avenue issues but the capacity issues on US20 remain. The West D, D- Cooley Slip alternatives add significantly more traffic to the common section of US20/97 and US20 while the WS West alternative significantly adds more traffic to US97 north of the US20 interchange. The increased traffic created because of additional service-based access to Cooley Road minimizes any benefit that they may have.

Only the West E alternative resolves the US20, 3rd Street and Empire Avenue issues without moving the problem elsewhere as impacts to the local system are minimized. West E offers an overall solution for the project area by offering more access without compromising highway operations.

Conclusions

Table 13 shows the recommendations for forwarding to the next level from the screening analysis.

Table 13. Recommendations

Scenario	Recommendation
Northern Partial vs. Full Interchange	Full service interchange phased in over time
West A	Drop
West C	Drop
West D	Drop
West D-Slip	Drop
West E	Keep
WS West	Drop
East A	Keep
East B	Drop
TSM-TDM	Drop

If there are any questions or comments, please contact me at 503-986-4110.

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File

Figure J-14 US 97 Bend North Corridor - Committed Scenario

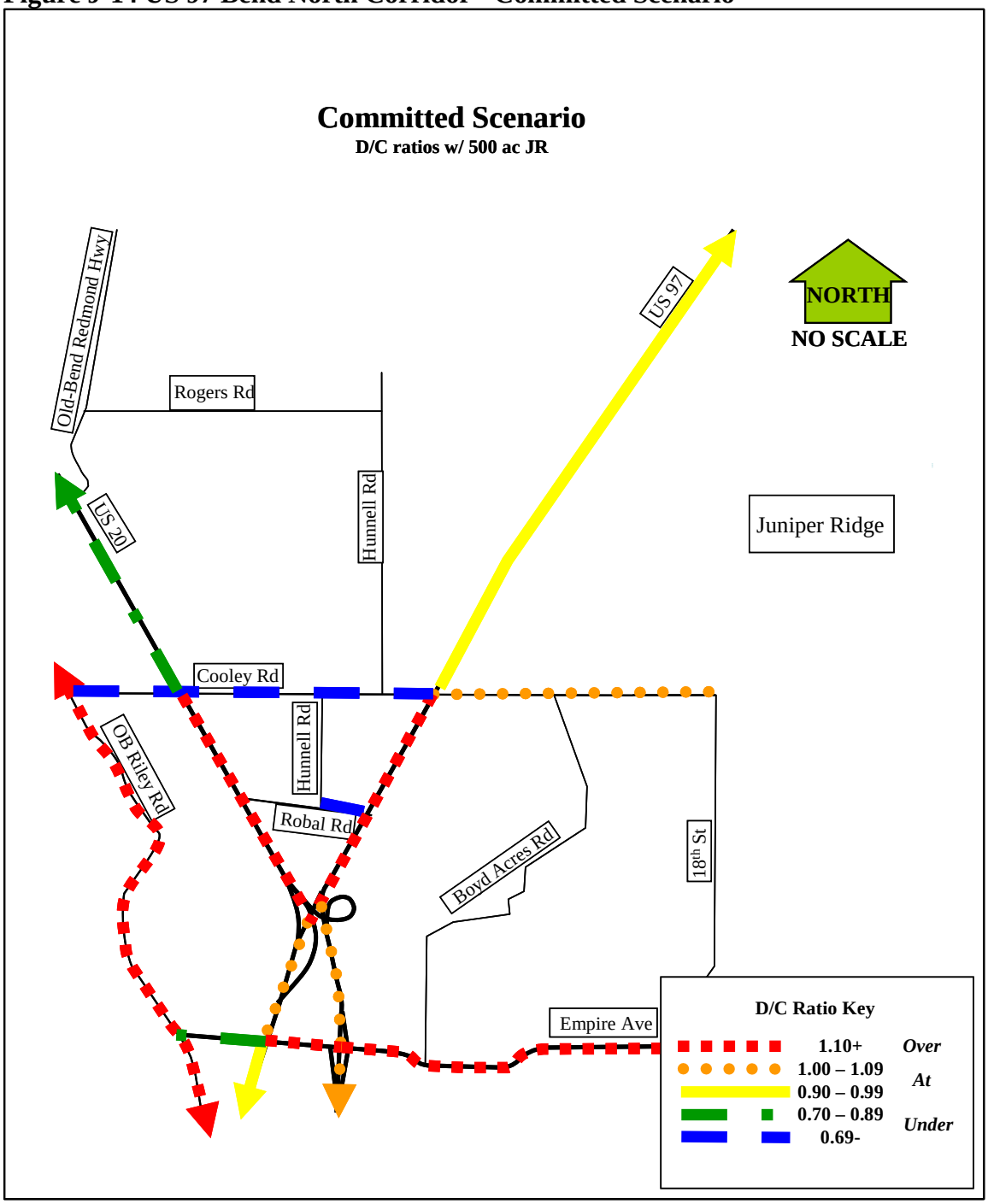

Figure J-15 US 97 Bend North Corridor - TSM-TDM Scenario

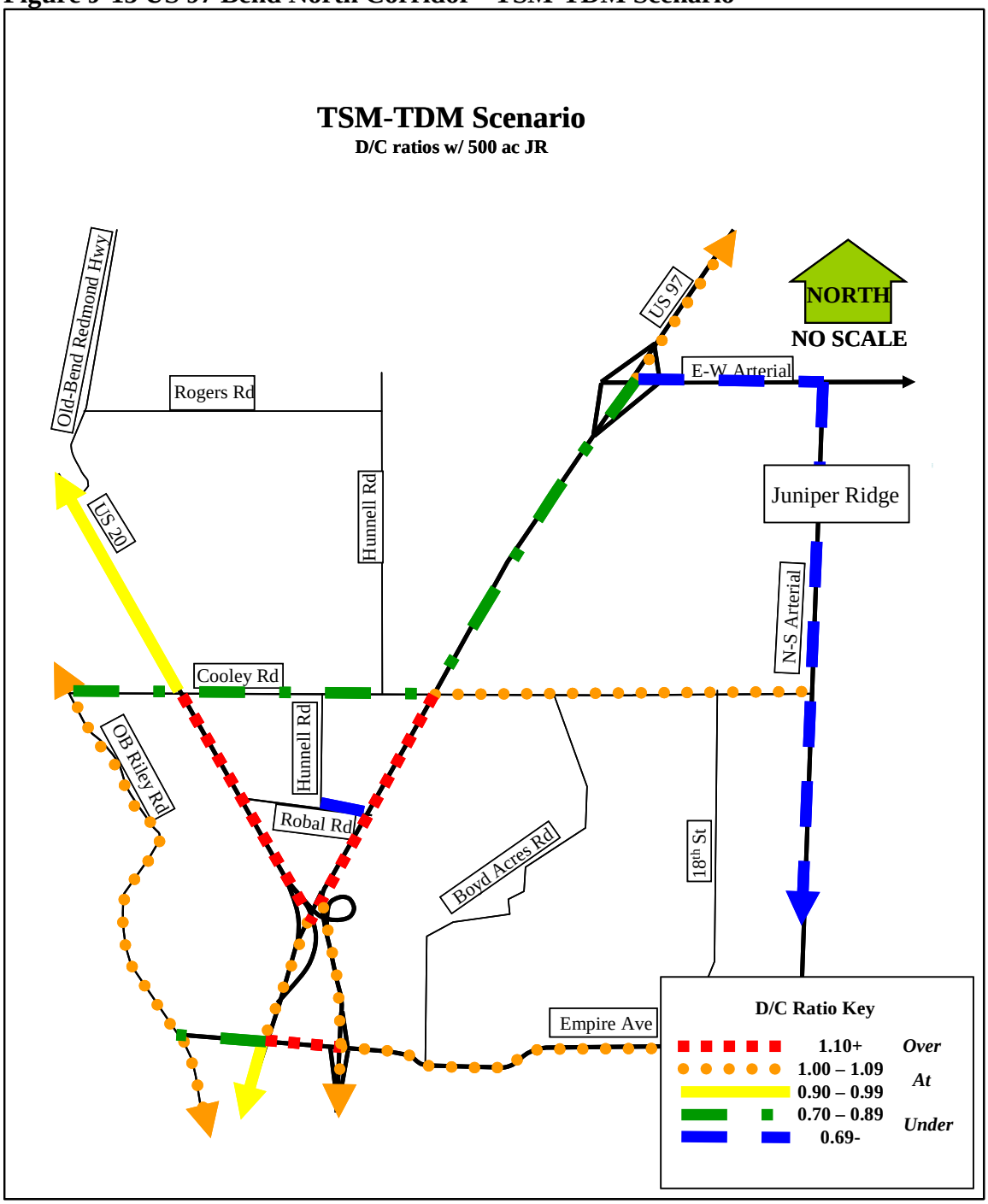

Figure J-16 US 97 Bend North Corridor - Alternative West A

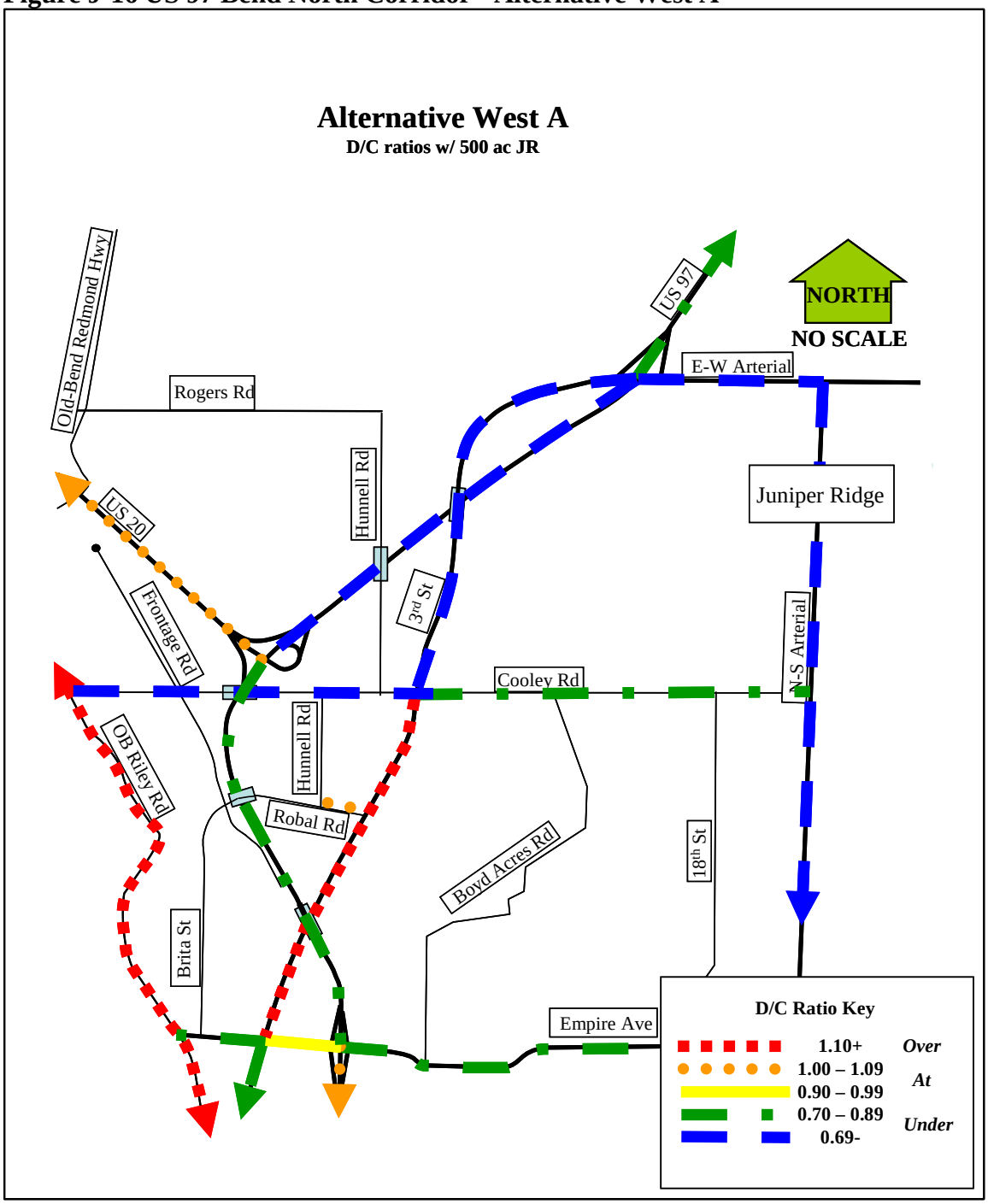

Figure J-17 US 97 Bend North Corridor - Alternative West A

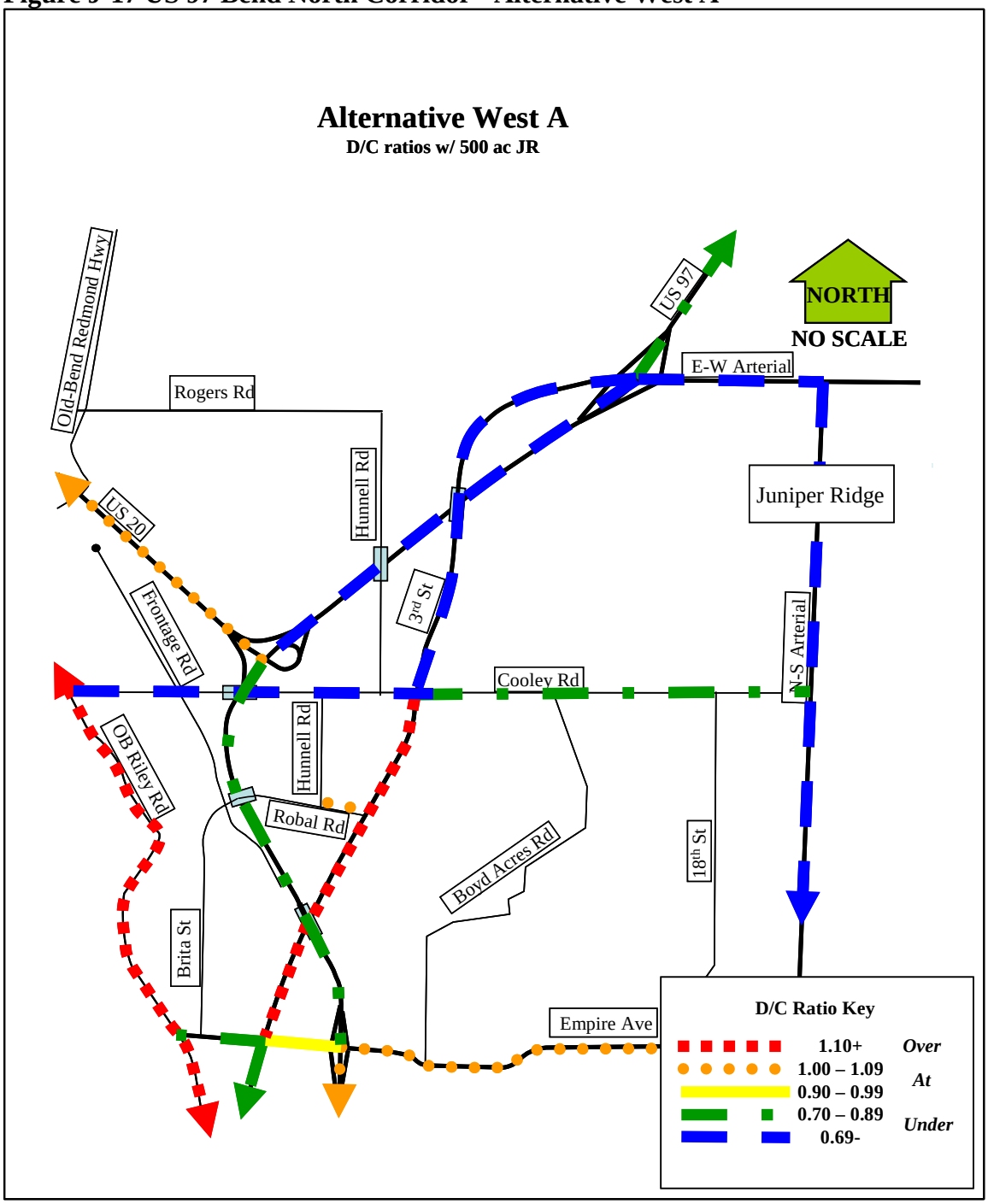

Figure J-18 US 97 Bend North Corridor - Alternative West C

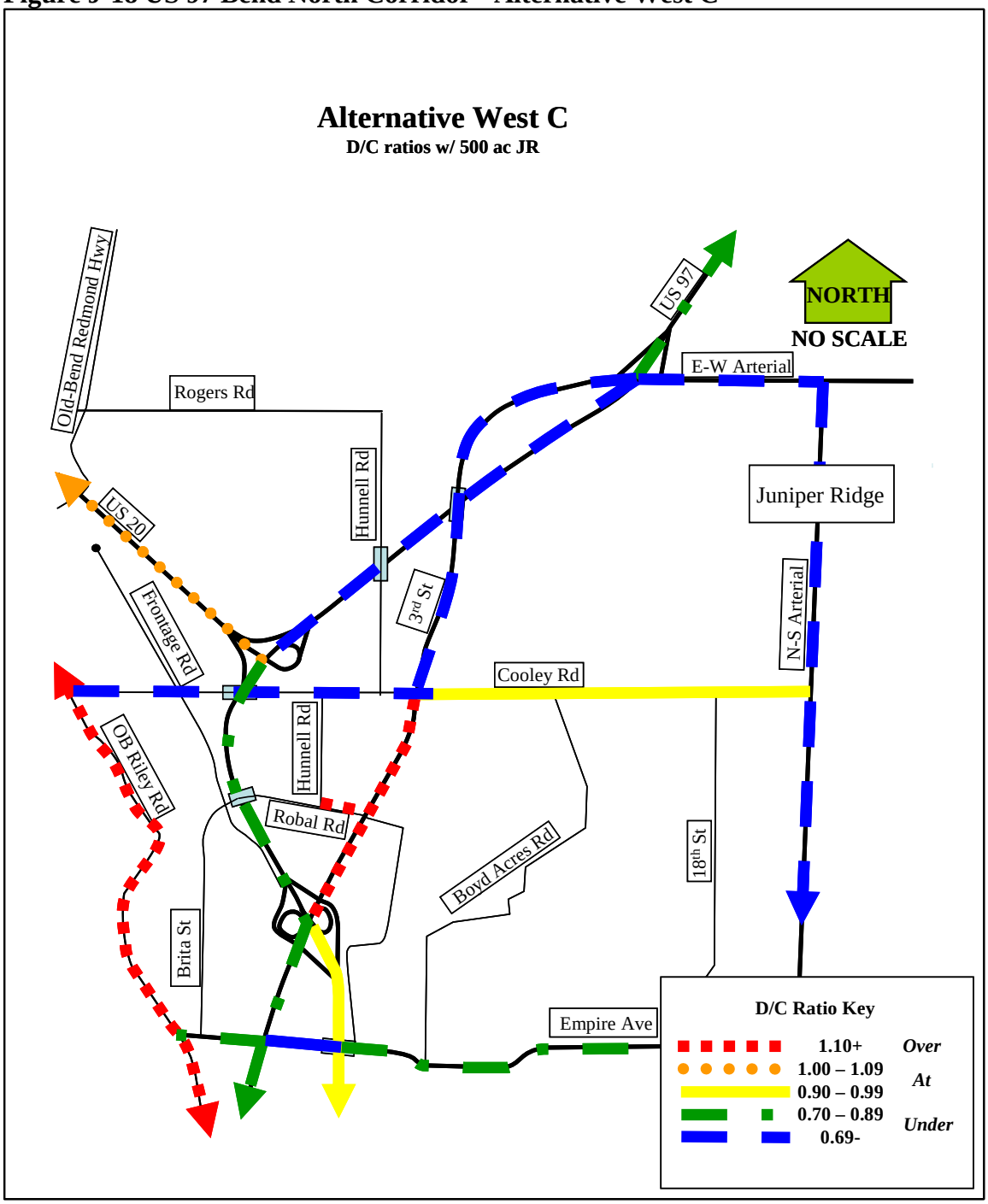

Figure J-19 US 97 Bend North Corridor - Alternative West C

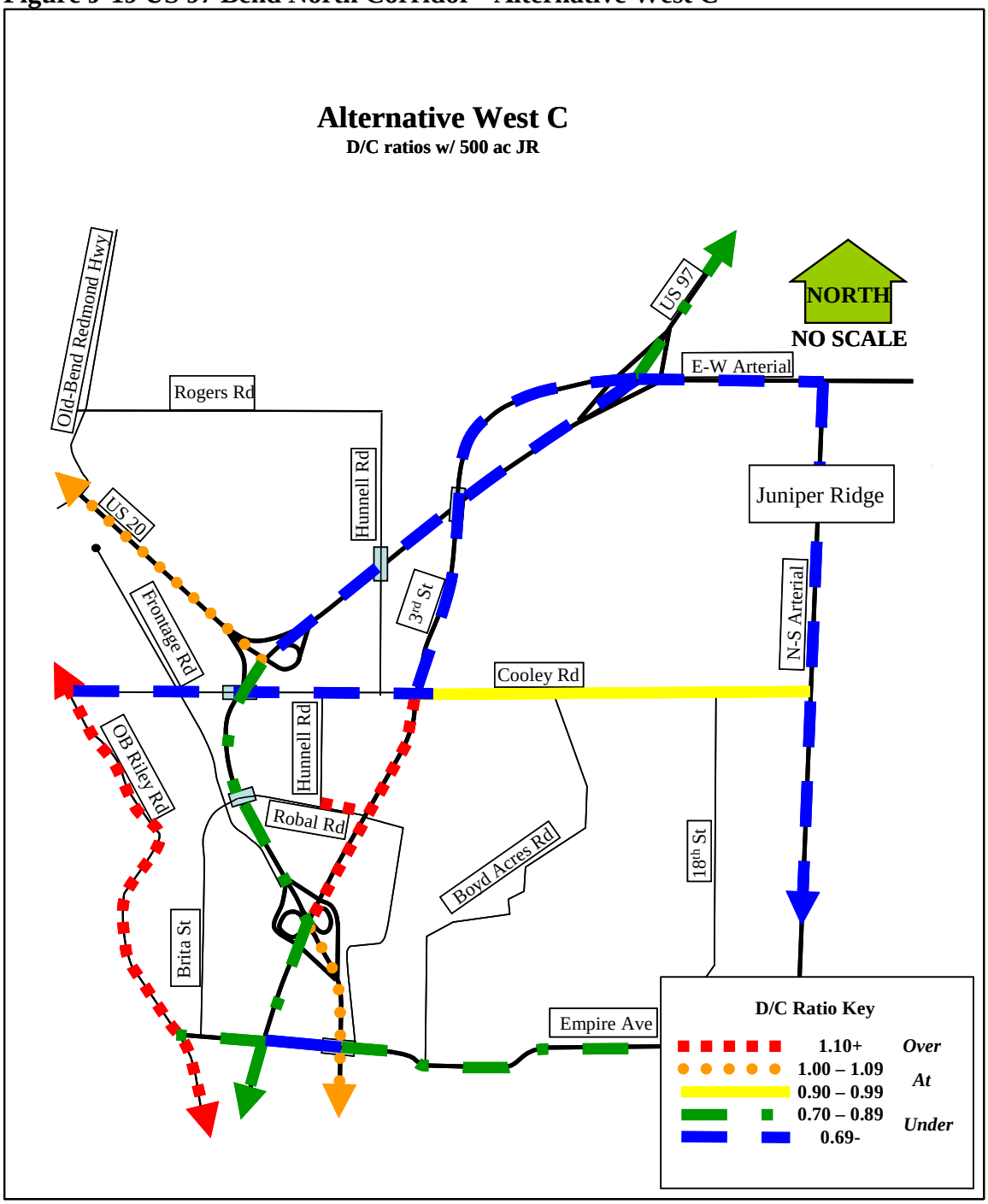

Figure J-20 US 97 Bend North Corridor - Alternative West D

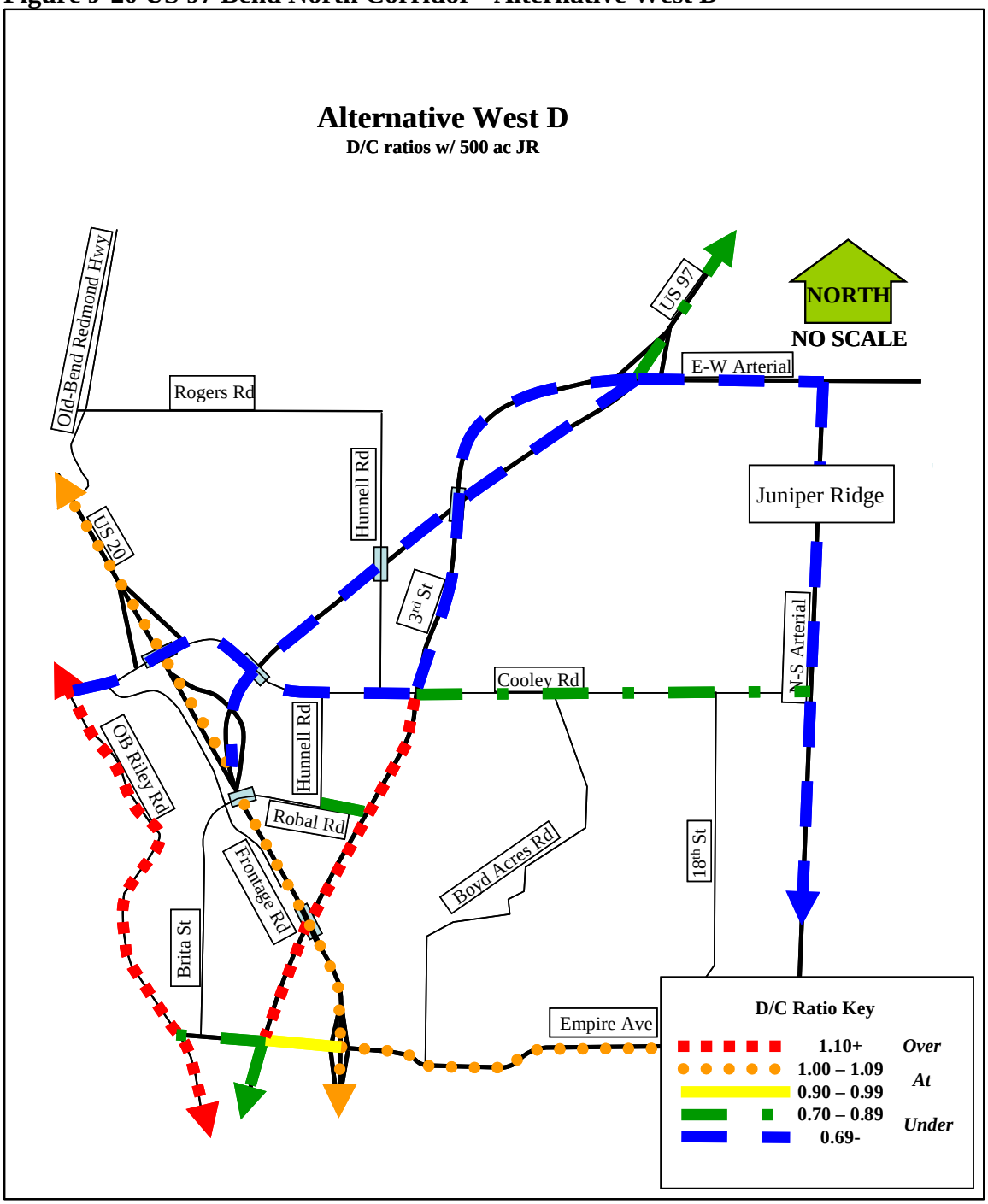

Figure J-21 US 97 Bend North Corridor - Alternative West D

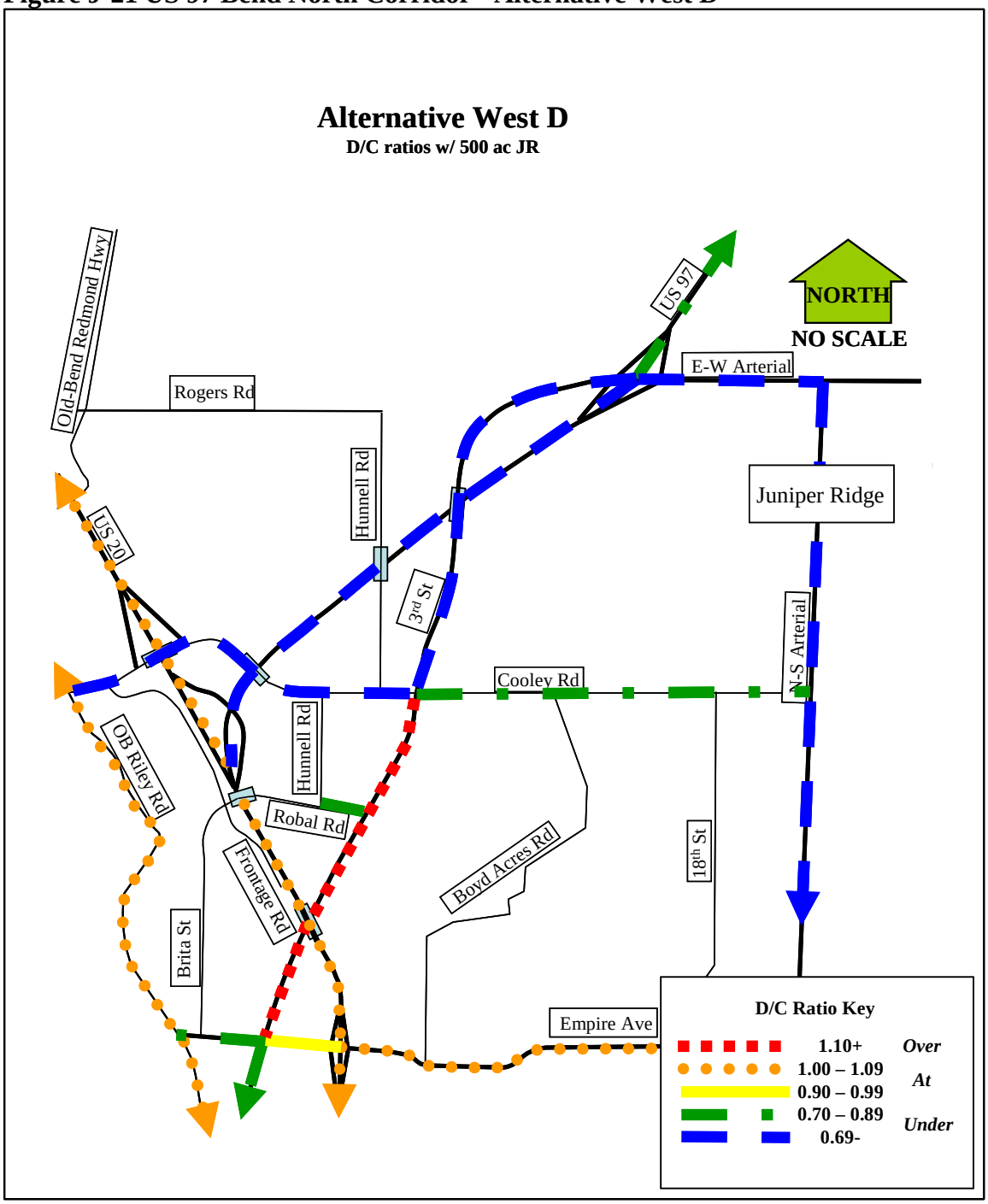

Figure J-22 US 97 Bend North Corridor - Alternative West D-Cooley Slip

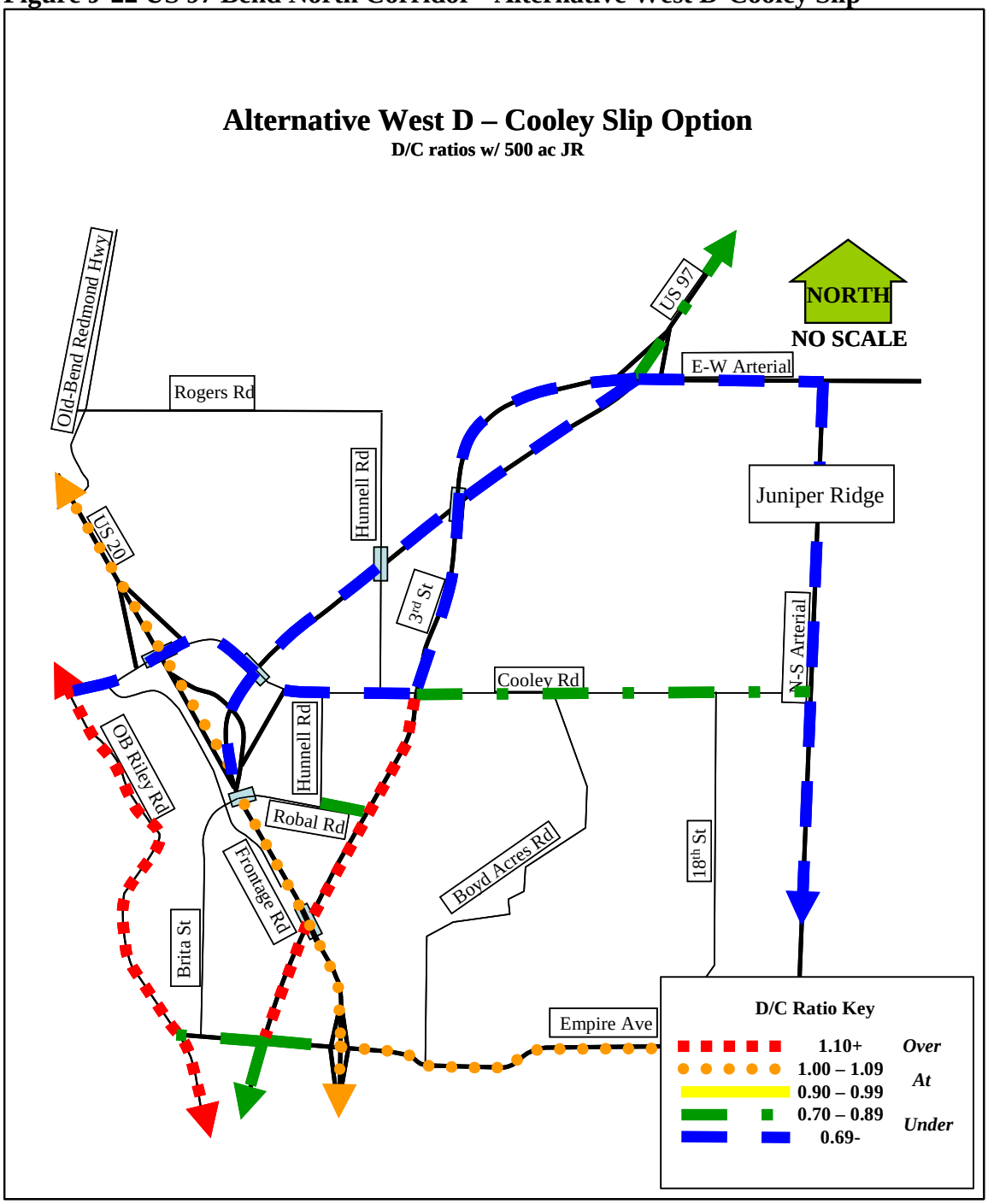

Figure J-23 US 97 Bend North Corridor - Alternative West D-Cooley Slip

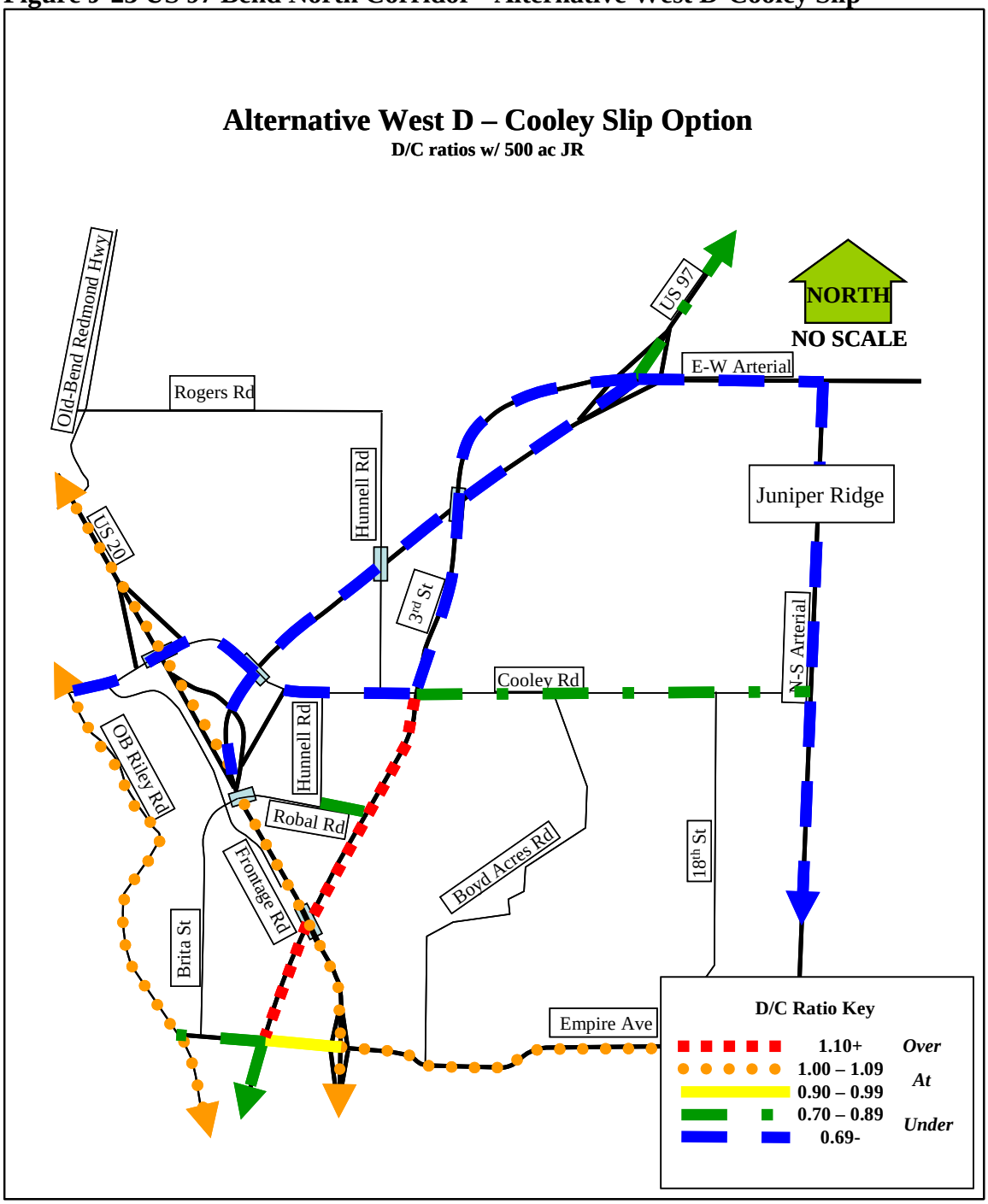

Figure J-24 US 97 Bend North Corridor - Alternative West E

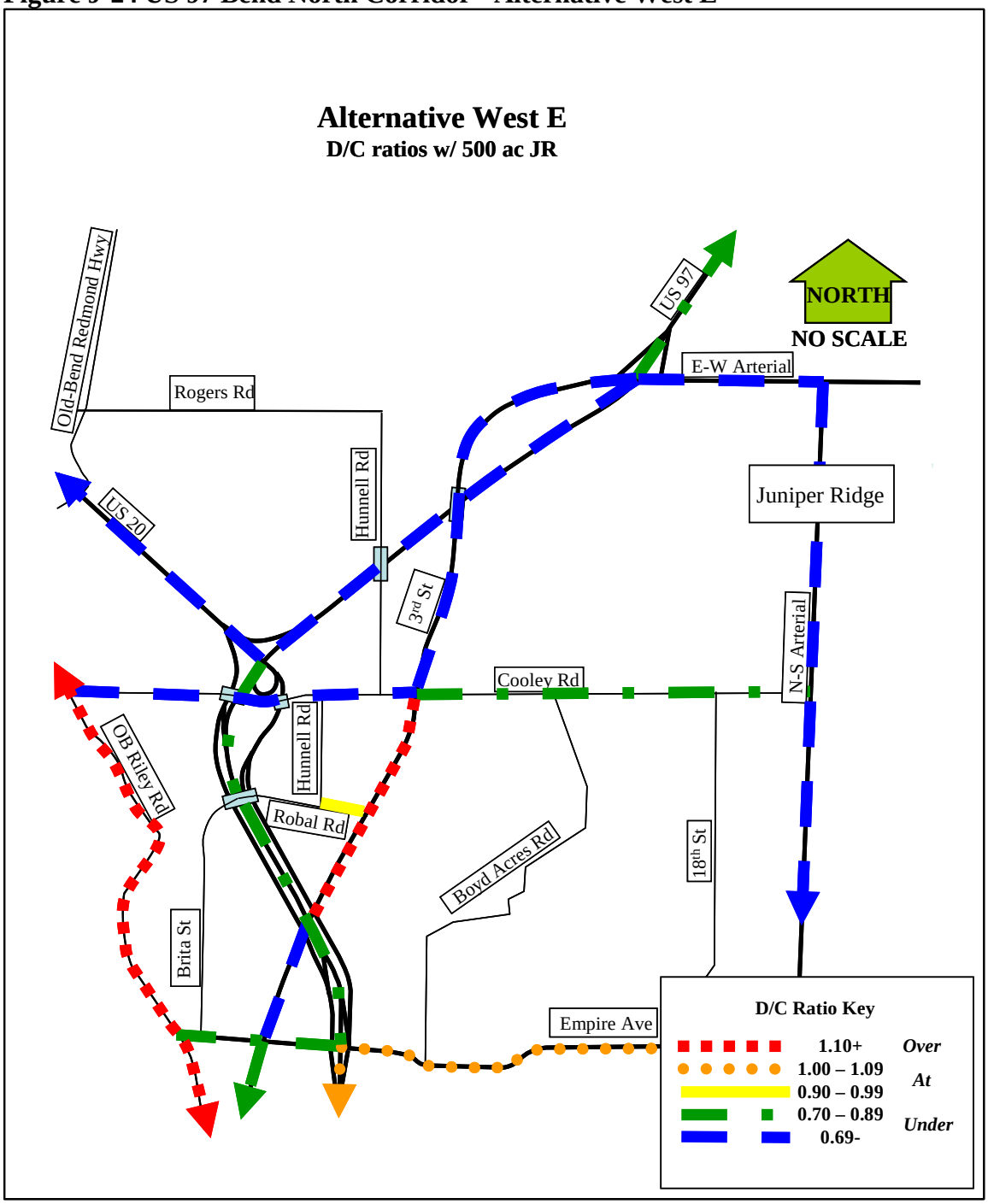

Figure J-25 US 97 Bend North Corridor - Alternative West E

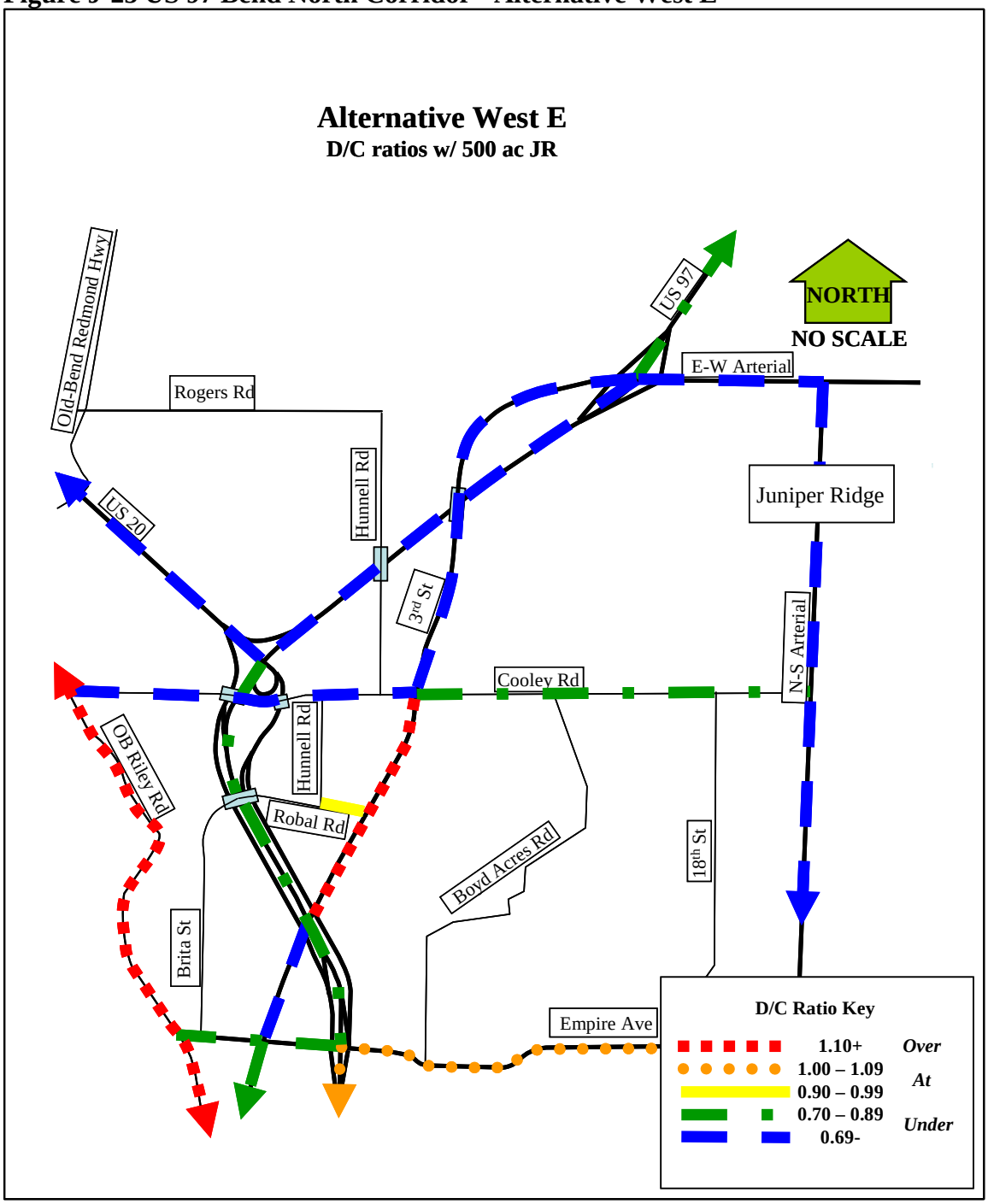

Figure J-26 US 97 Bend North Corridor - Alternative WS West

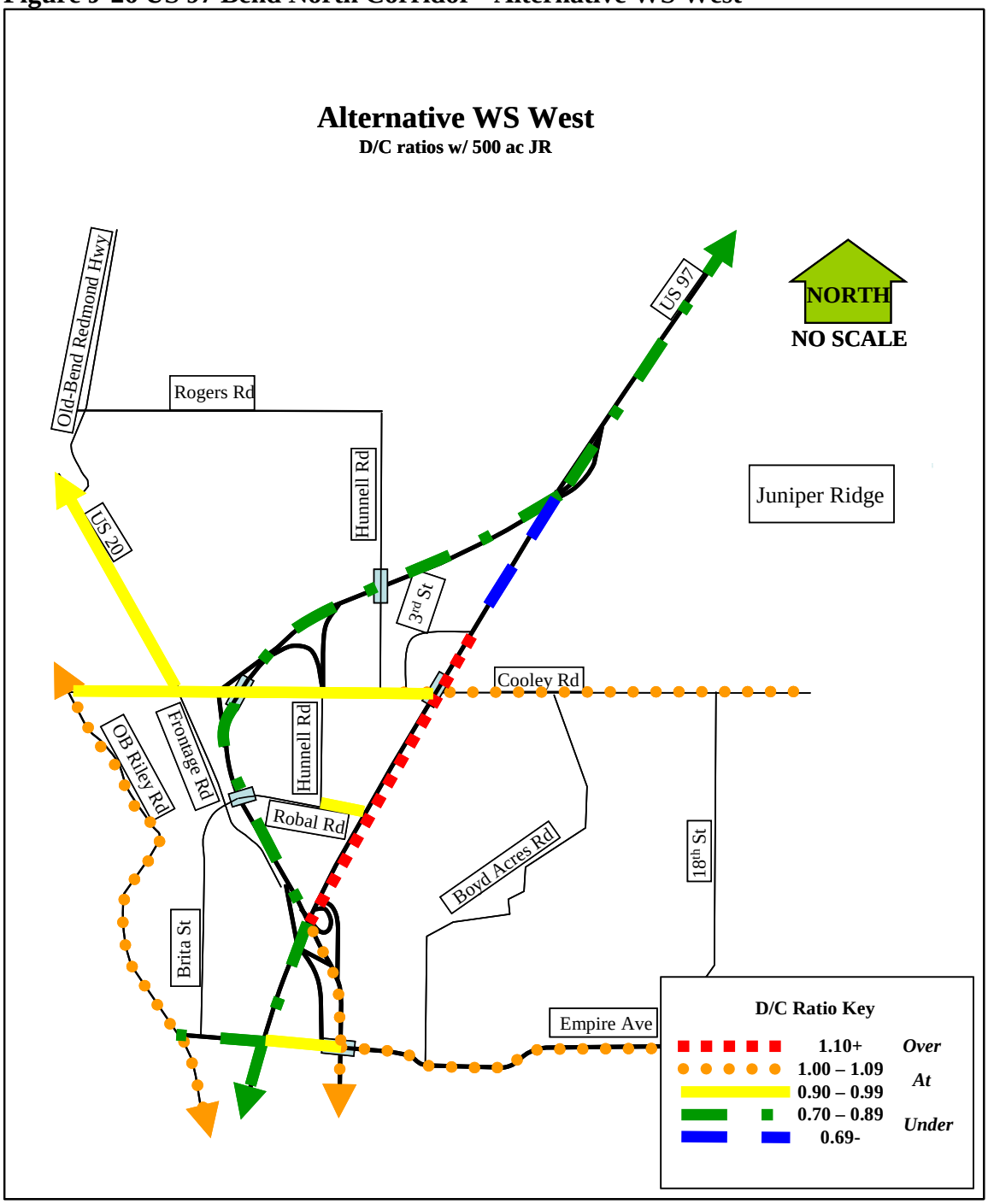

Figure J-27 US 97 Bend North Corridor - Alternative East A

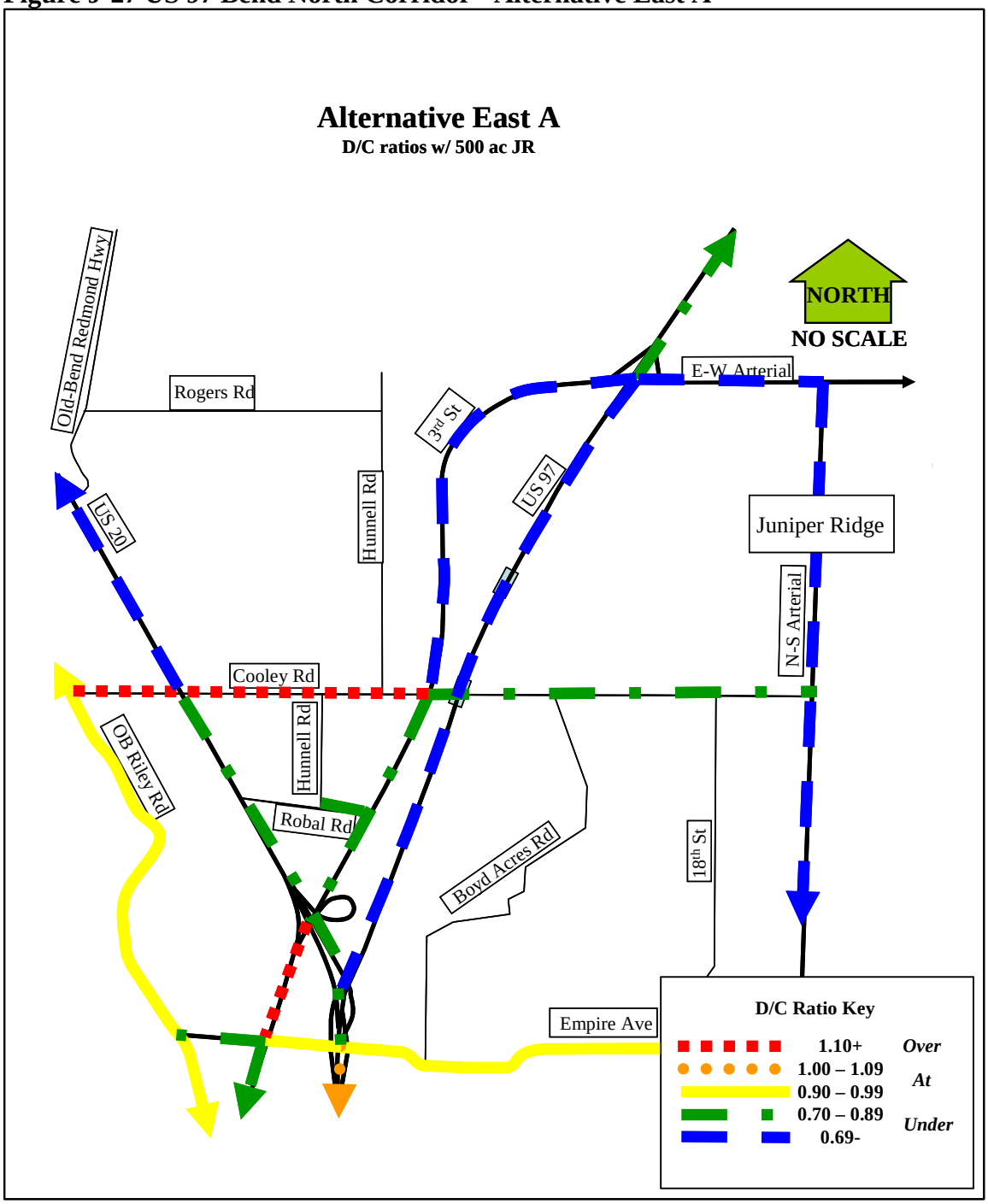

Figure J-28 US 97 Bend North Corridor - Alternative East A

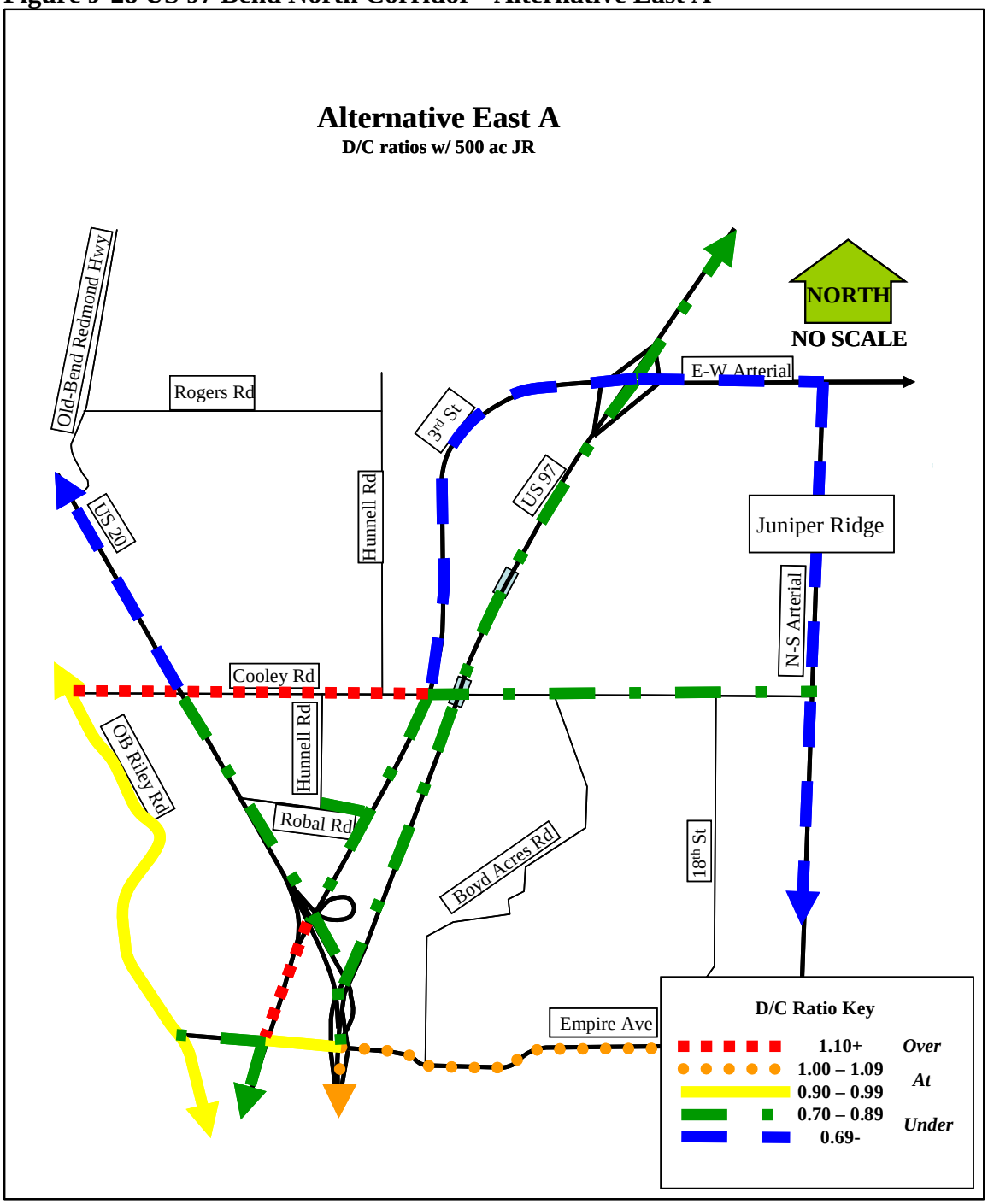

Figure J-29 US 97 Bend North Corridor - Alternative East B

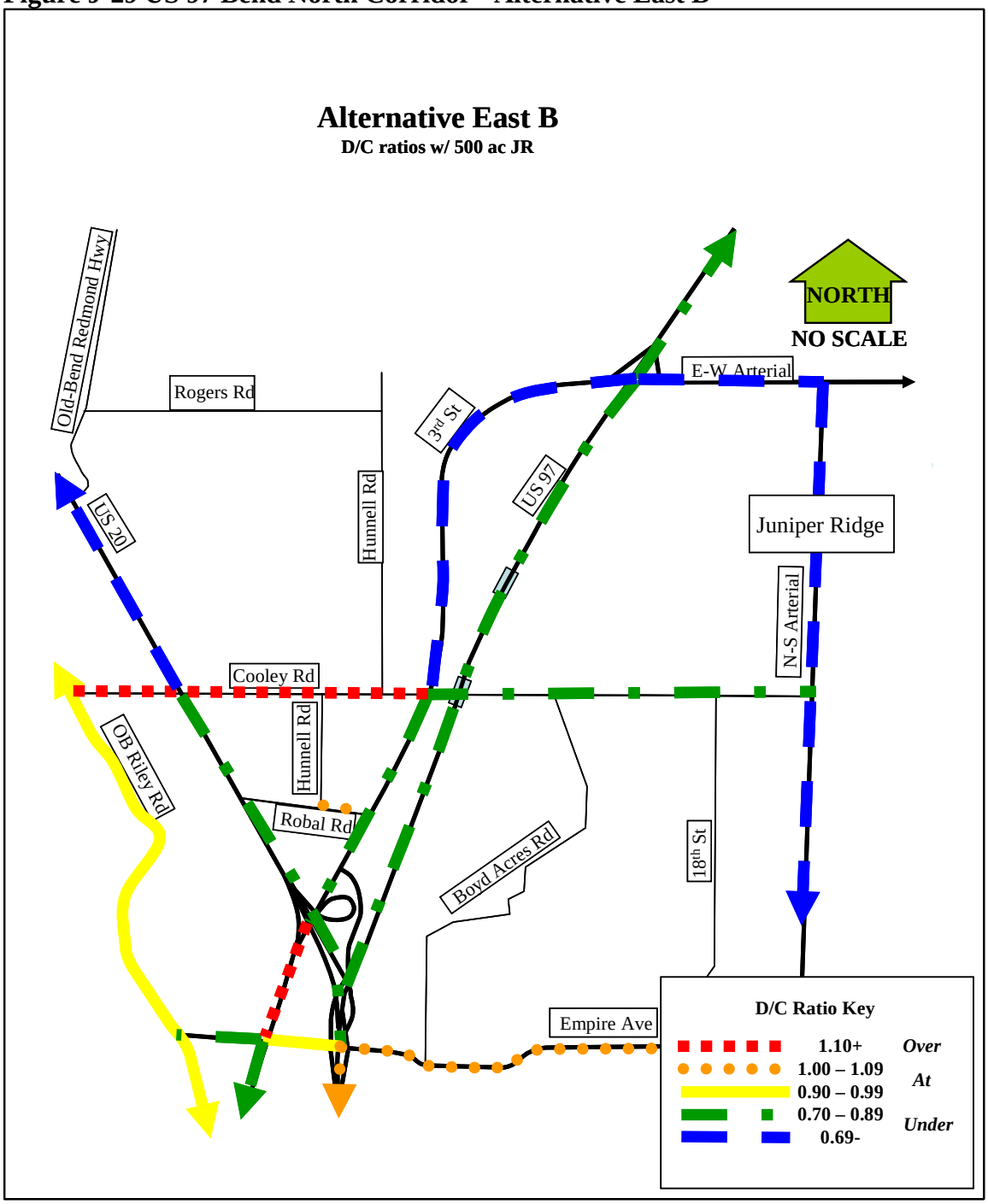

Figure J-30 US 97 Bend North Corridor - Alternative East B

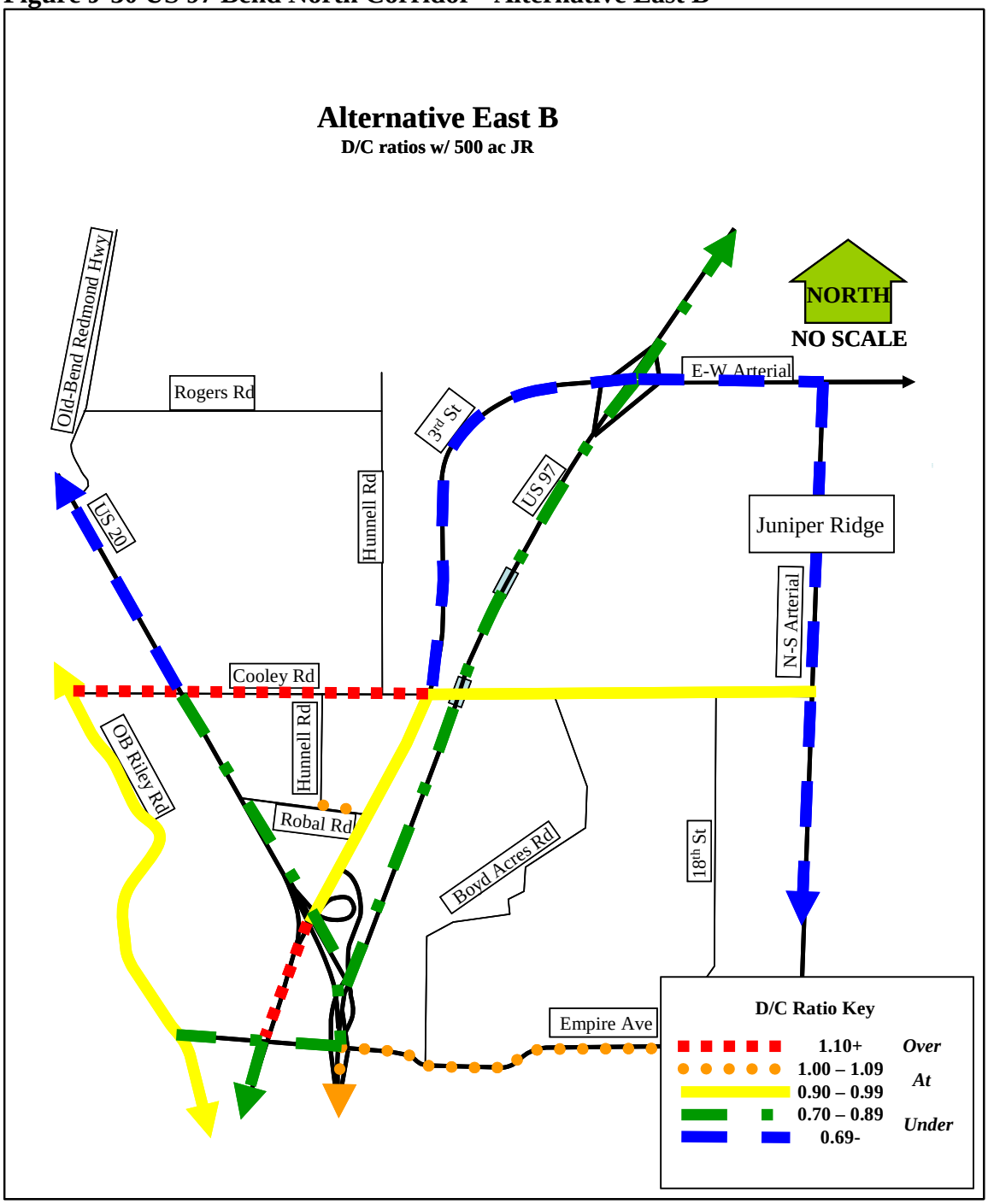

Figure J-31 Updated Final: Technical Memorandum #7: Downscaled Alternatives Screening Evaluations

STATE OF OREGON **INTEROFFICE MEMO**

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File Code:

Date: April 21, 2010

TO: **Jon Heacock**
US97 North Corridor Project Manager

FROM: **Peter L. Schuytema, P.E., Senior Transportation Analyst**
Transportation Planning Analysis Unit

SUBJECT: **UPDATED FINAL: Technical Memorandum #7: Downscaled Alternatives Screening Evaluations**

This technical memorandum contains the results for the Purpose and Need screening and the Goals and Objectives screening for the downscaled alternatives for the US97 Bend North Corridor project. The purpose of this screening analysis is to compare and contrast the alternatives to determine their system-level impacts.

The East DS1 scenario has the best overall performance of the four scenarios studied. The extension of 18th Street does not significantly affect the realigned US97 or 3rd Street south of the northern interchange and is not needed to be part of the East DS1 scenario. The West DS1 scenario almost works as well as East DS1 but the high volume imbalance between US97 and 3rd Street will likely cause additional congestion on 3rd south of Robal Road. The Existing DS1 scenario does the poorest job of handling traffic of the three major scenarios because it has more at/over capacity segments on US97, US20 and the local system. The addition of ramp meters in the project area can preserve capacity on US97 but does cause diverting traffic to significantly increase Empire Avenue and 3rd Street traffic.

Background

The BMPO (Bend Metropolitan Planning Organization) regional travel demand model was used for this first-level analysis for the US97 Bend North Corridor project. Travel demand models are a combination of mathematical equations and relationships using locally-provided existing housing and employment information to project future traffic

conditions. These future traffic conditions are placed on a network which is similar to the actual roadway network. An individual scenario was created for each conceptual alternative. These scenarios were compared together on a relative basis (proportions and percents) rather than using the actual volumes reported on each segment or "link" to find the differences between them. The actual model volumes cannot be directly used because the model is just mathematical relationships and needs to be tied to actual traffic volumes.

The future 2030 Metropolitan Transportation Plan (MTP) roadway network was used to be consistent with the federally required 20-year financially constrained outlook. Note that this is different from previous model screening Technical Memorandums #1, #2, #5 and #6 which used the Committed network. The "Committed" designation means that the network included all the city, county and state projects that are listed in a funding committed construction program (i.e. ODOT's Statewide Transportation Improvement Plan; STIP) in the Bend metro area. The MTP assumes all projects that are in the Committed network plus projects that are fundable in the next 20 years from the Regional Transportation Plan (RTP). These projects are assumed to occur regardless of what happens in the US97/20 project area.

Additionally, volumes can easily fluctuate 10% over a given week, so this analysis uses a 10% threshold for determining if a change makes a difference (i.e. significant). It should be noted that not every detail is large enough for a model to see relative differences between (e.g., signals, residential street alignments, or whether an interchange ramp is straight or a loop). The scenarios were compared on a relative basis with segment volume and capacity evaluations.

Scenario Descriptions

In fall 2009, increased scrutiny was placed on the then-current long term alternatives (East 1-3 and West 1) comparing their overall size and cost with the financial ability of the region. The larger alternatives were outside the regional capability to fund them in a 20-year period. Region 4 decided to investigate downscaling of the larger alternatives to a more reasonable size by minimizing interchange connections and local street improvements to known common elements. Some of these elements are full access control, four lanes, and no signals on US97; turn lane improvements at the 3rd Street/Empire Avenue intersection; realignment of Hunnell Road and extension of Robal Road to O. B. Riley Road. One downscaled alternative from each of the east and west corridors and one on the existing alignment resulted from the alternative development effort that followed. A figure and related description of each scenario follow.

Figure 1: MTP Scenario

This scenario includes all city, county and state projects that are listed in a funding committed construction program (i.e. ODOT's Statewide Transportation Improvement Plan; STIP) plus all RTP financially constrained projects in the Bend metro area. Projects of note in the study area include the southbound US97/Empire Avenue off-ramp, the widening of Empire Avenue from 3rd Street to 27th Street to four lanes, the Cooley Road extension east to Deschutes Market Road, and the extension of Robal Road west to a completed Britta Street.

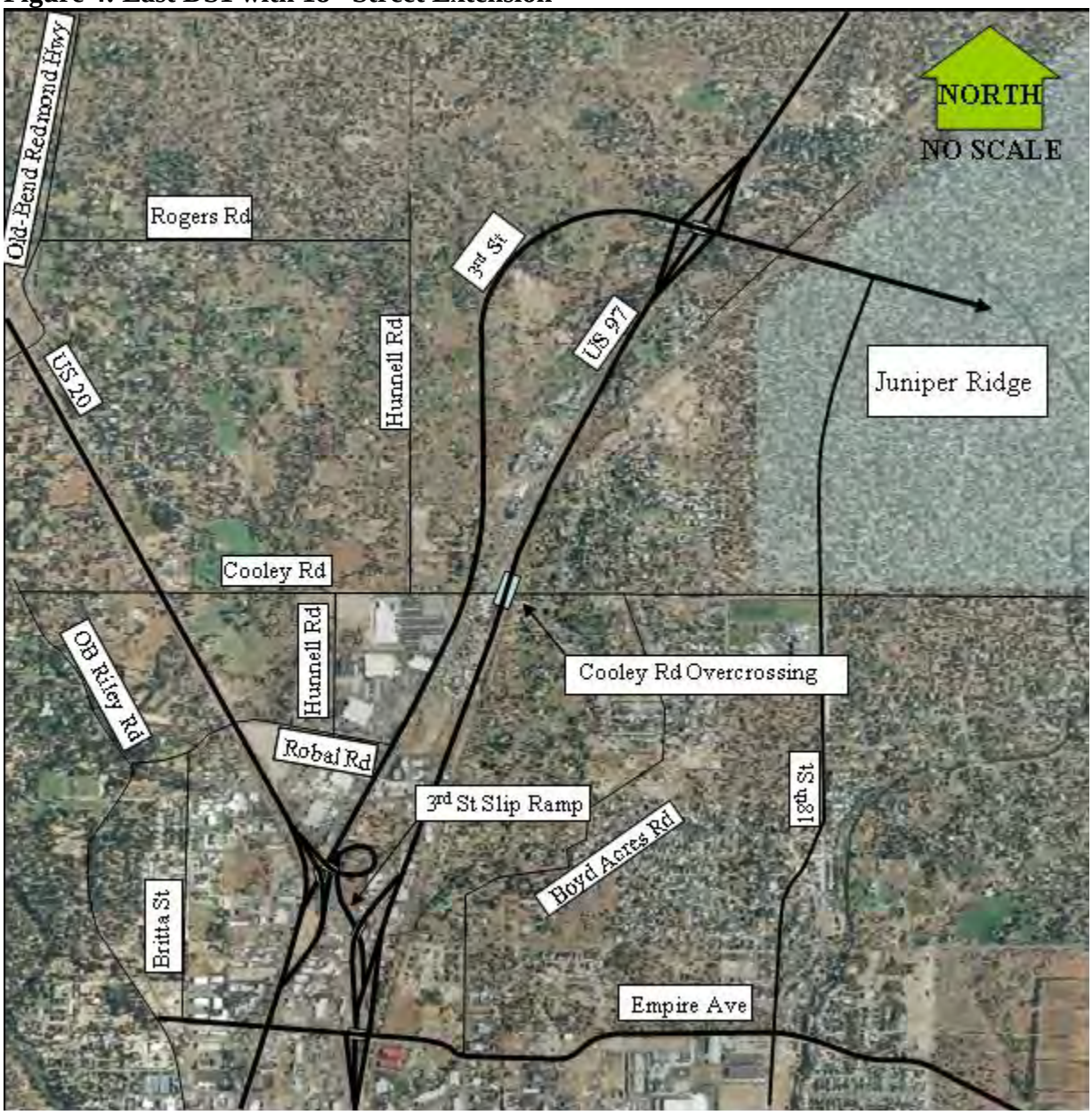
Figure 2: Existing DS1 Scenario

This scenario has US97 on the existing alignment. US97 has three lanes (two through plus an auxiliary lane) in each direction between Cooley and US20. US97 has a full interchange at Cooley Road and an overcrossing at Robal Road. Additionally, a northbound slip ramp to Robal Road facilitates access into the Nels Anderson industrial area and the commercial triangle area. In addition, from the Cooley Road interchange south to the US20/Butler Market Road interchange, all of the on-ramps have ramp metering.

Figure 3: East DS1 Scenario

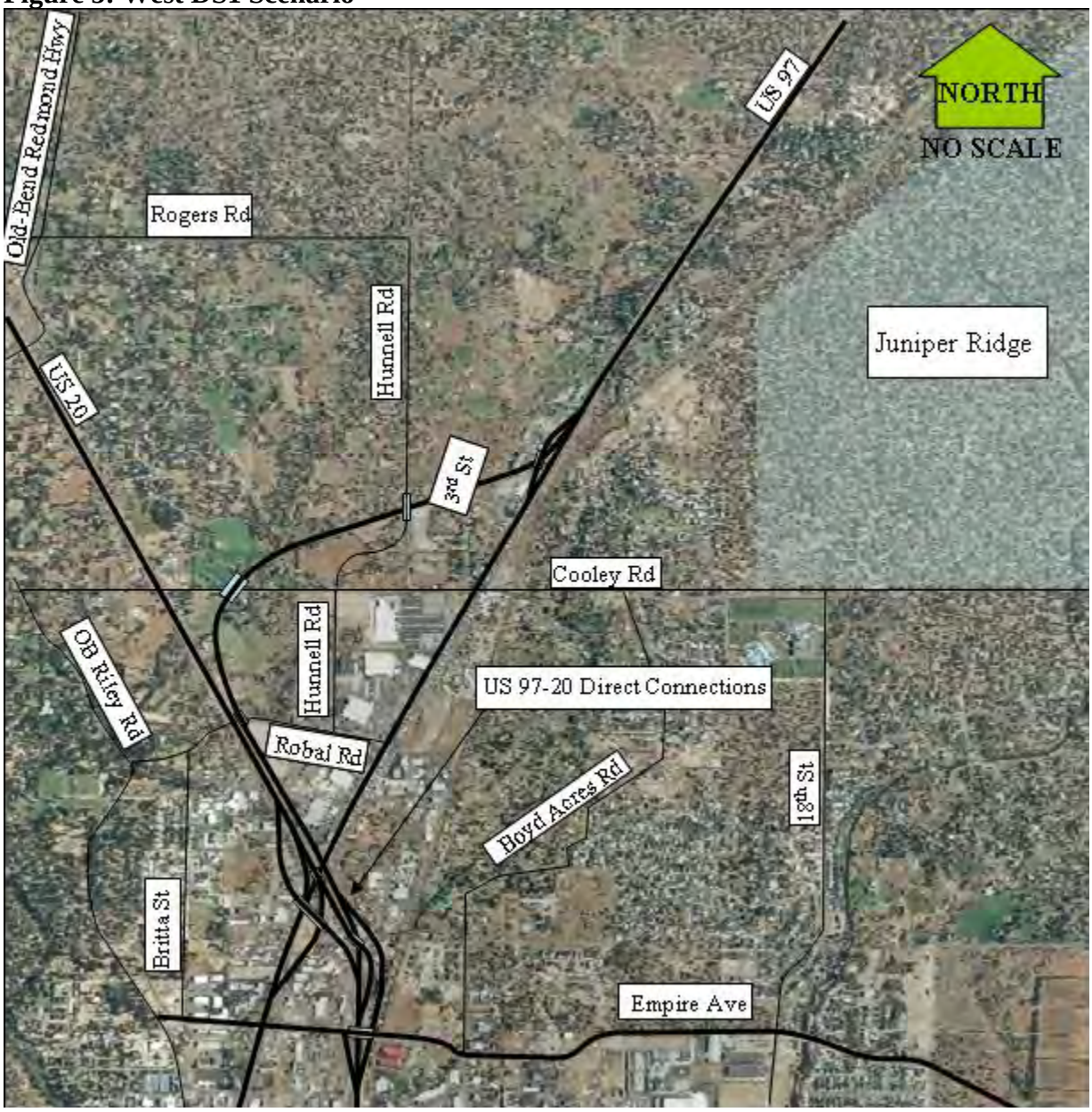
This scenario has US97 on the east corridor alignment. US97 has a full interchange north of Cooley Road with an extension of 3rd Street. Third Street provides local access north of Cooley Road and a future connection into the Juniper Ridge development. Third Street is two lanes from the interchange down to start of the commercial area north of Cooley Road. A northbound left-exit off-ramp from US97 provides a connection to US20 via the existing loop ramp and to 3rd Street. In addition, from the northern interchange south to the US20/Butler Market Road interchange, all of the on-ramps have ramp metering.

Figure 4: East DS1 with 18th Street Extension



This scenario is the same as the East DS1 scenario except for the extension of 3rd Street (E-W Arterial) to an extended 18th Street. Eighteenth Street has been upgraded to four lanes and has arterial classification from Empire Avenue to the E-W Arterial.

Figure 5: West DS1 Scenario

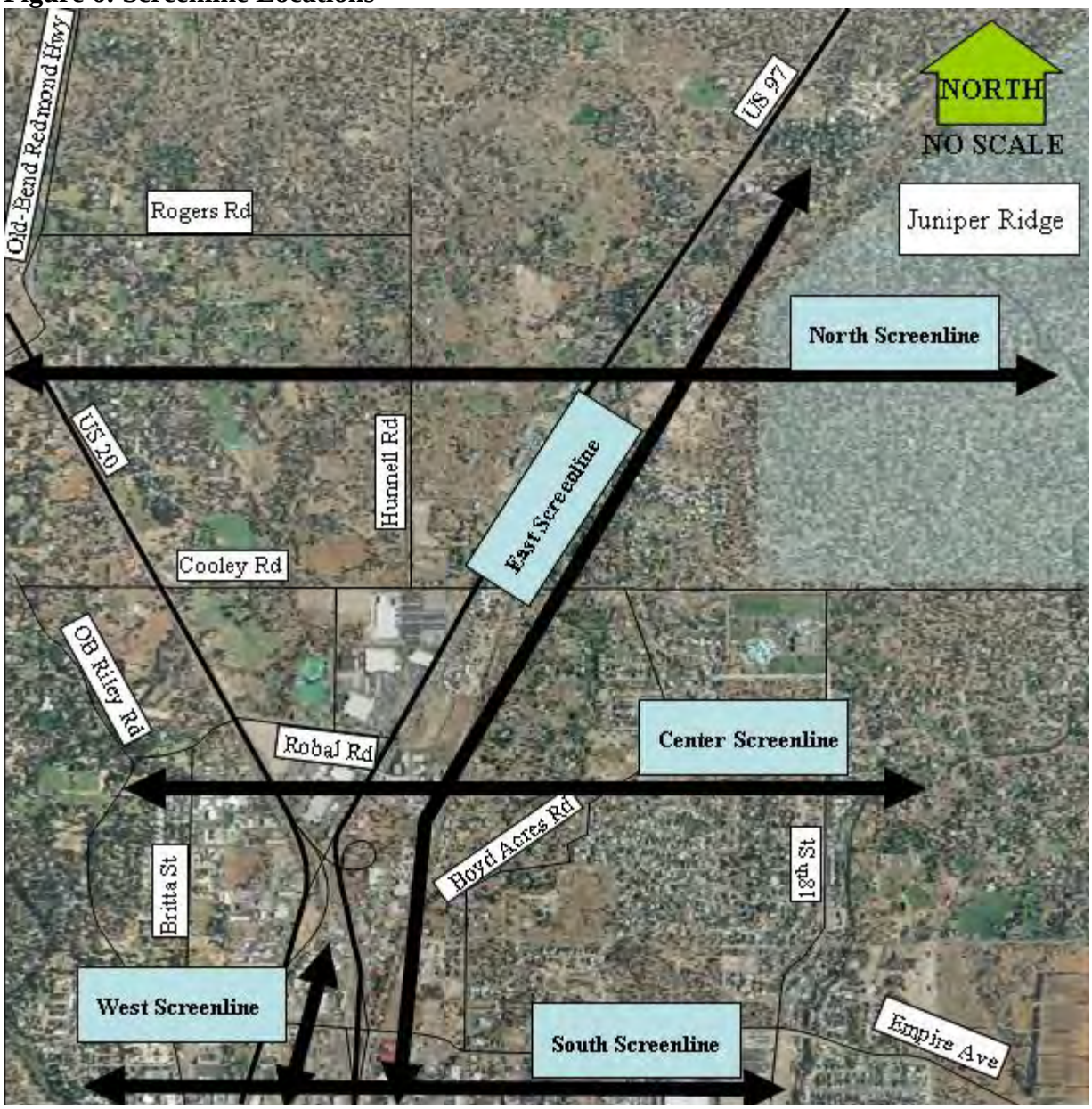


This scenario has US97 on the west corridor alignment. US97 has a partial system interchange north of Cooley Road with 3rd Street. US97 has grade-separated crossings of Hunnell Road, Cooley Road, Robal Road and 3rd Street. US97 is in a dual-corridor format with US20 so US20 can continue to provide local access at Cooley and Robal Road. Direct connection ramps are provided between US97 and US20, 3rd street is reconnected at US20 and the existing US20-3rd Street connections are retained. In addition, from the northern interchange south to the US20/Butler Market Road interchange, all of the on-ramps have ramp metering.

Evaluation Methodology

Screenlines were created cutting through the study area north and south of Cooley Road, south of Empire Avenue, and east of US97 (Figure 6). In addition, a screenline was used on Empire Avenue west of US97. The scenario volumes were compared where major roadways intersected the screenlines.

Figure 6: Screenline Locations



In addition, the model demand-to-capacity ratios were evaluated for major road segments in the project area. Model demand-to-capacity (d/c) ratios are mid-block or segment based and they can only be relatively compared on a large-scale basis such as below, at, or over capacity. They cannot be compared with the Oregon Highway Plan or Highway

Design Manual volume-to-capacity ratios as these require that volumes are based on the 30th highest hour from actual ground counts.

Scenario Results

Table 1 shows key intersecting screenline/roadway locations and percent differences in screenline volume for the scenarios compared with the MTP (future no-build) scenario. The north screenline is not shown in the table because it is mainly used to check the flows outside of the immediate alternative area and would provide limited comparison information. The main areas of concern are along the center screenline where it crosses US97, US20, and 3rd Street south of Robal Road; the south screenline where it crosses US20/3rd Street and US97 south of Empire Avenue; the east screenline where it crosses Cooley Road and Empire Avenue east of US97; and the west screenline where it crosses Empire Avenue west of US97. Totaled screenline volumes were not significantly different between the scenarios, which mean that these scenarios just shift traffic among adjacent roadways rather than attracting more traffic into the study area.

Table 1. Key Screenline Locations Comparison with MTP Scenario Peak Hour Volumes[1]

Scenario	US97		US20		3rd St	18th St	Cooley Rd	Empire Ave	
	Center (%)	South (%)	Center (%)	South (%)	Center (%)	Center (%)	East (%)	West (%)	East (%)
Existing DS1	**-15**	-6	**52**	**18**	**-15**	**-13**	18	20	-8
East DS1	**-50**	**-16**	-5	**21**	**-47**	**-22**	4	26	-9
East DS1 w/18th St Ext	**-52**	**-17**	-6	**21**	**-49**	52[2]	-9	22	**-16**
West DS1	**-67**	-9	9	**23**	**-37**	-3	6	28	**-10**

[1]Black-shaded cells indicate significant increased volumes over the MTP scenario. Un-shaded cells indicate significant decreased volumes over the MTP scenario. Gray-shaded cells indicate that the location did not significantly differ from the MTP scenario.
[2]18th Street has been widened to two lanes in each direction for the 18th Street extension scenario.

Appendix A contains color-patterned figures illustrating the d/c ratios for the significant roadway segments in the project area for each scenario. The three main tiers in the figures are under capacity (d/c's less than 0.90), at capacity (0.90 to 1.09 d/c), and over capacity (d/c's equal or higher than 1.10). Because model capacities are generally less than the detailed operational capacities, the below capacity links are likely relatively free of issues; at capacity links likely have significant problems but are probably solvable; and over capacity links indicate a serious issue that will require a large amount of

improvements or will result in outstanding capacity issues. All of the alternative scenarios are have some over-capacity segments.

No-build Scenario

In the MTP (future no-build) scenario in Figure A1, the major roadways are at or exceeding capacity. On the original alignment of US97, the signalized portion from the US20 loop ramp to Robal Road has less lane capacity than the southern Bend Parkway portion. Likewise, US20 has fewer lanes between 3rd Street and Robal Road in which to handle the local traffic heading to the mall area so this segment is also over capacity. Local traffic filtering out of the Awbrey Butte and Britta Street areas, heading south toward the center of Bend, causes O.B. Riley Road to exceed capacity in its southern segments. Empire Avenue, 3rd Street and US97 in the Empire Avenue area are at capacity. Cooley Road east of US97 and 18th Street north of Empire Avenue also are at capacity because of local demand to serve the Juniper Ridge area.

Existing DS1 Scenario

The Existing DS1 scenario in Figure A2 has some improvement to US97 and US20 over the no-build but does keep local traffic on US97 and adds more traffic to the local system. The addition of the interchange at Cooley Road increases traffic volumes on US97 north of the interchange about 15% which is enough to push the roadway section into near capacity conditions. This creates a problem area that does not exist in the no-build (north of Grandview Avenue) or most of the other alternatives. This is because US97 is attracting traffic away from Deschutes Market Road and rerouting it via Cooley Road to US97.

The section of US97 between US20 and Cooley Road is significantly under capacity with about 15% less traffic than with the no-build as shown in Table 1. However, this reduction is mainly from having three lanes in each direction rather than shifting traffic to other routes (i.e. improved the capacity but not too much reduction in demand). The 15% reduction is the result of the ramp metering in the scenario as there are no new roadway alignments to remove traffic as in the other scenarios. The section between US20 and Empire Avenue is still at capacity but operations will improve over the no-build.

US20 from the project limits to 3rd Street is at or under capacity which is improved over the no-build scenario. A problem area, common to all of the alternatives, is the section north of Empire Avenue which is significantly over capacity and worse than the no-build. There is not enough lane capacity available to handle the additional traffic coming from the southbound US97 off-ramp. Poor operations are likely in this segment. Volumes on US20 (3rd Street) south of Empire Avenue increase by about 20% but the roadway is still under capacity as traffic diverts away from US97. These increased volumes may cause intersection capacity issues in the Division Street/Butler Market Road area.

On the local system, the ramp metering has some effect on Empire Avenue as volumes slightly decrease east of US97 as traffic uses other routes. Volumes increase 28% west of US97 because of local traffic remaining on Empire and diverting to 3rd Street instead of

using the southbound on-ramp. More traffic adds to Cooley Road west of US97 to access the triangle area but the segment is still under capacity. Similarly, more volume adds to Cooley east of US97 but Cooley remains at capacity. Eighteenth Street remains at capacity but volumes drop about 13% as more traffic is attracted to US97.

A significant problem area is Robal Road mostly between Hunnell Road and US20. This section is significantly over capacity and much worse than the no-build which was significantly under capacity. The US20/Robal intersection becomes the primary and closest access to the triangle area and avoids the localized congestion at the ramp meters at the US97/Cooley interchange. Widening of Robal to two lanes in each direction plus associated turn lane improvements will be necessary for the entire section between US97 and US20, but operational problems will still be likely. In addition, capacity improvements to US20 do shift almost a quarter of the trips off of O.B. Riley Road to US20 north of Robal Road. There is not a significant change south of Robal because both US20 and O. B. Riley are over capacity north of Empire Avenue.

East DS1 Scenario

The East DS1 scenario in Figure A3 improves US97 and US20 and minimizes impacts to the local system. The section of realigned US97 from the northern project limits south to Empire is significantly under capacity with about 50% of the traffic compared to the no-build scenario as shown in Table 1. The addition of a full-movement interchange does not appear to negatively impact US97 as the demand on the ramps to/from the south is very little compared to the ramps to/from the north. The East scenarios are the only scenarios to significantly decrease volumes on US97 south of Empire Avenue as traffic that diverts from US97 at the northern connection does not return to US97 at Empire. US20 is also significantly under capacity from the project limits down to 3rd Street.

A problem area is the section of US20 (3rd Street) north of Empire Avenue which is significantly over capacity and worse than the no-build. There is not enough lane capacity available to handle the combined traffic from eastbound US20 and southbound 3rd Street. Previous analyses have indicated that adding lanes does not resolve the problem as this just attracts more traffic and that there is not enough distance to properly handle the lane-change movements between the US20 ramps and Empire Avenue. The East scenarios do the poorest job in this section with the 30% higher d/c ratio over the no-build. Poor operational problems will be the result mirroring the larger older East A analysis (See Technical Memo #6). The free-flow ramps to/from US20 may not operate well and may require a signalized “Y-type” intersection as was done with East 1.

In addition, the traffic volumes indicate that the ramps to and from 3rd Street to US20, and the ramp from US97 to 3rd Street may need to be two-lanes to handle the demand into the triangle area. While the section of US20 (3rd Street) south of Empire Avenue has volume increases of about 20%, the section is still under capacity as traffic diverts away from US97. However, this volume increase could cause intersection capacity issues in the Division Street/Butler Market Road area.

On the local system, the ramp metering has some effect on Empire Avenue as volumes decrease 17% east of US97 as this traffic moves to other routes. Empire Avenue west of US97 actually increases in volume by 26% as local traffic that would normally use the southbound US97 on-ramp diverts to 3rd Street. Cooley and Robal Roads remain the same as in the no-build. The improvements to the US97 corridor and the resulting close to 50% drop in volumes on 3rd Street over the no-build frees up capacity which pulls local traffic from at-capacity adjacent lower class roadways like 18th Street.

East DS1 Scenario with 18th Street Extension

The East DS1 Scenario with 18th Street Extension shown in Figure A4 has very little impact to the realigned section of US97. Volume differences between the two East scenarios are not significant (i.e. less than 10%) except on 18th Street and Cooley Road (see Table 1). Roadway capacities and related issues are generally the same as the East DS1 Scenario. The biggest changes are on east-west roadways that connect to 18th Street and 18th itself. Having the 18th Street Extension at four lanes from the northern interchange to Cooley Road and widening 18th Street between Cooley and Empire Avenue resulted in volumes doubling on 18th. The widened section of 18th between Cooley and Empire is still at capacity but with four lanes instead of two in the no-build.

About 75% of the traffic on 18th is from traffic diverting from Deschutes Market Road, north of Cooley Road, which results in a shorter path from east Bend to US97 north. This traffic was bound for US97 anyway but it will just get on/off further south instead of at Deschutes Junction. The remaining 25% of traffic comes mainly from southeast Bend via 27th Street which would have used Butler Market Road, Empire Avenue, Cooley Road, or Deschutes Market road to access US97. Traffic concentrating on 18th results in a significant 16% volume drop on Empire east of US97 and a lesser drop on Cooley. Traffic volumes on Empire west of US97 still increase 22% because of diverting local traffic but this is slightly less than the regular East DS1 scenario.

West DS1 Scenario

The West DS1 Scenario in Figure A5 significantly improves the realigned US97, US20 and the local system over the no-build. US97 is significantly under capacity in the rerouted segment with volumes reduced by two-thirds over the current US97 alignment (see Table 1). The lack of connections and the longer route discourages most short distance travel. The d/c ratios are depressed to the point that US97 could be two lanes in each direction and still be under capacity. It also has the potential to improve operations south of Empire Avenue mainly because of the limiting effects of the ramp meters on the on-ramps.

US20 from the project limits to 3rd Street is under capacity even in the Robal Road – 3rd Street segment which is significantly over capacity in the no-build. The four-lane section can easily handle the volumes rom the triangle area and the US97 direct-connect ramps. Like with the other scenarios, the section of US20 north of Empire is over capacity. There is not enough lane capacity to combine the four lanes of traffic from US20 and 3rd

Street together in a four-lane section, so poor operations are likely. This scenario adds a significant amount (23%) of diverting traffic to 3rd Street south of Empire. Even though the section is likely still under capacity at this high analysis level, this will likely impact intersection operations in the Division Street/ Butler Market Road area.

Removal of the long-distance trips from the old US97 alignment (3rd Street) south of Cooley Road reduces the total 3rd Street volume by a little more than a third. Conditions south of Robal Road are reduced from the no-build but still at capacity. The Robal-US20 section of 3rd Street is still a problem area although less than the no-build. Cooley, Robal, and O.B. Riley Roads along with 18th Street remain at no-build levels which are generally at or under capacity. The exception is O.B. Riley Road from its intersection with the Robal Road extension south to 3rd Street. This roadway essentially gathers up all of the local traffic that is diverting from US20/3rd Street. Empire Avenue has higher volumes west of US97 because of traffic avoiding the US97 ramp meters. Volumes drop east of US97 on Empire Avenue mainly because of local traffic avoiding the ramp meters at the Empire Avenue interchange and diverting elsewhere.

Scenario Summary

Table 2 shows the overall scenario comparison for volume and d/c impacts. The East scenarios are the only ones to balance the traffic flows and capacities between US97 and 3rd Street. The East DS1 scenario has an approximately 50/50 split between US97 and 3rd Street which puts both roadways under capacity. The full northern interchange does not have a significant effect on US97 because there is no connection to the adjacent Juniper Ridge area. The East scenarios are efficient enough so diverting traffic (avoiding the ramp meters) does not return to US97 south of Empire which results in significant volume reductions. The East scenarios have no significant impact to US20 from the 3rd Street connections north to the project limits. US20 (3rd Street) north of Empire Avenue is still over capacity in all scenarios.

Table 2. Overall Scenario Comparison[1]

	No-build (MTP)	Existing DS1	East DS1	East DS1 with 18th	West DS1
Volume impacts to US97 north of interchange[2]?	n/a	+15%			
Volume impacts to US97 south of interchange[2]?	n/a	-15%	-50%	-52%	-67%
US97 volume impacts south of Empire Avenue?	n/a		-16%	-17%	
US20 volume impacts north of 3rd Street?	n/a	+52%			
3rd Street volume impacts south of Robal Road?	n/a	-15%	-47%	-49%	-37%
Number of US97 segments at or over capacity?	5	3	1	2	1
Number of US20 segments at or over capacity?	2	2	1	2	1
Number of local road segments at or over capacity?	6	7	6	6	6

[1]Gray-shaded cells indicate that change was not significant (less than 10%).
[2]The interchange referred to is the US97/Cooley Road interchange in the Existing Scenario, the 3rd St/US97 full "northern" interchange in the East Scenarios, and the 3rd St /US97 partial "southern" interchange in the West Scenario.

The East DS1 scenario with the 18th Street Extension does connect the northern interchange with Juniper Ridge and results in a 15% increase in volumes on US97 north of the interchange. This creates near-capacity conditions on this segment of US97. This increase is because of diverting traffic from Deschutes Market Road that would have gotten on US97 at Deschutes Junction, so the overall impact is not significant north of Deschutes Junction. Otherwise, there are no other significant improvements or impacts to the highway system, so the 18th Street Extension/18th Street widening would not need to be included as part of the East DS1 scenario. The major impact of the extension would be the doubling of traffic on the existing section of 18th between Cooley Road and Empire Avenue. Because of limited overall system north-south capacity, 18th Street becomes a four-lane at-capacity roadway rather than a two-lane at-capacity roadway in the no-build.

The West DS1 scenario only has a little more than a third of the total traffic on the new US97 alignment with the rest staying on 3rd Street (original US97). Lack of connections and a longer route than East DS1 remove most of the short-distance trips. As a result, 3rd Street south of Robal Road ends up being at capacity while US97 would be under capacity even as a two-lane roadway. West DS1's limited volumes reduction on 3rd Street will still result in capacity problems south of Robal Road, potentially mirroring the East alternative in this area and limiting the overall effectiveness of this scenario. The West DS1 scenario has a slight impact to US20 over the no-build but still significantly more

than East (15%) as traffic diverts from the at-capacity 3rd Street to the under-capacity US20.

The Cooley Road interchange in the Existing DS1 scenario attracts enough new traffic to US97 to create near capacity conditions north of the interchange which is higher than the East or West DS1 scenarios and even more than most of the no-build scenario. This traffic is rerouting from Deschutes Market Road. US97 is under capacity south of the Cooley Road interchange, but that is mainly because of having three lanes (two through lanes and an auxiliary lane between interchanges) in each direction. The widened US97 also attracts local traffic from adjacent roadways such as Boyd Acres Road and 18th Street which tempers the effectiveness of the scenario. This scenario does have the effect of keeping local traffic on the state highway system as there are not any additional routes. Since there are no new US97 alignments in the Existing scenario, the 15% volume reduction is because of traffic avoiding the ramp meters and diverting to US20. Limited access from 3rd Street (US97) causes traffic to use US20 as the main access in/out of the triangle area. Volumes on US20 increase 52%, which is 38% higher than the East scenarios and 29% higher than West. Most of this traffic uses Robal Road which creates an extreme capacity problem between US20 and Hunnell Road. Even with widening to a four/five lane cross-section, operations are still likely to be problematic in this segment. Also, Existing DS1 is the only scenario that has a significant impact to Cooley Road east of US97 because of the interchange combined with the Cooley Road extension to Deschutes Market Road.

Including ramp meters from the north US97 connection down through the Butler Market interchange has a similar effect on all scenarios. Ramp meters help to smooth out the flow on the main roadway by breaking up platoons (groups) of vehicles coming in from the on-ramps. Because ramp meters introduce delay on the on-ramps in order to improve delays, travel times, and speeds on the mainline, local traffic that currently uses the highway for short trips may divert to other facilities. This diverting traffic increases volumes on 3rd Street south of Empire Avenue by about 20% and 24% on Empire west of US97 with insignificant differences between the scenarios. The increase on 3rd Street might cause additional intersection capacity issues in the Butler Market/Mt. Washington/Division Street area over the no-build.

Conclusions

The following conclusions can be made:

- For overall traffic operations, the East DS1 Scenario has the best performance.
- The extension of 18th Street does not significantly affect US97 or 3rd Street south of the northern interchange and is not needed to be part of the East DS1 scenario.
- The West DS1 Scenario works almost as well as East DS1 but the high volume imbalance between US97 and 3rd Street limits the effectiveness with more capacity issues on 3rd Street.
- The Existing DS1 scenario has the poorest overall performance of the three major scenarios because it has more segments at or over capacity in the study area, has

problem areas worse than the no-build, and only performs slightly better than the no-build.

- The addition of ramp meters in the project area can preserve capacity on US97 but diverting traffic may cause additional intersection capacity problems in the 3rd Street & Butler Market Road intersection area.

Table 3 shows the recommendations for forwarding to the next level from the screening analysis.

Table 3. Recommendations

Scenario	Recommendation
Existing DS-1	Drop
East DS-1	Keep
East DS-1 w/ 18th St Ext.	Drop
West DS-1	Keep

If there are any questions or comments, please contact me at 503-986-4110.

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Rod Cathcart, Region 4 Program & Planning
Amy Pfeiffer, Region 4 Project Leader
Mike Morris, Region 4 Roadway
Ray Thwaits, Region 4 Roadway
Martin Matejsek, District 11/Region 4 Roadway
Joel McCarroll, Region 4 Traffic
Mary Whitaker, Region 4 Right-Of-Way
Rick Williams, Region 4 Environmental
File

Appendix A: Demand-to-Capacity Figures

Figure A1: MTP Scenario Demand-to-Capacity Ratios

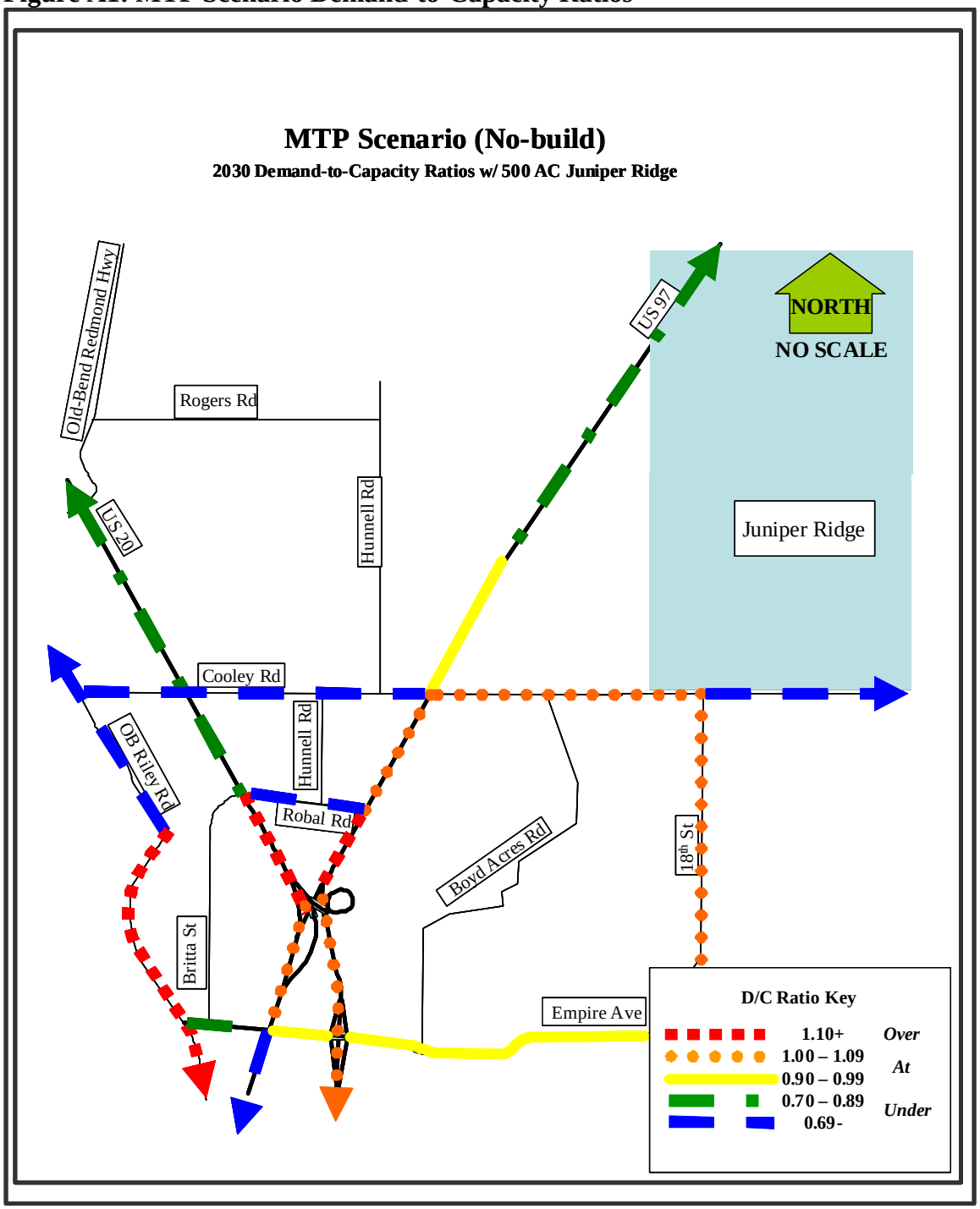


Figure A2: Existing DS1 Scenario Demand-to-Capacity Ratios

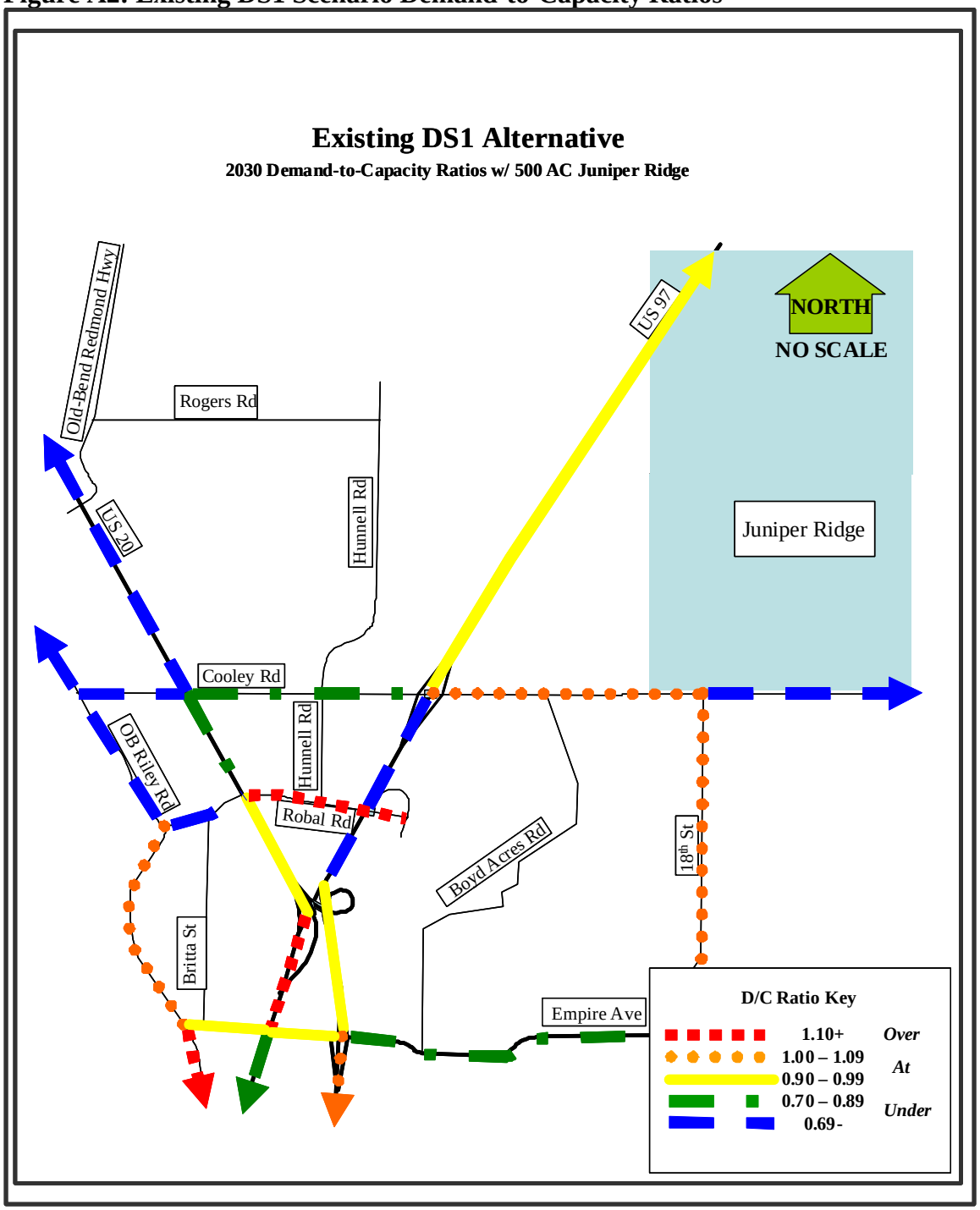


Figure A3: East DS1 Scenario Demand-to-Capacity Ratios

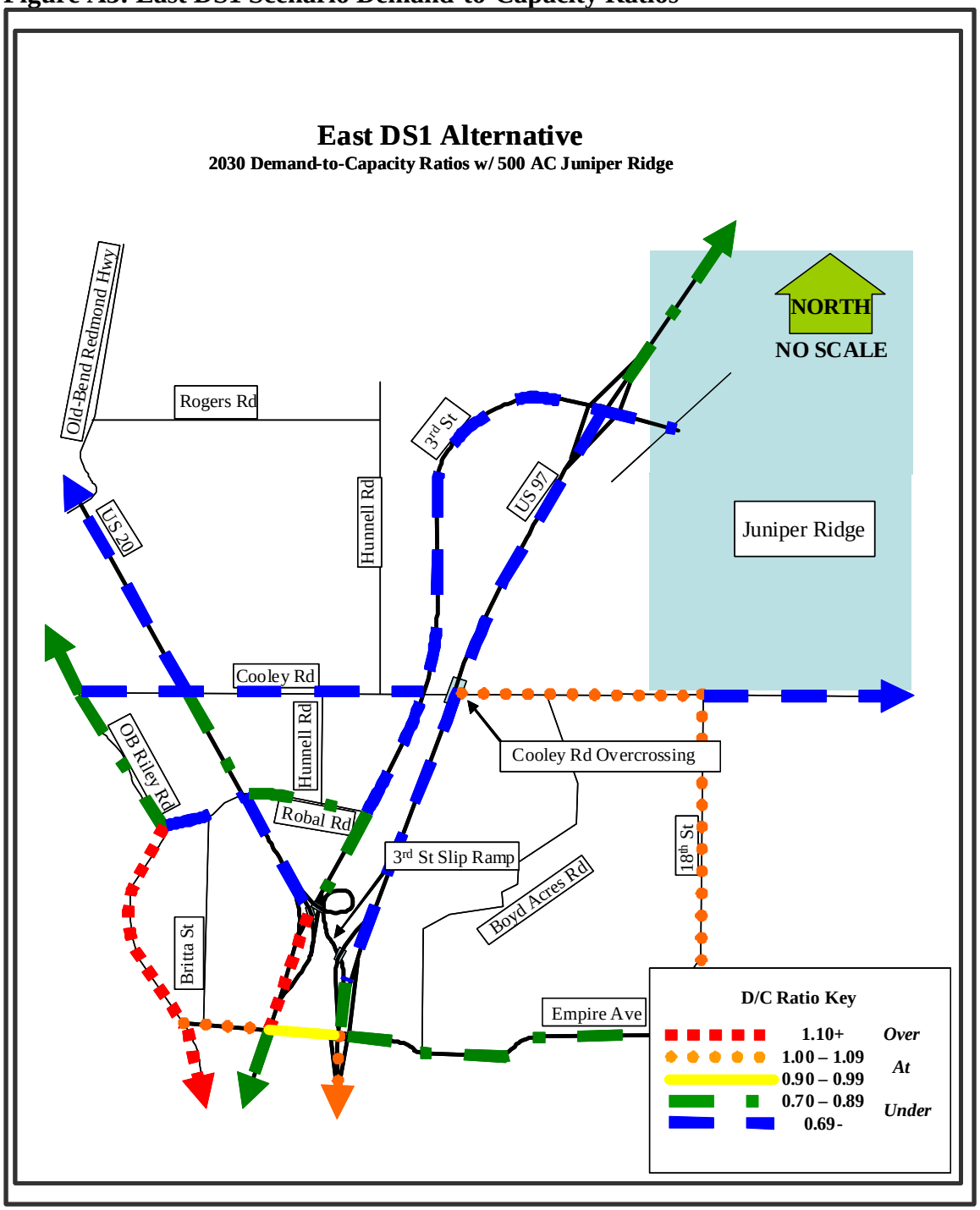


Figure A4: East DS1 with 18th Street Extension Scenario Demand-to-Capacity Ratios

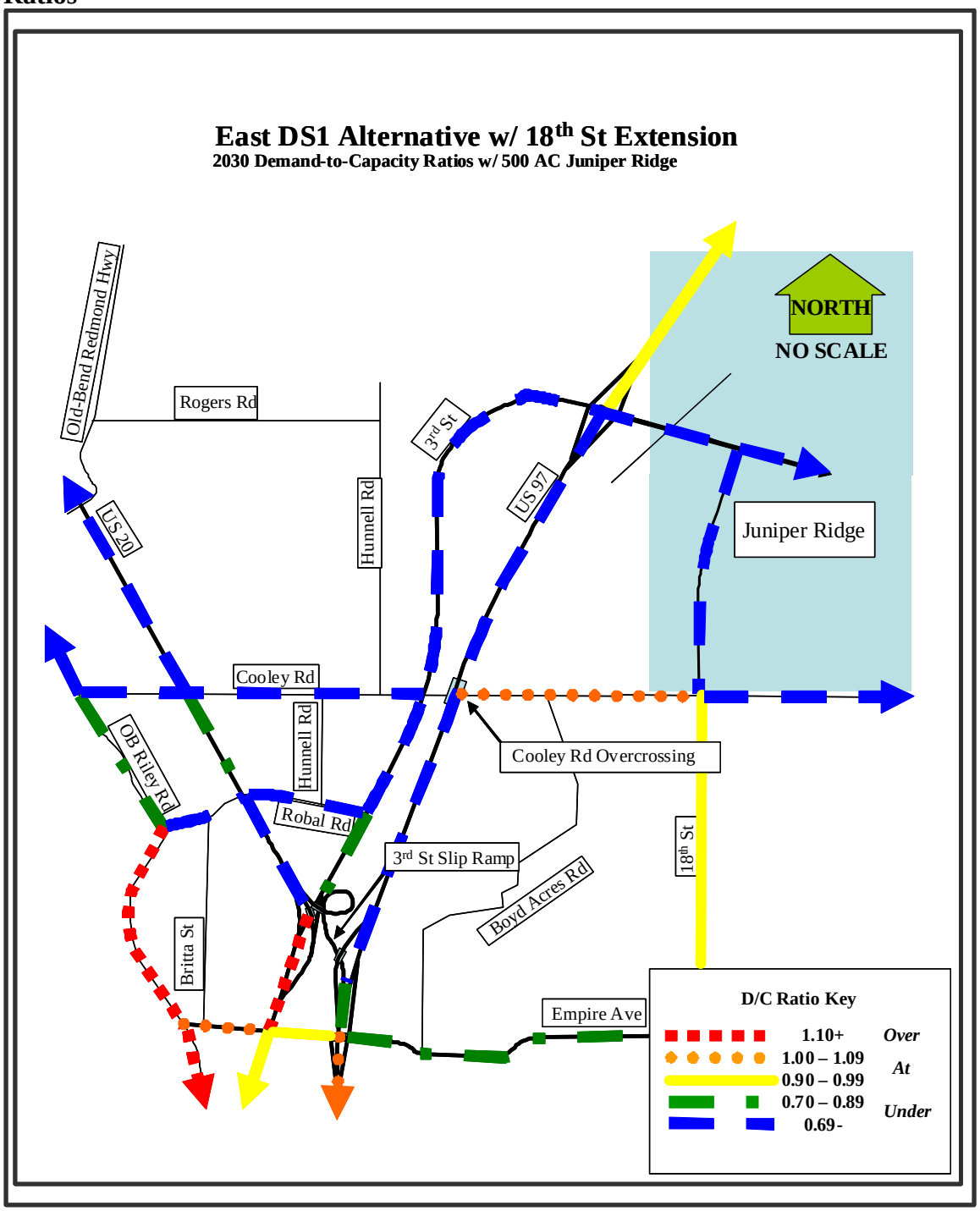
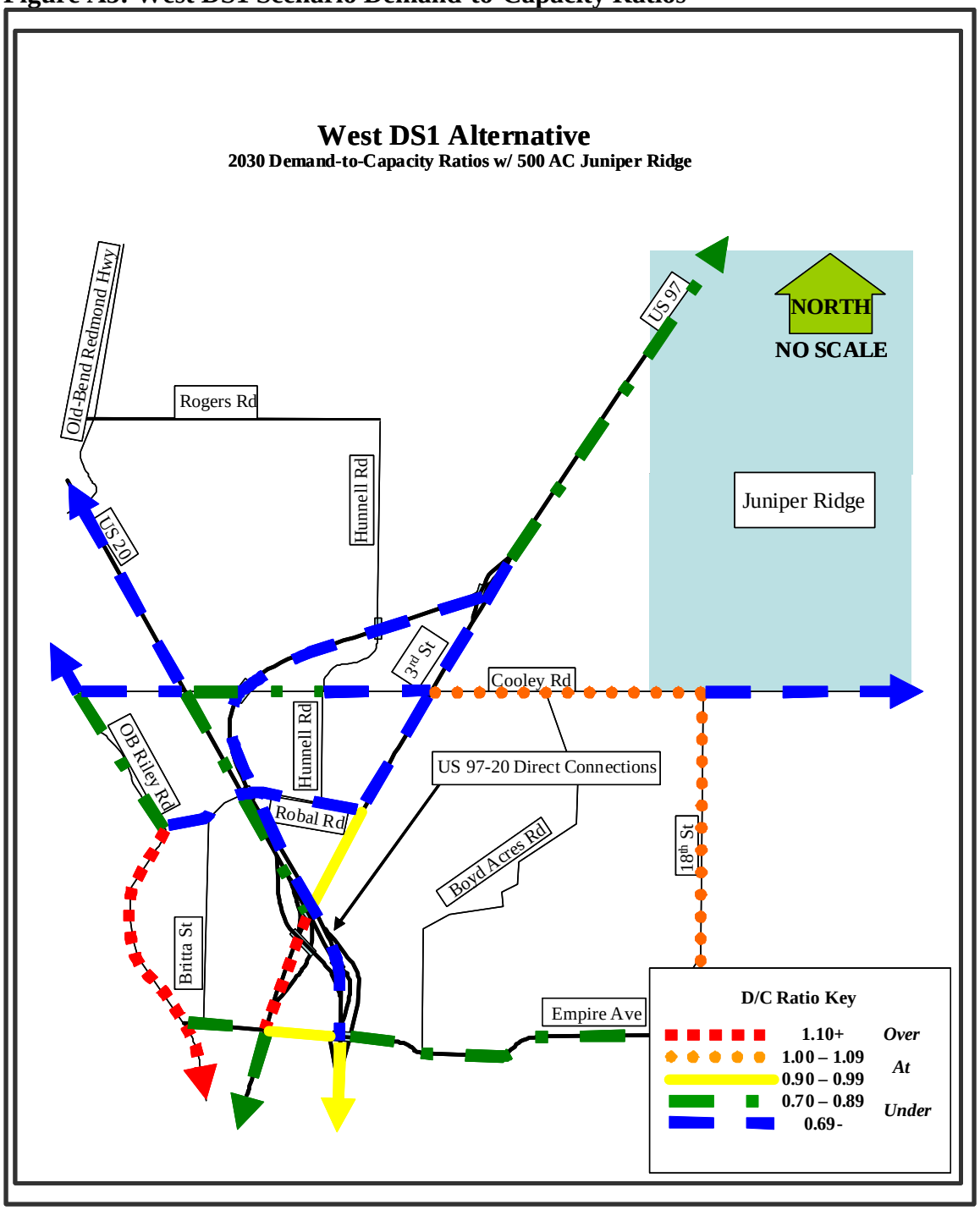


Figure A5: West DS1 Scenario Demand-to-Capacity Ratios



APPENDIX K: 2015 & 2035 ALTERNATIVE EAST DS-1 DESIGN HOUR VOLUMES

Figure K-1 Alternative East DS-1 2015 DHV & Lane Configurations

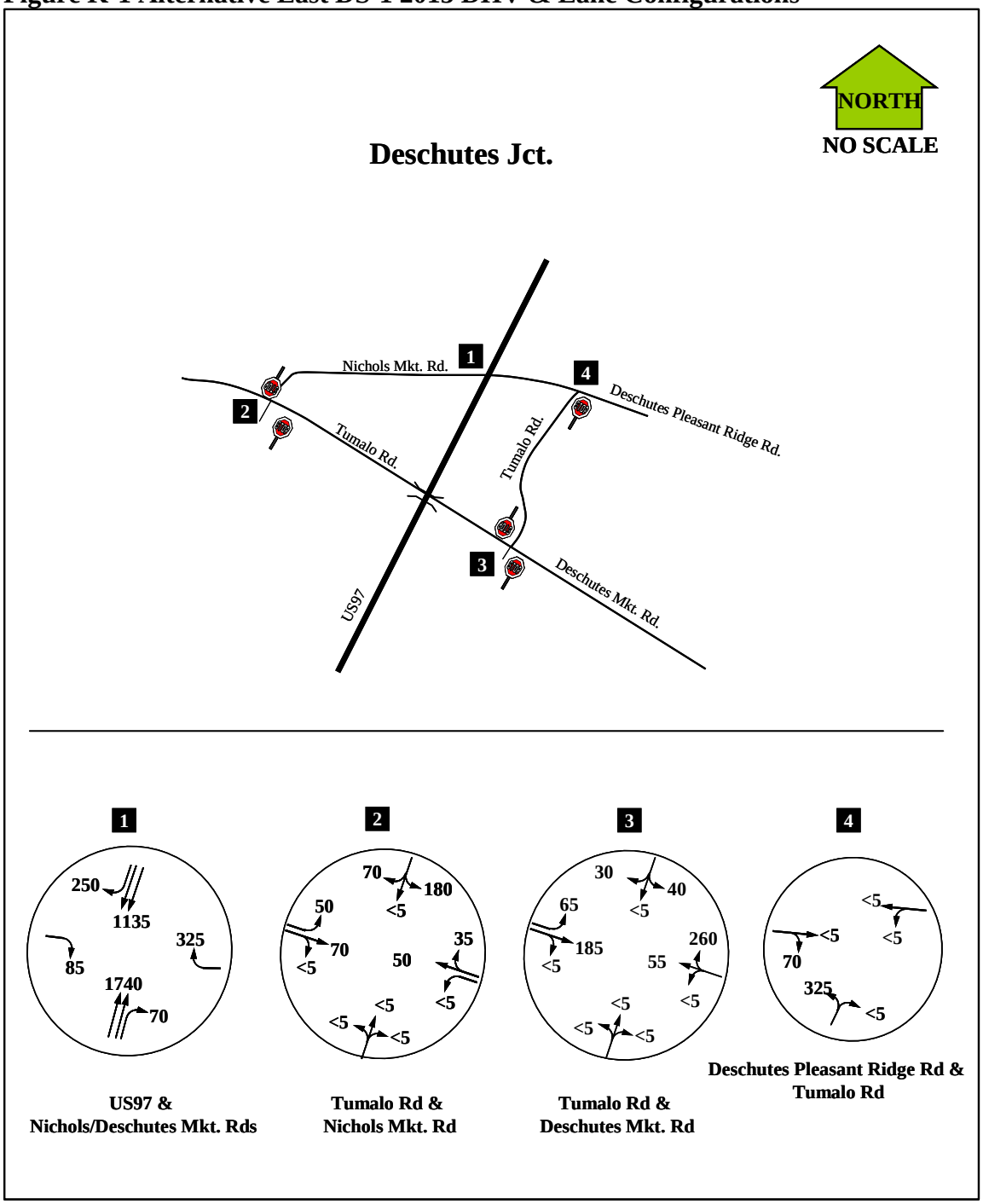


Figure K-2 Alternative East DS-1 2015 DHV & Lane Configurations

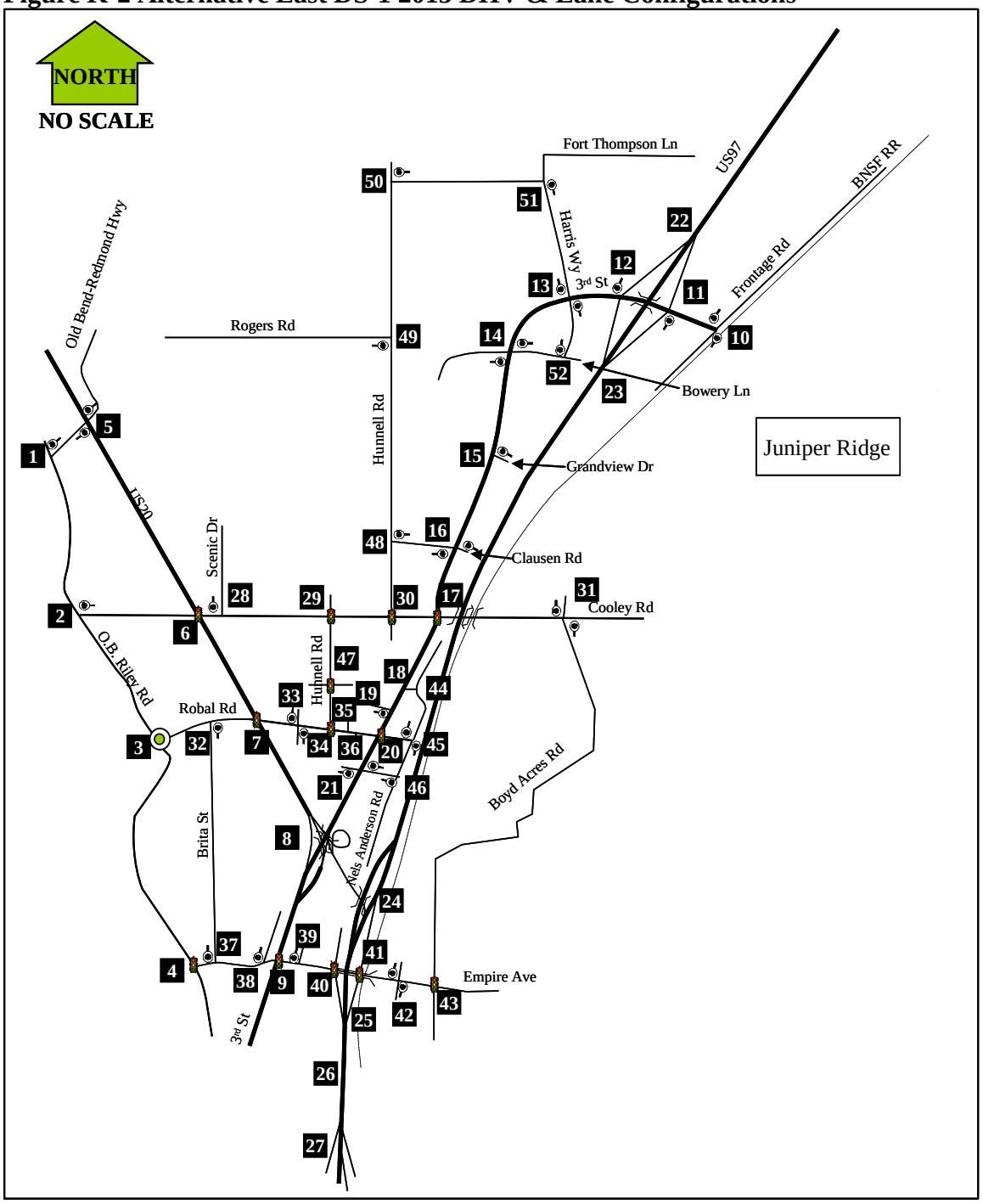


Figure K-3 Alternative East DS-1 2015 DHV & Lane Configurations

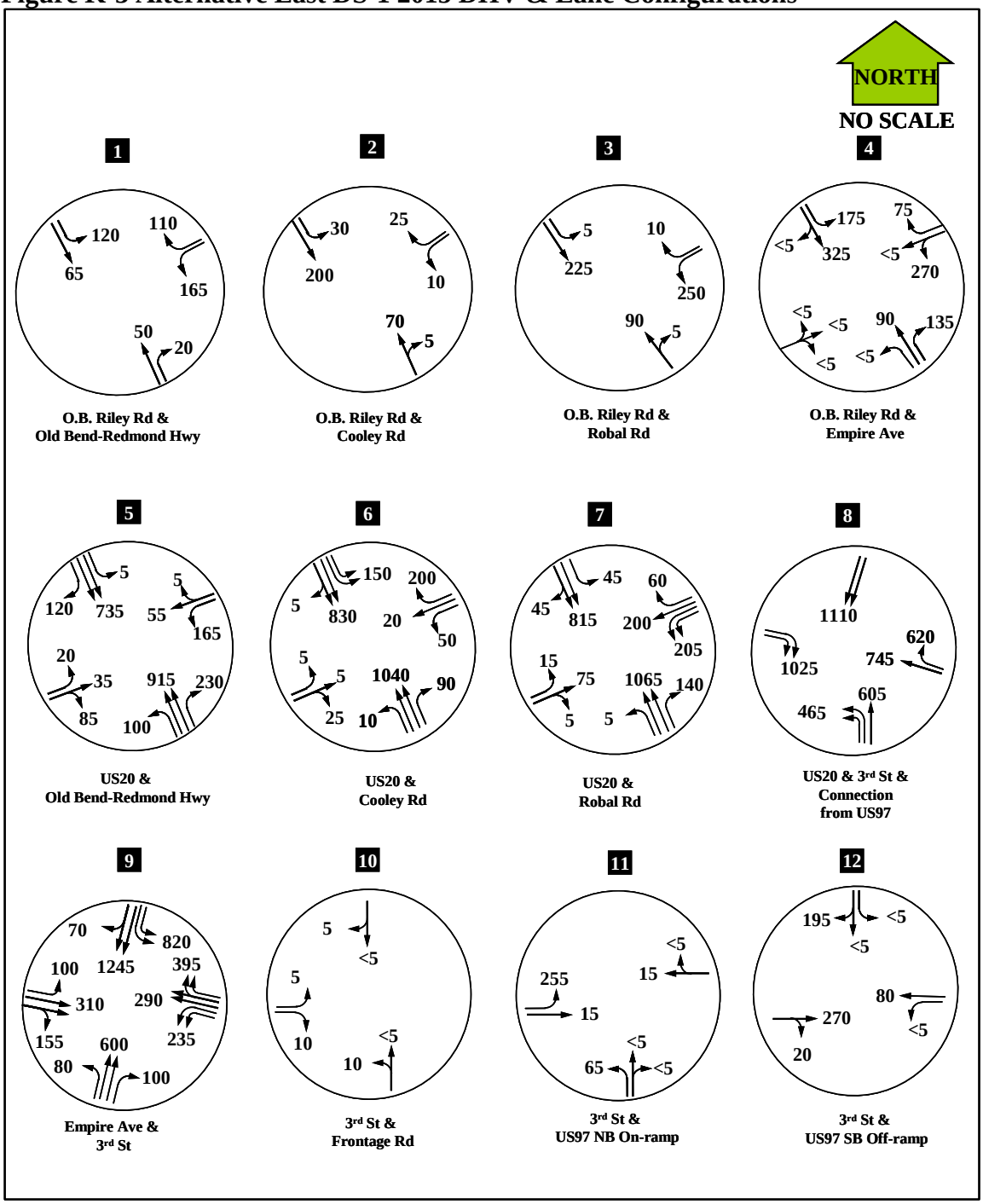


Figure K-4 Alternative East DS-1 2015 DHV & Lane Configurations

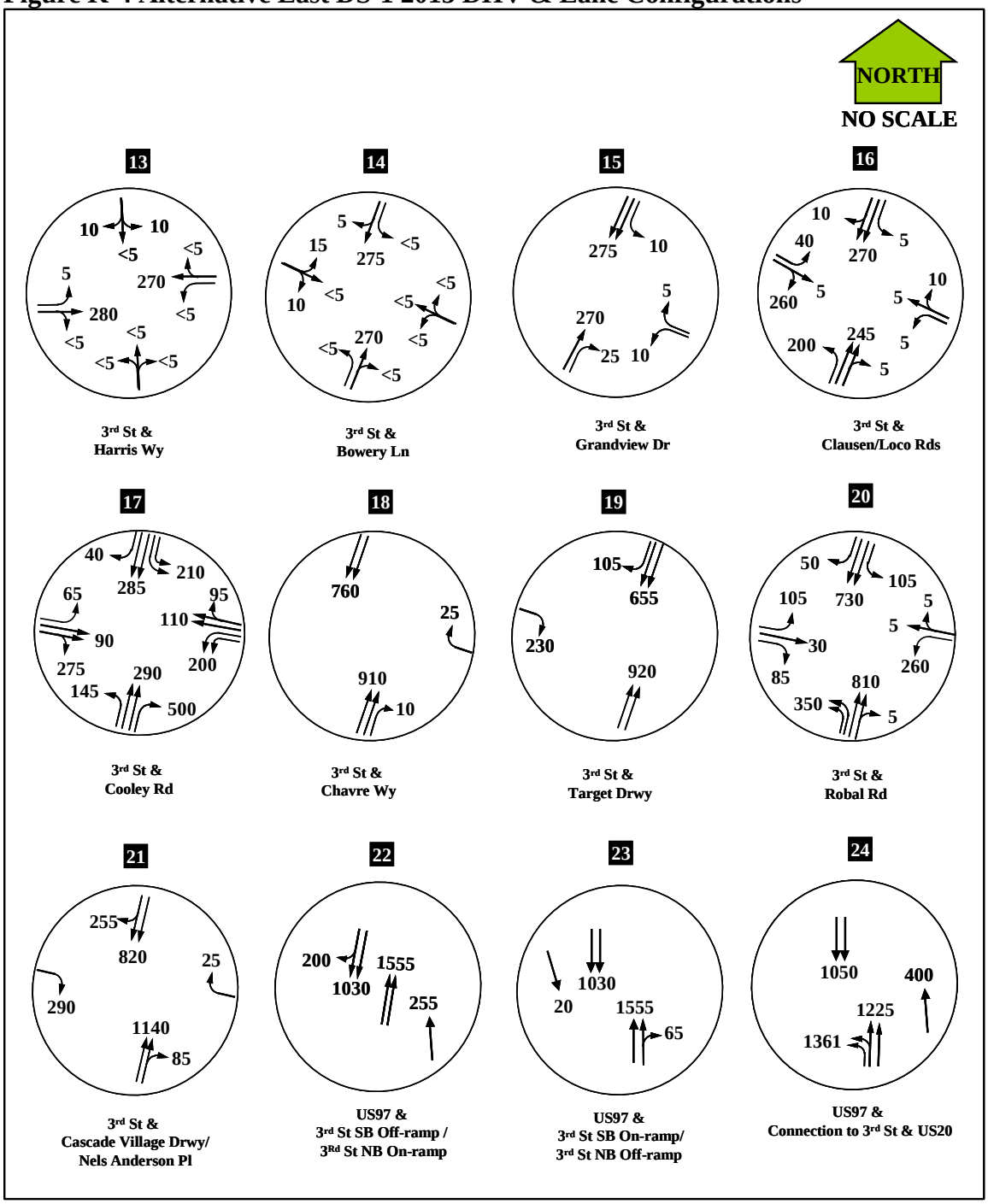


Figure K-5 Alternative East DS-1 2015 DHV & Lane Configurations

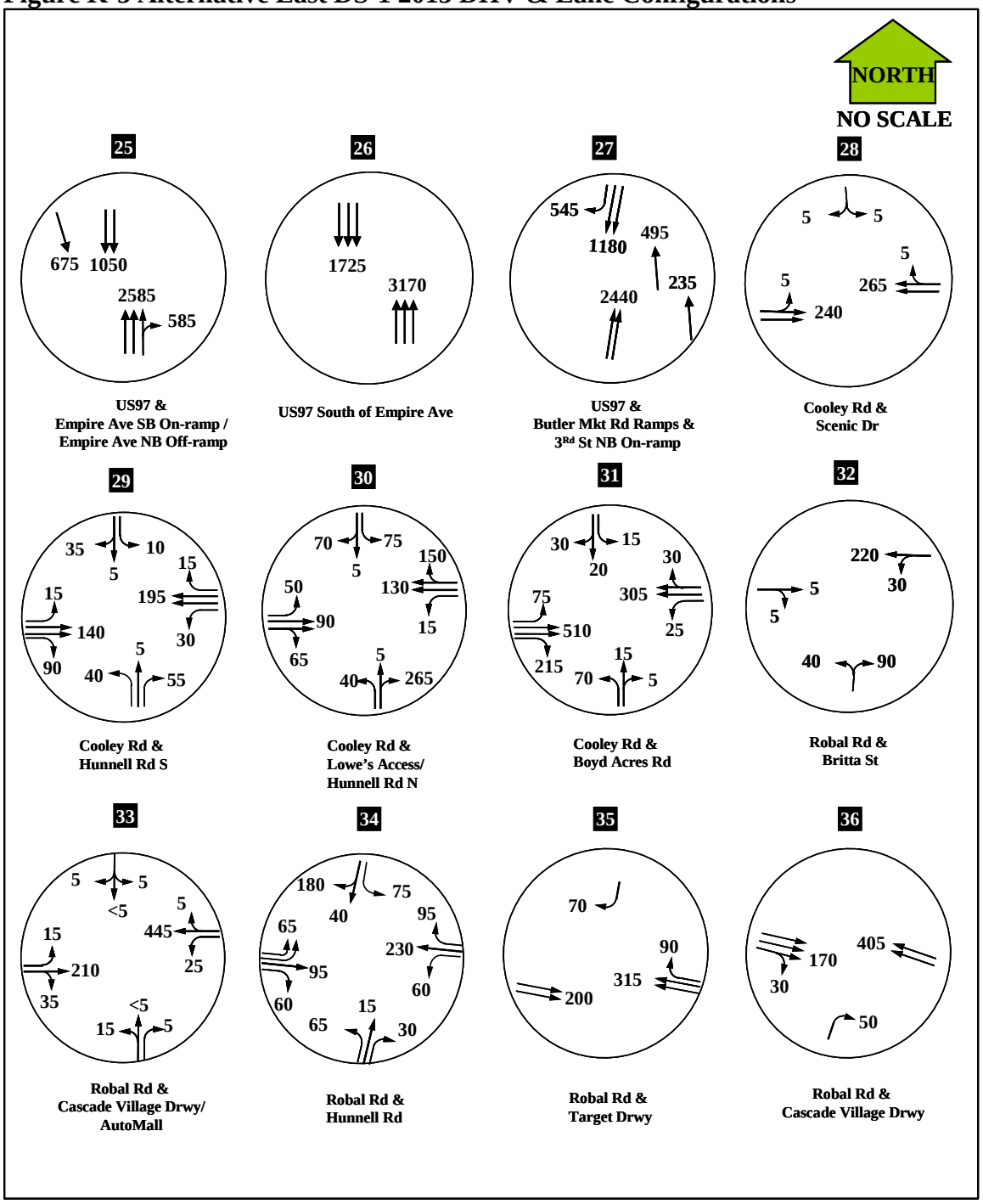


Figure K-6 Alternative East DS-1 2015 DHV & Lane Configurations

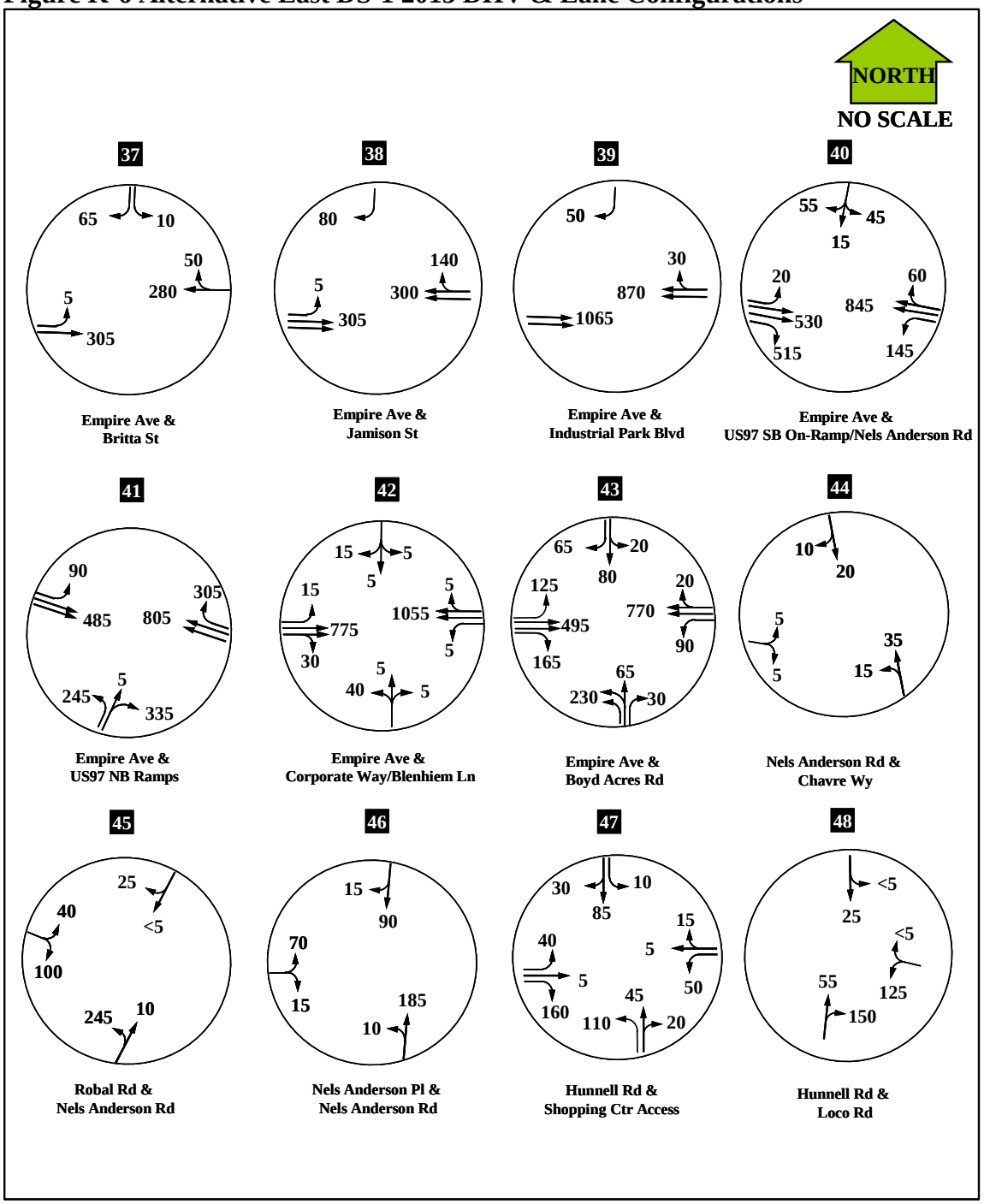


Figure K-7 Alternative East DS-1 2015 DHV & Lane Configurations

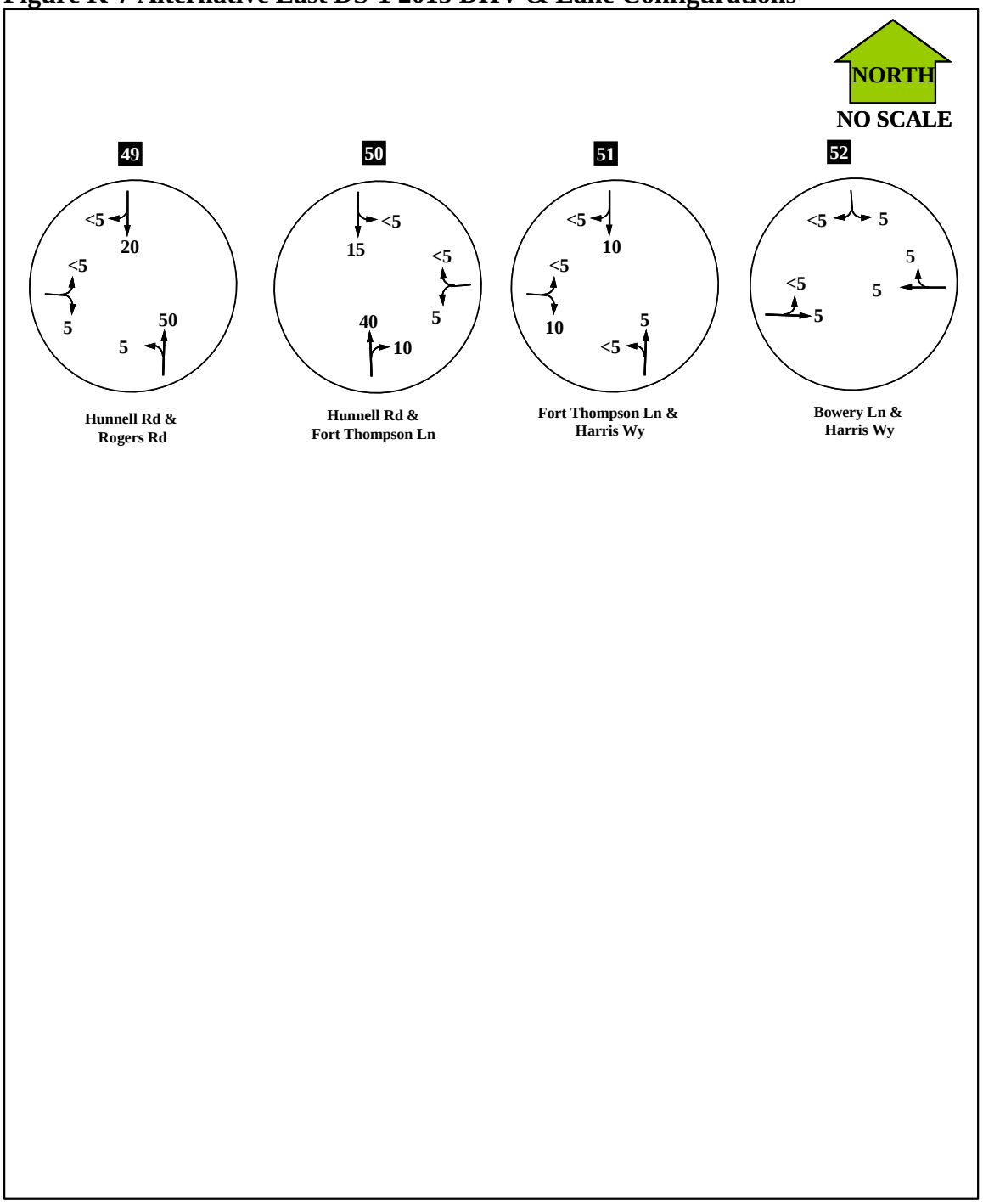


Figure K-8 Alternative East DS-1 2035 DHV & Lane Configurations

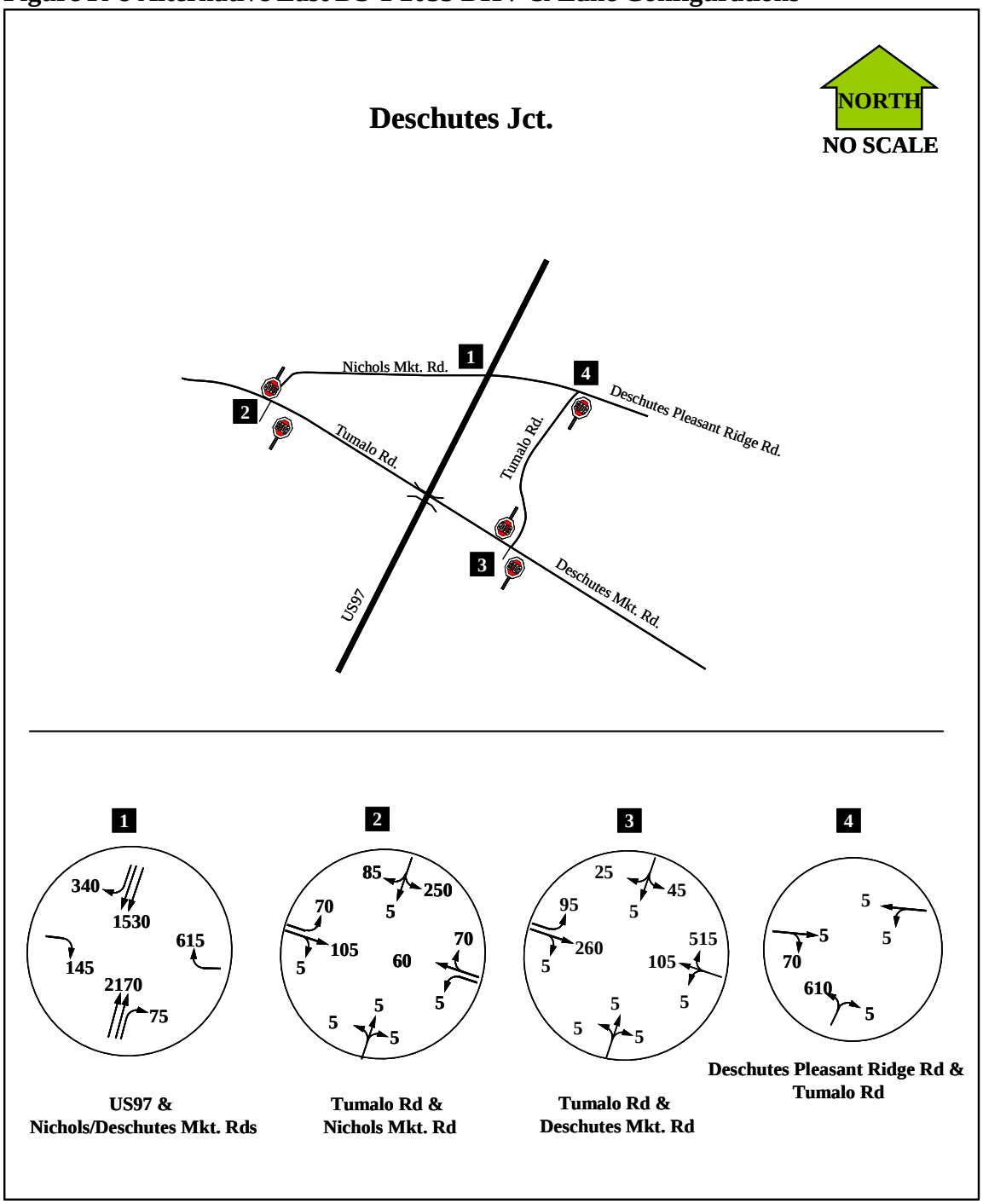


Figure K-9 Alternative East DS-1 2035 DHV Intersection Key

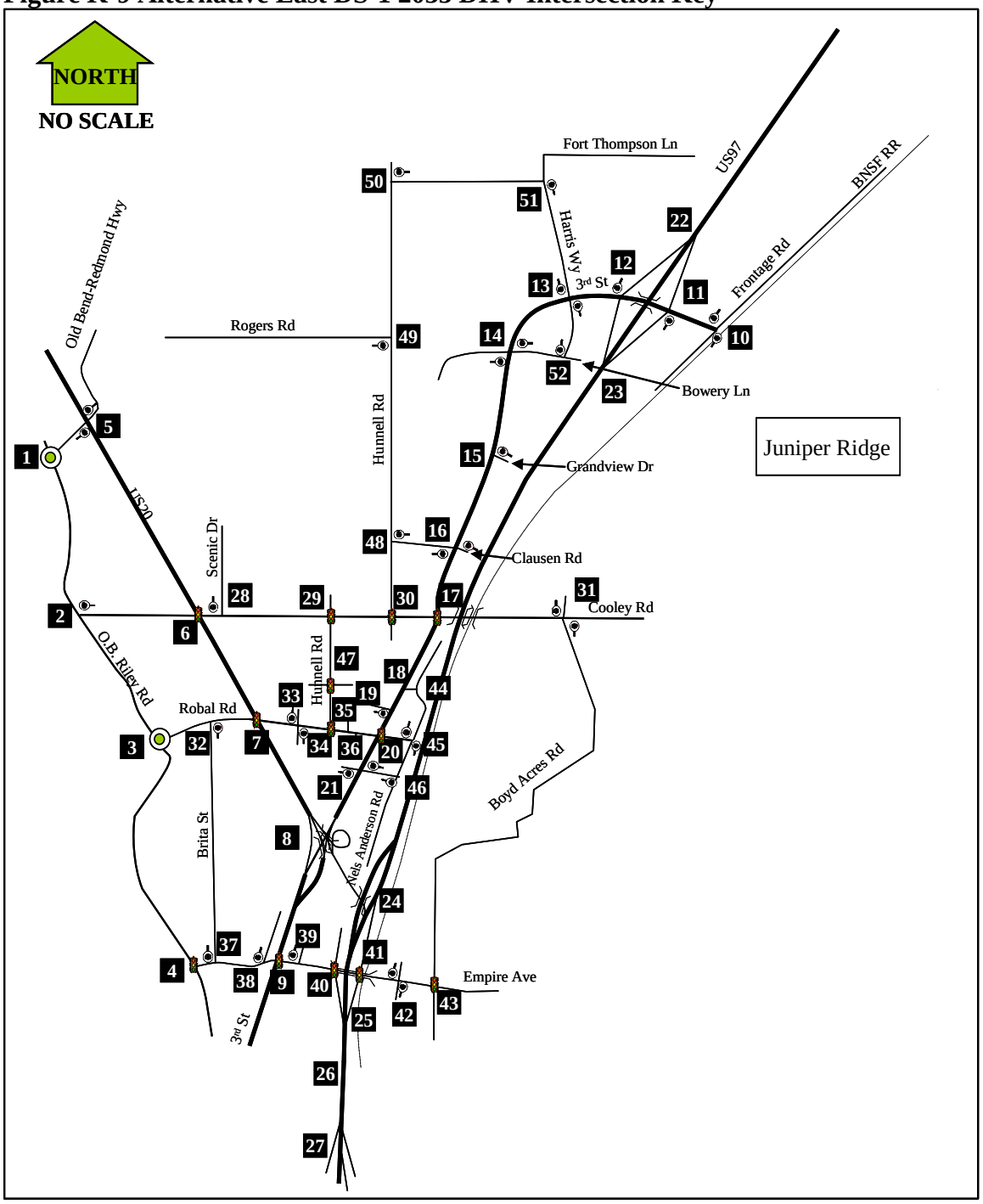


Figure K-10 Alternative East DS-1 2035 DHV & Lane Configurations

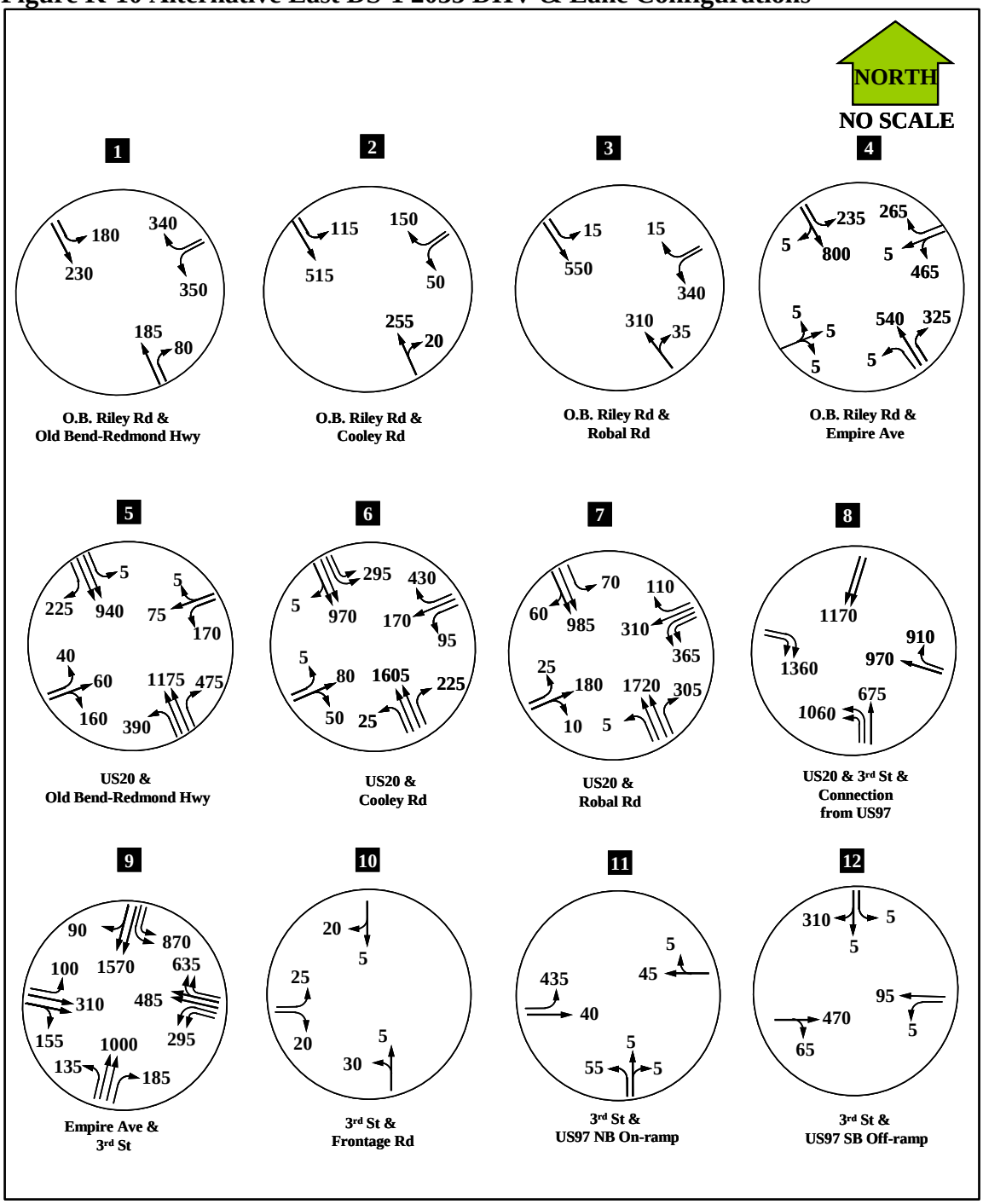


Figure K-11 Alternative East DS-1 2035 DHV & Lane Configurations

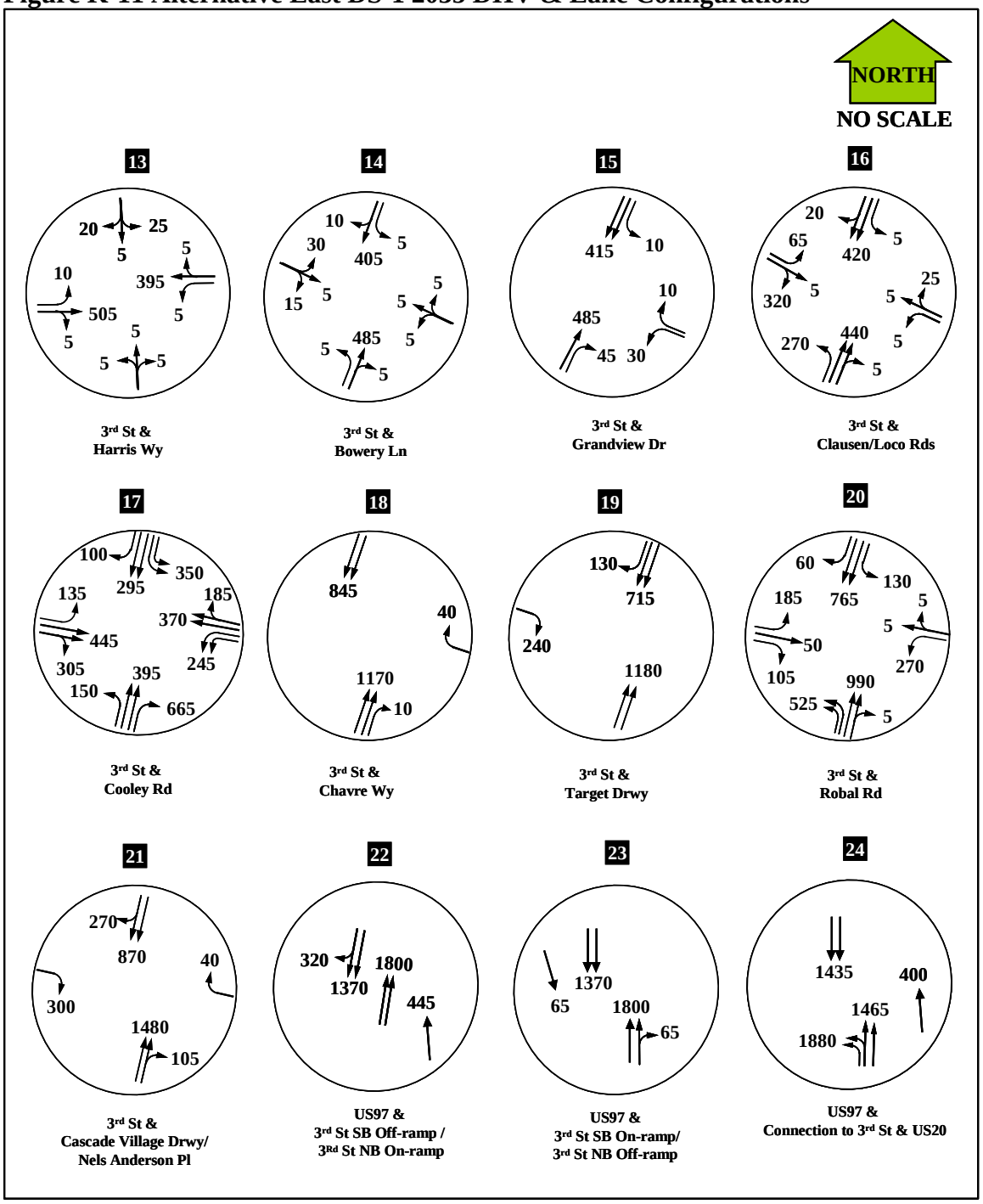


Figure K-12 Alternative East DS-1 2035 DHV & Lane Configurations

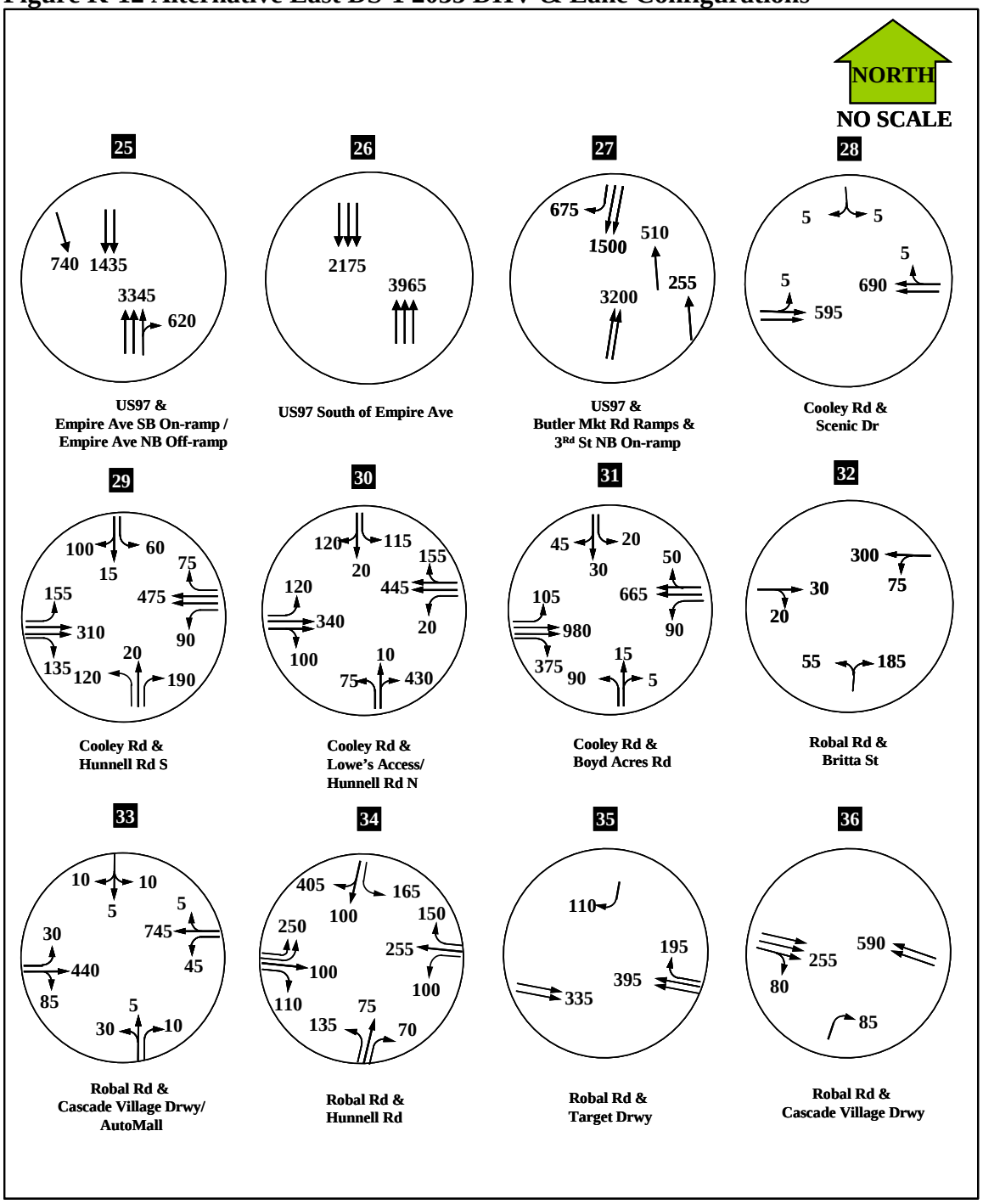


Figure K-13 Alternative East DS-1 2035 DHV & Lane Configurations

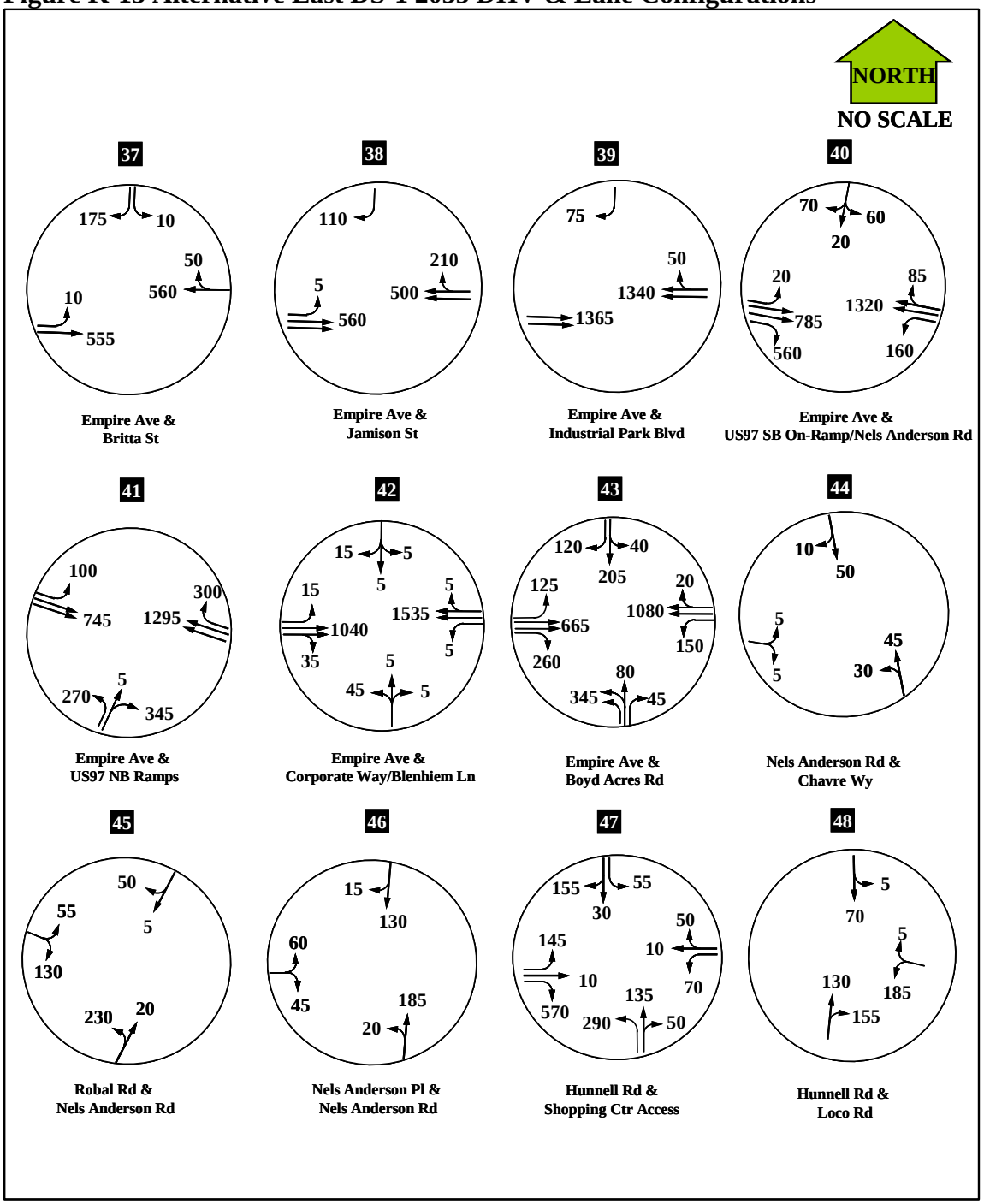
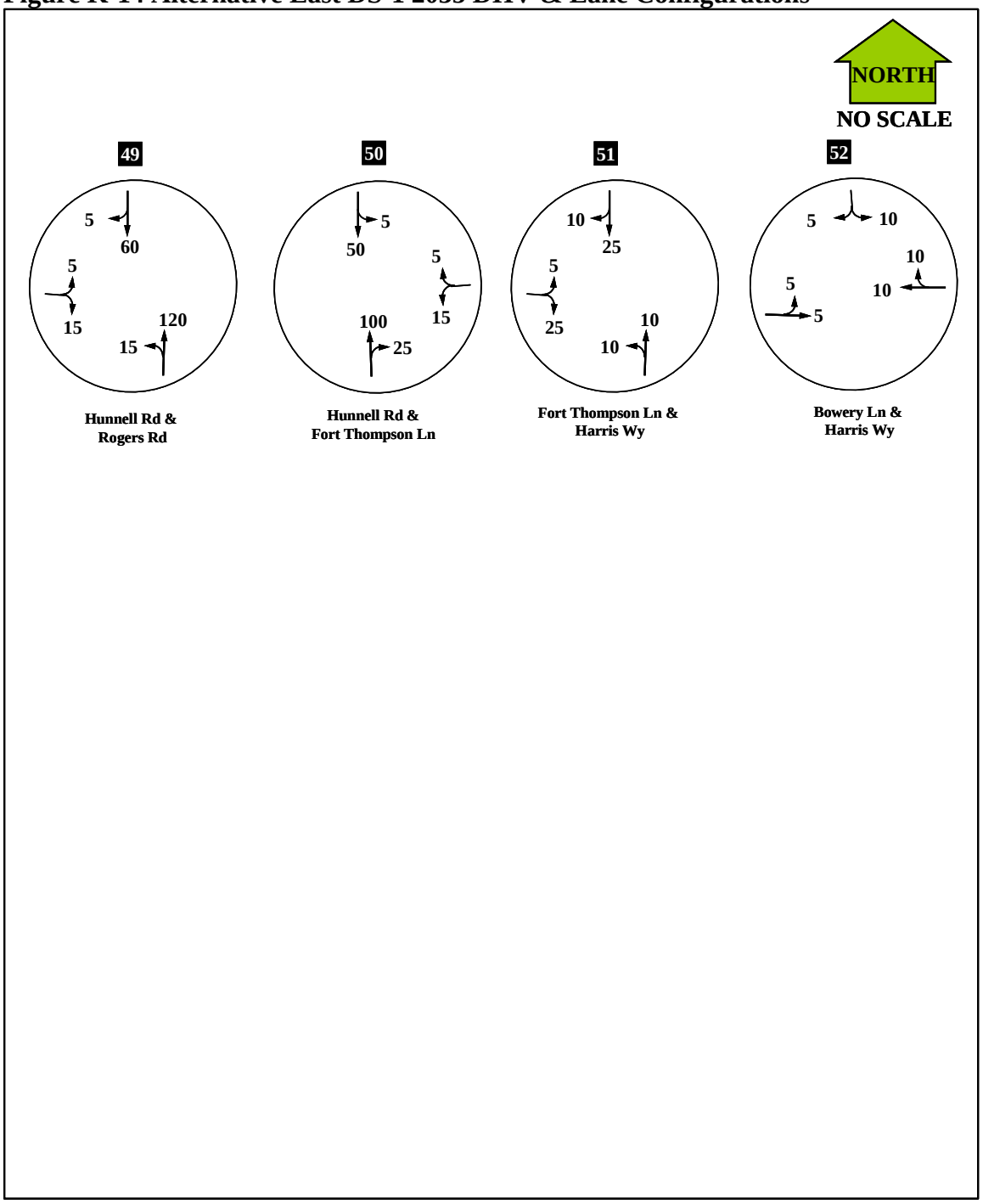


Figure K-14 Alternative East DS-1 2035 DHV & Lane Configurations



APPENDIX L: 2015 & 2035 ALTERNATIVE EAST DS-1 95TH PERCENTILE QUEUES

Figure L-1 East DS-1 2015 95th Percentile Queues

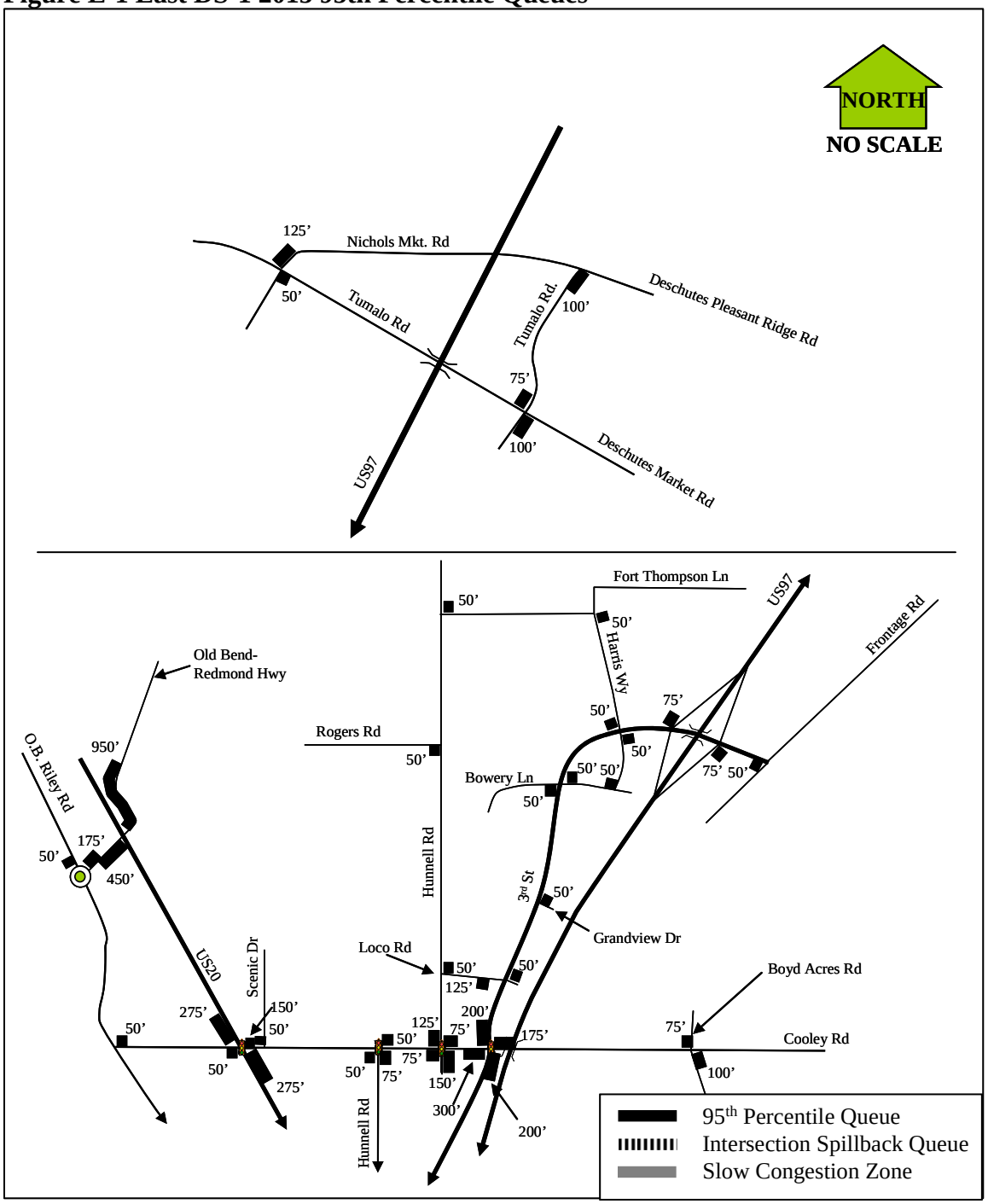


Figure L-2 East DS-1 2015 95th Percentile Queues

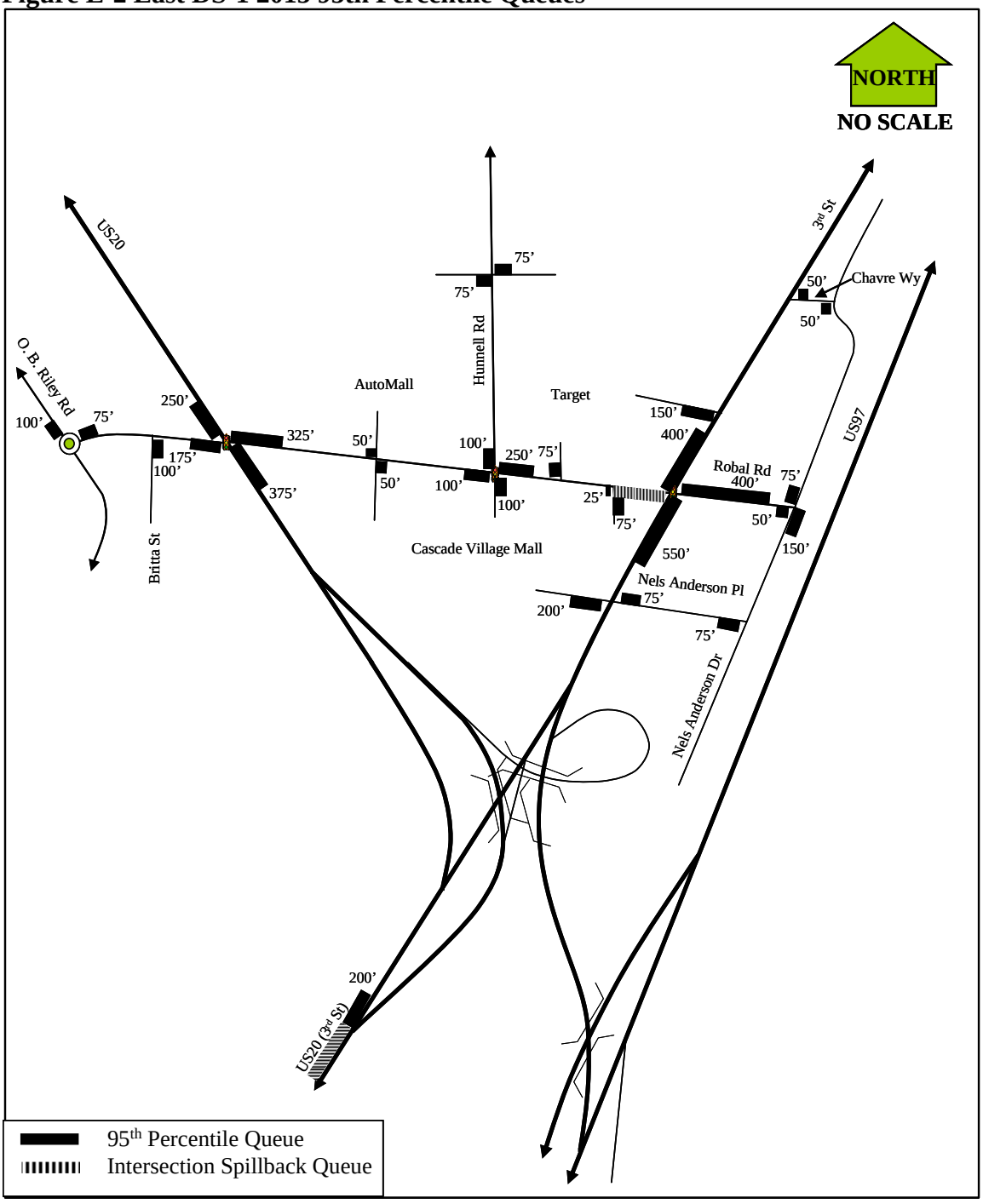


Figure L-3 East DS-1 2015 95th Percentile Queues

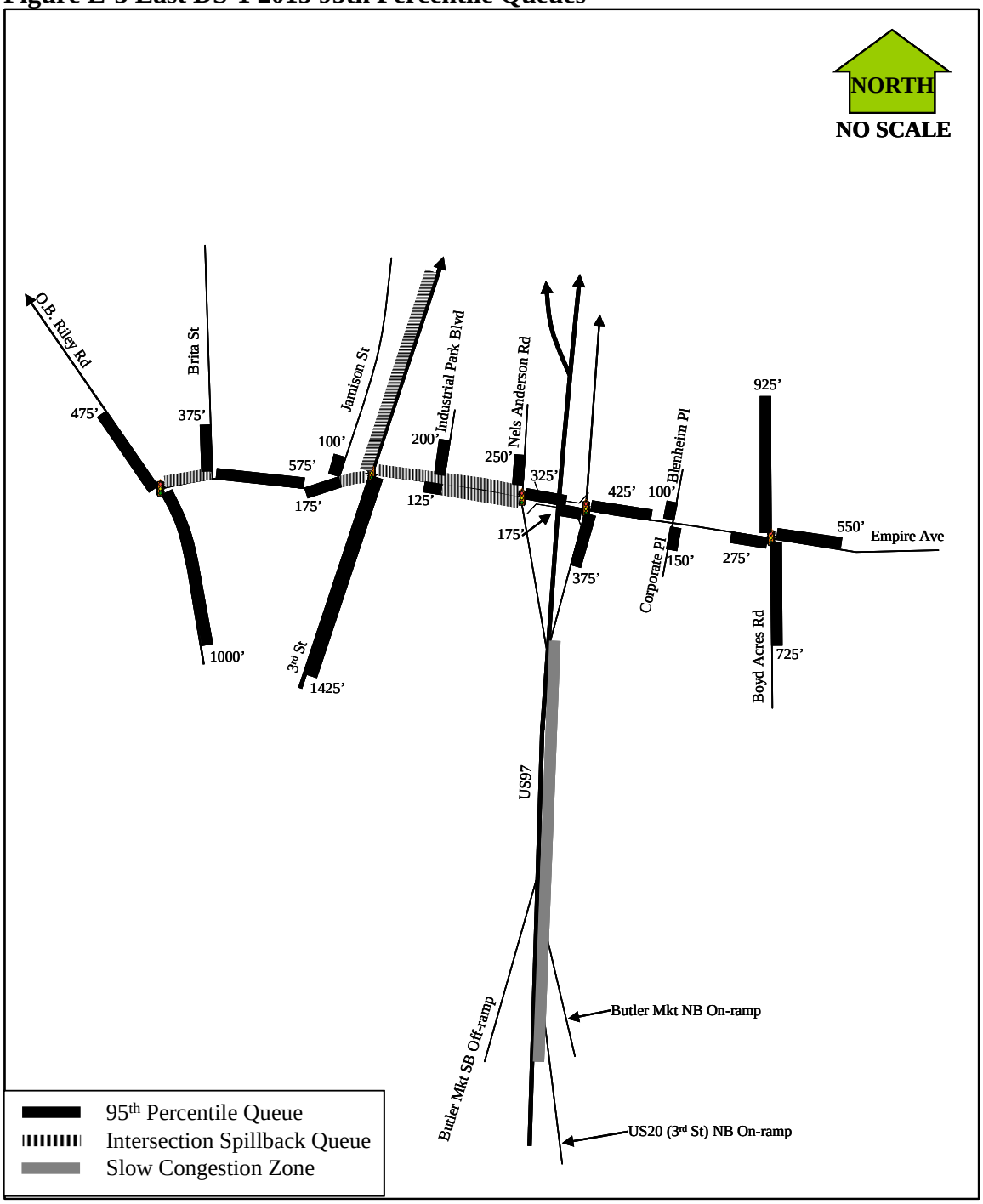


Figure L-4 East DS-1 2035 95th Percentile Queues

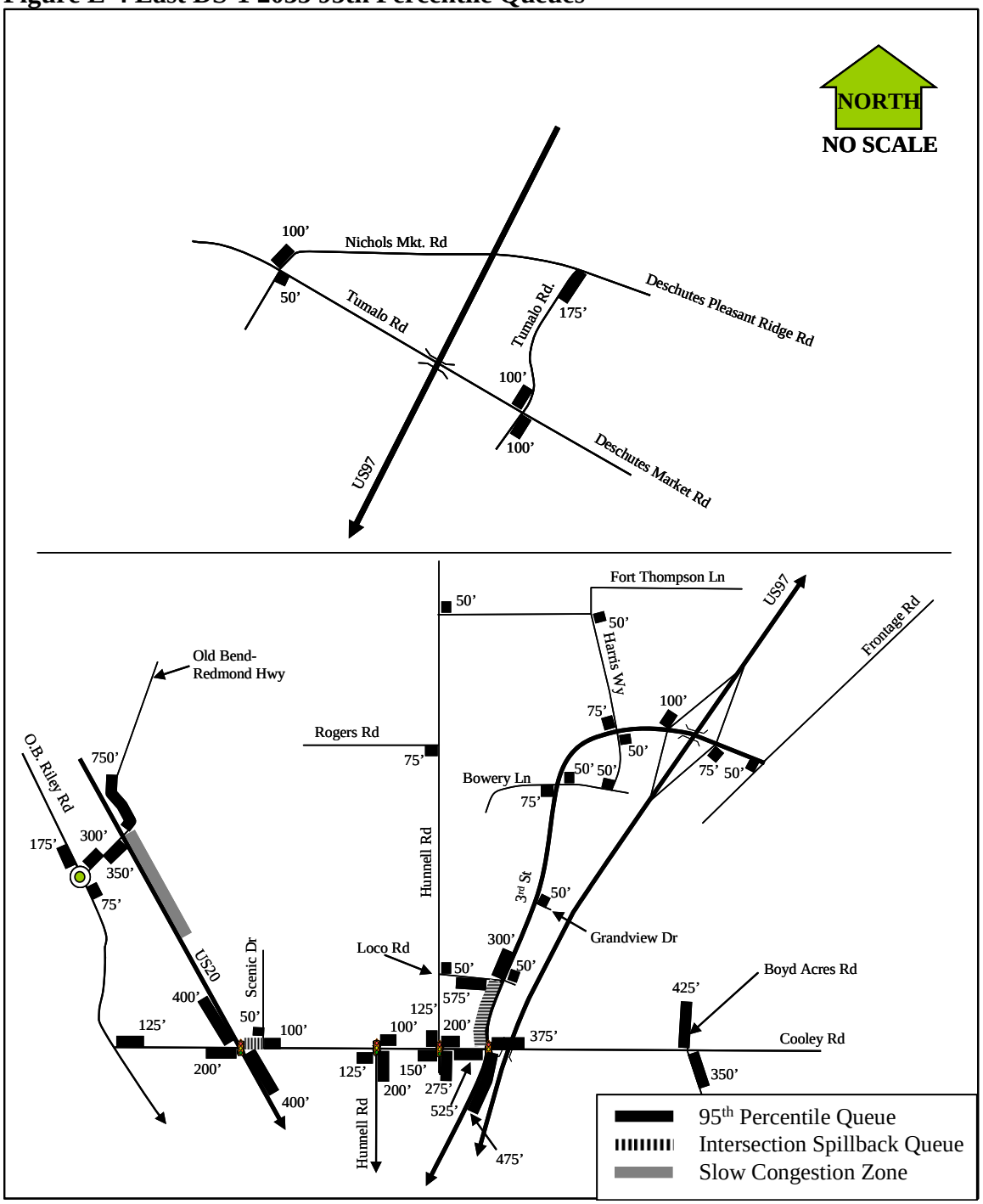


Figure L-5 East DS-1 2035 95th Percentile Queues

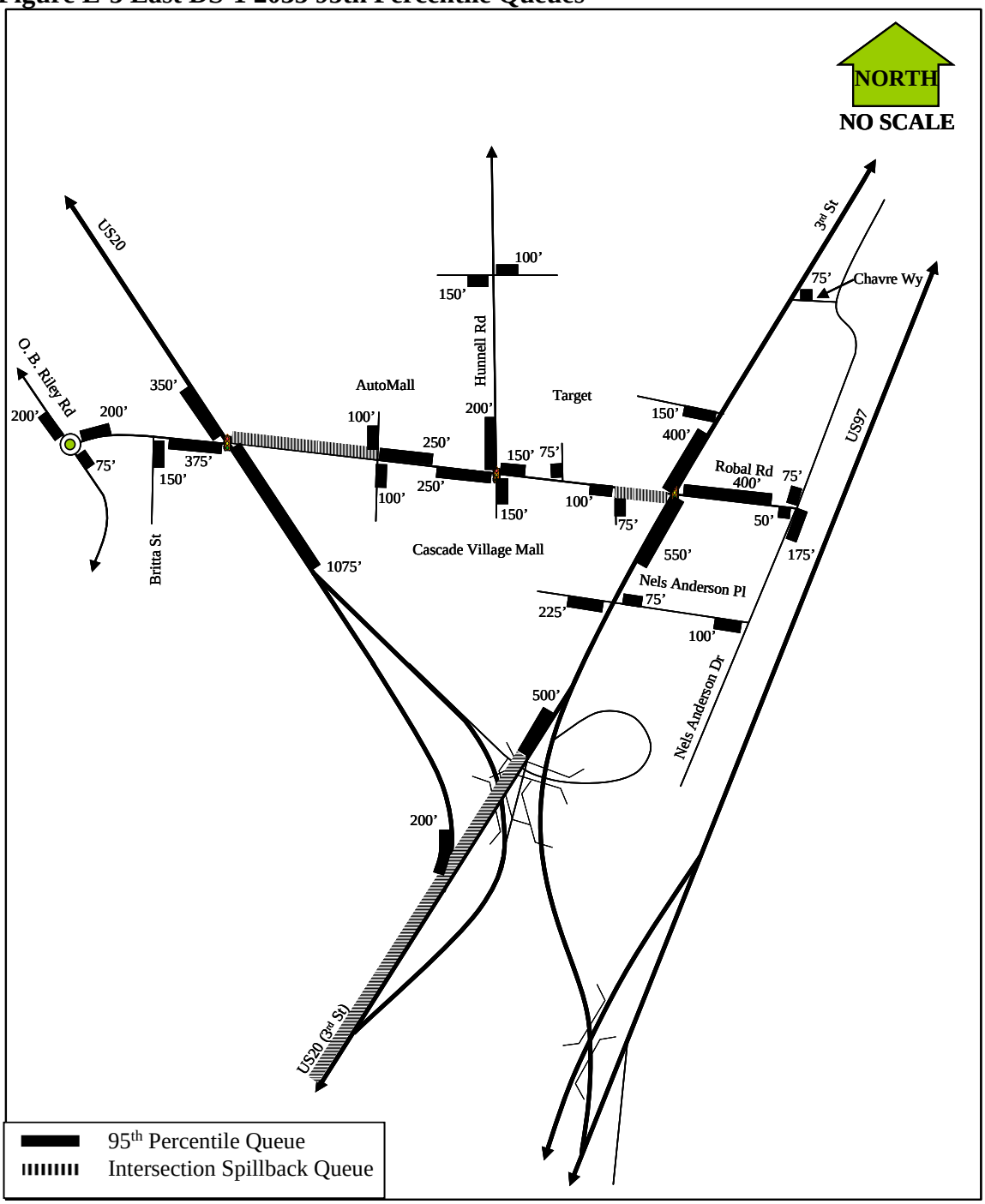
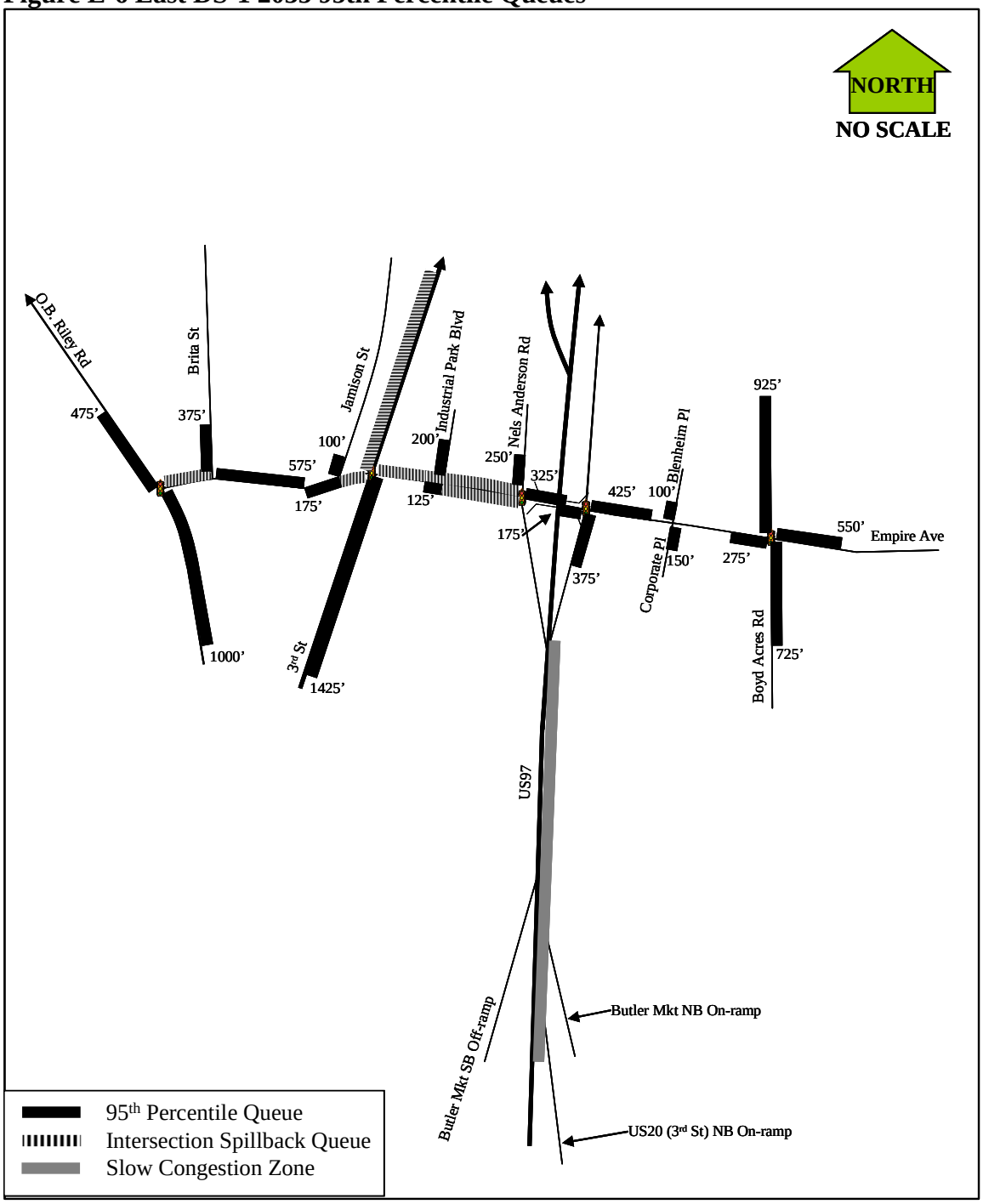


Figure L-6 East DS-1 2035 95th Percentile Queues



APPENDIX M: 2015 & 2035 ALTERNATIVE EAST DS-2 DESIGN HOUR VOLUMES

Figure M-1 Alternative East DS-2 2015 DHV & Lane Configurations

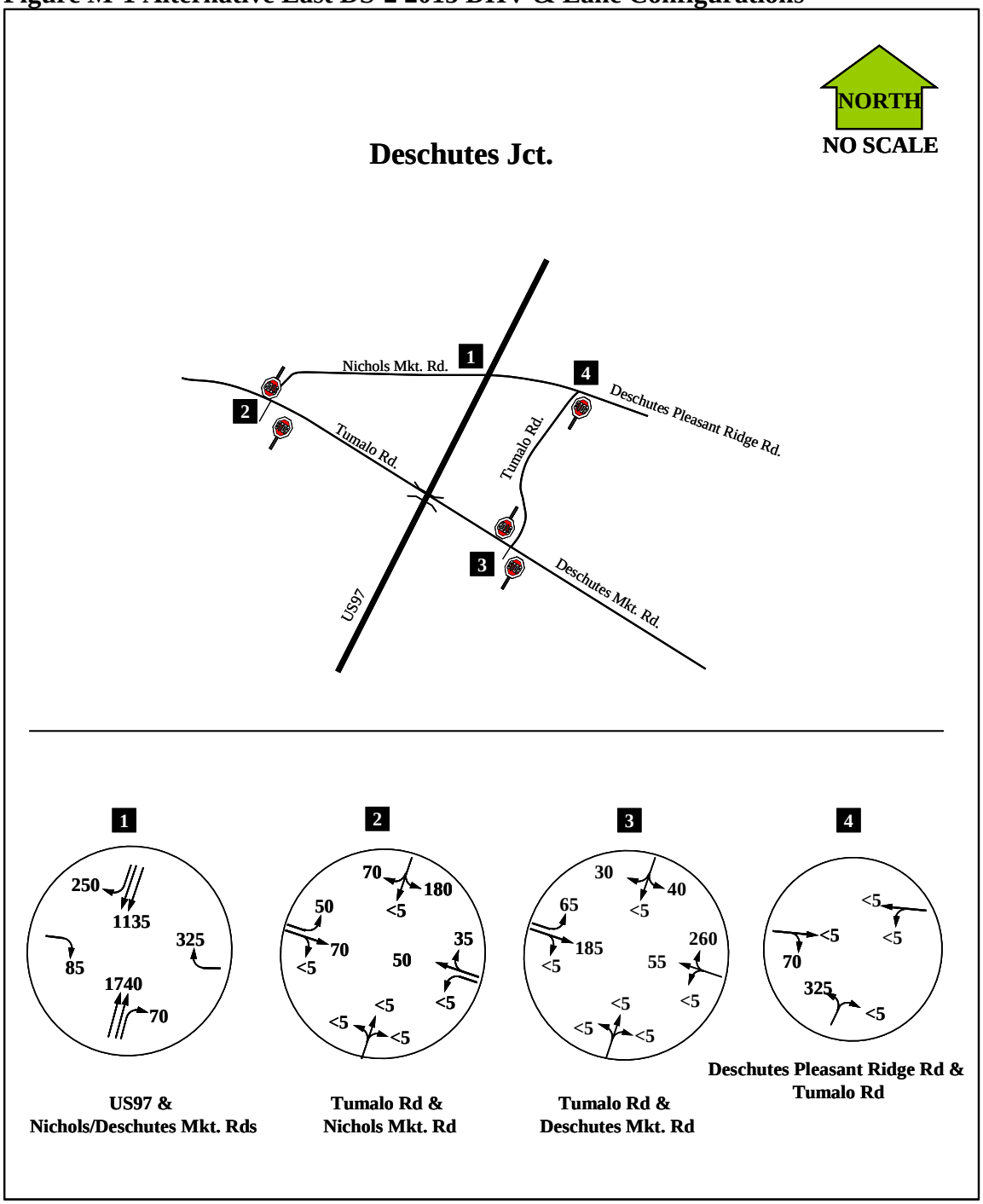


Figure M-2 Alternative East DS-2 2015 DHV & Lane Configurations

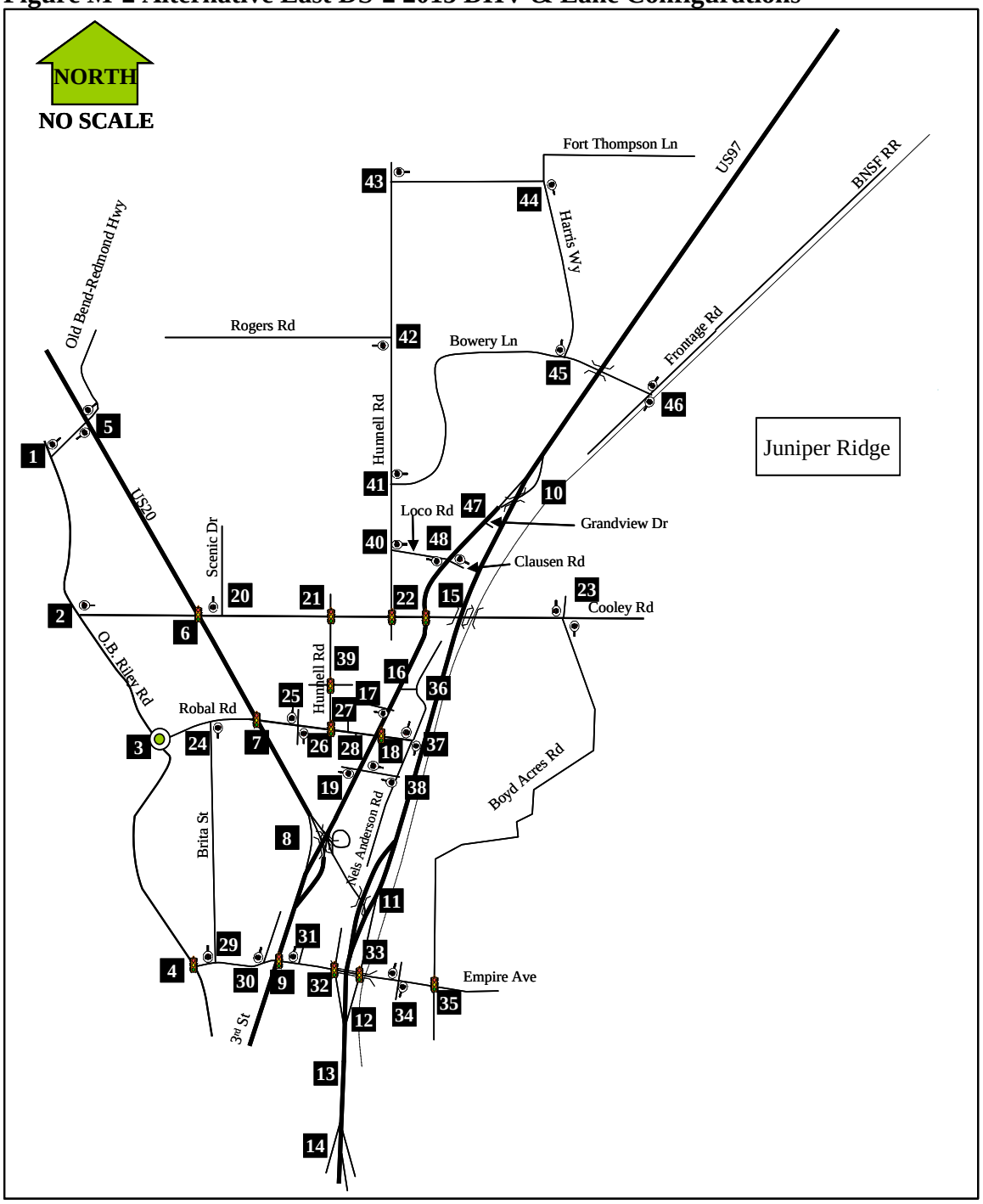


Figure M-3 Alternative East DS-2 2015 DHV & Lane Configurations

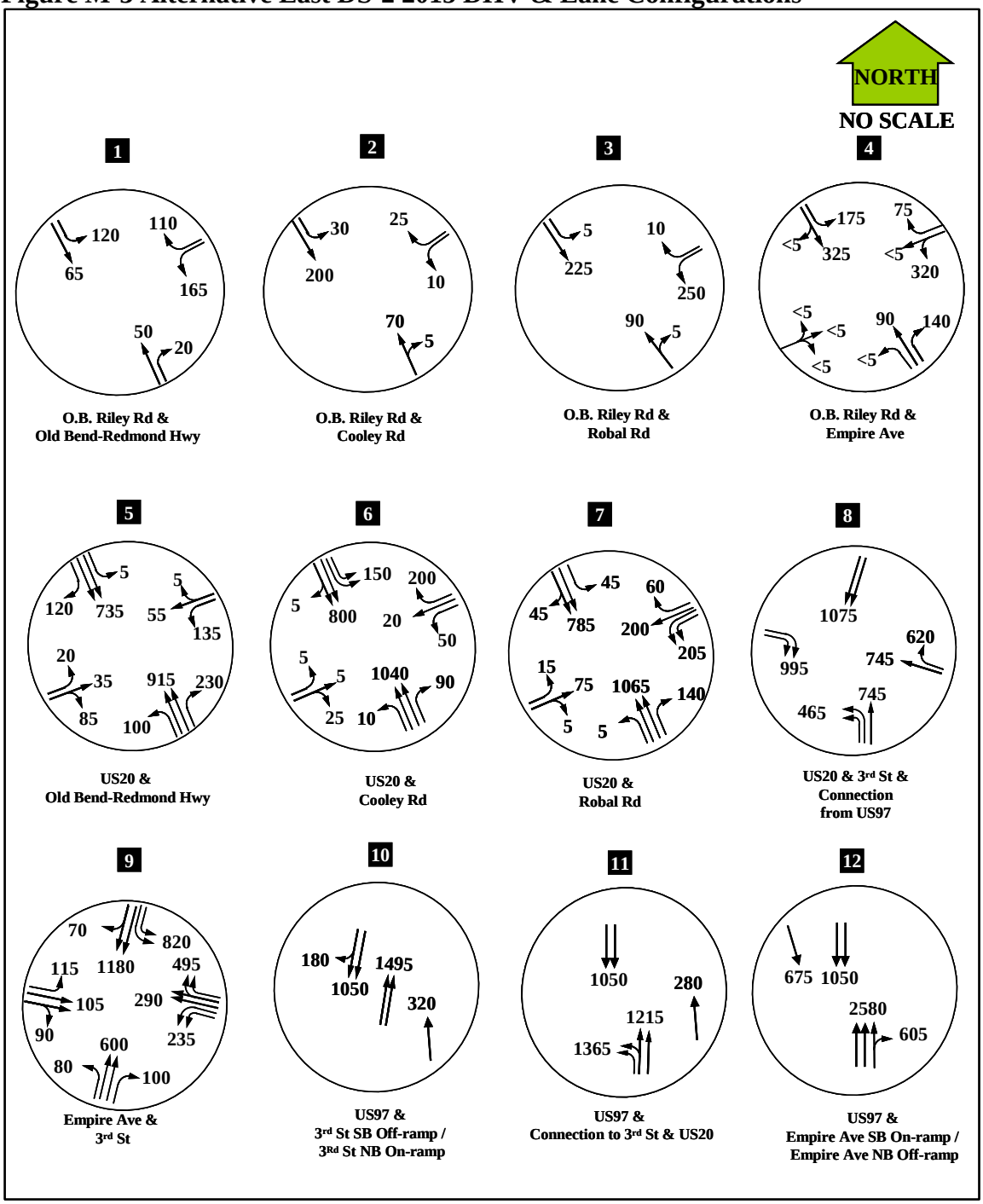


Figure M-4 Alternative East DS-2 2015 DHV & Lane Configurations

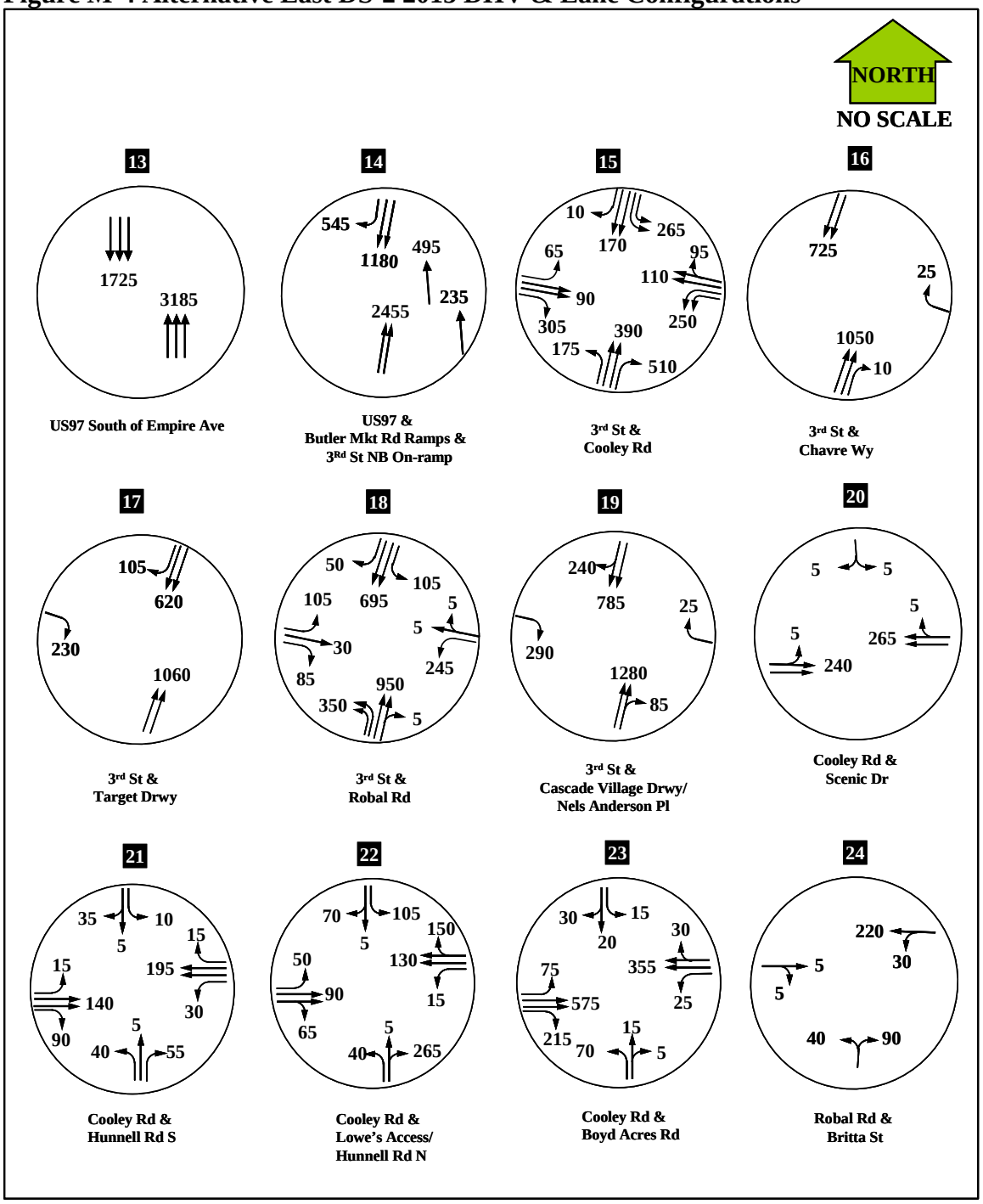


Figure M-5 Alternative East DS-2 2015 DHV & Lane Configurations

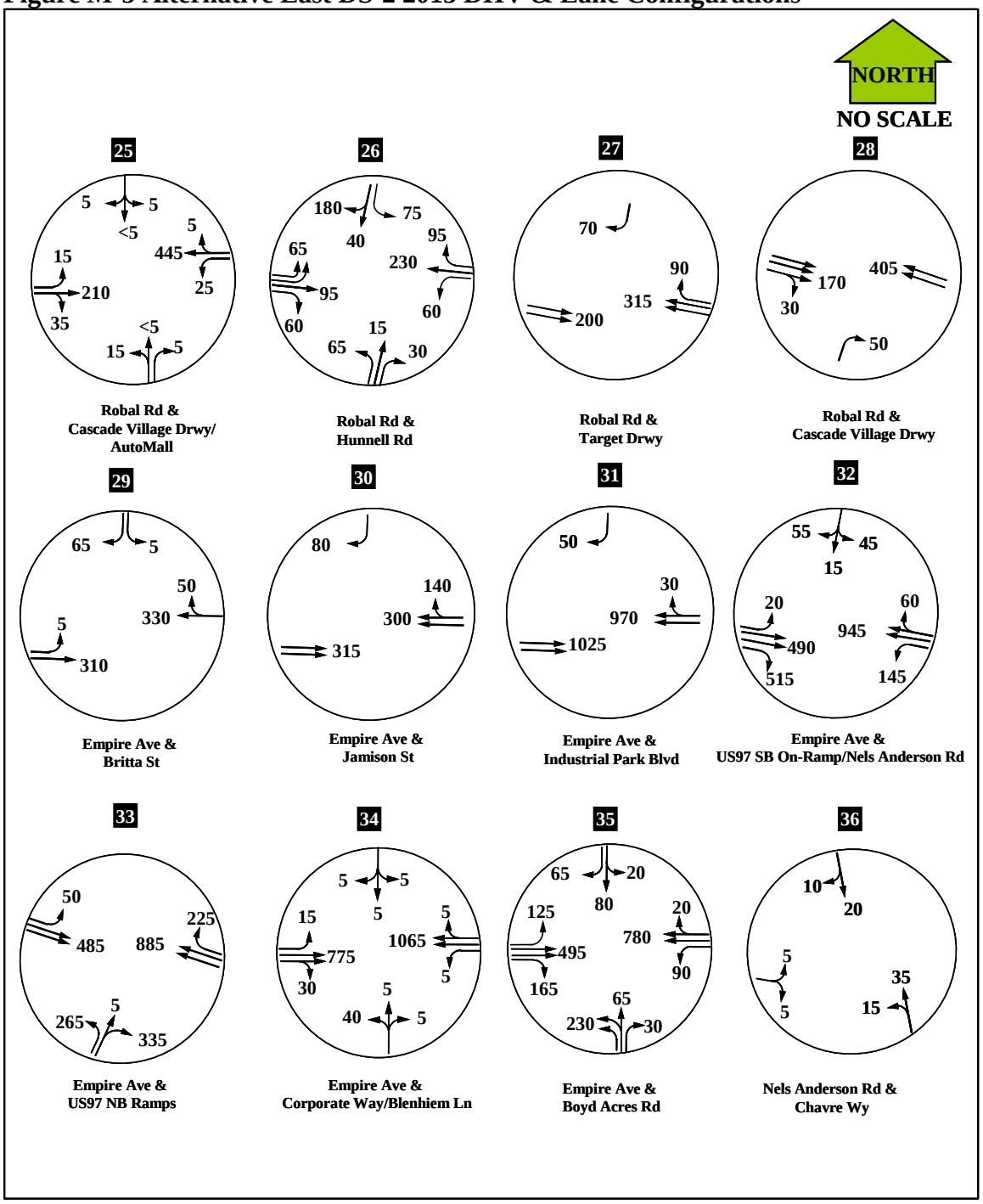


Figure M-6 Alternative East DS-2 2015 DHV & Lane Configurations

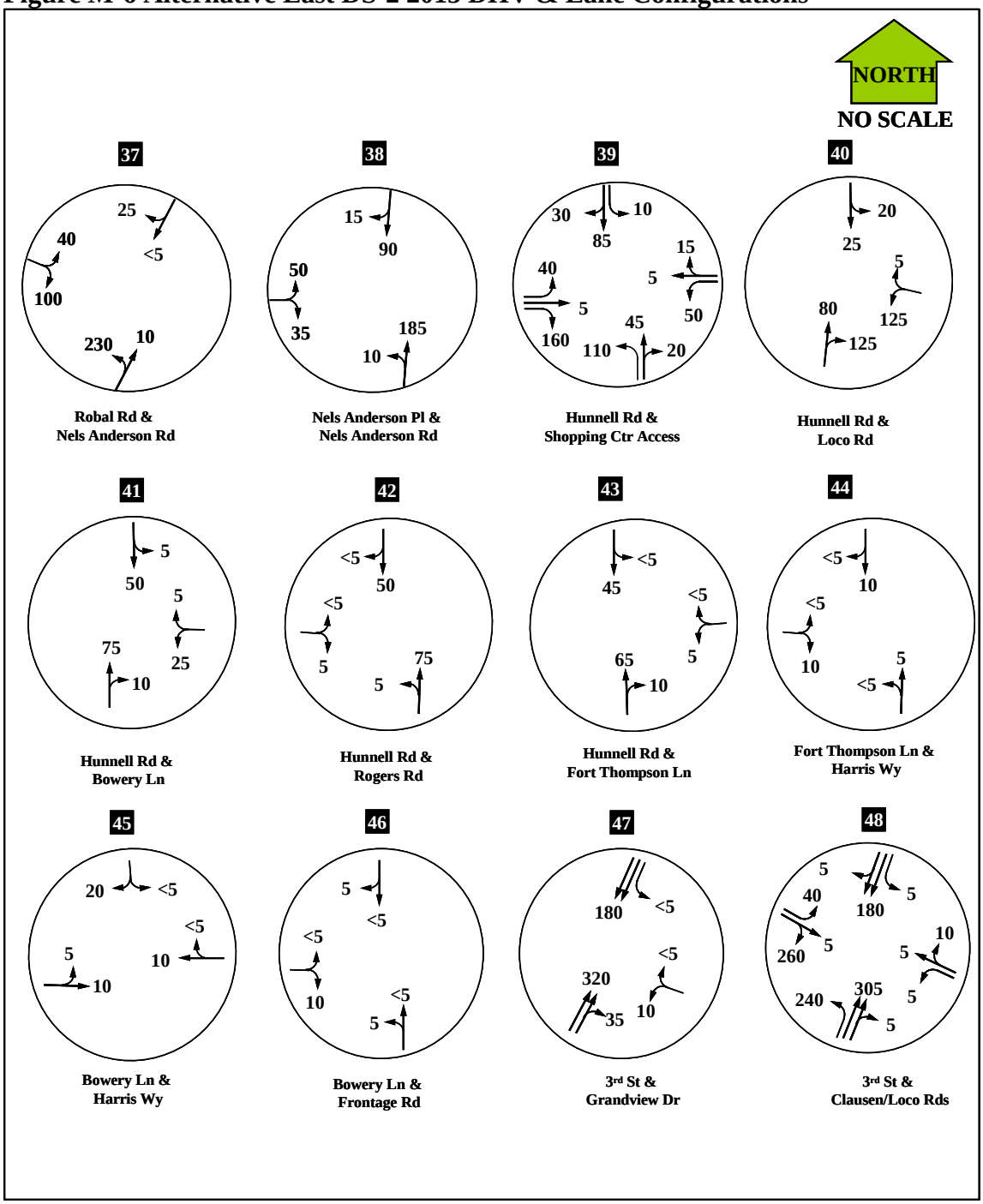


Figure M-7 Alternative East DS-2 2035 DHV & Lane Configurations

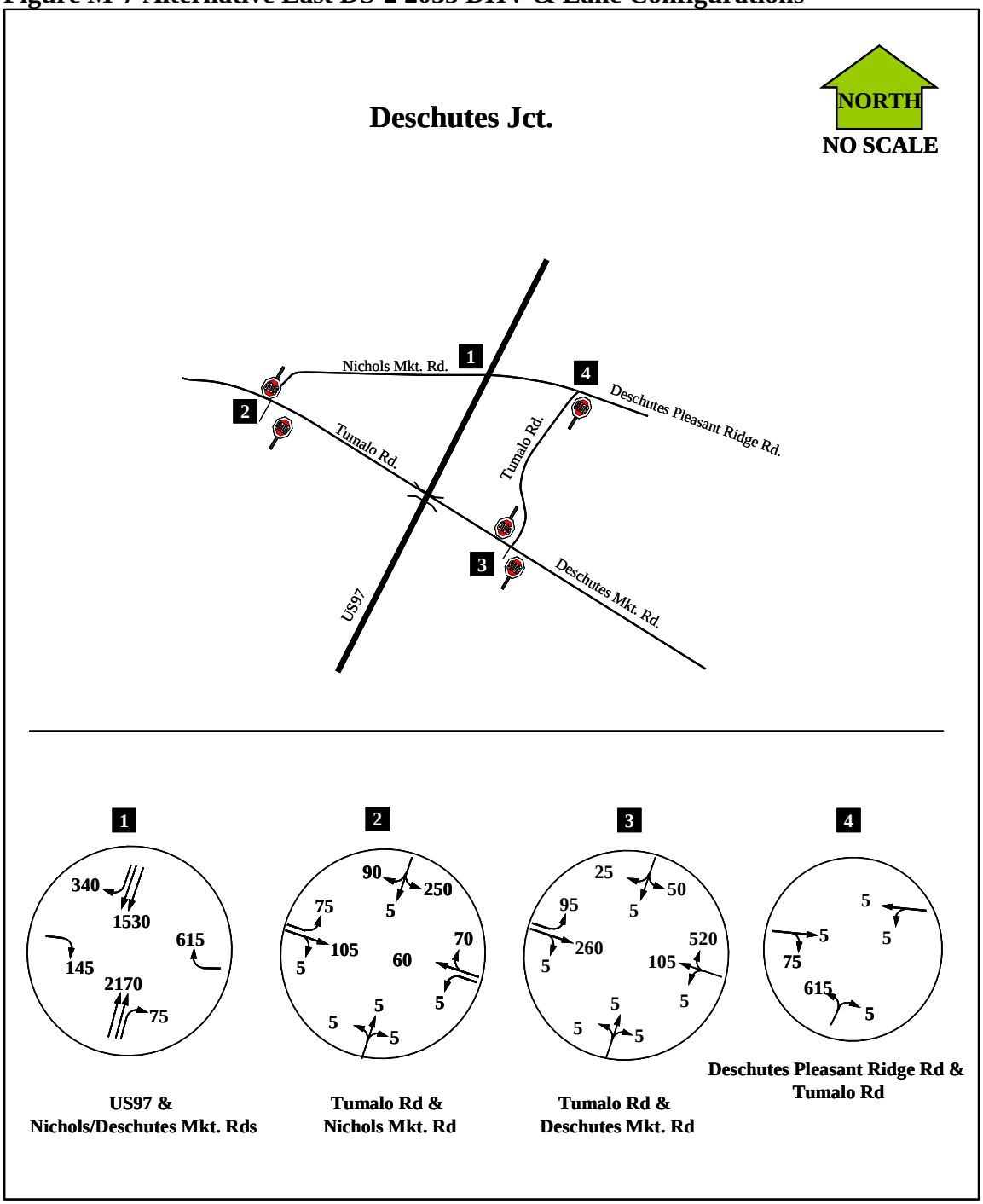


Figure M-8 Alternative East DS-2 2035 DHV Intersection Key

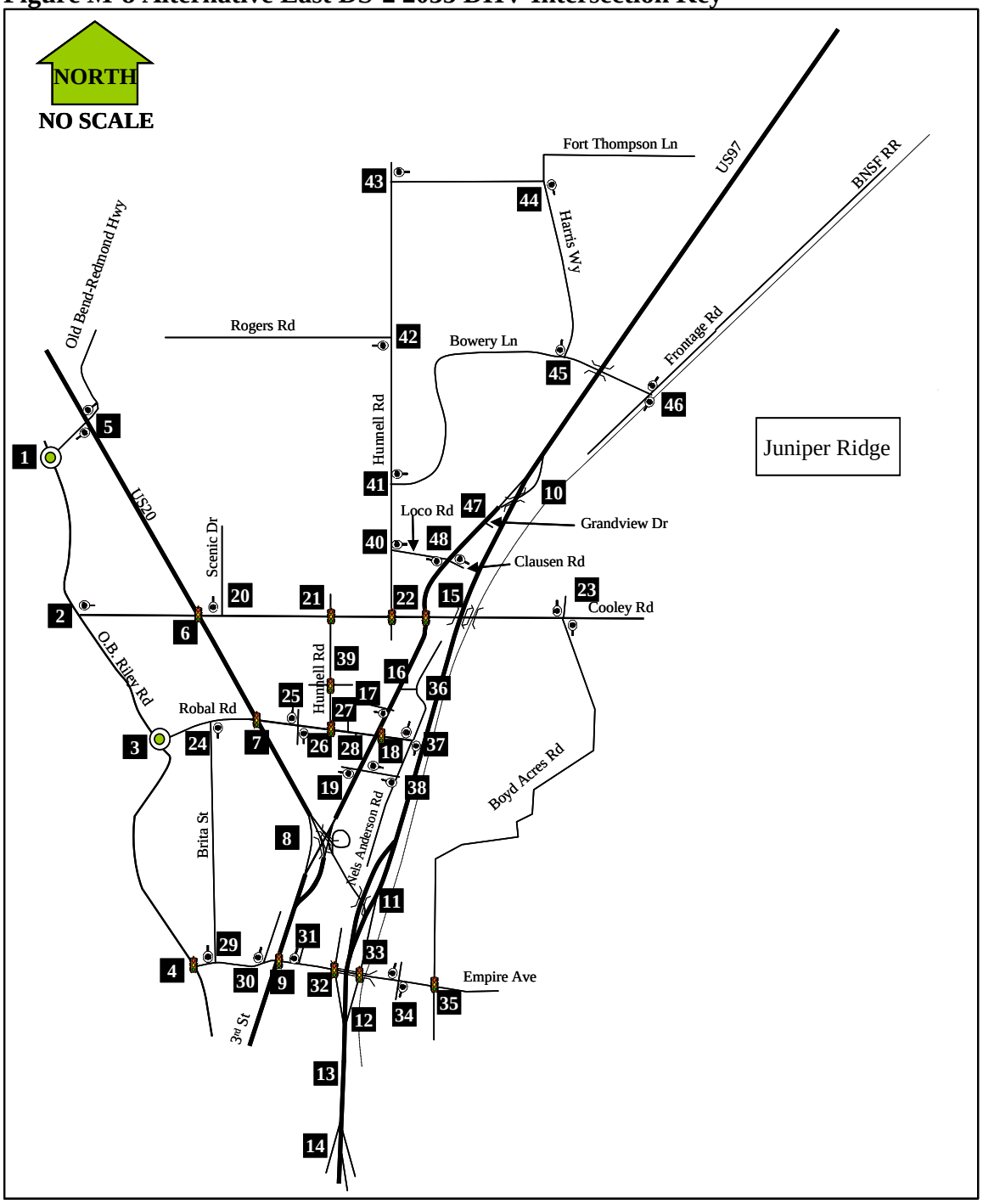


Figure M-9 Alternative East DS-2 2035 DHV & Lane Configurations

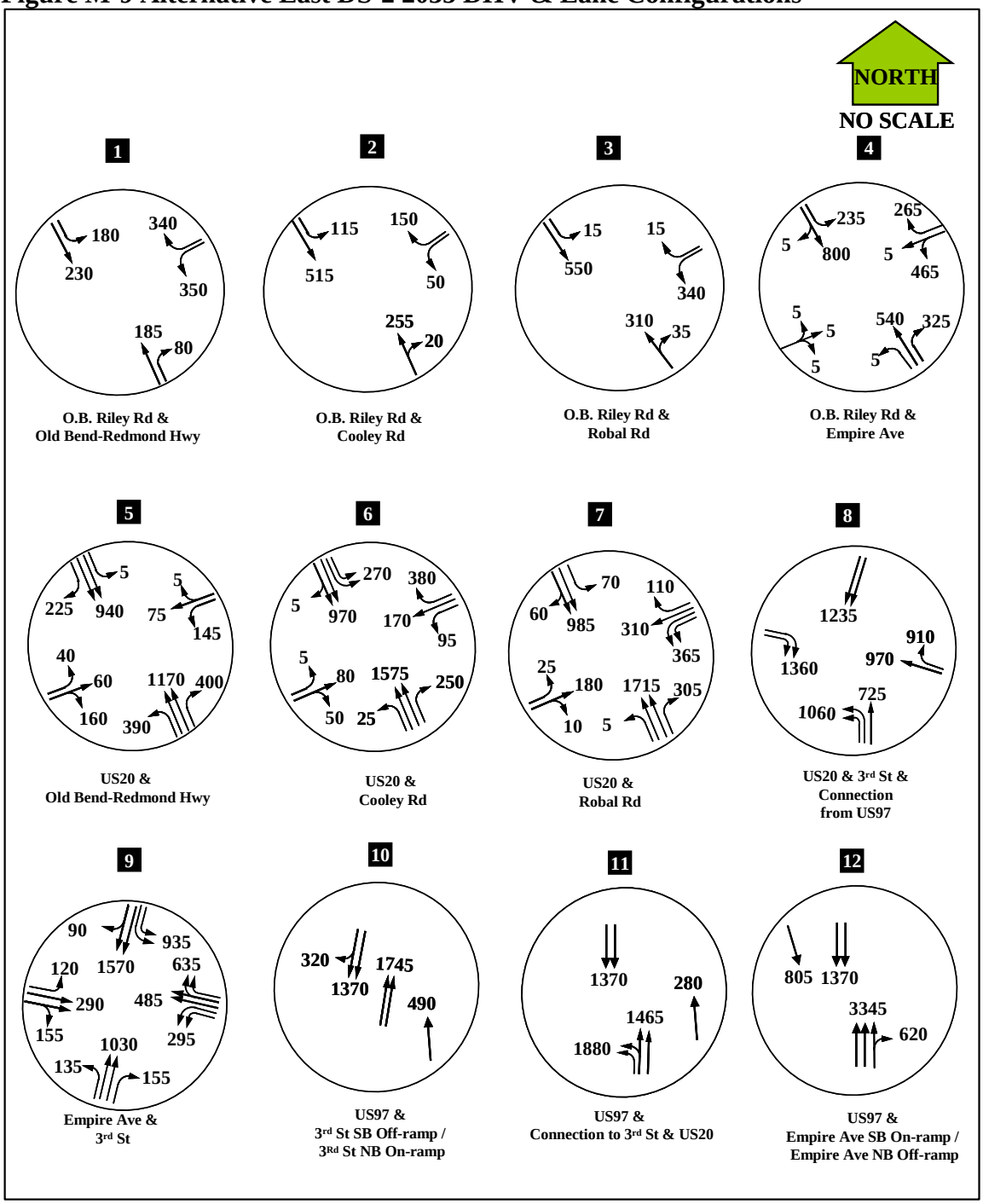


Figure M-10 Alternative East DS-2 2035 DHV & Lane Configurations

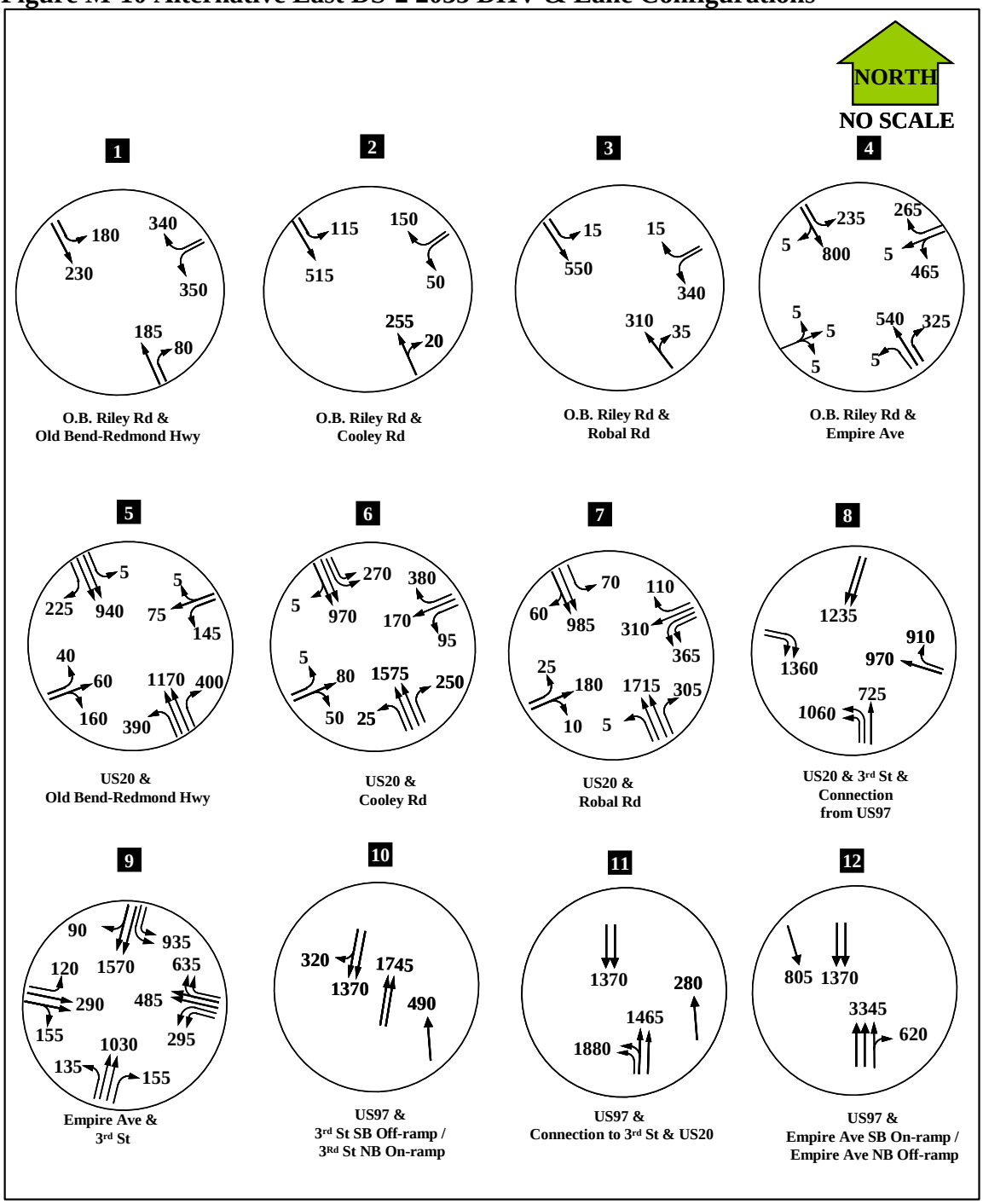


Figure M-11 Alternative East DS-2 2035 DHV & Lane Configurations

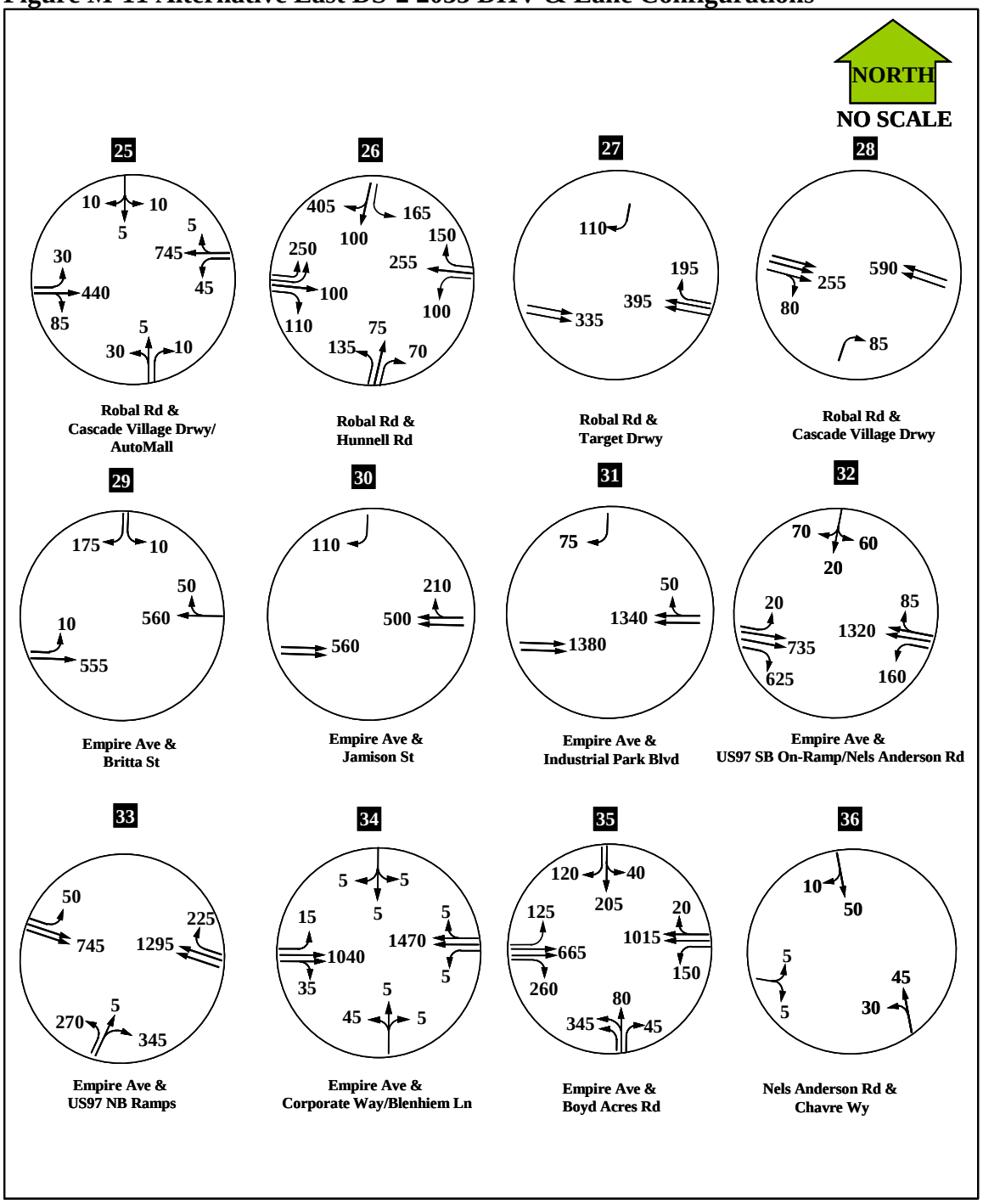
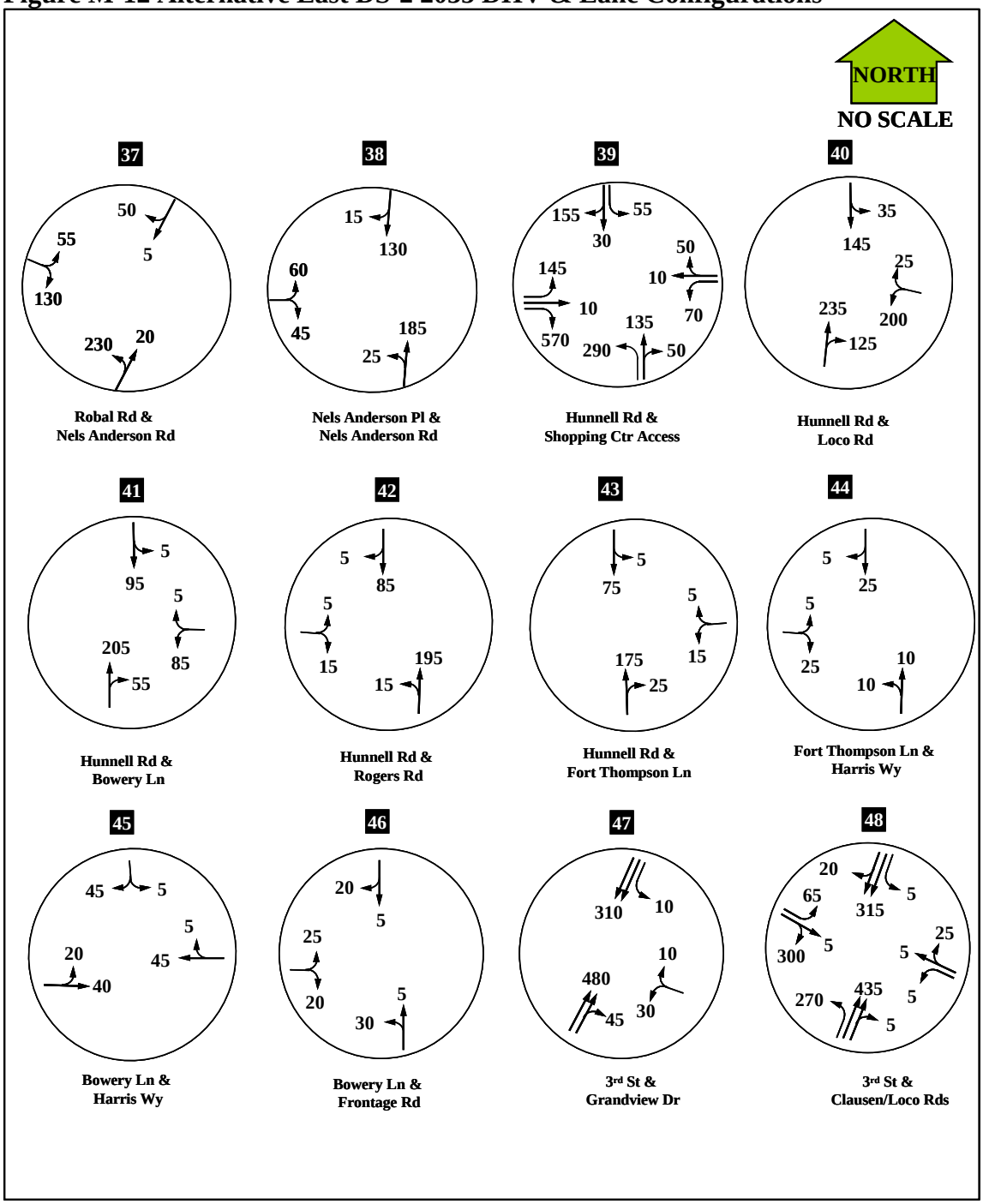


Figure M-12 Alternative East DS-2 2035 DHV & Lane Configurations



APPENDIX N: 2015 & 2035 ALTERNATIVE EAST DS-2 95TH PERCENTILE QUEUES

Figure N-1 East DS-2 2015 95th Percentile Queues

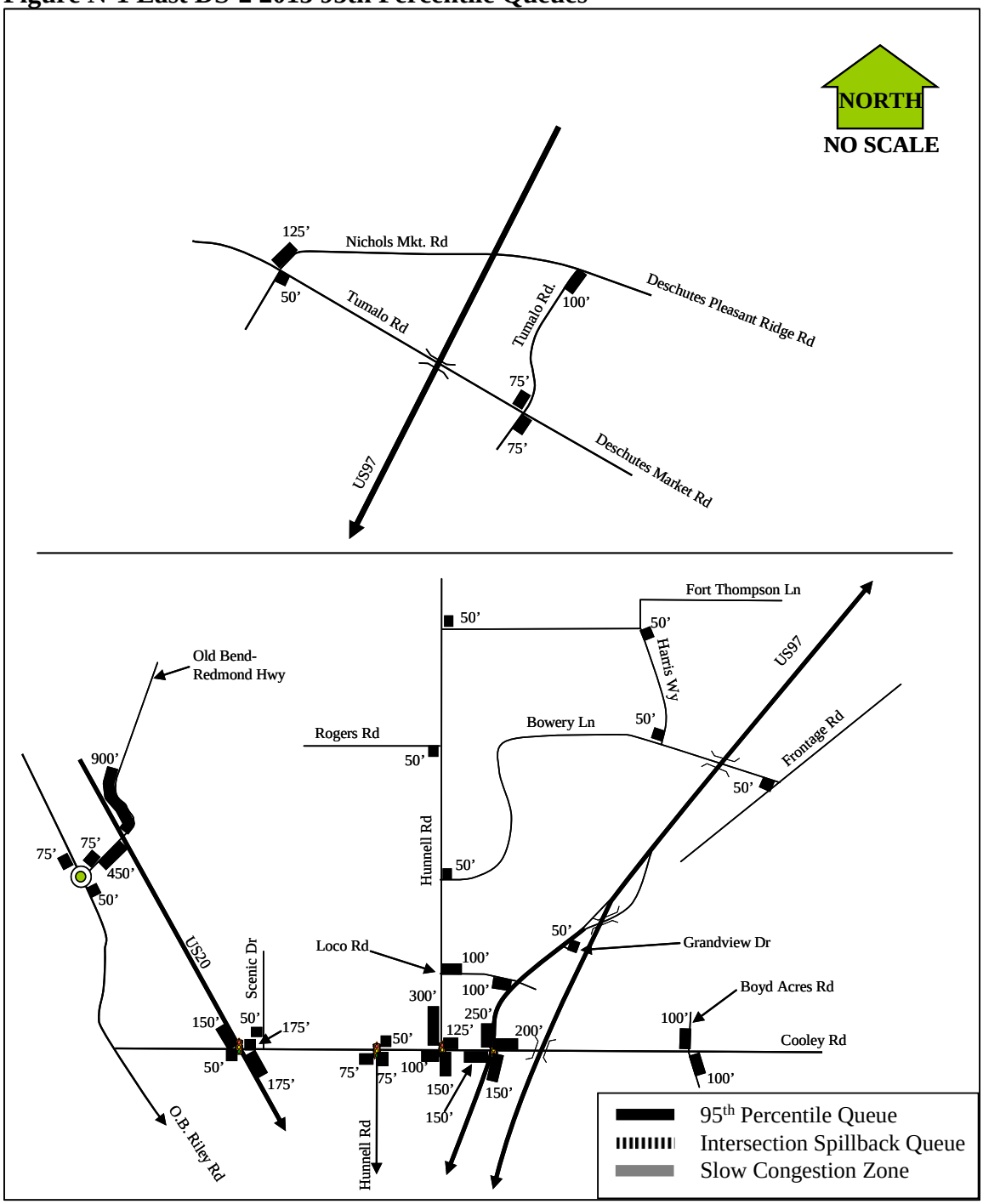


Figure N-2 East DS-2 2015 95th Percentile Queues

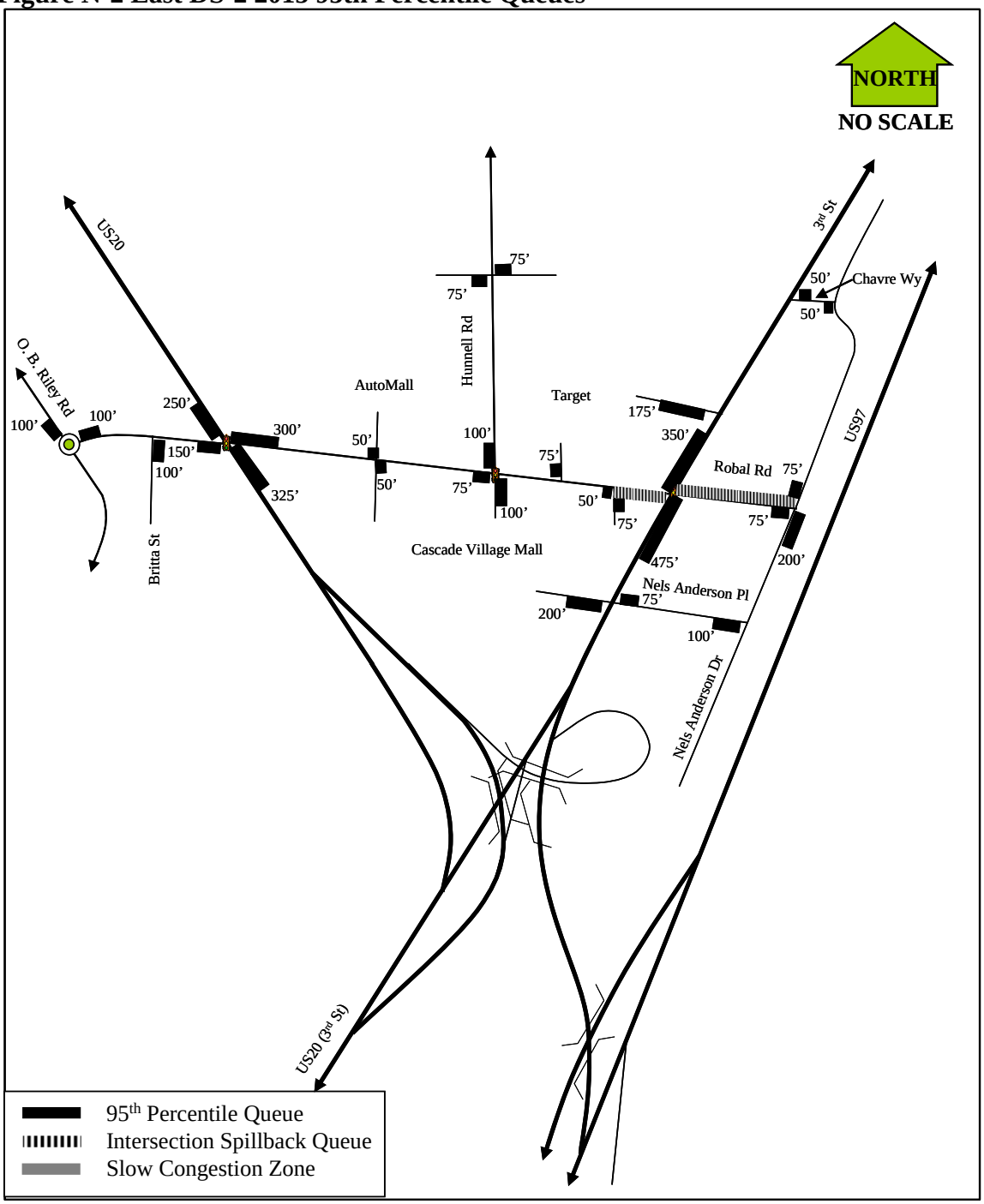


Figure N-3 East DS-2 2015 95th Percentile Queues

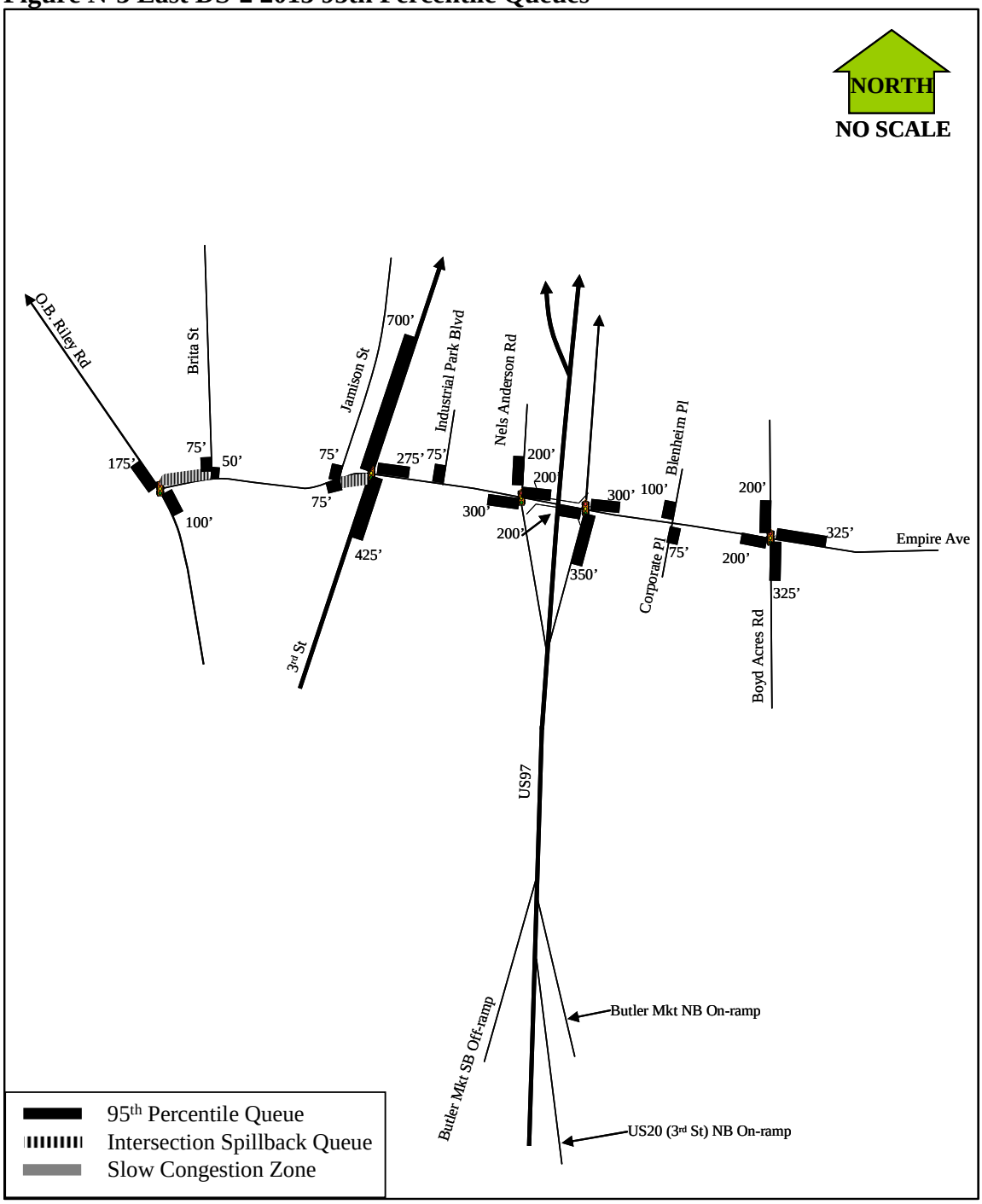


Figure N-4 East DS-2 2035 95th Percentile Queues

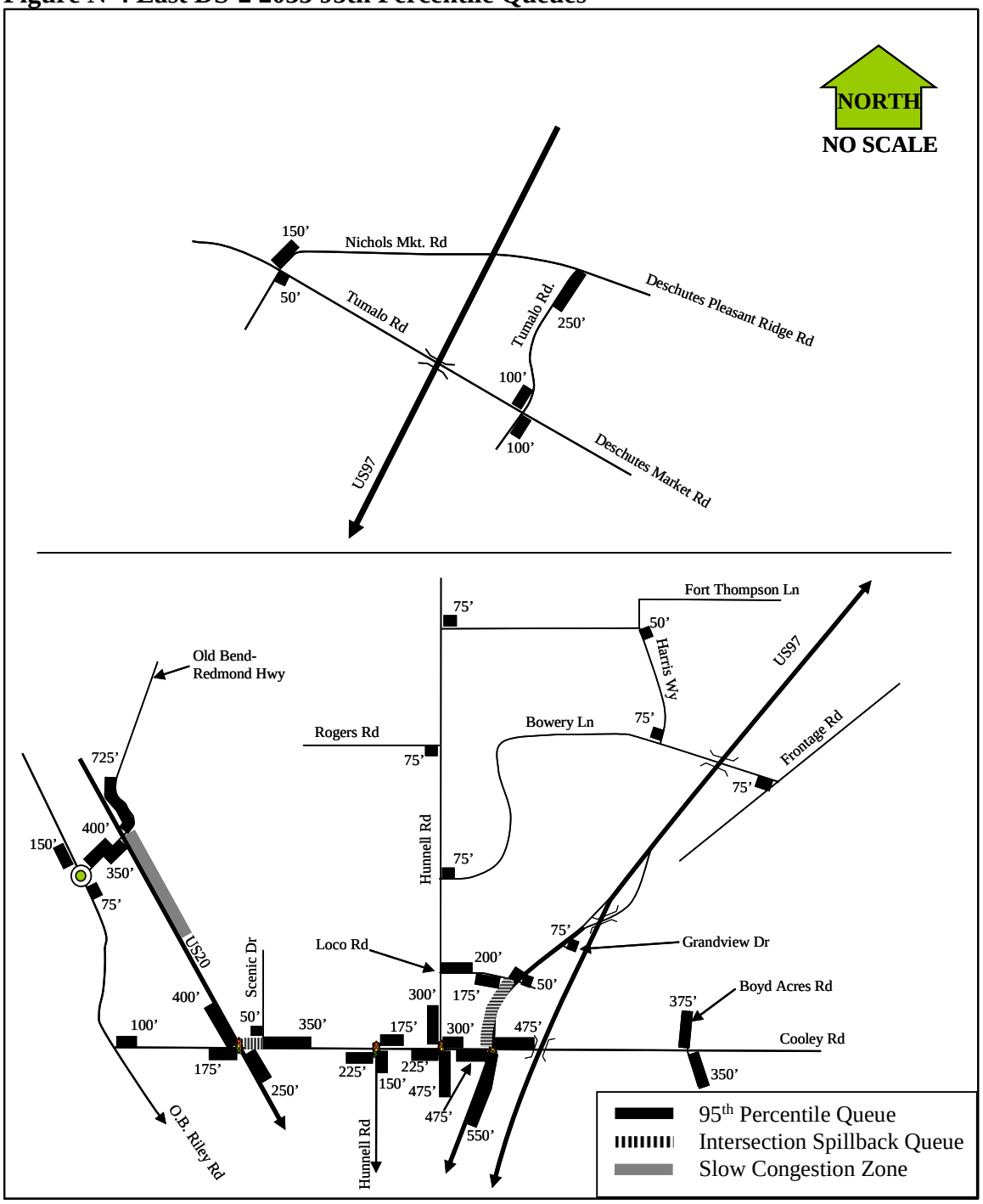
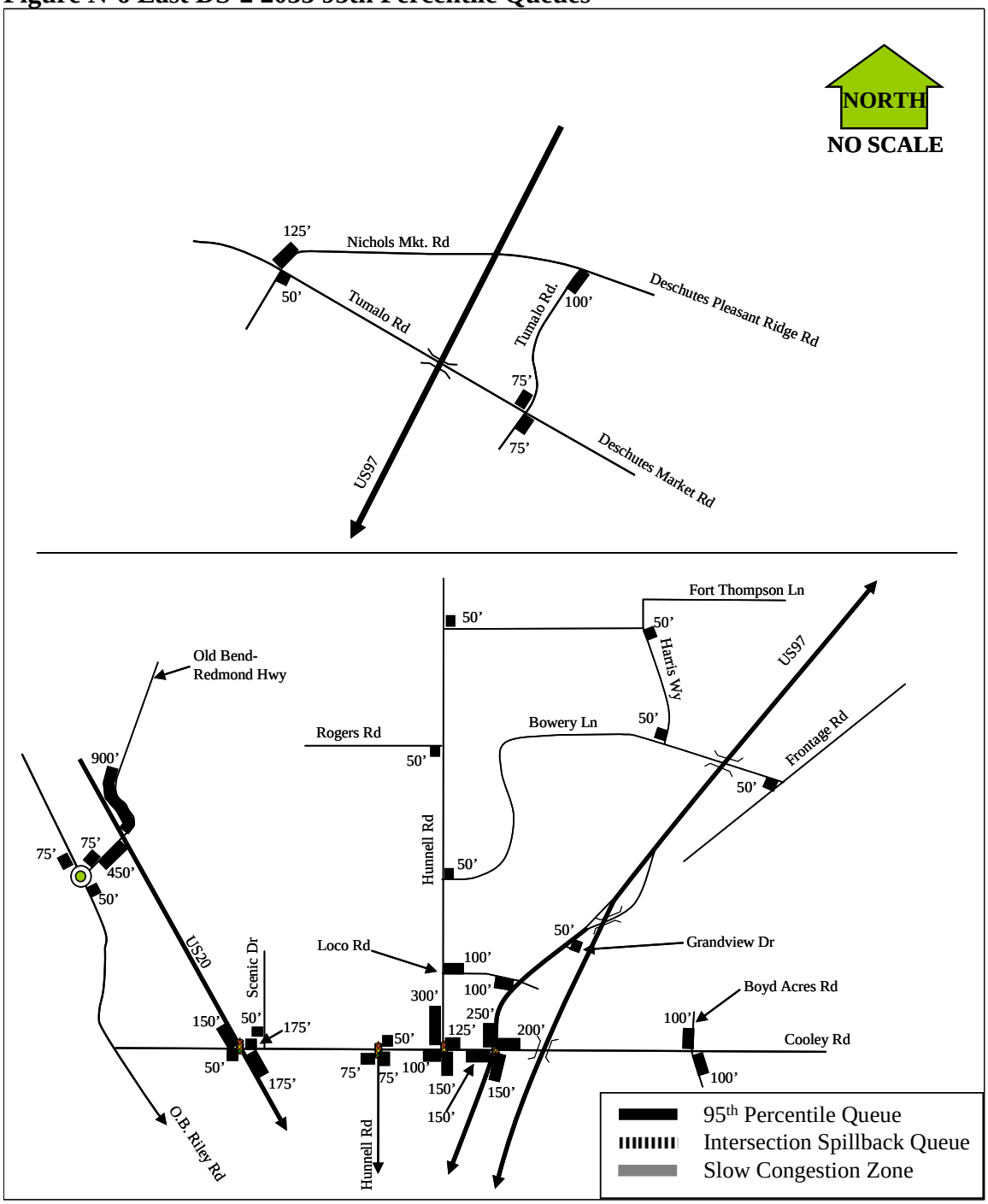


Figure N-5 East DS-2 2035 95th Percentile Queues

Figure N-6 East DS-2 2035 95th Percentile Queues



APPENDIX O: ALTERNATIVE EAST DS-1 & DS-2 DESIGN STORAGE LENGTHS

Table O-1 East DS-1 Design Storage Lengths[1]

Intersection	Approach	Turn Bay	Length (feet)[2]
O.B Riley Rd & Cooley Rd	SB	L	100
	WB	L	140
O.B. Riley Rd & Empire Ave	NB	L	100
		R	200
	SB	L	250
	WB	R	150
US20 & Cooley Rd	NB	L	150
		R	150
	EB	L	100
	SB	Dual L	200
	WB	L	200
		R	Drop Lane
US20 & Robal Rd	NB	L	200
		R	250
	EB	L	100
	SB	L	250
	WB	Dual L	250
		R	150
3rd St & Empire Ave	NB	L	250
		R	225
	EB	L	150
	SB	Dual L	500
	WB	Dual L	300
		R	300
3rd St & Frontage Rd	EB	L	150
3rd St & US97 NB Ramps	NB	L	150
	EB	L	100
3rd St & US97 SB Ramps	SB	L	150
	WB	L	100
3rd St & Harris Wy	EB	L	150
	WB	L	150
3rd St & Bowery Ln	NB	L	100
	SB	L	150
3rd St & Grandview Dr	NB	R	Drop Lane
	SB	L	200
	WB	L	100
3rd St & Clausen/Loco Rds	NB	L	150
	EB	L	100
	SB	L	150
	WB	L	100

Intersection	Approach	Turn Bay	Length (feet)[2]
3rd St & Cooley Rd	NB	L	250
		R	150
	EB	L	200
	SB	Dual L	350
		R	150
	WB	Dual L	200
3rd St & Robal Rd	NB	Dual L	330
	EB	L	225
		R	225
	SB	L	350
		R	250
	WB	L	250
Cooley Rd & Hunnell Rd S	NB	L	150
		R	125
	EB	L	125
		R	100
	SB	L	100
	WB	L	125
		R	100
Cooley Rd & Hunnell Rd N	NB	L	150
	EB	L	125
	SB	L	150
	WB	L	125
Cooley Rd & Boyd Acres Rd	NB	L	200
	EB	L	150
		R	150
	SB	L	150
	WB	L	150
Robal Rd & Cascade Village Drwy/AutoMall	NB	R	175
	EB	L	100
	WB	L	80
Robal Rd & Hunnell Rd	NB	L	150
		R	150
	EB	Dual L	150
		R	100
	SB	L	300
	WB	L	150
		R	Drop Lane
Robal Rd & Target Drwy	WB	R	100
Empire Ave & Britta St	EB	L	100
	SB	L	100
Empire Ave & Jamison St	EB	L	250

Intersection	Approach	Turn Bay	Length (feet)[2]
Empire Ave & US97 SB On-ramp	EB	L	100
		R	100
	WB	L	200
Empire Ave & US97 NB Ramps	NB	L	250
	EB	L	175
	WB	R	150
Hunnell Rd & Shopping Ctr Access	NB	L	Drop Lane
	EB	L	100
		R	100
	SB	L	100
	WB	L	100

[1]Intersections not shown are not modified and use existing storage bays or intersections do not have storage bays.
[2]Storage bay length shown does not include taper length, so the actual full turn lane will be longer than shown.

Table O-2 East DS-2 Design Storage Lengths[1]

Intersection	Approach	Turn Bay	Length (feet)[2]
O.B Riley Rd & Cooley Rd	SB	L	100
	WB	L	140
O.B. Riley Rd & Empire Ave	NB	L	100
		R	200
	SB	L	250
	WB	R	150
US20 & Cooley Rd	NB	L	150
		R	150
	EB	L	100
	SB	Dual L	200?
	WB	L	100
		R	Drop Lane
US20 & Robal Rd	NB	L	200
		R	200
	EB	L	150
	SB	L	200
	WB	Dual L	250
		R	100
3rd St & Empire Ave	NB	L	250
		R	225
	EB	L	150
	SB	Dual L	Drop Lane
	WB	Dual L	300
		R	300
3rd St & Grandview Dr	SB	L	150
3rd St & Clausen/Loco Rds	NB	L	150
	EB	L	150
	SB	L	150
	WB	L	150
		R	150
	EB	L	185
		R	185
	SB	Dual L	350
		R	150
	WB	Dual L	200

Intersection	Approach	Turn Bay	Length (feet)[2]
3rd St & Robal Rd	NB	Dual L	330
	EB	L	225
		R	225
	SB	L	350
		R	250
	WB	L	200
Cooley Rd & Hunnell Rd S	NB	L	225
		R	100
	EB	L	100
		R	100
	SB	L	200
	WB	L	125
		R	100
Cooley Rd & Hunnell Rd N	NB	L	100
	EB	L	150
	SB	L	350
	WB	L	150
Cooley Rd & Boyd Acres Rd	NB	L	175
	EB	L	100
		R	150
	SB	L	100
	WB	L	100
Robal Rd & Cascade Village Drwy/AutoMall	NB	R	175
	EB	L	100
	WB	L	80
Robal Rd & Hunnell Rd	NB	L	100
		R	100
	EB	Dual L	150
		R	100
	SB	L	300
	WB	L	150
		R	Drop Lane
Robal Rd & Target Drwy	WB	R	100
Empire Ave & Britta St	EB	L	100
	SB	L	100
Empire Ave & Jamison St	EB	L	250
Empire Ave & US97 SB On-ramp	EB	L	100
		R	100
	WB	L	200
Empire Ave & US97 NB Ramps	NB	L	250
	EB	L	175
	WB	R	150

Intersection	Approach	Turn Bay	Length (feet)[2]
Hunnell Rd & Shopping Ctr Access	NB	L	Drop Lane
	EB	L	100
		R	100
	SB	L	100
	WB	L	100

[1]Intersections not shown are not modified and use existing storage bays or intersections do not have storage bays.
[2]Storage bay length shown does not include taper length, so the actual full turn lane will be longer than shown.

APPENDIX P: – ANALYSIS METHODOLOGIES

General Analysis Methodologies

All v/c ratios with obtained from Highway Capacity Software (HCS2000) or the Highway Capacity Manual (HCM2000) methods following methods prescribed in ODOT's Analysis Procedure Manual. Base saturation flows were set at 1750 pcphgpl (consistent for smaller cities and metropolitan areas) unless saturation flow counts were obtained. Roundabouts were analyzed following the National Cooperative Highway Research Program Report 572 methods that ODOT has adopted.

HCS was used to obtain v/c ratios for segment, merge, diverge, and weaving sections. Weaving flows were estimated using a peak hour video count between the Empire Avenue on-ramp and the Sister's Loop (to US20) off-ramp northbound on US97 to match up vehicles traveling through the section for the existing and future no-build. Select-link analyses were done in the Bend MPO travel demand model to determine the flow paths for the alternatives.

Preliminary ADT Traffic Signal Warrants

Preliminary Signal Warrants (PSW) are based on average daily traffic (ADT) volumes and are based on Warrant 1 in the Manual on Uniform Traffic Control Devices (MUTCD). Of the eight warrants (Page 4C-1) in the MUTCD, only Warrant 1 (Case A or Case B) can be used to project a future need for a traffic signal, according to Oregon Administrative Rule 734-020-0460. Case A (minimum vehicular volume) is mainly for high volumes on the minor street. Case B (interruption of Continuous Volume) deals with high volumes on the major street and the potential delays and safety hazards with minor street traffic crossing or turning onto the major street.

When evaluating PSW's for unsignalized intersections, both the size of the community and the speeds are considered. Intersections have the 85th percentile speed in excess of 40 MPH on the major street (the roadway not being stopped) or are located in an isolated community with a population less than 10,000 are evaluated with 70 percent of the standard warrants. If the 85th percentile speed is less than 40 miles per hour and the population are greater than 10,000, full standard warrants are used for evaluation. High speed locations, such as along US97, US20, and O.B. Riley Road had 70 percent warrants used. Right turn volumes in excess of 85% of capacity of the exclusive or shared right turn lane were included in the approach volumes.

Meeting Preliminary ADT Traffic Signal Warrants does not guarantee that a signal will be installed. Before any signals are considered for installation on the state highway system, ODOT Region Traffic staff need to perform a full traffic signal investigation and submit a recommendation to the ODOT Traffic-Roadway Section. Even if the MUTCD signal warrants are met, the State Traffic Engineer must approve the signals before they may be installed.

Synchro/SimTraffic

The v/c ratios and intersection queuing for signalized intersections were analyzed using Synchro and SimTraffic, which are intended to be used as companion models. The signalized intersection v/c ratio is a quantitative measure of the ratio between the existing for projected volumes to the ideal capacity of the roadway at a given location. The OHP lists v/c mobility standards based on highway classification and surrounding land use.

Synchro is a software package for intersection capacity analysis, modeling actuated signals and optimizing traffic signal timings. Synchro determines v/c ratios and delays at a macro level, while SimTraffic determines system problems that may not be realized with a macro-level model. Synchro represents traffic in terms of aggregate measures for each intersection movement. Measures of effectiveness like delay and queue length are determined with equations. These models do not account for "bottleneck" situations where upstream traffic deficiencies reduce the amount of traffic reaching downstream intersections. This situation would have Synchro showing more delay than SimTraffic because of the reduced volumes arriving at the intersection.

SimTraffic is traffic simulation and animation software that models the behavior of vehicles. Turn moves use gap acceptance methodology. SimTraffic provides average speeds for the link conditions and maximum queue length over the designated time period. SimTraffic also includes vehicle and driver performance characteristics developed by the Federal Highway Administration for use in traffic modeling. SimTraffic is a microscopic simulation model that has the capability to simulate a variety of traffic controls, including a network with traffic signals operating on different cycle lengths or under fully actuated conditions. Most other traffic analysis software packages do not allow for a direct evaluation of these types of traffic conditions.

The Synchro/SimTraffic models used in the project were based on aerial photographs and scaled to fit. Thirtieth highest hour volumes were used for the 2007 existing conditions and post-processed volumes from the Bend travel demand model were used for the future no-build and alternative design hour volumes. Truck percentages, pedestrian numbers, and peak hour factors were obtained from the traffic counts. Geometric and operational data such as lane width, crosswalk width, turn bay length, taper lengths, speed limits, traffic control, and detector locations were obtained by field visit. Traffic signal timing for state and city intersections was obtained from ODOT Region 4 Traffic (ODOT times the City of Bend traffic signals per agreement). Operational issues (blocked intersections, queuing problems, etc) were noted. Remaining default values followed ODOT's Analysis Procedure Manual (APM) guidelines.

Operational data for model refinement and calibration including obtaining 85th percentile speeds for the free-flow section of US97 between Empire Avenue and the US20 connections. Eighty-fifth percentile speeds were also computed for the US20-3rd and US97-US20 ramps using speed data from machine counts. Turning speeds (85th percentile obtained where possible) were also captured for any skewed turning

movements. Saturation flow counts were obtained at southbound US97 & Cooley Road, northbound US97 & Robal Road, and northbound and southbound US20 (3rd Street) at Empire Avenue in July 2007. The results were significantly different from the base 1750 pcphgpl, and so were used in the existing condition simulation. Values ranged from 1595 pcphgpl at Robal Road to 1845 pcphgpl at Empire Avenue. Floating car travel time runs were done during the peak period for both US97 and 3rd Street.

The SimTraffic operational files were modified using a project-specific vehicle fleet mix obtained from classifications counts near the boundaries of the study area. In addition, driver reaction times and vehicle lengths were modified as per the APM.

The 2007 existing condition simulation was initially visually calibrated to the observed conditions. The simulation was also peer reviewed by Region 4 Traffic staff which resulted in additional adjustments to side-street approach blocking and traffic signal timing. At key intersections (US97 & Cooley Road, US97 & Robal Road, and US20 & 3rd Street, the simulation was calibrated to (or to as close as possible) a one percent overall tolerance in volume throughput (vehicles exited) on the mainline approaches. Simulation results are based on at least five one-hour runs (based on a 90% confidence interval) that are clear of unrealistic blocking (stuck vehicles).

Changes to the future no-build simulations for 2015 and 2035 were limited to updating the volumes, adding in likely traffic control changes for the local system based on preliminary signal warrant results, and optimizing the traffic signal systems and progression. Simulation results were based on five one-hour runs for 2015 and five 30 minute runs for 2035. The 2035 no-build system is extremely congested and beyond 30 minutes the network fills up and no longer offers any realistic results.

The alternative simulations were created by modifying the links and intersections of the future no-build simulations to match MicroStation roadway design files. The alternatives used post-processed design hour volumes created for each alternative. Traffic signal timing was based on APM guidelines and fully optimized for each system. Simulation results for each alternative are based on five one-hour runs that are clear of any unrealistic queuing or blocking.

All queues shown are the 95th percentile queue based from SimTraffic results and rounded up to the next highest 25 feet. The 95th percentile queue represents the length that covers 95% of all queues that exist for a particular movement. The remaining 5% generally occurs with volumes that exceed the 30th highest hour. The 95th percentile queue is also used as the design standard in determining the length of turn storage bays. A 5% threshold for intersection and turn bay blocking percentages was used as the number of affected signal cycles including recovery time becomes significant at this level.

APPENDIX Q: NO-BUILD EIS DATA

Figure Q-1 2007, 2015 & 2035 No-build EIS Links

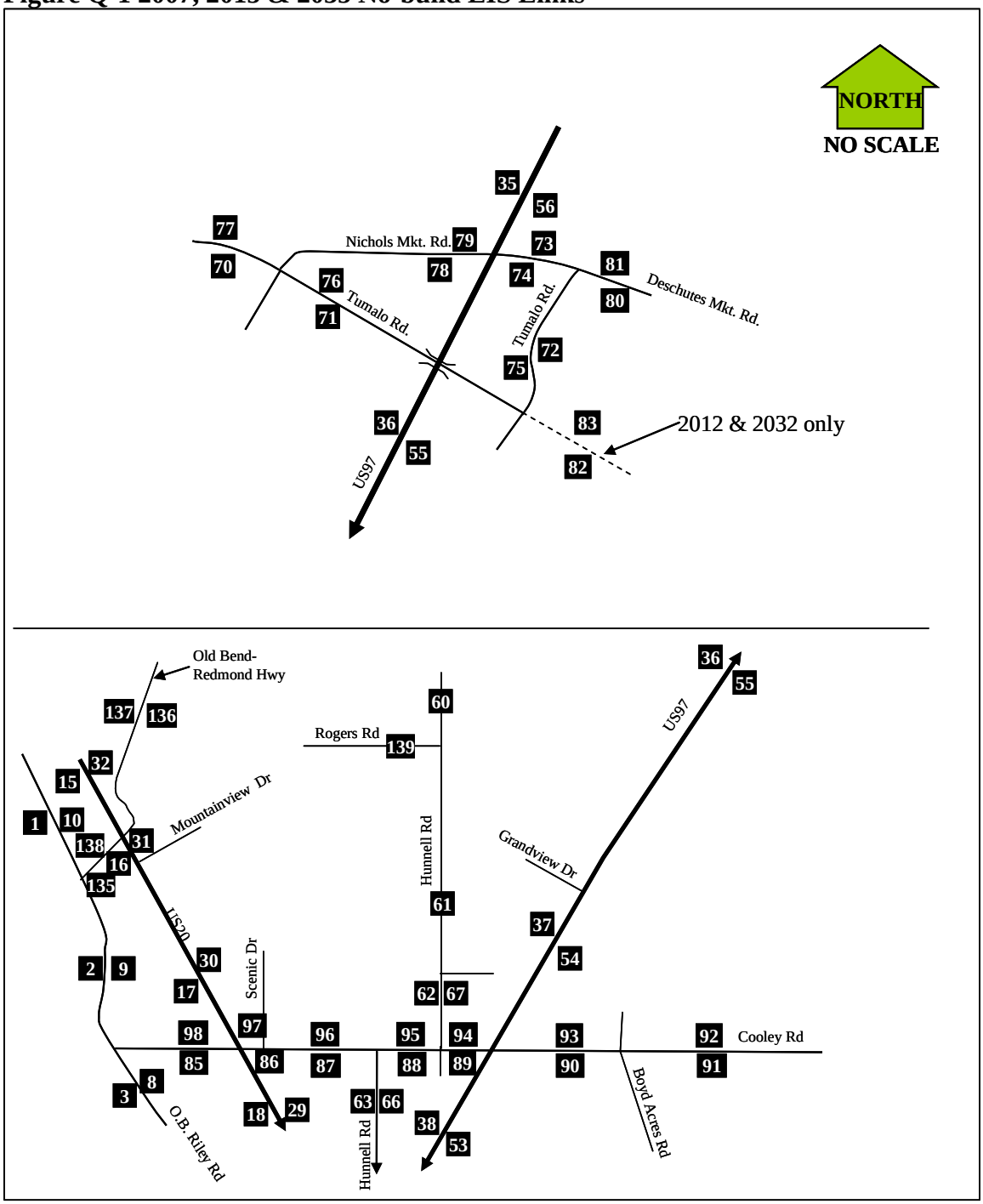


Figure Q-2 2007, 2015 & 2035 No-build EIS Links

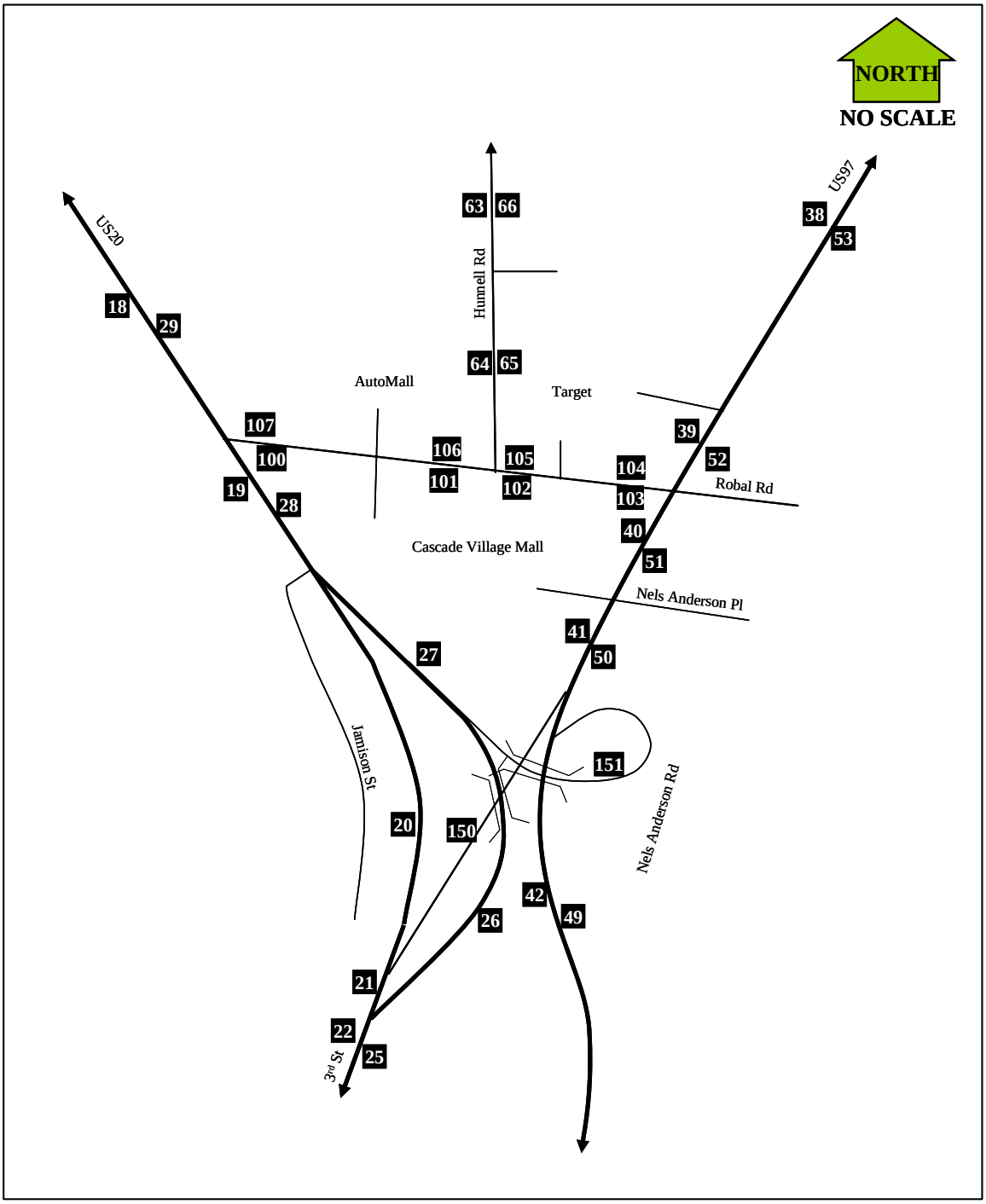


Figure Q-3 2007, 2015 & 2035 No-build EIS Links

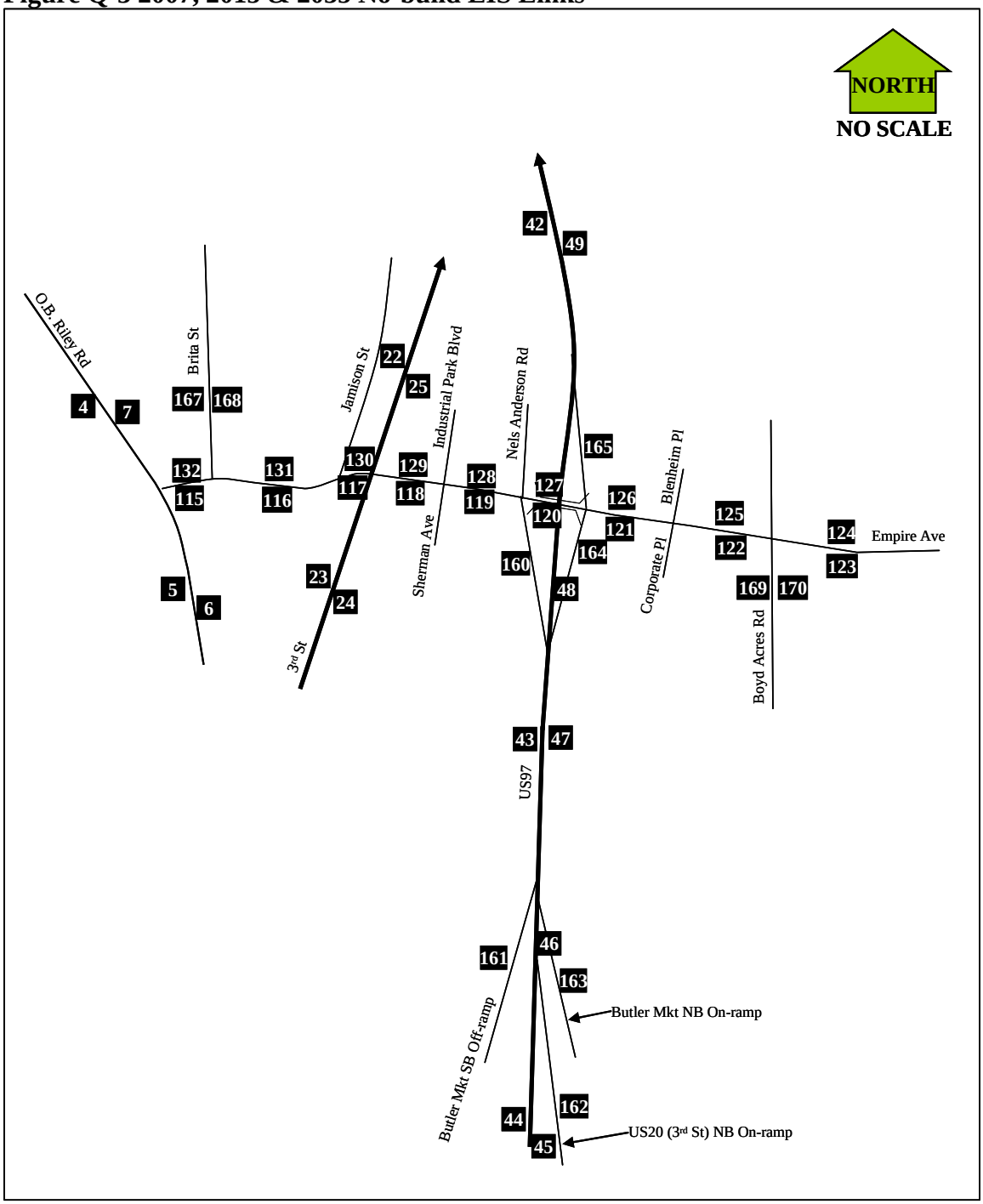


Figure Q-4 2007 Existing Condition EIS Data Sheets

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2007 Existing Conditions

PAGE: 1
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UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
OB Riley SB - N of OB Rec 001	0.25	2007	1400	134	45	140	127	7	6	45	0	0	45	140	120	11	9	45
OB Riley SB - N of Cooley 002	0.33	2007	1700	141	45	150	136	9	5	45	0	0	45	150	130	11	9	45
OB Riley SB - S of Cooley 003	0.65	2007	1800	148	45	150	133	8	9	45	0	0	45	150	133	8	9	45
OB Riley SB - N of Empire 004	0.71	2007	2500	190	45	200	192	8	0	45	0	0	45	200	189	11	0	45
OB Riley SB - S of Empire 005	0.25	2007	2700	230	45	180	166	10	4	45	0	0	45	180	160	15	5	45
OB Riley NB - S of Empire 006	0.25	2007	1800	205	45	100	88	11	1	45	0	0	45	60	59	13	8	45
OB Riley NB - N of Empire 007	0.71	2007	2200	153	45	140	129	11	0	45	0	0	45	100	84	13	3	45
OB Riley NB - S of Cooley 008	0.65	2007	1200	83	45	80	78	2	0	45	0	0	45	80	69	5	6	45
OB Riley NB - S of OB Rec 009	0.33	2007	1000	82	45	60	57	3	0	45	0	0	45	60	47	7	6	45
OB Riley NB - N of OB Rec 010	0.25	2007	900	76	45	50	48	1	1	45	0	0	45	50	38	8	4	45
Unused 011	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 012	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 013	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 014	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
US20 SB - N of OB Redmo																		

ABBREVIATION SECT = SECTION NUMBER
VOL = TOTAL VOLUME
MTR = MEDIUM TRUCK VOLUM
SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuyler
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FILE: NCORR_EX.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2007 Existing Conditions

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UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
015	0.25	2007	12000	1644	55	880	774	51	35	55	0	0	55	790	672	60	58	55
US20 SB - N of Mountainvi 016	0.12	2007	13400	1729	55	970	878	57	35	33	0	0	55	920	794	65	61	37
US20 SB - N of Cooley 017	0.57	2007	13400	1742	55	980	885	61	34	32	0	0	55	960	831	69	60	34
US20 SB - N of Robal 018	0.41	2007	14200	1576	55	910	831	51	28	52	0	0	55	890	799	34	57	52
US20 SB - N of Jamison 019	0.29	2007	14600	1577	45	960	873	59	28	10	0	0	45	920	812	60	48	10
US20 SB - One-way Conn 020	0.31	2007	13300	1543	45	940	854	56	30	45	0	0	45	910	799	63	48	45
3rd St (US20) SB - SB Con 021	0.21	2007	22500	2430	45	1650	1496	109	46	45	0	0	45	1140	947	127	66	45
3rd St (US20) SB - N of En 022	0.08	2007	22500	2430	45	1650	1495	109	46	10	0	0	45	1140	947	127	66	34
3rd St (US20) SB - S of En 023	0.25	2007	18900	1512	45	1350	1261	59	30	36	0	0	45	800	698	70	32	45
3rd St (US20) NB - S of En 024	0.25	2007	10800	605	45	840	801	29	10	45	0	0	45	480	432	38	10	45
3rd St (US20) NB - N of En 025	0.08	2007	7500	465	45	590	556	25	9	45	0	0	45	340	305	27	8	45
US20 NB - One-way Conn 026	0.58	2007	7500	465	45	590	556	25	9	45	0	0	45	340	305	27	8	45
US20 NB - One-way Conn 027	0.04	2007	14200	1505	45	1120	1020	63	37	45	0	0	45	720	613	68	39	45
US20 NB - S of Robal 028	0.29	2007	15300	1530	45	1190	1083	68	39	10	0	0	45	750	639	71	40	25
US20 NB - S of Cooley 029	0.41	2007	13300	1410	55	1040	946	59	35	55	0	0	55	840	541	60	39	55

ABBREVIATION SECT = SECTION NUMBER
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MTR = MEDIUM TRUCK VOLUM

SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuytema
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TRANSPORTATION PLANNING ANALYSIS UNIT
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PROJECT: US97 North Corridor
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
US20 NB - S of Mountainvi 030	0.57	2007	14600	1591	55	1150	1026	34	60	55	0	0	55	700	565	66	69	55
US20 NB - S of OB Redmc 031	0.12	2007	14300	1573	55	1130	1006	61	63	55	0	0	55	690	559	63	68	55
US20 NB - N of OB Redmc 032	0.25	2007	11600	1438	55	910	800	46	64	55	0	0	55	610	490	52	68	55
Unused 033	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 034	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
US97 SB - N of Nichols Mk 035	0.25	2007	20500	2809	55	1390	1229	63	78	55	0	0	55	1350	1135	111	104	55
US97 SB - S of Nichols Mk 036	3.43	2007	20800	2760	55	1380	1228	77	75	55	0	0	55	1380	1165	116	99	55
US97 SB - N of Cooley 037	0.39	2007	21600	2765	45	1450	1293	80	77	39	0	0	45	1410	1197	114	99	41
US97 SB - N of Target 038	0.33	2007	21800	2538	45	1430	1287	82	61	45	0	0	45	1410	1225	99	86	45
US97 SB - N of Robal 039	0.11	2007	24300	2597	45	1620	1474	84	62	38	0	0	45	1460	1263	109	88	45
US97 SB - N of Nels Ander 040	0.16	2007	25800	2814	45	1840	1686	88	66	10	0	0	45	1490	1292	110	88	27
US97 SB - N of 3rd Conn 041	0.18	2007	29000	2813	45	2030	1870	93	67	44	0	0	45	1510	1310	112	88	45
US97 SB - S of 3rd Conn 042	0.84	2007	19800	1940	45	1310	1219	41	50	45	0	0	45	1270	1153	47	70	45
US97 SB - N of Butler Off-r 043	0.21	2007	29600	2960	45	2100	1953	84	63	45	0	0	45	1920	1703	129	88	45

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SP = SPEED OF VEHICLE
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HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuyleria
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TRANSPORTATION PLANNING ANALYSIS UNIT
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PROJECT: US97 North Corridor
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
US97 SB - S of Butler Off-r 044	0.25	2007	25500	2754	45	1750	1626	66	58	45	0	0	45	1750	1556	110	84	45
US97 NB - S of 3rd On-ram 045	0.26	2007	19100	1967	45	1880	1722	49	109	45	0	0	45	1200	1014	76	110	45
US97 NB - S of Butler On-r 046	0.26	2007	26500	3021	45	2430	2199	109	122	45	0	0	45	1530	1279	136	124	45
US97 NB - S of Empire Off 047	0.26	2007	29900	3229	45	2740	2491	123	126	44	0	0	45	1690	1410	152	128	45
US97 NB - S of Empire On 048	0.53	2007	22500	2588	45	2290	2077	101	112	45	0	0	45	1310	1073	123	114	45
US97 NB - S of Sister's Lo 049	0.20	2007	28400	3380	45	2760	2495	144	121	44	0	0	45	1630	1332	168	130	45
US97 NB - S of Nels Ander 050	0.16	2007	31700	2322	45	2230	2032	107	91	15	0	0	45	1250	1024	127	99	45
US97 NB - S of Robal 051	0.11	2007	19600	2136	45	1980	1792	103	85	27	0	0	45	1190	979	112	99	45
US97 NB - S of Target 052	0.16	2007	20200	2101	45	1920	1738	94	88	12	0	0	45	1120	909	109	102	45
US97 NB - S of Cooley 053	0.33	2007	20400	2101	45	1940	1758	95	87	11	0	0	45	1140	934	103	103	45
US97 NB - S of Grandview 054	0.39	2007	20700	2215	45	1960	1776	94	90	45	0	0	45	1150	937	112	101	45
US97 NB - S of Desc Mkt 055	3.43	2007	19300	2142	55	1890	1704	95	91	55	0	0	55	1160	945	113	102	55
US97 NB - N of Desc Mkt 056	0.25	2007	21200	2247	55	2000	1824	92	84	55	0	0	55	1260	1045	113	102	55
Unused 057	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		

ABBREVIATION SECT = SECTION NUMBER
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MTR = MEDIUM TRUCK VOLUME
SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuytema
CHECKED BY:
FILE: NCORR_EX.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2007 Existing Conditions

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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
058	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 059	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hunnell - N of Rogers 060	0.25	2007	200	11	45	20	19	1	0	45	0	0	45	20	19	1	0	45
Hunnell - N of Loco 061	0.74	2007	0	0	45	0	0	0	0	45	0	0	45	0	0	0	0	45
Hunnell SB - N of Cooley 062	0.24	2007	800	46	45	60	56	3	1	45	0	0	45	20	15	3	2	45
Hunnell SB - S of Cooley 063	0.20	2007	1400	101	35	60	55	5	0	35	0	0	35	60	49	8	3	35
Hunnell SB - N of Robal 064	0.20	2007	3500	231	35	310	286	12	12	35	0	0	35	150	126	13	11	35
Hunnell NB - N of Robal 065	0.20	2007	2700	176	35	260	242	12	6	35	0	0	35	70	51	12	7	35
Hunnell NB - S of Cooley 066	0.20	2007	2800	133	35	230	218	9	3	35	0	0	35	70	55	9	6	35
Hunnell NB - S of Loco 067	0.24	2007	300	22	45	20	19	1	0	45	0	0	45	20	15	4	1	45
Unused 068	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 069	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tumalo EB - W of Nichols I 070	0.25	2007	2000	224	55	110	98	9	3	55	0	0	55	110	96	11	3	55
Tumalo EB - E of Nichols M 071	0.38	2007	1700	228	55	110	93	12	5	55	0	0	55	110	87	13	10	55
Tumalo Conn NB - S of Da 072	0.24	2007	1700	211	55	110	93	10	7	55	0	0	55	110	90	11	9	55

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HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuyler
CHECKED BY:
FILE: NCORR EX.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2007 Existing Conditions

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SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
Desc Mkt WB - E of Tumal 073	0.12	2007	3200	256	55	320	301	15	4	48	0	0	55	170	142	16	12	55
Desc Mkt EB - E of Tumalc 074	0.12	2007	1700	196	55	210	185	14	11	55	0	0	55	70	43	15	12	55
Tumalo Conn SB - N of Tu 075	0.24	2007	2400	216	55	250	216	21	13	55	0	0	55	130	95	21	14	55
Tumalo WB - E of Nichols I 076	0.38	2007	2400	214	55	250	230	17	3	55	0	0	55	130	101	21	8	55
Tumalo WB - W of Nichols 077	0.25	2007	2100	216	55	250	225	21	4	55	0	0	55	60	52	21	7	55
Nichols Mkt EB - W of US9 078	0.31	2007	1500	132	55	100	89	8	3	55	0	0	55	100	79	17	4	55
Nichols Mkt WB - W of US 079	0.31	2007	1300	170	55	100	81	13	6	10	0	0	55	60	34	16	8	11
Desc Mkt EB - E of Tumalc 080	0.25	2007	1500	211	55	140	125	7	8	55	0	0	55	110	87	15	8	55
Desc Mkt WB - E of Tumal 081	0.25	2007	3800	277	55	390	365	19	6	55	0	0	55	220	182	25	13	55
New Desc Mkt EB - Not ye 082	0.25	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New Desc Mkt WB - Not ye 083	0.25	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 084	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cooley EB - W of US20 085	0.32	2007	400	22	45	40	38	2	0	45	0	0	45	30	28	2	0	45
Cooley EB - W of Scenic 086	0.07	2007	2000	249	35	150	129	15	6	35	0	0	35	100	75	16	9	35

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ANALYST: Peter Schulzeski
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TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2007 Existing Conditions

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UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Cooley EB - W of Hunnell S																		
087	0.33	2007	2000	288	35	150	134	11	5	35	0	0	35	120	98	12	10	35
Cooley EB - W of Hunnell F																		
088	0.17	2007	4000	332	35	340	316	18	6	35	0	0	35	210	171	19	20	35
Cooley EB - W of US97																		
089	0.14	2007	4200	433	35	370	336	24	10	10	0	0	35	150	107	26	17	35
Cooley EB - W of Boyd Acr																		
090	0.34	2007	4800	360	40	410	377	25	8	40	0	0	40	190	147	30	13	40
Cooley EB - E of Boyd Acr																		
091	0.25	2007	3500	266	40	290	263	19	8	40	0	0	40	180	144	23	13	40
Cooley WB - E of Boyd Acr																		
092	0.25	2007	2900	217	40	220	201	16	3	40	0	0	40	210	178	22	10	40
Cooley WB - E of US97																		
093	0.34	2007	3400	316	40	290	268	19	3	38	0	0	40	240	209	20	11	40
Cooley WB - E of Hunnell F																		
094	0.14	2007	2900	394	35	230	189	19	22	35	0	0	35	170	126	19	25	35
Cooley WB - E of Hunnell S																		
095	0.17	2007	2700	375	35	200	169	10	21	35	0	0	35	180	136	13	31	35
Cooley WB - E of Scenic																		
096	0.33	2007	1800	268	35	180	150	7	23	35	0	0	35	110	78	8	24	35
Cooley WB - E of US20																		
097	0.07	2007	1800	257	35	180	146	10	24	35	0	0	35	80	46	10	24	35
Cooley WB - W of OB Riley																		
098	0.32	2007	400	28	45	30	29	1	0	45	0	0	45	20	19	1	0	45
Unused																		
099	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Robal EB - W of CV Mall																		
100	0.15	2007	4700	357	35	360	341	14	5	35	0	0	35	190	156	23	11	35
Robal EB - W of Hunnell																		

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ANALYST: Peter Schuytema
CHECKED BY:
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TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
101	0.08	2007	3700	252	35	280	270	8	2	35	0	0	35	110	99	8	3	35
Robal EB - W of Target 102	0.08	2007	3700	233	35	320	309	4	7	35	0	0	35	130	110	11	9	35
Robal EB - W of US97 103	0.08	2007	4400	268	35	380	361	11	8	23	0	0	35	130	109	12	9	35
Robal WB - E of Target 104	0.08	2007	4900	289	35	360	345	14	1	35	0	0	35	160	158	14	8	35
Robal WB - E of Hunnell 105	0.08	2007	2000	242	35	290	282	6	2	35	0	0	35	110	90	12	8	35
Robal WB - E of AutoMall 106	0.08	2007	2800	216	35	270	263	6	1	35	0	0	35	100	90	7	3	35
Robal WB - E of US20 107	0.15	2007	3000	237	35	250	238	11	1	35	0	0	35	100	81	18	1	35
Unused 108	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 109	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 110	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 111	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 112	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 113	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 114	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Empire EB - W of Britta 115	0.05	2007	2700	278	30	200	180	19	1	30	0	0	30	190	159	18	13	30

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ANALYST: Peter Schuyleman
CHECKED BY:
FILE: NOORR_EX.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2007 Existing Conditions

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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Empire EB - W of Jamison																		
116	0.16	2007	3200	291	30	260	242	17	1	30	0	0	30	210	179	18	13	30
Empire EB - W of 3rd																		
117	0.04	2007	4700	395	30	410	390	18	2	21	0	0	30	270	230	25	15	30
Empire EB - W of Sherman																		
118	0.09	2007	12300	1415	30	990	898	71	21	10	0	0	30	790	654	82	54	17
Empire EB - W of Empire C																		
119	0.07	2007	13700	1562	30	1090	993	81	16	10	0	0	30	840	705	95	40	13
Empire EB - Between ramp																		
120	0.08	2007	7900	1011	30	630	567	51	12	30	0	0	30	490	403	54	33	30
Empire EB - W of Corporal																		
121	0.14	2007	9600	950	30	590	547	33	10	30	0	0	30	500	420	43	37	30
Empire EB - W of Boyd Ac																		
122	0.09	2007	9600	941	30	640	589	41	10	30	0	0	30	530	454	45	31	30
Empire EB - E of Boyd Acr																		
123	0.25	2007	6900	538	30	370	338	23	9	30	0	0	30	340	299	23	18	30
Empire WB - E of Boyd Ac																		
124	0.25	2007	6300	680	30	410	392	14	4	30	0	0	30	350	305	30	15	30
Empire WB - E of Blenheim																		
125	0.09	2007	9900	1069	30	700	656	34	10	30	0	0	30	580	473	70	37	30
Empire WB - E of Empire C																		
126	0.14	2007	10400	1082	30	730	688	32	10	27	0	0	30	690	577	83	30	29
Empire WB - Between ram																		
127	0.08	2007	10300	1009	30	760	717	29	14	19	0	0	30	740	639	78	23	20
Empire WB - E of Industria																		
128	0.07	2007	6600	455	30	450	422	20	8	30	0	0	30	440	397	33	10	30
Empire WB - E of 3rd																		
129	0.09	2007	6000	384	30	410	389	16	5	30	0	0	30	410	373	27	10	30

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ANALYST: Peter Schuyleme
CHECKED BY:
FILE: NCORR_EX.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2007 Existing Conditions

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UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
Empire WB - E of Jamison																		
130	0.04	2007	5400	437	30	370	348	16	6	30	0	0	30	360	317	36	7	30
Empire WB - E of Britta																		
131	0.16	2007	3400	286	30	220	203	13	4	30	0	0	30	210	181	22	7	30
Empire WB - E of OB Riley																		
132	0.05	2007	3200	275	30	210	192	14	4	10	0	0	30	160	153	20	7	10
Unused																		
133	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
134	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OB Redmond NB - S of US																		
135	0.20	2007	400	55	45	40	36	3	1	45	0	0	45	40	34	3	3	45
OB Redmond NB - N of US																		
136	0.25	2007	2800	162	45	220	208	12	0	45	0	0	45	70	55	13	2	45
OB Redmond SB - N of US																		
137	0.25	2007	2100	116	45	120	114	5	1	45	0	0	45	120	112	6	2	45
OB Redmond SB - N of OE																		
138	0.20	2007	700	68	45	40	36	3	1	45	0	0	45	40	36	3	1	45
Rogers - W of Hunnell																		
139	0.25	2007	200	11	45	20	19	1	0	45	0	0	45	20	19	1	0	45
Unused																		
140	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
141	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
142	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
143	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		

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ANALYST: Peter Schuytema
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TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
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			AVERAGE DAY			PEAK HOUR					AVERAGE HOUR			PEAK TRUCK HOUR				
SECT	DIST	YEAR	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP
144	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 145	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 146	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 147	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 148	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 149	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3rd Conn SB 150	0.21	2007	9200	892	45	720	650	53	17	45	0	0	45	240	158	64	18	45
Sister's Loop NB 151	0.54	2007	6700	1045	30	520	452	38	30	30	0	0	30	380	308	41	31	30
Unused 152	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 153	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 154	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 155	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 156	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 157	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused 158	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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ANALYST: Peter Schuyleman
CHECKED BY:
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TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2007 Existing Conditions

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UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Unused																		
159	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Empire SB On-ramp																		
160	0.32	2007	9900	1039	45	790	733	44	13	45	0	0	45	670	567	82	21	45
Butler Mkt SB Off-ramp																		
161	0.25	2007	4200	227	45	350	328	18	4	45	0	0	45	170	147	18	5	45
3rd NB On-ramp																		
162	0.25	2007	7500	1065	45	540	468	60	12	45	0	0	45	330	255	61	14	45
Butler Mkt NB On-ramp																		
163	0.25	2007	3400	211	45	320	301	15	4	45	0	0	45	170	149	17	5	45
Empire NB Off-ramp																		
164	0.30	2007	7400	636	45	450	414	22	14	10	0	0	45	380	337	28	15	10
Empire NB On-ramp																		
165	0.23	2007	5800	771	45	470	418	42	10	45	0	0	45	330	268	46	18	45
Unused																		
166	0.00	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Britta SB - N of Empire																		
167	0.14	2007	600	28	25	80	79	1	0	25	0	0	25	30	26	2	2	25
Britta NB - N of Empire																		
168	0.14	2007	300	21	25	20	19	1	0	25	0	0	25	20	19	1	0	25
Boyd Acres SB - S of Empi																		
169	0.25	2007	4200	546	25	200	179	19	2	25	0	0	25	200	167	21	12	25
Boyd Acres NB - S of Empi																		
170	0.25	2007	4700	526	25	440	418	15	7	24	0	0	25	270	203	45	22	25

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ANALYST: Peter Schuyleme
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Figure Q-5 No-Build 2012/2032 EIS Data Sheets

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
OB Riley SB - N of OB Rec																		
001	0.25	2015	2500	240	45	240	218	12	10	45	0	0	45	240	206	19	15	45
001	0.25	2035	6700	643	45	600	544	30	26	45	0	0	45	600	514	48	38	45
OB Riley SB - N of Cooley																		
002	0.33	2015	3300	274	45	260	235	16	9	45	0	0	45	260	225	19	16	45
002	0.33	2032	9700	805	45	690	623	42	25	45	0	0	45	690	597	52	41	45
OB Riley SB - S of Cooley																		
003	0.65	2015	3600	295	45	320	283	18	19	45	0	0	45	320	283	18	19	45
003	0.65	2035	10600	869	45	960	848	54	58	18	0	0	45	960	848	54	58	18
OB Riley SB - N of Empire																		
004	0.71	2015	4300	314	45	370	354	16	0	45	0	0	45	370	349	21	0	45
004	0.71	2035	11000	803	45	1020	977	43	0	20	0	0	45	1010	953	57	0	21
OB Riley SB - S of Empire																		
005	0.25	2015	4600	391	45	350	323	19	8	45	0	0	45	340	302	28	10	45
005	0.25	2035	12600	1071	45	990	915	53	22	15	0	0	45	970	862	81	27	17
OB Riley NB - S of Empire																		
006	0.25	2015	3200	365	45	180	158	21	1	45	0	0	45	140	104	23	13	45
006	0.25	2035	8700	992	45	460	405	52	3	45	0	0	45	370	273	62	35	45
OB Riley NB - N of Empire																		
007	0.71	2015	3500	259	45	200	184	16	0	45	0	0	45	140	117	18	5	45
007	0.71	2035	8900	659	45	450	414	36	0	45	0	0	45	310	260	40	10	45
OB Riley NB - S of Cooley																		
008	0.65	2015	2400	166	45	140	137	3	0	45	0	0	45	130	111	9	10	45
008	0.65	2035	7000	483	45	420	410	10	0	45	0	0	45	390	333	26	31	45
OB Riley NB - S of OB Rec																		
009	0.33	2015	2000	164	45	140	133	7	0	45	0	0	45	140	111	16	13	45
009	0.33	2035	5700	467	45	460	438	22	0	45	0	0	45	450	356	52	42	45
OB Riley NB - N of OB Rec																		
010	0.25	2015	1600	134	45	110	105	2	3	45	0	0	45	110	85	17	8	45
010	0.25	2035	4100	344	45	290	276	6	8	45	0	0	45	290	223	45	22	45
Unused																		

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ANALYST: Peter Schuyleman
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TRANSPORTATION PLANNING ANALYSIS UNIT
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SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
011	0.00		0			0												
011	0.00																	
Unused																		
012	0.00		0			0												
012	0.00																	
Unused																		
013	0.00		0			0												
013	0.00																	
Unused																		
014	0.00		0			0												
014	0.00																	
US20 SB - N of OB Redmc																		
015	0.25	2015	13200	1808	55	940	846	55	39	55	0	0	55	870	740	66	64	55
015	0.25	2035	17900	2452	55	1300	1170	77	53	52	0	0	55	1200	1020	91	89	54
US20 SB - N of Mountainvi																		
016	0.12	2015	14900	1922	55	1100	995	65	40	20	0	0	55	1040	897	74	69	28
016	0.12	2035	20800	2683	55	1590	1439	94	57	10	0	0	55	1510	1303	107	100	10
US20 SB - N of Cooley																		
017	0.57	2015	15100	1963	55	1100	993	68	39	20	0	0	55	1080	935	78	67	23
017	0.57	2035	21500	2795	55	1600	1445	99	56	10	0	0	55	1570	1360	113	97	10
US20 SB - N of Robal																		
018	0.41	2015	15500	1721	55	990	904	55	31	41	0	0	55	970	871	37	62	42
018	0.41	2035	21000	2331	55	1300	1187	73	40	35	0	0	55	1280	1149	49	82	36
US20 SB - N of Jamison																		
019	0.29	2015	15900	1717	45	1070	974	65	31	10	0	0	45	1030	909	67	54	10
019	0.29	2035	21200	2290	45	1510	1374	92	44	10	0	0	45	1450	1281	94	75	10
US20 SB - One-way Conn																		
020	0.31	2015	14800	1717	45	1040	945	62	33	44	0	0	45	1000	878	69	53	44
020	0.31	2035	20800	2413	45	1470	1335	88	47	11	0	0	45	1420	1247	98	75	16
3rd St (US20) SB - SB Con																		
021	0.21	2015	24200	2614	45	1760	1595	116	49	45	0	0	45	1220	1014	135	71	45

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TRANSPORTATION PLANNING ANALYSIS UNIT
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			AVERAGE DAY			PEAK HOUR					AVERAGE HOUR			PEAK TRUCK HOUR				
SECT	DIST	YEAR	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP
021	0.21	2035	31000	3348	45	2150	1948	142	60	44	0	0	45	1490	1239	165	86	45
3rd St (US20) SB - N of En																		
022	0.08	2015	24200	2614	45	1750	1585	116	49	10	0	0	45	1210	1006	134	70	10
022	0.08	2035	31000	3348	45	2140	1939	141	60	10	0	0	45	1480	1230	164	86	10
3rd St (US20) SB - S of En																		
023	0.25	2015	19600	1568	45	1420	1327	62	31	32	0	0	45	840	733	73	34	45
023	0.25	2035	22000	1760	45	1780	1663	78	39	10	0	0	45	1060	926	92	42	45
3rd St (US20) NB - S of En																		
024	0.25	2015	11500	644	45	920	877	32	11	45	0	0	45	520	467	42	11	45
024	0.25	2035	14700	823	45	1220	1162	43	15	44	0	0	45	690	621	55	14	45
3rd St (US20) NB - N of En																		
025	0.08	2015	8500	527	45	660	622	28	10	45	0	0	45	380	341	30	9	45
025	0.08	2035	12200	756	45	960	906	40	14	45	0	0	45	550	494	43	13	45
US20 NB - One-way Conn																		
026	0.58	2015	8500	527	45	660	622	28	10	45	0	0	45	380	341	30	9	45
026	0.58	2035	12200	756	45	960	906	40	14	45	0	0	45	550	494	43	13	45
US20 NB - One-way Conn																		
027	0.04	2015	15800	1675	45	1240	1130	69	41	44	0	0	45	800	682	75	43	45
027	0.04	2035	22000	2332	45	1730	1576	97	57	13	0	0	45	1120	955	105	60	45
US20 NB - S of Robal																		
028	0.29	2015	17000	1700	45	1330	1210	76	44	40	0	0	45	840	716	79	45	45
028	0.29	2035	23900	2390	45	1860	1693	106	61	10	0	0	45	1180	1006	111	63	38
US20 NB - S of Cooley																		
029	0.41	2015	14600	1548	55	1160	1055	66	39	55	0	0	55	720	608	68	44	55
029	0.41	2035	20200	2141	55	1640	1491	93	56	53	0	0	55	1010	853	95	62	55
US20 NB - S of Mountainvi																		
030	0.57	2015	16100	1755	55	1300	1159	73	68	52	0	0	55	790	639	74	77	55
030	0.57	2035	21900	2387	55	1810	1615	101	94	38	0	0	55	1100	889	103	108	55
US20 NB - S of OB Redmc																		
031	0.12	2015	15800	1738	55	1280	1139	69	72	52	0	0	55	790	640	73	77	55
031	0.12	2035	21600	2376	55	1800	1602	97	101	38	0	0	55	1110	899	102	109	55

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ANALYST: Peter Schuytema
CHECKED BY: Dorothy J. Upton
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
US20 NB - N of OB Redmc																		
032	0.25	2015	12500	1550	55	1020	898	51	71	55	0	0	55	690	554	59	77	55
032	0.25	2035	16300	2021	55	1330	1170	67	93	51	0	0	55	900	723	77	100	55
Unused																		
033	0.00		0			0												
033	0.00																	
Unused																		
034	0.00		0			0												
034	0.00																	
US97 SB - N of Nichols Mk																		
035	0.25	2015	22000	3014	55	1480	1315	81	84	55	0	0	55	1480	1246	124	110	55
035	0.25	2035	28300	3877	55	1860	1652	102	106	55	0	0	55	1860	1566	156	138	55
US97 SB - S of Nichols Mk																		
036	3.43	2015	22300	2988	55	1470	1309	82	79	55	0	0	55	1470	1241	123	106	55
036	3.43	2035	29000	3886	55	1920	1708	108	104	55	0	0	55	1920	1621	161	138	55
US97 SB - N of Cooley																		
037	0.39	2015	23100	2957	45	1540	1373	85	82	40	0	0	45	1500	1273	122	105	42
037	0.39	2035	29200	3738	45	2020	1802	111	107	10	0	0	45	1970	1672	160	138	10
US97 SB - N of Target																		
038	0.33	2015	23300	2819	45	1560	1404	89	67	39	0	0	45	1540	1338	108	94	40
038	0.33	2035	29600	3582	45	2150	1935	123	92	10	0	0	45	2120	1843	148	129	10
US97 SB - N of Robal																		
039	0.11	2015	26000	2886	45	1680	1529	87	64	33	0	0	45	1510	1306	113	91	42
039	0.11	2035	33100	3674	45	2040	1856	106	78	14	0	0	45	1840	1592	138	110	24
US97 SB - N of Nels Ander																		
040	0.16	2015	28200	2961	45	1920	1759	92	69	10	0	0	45	1550	1344	115	91	24
040	0.16	2035	33800	3549	45	2380	2180	114	86	10	0	0	45	1920	1665	142	113	10
US97 SB - N of 3rd Conn																		
041	0.18	2015	30300	2939	45	2070	1907	95	68	42	0	0	45	1540	1337	114	89	45
041	0.18	2035	35600	3453	45	2320	2136	107	77	33	0	0	45	1720	1493	127	100	45

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SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
US97 SB - S of 3rd Conn																		
042	0.84	2015	20900	2048	45	1180	1098	37	45	45	0	0	45	1140	1035	42	63	45
042	0.84	2035	25400	2489	45	1250	1164	39	47	45	0	0	45	1210	1098	45	67	45
US97 SB - N of Butler Off-r																		
043	0.21	2015	32100	3210	45	2260	2102	90	68	45	0	0	45	2070	1836	139	95	45
043	0.21	2035	42300	4230	45	3000	2790	120	90	41	0	0	45	2750	2440	184	126	44
US97 SB - S of Butler Off-r																		
044	0.25	2015	28000	3024	45	1900	1765	72	63	45	0	0	45	1900	1689	120	91	45
044	0.25	2035	38200	4126	45	2660	2471	101	88	44	0	0	45	2660	2364	168	128	44
US97 NB - S of 3rd On-ran																		
045	0.26	2015	21800	2245	45	2120	1942	55	123	45	0	0	45	1350	1141	85	124	45
045	0.26	2035	32700	3368	45	3120	2858	81	181	36	0	0	45	1980	1673	125	182	45
US97 NB - S of Butler On-r																		
046	0.26	2015	29100	3317	45	2660	2407	120	133	44	0	0	45	1670	1386	149	135	45
046	0.26	2035	39400	4492	45	3600	3258	162	180	17	0	0	45	2260	1876	201	183	45
US97 NB - S of Empire Off																		
047	0.26	2015	32500	3510	45	2980	2709	134	137	41	0	0	45	1840	1534	166	140	45
047	0.26	2035	42700	4612	45	3920	3564	176	180	10	0	0	45	2410	2010	217	183	45
US97 NB - S of Empire On																		
048	0.53	2015	23900	2749	45	2440	2213	107	120	45	0	0	45	1390	1138	131	121	45
048	0.53	2035	29500	3393	45	3100	2812	136	152	37	0	0	45	1770	1450	166	154	45
US97 NB - S of Sister's Lo																		
049	0.20	2015	30700	3653	45	2980	2694	155	131	41	0	0	45	1760	1438	181	141	45
049	0.20	2035	39800	4736	45	3930	3553	204	173	10	0	0	45	2330	1904	240	186	45
US97 NB - S of Nels Ander																		
050	0.16	2015	23300	2493	45	2410	2195	116	99	10	0	0	45	1350	1105	138	107	45
050	0.16	2035	29900	3199	45	3160	2878	152	130	10	0	0	45	1770	1449	181	140	33
US97 NB - S of Robal																		
051	0.11	2015	21000	2289	45	2100	1901	109	90	20	0	0	45	1260	1037	118	105	45
051	0.11	2035	26600	2899	45	2640	2389	137	114	10	0	0	45	1580	1300	149	131	43
US97 NB - S of Target																		

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			AVERAGE DAY			PEAK HOUR					AVERAGE HOUR			PEAK TRUCK HOUR				
SECT	DIST	YEAR	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP
052	0.16	2015	21300	2215	45	2060	1864	101	95	10	0	0	45	1210	983	117	110	43
052	0.16	2035	25600	2662	45	2640	2390	129	121	10	0	0	45	1540	1251	149	140	14
US97 NB - S of Cooley																		
053	0.33	2015	21900	2256	45	2070	1876	101	93	10	0	0	45	1220	1000	110	110	42
053	0.33	2035	27800	2863	45	2350	2129	115	106	10	0	0	45	1380	1132	124	124	25
US97 NB - S of Grandview																		
054	0.39	2015	22200	2375	45	2080	1884	100	96	45	0	0	45	1220	995	118	107	45
054	0.39	2035	28000	2996	45	2580	2337	124	119	45	0	0	45	1520	1239	147	134	45
US97 NB - S of Desc Mkt																		
055	3.43	2015	21300	2364	55	2040	1840	102	98	55	0	0	55	1250	1019	121	110	55
055	3.43	2035	27600	3064	55	2660	2399	133	128	50	0	0	55	1630	1329	158	143	55
US97 NB - N of Desc Mkt																		
056	0.25	2015	22600	2441	55	1980	1796	95	89	55	0	0	55	1260	1037	116	107	55
056	0.25	2035	28200	3046	55	2580	2340	124	116	51	0	0	55	1640	1350	151	139	55
Unused																		
057	0.00		0			0												
057	0.00																	
Unused																		
058	0.00		0			0												
058	0.00																	
Unused																		
059	0.00		0			0												
059	0.00																	
Hunnell - N of Rogers																		
060	0.25	2015	200	11	45	20	19	1	0	45	0	0	45	20	19	1	0	45
060	0.25	2035	300	17	45	20	19	1	0	45	0	0	45	20	19	1	0	45
Hunnell - N of Loco																		
061	0.74	2015	100	6	45	10	10	0	0	45	0	0	45	10	9	1	0	45
061	0.74	2035	200	11	45	20	19	1	0	45	0	0	45	20	19	1	0	45
Hunnell SB - N of Cooley																		
062	0.24	2015	1500	86	45	260	245	11	4	45	0	0	45	90	70	12	8	45

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			AVERAGE DAY			PEAK HOUR					AVERAGE HOUR			PEAK TRUCK HOUR				
SECT	DIST	YEAR	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP
062	0.24	2035	4500	257	45	1020	963	43	14	16	0	0	45	360	282	47	31	45
Hunnell SB - S of Cooley																		
063	0.20	2015	2200	158	35	140	129	11	0	35	0	0	35	140	115	18	7	35
063	0.20	2035	5200	374	35	440	405	35	0	35	0	0	35	440	363	56	21	35
Hunnell SB - N of Robal																		
064	0.20	2015	4300	284	35	410	380	16	14	35	0	0	35	200	169	17	14	35
064	0.20	2035	7200	475	35	780	723	30	27	10	0	0	35	390	329	34	27	35
Hunnell NB - N of Robal																		
065	0.20	2015	3300	215	35	300	279	14	7	35	0	0	35	90	64	16	10	35
065	0.20	2035	6000	390	35	430	400	20	10	35	0	0	35	120	86	21	13	35
Hunnell NB - S of Cooley																		
066	0.20	2015	3900	199	35	270	255	11	4	35	0	0	35	90	71	12	7	35
066	0.20	2035	9300	474	35	420	398	16	6	35	0	0	35	140	110	19	11	35
Hunnell NB - S of Loco																		
067	0.24	2015	1200	86	45	300	279	21	0	45	0	0	45	300	226	60	14	45
067	0.24	2035	4600	331	45	300	279	21	0	45	0	0	45	300	226	60	14	45
Unused																		
068	0.00		0			0												
068	0.00																	
Unused																		
069	0.00		0			0												
069	0.00																	
Tumalo EB - W of Nichols I																		
070	0.25	2015	2200	246	55	120	107	10	3	55	0	0	55	70	54	12	4	55
070	0.25	2035	3500	392	55	320	284	27	9	55	0	0	55	180	139	31	10	55
Tumalo EB - E of Nichols N																		
071	0.38	2015	1300	174	55	100	75	16	9	55	0	0	55	100	74	17	9	55
071	0.38	2035	1800	241	55	100	75	16	9	55	0	0	55	100	74	17	9	55
Tumalo Conn NB - S of De																		
072	0.24	2015	3100	273	55	340	312	17	11	55	0	0	55	220	179	23	18	55
072	0.24	2035	3700	326	55	390	358	19	13	55	0	0	55	260	212	27	21	55

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CHECKED BY: Stanley J Upton
FILE: NCORR_NB.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Future No-build

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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Desc Mkt WB - E of Tumal																		
073	0.12	2015	1500	120	55	170	160	8	2	55	0	0	55	90	68	12	10	55
073	0.12	2035	2700	216	55	190	179	9	2	55	0	0	55	100	76	13	11	55
Desc Mkt EB - E of Tumalc																		
074	0.12	2015	1200	138	55	220	194	15	11	55	0	0	55	80	50	17	13	55
074	0.12	2035	2100	242	55	280	246	19	15	55	0	0	55	100	62	21	17	55
Tumalo Conn SB - N of Tu																		
075	0.24	2015	2900	261	55	240	212	16	12	55	0	0	55	90	57	18	15	55
075	0.24	2035	3100	279	55	290	257	19	14	55	0	0	55	100	64	20	16	55
Tumalo WB - E of Nichols I																		
076	0.38	2015	1700	151	55	260	239	18	3	55	0	0	55	80	55	18	7	55
076	0.38	2035	2800	249	55	320	294	22	4	55	0	0	55	100	68	23	9	55
Tumalo WB - W of Nichols																		
077	0.25	2015	2100	197	55	270	243	23	4	55	0	0	55	90	58	24	8	55
077	0.25	2035	4300	404	55	320	288	27	5	55	0	0	55	100	64	27	9	55
Nichols Mkt EB - W of US9																		
078	0.31	2015	1700	150	55	100	89	8	3	48	0	0	55	100	79	17	4	48
078	0.31	2035	1900	167	55	120	107	9	4	34	0	0	55	120	95	20	5	34
Nichols Mkt WB - W of US																		
079	0.31	2015	1100	144	55	120	113	3	4	55	0	0	55	30	17	9	4	55
079	0.31	2035	1300	170	55	140	131	4	5	55	0	0	55	40	23	12	5	55
Desc Mkt EB - E of Tumalc																		
080	0.25	2015	1100	140	55	180	169	9	2	55	0	0	55	140	119	12	9	55
080	0.25	2035	1300	165	55	200	188	10	2	55	0	0	55	150	128	12	10	55
Desc Mkt WB - E of Tumal																		
081	0.25	2015	1100	80	55	20	19	1	0	55	0	0	55	10	8	1	1	55
081	0.25	2035	1300	95	55	20	19	1	0	55	0	0	55	10	8	1	1	55
New Desc Mkt EB Ext																		
082	0.25	2015	1700	216	55	160	138	14	8	55	0	0	55	120	95	16	9	55
082	0.25	2035	2600	330	55	180	156	15	9	55	0	0	55	130	102	18	10	55

ABBREVIATION SECT = SECTION NUMBER
VOL = TOTAL VOLUME
MTR = MEDIUM TRUCK VOLUI
SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schulema
CHECKED BY: Dorothy Upton
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TRANSPORTATION PLANNING ANALYSIS UNIT
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PROJECT: US97 North Corridor
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SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
New Desc Mkt WB Ext																		
083	0.25	2015	2500	290	55	420	400	17	3	55	0	0	55	240	206	23	11	55
083	0.25	2035	3800	441	55	480	458	19	3	55	0	0	55	270	231	26	13	55
Unused																		
084	0.00		0			0												
084	0.00																	
Cooley EB - W of US20																		
085	0.32	2015	1100	62	45	80	76	4	0	45	0	0	45	60	56	4	0	45
085	0.32	2035	4000	224	45	200	191	9	0	45	0	0	45	150	140	10	0	45
Cooley EB - W of Scenic																		
086	0.07	2015	2900	360	35	240	207	24	9	35	0	0	35	160	120	26	14	35
086	0.07	2035	6500	806	35	560	483	55	22	35	0	0	35	370	278	59	33	35
Cooley EB - W of Hunnell S																		
087	0.33	2015	2900	418	35	240	215	17	8	35	0	0	35	200	165	19	16	35
087	0.33	2035	6800	979	35	560	502	40	18	35	0	0	35	460	379	44	37	35
Cooley EB - W of Hunnell N																		
088	0.17	2015	5900	490	35	420	391	22	7	35	0	0	35	260	211	24	25	35
088	0.17	2035	13500	1121	35	700	651	37	12	35	0	0	35	430	350	39	41	35
Cooley EB - W of US97																		
089	0.14	2015	6200	639	35	520	472	34	14	35	0	0	35	210	150	36	24	35
089	0.14	2035	14100	1452	35	900	817	59	24	10	0	0	35	360	258	61	41	35
Cooley EB - W of Boyd Acr																		
090	0.34	2015	6500	487	40	560	514	35	11	40	0	0	40	250	192	40	18	40
090	0.34	2035	13500	1012	40	1140	1047	71	22	10	0	0	40	520	401	83	36	40
Cooley EB - E of Boyd Acr																		
091	0.25	2015	5300	403	40	420	380	28	12	40	0	0	40	270	216	35	19	40
091	0.25	2035	12600	958	40	840	761	55	24	15	0	0	40	530	425	68	37	40
Cooley WB - E of Boyd Acr																		
092	0.25	2015	4400	330	40	360	329	26	5	40	0	0	40	340	288	36	16	40
092	0.25	2035	10400	780	40	980	895	70	15	10	0	0	40	930	786	99	45	10
Cooley WB - E of US97																		

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ANALYST: Peter Schuttema
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PROJECT: US97 North Corridor
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			AVERAGE DAY			PEAK HOUR					AVERAGE HOUR			PEAK TRUCK HOUR				
SECT	DIST	YEAR	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP
093	0.34	2015	4700	437	40	400	369	26	5	22	0	0	40	330	287	28	15	36
093	0.34	2035	9600	893	40	830	766	54	10	10	0	0	40	680	592	57	31	10
Cooley WB - E of Hunnell I																		
094	0.14	2015	4300	585	35	330	272	27	31	35	0	0	35	250	185	29	36	35
094	0.14	2035	9700	1319	35	1080	889	89	102	18	0	0	35	800	592	91	117	35
Cooley WB - E of Hunnell S																		
095	0.17	2015	4000	556	35	380	321	19	40	35	0	0	35	340	257	25	58	35
095	0.17	2035	9100	1265	35	1060	898	52	110	10	0	0	35	950	718	70	162	10
Cooley WB - E of Scenic																		
096	0.33	2015	2800	417	35	280	233	11	36	35	0	0	35	170	121	12	37	35
096	0.33	2035	6500	968	35	620	517	24	79	35	0	0	35	370	263	26	81	35
Cooley WB - E of US20																		
097	0.07	2015	2700	386	35	300	244	16	40	35	0	0	35	140	80	18	42	35
097	0.07	2035	6300	901	35	630	512	34	84	35	0	0	35	300	172	38	90	35
Cooley WB - W of OB Riley																		
098	0.32	2015	1000	70	45	100	96	4	0	45	0	0	45	80	74	4	2	45
098	0.32	2035	3500	245	45	400	385	15	0	45	0	0	45	320	297	17	6	45
Unused																		
099	0.00		0			0												
099	0.00																	
Robal EB - W of CV Mall																		
100	0.15	2015	5900	448	35	420	398	16	6	35	0	0	35	230	190	27	13	35
100	0.15	2035	10600	806	35	690	653	27	10	27	0	0	35	370	305	44	21	35
Robal EB - W of Hunnell																		
101	0.08	2015	4500	306	35	330	318	10	2	35	0	0	35	130	116	10	4	35
101	0.08	2035	8000	544	35	570	549	17	4	34	0	0	35	230	206	18	6	35
Robal EB - W of Target																		
102	0.08	2015	4100	258	35	360	348	4	8	35	0	0	35	150	128	12	10	35
102	0.08	2035	5900	372	35	510	493	6	11	35	0	0	35	210	179	17	14	35
Robal EB - W of US97																		
103	0.08	2015	4800	293	35	400	381	11	8	20	0	0	35	130	109	12	9	35

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ANALYST: Peter Schuytema
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
103	0.08	2035	6300	384	35	520	494	15	11	10	0	0	35	170	142	16	12	35
Robal WB - E of Target																		
104	0.08	2015	5200	307	35	400	384	15	1	35	0	0	35	200	176	15	9	35
104	0.08	2035	6400	378	35	490	470	19	1	35	0	0	35	250	220	19	11	35
Robal WB - E of Hunnell																		
105	0.08	2015	2100	254	35	320	311	7	2	35	0	0	35	120	96	13	9	35
105	0.08	2035	2800	339	35	400	389	8	3	35	0	0	35	150	122	17	11	35
Robal WB - E of AutoMall																		
106	0.08	2015	3600	277	35	360	351	8	1	35	0	0	35	130	117	9	4	35
106	0.08	2035	6800	524	35	720	701	16	3	25	0	0	35	270	243	19	8	35
Robal WB - E of US20																		
107	0.15	2015	3700	292	35	340	325	14	1	35	0	0	35	140	113	26	1	35
107	0.15	2035	6600	521	35	690	658	29	3	10	0	0	35	290	234	53	3	35
Unused																		
108	0.00		0			0												
108	0.00																	
Unused																		
109	0.00		0			0												
109	0.00																	
Unused																		
110	0.00		0			0												
110	0.00																	
Unused																		
111	0.00		0			0												
111	0.00																	
Unused																		
112	0.00		0			0												
112	0.00																	
Unused																		
113	0.00		0			0												
113	0.00																	

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TRANSPORTATION PLANNING ANALYSIS UNIT
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Unused																		
114	0.00		0			0												
114	0.00																	
Empire EB - W of Britta																		
115	0.05	2015	3400	350	30	260	235	24	1	30	0	0	30	250	209	24	17	30
115	0.05	2035	6400	659	30	520	469	49	2	30	0	0	30	500	419	48	33	30
Empire EB - W of Jamison																		
116	0.16	2015	4100	373	30	360	336	23	1	30	0	0	30	300	256	26	18	30
116	0.16	2035	7800	710	30	720	671	46	3	22	0	0	30	590	504	51	35	30
Empire EB - W of 3rd																		
117	0.04	2015	5800	487	30	520	494	23	3	10	0	0	30	340	289	32	19	28
117	0.04	2035	10000	840	30	970	922	43	5	10	0	0	30	640	544	60	36	10
Empire EB - W of Shermar																		
118	0.09	2015	14200	1633	30	1120	1015	81	24	10	0	0	30	890	736	93	61	10
118	0.09	2035	21600	2484	30	1660	1505	120	35	10	0	0	30	1320	1093	137	90	10
Empire EB - W of Empire (																		
119	0.07	2015	15900	1813	30	1250	1139	92	19	10	0	0	30	970	813	110	47	10
119	0.07	2035	24600	2804	30	1880	1713	139	28	10	0	0	30	1460	1225	165	70	10
Empire EB - Between ramp																		
120	0.08	2015	9500	1216	30	740	666	60	14	30	0	0	30	580	477	64	39	30
120	0.08	2035	15700	2010	30	1180	1062	96	22	10	0	0	30	920	757	101	62	23
Empire EB - W of Corporat																		
121	0.14	2015	11700	1158	30	720	668	40	12	30	0	0	30	610	513	52	45	30
121	0.14	2035	20300	2010	30	1200	1113	67	20	30	0	0	30	1020	857	88	75	30
Empire EB - W of Boyd Ac																		
122	0.09	2015	11800	1156	30	720	662	46	12	30	0	0	30	600	514	51	35	30
122	0.09	2035	20600	2019	30	1200	1104	77	19	29	0	0	30	1000	857	85	58	30
Empire EB - E of Boyd Acr																		
123	0.25	2015	9200	718	30	790	722	49	19	25	0	0	30	730	642	49	39	28
123	0.25	2035	18700	1459	30	980	895	61	24	13	0	0	30	910	800	61	49	17

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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Empire WB - E of Boyd Acı																		
124	0.25	2015	8700	940	30	580	554	20	6	30	0	0	30	500	436	43	21	30
124	0.25	2035	18400	1987	30	1240	1186	42	12	15	0	0	30	1060	922	92	46	23
Empire WB - E of Bienheim																		
125	0.09	2015	11900	1285	30	880	825	43	12	30	0	0	30	730	596	88	46	30
125	0.09	2035	19900	2149	30	1580	1481	77	22	25	0	0	30	1310	1070	157	83	30
Empire WB - E of Empire (																		
126	0.14	2015	12700	1321	30	910	857	40	13	19	0	0	30	860	719	104	37	22
126	0.14	2035	22100	2298	30	1620	1526	71	23	10	0	0	30	1520	1271	184	65	10
Empire WB - Between ram																		
127	0.08	2015	12300	1205	30	920	868	35	17	10	0	0	30	900	777	95	28	10
127	0.08	2035	20200	1980	30	1580	1492	60	28	10	0	0	30	1540	1329	163	48	10
Empire WB - E of Industria																		
128	0.07	2015	7700	531	30	540	506	24	10	30	0	0	30	530	479	39	12	30
128	0.07	2035	12000	828	30	910	854	40	16	10	0	0	30	900	813	67	20	10
Empire WB - E of 3rd																		
129	0.09	2015	6900	442	30	480	455	19	6	30	0	0	30	480	437	31	12	30
129	0.09	2035	10500	672	30	770	731	30	9	15	0	0	30	770	701	50	19	15
Empire WB - E of Jamison																		
130	0.04	2015	6400	518	30	440	414	19	7	30	0	0	30	430	379	43	8	30
130	0.04	2035	10500	851	30	700	659	30	11	23	0	0	30	690	607	70	13	24
Empire WB - E of Britta																		
131	0.16	2015	4500	378	30	280	258	17	5	30	0	0	30	260	224	27	9	30
131	0.16	2035	6700	731	30	510	470	31	9	30	0	0	30	480	414	50	16	30
Empire WB - E of OB Riley																		
132	0.05	2015	4200	361	30	260	237	18	5	30	0	0	30	220	187	24	9	30
132	0.05	2035	8000	688	30	480	438	33	9	30	0	0	30	410	348	46	16	30
Unused																		
133	0.00		0			0												
133	0.00																	
Unused																		

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SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
134	0.00		0			0												
134	0.00																	
OB Redmond NB - S of US																		
135	0.20	2015	1100	152	45	90	80	7	3	45	0	0	45	90	75	7	8	45
135	0.20	2035	3700	511	45	300	268	24	8	45	0	0	45	300	252	23	25	45
OB Redmond NB - N of US																		
136	0.25	2015	3300	191	45	260	246	14	0	45	0	0	45	80	64	14	2	45
136	0.25	2035	5200	302	45	400	378	22	0	45	0	0	45	130	102	24	4	45
OB Redmond SB - N of US																		
137	0.25	2015	2500	140	45	150	142	7	1	45	0	0	45	150	140	8	2	45
137	0.25	2035	4200	235	45	260	247	11	2	45	0	0	45	260	242	14	4	45
OB Redmond SB - N of OE																		
138	0.20	2015	1600	155	45	100	89	8	3	45	0	0	45	100	88	8	4	45
138	0.20	2035	5100	495	45	320	287	25	8	45	0	0	45	310	275	24	11	45
Rogers - W of Hunnell																		
139	0.25	2015	200	11	45	20	19	1	0	45	0	0	45	20	19	1	0	45
139	0.25	2035	300	17	45	20	19	1	0	45	0	0	45	20	19	1	0	45
Unused																		
140	0.00		0			0												
140	0.00																	
Unused																		
141	0.00		0			0												
141	0.00																	
Unused																		
142	0.00		0			0												
142	0.00																	
Unused																		
143	0.00		0			0												
143	0.00																	
Unused																		
144	0.00		0			0												

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ANALYST: Peter Sanoutema
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TRANSPORTATION PLANNING ANALYSIS UNIT
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
144	0.00																	
Unused																		
145	0.00		0			0												
145	0.00																	
Unused																		
146	0.00		0			0												
146	0.00																	
Unused																		
147	0.00		0			0												
147	0.00																	
Unused																		
148	0.00		0			0												
148	0.00																	
Unused																		
149	0.00		0			0												
149	0.00																	
3rd Conn SB																		
150	0.21	2015	9400	912	45	730	658	54	18	45	0	0	45	250	165	67	18	45
150	0.21	2035	10100	980	45	790	713	58	19	45	0	0	45	270	178	72	20	45
Sister's Loop NB																		
151	0.54	2015	7300	1139	30	580	505	42	33	30	0	0	30	420	341	45	34	30
151	0.54	2035	9800	1529	30	760	662	55	43	30	0	0	30	550	446	59	45	30
Unused																		
152	0.00		0			0												
152	0.00																	
Unused																		
153	0.00		0			0												
153	0.00																	
Unused																		
154	0.00		0			0												
154	0.00																	

ABBREVIATION SECT = SECTION NUMBER
VOL = TOTAL VOLUME
MTR = MEDIUM TRUCK VOLUI
SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuytema
CHECKED BY: Timothy J. Upton
FILE: NCORR_NB.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Future No-build

PAGE: 16
PRINTING DATE: Jun 30, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Unused																		
155	0.00		0			0												
155	0.00																	
Unused																		
156	0.00		0			0												
156	0.00																	
Unused																		
157	0.00		0			0												
157	0.00																	
Unused																		
158	0.00		0			0												
158	0.00																	
Unused																		
159	0.00		0			0												
159	0.00																	
Empire SB On-ramp																		
160	0.32	2015	11300	1186	45	900	836	50	14	45	0	0	45	760	643	93	24	45
160	0.32	2035	16800	1764	45	1350	1252	76	22	23	0	0	45	1140	965	140	35	44
Butler Mkt SB Off-ramp																		
161	0.25	2015	4100	221	45	350	328	18	4	45	0	0	45	170	147	18	5	45
161	0.25	2035	4000	216	45	340	319	17	4	45	0	0	45	170	147	18	5	45
3rd NB On-ramp																		
162	0.25	2015	7300	1037	45	540	468	60	12	45	0	0	45	330	255	61	14	45
162	0.25	2035	6600	937	45	480	416	53	11	45	0	0	45	290	224	54	12	45
Butler Mkt NB On-ramp																		
163	0.25	2015	3400	211	45	320	301	15	4	45	0	0	45	170	148	17	5	45
163	0.25	2035	3300	205	45	310	291	15	4	45	0	0	45	160	139	16	5	45
Empire NB Off-ramp																		
164	0.30	2015	8600	740	45	530	489	25	16	10	0	0	45	450	399	33	18	10
164	0.30	2035	13200	1135	45	810	746	39	25	10	0	0	45	690	612	51	27	10

ABBREVIATION SECT = SECTION NUMBER
VOL = TOTAL VOLUME
MTR = MEDIUM TRUCK VOLUM
SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuyleman
CHECKED BY:
FILE: NCORR_NB.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Future No-build

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PRINTING DATE: Jun 30, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Empire NB On-ramp																		
165	0.23	2015	6700	891	45	540	479	49	12	45	0	0	45	380	309	52	19	45
165	0.23	2035	10300	1370	45	820	728	74	18	45	0	0	45	570	463	79	28	45
Unused																		
166	0.00		0			0												
166	0.00																	
Britta SB - N of Empire																		
167	0.14	2015	800	37	25	100	99	1	0	25	0	0	25	30	26	2	2	25
167	0.14	2035	1500	69	25	220	217	3	0	20	0	0	25	70	62	4	4	25
Britta NB - N of Empire																		
168	0.14	2015	400	28	25	30	29	1	0	25	0	0	25	30	29	1	0	25
168	0.14	2035	800	56	25	50	49	1	0	25	0	0	25	50	49	1	0	25
Boyd Acres SB - S of Empi																		
169	0.25	2015	4900	637	25	240	215	23	2	25	0	0	25	240	201	25	14	25
169	0.25	2035	7700	1001	25	400	358	38	4	25	0	0	25	400	335	41	24	25
Boyd Acres NB - S of Empi																		
170	0.25	2015	5600	627	25	520	495	17	8	25	0	0	25	320	240	53	27	25
170	0.25	2035	9200	1030	25	800	761	26	13	10	0	0	25	490	368	81	41	25

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AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schayterma
CHECKED BY:
FILE: NCORR_NB.MDB

APPENDIX R: ALTERNATIVE EAST DS-1 EIS DATA

Figure R-1 2015 & 2035 East DS-1 EIS Links

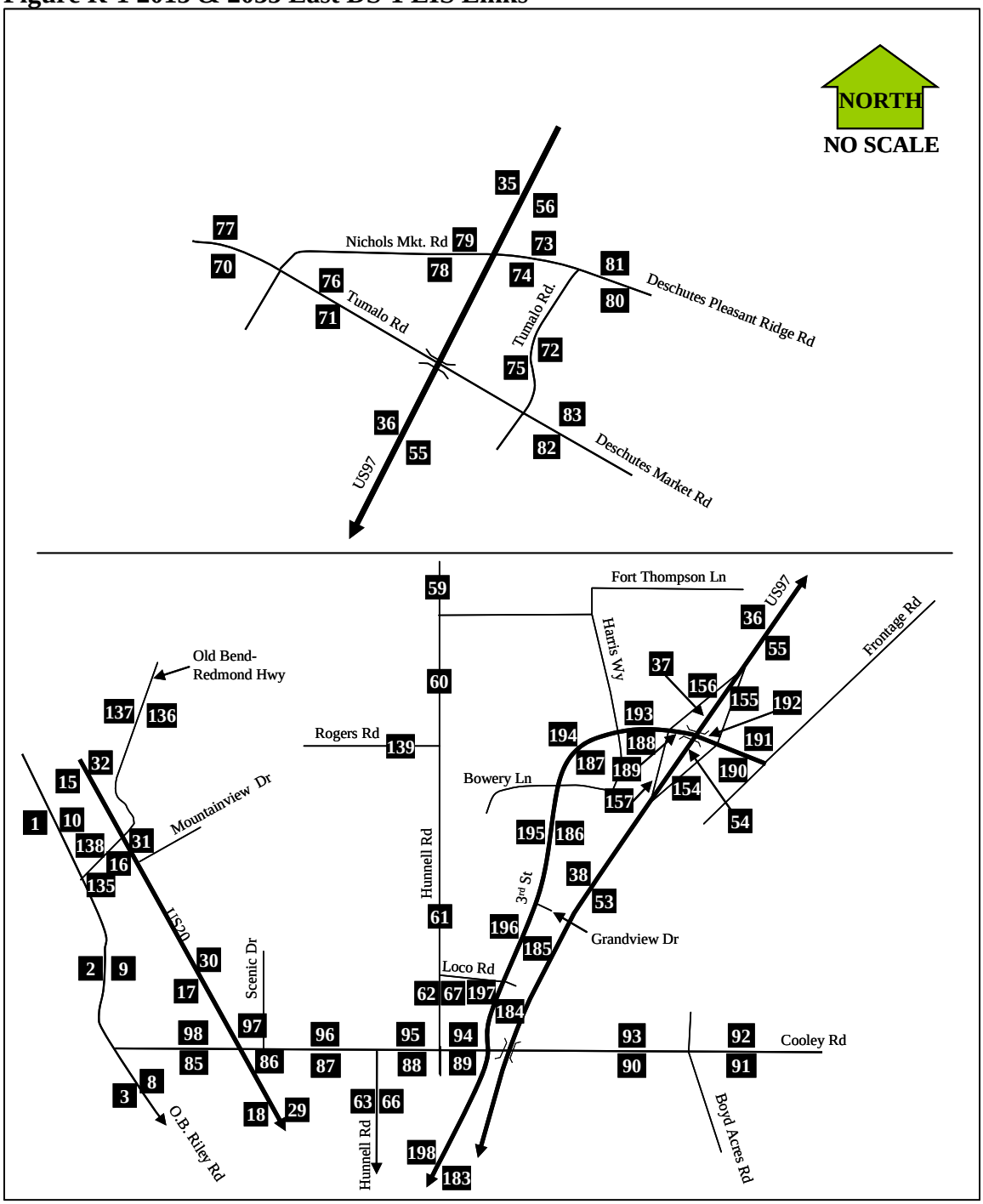

Figure R-2 2015 & 2035 East DS-1 EIS Links

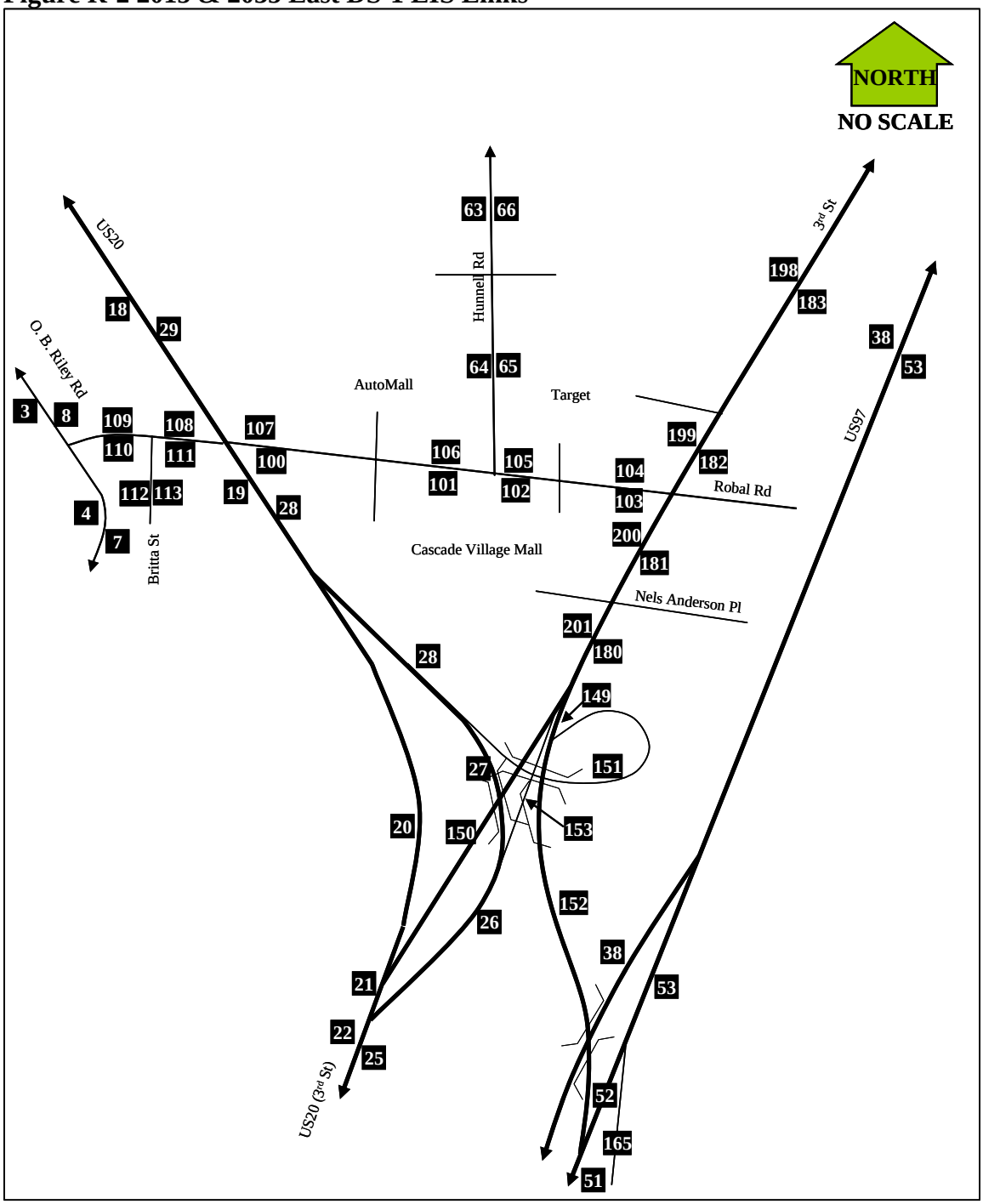

Figure R-3 2015 & 2035 East DS-1 EIS Links

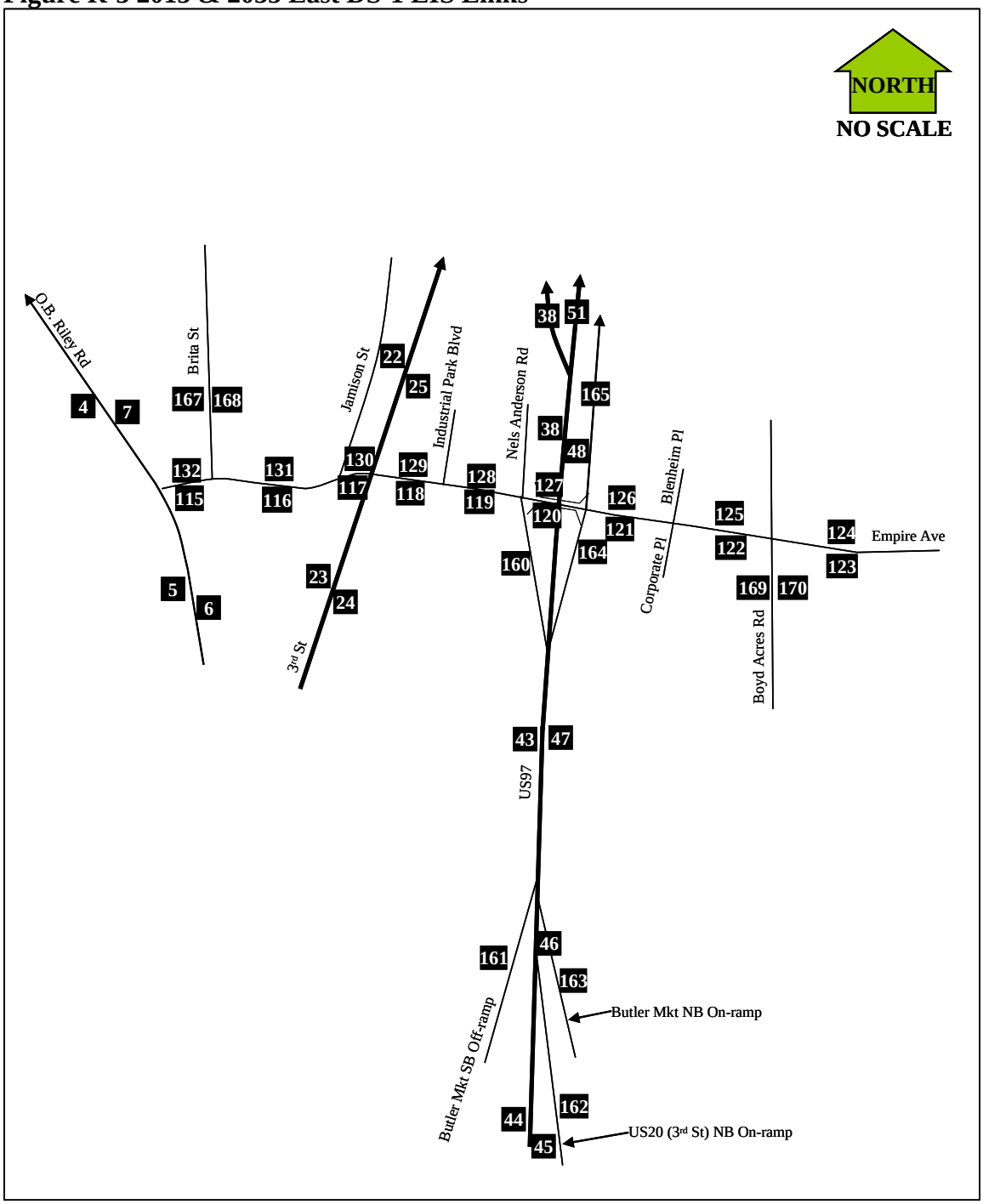

Figure R-4 Alternative East DS-1 EIS Data Sheets

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-1

PAGE: 1
PRINTING DATE: Jul 8, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
OB Riley SB - N of OB Rec																		
001	0.25	2015	2200	211	45	180	160	13	7	45	0	0	45	140	118	13	9	45
001	0.25	2035	5800	557	45	410	363	30	17	45	0	0	45	320	270	30	20	45
OB Riley SB - N of Cooley																		
002	0.33	2015	1800	119	45	230	211	14	5	45	0	0	45	200	174	18	8	45
002	0.33	2035	6300	416	45	600	550	37	13	45	0	0	45	520	453	46	21	45
OB Riley SB - S of Cooley																		
003	0.42	2015	2100	132	45	220	203	13	4	45	0	0	45	210	189	17	4	45
003	0.42	2035	5900	372	45	560	515	34	11	45	0	0	45	530	476	43	11	45
OB Riley SB - S of Robal																		
004	0.94	2015	4600	336	45	490	468	19	3	45	0	0	45	490	460	27	3	45
004	0.94	2035	11800	861	45	980	916	37	7	23	0	0	45	950	891	52	7	24
OB Riley SB - S of Empire																		
005	0.25	2015	5800	493	45	600	559	35	6	45	0	0	45	560	499	45	16	45
005	0.25	2035	16300	1386	45	1270	1182	75	13	10	0	0	45	1180	1051	96	33	10
OB Riley NB - S of Empire																		
006	0.25	2015	4900	549	45	220	196	23	1	45	0	0	45	180	137	30	13	45
006	0.25	2035	13100	1467	45	670	774	91	5	43	0	0	45	700	583	117	50	45
OB Riley NB - S of Robal																		
007	0.94	2015	3900	289	45	130	119	11	0	45	0	0	45	90	75	12	3	45
007	0.94	2035	10000	740	45	580	529	50	1	45	0	0	45	400	335	52	13	45
OB Riley NB - S of Cooley																		
008	0.42	2015	1500	104	45	80	66	12	2	45	0	0	45	70	54	11	5	45
008	0.42	2035	4400	304	45	300	248	46	6	45	0	0	45	280	212	46	22	45
OB Riley NB - S of OB Rec																		
009	0.33	2015	1200	98	45	80	74	4	2	45	0	0	45	80	60	12	8	45
009	0.33	2035	4700	385	45	320	296	15	9	45	0	0	45	310	233	46	29	45
OB Riley NB - N of OB Rec																		
010	0.25	2015	2500	210	45	160	140	15	5	45	0	0	45	160	132	16	10	45
010	0.25	2035	6300	529	45	520	458	47	15	45	0	0	45	520	426	60	34	45
Unused																		

ABBREVIATION SECT = SECTION NUMBER
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ANALYST: Peter Schuyler
CHECKED BY:
FILE: ALT_EDS1.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-1

PAGE: 2
PRINTING DATE: Jul 8, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
011	0.00		0			0												
011	0.00																	
Unused																		
012	0.00		0			0												
012	0.00																	
Unused																		
013	0.00		0			0												
013	0.00																	
Unused																		
014	0.00		0			0												
014	0.00																	
US20 SB - N of OR Redmc																		
015	0.25	2015	12200	1647	55	860	755	57	46	55	0	0	55	790	675	60	55	55
015	0.25	2035	15200	2187	55	1170	1027	77	66	55	0	0	55	1080	923	82	75	55
US20 SB - N of Mountainw																		
016	0.12	2015	14700	1926	55	980	877	56	47	55	0	0	55	920	790	65	65	55
016	0.12	2035	20600	2699	55	1270	1137	72	61	52	0	0	55	1190	1022	84	84	54
US20 SB - N of Cooley																		
017	0.57	2015	14100	1833	55	980	876	59	45	53	0	0	55	940	808	68	64	54
017	0.57	2035	20800	2704	55	1270	1138	76	56	52	0	0	55	1210	1041	87	82	53
US20 SB - N of Robal																		
018	0.41	2015	13600	1628	55	900	822	42	36	53	0	0	55	860	767	42	51	55
018	0.41	2035	21200	2502	55	1120	1022	53	45	43	0	0	55	1070	955	52	63	45
US20 SB - S of Robal																		
019	0.24	2015	13700	1617	45	1020	925	64	31	45	0	0	45	900	794	65	41	45
019	0.24	2035	19000	2242	45	1360	1233	86	41	45	0	0	45	1200	1059	86	55	45
US20 SB - One-way Conn																		
020	0.33	2015	13700	1617	45	1020	925	64	31	45	0	0	45	900	794	65	41	45
020	0.33	2035	19000	2242	45	1360	1233	86	41	45	0	0	45	1200	1059	86	55	45
3rd St (US20) SB																		
021	0.22	2015	31700	3075	45	2140	1973	109	58	45	0	0	45	1590	1398	122	70	45

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ANALYST: Peter Schuytema
CHECKED BY:
FILE: ALT_EDS1.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-1

PAGE: 3
PRINTING DATE: Jul 8, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
021	0.22	2035	39400	3822	45	2530	2333	129	68	45	0	0	45	1870	1644	144	82	45
3rd St (US20) SB - N of En																		
022	0.08	2015	31700	3075	45	2180	1973	109	58	14	0	0	45	1590	1398	122	70	41
022	0.08	2035	39400	3822	45	2530	2333	129	68	10	0	0	45	1870	1644	144	82	30
3rd St (US20) SB - S of En																		
023	0.25	2015	21500	1484	45	1640	1553	51	36	18	0	0	45	1270	1141	93	36	41
023	0.25	2035	32800	2263	45	2020	1913	63	44	10	0	0	45	1560	1402	114	44	23
3rd St (US20) NB - S of En																		
024	0.25	2015	10700	749	45	780	729	35	16	45	0	0	45	390	339	40	11	45
024	0.25	2035	24500	1715	45	1320	1235	59	26	39	0	0	45	660	574	68	18	45
3rd St (US20) NB - N of En																		
025	0.08	2015	13900	1348	45	1100	1012	65	23	45	0	0	45	760	641	71	48	45
025	0.08	2035	22800	2212	45	1740	1600	103	37	12	0	0	45	1200	1012	112	76	45
US20 NB - S of Conn to 3r																		
026	0.10	2015	13900	1348	45	1100	1012	65	23	45	0	0	45	760	641	71	48	45
026	0.10	2035	22800	2212	45	1740	1600	103	37	45	0	0	45	1200	1012	112	76	45
US20 NB - S of Sisters Lo																		
027	0.40	2015	8600	980	45	450	413	34	13	45	0	0	45	350	287	36	28	45
027	0.40	2035	16100	1635	45	1060	951	79	30	45	0	0	45	810	664	80	66	45
US20 NB - S of Robal																		
028	0.33	2015	16500	1518	45	1210	1118	68	24	45	0	0	45	830	707	76	47	45
028	0.33	2035	26100	2401	45	2030	1875	114	41	10	0	0	45	1390	1185	128	79	37
US20 NB - S of Cooley																		
029	0.41	2015	14800	1480	55	1140	1054	60	26	54	0	0	55	730	616	69	45	55
029	0.41	2035	23500	2350	55	1860	1718	99	43	28	0	0	55	1180	996	111	73	55
US20 NB - S of Mountainvi																		
030	0.57	2015	15300	1652	55	1240	1139	63	38	53	0	0	55	760	613	79	58	55
030	0.57	2035	22500	2430	55	2040	1873	104	63	30	0	0	55	1240	1001	129	110	53
US20 NB - S of OB Redmc																		
031	0.12	2015	15200	1657	55	1240	1141	62	37	53	0	0	55	760	616	77	67	55
031	0.12	2035	22400	2442	55	2040	1877	102	61	30	0	0	55	1250	1014	126	110	53

ABBREVIATION SECT = SECTION NUMBER
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ANALYST: Peter Schuytema
CHECKED BY:
FILE: ALT_EDS1.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-1

PAGE: 4
PRINTING DATE: Jul 8, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
US20 NB - N of OB Redmc																		
032	0.25	2015	11000	1386	55	940	840	49	51	55	0	0	55	630	496	62	72	55
032	0.25	2035	14800	1877	55	1220	1091	63	66	53	0	0	55	810	639	79	92	55
Unused																		
033	0.00		0			0												
033	0.00																	
Unused																		
034	0.00		0			0												
034	0.00																	
US97 SB - N of Nichols Mk																		
035	0.25	2015	22900	3137	55	1380	1227	75	77	55	0	0	55	1370	1154	115	101	55
035	0.25	2035	28300	3877	55	1870	1662	103	105	55	0	0	55	1850	1558	155	137	55
US97 SB - S of Nichols Mk																		
036	2.47	2015	23200	3109	55	1220	1082	67	71	55	0	0	55	1180	1027	72	81	55
036	2.47	2035	27300	3658	55	1580	1491	92	97	55	0	0	55	1620	1409	99	112	55
US97 SB - Btwn 3rd St Ran																		
037	0.49	2015	20500	2850	55	1020	899	54	67	55	0	0	55	1020	889	55	75	55
037	0.49	2035	23000	3197	55	1370	1207	73	90	55	0	0	55	1370	1193	74	103	55
US97 SB - S of SB On-ram																		
038	2.42	2015	20800	2870	45	1050	926	57	67	45	0	0	45	1040	906	58	76	45
038	2.42	2035	24000	3312	45	1440	1270	78	92	45	0	0	45	1430	1246	80	104	45
Unused																		
039	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
039	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
040	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
040	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
041	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
041	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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TRANSPORTATION PLANNING ANALYSIS UNIT
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PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-1

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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Unused																		
042	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
042	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
US97 SB - N of Butler Off-r																		
043	0.21	2015	30400	3952	45	1720	1551	88	81	45	0	0	45	1530	1316	119	95	45
043	0.21	2035	35100	4563	45	2180	1967	111	102	45	0	0	45	1940	1669	151	120	45
US97 SB - S of Butler Off-r																		
044	0.25	2015	23900	3657	45	1180	1046	60	74	45	0	0	45	1180	1012	83	85	45
044	0.25	2035	27100	4148	45	1500	1329	76	95	45	0	0	45	1500	1287	105	108	45
US97 NB - S of 3rd On-ram																		
045	0.25	2015	29400	2176	45	2440	2291	56	93	45	0	0	45	1500	1315	87	98	45
045	0.25	2035	37400	2768	45	3200	3004	74	122	33	0	0	45	1960	1719	114	127	45
US97 NB - S of Butler On-r																		
046	0.26	2015	36200	3077	45	2940	2728	106	106	45	0	0	45	1800	1553	135	112	45
046	0.26	2035	44400	3774	45	3710	3442	134	134	45	0	0	45	2270	1959	170	141	45
US97 NB - S of Empire Off																		
047	0.26	2015	38700	3251	45	3170	2942	117	111	45	0	0	45	1930	1665	149	116	45
047	0.26	2035	47200	3965	45	3860	3674	147	139	44	0	0	45	2410	2079	186	145	45
US97 NB - S of Empire Off																		
048	0.21	2015	29600	2486	45	2580	2400	90	90	44	0	0	45	1450	1239	115	96	45
048	0.21	2035	37400	3142	45	3340	3108	117	117	27	0	0	45	1880	1607	149	124	45
Unused																		
049	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
049	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
050	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
050	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
US97 NB - S of Left Exit to																		
051	0.09	2015	29600	2486	45	2580	2400	90	90	44	0	0	45	1450	1239	115	96	45
051	0.09	2035	37400	3142	45	3340	3108	117	117	27	0	0	45	1880	1607	149	124	45
US97 NB - S of Empire NB																		

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ANALYST: Peter Schuyleman
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TRANSPORTATION PLANNING ANALYSIS UNIT
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052	0.59	2015	14400	1627	45	1220	1096	41	81	45	0	0	45	830	501	49	80	45
052	0.59	2035	18100	2045	45	1460	1314	50	96	45	0	0	45	760	604	59	97	45
US97 NB - S of 3rd St NB I																		
053	1.88	2015	19400	2289	45	1620	1453	75	92	45	0	0	45	900	721	85	94	45
053	1.88	2035	23300	2749	45	1860	1668	86	106	45	0	0	45	1030	825	97	108	45
US97 NB - Btwn 3rd St ram																		
054	0.49	2015	18600	2176	45	1560	1398	72	90	45	0	0	45	850	679	78	93	45
054	0.49	2035	22400	2621	45	1800	1613	83	104	45	0	0	45	980	783	90	107	45
US97 NB - S of Desc Mkt																		
055	2.47	2015	21200	2374	55	1810	1638	81	91	55	0	0	55	1050	885	93	92	55
055	2.47	2035	25900	3013	55	2240	2027	101	112	55	0	0	55	1300	1070	116	114	55
US97 NB - N of Desc Mkt																		
056	0.25	2015	21600	2333	55	2090	1880	93	87	55	0	0	55	1210	996	111	103	55
056	0.25	2035	28200	3046	55	2780	2538	125	117	48	0	0	55	1640	1350	151	139	55
Unused																		
057	0.00		0			0												
057	0.00																	
Unused																		
058	0.00		0			0												
058	0.00																	
Hunnell - N of Fort Thomps																		
059	0.25	2015	800	44	45	60	57	3	0	45	0	0	45	60	56	3	1	45
059	0.25	2035	2100	116	45	160	152	7	1	45	0	0	45	160	150	8	2	45
Hunnell - N of Rogers																		
060	0.38	2015	1000	55	45	80	77	3	0	45	0	0	45	80	75	4	1	45
060	0.38	2035	2500	138	45	190	181	8	1	45	0	0	45	190	177	10	3	45
Hunnell - N of Loop																		
061	0.74	2015	1000	55	45	80	77	3	0	45	0	0	45	80	74	4	2	45
061	0.74	2035	2700	149	45	210	200	9	1	45	0	0	45	210	195	11	4	45
Hunnell SB - N of Cooley																		
062	0.24	2015	3200	211	45	150	142	6	2	45	0	0	45	90	64	15	11	45

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062	0.24	2035	5000	330	45	260	245	11	4	45	0	0	45	160	114	27	19	45
Hunnell SB - S of Cooley																		
063	0.20	2015	2000	144	35	120	109	9	2	35	0	0	35	120	106	9	5	35
063	0.20	2035	5100	367	35	240	218	19	3	35	0	0	35	240	211	19	10	35
Hunnell SB - N of Robal																		
064	0.20	2015	2900	191	35	300	283	11	6	35	0	0	35	130	106	13	11	35
064	0.20	2035	6800	449	35	670	633	24	13	22	0	0	35	300	246	30	24	35
Hunnell NB - N of Robal																		
065	0.20	2015	2200	143	35	190	188	8	4	35	0	0	35	70	54	10	6	35
065	0.20	2035	5600	364	35	480	447	22	11	35	0	0	35	170	130	25	15	35
Hunnell NB - S of Cooley																		
066	0.20	2015	2500	127	35	100	94	4	2	35	0	0	35	30	23	4	3	35
066	0.20	2035	5900	301	35	330	310	13	7	35	0	0	35	100	75	14	11	35
Hunnell NB - S of Loco																		
067	0.24	2015	1600	99	45	200	186	14	0	45	0	0	45	150	125	19	6	45
067	0.24	2035	2200	135	45	280	260	20	0	45	0	0	45	210	178	26	8	45
Unused																		
068	0.00		0			0												
068	0.00																	
Unused																		
069	0.00		0			0												
069	0.00																	
Tumalo EB - W of Nichols																		
070	0.25	2015	1500	154	55	120	101	15	4	55	0	0	55	60	41	15	4	55
070	0.25	2035	2100	216	55	180	151	23	6	55	0	0	55	100	70	24	6	55
Tumalo EB - E of Nichols M																		
071	0.38	2015	2000	268	55	250	212	25	13	55	0	0	55	230	158	50	22	55
071	0.38	2035	2900	389	55	360	305	36	19	55	0	0	55	330	227	72	31	55
Tumalo Conn NB - S of De																		
072	0.24	2015	3100	260	55	320	298	16	6	55	0	0	55	190	151	22	17	55
072	0.24	2035	4900	412	55	620	579	30	11	51	0	0	55	370	295	42	33	55

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SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
Desc Pts Ridge WB - W of																		
073	0.12	2015	2000	160	55	320	300	15	5	35	0	0	55	190	151	22	17	55
073	0.12	2035	3900	312	55	620	581	29	10	10	0	0	55	360	286	41	33	42
Desc Pts Ridge EB - W of																		
074	0.12	2015	1700	194	55	70	59	5	6	55	0	0	55	20	7	5	8	55
074	0.12	2035	2600	296	55	80	69	5	6	55	0	0	55	30	11	8	11	55
Tumalo Conn SB - N of Tu																		
075	0.24	2015	2700	243	55	70	59	5	6	55	0	0	55	30	15	6	9	55
075	0.24	2035	3500	315	55	80	69	5	6	55	0	0	55	30	15	6	9	55
Tumalo WB - E of Nichols																		
076	0.38	2015	2800	249	55	80	74	5	1	55	0	0	55	30	23	5	2	55
076	0.38	2035	3100	276	55	140	129	9	2	55	0	0	55	50	37	9	4	55
Tumalo WB - W of Nichols																		
077	0.25	2015	1900	179	55	120	114	5	1	55	0	0	55	40	23	13	4	55
077	0.25	2035	2700	254	55	150	143	6	1	55	0	0	55	50	28	17	5	55
Nichols Mkt EB - W of US9																		
078	0.31	2015	2900	255	55	80	74	3	3	55	0	0	55	30	20	7	3	55
078	0.31	2035	3000	264	55	140	129	5	6	55	0	0	55	60	40	14	6	55
Nichols Mkt WB - W of US																		
079	0.31	2015	2500	302	55	250	229	11	10	55	0	0	55	210	137	50	23	55
079	0.31	2035	3400	411	55	340	311	15	14	55	0	0	55	290	189	69	32	55
Desc Pts Ridge EB - E of T																		
080	0.25	2015	1100	140	55	0	0	0	0	55	0	0	55	0	0	0	0	55
080	0.25	2035	1300	165	55	10	7	2	1	55	0	0	55	10	7	2	1	55
Desc Pts Ridge WB - E of																		
081	0.25	2015	1100	80	55	0	0	0	0	55	0	0	55	0	0	0	0	55
081	0.25	2035	1300	95	55	10	10	0	0	55	0	0	55	0	0	0	0	55
New Desc Mkt EB Ext																		
082	0.25	2015	1700	216	55	220	190	19	11	55	0	0	55	190	152	25	13	55
082	0.25	2035	2900	368	55	310	267	27	16	55	0	0	55	270	215	36	19	55

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New Desc Mkl WB Ex																		
083	0.25	2015	2800	218	55	320	305	13	2	55	0	0	55	170	146	18	6	55
083	0.25	2035	4400	343	55	520	591	25	4	53	0	0	55	330	283	31	16	55
Unused																		
084	0.00		0			0												
084	0.00																	
Cooley EB - W of US20																		
085	0.32	2015	500	26	45	40	37	2	1	45	0	0	45	30	24	2	4	45
085	0.32	2035	2200	114	45	140	128	8	4	40	0	0	45	110	88	9	13	45
Cooley EB - W of Scenic																		
086	0.07	2015	2800	370	35	240	214	16	6	35	0	0	35	170	121	27	22	35
086	0.07	2035	7500	980	35	600	533	46	21	35	0	0	35	420	299	66	55	35
Cooley EB - W of Hunnell S																		
087	0.33	2015	2800	403	35	240	215	17	8	35	0	0	35	190	143	25	22	35
087	0.33	2035	7000	1094	35	600	536	43	21	35	0	0	35	470	353	62	55	35
Cooley EB - W of Hunnell F																		
088	0.17	2015	3000	288	35	200	184	23	13	35	0	0	35	200	151	24	25	35
088	0.17	2035	7100	682	35	360	295	42	23	35	0	0	35	360	272	43	45	35
Cooley EB - W of US97																		
089	0.14	2015	5300	541	35	430	390	28	12	27	0	0	35	160	106	30	24	35
089	0.14	2035	11000	1122	35	880	756	58	24	10	0	0	35	340	225	64	51	35
Cooley EB - W of Boyd Acc																		
090	0.34	2015	7900	592	40	800	744	41	15	40	0	0	40	380	307	52	21	40
090	0.34	2035	14900	1117	40	1460	1358	74	28	26	0	0	40	680	551	92	37	40
Cooley EB - E of Boyd Acc																		
091	0.25	2015	5700	433	40	530	489	35	6	40	0	0	40	350	295	36	19	40
091	0.25	2035	11800	897	40	1000	923	66	11	40	0	0	40	660	556	68	36	40
Cooley WB - E of Boyd Acc																		
092	0.25	2015	5300	392	40	360	329	26	5	40	0	0	40	330	276	35	20	40
092	0.25	2035	10800	799	40	800	731	57	12	40	0	0	40	740	618	78	44	40
Cooley WB - E of US97																		

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093	0.34	2015	6200	570	40	400	369	26	5	40	0	0	40	320	271	30	19	40
093	0.34	2035	11500	1058	40	800	738	52	10	40	0	0	40	640	542	60	38	40
Cooley WB - E of Hunnell I																		
094	0.14	2015	3400	462	35	300	264	25	11	35	0	0	35	230	176	26	26	35
094	0.14	2035	7000	952	35	620	546	51	23	35	0	0	35	480	371	54	55	35
Cooley WB - E of Hunnell E																		
095	0.17	2015	2700	324	35	240	218	12	10	28	0	0	35	160	126	12	22	35
095	0.17	2035	5900	708	35	640	583	31	26	10	0	0	35	440	348	32	60	15
Cooley WB - E of Scenic																		
096	0.33	2015	3000	441	35	270	249	10	11	35	0	0	35	160	115	18	27	35
096	0.33	2035	7100	1044	35	700	646	26	28	35	0	0	35	420	301	47	72	35
Cooley WB - E of US20																		
097	0.07	2015	2900	389	35	270	247	12	11	35	0	0	35	150	102	20	28	35
097	0.07	2035	6600	911	35	700	641	30	29	14	0	0	35	390	266	51	73	35
Cooley WB - W of OB Riley																		
098	0.32	2015	400	30	45	40	37	2	1	45	0	0	45	30	26	2	2	45
098	0.32	2035	2000	150	45	200	186	9	5	45	0	0	45	150	130	9	11	45
Unused																		
099	0.00		0			0												
099	0.00																	
Robal EB - W of CV Mall																		
100	0.15	2015	5000	415	35	260	248	10	2	35	0	0	35	130	108	17	7	35
100	0.15	2035	10000	830	35	560	534	21	5	35	0	0	35	280	227	38	15	35
Robal EB - W of Hunnell																		
101	0.08	2015	3900	300	35	220	212	6	2	35	0	0	35	80	70	8	2	35
101	0.08	2035	7700	593	35	460	445	12	3	35	0	0	35	160	141	16	3	35
Robal EB - W of Target																		
102	0.08	2015	2900	183	35	200	194	2	4	35	0	0	35	90	75	8	7	35
102	0.08	2035	4900	309	35	340	330	4	6	35	0	0	35	150	125	13	12	35
Robal EB - W of US97																		
103	0.06	2015	3600	220	35	220	210	6	4	33	0	0	35	80	66	8	6	35

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103	0.08	2035	5900	360	35	340	324	10	6	35	0	0	35	120	100	11	9	35
Robal WB - E of Target																		
104	0.08	2015	4400	251	35	400	365	14	1	35	0	0	35	200	180	14	6	35
104	0.08	2035	6000	342	35	590	568	20	2	35	0	0	35	290	260	21	9	35
Robal WB - E of Hunnell																		
105	0.08	2015	1900	220	35	380	370	7	3	35	0	0	35	130	109	14	7	35
105	0.08	2035	2400	278	35	500	487	9	4	24	0	0	35	180	152	19	9	35
Robal WB - E of AutoMall																		
106	0.08	2015	3500	310	35	480	466	12	2	35	0	0	35	190	167	17	6	35
106	0.08	2035	6400	550	35	600	778	19	3	18	0	0	35	320	282	28	10	35
Robal WB - E of US20																		
107	0.15	2015	3700	270	35	460	437	21	2	30	0	0	35	210	174	34	2	35
107	0.15	2035	6400	467	35	780	742	35	3	10	0	0	35	350	289	57	4	35
Robal WB - E of Britta																		
108	0.09	2015	2500	175	35	250	234	11	5	35	0	0	35	230	210	14	6	35
108	0.09	2035	4500	315	35	380	357	16	7	35	0	0	35	350	320	21	9	35
Robal WB - E of OB Riley																		
109	0.22	2015	1800	125	35	260	244	12	4	35	0	0	35	260	237	16	7	35
109	0.22	2035	2600	203	35	350	338	16	6	35	0	0	35	350	320	21	9	35
Robal EB - W of Britta																		
110	0.22	2015	1500	98	35	10	6	3	1	35	0	0	35	10	5	4	1	35
110	0.22	2035	2200	143	35	50	31	16	3	35	0	0	35	40	20	16	4	35
Robal EB - W of US20																		
111	0.09	2015	2100	151	35	100	89	9	2	35	0	0	35	90	79	8	2	35
111	0.09	2035	3400	245	35	220	197	19	4	35	0	0	35	190	166	19	5	35
Britta SB - S of Robal																		
112	0.25	2015	900	41	25	40	39	1	0	25	0	0	25	10	9	1	0	25
112	0.25	2035	2000	92	25	100	97	2	1	25	0	0	25	30	27	2	1	25
Britta NB - S of Robal																		
113	0.25	2015	600	39	25	90	88	2	0	25	0	0	25	90	87	2	1	25
113	0.25	2035	1300	82	25	180	174	5	1	25	0	0	25	180	173	5	2	25

ABBREVIATION SECT = SECTION NUMBER
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AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuyleman
CHECKED BY:
FILE: ALT_DS1.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Unused																		
114	0.00		0			0												
114	0.00																	
Empire EB - W of Britta																		
115	0.05	2015	4700	451	30	310	290	18	2	30	0	0	30	310	256	35	19	30
115	0.05	2035	8700	835	30	560	525	32	3	30	0	0	30	560	483	63	34	30
Empire EB - W of Jamison																		
116	0.16	2015	4500	468	30	300	281	17	2	30	0	0	30	300	245	35	20	30
116	0.16	2035	7900	822	30	560	525	32	3	22	0	0	30	560	457	65	38	22
Empire EB - W of 3rd																		
117	0.04	2015	4500	468	30	380	337	21	2	30	0	0	30	360	294	42	24	30
117	0.04	2035	7900	822	30	560	525	32	3	22	0	0	30	550	449	64	37	23
Empire EB - W of Shermer																		
118	0.09	2015	15300	1606	30	1080	976	87	17	30	0	0	30	810	699	75	36	30
118	0.09	2035	20900	2194	30	1380	1252	86	22	30	0	0	30	1040	898	96	46	30
Empire EB - W of Empire (																		
119	0.07	2015	15300	1606	30	1080	976	87	17	30	0	0	30	810	699	75	36	30
119	0.07	2035	20900	2194	30	1380	1252	86	22	30	0	0	30	1040	898	96	46	30
Empire EB - Between ramp																		
120	0.08	2015	8900	1112	30	580	532	37	11	30	0	0	30	450	374	47	29	30
120	0.08	2035	13400	1675	30	840	770	54	16	30	0	0	30	660	548	69	43	30
Empire EB - W of Corporat																		
121	0.14	2015	14800	1495	30	820	767	39	14	30	0	0	30	680	572	58	50	30
121	0.14	2035	19800	2000	30	1090	1019	52	19	30	0	0	30	910	765	78	67	30
Empire EB - W of Boyd Acr																		
122	0.09	2015	14000	1400	30	780	725	43	12	30	0	0	30	640	549	54	37	30
122	0.09	2035	18500	1850	30	1050	975	58	17	28	0	0	30	860	737	73	50	30
Empire EB - E of Boyd Acr																		
123	0.25	2015	12400	905	30	540	499	30	11	30	0	0	30	430	379	31	20	30
123	0.25	2035	15900	1234	30	750	693	42	15	30	0	0	30	590	520	42	28	30

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TRANSPORTATION PLANNING ANALYSIS UNIT
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PROJECT: US97 North Corridor
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Empire WB - E of Boyd Ac																		
124	0.25	2015	11300	1277	30	880	826	43	11	21	0	0	30	860	745	75	40	23
124	0.25	2035	15900	1797	30	1250	1174	61	15	10	0	0	30	1220	1058	106	56	10
Empire WB - E of Blanchem																		
125	0.09	2015	12700	1346	30	1060	996	49	15	30	0	0	30	880	728	98	54	30
125	0.09	2035	18700	1982	30	1540	1447	71	22	26	0	0	30	1280	1060	142	78	30
Empire WB - E of Empire C																		
126	0.14	2015	14500	1479	30	1120	1059	46	15	30	0	0	30	1050	888	119	43	30
126	0.14	2035	20000	2040	30	1600	1513	66	21	19	0	0	30	1500	1268	170	62	23
Empire WB - Between ram																		
127	0.08	2015	12700	1270	30	1050	991	40	19	28	0	0	30	1010	872	107	31	30
127	0.08	2035	18300	1830	30	1560	1473	59	28	19	0	0	30	1500	1295	159	46	21
Empire WB - E of industria																		
128	0.07	2015	9800	735	30	900	847	38	15	30	0	0	30	890	794	75	21	30
128	0.07	2035	14600	1086	30	1390	1308	58	24	23	0	0	30	1370	1222	115	33	24
Empire WB - E of 3rd																		
129	0.09	2015	10000	700	30	920	876	34	10	30	0	0	30	920	827	68	25	30
129	0.09	2035	14800	1043	30	1420	1351	53	16	14	0	0	30	1420	1277	106	38	14
Empire WB - E of Jamison																		
130	0.04	2015	6100	421	30	440	419	14	7	30	0	0	30	440	395	38	7	30
130	0.04	2035	10200	704	30	710	677	22	11	30	0	0	30	710	638	61	11	30
Empire WB - E of Brita																		
131	0.16	2015	4400	308	30	380	357	17	6	30	0	0	30	300	266	25	9	30
131	0.16	2035	8500	595	30	610	573	28	9	29	0	0	30	490	435	40	15	30
Empire WB - E of OB Riley																		
132	0.05	2015	4800	298	30	340	323	13	4	30	0	0	30	230	200	19	11	30
132	0.05	2035	10000	620	30	740	703	28	9	12	0	0	30	490	426	41	23	30
Unused																		
133	0.00		0			0												
133	0.00																	
Unused																		

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ANALYST: Peter Schuylema
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TRANSPORTATION PLANNING ANALYSIS UNIT
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PROJECT: US97 North Corridor
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SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
134	0.00		0			0												
134	0.00																	
OB Redmond NB - S of US																		
135	0.20	2015	2600	354	45	140	124	13	3	41	0	0	45	140	122	13	5	41
135	0.20	2035	6000	816	45	260	231	24	5	39	0	0	45	260	225	25	10	39
OB Redmond NB - N of US																		
136	0.25	2015	3900	230	45	270	254	15	1	45	0	0	45	90	71	16	3	45
136	0.25	2035	5800	342	45	540	508	31	1	44	0	0	45	170	134	30	6	45
OB Redmond SB - N of US																		
137	0.25	2015	3200	176	45	220	206	11	3	10	0	0	45	220	205	11	4	10
137	0.25	2035	4800	264	45	250	235	12	3	33	0	0	45	250	233	13	4	33
OB Redmond SB - N of OE																		
138	0.20	2015	3600	349	45	280	265	12	3	45	0	0	45	270	243	21	6	45
138	0.20	2035	8100	786	45	690	654	29	7	44	0	0	45	670	604	52	14	45
Rogers - W of Hunnell																		
139	0.25	2015	200	11	45	20	19	1	0	45	0	0	45	20	18	1	1	45
139	0.25	2035	500	28	45	40	38	2	0	45	0	0	45	40	37	2	1	45
Unused																		
140	0.00		0			0												
140	0.00																	
Unused																		
141	0.00		0			0												
141	0.00																	
Unused																		
142	0.00		0			0												
142	0.00																	
Unused																		
143	0.00		0			0												
143	0.00																	
Unused																		
144	0.00		0			0												

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ANALYST: Peter Schuyleman
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TRANSPORTATION PLANNING ANALYSIS UNIT
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PROJECT: US97 North Corridor
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
144	0.00																	
Unused																		
145	0.00		0			0												
145	0.00																	
Unused																		
146	0.00		0			0												
146	0.00																	
Unused																		
147	0.00		0			0												
147	0.00																	
Unused																		
148	0.00		0			0												
148	0.00																	
NB Conn to 3rd/US20 - N c																		
149	0.07	2015	7300	409	45	820	591	22	7	45	0	0	45	370	331	30	9	45
149	0.07	2035	9200	515	45	910	868	32	10	45	0	0	45	540	484	43	13	45
3rd Conn SB - N of US20																		
150	0.21	2015	18000	1388	45	1110	1041	42	27	45	0	0	45	640	559	54	27	45
150	0.21	2035	20400	1571	45	1170	1099	44	28	45	0	0	45	670	585	57	28	45
Sister's Loop NB																		
151	0.54	2015	7900	442	30	740	703	28	9	30	0	0	30	450	403	35	11	30
151	0.54	2035	10000	560	30	970	921	37	12	31	0	0	30	580	520	46	14	30
NB Conn to 3rd St/US20																		
152	0.45	2015	15200	851	45	1360	1296	49	15	45	0	0	45	810	726	65	19	45
152	0.45	2035	19200	1075	45	1880	1791	68	21	45	0	0	45	1120	1003	90	27	45
3rd St Conn NB																		
153	0.34	2015	5200	291	45	600	574	20	6	45	0	0	45	350	313	28	9	45
153	0.34	2035	6700	375	45	680	650	23	7	45	0	0	45	390	349	31	10	45
3rd St NB Off-ramp																		
154	0.24	2015	900	126	45	60	55	4	1	45	0	0	45	50	41	6	3	45
154	0.24	2035	900	126	45	60	55	4	1	45	0	0	45	50	41	6	3	45

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ANALYST: Peter Schuytema
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TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-1

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SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
3rd St NB On-ramp																		
155	0.25	2015	2700	240	45	280	245	11	4	45	0	0	45	190	170	15	5	45
155	0.25	2035	4500	400	45	460	434	19	7	45	0	0	45	330	295	26	9	45
Unused																		
156	0.24	2015	2700	292	45	200	183	12	4	45	0	0	45	160	138	15	5	45
156	0.24	2035	4900	529	45	320	293	20	7	45	0	0	45	250	215	25	10	45
3rd St SB On-ramp																		
157	0.26	2015	300	32	45	20	18	1	1	45	0	0	45	20	17	2	1	45
157	0.26	2035	900	97	45	70	63	5	2	45	0	0	45	60	52	5	2	45
Unused																		
158	0.00		0			0												
158	0.00																	
Unused																		
159	0.00		0			0												
159	0.00																	
Empire SB On-ramp																		
160	0.32	2015	9600	1094	45	580	639	31	10	45	0	0	45	470	389	65	16	45
160	0.32	2035	11100	1265	45	740	695	33	11	45	0	0	45	510	423	70	17	45
Butler Mkt SB Off-ramp																		
161	0.25	2015	6500	351	45	540	507	27	6	45	0	0	45	350	303	37	10	45
161	0.25	2035	8000	432	45	580	638	34	8	45	0	0	45	440	381	46	13	45
3rd NB On-ramp																		
162	0.25	2015	6800	966	45	500	432	56	12	45	0	0	45	300	232	55	13	45
162	0.25	2035	7000	994	45	510	441	57	12	45	0	0	45	310	240	57	13	45
Butler Mkt NB On-ramp																		
163	0.25	2015	2500	155	45	240	224	12	4	45	0	0	45	120	104	12	4	45
163	0.25	2035	2800	174	45	260	243	13	4	45	0	0	45	130	112	13	5	45
Empire NB Off-ramp																		
164	0.30	2015	9100	784	45	580	536	26	16	45	0	0	45	490	437	33	20	45
164	0.30	2035	9900	832	45	620	573	28	19	44	0	0	45	530	473	36	21	45

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ANALYST: Peter Schuytema
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TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Empire NB On-ramp																		
165	0.23	2015	5000	680	45	400	355	36	9	45	0	0	45	270	220	38	12	45
165	0.23	2035	5100	694	45	400	355	36	9	45	0	0	45	270	220	38	12	45
Unused																		
166	0.00		0			0												
166	0.00																	
Britta SB - N of Empire																		
167	0.14	2015	700	34	25	80	79	1	0	25	0	0	25	60	56	2	2	25
167	0.14	2035	1500	72	25	180	178	2	0	25	0	0	25	60	53	4	3	25
Britta NB - N of Empire																		
168	0.14	2015	500	32	25	60	58	2	0	25	0	0	25	60	57	2	1	25
168	0.14	2035	800	51	25	60	58	2	0	25	0	0	25	60	57	2	1	25
Boyd Acres SB - S of Empi																		
169	0.25	2015	4900	598	25	340	321	16	3	25	0	0	25	290	249	26	15	25
169	0.25	2035	8200	1000	25	620	586	29	5	24	0	0	25	530	454	48	28	25
Boyd Acres NB - S of Emp																		
170	0.25	2015	4600	543	25	320	298	16	6	25	0	0	25	220	163	37	20	25
170	0.25	2035	9400	1109	25	470	438	23	9	20	0	0	25	330	240	55	29	25
Unused																		
171	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
172	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
172	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
173	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
173	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
174	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
174	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		

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ANALYST: Peter Schuytema
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TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
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			AVERAGE DAY			PEAK HOUR					AVERAGE HOUR			PEAK TRUCK HOUR				
SECT	DIST	YEAR	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP
175	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
176	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
177	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
177	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
178	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
178	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unused																		
179	0.00	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
179	0.00	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3rd St NB - S of Nels Anderson																		
180	0.18	2015	12500	700	45	1220	1164	43	13	45	0	0	45	710	635	57	18	45
180	0.18	2035	15900	890	45	1580	1508	55	17	45	0	0	45	930	833	74	23	45
3rd St NB - S of Robal																		
181	0.11	2015	12000	672	45	1160	1106	41	13	44	0	0	45	680	609	54	17	45
181	0.11	2035	15800	885	45	1520	1450	53	17	20	0	0	45	890	797	71	22	45
3rd St NB - S of Target																		
182	0.16	2015	10800	605	45	920	877	32	11	41	0	0	45	510	451	45	14	45
182	0.16	2035	12300	689	45	1180	1125	41	14	10	0	0	45	650	575	57	18	45
3rd St NB - S of Cooley																		
183	0.33	2015	10100	566	45	940	896	33	11	39	0	0	45	520	461	45	14	45
183	0.33	2035	12200	683	45	1210	1153	42	15	10	0	0	45	670	594	58	18	45
3rd St NB - S of Loco																		
184	0.25	2015	5500	308	45	450	429	14	7	45	0	0	45	250	225	18	7	45
184	0.25	2035	8400	470	45	720	686	23	11	45	0	0	45	410	369	30	11	45
3rd St NB - S of Grandview																		
185	0.20	2015	3200	179	45	300	286	9	5	45	0	0	45	170	154	11	5	45

ABBREVIATION SECT = SECTION NUMBER
VOL = TOTAL VOLUME
MTR = MEDIUM TRUCK VOLUM
SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuyema
CHECKED BY:
FILE: ALT_DS1.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-1

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PRINTING DATE: Jul 8, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
185	0.20	2035	5400	302	45	430	410	13	7	45	0	0	45	240	217	16	7	45
3rd St NB - S of Bowery																		
186	0.50	2015	3000	158	45	270	257	9	4	45	0	0	45	150	136	10	4	45
186	0.50	2035	5600	314	45	500	476	16	8	45	0	0	45	280	253	19	8	45
3rd St EB - W of Harris																		
187	0.42	2015	3100	174	45	290	276	10	4	45	0	0	45	160	145	11	4	45
187	0.42	2035	5700	319	45	540	514	18	8	45	0	0	45	300	271	21	8	45
3rd St EB - W of SB ramps																		
188	0.20	2015	3100	174	45	290	276	10	4	45	0	0	45	160	145	11	4	45
188	0.20	2035	5700	319	45	540	514	18	8	45	0	0	45	300	271	21	8	45
3rd St EB Btwn Ramps																		
189	0.05	2015	2700	194	45	270	256	10	4	45	0	0	45	170	153	13	4	45
189	0.05	2035	4900	352	45	480	456	16	8	45	0	0	45	310	278	24	8	45
3rd St EB - W of Frontage																		
190	0.18	2015	200	14	45	20	19	1	0	45	0	0	45	10	8	1	1	45
190	0.18	2035	600	43	45	40	38	2	0	45	0	0	45	30	25	3	2	45
3rd St WB - W of Frontage																		
191	0.18	2015	200	15	45	20	19	1	0	45	0	0	45	20	18	1	1	45
191	0.18	2035	700	54	45	50	47	2	1	45	0	0	45	50	45	3	2	45
3rd St WB Btwn ramps																		
192	0.05	2015	1000	66	45	80	77	2	1	45	0	0	45	40	34	4	2	45
192	0.05	2035	1400	92	45	100	95	3	1	45	0	0	45	50	43	5	2	45
3rd St WB - E of Harris																		
193	0.20	2015	3700	289	45	280	262	12	6	45	0	0	45	170	148	15	7	45
193	0.20	2035	6300	491	45	400	374	16	8	45	0	0	45	240	209	21	10	45
3rd St SB - N of Bowery																		
194	0.42	2015	3600	281	45	270	253	12	5	45	0	0	45	160	139	14	7	45
194	0.42	2035	6300	491	45	400	374	18	8	45	0	0	45	240	209	21	10	45
3rd St SB - N of Grandview																		
195	0.50	2015	3600	281	45	280	262	13	5	45	0	0	45	170	148	15	7	45
195	0.50	2035	6100	476	45	420	393	19	8	45	0	0	45	250	218	22	10	45

ABBREVIATION SECT = SECTION NUMBER
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MTR = MEDIUM TRUCK VOLUM
SP = SPEED OF VEHICLE
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HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schwiterm
CHECKED BY:
FILE: ALT_EDS1.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-1

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PRINTING DATE: Jul 8, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
3rd St S of Loco																		
196	0.20	2015	3800	296	45	280	261	13	6	45	0	0	45	170	148	15	7	45
196	0.20	2035	5800	452	45	440	411	20	9	45	0	0	45	260	226	23	11	45
3rd St SB - N of Cooley																		
197	0.25	2015	7000	553	45	540	505	24	11	39	0	0	45	320	279	28	13	45
197	0.25	2035	10800	853	45	740	692	33	15	18	0	0	45	440	383	39	18	45
3rd St SB - N of Target																		
198	0.33	2015	11700	936	45	760	710	33	17	45	0	0	45	470	410	41	19	45
198	0.33	2035	15100	1208	45	840	785	37	18	45	0	0	45	520	454	45	21	45
3rd St SB - N of Robal																		
199	0.16	2015	12500	1008	45	880	822	39	19	45	0	0	45	540	472	47	21	45
199	0.16	2035	16400	1312	45	960	897	42	21	44	0	0	45	590	516	51	23	45
3rd St SB - N of Nels Ande																		
200	0.11	2015	17300	1332	45	1080	1012	42	26	45	0	0	45	620	543	52	25	45
200	0.11	2035	19700	1517	45	1140	1069	44	27	45	0	0	45	660	578	55	27	45
3rd St SB - S of Nels Ande																		
201	0.18	2015	18000	1386	45	1110	1041	42	27	45	0	0	45	640	559	54	27	45
201	0.18	2035	20400	1571	45	1170	1098	44	28	45	0	0	45	670	585	57	28	45

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HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schylama
CHECKED BY:
FILE: ALT_E0S1.MDB

APPENDIX S: ALTERNATIVE EAST DS-2 EIS DATA

Figure S-1 2015 & 2035 East DS-2 EIS Links

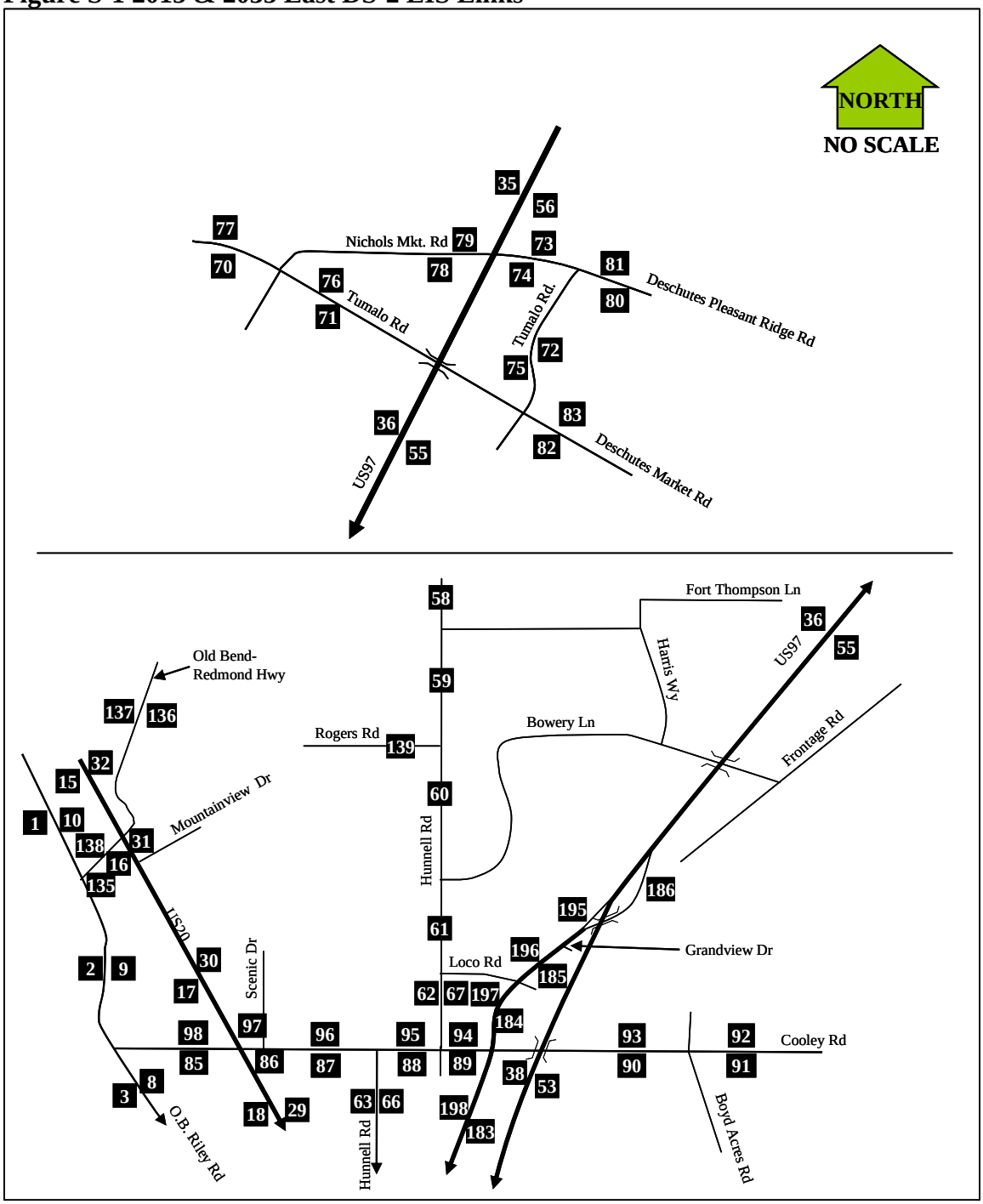

Figure S-2 2015 & 2035 East DS-2 EIS Links

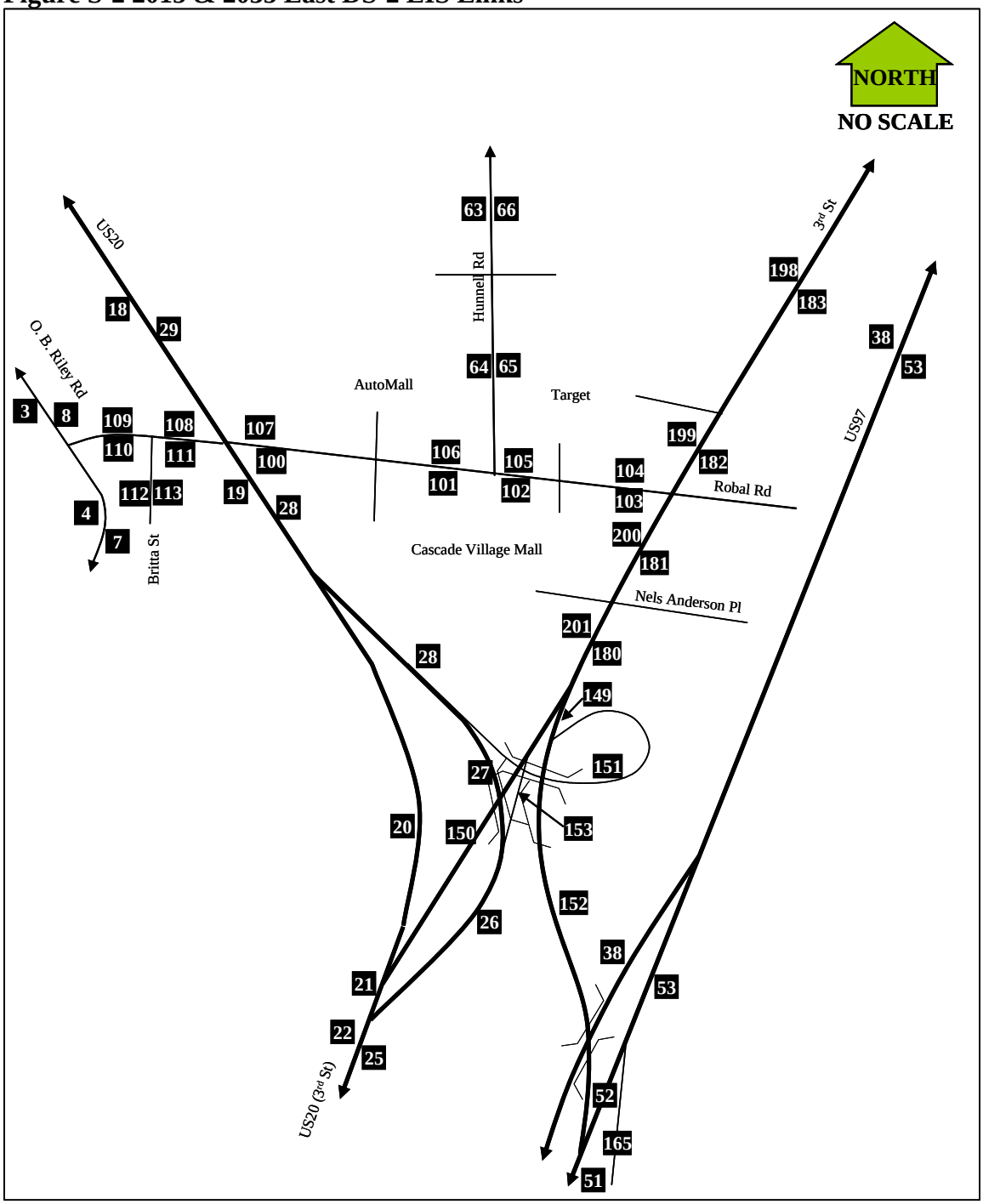

Figure S-3 2015 & 2035 East DS-2 EIS Links

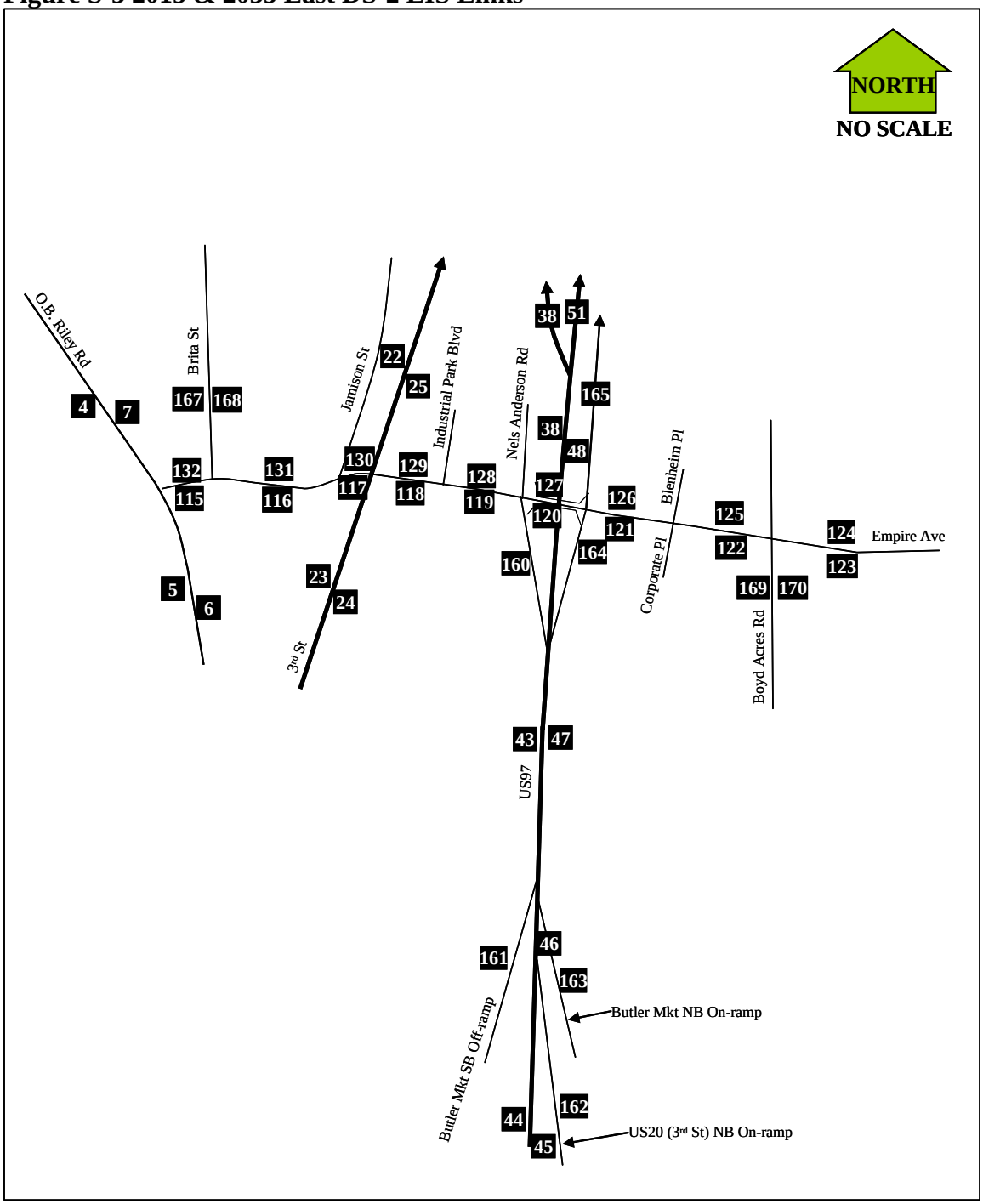

Figure S-4 Alternative East DS-2 EIS Data Sheets

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

PAGE: 1
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UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
OB Riley SB - N of OB Rec																		
001	0.25	2015	2200	180	45	180	160	13	7	45	0	0	45	140	118	13	9	45
001	0.25	2035	5800	476	45	410	363	30	17	45	0	0	45	320	270	30	20	45
OB Riley SB - N of Cooley																		
002	0.33	2015	1800	119	45	230	211	14	5	45	0	0	45	200	174	18	8	45
002	0.33	2035	6300	416	45	600	550	37	13	45	0	0	45	520	453	46	21	45
OB Riley SB - S of Cooley																		
003	0.42	2015	2100	132	45	220	203	13	4	45	0	0	45	210	189	17	4	45
003	0.42	2035	5900	372	45	560	515	34	11	45	0	0	45	530	475	43	11	45
OB Riley SB - S of Robal																		
004	0.94	2015	4600	336	45	490	468	19	3	45	0	0	45	490	460	27	3	45
004	0.94	2035	11800	861	45	960	916	37	7	23	0	0	45	950	891	52	7	24
OB Riley SB - S of Empire																		
005	0.25	2015	5700	456	45	640	594	38	8	45	0	0	45	580	532	50	8	45
005	0.25	2035	15200	1216	45	1270	1177	76	17	10	0	0	45	1180	1084	99	17	10
OB Riley NB - S of Empire																		
006	0.25	2015	4900	549	45	220	196	23	1	45	0	0	45	180	141	30	9	45
006	0.25	2035	13100	1467	45	870	774	91	5	43	0	0	45	700	549	117	34	45
OB Riley NB - S of Robal																		
007	0.94	2015	3900	289	45	130	119	11	0	45	0	0	45	90	75	12	3	45
007	0.94	2035	10000	740	45	580	529	50	1	45	0	0	45	400	335	52	13	45
OB Riley NB - S of Cooley																		
008	0.42	2015	1500	104	45	80	66	12	2	45	0	0	45	70	54	11	5	45
008	0.42	2035	4400	304	45	300	248	46	6	45	0	0	45	280	212	46	22	45
OB Riley NB - S of OB Rec																		
009	0.33	2015	1200	98	45	80	74	4	2	45	0	0	45	80	60	12	8	45
009	0.33	2035	4700	386	45	320	296	15	9	45	0	0	45	310	233	48	29	45
OB Riley NB - N of OB Rec																		
010	0.25	2015	2500	210	45	160	140	15	5	45	0	0	45	160	132	18	10	45
010	0.25	2035	6300	529	45	520	458	47	15	45	0	0	45	520	426	60	34	45
Unused																		

ABBREVIATION SECT = SECTION NUMBER
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MTR = MEDIUM TRUCK VOLUM
SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuytema
CHECKED BY:
FILE: ALT_ED S2.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

PAGE: 2
PRINTING DATE: Aug 2, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
011	0.00		0			0												
011	0.00																	
Unused																		
012	0.00		0			0												
012	0.00																	
Unused																		
013	0.00		0			0												
013	0.00																	
Unused																		
014	0.00		0			0												
014	0.00																	
US20 SB - N of OB Redmc																		
015	0.25	2015	12200	1647	55	860	755	57	48	55	0	0	55	790	675	60	55	55
015	0.25	2035	16200	2187	55	1170	1027	77	66	55	0	0	55	1080	923	82	75	55
US20 SB - N of Mountainvi																		
016	0.12	2015	14500	1871	55	960	856	59	45	55	0	0	55	890	765	61	64	55
016	0.12	2035	20400	2632	55	1240	1106	76	58	53	0	0	55	1150	989	76	83	55
US20 SB - N of Cooley																		
017	0.57	2015	14000	1820	55	960	854	61	45	55	0	0	55	910	785	62	63	55
017	0.57	2035	20100	2613	55	1240	1103	79	58	50	0	0	55	1170	1009	80	81	52
US20 SB - N of Robal																		
018	0.41	2015	13800	1601	55	880	800	46	34	46	0	0	55	830	735	46	49	48
018	0.41	2035	21000	2436	55	1120	1018	58	44	40	0	0	55	1060	939	58	63	43
US20 SB - S of Robal																		
019	0.24	2015	13800	1518	45	1000	905	67	28	45	0	0	45	870	734	97	39	45
019	0.24	2035	18800	2068	45	1360	1231	91	38	45	0	0	45	1190	1003	133	54	45
US20 SB - One-way Conn																		
020	0.33	2015	13800	1518	45	1000	905	67	28	45	0	0	45	870	734	97	39	45
020	0.33	2035	18800	2068	45	1360	1231	91	38	45	0	0	45	1190	1003	133	54	45
3rd St (US20) SB																		
021	0.22	2015	31400	2889	45	2070	1906	112	52	45	0	0	45	1550	1327	149	74	45

ABBREVIATION: SECT = SECTION NUMBER; VOL = TOTAL VOLUME; MTR = MEDIUM TRUCK VOLUM; SP = SPEED OF VEHICLE; AUTO = AUTOMOBILE VOLUME; HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuyleman
CHECKED BY:
FILE: ALT_EDS2.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

PAGE: 3
PRINTING DATE: Aug 2, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
021	0.22	2035	39200	3606	45	2600	2395	140	65	45	0	0	45	1940	1661	186	93	45
3rd St (US20) SB - N of En																		
022	0.08	2015	31400	2889	45	2070	1906	112	52	19	0	0	45	1560	1327	149	74	44
022	0.08	2035	39200	3606	45	2600	2395	140	65	10	0	0	45	1940	1661	186	93	23
3rd St (US20) SB - S of En																		
023	0.25	2015	19300	1158	45	1500	1426	46	28	27	0	0	45	1130	1003	89	38	45
023	0.25	2035	25500	1530	45	2020	1919	63	38	10	0	0	45	1520	1348	120	52	25
3rd St (US20) NB - S of En																		
024	0.25	2015	11500	816	45	780	710	33	17	45	0	0	45	400	343	39	18	45
024	0.25	2035	19000	1349	45	1340	1251	58	31	32	0	0	45	700	601	68	31	45
3rd St (US20) NB - N of En																		
025	0.08	2015	16200	1555	45	1190	1084	69	27	45	0	0	45	790	662	77	51	45
025	0.08	2035	23600	2266	45	1800	1655	104	41	10	0	0	45	1200	1005	118	77	45
US20 NB - S of Corn to 3r																		
026	0.10	2015	16200	1555	45	1190	1084	69	27	45	0	0	45	790	662	77	51	45
026	0.10	2035	23600	2266	45	1800	1655	104	41	45	0	0	45	1200	1005	118	77	45
US20 NB - S of Sisters Loc																		
027	0.40	2015	8600	980	45	460	413	34	13	45	0	0	45	350	287	35	28	45
027	0.40	2035	16100	1835	45	1060	951	79	30	45	0	0	45	810	684	80	66	45
US20 NB - S of Robal																		
028	0.33	2015	16500	1518	45	1210	1118	68	24	45	0	0	45	830	707	76	47	45
028	0.33	2035	25100	2401	45	2030	1875	114	41	10	0	0	45	1390	1185	126	79	37
US20 NB - S of Cooley																		
029	0.41	2015	14800	1480	55	1140	1054	60	26	54	0	0	55	730	616	69	45	55
029	0.41	2035	23500	2350	55	1860	1718	99	43	28	0	0	55	1180	996	111	73	55
US20 NB - S of Mountainvi																		
030	0.57	2015	15000	1605	55	1240	1142	60	38	53	0	0	55	760	613	79	68	55
030	0.57	2035	21800	2333	55	1960	1805	94	61	32	0	0	55	1210	976	126	108	54
US20 NB - S of OB Redmc																		
031	0.12	2015	14900	1609	55	1240	1145	57	38	53	0	0	55	770	624	78	68	55
031	0.12	2035	21700	2344	55	1960	1809	90	61	32	0	0	55	1220	990	123	107	53

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ANALYST: Peter Schuyteman
CHECKED BY:
FILE: ALT_EDS2.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

PAGE: 4
PRINTING DATE: Aug 2, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
US20 NB - N of OB Redmo																		
032	0.25	2015	11000	1386	55	940	840	49	51	55	0	0	55	630	496	62	72	55
032	0.25	2035	14900	1877	55	1220	1091	63	66	53	0	0	55	810	639	79	92	55
Unused																		
033	0.00		0			0												
033	0.00																	
Unused																		
034	0.00		0			0												
034	0.00																	
US97 SB - N of Nichols Mk																		
035	0.25	2015	22900	3137	56	1380	1227	76	77	55	0	0	56	1370	1154	115	101	55
035	0.25	2035	28300	3877	55	1870	1662	103	105	55	0	0	55	1850	1558	155	137	55
US97 SB - S of Nichols Mk																		
036	2.90	2015	23200	3109	56	1220	1082	67	71	55	0	0	55	1180	1027	72	81	55
036	2.90	2035	27300	3858	55	1680	1491	92	97	55	0	0	55	1620	1409	99	112	55
Unused																		
037	0.00																	
037	0.00																	
US97 SB - S of SB On-ram																		
038	1.68	2015	18400	2815	45	1050	922	61	67	45	0	0	45	1040	902	60	78	45
038	1.68	2035	20600	3152	45	1370	1203	79	88	45	0	0	45	1360	1179	79	102	45
Unused																		
039	0.00		0			0												
039	0.00																	
Unused																		
040	0.00		0			0												
040	0.00																	
Unused																		
041	0.00		0			0												
041	0.00																	

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ANALYST: Peter Schuyema
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TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Unused																		
042	0.00		0			0												
042	0.00																	
US97 SB - N of Butler Off-r																		
043	0.21	2015	29700	4539	45	1720	1538	103	79	45	0	0	45	1590	1358	135	97	45
043	0.21	2035	34400	4678	45	2160	1949	131	100	45	0	0	45	2010	1716	171	123	45
US97 SB - S of Butler Off-r																		
044	0.25	2015	23200	3735	45	1180	1043	64	73	45	0	0	45	1180	1002	93	85	45
044	0.25	2035	26400	4250	45	1500	1326	81	93	45	0	0	45	1500	1273	119	108	45
US97 NB - S of 3rd On-ram																		
045	0.25	2015	29600	2220	45	2460	2310	57	93	45	0	0	45	1520	1333	90	97	45
045	0.25	2035	37400	2805	45	3200	3004	74	122	33	0	0	45	1980	1736	117	127	45
US97 NB - S of Butler On-r																		
046	0.26	2015	35400	3094	45	2950	2738	106	106	45	0	0	45	1920	1571	138	111	45
046	0.26	2035	44400	3774	45	3710	3442	134	134	45	0	0	45	2290	1976	174	140	45
US97 NB - S of Empire Off																		
047	0.26	2015	38900	3268	45	3180	2951	118	111	45	0	0	45	1940	1675	149	116	45
047	0.26	2035	47200	3965	45	3960	3674	147	139	44	0	0	45	2420	2089	186	145	45
US97 NB - S of Empire Off																		
048	0.21	2015	29600	2486	45	2580	2400	90	90	44	0	0	45	1450	1239	115	96	45
048	0.21	2035	37400	3142	45	3340	3106	117	117	27	0	0	45	1880	1607	149	124	45
Unused																		
049	0.00		0			0												
049	0.00																	
Unused																		
050	0.00		0			0												
050	0.00																	
US97 NB - S of Left Exit to																		
051	0.09	2015	29600	2486	45	2580	2400	90	90	44	0	0	45	1450	1239	115	96	45
051	0.09	2035	37400	3142	45	3340	3106	117	117	27	0	0	45	1880	1607	149	124	45
US97 NB - S of Empire NB																		

ABBREVIATION SECT = SECTION NUMBER
VOL = TOTAL VOLUME
MTR = MEDIUM TRUCK VOLUM

SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuyler
CHECKED BY:
FILE: ALT_EDS2.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
052	0.59	2015	14400	1627	45	1220	1098	41	81	45	0	0	45	630	501	49	80	45
052	0.59	2035	18100	2045	45	1460	1314	50	96	45	0	0	45	760	604	59	97	45
US97 NB - S of 3rd St NB I																		
053	1.91	2015	18200	2275	45	1500	1336	74	90	45	0	0	45	860	688	83	89	45
053	1.91	2035	22100	2762	45	1720	1533	84	103	45	0	0	45	990	791	96	103	45
Unused																		
054	0.00		0			0												
054	0.00																	
US97 NB - S of Desc Mkt																		
055	2.90	2015	21200	2374	55	1810	1638	81	91	55	0	0	55	1050	885	93	92	55
055	2.90	2035	26900	3013	55	2240	2027	101	112	55	0	0	55	1300	1070	116	114	55
US97 NB - N of Desc Mkt																		
056	0.25	2015	21600	2333	55	2060	1880	93	87	55	0	0	55	1210	996	111	103	55
056	0.25	2035	28200	3046	55	2780	2538	125	117	48	0	0	55	1640	1350	151	139	55
Unused																		
057	0.00		0			0												
057	0.00																	
Unused																		
058	0.00		0			0												
058	0.00																	
Hunnell - N of Fort Thomps																		
059	0.25	2015	1300	69	45	120	114	5	1	45	0	0	45	120	110	7	3	45
059	0.25	2035	2700	143	45	280	247	11	2	45	0	0	45	260	239	14	7	45
Hunnell - N of Rogers																		
060	0.38	2015	1600	85	45	140	133	6	1	45	0	0	45	140	128	8	4	45
060	0.38	2035	3100	164	45	290	276	12	2	45	0	0	45	290	265	16	9	45
Hunnell - N of Loco																		
061	0.74	2015	1600	86	45	140	133	6	1	45	0	0	45	140	127	8	5	45
061	0.74	2035	3400	184	45	310	295	13	2	45	0	0	45	310	283	17	10	45
Hunnell SB - N of Cooley																		
062	0.24	2015	3400	190	45	180	169	8	3	45	0	0	45	90	56	21	13	45

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ANALYST: Peter Schuyleme
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TRANSPORTATION PLANNING ANALYSIS UNIT
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
062	0.24	2035	6300	353	45	340	320	15	5	45	0	0	45	170	107	39	24	45
Hunnell SB - S of Cooley																		
063	0.20	2015	2300	202	35	120	109	9	2	35	0	0	35	100	88	8	3	35
063	0.20	2035	4700	414	35	240	218	19	3	35	0	0	35	210	184	19	7	35
Hunnell SB - N of Robal																		
064	0.20	2015	2900	191	35	300	283	11	6	35	0	0	35	130	106	13	11	35
064	0.20	2035	6800	449	35	670	633	24	13	22	0	0	35	300	246	30	24	35
Hunnell NB - N of Robal																		
065	0.20	2015	2200	143	35	180	168	8	4	35	0	0	35	70	54	10	6	35
065	0.20	2035	5800	364	35	480	447	22	11	35	0	0	35	170	130	25	15	35
Hunnell NB - S of Cooley																		
066	0.20	2015	2500	127	35	100	94	4	2	35	0	0	35	30	23	4	3	35
066	0.20	2035	5900	301	35	330	310	13	7	35	0	0	35	100	75	14	11	35
Hunnell NB - S of Loco																		
067	0.24	2015	1700	122	45	200	187	13	0	45	0	0	45	180	156	17	7	45
067	0.24	2035	3000	216	45	360	337	23	0	45	0	0	45	330	286	31	13	45
Unused																		
068	0.00		0			0												
068	0.00																	
Unused																		
069	0.00		0			0												
069	0.00																	
Tumalo EB - W of Nichols I																		
070	0.25	2015	1500	154	55	120	101	15	4	55	0	0	55	60	41	15	4	55
070	0.25	2035	2100	216	55	180	151	23	6	55	0	0	55	100	70	24	6	55
Tumalo EB - E of Nichols I																		
071	0.38	2015	2000	268	55	250	212	25	13	55	0	0	55	250	158	50	22	55
071	0.38	2035	2900	389	55	360	305	36	19	55	0	0	55	330	227	72	31	55
Tumalo Conn NB - S of De																		
072	0.24	2015	3100	280	55	320	298	16	8	55	0	0	55	190	151	22	17	55
072	0.24	2035	4900	412	55	620	579	30	11	51	0	0	55	370	296	42	33	55

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TRANSPORTATION PLANNING ANALYSIS UNIT
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PROJECT: US97 North Corridor
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Desc Pls Ridge WB - W of																		
073	0.12	2015	2000	160	55	320	300	15	5	35	0	0	55	190	151	22	17	55
073	0.12	2035	3900	312	55	620	581	29	10	10	0	0	55	360	286	41	33	42
Desc Pls Ridge EB - W of																		
074	0.12	2015	1700	194	55	70	59	5	6	55	0	0	55	20	7	5	8	55
074	0.12	2035	2600	290	55	80	69	5	6	55	0	0	55	30	11	8	11	55
Tumalo Conn SB - N of Tu																		
075	0.24	2015	2700	243	55	70	59	5	6	55	0	0	55	30	15	6	9	55
075	0.24	2035	3500	315	55	80	69	5	6	55	0	0	55	30	15	6	9	55
Tumalo WB - E of Nichols																		
076	0.38	2015	2800	249	55	80	74	5	1	55	0	0	55	30	23	5	2	55
076	0.38	2035	3100	276	55	140	129	8	2	55	0	0	55	50	37	9	4	55
Tumalo WB - W of Nichols																		
077	0.25	2015	1900	179	55	120	114	5	1	55	0	0	55	40	23	13	4	55
077	0.25	2035	2700	254	55	150	143	6	1	55	0	0	55	50	28	17	5	55
Nichols Mkt EB - W of US																		
078	0.31	2015	2900	255	55	80	74	3	3	55	0	0	55	30	20	7	3	55
078	0.31	2035	3000	264	55	140	129	5	6	55	0	0	55	60	40	14	6	55
Nichols Mkt WB - W of US																		
079	0.31	2015	2500	302	55	250	229	11	10	55	0	0	55	210	137	50	23	55
079	0.31	2035	3400	411	55	340	311	15	14	55	0	0	55	290	189	69	32	55
Desc Pls Ridge EB - E of T																		
080	0.25	2015	1100	140	55	0	0	0	0	55	0	0	55	0	0	0	0	55
080	0.25	2035	1300	165	55	10	7	2	1	55	0	0	55	10	7	2	1	55
Desc Pls Ridge WB - E of																		
081	0.25	2015	1100	80	55	0	0	0	0	55	0	0	55	0	0	0	0	55
081	0.25	2035	1300	95	55	10	10	0	0	55	0	0	55	10	8	2	2	55
New Desc Mkt EB Ext																		
082	0.25	2015	1700	216	55	220	190	19	11	55	0	0	55	190	152	25	13	55
082	0.25	2035	2900	368	55	310	267	27	16	55	0	0	55	270	215	36	19	55

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TRANSPORTATION PLANNING ANALYSIS UNIT
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
New Desc Mkt WB Ext																		
083	0.25	2015	2800	218	55	320	305	13	2	55	0	0	55	170	146	16	8	55
083	0.25	2035	4400	343	55	520	491	25	4	53	0	0	55	330	283	31	16	55
Unused																		
084	0.00		0			0												
084	0.00																	
Cooley EB - W of US20																		
085	0.32	2015	500	26	45	40	37	2	1	45	0	0	45	30	24	2	4	45
085	0.32	2035	2200	114	45	140	126	6	4	40	0	0	45	110	88	9	13	45
Cooley EB - W of Scenic																		
086	0.07	2015	2800	370	35	240	214	18	8	35	0	0	35	170	121	27	22	35
086	0.07	2035	7500	990	35	600	533	46	21	35	0	0	35	420	299	66	55	35
Cooley EB - W of Hunnell S																		
087	0.33	2015	2800	403	35	240	215	17	8	35	0	0	35	190	143	25	22	35
087	0.33	2035	7600	1094	35	600	536	43	21	35	0	0	35	470	353	62	55	35
Cooley EB - W of Hunnell F																		
088	0.17	2015	3000	303	35	200	176	16	8	35	0	0	35	170	138	16	16	35
088	0.17	2035	8100	818	35	590	518	48	24	35	0	0	35	510	413	48	49	35
Cooley EB - W of US97																		
089	0.14	2015	5500	566	35	460	418	30	12	17	0	0	35	210	144	30	36	35
089	0.14	2035	12200	1257	35	1000	907	66	27	10	0	0	35	460	315	66	79	35
Cooley EB - W of Boyd Acr																		
090	0.34	2015	8600	636	40	860	802	44	14	40	0	0	40	430	341	55	34	40
090	0.34	2035	15400	1140	40	1470	1371	75	24	26	0	0	40	730	579	93	58	40
Cooley EB - E of Boyd Acr																		
091	0.25	2015	6400	480	40	580	538	38	4	40	0	0	40	400	330	38	32	40
091	0.25	2035	12300	922	40	1020	946	67	7	40	0	0	40	710	586	67	57	40
Cooley WB - E of Boyd Acr																		
092	0.25	2015	5900	442	40	410	374	29	7	40	0	0	40	360	301	42	17	40
092	0.25	2035	11200	840	40	880	803	62	15	40	0	0	40	770	644	98	37	40
Cooley WB - E of US97																		

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			AVERAGE DAY			PEAK HOUR					AVERAGE HOUR			PEAK TRUCK HOUR				
SECT	DIST	YEAR	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP	VOL	TRKS	SP	VOL	AUTO	MTR	HTR	SP
093	0.34	2015	6700	623	40	460	423	30	7	40	0	0	40	340	288	36	16	40
093	0.34	2035	11900	1107	40	870	800	57	13	34	0	0	40	650	551	69	30	40
Cooley WB - E of Hunnell I																		
094	0.14	2015	3500	469	35	300	265	25	10	35	0	0	35	190	142	30	18	35
094	0.14	2035	7800	1045	35	680	601	56	23	35	0	0	35	430	320	68	42	35
Cooley WB - E of Hunnell S																		
095	0.17	2015	2700	289	35	240	218	12	10	35	0	0	35	120	76	22	22	35
095	0.17	2035	6900	738	35	620	565	30	25	35	0	0	35	310	194	58	58	35
Cooley WB - E of Scenic																		
096	0.33	2015	2800	378	35	270	251	8	11	35	0	0	35	170	112	29	29	35
096	0.33	2035	6700	905	35	640	595	19	26	35	0	0	35	400	265	67	68	35
Cooley WB - E of US20																		
097	0.07	2015	2700	346	35	270	250	9	11	35	0	0	35	160	99	31	30	35
097	0.07	2035	6600	845	35	640	592	21	27	28	0	0	35	370	229	71	70	35
Cooley WB - W of OB Riley																		
098	0.32	2015	400	30	45	40	37	2	1	45	0	0	45	30	26	2	2	45
098	0.32	2035	2000	150	45	200	186	9	5	45	0	0	45	150	130	9	11	45
Unused																		
099	0.00		0			0												
099	0.00																	
Robal EB - W of CV Mall																		
100	0.15	2015	5000	415	35	260	248	10	2	35	0	0	35	130	106	17	7	35
100	0.15	2035	10000	830	35	560	534	21	5	35	0	0	35	280	227	38	15	35
Robal EB - W of Hunnell																		
101	0.08	2015	3900	300	35	220	212	6	2	35	0	0	35	80	70	8	2	35
101	0.08	2035	7700	593	35	460	445	12	3	35	0	0	35	160	141	16	3	35
Robal EB - W of Target																		
102	0.08	2015	2900	183	35	200	194	2	4	35	0	0	35	90	75	8	7	35
102	0.08	2035	4900	309	35	340	330	4	6	35	0	0	35	160	125	13	12	35
Robal EB - W of US97																		
103	0.06	2015	3600	220	35	220	210	6	4	33	0	0	35	60	66	8	6	35

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ANALYST: Peter Schuyleman
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TRANSPORTATION PLANNING ANALYSIS UNIT
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PROJECT: US97 North Corridor
LOCATION: Bend
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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
103	0.08	2035	5900	360	35	340	324	10	6	35	0	0	35	120	100	11	9	35
Robal WB - E of Target																		
104	0.08	2015	4400	251	35	400	385	14	1	35	0	0	35	200	180	14	6	35
104	0.08	2035	6000	342	35	590	568	20	2	35	0	0	35	290	260	21	9	35
Robal WB - E of Hunnell																		
105	0.08	2015	1900	220	35	380	370	7	3	35	0	0	35	130	109	14	7	35
105	0.08	2035	2400	278	35	500	487	9	4	24	0	0	35	180	152	19	9	35
Robal WB - E of AutoMall																		
106	0.08	2015	3600	310	35	460	448	12	2	35	0	0	35	190	167	17	6	35
106	0.08	2035	5400	550	35	800	778	19	3	15	0	0	35	320	282	28	10	35
Robal WB - E of US20																		
107	0.15	2015	3700	270	35	460	437	21	2	30	0	0	35	210	174	34	2	35
107	0.15	2035	6400	487	35	760	742	35	3	10	0	0	35	350	289	57	4	35
Robal WB - E of Britta																		
108	0.09	2015	2500	175	35	250	234	11	5	35	0	0	35	230	210	14	6	35
108	0.09	2035	4500	315	35	380	357	16	7	35	0	0	35	350	320	21	9	35
Robal WB - E of OB Riley																		
109	0.22	2015	1600	125	35	260	244	12	4	35	0	0	35	260	237	16	7	35
109	0.22	2035	2600	203	35	360	338	16	6	35	0	0	35	350	320	21	9	35
Robal EB - W of Britta																		
110	0.22	2015	1500	98	35	10	6	3	1	35	0	0	35	10	5	4	1	35
110	0.22	2035	2200	143	35	50	31	16	3	35	0	0	35	40	20	16	4	35
Robal EB - W of US20																		
111	0.09	2015	2100	151	35	100	89	9	2	35	0	0	35	90	79	9	2	35
111	0.09	2035	3400	245	35	220	197	19	4	35	0	0	35	190	168	19	5	35
Britta SB - S of Robal																		
112	0.25	2015	900	41	25	40	39	1	0	25	0	0	25	10	9	1	0	25
112	0.25	2035	2000	92	25	100	97	2	1	25	0	0	25	30	27	2	1	25
Britta NB - S of Robal																		
113	0.25	2015	1000	03	25	130	126	3	1	25	0	0	25	100	96	3	1	25
113	0.25	2035	1300	82	25	240	234	5	1	25	0	0	25	190	183	5	2	25

ABBREVIATION SECT = SECTION NUMBER
VOL = TOTAL VOLUME
MTR = MEDIUM TRUCK VOLUM
SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuyleman
CHECKED BY:
FILE: ALT_EDS2.MOB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 All East DS-2

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UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Unused																		
114	0.00		0			0												
114	0.00																	
Empire EB - W of Britta																		
115	0.05	2015	5100	530	30	320	300	18	2	30	0	0	30	320	269	35	16	30
115	0.05	2035	9400	978	30	560	525	31	4	30	0	0	30	560	470	62	28	30
Empire EB - W of Jamison																		
116	0.16	2015	4800	514	30	320	300	18	2	30	0	0	30	320	268	35	17	30
116	0.16	2035	9000	963	30	580	525	31	4	19	0	0	30	560	470	61	29	19
Empire EB - W of 3rd																		
117	0.04	2015	4800	514	30	310	291	17	2	30	0	0	30	310	260	34	16	30
117	0.04	2035	9000	963	30	580	525	31	4	19	0	0	30	560	470	61	29	19
Empire EB - W of Sherma																		
118	0.09	2015	16300	1760	30	1020	936	67	17	30	0	0	30	840	724	80	36	30
118	0.09	2035	22000	2376	30	1380	1266	91	23	30	0	0	30	1140	983	108	49	30
Empire EB - W of Empire (																		
119	0.07	2015	16300	1760	30	1020	936	67	17	30	0	0	30	840	724	80	36	30
119	0.07	2035	22000	2376	30	1380	1266	91	23	30	0	0	30	1140	983	108	49	30
Empire EB - Between ramp																		
120	0.08	2015	8100	1037	30	340	313	21	6	30	0	0	30	270	224	28	18	30
120	0.08	2035	13100	1677	30	800	735	50	15	30	0	0	30	630	523	66	41	30
Empire EB - W of Corporat																		
121	0.14	2015	14800	1495	30	820	767	39	14	30	0	0	30	680	572	58	50	30
121	0.14	2035	19800	2000	30	1090	1019	52	19	30	0	0	30	910	765	78	67	30
Empire EB - W of Boyd Acr																		
122	0.09	2015	14000	1400	30	780	725	43	12	30	0	0	30	640	549	54	37	30
122	0.09	2035	18500	1850	30	1050	975	58	17	28	0	0	30	860	737	73	50	30
Empire EB - E of Boyd Acr																		
123	0.25	2015	12400	905	30	540	499	30	11	30	0	0	30	430	379	31	20	30
123	0.25	2035	16900	1234	30	750	693	42	15	30	0	0	30	590	520	42	28	30

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ANALYST: Peter Schuyema
CHECKED BY:
FILE: ALT_EDS2.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

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PRINTING DATE: Aug 2, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
Empire WB - E of Boyd Acc																		
124	0.25	2015	11500	920	30	890	836	43	11	25	0	0	30	880	773	77	40	25
124	0.25	2035	15200	1218	30	1180	1109	57	14	17	0	0	30	1180	1026	101	53	17
Empire WB - E of Blanham																		
125	0.09	2015	12900	1393	30	1080	1016	49	15	30	0	0	30	910	753	101	56	30
125	0.09	2035	18000	1944	30	1480	1392	67	21	28	0	0	30	1250	1035	139	76	30
Empire WB - E of Empire C																		
126	0.14	2015	14200	1477	30	1110	1052	44	14	30	0	0	30	1080	897	120	43	30
126	0.14	2035	19800	2059	30	1520	1439	61	20	22	0	0	30	1450	1227	164	59	24
Empire WB - Between ram																		
127	0.08	2015	13000	1274	30	1150	1089	41	20	25	0	0	30	1070	925	111	34	28
127	0.08	2035	18800	1852	30	1560	1477	56	27	19	0	0	30	1450	1253	151	46	23
Empire WB - E of Industris																		
128	0.07	2015	10000	730	30	1000	941	43	16	30	0	0	30	950	851	76	23	30
128	0.07	2035	13900	1015	30	1390	1308	60	22	23	0	0	30	1320	1182	106	32	26
Empire WB - E of 3rd																		
129	0.09	2015	10200	694	30	1020	971	39	10	27	0	0	30	980	889	66	25	29
129	0.09	2035	14200	966	30	1420	1352	54	14	10	0	0	30	1360	1234	91	35	12
Empire WB - E of Jamison																		
130	0.04	2015	6100	421	30	440	419	14	7	30	0	0	30	440	395	38	7	30
130	0.04	2035	10200	704	30	710	677	22	11	30	0	0	30	710	638	61	11	30
Empire WB - E of Brita																		
131	0.16	2015	4400	308	30	380	357	17	6	30	0	0	30	300	265	25	9	30
131	0.16	2035	6500	595	30	610	573	28	9	29	0	0	30	490	435	40	15	30
Empire WB - E of OB Riley																		
132	0.05	2015	5200	338	30	400	380	15	5	30	0	0	30	270	237	24	9	30
132	0.05	2035	9600	624	30	740	703	28	9	12	0	0	30	490	431	43	16	30
Unused																		
133	0.00		0			0												
133	0.00																	
Unused																		

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ANALYST: Peter Sauvigné
CHECKED BY:
FILE: ALT_EDS2.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
134	0.00		0			0												
134	0.00																	
OB Redmond NB - S of US																		
135	0.20	2015	2600	354	45	140	124	13	3	41	0	0	45	140	122	13	5	41
135	0.20	2035	6000	816	45	260	231	24	5	39	0	0	45	260	225	25	10	39
OB Redmond NB - N of US																		
136	0.25	2015	3600	209	45	270	250	19	1	45	0	0	45	90	67	20	3	45
136	0.25	2035	5000	290	45	460	426	33	1	45	0	0	45	150	112	33	5	45
OB Redmond SB - N of US																		
137	0.25	2015	3000	165	45	200	185	12	3	24	0	0	45	200	184	12	4	24
137	0.25	2035	4500	248	45	220	204	13	3	39	0	0	45	220	203	13	4	39
OB Redmond SB - N of OB																		
138	0.20	2015	3800	349	45	280	265	12	3	45	0	0	45	270	243	21	6	45
138	0.20	2035	8100	786	45	690	654	29	7	44	0	0	45	670	604	52	14	45
Rogers - W of Hunnell																		
139	0.25	2015	200	11	45	20	19	1	0	45	0	0	45	20	18	1	1	45
139	0.25	2035	500	28	45	40	38	2	0	45	0	0	45	40	37	2	1	45
Unused																		
140	0.00		0			0												
140	0.00																	
Unused																		
141	0.00		0			0												
141	0.00																	
Unused																		
142	0.00		0			0												
142	0.00																	
Unused																		
143	0.00		0			0												
143	0.00																	
Unused																		
144	0.00		0			0												

ABBREVIATION SECT = SECTION NUMBER
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MTR = MEDIUM TRUCK VOLUM
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ANALYST: Peter Schuyleme
CHECKED BY:
FILE: ALT_EDS2.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

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UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
144	0.00																	
Unused																		
145	0.00		0			0												
145	0.00																	
Unused																		
146	0.00		0			0												
146	0.00																	
Unused																		
147	0.00		0			0												
147	0.00																	
Unused																		
148	0.00		0			0												
148	0.00																	
NB Conn to 3rd/US20 - N o																		
149	0.07	2015	7300	409	45	820	591	22	7	45	0	0	45	370	331	30	9	45
149	0.07	2035	9200	515	45	910	868	32	10	45	0	0	45	540	484	43	13	45
3rd Conn SB - N of US20																		
150	0.21	2015	17600	1320	45	1080	1015	42	23	45	0	0	45	660	580	46	34	45
150	0.21	2035	20400	1530	45	1240	1166	48	26	45	0	0	45	760	667	53	40	45
Sister's Loop NB																		
151	0.54	2015	7900	442	30	740	703	28	9	30	0	0	30	450	403	36	11	30
151	0.54	2035	10000	560	30	970	921	37	12	31	0	0	30	580	520	46	14	30
NB Conn to 3rd St/US20																		
152	0.45	2015	15200	851	45	1360	1296	48	15	45	0	0	45	810	726	65	19	45
152	0.45	2035	19200	1075	45	1880	1791	68	21	45	0	0	45	1120	1003	90	27	45
3rd St Conn NB																		
153	0.34	2015	7500	420	45	720	685	24	11	45	0	0	45	380	333	36	11	45
153	0.34	2035	7500	420	45	740	704	25	11	45	0	0	45	390	342	37	11	45
Unused																		
154	0.00		0			0												
154	0.00																	

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ANALYST: Peter Schu[illegible]
CHECKED BY: [illegible]
FILE: ALT_EDS2.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

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PRINTING DATE: Aug 2, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Unused																		
155	0.00		0			0												
155	0.00																	
Unused																		
156	0.24		0			0												
156	0.24																	
Unused																		
157	0.00		0			0												
157	0.00																	
Unused																		
158	0.00		0			0												
158	0.00																	
Unused																		
159	0.00		0			0												
159	0.00																	
Empire SB On-ramp																		
160	0.32	2015	11200	1243	45	800	753	37	10	45	0	0	45	530	438	75	17	45
160	0.32	2035	13900	1543	45	980	922	45	13	44	0	0	45	650	537	92	21	45
Butler Mkt SB Off-ramp																		
161	0.25	2015	6500	351	45	540	507	27	6	45	0	0	45	410	355	43	12	45
161	0.25	2035	8000	432	45	680	638	34	8	45	0	0	45	510	442	53	15	45
3rd NB On-ramp																		
162	0.25	2015	6800	966	45	500	432	56	12	45	0	0	45	300	232	55	13	45
162	0.25	2035	7900	994	45	510	441	57	12	45	0	0	45	310	240	57	13	45
Butler Mkt NB On-ramp																		
163	0.25	2015	2500	155	45	240	224	12	4	45	0	0	45	120	103	12	5	45
163	0.25	2035	2700	167	45	260	243	13	4	45	0	0	45	130	112	13	5	45
Empire NB Off-ramp																		
164	0.30	2015	9300	800	45	600	554	27	19	45	0	0	45	520	464	36	20	45
164	0.30	2035	9800	843	45	620	573	28	19	44	0	0	45	540	482	37	21	45

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ANALYST: Peter Schuyleme
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TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

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UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
Empire NB On-ramp																		
165	0.23	2015	3800	684	45	280	237	35	8	45	0	0	45	240	195	37	8	45
165	0.23	2035	3900	702	45	280	237	35	8	45	0	0	45	240	195	37	8	45
Unused																		
166	0.00		0			0												
166	0.00																	
Britta SB - N of Empire																		
167	0.14	2015	1000	51	25	70	69	1	0	25	0	0	25	20	18	1	1	25
167	0.14	2035	1500	76	25	180	178	2	0	25	0	0	25	60	53	4	3	25
Britta NB - N of Empire																		
168	0.14	2015	500	32	25	60	58	2	0	25	0	0	25	60	57	2	1	25
168	0.14	2035	600	51	25	60	58	2	0	25	0	0	25	60	57	2	1	25
Boyd Acres SB - S of Empi																		
169	0.25	2015	4900	598	25	340	321	16	3	25	0	0	25	290	249	26	15	25
169	0.25	2035	6200	1000	25	620	588	29	5	24	0	0	25	530	454	48	28	25
Boyd Acres NB - S of Empi																		
170	0.25	2015	4600	543	25	320	298	16	6	25	0	0	25	220	163	37	20	25
170	0.25	2035	9400	1109	25	470	438	23	9	20	0	0	25	330	246	55	29	25
Unused																		
171	0.00		0			0												
171	0.00																	
Unused																		
172	0.00		0			0												
172	0.00																	
Unused																		
173	0.00		0			0												
173	0.00																	
Unused																		
174	0.00		0			0												
174	0.00																	
Unused																		

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ANALYST: Peter Schultens
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TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

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SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
175	0.00		0			0												
175	0.00																	
Unused																		
176	0.00		0			0												
176	0.00																	
Unused																		
177	0.00		0			0												
177	0.00																	
Unused																		
178	0.00		0			0												
178	0.00																	
Unused																		
179	0.00		0			0												
179	0.00																	
3rd St NB - S of Nels Anderson																		
180	0.18	2015	14800	829	45	1340	1277	46	17	45	0	0	45	750	687	64	19	45
180	0.18	2035	16800	941	45	1660	1582	56	22	45	0	0	45	930	826	80	24	45
3rd St NB - S of Robal																		
181	0.11	2015	14300	801	45	1300	1237	46	17	35	0	0	45	730	648	63	19	45
181	0.11	2035	16200	907	45	1590	1513	56	21	18	0	0	45	890	790	77	23	45
3rd St NB - S of Target																		
182	0.16	2015	11300	533	45	1040	990	35	15	25	0	0	45	530	459	53	18	45
182	0.16	2035	12800	717	45	1250	1189	43	18	10	0	0	45	640	554	64	22	45
3rd St NB - S of Cooley																		
183	0.33	2015	10600	594	45	1060	1008	36	16	24	0	0	45	540	469	53	18	45
183	0.33	2035	12300	689	45	1280	1217	44	19	10	0	0	45	660	573	65	22	45
3rd St NB - S of Loco																		
184	0.25	2015	5400	297	45	540	515	17	8	45	0	0	45	320	288	22	10	45
184	0.25	2035	7300	402	45	720	687	23	10	45	0	0	45	430	388	29	13	45
3rd St NB - S of Grandview																		
185	0.20	2015	2900	160	45	380	344	11	5	45	0	0	45	220	200	13	7	45

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ANALYST: Peter Scourtema
CHECKED BY:
FILE: ALT_EBS2.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

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SECT	DIST	YEAR	AVERAGE DAY VOL	TRKS	SP	PEAK HOUR VOL	AUTO	MTR	HTR	SP	AVERAGE HOUR VOL	TRKS	SP	PEAK TRUCK HOUR VOL	AUTO	MTR	HTR	SP
185	0.20	2035	4800	253	45	520	496	16	8	45	0	0	45	310	281	19	10	45
3rd St NB - S of Bowery																		
186	0.58	2015	3100	171	45	320	308	10	4	45	0	0	45	190	172	12	6	45
186	0.58	2035	4800	264	45	500	477	16	7	45	0	0	45	300	271	19	10	45
Unused																		
187	0.00		0			0												
187	0.00																	
Unused																		
188	0.00		0			0												
188	0.00																	
Unused																		
189	0.00		0			0												
189	0.00																	
Unused																		
190	0.00		0			0												
190	0.00																	
Unused																		
191	0.00		0			0												
191	0.00																	
Unused																		
192	0.00		0			0												
192	0.00																	
Unused																		
193	0.00		0			0												
193	0.00																	
Unused																		
194	0.00		0			0												
194	0.00																	
3rd St SB - N of Grandview																		
195	0.32	2015	4800	384	45	180	157	8	5	45	0	0	45	150	132	12	6	45
195	0.32	2035	7400	592	45	320	297	14	9	45	0	0	45	260	230	20	10	45

ABBREVIATION SECT = SECTION NUMBER
VOL = TOTAL VOLUME
MTR = MEDIUM TRUCK VOLUM
SP = SPEED OF VEHICLE
AUTO = AUTOMOBILE VOLUME
HTR = HEAVY TRUCK VOLUME

ANALYST: Peter Schuyleme
CHECKED BY:
FILE: ALT_EDS2.MDB

TRANSPORTATION PLANNING ANALYSIS UNIT
EIS TRAFFIC DATA

PROJECT: US97 North Corridor
LOCATION: Bend
ALTERNATIVE: 2015-2035 Alt East DS-2

PAGE: 20
PRINTING DATE: Aug 2, 2010
UNIT: English

SECT	DIST	YEAR	AVERAGE DAY VOL	AVERAGE DAY TRKS	AVERAGE DAY SP	PEAK HOUR VOL	PEAK HOUR AUTO	PEAK HOUR MTR	PEAK HOUR HTR	PEAK HOUR SP	AVERAGE HOUR VOL	AVERAGE HOUR TRKS	AVERAGE HOUR SP	PEAK TRUCK HOUR VOL	PEAK TRUCK HOUR AUTO	PEAK TRUCK HOUR MTR	PEAK TRUCK HOUR HTR	PEAK TRUCK HOUR SP
3rd St S of Loco																		
196	0.20	2015	4500	360	45	190	176	8	6	45	0	0	45	150	132	12	6	45
196	0.20	2035	7000	560	45	340	315	15	10	45	0	0	45	270	236	21	11	45
3rd St SB - N of Cooley																		
197	0.25	2015	7900	632	45	440	410	19	11	45	0	0	45	290	254	24	12	45
197	0.25	2035	10700	856	45	520	578	27	15	17	0	0	45	400	351	33	16	45
3rd St SB - N of Target																		
198	0.33	2015	13100	1035	45	720	674	32	14	45	0	0	45	470	408	34	28	45
198	0.33	2035	16700	1319	45	910	853	40	17	45	0	0	45	590	512	43	35	45
3rd St SB - N of Robal																		
199	0.16	2015	14000	1106	45	850	797	37	16	45	0	0	45	550	478	41	31	45
199	0.16	2035	17300	1367	45	1020	953	45	19	38	0	0	45	650	565	49	36	45
3rd St SB - N of Nels Ande																		
200	0.11	2015	16800	1260	45	1020	959	40	21	45	0	0	45	620	544	44	32	45
200	0.11	2035	21100	1582	45	1200	1128	47	25	45	0	0	45	730	640	52	38	45
3rd St SB - S of Nels Ande																		
201	0.16	2015	17600	1320	45	1080	1015	42	23	45	0	0	45	660	580	46	34	45
201	0.16	2035	20400	1530	45	1240	1166	48	26	45	0	0	45	760	667	53	40	45

ABBREVIATION: SECT = SECTION NUMBER
VOL = TOTAL VOLUME
MTR = MEDIUM TRUCK VOLUM
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AUTO = AUTOMOBILE VOLUME
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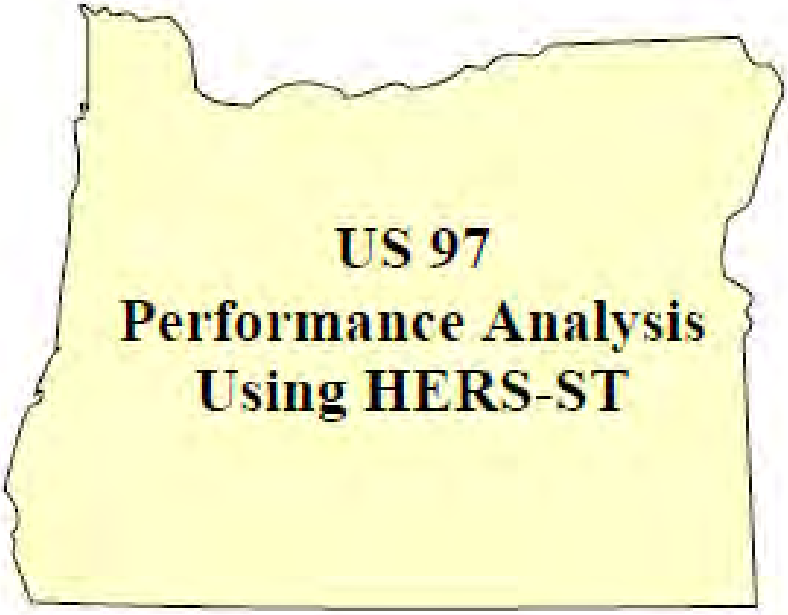
FILE: ALT EDS2 MOB

APPENDIX T: HERS-ST US97 SYSTEM PERFORMANCE ANALYSIS REPORT

Oregon Department of Transportation



US 97 Performance Analysis Using HERS-ST

October 2009

Prepared by:
Oregon Department of Transportation
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Transportation Planning Section
Transportation Development Division, Salem, Oregon

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List of Acronyms

AADT	Average Annual Daily Traffic
AES	Average effective speed
APLVM	Aggregate Probabilistic Limiting Velocity Model
BCR	Benefit-Cost Ratio
BMPO	Bend Metropolitan Planning Area
CMS	Congestion Management System
EIS	Environmental Impact Statement
FFS	Free-flow speed
FHWA	Federal Highway Administration
HERS-ST	State version of the Highway Economic Requirements System
HPMS	Highway Performance Monitoring System
MPH	Miles per hour
ROW	Right-of-way
TPAU	ODOT Transportation Planning Analysis Unit
UGB	Urban Growth Boundary
VCR	Volume-to-capacity ratio
VMT	Vehicle miles traveled

Executive Summary

Over the past decade, the northern area of the City of Bend has undergone considerable business growth and change. The area known locally as the "Cooley Triangle" has been the location of choice for many retail organizations moving into this Central Oregon community. With growth comes traffic and associated congestion and this area is a source of current congestion issues. The location makes it extremely attractive for future retail development, which will result in greater congestion in the future. Traffic analysis of this area is important for planning how the area develops, grows, and flows.

This project analysis evaluated changes in long-range system performance measures and looked at economic benefits for improving the roadway system based on a generic benefit-cost Ratio (BCR) concept. A number of system performance measures were evaluated using the state version of the Highway Economic Requirements System (HERS-ST). Based on the BCR concept, the analysis looked at economic benefits for improving the roadway system for three roadway scenarios:

- The *No-Build: Intersection* scenario is the existing roadway system. This is the "no build" condition and the base case against which the "build" scenarios are compared.
- The *Build: Interchange* scenario replaced the existing Cooley Road signalized intersection with a full interchange and removed all other signal and access points to US 97.
- The *Build: Bypass* scenario made no changes to the existing alignment, but added a "new" bypass alignment around the analysis area.

HERS-ST was used to evaluate each scenario as if it were operational at the beginning of the analysis period. The analysis addressed the question "what is the long-range system performance for this condition?"

For each scenario, the average segment speed, delay, and volume-to-capacity ratio (VCR) was captured and compared. For both "build" scenarios, as compared with the "no build", the average speed increased by about 50 percent, the average delay decreased by over 80 percent (varies by scenario), and the VCR improved by up to 50 percent. Both "build" scenarios showed significant improvements for these performance measures, and the Total User Costs decreased by as much as 45 percent, compared with the "no build" scenario.

Since a true construction cost for the "build" options was not available for this analysis, two different assumed construction costs, $50 million and $100 million, were used to evaluate the two "build" scenarios. For both funding levels, the *Build: Interchange* scenario has approximately double the BCR then the *Build: Bypass* scenario, all other things remaining equal. The *Build: Interchange* scenario BCR is about 3.4 for the $50 million construction cost and about 3.1 for a construction cost of $100 million. The BCR for the bypass is about 1.9 for the construction cost of $50 million and about 1.7 for the $100 million construction cost. In general, for any project with BCR greater than one, the improvement benefit outweighs the cost and is considered a worthwhile project.

Introduction

Over the past decade, the northern area of the City of Bend has undergone considerable business growth and change. The area known locally as the "Cooley Triangle" has been the location of choice for many retail organizations moving into this Central Oregon community. With growth comes traffic and associated congestion. There are existing congestion issues in this area, and its attractiveness for future retail development will result in greater congestion issues in the future. Traffic analysis of the area is particularly important, specifically regarding how the area develops, grows, and flows.

Numerous studies were conducted in the Cooley Triangle area over the years, ending with the US 97/20 Refinement Plan. The plan indicated a need for two corridors (a bypass of the old alignment) instead of relying on one facility to meet all the needs. This plan transitioned into the current project, the US 97 Bend North Corridor Environmental Impact Statement (EIS), which looked at many different project scenarios and resulted in east and west corridor alternatives. The cost of the alternative solutions to address the needs is $350-$400 million. This far exceeds the available monies over the next 20 years, so the likelihood of funding is small. The project teams are looking at smaller scale solutions to begin to address the needs at a reasonable cost. HERS-ST can help inform decision-makers on the funding level range with the highest value to the state[1].

HERS-ST Process

The state version of the Highway Economic Requirements System (HERS-ST) uses an input dataset formatted in the standard Highway Performance Monitoring System (HPMS), where each data record represents a unique roadway segment. For each funding period, the HERS-ST model evaluates each data record one at a time, independent of all other records, to determine whether a road segment has a deficiency as defined by the user. For each deficiency, the HERS-ST model uses a benefit-cost analysis process to evaluate a number of potential improvements to determine the best economical solution to correct the problem. The best economical improvement is then implemented in the dataset and simulated during future funding period analysis.

The analyst defines the timeframe for the HERS-ST analysis period. The general analysis consists of four five-year funding periods for a total 20-year analysis period.

Average Speed

The HERS-ST model consists of a number of individual complex sub-models, including Pavement Deterioration, Safety, and Speed Models[2]. The primary focus for this report is the

[1] This analysis does not address downstream impacts. For example, the Bend Parkway (US 97) segment south of the project area (south of Empire Avenue) is expected to be at capacity in the future. Fixing a bottleneck at one location does not guarantee against creating a problem at other location(s) and additional regional analysis is required to determine additional downstream impacts.

[2] HERS-ST model uses six internal models: Fleet Composite Model, Widen Feasibility Model, Capacity Model, Pavement Deterioration Model, Speed Model and Travel Forecast Model

speed model procedures, as the majority of the US 97 analysis is centered on speed and delay calculations.

The speed procedure within HERS-ST is based on the Aggregate Probabilistic Limiting Velocity Model (APLVM) and covers two distinct processes, free-flow speed (FFS) and average effective speed (AES). The FFS estimation is developed to reflect the average unconstrained speed that exists on the highway system in the absence of any other traffic or geometric influences. Then, the FFS estimates are adjusted to account for the effects of congestion delay and traffic control devices to produce the AES for each roadway segment.

Several key data elements affect speed, including vehicle type, curves, grades, pavement surface quality, speed limits, congestion, and traffic control devices. There are three controlling factors in the APLVM that potentially limit the free speed on a roadway section: curves, pavement roughness and posted speed limit. All of these factors have the potential of lowering the sectional speed estimate.

A vehicle traveling through a curved roadway section is subject to a centrifugal force that acts against the vehicle, forcing it to leave the curve path of the roadway. The higher the vehicular speed entering the curve, the heavier the vehicle, and the sharper the curvature of the road, the greater the external force acting upon the vehicle. This results in a reduced FFS for the roadway section.

When the pavement is smooth and the curvature is low (below two degrees) the average speed is governed by the posted speed limits. This model does not explicitly consider enforcement.

Average Delay

There are three kinds of delays estimated in HERS-ST:

- Zero-Volume Delay is the delay associated with traffic control devices. This is the expected delay that a single vehicle would encounter even if it were the only vehicle on the road. Zero-volume delay only exists for sections controlled with stop signs or traffic signals and is not calculated for uncontrolled sections.
- Incident Delay is the delay associated with crashes. HERS-ST estimates delay due to crashes through a secondary (or inferred) process where the HERS-ST model estimates the delay cost of crashes and then back-calculates the delay estimates due to crash incidents from the cost calculations.
- Other Congestion (or Recurring) Delay is the average delay due to non-incident congestion.

Total daily traffic is broken into three phases, or demand periods, for all capacity, delay and speed analysis:

- Peak period analysis in the peak direction.
- Peak period analysis in the counter peak direction.
- Off peak analysis in both directions.

Benefit-Cost Ratio

HERS-ST defines the benefit-cost Ratio (BCR) of a highway improvement as the discounted sum of the present value benefits for the user, agency, and environment divided by the implementation costs of the improvement. For BCR analysis, HERS-ST recognizes four broad classes of costs:

- User costs are the costs incurred by the highway user and include Travel Time Costs, Operating Costs, and Safety Costs.
- Agency Costs are roadway maintenance costs borne by the administrative agency responsible for the highway section.
- External Costs (emissions costs) are the social costs passed to the non-users of the highway system.
- Capital Improvement Costs are the estimated construction costs of the improvement.

The analyst can change many variables and factors[3] within the HERS-ST model that influence User, Agency and External Costs. The HERS-ST procedure estimates the incremental costs and benefits of each potential improvement for each period of the benefit-cost analysis period, as well as the residual value of the improvement at the end of the analysis period. For BCR, the benefits of an improvement are defined as a reduction in user, agency and external costs as the result of implementing an improvement, and are measured as the difference in costs between the no-improved case and the improved case. The cost variable is the estimated capital improvement cost.

The little known part of the BCR equation is in the residual value (RV) of an improvement. The residual value is the capital value of the improvement that still remains at the end of the final analysis period, and is credited back as the unused portion of the investment. The RV for an improvement is discounted back to the initial year of the analysis period and treated as a benefit.

In theory, any project with BCR greater than one is considered a worthy project. However, the HERS-ST BCR is used to reveal the value of a set of alternative projects related to each other.

User Costs

For Travel Time Costs, HERS-ST incorporates national U.S. Department of Transportation values of time per person for personal and business travel. The Operating Costs evaluate vehicle operating costs as a function of cost for fuel and oil consumption, tire wear, vehicle maintenance and repair, and mileage-related depreciation. The Safety Costs use national crash rates to estimate the number of crashes and severity for improved and unimproved roadway segments.

The benefits for each variable are defined as a reduction in costs as a result of the implementation of an improvement. Some improvements might show a savings in one

[3] User parameters affect deficiency levels, design standards, improvement costs, auto and truck growth factors, funding and performance constrains, and weights for highway performance goals.

variable, such as travel time, while showing an increased cost (disbenefit) in another variable, such as increased fuel consumption. A reduction in the summation of all three costs is defined as the total benefit for the selected improvement.

Agency Costs

Agency Costs include the cost of routine maintenance. A selected improvement may or may not be associated with a reduction in roadway maintenance costs. HERS-ST evaluates this measure for the current funding period and evaluates the potential reduction of improvement costs in future years resulting from the improvement.

External Costs

The HERS-ST model uses national values to estimate the cost of damages from vehicular emissions (air pollutants) resulting from the implementation of a selected improvement. The air pollution costs are measured as the difference between total pollution costs generated by the forecast volumes of travel on the section under unimproved and improved conditions. Because the cost of air pollutant emissions per vehicle-mile varies by both travel speed and vehicle class, this effect can be negative or positive depending on how a proposed improvement influences forecast travel volumes, the mix of vehicle types and travel speeds.

Capital Improvement Costs

HERS-ST identifies segment deficiencies, evaluates a series of improvements that will correct the condition, and estimates the cost of the highway improvement. The Capital Improvement Costs are simply the construction costs for the selected improvements. When analyzing the economic attractiveness of a potential improvement, the improvement cost is used as the denominator in the benefit-cost equation.

Analysis Data

This project analysis covers the US 97 roadway segment from the northern City of Bend urban growth boundary (UGB), at Milepost (MP) 133.56, to the US 97/20 Junction, at Milepost 134.96, a total of approximately 1½ miles. The project is located in the north-central area of the Bend Metropolitan Planning Area (BMPO) and the north-south alignment fronts to the east of an area known locally as the “Cooley Triangle”. The roadway is designated an urbanized principal arterial.

This area currently has congestion issues and the specific location is attractive for future retail development, which will result in greater congestion issues in the future. Traffic analysis of this area is important to help plan for how the area grows and flows. The analysis segment is divided into four roadway sections representing homogenous alignments, as shown in Table 1.

Table 1: Roadway Sections

Section Number	Description	Begin MP	End MP	Section Length (ml)
1	Bend CL - Cooley Rd	133.56	134.11	0.55
2	Cooley Rd - Robal Rd	134.11	134.67	0.56
3	Robal Rd - Nels Anderson Pl	134.67	134.75	0.08
4	Nels Anderson Pl - JCT	134.75	134.96	0.21

Three scenarios were analyzed for this project:

- No-Build: Intersection
- Build: Interchange
- Build: Bypass

The *No-Build: Intersection* scenario is the base case and reflects the existing system layout. The existing US 97 alignment includes signalized intersections at Cooley Road and Robal Road and a number of non-signalized intersections and accesses onto US 97. The analysis used the 2006 Congestion Management System (CMS) dataset, developed for HERS-ST. The input data was checked using ODOT's video log and on-line mapping images to ensure the data correctly reflects the existing condition. US 97 project staff provided the current and future average annual daily traffic (AADT) and associated Direction Factors. Other HPMS data elements updated for this analysis include: K-Factor = 9 percent, Capacity = 1600 passenger cars per hour per lane (pcphpl), Base Year = 2007, and Future Year = 2032.

For the *Build: Interchange* scenario, a second dataset was developed to reflect an interchange condition at Cooley Road. As part of this condition, access management control measures assumed the closure all additional accesses onto US 97, including the signalized intersection at Robal Road. The Access Control data field was set to "full" for this scenario. This scenario used all data inputs defined for the *No-Build: Intersection* scenario, with the exception of the segment capacity that was increased to 2200 pcphpl. The *Build: Interchange* scenario assumed that a controlled interchange replaced the US 97/Cooley Road intersection prior to beginning the analysis.

The *Build: Bypass* scenario is based on the "Alternative East A" traffic analysis data provided by the Transportation Planning Analysis Unit (TPAU). For this scenario, a single HPMS record was developed to represent a bypass alignment and was added to the initial dataset defined for the *No-Build: Intersection* scenario. The HPMS dataset represents two parallel alignments, one with signals (existing) and one with a full access control. The *Build: Bypass* alignment was coded as an urbanized expressway with full access control, and the network number of lanes, speed and capacity was coded at two lanes per direction, 55 miles per hour (mph) and 2200 pcphpl, respectively. Due to the parallel roadway alignments, the total roadway length for this scenario is double that of the first two scenarios.

The *Build: Bypass* alignment pulls a large number of trips off the existing alignment simply because these trips do not stop within the project area. These are considered "pass through"

trips because they are using the facility to travel from one end of the project area to the other with minimal interruptions.

All three scenarios were run independently and each scenario was treated as if it actually exists on the ground. The *No-Build: Intersection* scenario data is the base case and the two build scenarios are compared against this scenario. The purpose of the analysis was to evaluate the relative differences in key performance measures between scenarios. HERS-ST was not allowed to simulate additional improvements. For BCR, the user, agency and external costs were collected and compared through a post-process analysis outside of HERS-ST. The post-process is discussed in another section.

Analysis Process

All three scenarios used the Federal Highway Administration (FHWA) HERS-ST (version 4.3) modeling software. The primary reason for using HERS-ST was to develop Total User Costs for each scenario for the purpose of comparisons between scenarios.

The HERS-ST model was not allowed to identify deficiencies and simulate improvements on the roadway system. The global widening feasibility flag was set to "one" so that no widening would be allowed on any roadway segment, and the pavement deterioration rate was reduced in order to restrict pavement deterioration from triggering preservation-type improvements throughout the 20-year analysis period.

To simplify the analysis, each scenario dataset was run independently. The analysis assumed that the scenario already exists. The post-processing compared performance and cost measures for the two build scenarios against the no-build scenario to evaluate the potential benefits associated with each scenario. Keeping the timeframe identical for all three scenarios reduced the need to discount the improvement benefits back to different implantation time periods, and facilitated the post-process analysis of the results.

Basic Analysis Results

Table 2 shows key performance measures. These are future performance measure forecasts depicting system condition at the end of the 20-year analysis period, and represent a reasonable expectation of the long-range impacts for each scenario. The purpose of this analysis is to compare relative change between performance measures.

Table 2: Scenario Performance Measure Overview

Scenarios	VCR	VMT (million)	Avg. Speed (mph)	Delay (hr/1000 VMT)
No Build: Intersection	*0.75*	*24.4*	*36.0*	*35.1*
Build: Interchange	0.54	24.2	54.0	0.5
Build: Bypass	0.36	26.3	53.1	7.2

*Measured at the end of the 20-year analysis period.

Replacing the *No-Build: Intersection* with the *Build: Interchange* scenario reduces the 20-year volume-to-capacity ratio (VCR) by about 25 percent, due to the additional access control features. The VCR for the *Build: Bypass* scenario is half the *No-Build: Intersection* scenario.

Intersection VCR is a key measure for traffic analysis; however, HERS-ST does not perform intersection analysis. Although the 20-year VCR for the *No-Build: Intersection* scenario seems lower than expected, the VCR reflects the average value for the total segment alignment, averaging the intersection congestion across the entire length of the analysis area. Congestion issues discussed here represent system-wide congestion, whereas a more detailed analysis is required to evaluate the interchange and intersection congestion.

A comparison between the *Build: Bypass* scenario and the *No-build: Intersection* scenarios indicates a substantial improvement in all three performance measures. The 20-year system VCR is uncongested and the speed and delay demonstrates substantial improvements.

As expected, the average speed increases for either of the build scenarios, by about 35 percent. Both build scenarios significantly reduce the total hours of delay as compared with the no-build.

Table 3 shows the breakdown for the Total User Cost. The *No-Build: Intersection* scenario is the base case condition representing the alignment as it currently exists on the ground, and reflects a "do nothing" action. The Total User Cost is a sum of three subcategories: Travel Time Costs, Operating Costs, and Crash Costs.

Table 3: Summary of Total User Costs*
($ per 1,000 VMT)

Scenarios			Description
Intersection	Interchange	Bypass	
$9,382	$6,230	$6,298	Travel Time Costs
$4,418	$4,382	$4,578	Operating Costs
$3,960	$962	$1,732	Cost of Crashes
$17,760	**$11,574**	**$12,608**	**Total User Costs**
---	**$6,186**	**$5,152**	**Total User Benefit**

*Total average 20-year cost

The 20-year Total User Benefits for the *Build: Interchange* scenario is $6,186 per 1,000 VMT, which is approximately 20 percent greater than the $5,152 per 1,000 VMT benefit for the *Build: Bypass* scenario.

In all cases, the Travel Time Costs account for 50-55 percent of the Total User Cost. The Travel Time Costs reduce by about a third for the two build scenarios as compared with the no-build. This validates observations from Table 2, where the speed and delay values are significantly improved. This suggests that access control-type measures would be useful for this corridor.

The Operating Costs comprise about one third of the Total User Costs for the two build scenarios. There is a five percent difference in costs between the *No-Build: Interchange* scenario and the *Build: Interchange* scenario, which indicates that the Operating Costs are less likely to have an impact on the overall analysis, as compared with the other two costs. The Operating Cost is a function of the numerous variables that can be adjusted by the analyst and includes the cost to the user of fuel and oil consumption, tire wear, and vehicle maintenance, repair and depreciation. The benefit associated with an increase in the speed is likely to be balanced with a disbenefit from an increase in vehicle operating costs. In this analysis, the associated travel time cost savings to the system is considerably greater than the associated operating cost saving for the same roadway segment. Table 2 showed that the total delay in the study area reduces by 85-90 percent for the build conditions, and this is reflected in the Travel Time Costs as a benefit with reduction in costs.

The Operating Costs for the *Build: Bypass* scenario are higher than for the *No-Build: Interchange* scenario, even though the Travel Time Costs are lower. This is probably because the *Build: Bypass* scenario includes a doubling in the centerline mileage as compared with the other two scenarios.

The Crash Costs for the *Build: Bypass* scenario is about half and the *Build: Interchange* scenario is about a quarter of the cost of the *No-Build: Intersection* scenario. The Crash Costs are from the crash analysis within the HERS-ST model, which is based on national crash rates.

Crash costs and rates are a function of safety issues on the roadway system. By removing contact points, both crash rates and costs are reduced. This analysis identifies substantial savings for both measures. Table 4 presents a summary of the crash rates.

Table 4: Summary of Crash Rates
(Number of Crashes per 100 Million VMT)

Scenarios			Description
Intersection	Interchange	Bypass	
3132	830	1794	Rate of which crashes occur
1288	341	738	Rate of which injuries occur
9	2	5	Rate of which fatalities occur

The trend in the crash costs in Table 3 is also evident in Table 4. For all categories the crash rates for the *Build: Interchange* scenario are about a quarter of the no-build condition. The *Build: Bypass* scenario is about half the no-build condition and would be lower, except the alignment mileage is doubled for this scenario. The analyst can adjust the crash variables within HERS-ST, but these factors were not calibrated to reflect Oregon values.

The Total Costs shown in Table 5 reduces by 45 percent for the *Build: Interchange* scenario, and by 30 percent for the *Build: Bypass scenario,* as compared with the *No-Build:*

Intersection scenario. The Total Benefits for the *Build: Interchange* scenario is approximately 20 percent greater than the benefit for the *Build: Bypass* scenario.

Agency Costs are more closely associated with the reduction in the cost of routine maintenance resulting from resurface or reconstruction of pavement. This includes a reduction in the future cost of the next improvement resulting from the improved condition of the section when that improvement is implemented; the latter part is only applicable to additional improvements in subsequent funding periods but within the same analysis period.

The Agency Costs shown in Table 5 do not vary much for the *No-Build: Intersection* and the *Build: Interchange* scenarios. However, there is a 25 percent increase in cost for the *Build: Bypass* scenario, which is most likely due to the doubling of centerline miles.

Table 5: Summary of All Costs*
($ per 1000 VMT)

Scenarios			Description
Intersection	Interchange	Bypass	
$17,760	$11,574	$12,608	Total Cost to User
$140	$140	$178	Agency Cost**
$138	$146	$156	External Cost
$18,037	**$11,860**	**$12,942**	**Total Costs**
---	**$6,178**	**$5,095**	**Total Benefit**

*Total average 20-year cost
**Maintenance cost converted from "$ per mile" to "$ per 1,000 VMT"

Annual maintenance costs are calculated as a cost per mile. For the purpose of comparative analysis, the values were converted to $ per 1,000 VMT to be consistent with all other costs.

The External Costs are a reflection of pollution damages associated with vehicle emissions. HERS-ST employs a set of tables to specify the average cost of air pollutant emissions on each functional class generated per vehicle-mile, by vehicle class, and operating at various speeds. HERS-ST uses the projected mix of vehicle classes and the average speed of travel on each section to determine the average cost of emissions per vehicle-mile, and multiplies this value by the total vehicle-mile forecasts to calculate the total cost of air pollutant emissions generated by travel on the section. The maximum difference between all scenarios is 10 percent (see Table 5).

The final factor in the BCR equation is the residual value, which addresses the capital value of the project that remains at the end of the analysis period and covers continued future value of improvement beyond the analysis period. This is an important asset management measure described as the salvage value of an improvement discounted back to the beginning of the analysis timeframe (similar to getting credit for the unused portion of an investment).

For the purpose of this analysis, the residual value is a function of the Capital Improvement Cost. This includes the purchase price for procuring right-of-way (ROW) for the build

scenario; construction costs that go beyond the standard preservation pavement work (connectors, new bypass alignment, etc.); pavement construction and overlay costs; structural construction (overpasses and ramps); and general additional construction costs, such as operation and mobilization.

The pavement element is not included in the residual value discussion because the roadway will require similar on-going maintenance regardless of the scenario. In the same manner, most of the other construction costs are not included here.

The Capital Improvement Costs for ROW should vary significantly between the two build scenarios. The *Build: Interchange* scenario includes ROW for ramps and access management features, such as closure of access points and intersections on US 97 and realignment of access through frontage roads; pavement overlay costs; and structure and ramp construction costs. The *Build: Bypass* scenario includes ROW and construction costs for new alignment, including connectors at both ends, and structural overpasses/underpasses. Since this information is not available, they are both assumed to be 10 percent of the total Capital Improvement Costs for the purpose of this analysis.

Likewise, the construction costs for structures will vary significantly between the two build scenarios. For simplicity, this analysis assumes that 25 percent of the total Capital Improvement Costs is for structural costs. Calculations based on this assumption can be changed when better data becomes available.

Economists within the ODOT Planning Section suggested that 100 percent of the ROW purchase price and 70 percent of the structural costs (including alignment improvements and connectors) can be included in the residual value. The costs of the scenario improvements is unknown for this higher-level planning analysis, so BCR was calculated with generic capital costs of $50 million (Table 6) and $100 million (Table 7) to provide a relative level of BCR. The benefit-cost ratio is the benefit of an improvement (defined as a reduction in total costs) plus residual value, divided by the cost of an improvement.

Table 6: Summary of BCR Assuming $50M Improvement Costs
Total 20-year Benefit

Scenarios		Description
Interchange	Bypass	
$149,578,657	$133,893,192	Total Benefit
$18,750,000	$18,750,000	RV for $50m
$50,000,000	$50,000,000	Capital Improvement Costs
3.37	3.05	BCR for $50M

Table 7: Summary of BCR Assuming $100M Improvement Costs
Total 20-year Benefit

Scenarios		Description
Interchange	Bypass	
$149,578,657	$133,893,192	Total Benefit
$37,500,000	$37,500,000	RV for $100m
$100,000,000	$100,000,000	Capital Improvement Costs
1.87	1.71	BCR for $100M

With either a $50 million or $100 million Capital Improvement Cost and based on the reduction in costs, the net benefit for the *Build: Interchange* scenario is approximately 10 percent greater then the same benefit for the *Build: Bypass* scenario. The resulting BCR for both improvement scenarios are well over one, meaning that both improvement scenarios are acceptable. The calculated BCR for the *Build: Interchange* scenario is approximately 10 percent better than the *Build: Bypass* scenario and would be favored, all other things being equal.

This report does not consider whether $50 million is sufficient to build a Bypass alignment. The focus of the analysis is to evaluate the potential BCR for the scenarios and the BCR for the $100 million analysis is about half the BCR for $50 million. This implies that the system Benefits trend does not change as quickly as the construction costs. At some point, probably about $160-$180 million, the system Benefits will no longer justify the construction costs.

Additional Analysis Results

Several performance measures were also evaluated at the individual section level for the same future analysis year, holding all other things equal.

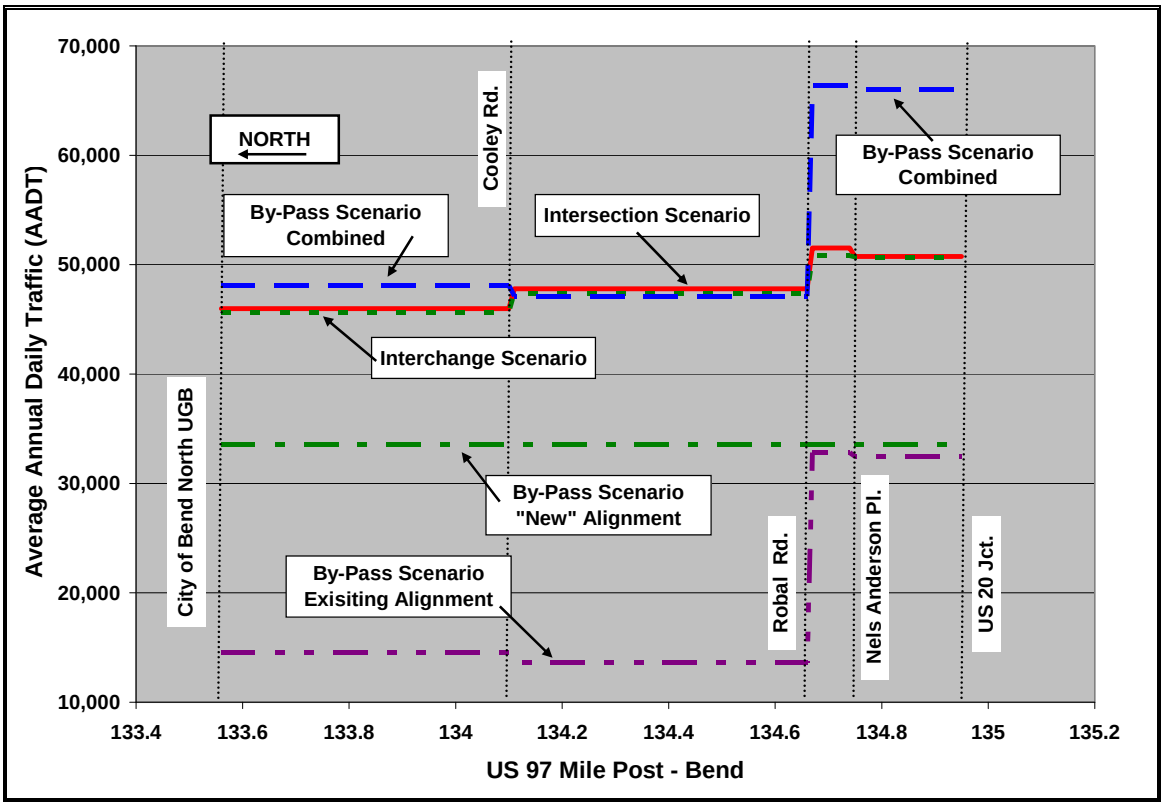
Average Annual Daily Traffic

TPAU provided the AADT values for each scenario. Figure 1 graphs the traffic volume on the four roadway segments. There are two alignments in the *Build: Bypass* scenario, each with a separate set of AADT flow, and they are shown individually and combined.

The AADT flow across the study area is similar for the *No-Build: Intersection* and the *Build: Interchange* scenarios, with about a one percent difference. The AADT for all three scenarios, including the combined *Build: Bypass* scenario volumes, are within five percent of each other for the most northern segment between the UGB and Cooley Road, and within one percent for the second northern segment between Cooley Road and Robal Road.

The combined AADT for the *Build: Bypass* scenario is 30 percent higher for the two segments south of Robal Road. The increase in the traffic volume flow for the two southern segments is attributed to the trips on the existing intersection alignment, as defined for this scenario. The larger number of trips on these segments suggests that they are trips entering and leaving the study area from south US 97 and accessing the retail area off Robal Road.

Figure 1: Average Annual Daily Traffic from Sectional Analysis*



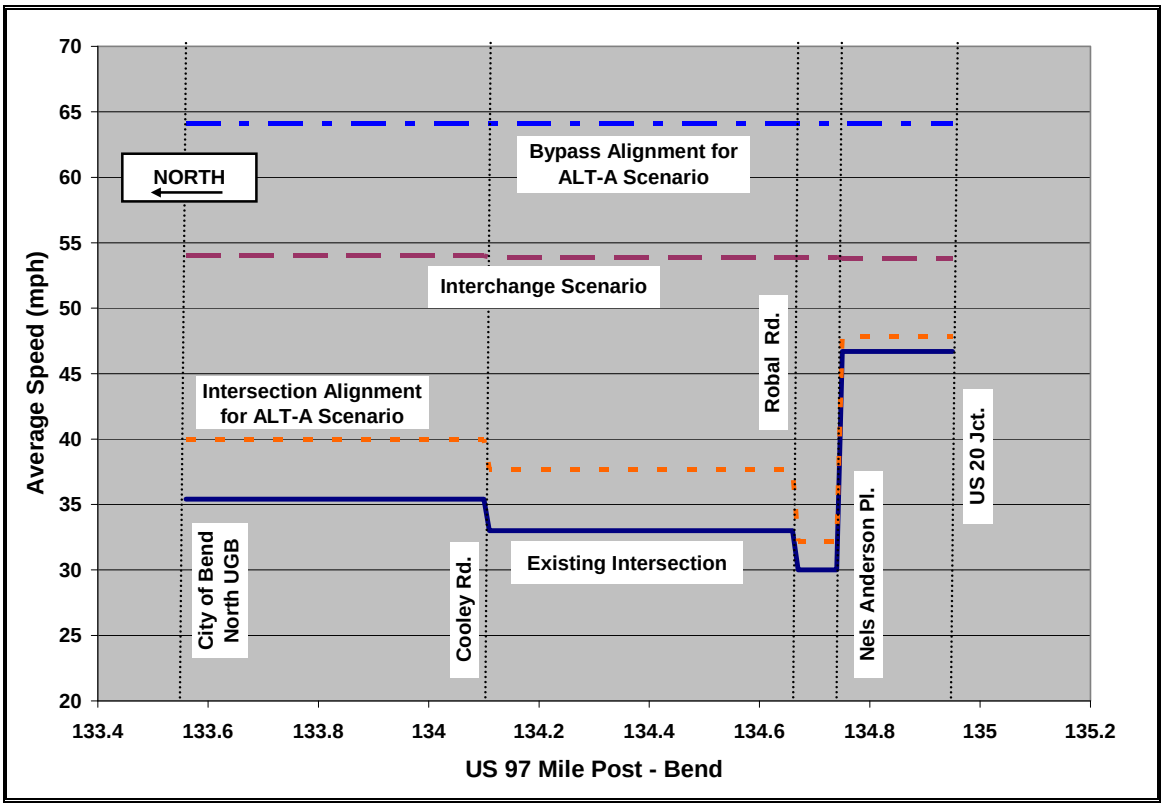
*Measured at the end of the 20-year analysis period.

VMT is a calculated value that uses AADT and section length. For each of the three scenarios, the VMT is lowest on the segment between Robal Road to Nels Anderson Place. This is directly due to the short length of the segment, as shown in many of the performance measure figures shown below.

Average Speed

Figure 2 shows the future year average model speed along each roadway segment for the three scenarios. Using the *No-Build: Interchange* scenario as an example (moving left to right), the average travel speed for trips along the first segment of US 97 is about 35 mph, traveling north to south between the City of Bend's North UGB and Cooley Road. The speed drops to about 33 mph for the second segment between Cooley Road and Robal Road, and then drops to 30 mph between Robal Road and Nels Anderson Place. Although the speed difference between these three sections is small and probably unperceivable to the traveling public, it reflects a 15 percent difference in average speed between the first and third segments. The average speed for the existing condition improves to about 47 mph between Nels Anderson Place and the US 20 Junction.

Figure 2: Average Speed from Sectional Analysis*
(mph)



*Measured at the end of the 20-year analysis period.

The existing intersection condition is the "do nothing" or "base case" scenario, and reflects the existing conditions. Replacing the *No-Build: Interchange* with the *Build: Interchange* scenario, which includes closure of all accesses along the analysis alignment, produces a steady average speed of 54 mph. Depending on the individual sections, the interchange alignment shows an average speed increase of between 14-74 percent.

The *Build: Bypass* scenario has two average speed flow curves that reflect the dual alignments within the scenario - the old alignment that includes the existing intersections, and the new bypass alignment that has no intermediate access. The addition of an access controlled bypass alignment in this scenario causes a large number of trips to shift onto the bypass alignment, resulting in a slight increase in the average speed on the existing intersection alignment as compared with the base case condition.

As previously stated, the "shifted" trips are considered "pass through" trips because these trips begin outside one end of the analysis segment and terminate outside the other end while never stopping within the study area. All "pass through" trips shift to the new alignment so that the only trips traveling on the existing alignment are those accessing points within the analysis area.

As expected, the average speeds on the existing alignment increase in direct proportion to the amount of traffic that moves to the bypass alignment. Congestion, Delay and Total User Cost along the old alignment are reduced in the same manner.

Note that the average speed on the "new" bypass alignment is 64 mph. The Speed Model within HERS-ST assumes that the beginning free-flow speed for a segment is 9 mph above the posted speed. The speed adjusts downward from there, according to the effects and influences of various elements, such as increased traffic volumes, start/stop cycles, and geometric alignments. For the bypass alignment, other elements do not appear to influence the free-flow speed, so the free flow speed is higher than the posted speed.

The free flow speed for the *Build: Interchange* scenario is 54 mph, whereas the posted speed is 45 mph. This implies that there are no other elements on the roadway system that influence the Speed Model analysis for these segments. Table 8 shows a summary of the average speeds for the sections.

Table 8: Summary of Average Speed*
(mph)

Section Number	Description	Begin MP	End MP	Section Length (ml)	Scenarios			
					Intersection	Interchange	Bypass	
							Existing	Bypass
1	Bend CL - Cooley Rd	133.56	134.11	0.55	35	54	40	64
2	Cooley Rd - Robal Rd	134.11	134.67	0.56	33	54	38	64
3	Robal Rd - Nels Anderson Pl	134.67	134.75	0.08	30	54	32	64
4	Nels Anderson Pl - JCT	134.75	134.96	0.21	47	54	48	64

*Measured at the end of the 20-year analysis period.

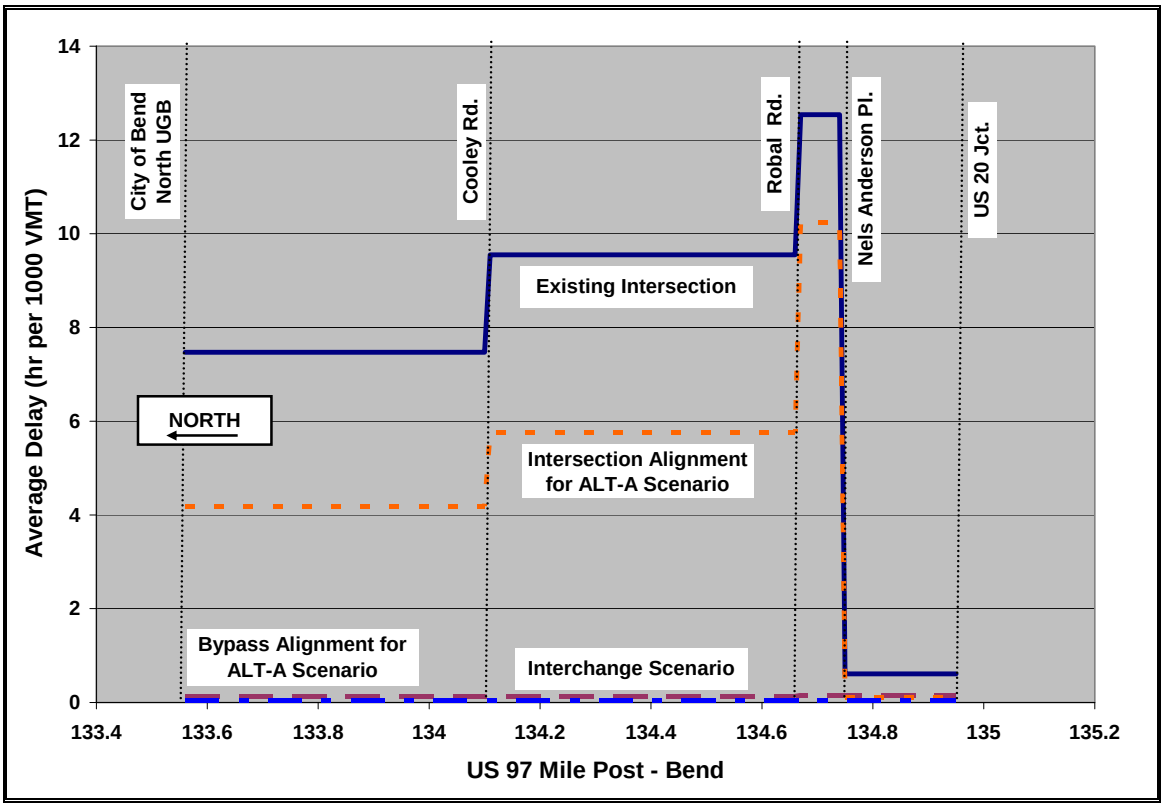
This analysis suggests a relative change in speed, not an absolute value. The average speed analysis suggests that the removal of the existing access control along the approximate 1½-mile segment will have significant positive improvements to the overall traffic flow.

Average Delay

The average delay for the future analysis period appears to be horizontally flipped (or mirrored) from the average speed chart. As expected, a decrease in the average speed in Figure 2 is directly associated with an increase in the average delay in Figure 3, and visa versa.

Using the *No-Build: Interchange* scenario as an example, an average vehicle traveling southbound (see Figure 3, moving left to right) on US 97 experiences an average delay increase of about 30 percent in the second section (Cooley Road to Robal Road), as compared with the average delay in the first section (North UGB to Cooley Road). The trip encounters another 30 percent increase in average delay in the third section (Robal Road to Nels Anderson Place) compared with the second section. The average delay quickly improves from Nels Anderson Place to the US 20 Junction.

Figure 3: Average Delay from Sectional Analysis*
(Hour per 1,000 VMT)



*Measured at the end of the 20-year analysis period.

The higher average delay seen between Robal Road and Nels Anderson Place as compared with the other sections suggests some type (or combination) of adverse traffic condition within that segment, such as traffic volumes, turning movements, signals or other.

The analysis reflects the average delay for the segment and assumes default stop/start delay associated with a signalized intersection. Although the HERS-ST calculations assume some signalized delay, the model does not specifically evaluate signal delay and averages the effects of the delay across the entire analysis segment. A formal signal delay analysis requires a more detailed analysis approach.

The two scenario alignments at the bottom of Figure 3 reflect the interchange and bypass alignments. Both alignment curves are difficult to see because of their close relative location with the x-axis, but Table 9 shows the associated data. The bypass alignment delay for the *Build: Bypass* scenario is about three minutes per 1,000 VMT and the *Build Interchange* scenario alignment delay is 6-12 minutes per 1,000 VMT.

Table 9: Summary of Average Delay by Sectional Analysis*
(Hours per 1,000 VMT)

Section Number	Description	Begin MP	End MP	Section Length (ml)	Scenarios				
					Intersection	Interchange	Bypass		
							Existing	Bypass	COMBO
1	Bend CL - Cooley Rd	133.56	134.11	0.55	7.5	0.1	4.2	0.05	4.2
2	Cooley Rd - Robal Rd	134.11	134.67	0.56	9.6	0.1	5.8	0.05	5.8
3	Robal Rd - Nels Anderson Pl	134.67	134.75	0.08	12.5	0.2	10.2	0.05	10.3
4	Nels Anderson Pl - JCT	134.75	134.96	0.21	0.6	0.2	0.1	0.05	0.15

*Measured at the end of the 20-year analysis period.

The *Build: Bypass* scenario has two different delay lines corresponding to the two alignments; an existing alignment and a bypass alignment. The average delay for the bypass alignment is about three minutes per 1,000 VMT, while the average delay for the existing alignment is about five hours per 1,000 VMT. The shape of the average delay line for the intersection alignment is similar to the shape of the *No-Build: Intersection* scenario, with an average improvement of about 2½ hours per 1,000 VMT.

The above discussion is based on delay at the section level. The following discussion is based on delay at the system level.

As seen in Table 10, the total 20-year delay decreases for both build scenarios compared with the no-build. Due to the access control elements, the average delay for the *Build: Interchange* scenario is about nine minutes per 1,000 VMT. The combined average delay for the *Build: Bypass* scenario is about 90 minutes. The improvements in both average delays are significant when compared with the average 7½ hour per 1,000 VMT delay for the *No-Build: Intersection* scenario.

Table 10: Summary of Average Delay by System Analysis
(Hours per 1,000 VMT)

Scenarios			Description
Intersection	Interchange	Bypass	
7.5	0.13	1.5	Average Delay (Hours per 1,000 VMT)
182,149	3,148	38,839	Average Delay (Total Hours)

The system-level summary in Table 11 shows the percentage breakdown of delay by the three delay categories for the three scenarios.

Table 11: Percent Split by Delay Category by System Analysis

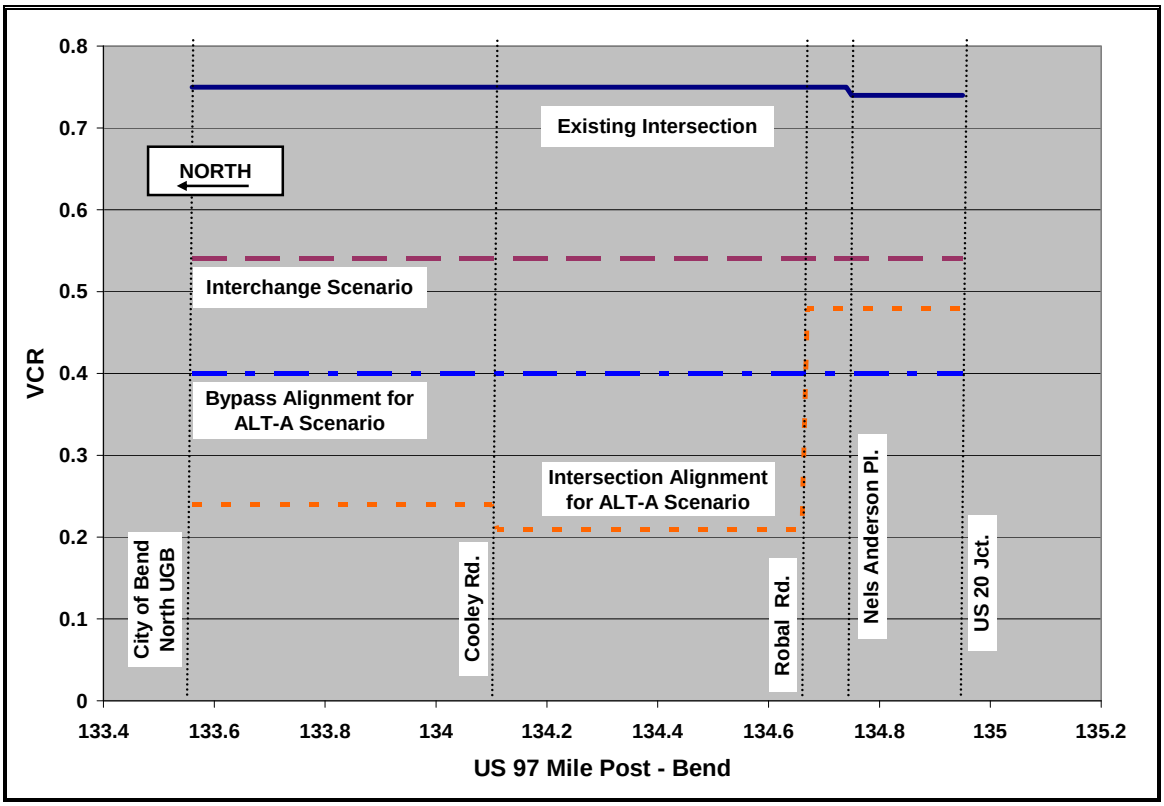
System Delay	Scenarios		
	Intersection	Interchange	Bypass
Zero Volume	43%	0%	68%
Incident	4%	97%	3%
Other	53%	3%	28%

Tables 10 and 11 show that the *Build: Bypass* scenario has an average of 90 minutes (1½ hours) delay per 1,000 VMT for the total scenario (i.e., combination of both alignments), of which approximately 62 minutes or 68 percent is Zero-Volume Delay, approximately three minutes or three percent is Incident Delay, and 25 minutes or 28 percent are Recurring Delay. In a similar manner, the *No-Build: Intersection* scenario has 193.5 minutes (≈ 3¼ hour) of Zero-Volume Delay, 18 minutes of Incident Delay, and 238.5 minutes (4 hours) of Recurring Delay. For the *Build: Interchange* scenario, of the nine minutes of average delay, 8½ minutes are associated with Incident Delay, and the remainder is Recurring Delay.

Volume-to-Capacity Ratio

The VCR remains fairly consistent across the entire study area for each scenario (see Figure 4 and Table 12). The exception is the existing alignment in the *Build: Bypass* scenario. Although the VCR for this alignment is well below a congested level, the VCR for the segments north of Robal Road is half the value of the VCR for the segments located south of Robal Road. This is due to the increased traffic in the southern area that is accessing the "Cooley Triangle" to travel south of the study area; i.e., trips to the retail area from the City of Bend. As expected, the increase in VCR for the existing alignment portion of the *Build: Bypass* scenario ties directly to the increased AADT for these segments on this alignment for this scenario (see Figure 1).

Figure 4: Volume-to-Capacity Ratio from Sectional Analysis*



*Measured at the end of the 20-year analysis period.

Table 12: Summary of Volume-to-Capacity Ratio*

Section Number	Description	Begin MP	End MP	Section Length (ml)	Scenarios			
					Intersection	Interchange	Bypass	
							Existing	Bypass
1	Bend CL - Cooley Rd	133.56	134.11	0.55	0.75	0.54	0.24	0.40
2	Cooley Rd - Robal Rd	134.11	134.67	0.56	0.75	0.54	0.21	0.40
3	Robal Rd - Nels Anderson Pl	134.67	134.75	0.08	0.75	0.54	0.48	0.40
4	Nels Anderson Pl - JCT	134.75	134.96	0.21	0.74	0.54	0.48	0.40

*Measured at the end of the 20-year analysis period.

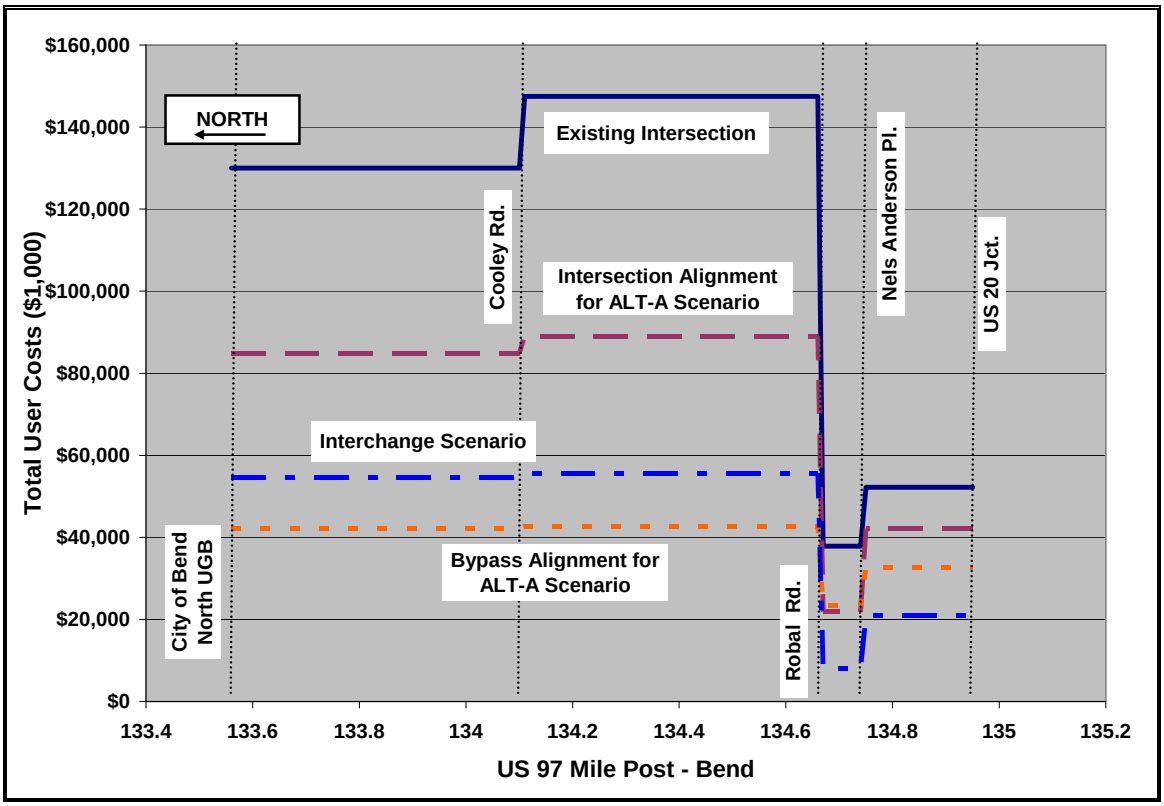
The reduction in VCR associated with the two build scenarios shows that 65-70 percent of trips traveling through the project area are “pass through” trips. Even so, there are still many trips attracted to the project area due to the retail activities. Based on the projected VCR operational performance, the build scenarios show substantial improvement.

Total User Costs

The Total User Costs reflect the travel time, operation and safety costs to the user on the system by scenario. Total User Costs are typically defined as "Dollars per 1,000 VMT", but have been converted to "Dollars" for the discussion in this section. The Total User Costs for the *No-Build: Intersection* scenario is the datum. All costs below the datum are considered benefits, while all costs above the datum are disbenefits.

The 20-year Total User Costs for all build scenarios, as shown in Figure 5, is significantly below the datum, reflecting a substantial benefit for each individual alignment.

Figure 5: 20-Year Total User Costs from Sectional Analysis*
($1,000)



*Total average 20-year cost

The true Total User Costs for the *Build: Bypass* scenario is a summation of the total costs of the individual bypass and the existing alignments for this scenario. To facilitate analysis, the Total User Costs for the bypass alignment are split proportionately and applied to each of the four segment length, as shown in Table 13.

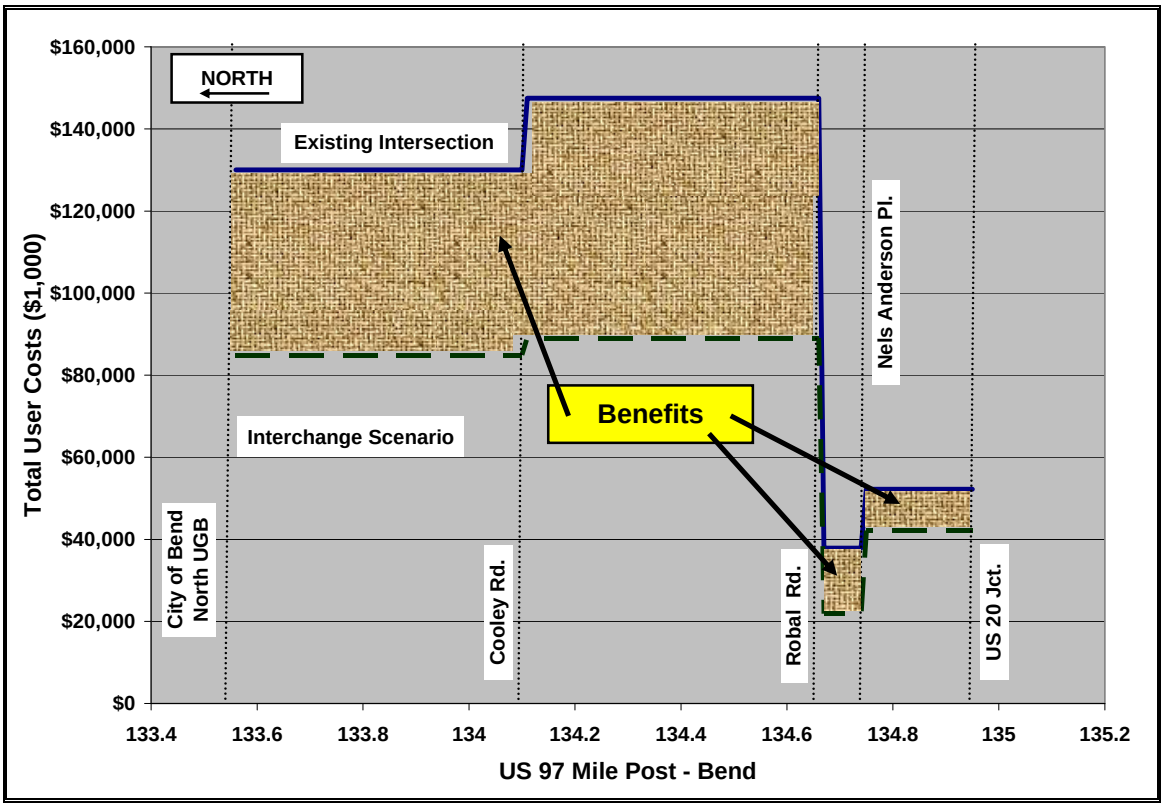
Table 13: Total User Costs*
($1,000)

Section Number	Description	Begin MP	End MP	Section Length (ml)	Scenarios ($1,000)				
					Intersection	Interchange	Bypass		
							Existing	Bypass**	COMBO
1	Bend CL - Cooley Rd	133.56	134.11	0.55	$130,000	$84,894	$42,256	$54,659	$96,915
2	Cooley Rd - Robal Rd	134.11	134.67	0.56	$147,478	$89,045	$42,727	$55,652	$98,379
3	Robal Rd - Nels Anderson Pl	134.67	134.75	0.08	$37,865	$21,859	$23,266	$7,950	$31,216
4	Nels Anderson Pl - JCT	134.75	134.96	0.21	$52,198	$42,141	$32,622	$20,870	$53,491

*Total average 20-year cost
**Total User Costs for Bypass Alignment split into segment lengths for comparison.

Figures 6 and 7 graph the Total User Benefits by section, as the difference between the scenario costs curves. The supporting data is provided in Table 13.

Figure 6: Total User Benefits for Build: Intersection Scenarios*
Benefit is the Area between Scenario Curves

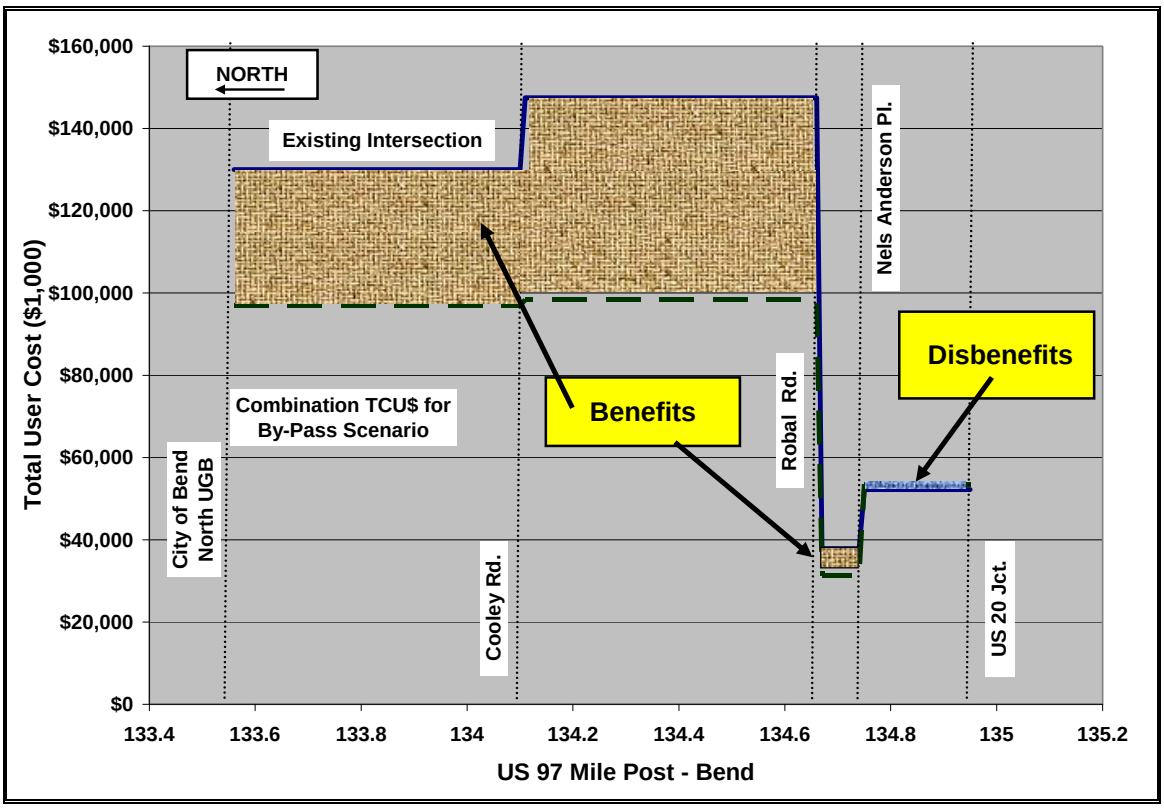


*Total average 20-year cost

Total User Benefits by section is graphed in Figure 6 as a comparison between Total User Costs for the *No-Build: Intersection* scenario (top line) and the *Build: Intersection* scenario (bottom line). The difference between the two costs is the area between the two curves. The comparison between scenarios indicates a substantial benefit for the roadway segments located north of Robal Road, while the Total User Benefits for the southern two segments are significantly lower. The reduction in benefit for the southern segments is due to the higher traffic movement through that area.

In a similar manner, Figure 7 is a comparison between Total User Costs for the *No-Build: Intersection* scenario (top line) and the *Build: Bypass* scenario (bottom line), where the build scenario curve accounts for costs associated with both the bypass and existing alignments combined. As with the Total User Benefits shown in Figure 6, a comparison of costs indicates a substantial benefit for the roadway segments north of Robal Road. There is a small positive benefit in costs between Robal Road and Nels Anderson Place, and a small negative benefit (or disbenefit) between Nels Anderson Place and the southern end of the study area.

Figure 7: Total User Benefits for Build: Bypass Scenarios*
Benefit is the Area between Scenario Curves



*Total average 20-year cost

Conclusion

The average segment speed, delay, and volume-to-capacity ratio (VCR) analyses showed that both "build" scenarios, as compared with the "no build", increased the average speed by about 50 percent, decreased the average delay by over 80 percent (varies by scenario), and improved the VCR by up to 50 percent in the analysis area. Both "build" scenarios showed significant improvements for these performance measures, and the Total User Costs decreases by as much as 45 percent, compared with the "no build" scenario.

Two different assumed construction costs, $50 million and $100 million were used for the BCR analysis since a true construction cost for the "build" options is not available. For both funding levels, the *Build: Interchange* scenario has approximately twice the BCR then the *Build: Bypass* Scenario, all other things remaining equal. The *Build: Interchange* scenario BCR range is 3.4 to 3.1 for an assumed construction cost of $50 million and $100 million, respectively, while the BCR range for the bypass is 1.7 to 1.9, respectively.

The *Build: Bypass* alignment pulls a large number of trips off the existing alignment and out of the existing traffic flow on the US 97 system. This option might have additional operational benefits not discussed that could reduce some of the current problems.

References

U.S. Department of Transportation: Federal Highway Administration. 2005. "Highway Economic Requirements System – State Version: Technical Report," August 2005

U.S. Department of Transportation: Federal Highway Administration. 2006. "Highway Economic Requirements System – State Version: User Guide," May 2006